ARCTIC BAY WASTE WATER FACILITY
ARCTIC BAY, NUNAVUT

OPERATIONS AND MAINTENANCE MANUAL
VOLUMES 1 AND 2

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1 Introduction

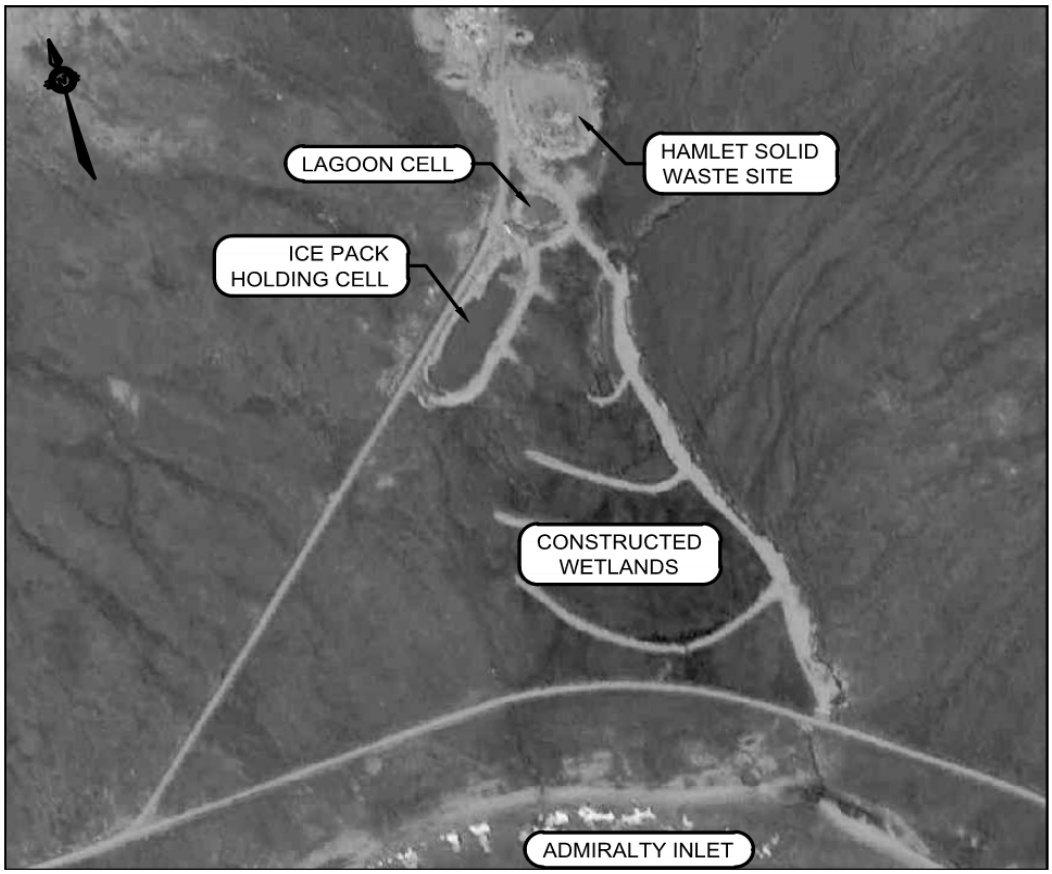
This Manual has been produced to establish standard operation and maintenance protocols for the management and treatment of sewage within the Hamlet of Arctic Bay. Information presented in this manual has been developed based on the document "*Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories, 1996*".

This operation and maintenance (O&M) manual is intended to instruct designated operators of the sewage lagoon facility on the O&M procedures required to comply with conditions set forth by the Nunavut Water Board in water license 3BM-ARC0810 found in Appendix A.

1.1 Preceding Lagoon

The Hamlet's existing wastewater treatment facility is located approximately 2 km to the east of the community. It is comprised of a single cell lagoon, ice pack storage area and wetlands, as shown in Figure 1-1. The sewage treatment system is bordered to the north by the Hamlet's solid waste disposal site and to the south by the Road to the Nanisivik airport. The existing lagoon was constructed in 1976. It is an unlined earth lagoon with a reported capacity of approximately 21,000 m^3 and was designed to hold sewage for 365 days with manual discharge. In 2003 the sewage system was expanded to include an ice pack area and modifications to improve the efficiency of the wetlands. Works were based on a project plan prepared by Dillon Consulting Ltd. and presented in the reported entitled *Arctic Bay – Wetlands Treatment Facility: Proposed Project Plan* dated 2002.

Figure 1-1: Existing Lagoon and Wetlands



In 2002 and 2003 effluent tests carried out by Indian and Northern Affairs cited problems with the effluent quality from the facility. In addition, effluent samples taken in September 2004 did not comply with the requirements under the Hamlet's water license.

1.2 Existing Water Supply

The Hamlet currently obtains its drinking water from a natural lake located approximately 8 km to the east of the community. The water supply facility is located on the north side of the lake with inclined pipes leading out into the lake where water is withdrawn. Chlorination is required for disinfection of the raw water, and treated drinking water is delivered by water truck to homes and facilities.

The existing water supply and its corresponding watershed are not influenced by the location of the sewage lagoon system. The two sites are separated by approximately 6 km with the new lagoon draining directly into Victor Bay on the north side of the peninsula.

1.3 Site Selection

The proposed sewage lagoon was constructed in a small valley overlooking the existing lagoons and Admiralty Inlet to the south and Victor Bay to the north. The vegetated area between the new lagoon and Victor Bay will be incorporated into the sewage treatment process. A new access road was constructed from the existing sewage lagoons to the new lagoon.

The Hamlet of Arctic Bay is required to operate a new sewage lagoon that is structurally sound and has the necessary capacity to accommodate the projected growth of the community over the next 20 years. In addition, it is necessary to decommission the existing sewage lagoons the berms of which are failing.

The project will not have long term negative effects on the environment or wildlife. Most effects are related to construction activities and are short term and all effects can be mitigated by applying suitable mitigation measures.

The existing site complies with the separation requirements of the Public Health Act (450m buffer), Transport Canada (3000m airport buffer), and the community water supply (400m buffer). The road servicing the old lagoon site is cleared and maintained year round to access the community solid waste site and metal dump. Additional maintenance will be required for the access road beyond the old facility. Figure 1-2 shows the location of the lagoon site with respect to the Hamlet centre, water supply lake, and the airport

Figure 1-2: Location Plan and Setbacks

1.4 Sewage Treatment

The proposed sewage treatment facility must meet the long term needs of the Hamlet, as well as the regulatory requirements of the Hamlet's water license. The Water and Sewage Facility Capital Program Standards and Criteria indicate the design horizon for sewage lagoons is to be between 15 – 20 years. As per the direction of the Community and Government Service, Government of Nunavut, the design horizon for this facility shall be the year 2028.

The wastewater treatment system utilizes the single cell sewage lagoon as the main method of treatment, with the filter strip wetlands providing additional treatment prior to the release to the environment.

As monitoring the performance of natural wetlands is difficult, the Hamlet of Arctic Bay's water license has set the compliance point for the wastewater treatment system at the discharge of the lagoon. This point represents the last point of measurement and control for the system. The water license further recognizes the treatment potential of the natural wetland and has set the compliance criteria recognizing the treatment the effluent will receive through the wetland.

1.5 Population Projections

The population projections for this project will be based on "Nunavut: Community Population Projections" as published by the Nunavut Bureau of Statistics. The Nunavut Bureau of Statistics population projections provide projected populations of the Nunavut communities to the year 2020. As a planning horizon for this project is past the current population projections available from the Nunavut Bureau of Statistics, the population projection from 2020 to 2029 are estimated using the average annual growth rate for the Hamlet between the year 2000 and 2020 of 2.04%. The table below summarizes the population projections to the year 2029.

Table 1-3: Population Projections

Planning Year	Year	Population	Planning Year	Year	Population
	2000	730	6	2015	1019
	2001	747	7	2016	1033
	2002	763	8	2017	1049
	2003	782	9	2018	1065
	2004	801	**10**	**2019**	**1078**
	2005	819	11	2020	1094
	2006	837	12	2021	1116
	2007	855	13	2022	1139
	2008	876	14	2023	1162
0	**2009**	**894**	**15**	**2024**	**1186**
1	2010	916	16	2025	1210
2	2011	939	17	2026	1235
3	2012	960	18	2027	1260
4	2013	980	19	2028	1286
5	**2014**	**1003**	**20**	**2029**	**1312**

The design population for the end of the design horizon, 2029, is projected to be 1312 persons.

1.6 Sewage Generation

Sewage generation rates are generally assumed to be equal to the water consumption rates for a community, with the water consumption rate being the total of the residential and non-residential water consumption. The Water and Sewage Facility Capital Program Standards and Criteria provide the following design values and formulae for estimating the water consumption and therefore the sewage generation rates for communities.

The residential water usage (RWU) for a community is based on the method of water delivery and sewage collection in the community. The litres per capita per day (lpcd) water usage rates for the different methods of water delivery and sewage collection are summarized in the Table 1-4.

Table 1-4: Residential Water Usage

Service Method	Residential Water Usage (RWU)
Trucked water and sewage	90 lpcd
Piped water and sewage	225 lpcd
Piped water supply and truck sewage pump out	110 lpcd
Trucked water delivery and individual septic fields	100 lpcd

The Hamlet of Arctic Bay has a trucked water and sewage system, therefore the RWU for the community is equal to 90 lpcd.

Non-residential water usage by a community tends to increase with increases in the population. To determine the Total Community Water Usage (TCWU), the Residential Water Usage is adjusted based on population to provide a Total Water Usage Per Capita. The daily water consumption by the community is equal to the population multiplied by the Total Water Usage Per Capita. The Total Water Usage Per Capita, including residential and non residential activities are estimated based on the equations in Table 1-5 Total Community Water Usage.

Table 1-5: Total Community Water Usage

Community Population	Total Water Use Per Capita
0 – 2000	RWU x (1.0 + 0.00023 x Population)
2000 – 10,000	RWU x [-1.0 + {0.323 x Ln(Population)}]
Over 10,000	RWU x 2.0

The daily water consumption, and therefore the sewage generated by the community, is equal to the population multiplied by the Total Water Usage Per Capita. Based on the design population of 1312 for the year 2029, and a total water usage per capita rate of 117 lpcd, the daily sewage generation rate is equal to 154,000 lpd. This is equal to a yearly sewage generation rate of 56,029 $m^{3.}$

1.7 Influent Characteristics

The characteristics of sewage generated in a community are heavily dependent upon the type of installation and sanitary facilities. The Hamlet of Arctic Bay water and sewage systems utilize holding tanks and truck delivery and collection systems. The waste generated from this arrangement is considered to be “Moderately Diluted Wastewater”, as per the Cold Climate Utility Manual. Table 1-6 - Characteristics of Basic Wastewater Categories is an excerpt from the Cold Climate Utilities Manual, summarizing the characteristics of moderately diluted wastewater.

Table 1-6: Wastewater Characteristics

Parameter	Units	Moderately Diluted
BOD_5	mg/L	460
COD	mg/L	1000
Suspended Solids	mg/L	490
Total Nitrogen	mg/l as N	--
Phosphorus	mg/L as P	--

‘Canadian Society for Civil Engineering, 1986, *Cold Climate Utilities Manual’*

1.8 Seasonal Climatic Conditions

The average annual rainfall in Arctic Bay, as recorded at the Nanisivik Airport, is 6.1 cm and the average annual snowfall is 173 cm (Environment Canada). Temperatures in the summer range between 0 and 7^{o}C and in winter between -25.0^{o}C and -33^{o}C. Permafrost is present in the soil; it recedes to approximately 1m below the surface in the summer time. Table 3.6 summarizes the Seasonal Climatic Conditions. The data presented is extracted from the climatic normal's from the National Climate Data and Information Archive posted by Environment Canada.

Table 1-7: Monthly Precipitation

Month	Precipitation Rate	Average Daily Maximum Temperature	Average Daily Minimum Temperature
January	7.6 mm	-26.1 °C	-32.1°C
February	3.9 mm	-27.5 °C	-33.1°C
March	6.6 mm	-24.8 °C	-30.8°C
April	9.8 mm	-16.6°C	-23.4°C
May	17.2 mm	-7.8°C	-13.5°C
June	23.5 mm	1.9°C	-2.8°C
July	35.3 mm	7.4°C	2.5°C
August	40.9 mm	3.7°C	-0.8°C
September	43.5 mm	-3.7°C	-7.4°C
October	30.9 mm	-12.5°C	-17.2°C
November	16.0 mm	-19.9 °C	-25.4°C
December	7.3 mm	-23.7 °C	-29.4°C

1.9 Contact List

Title	Phone Number
Senior Administrative Officer (SAO)	867-439-9917
Baffin Regional Director (Timoon Toonoo)	867-897-3601
Municipal Planning Engineer (Bhabesh Roy)	867-899-7314
Spill Contact: Territorial 24-hour Spill Line	867-920-8130
Aboriginal Affairs and Northern Development Canada – Manager of Field Operations	867-975-4295
GN-Emergency Measures Officer	888-624-4043
Arctic Bay Health Centre	867-439-8816
RCMP (Arctic Bay)	867-439-0123
Environment Canada (Emergency) Iqaluit	867-975-4644
GN Environment Health Office	867-975-4817
First Air Cargo	1-800-267-1247

2 Sewage Disposal System

2.1 Operational Plan

The sewage lagoon system for Arctic Bay is a storage lagoon providing the capacity to store the municipal sewage generated over a one year period.

2.2 Site Personnel

The responsibility of the Hamlets lagoon operations are overseen by the Senior Administrative Officer (SAO). The SAO is responsible for the foreman who conducts the day to day operation and maintenance of the sewage system together with one or two Hamlet employed labors to operate the sewage collection vehicles and help maintain the system.

2.3 Operational Procedures

The following details the proposed operations of the sewage treatment system for the Hamlet.

2.3.1 Operation and Maintenance Duties

Daily

- Collection of municipal wastewater from holding tanks and delivery to the sewage lagoon system.
- Minimize spills, and immediately clean up when they occur.
- Repairs to equipment when breakdowns occur.
- Maintain road, discharge point, and truck turning pads free of snow.
- Record Operation and Maintenance information as required.

Weekly

- Remove non-sewage materials from the lagoon. Floating materials such as plastic bags should be removed and solid waste items disposed at the solid waste site adjacent to the lagoon.
- Assess truck discharge location and containment berms for erosion.
- Record Operation and Maintenance information as required.

Monthly

- Preventative measures and maintenance on sewage trucks.
- Assess inventory of parts for truck maintenance.
- Grade and maintain the access road as required.
- Conduct monitoring program as required.
- Record Operation and Maintenance information as required.

Yearly

- Carry out decanting process during the designated timeframe.
- Conduct annual monitoring program.
- Decanting pump maintenance.
- Review the operation and maintenance records to evaluate the effectiveness of the sewage treatment system and plan for the upcoming year.

2.3.2 Collecting Operations

Wastewater is collected from the holding tanks of each residential and municipal serviced structure within the Hamlet. Suction trucks pump the wastewater out of the holding tanks through an outside service pipe accessible to the truck. The quick-connect fitting, on the service pipe and truck intake hosepipe, gives the operator a fast and reliable connection reducing spills and speeding up the operation.

The service truck will follow a predetermined set circuit throughout the Hamlet collecting the wastewater until the holding tank is full. Once full, the truck will travel out to the lagoon site, discharge the contents and then return to the collection circuit. Some structures will have to be serviced more than once per circuit, e.g. the Hamlet office, hotel, and other high wastewater producing structures may require a higher frequency. These high producers will have to be scheduled on a more regular basis.

Each time the wastewater is trucked and discharged into the lagoon; the sewage truck backs up to a chute on the gravel pad at the lagoon, and the valve is opened. Wastewater is discharged through the chute into the lagoon.

2.3.3 Detention Operations

September 15 – August 15

Over the period of eleven months, sewage trucks continually discharge to the lagoon. Discharging operations take place at the designated site on the south berm where the steel chutes are located. The sewage trucks will back up to the chute so that when releasing the contents, the chute directs the effluent to the lagoon. Two chutes are available to the operator. The choice of chute is dependent upon the preference of the operator during the discharge stage. Wind direction, snow buildup, or other factors might lead the operator to choose one chute over the other.

During this period the lagoon acts as a long term detention system containing the liquid and frozen untreated effluent until treatment can have effect.

2.3.4 Decanting Operations

August 15 – September 15

Mid-August the filter strip wetlands are now ice-free and considered active. The lagoon is decanted during this stage to provide a continuous release of effluent over the filter strip during the optimal period for treatment. Sewage trucks will continue discharging to the lagoon throughout the decanting process.

Decanting will be completed using a pump. The pump will be removed from the Hamlet storage garage and delivered to the north berm decanting area prior to the operation as seen in drawing TD1.

The pump suction shall be connected to the lagoon side (intake) infrastructure. The hose gaskets and joints completing the connection from the pump to the intake piping shall be checked for leaks and should be airtight. Be sure that proper suction hoses for this connection are used and can withstand the vacuum of the pump.

The pump discharge shall be connected to the distributing infrastructure (outlet) found on the north side of the berm exiting the lagoon site. The outlet infrastructure is complete with a distribution trough along the toe of the berm and used to disperse the pumped effluent across the head of the filterstrip wetland.

Upon completion of the decanting program, the pump will be disconnected from the fixed structures and returned to the Hamlet garage for over winter storage, along with the connection hoses. Prior to use, and after completing the decanting process, the pump should be inspected and regular start up and storage procedures should be followed. The operation and maintenance manual for the pump can be found in Appendix B.

The natural filterstrip wetlands will provide the post-lagoon final treatment prior to the release into Victor Bay. For public safety, the lagoon operator should publicly inform the Hamlet about the start time, date and estimated duration of the discharge before discharge is started.

2.4 Record Keeping and Recording

Records should be kept to assist in planning for yearly operations and to assist in the evaluation of the effectiveness of the sewage treatment facility. Copies of records pertaining to operation and maintenance of the sewage lagoon should be kept at both the Hamlet Office and the Maintenance Garage and be maintained by the Hamlet Foreman. Information that must be included in these records is listed below:

- Approximate volume of any effluent discharged to the environment.
- Approximate cell level before and after discharge (measured from the top of berm).
- Time required discharging each lagoon cell.
- Details of any maintenance undertaken at site.
- Volume records of delivered potable water from pump/filtration plant.
- Dates of collecting and submitting samples to laboratory.
- Record sheets.
- Copy of the Hamlet's water license.
- Copies of all manuals pertaining to the operation and maintenance of the Sewage Lagoon Facility.

Wastewater volumes will be approximated by the monthly municipal water volumes. Sewage trucks are not equipped with flow meters and therefore the last form of reliable consumption measurement is made at the water treatment plant. This flow measurement will reflect the approximate wastewater volume generated by the Hamlet and must be included in the records.

2.5 Health and Safety

Due to the potential health hazards associated with sewage handling and treatment, the following safety procedures should be obeyed in order to minimize health risks to personnel working in and around the wastewater facilities:

- Equipment is to be kept clean.
- Protective clothing such as gloves and boots are to be worn at all times.
- Work clothes should not be worn home.
- Hands are to be washed frequently, at a minimum before eating and after work.
- Personnel should receive appropriate vaccinations and ensure they are kept up-to-date.
- Change rooms for changing in and out of work clothes, as well as storage lockers to store work clothes, should be provided on site.
- Clothes washing facilities should be available on site to wash soiled work clothes.
- Visit the Health Clinic for all injuries. When working with wastewater the smallest cut or scratch is potentially dangerous.

Lagoon cells are facilities for treating human and industrial wastes, and as such people should be advised to keep away from them.

2.6 Spill Contingency Plan

A spill contingency plan has been developed for the Hamlet that identifies the procedures to follow when a spill of any hazardous material has occurred and can be found in Appendix C. Information presented in the spill contingency plan has been developed based on the document "*Guidelines for Spill Contingency Planning; Indian and Northern Affairs Canada, April 2007"* (INAC, 2007).

3 Maintenance

3.1 Berm Composition

Wastewater treatment lagoons are designed and constructed for the purpose of providing the right environmental conditions for bacteriological processes to proceed. They should be easily and safely operated without causing any adverse effects to the environment. The requirements of good wastewater treatment can be met if lagoon cells are constructed and maintained in such a way as to:

- Control berm seepage.
- Contain the quantity of effluent without interfering with the desired freeboard.
- Maintain an access road around the cell for inspection purposes.

To accomplish this, the berms were designed, constructed with a minimum 3H:1V internal slope and 3H:1V external slope with a 4m crest. The berm core is comprised of compacted Granular 'C'.

As per the recommendations of the geotechnical report and geothermal analysis, a liner on the upstream slope to provide an impermeable boundary has been installed, with an internal ice core dam providing secondary containment. This impermeable liner was installed into the underlying soils, ensuring the liner is keyed into an impermeable surface, i.e. the permafrost.

3.2 Berm Monitoring

Berm monitoring will be vital during the early operational years to ensure the proper freeze-back of permafrost into the base soils and berm core. Temperature records from the berms will also timeline the permafrost levels on a yearly basis summarizing the characteristics of the active layer at the lagoon.

3.2.1 Thermistors

Berm temperatures will be recorded by a data logger at each of the installed thermistor casings along the crest of the berm to model the permafrost. The thermistors are installed with a series of sensors going down to a final depth of approximately 8.0 – 10.0 metres into the berm foundation strata. Monitoring will trace the lower limit of the active permafrost revealing an early warning if the permafrost does not recover.

A sample monitoring sheet is found in Appendix D which requests the observed temperature for the thermistors at the various monitoring sites along the berm. Temperatures are recorded in degrees Celsius for the array of sensors corresponding to the thermistor. This data sheet will contain the information collected from all monitoring site thermistors for the observed date, and stored together with the QA/QC sampling data.

It is recommended that temperature readings be taken at noon on a daily or weekly basis, depending upon the time of the year. The following procedures will be performed for the operation and maintenance of the thermistors:

Calibration of the thermistors as specified by the supplier/manufacturer on an as required basis

Monitoring in the fall, corresponding to the decanting operations when the permafrost will be at its maximum retraction, will be vital to understanding the lower limits of active layer.

Retrieving temperature values from the thermistors is explained in the manufacturer's "Instruction Manual" found in Appendix E.

3.2.2 Sampling Wells

In addition to thermistors, a series of standpipes will be installed to monitor seepage. The standpipes should be monitored yearly, early to mid fall, for the presence of seepage. Sampling procedures will follow the QA/QC requirements.

3.2.3 Settlement Monitoring

Considering that the berms would be constructed on ice rich soils, it is recommended that settlements of the berms should be monitored for 2 to 3 years subsequent to completion of construction. The settlement readings should be undertaken at the beginning of spring and prior to the onset of winter. The settlements should be referenced to the bench mark noted in the site plans.

3.3 Sludge Management

It is anticipated that the sewage lagoon will not require desludging during its 20 year design life, the available storage for sludge is greater than the quantity estimated to be generated.

The effluent quality will guide the Hamlet if or when a sludge management program is implemented. Monitoring of the effluent from the lagoon will indicate when the performance of the lagoon starts to degrade. Degradation of the performance of a lagoon is normally caused by sludge accumulation and will be the indicator to desludge the lagoon.

Prior to disposal, the sludge must be tested to ensure the disposal method chosen is safe and environmentally responsible.

3.3.1 Assessment Criteria

Evaluating the analytical results obtained by sludge sampling, the Government of Nunavut defaults to criteria established by the Canadian Council of Ministers of the Environment (CCME). For soil, the CCME Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (updated September 2007) is used to compare the metals and VOC analytical results. The CCME has also established the Canada-Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil (April 2001), which is the federal remedial standard for petroleum impacted soils. The CCME and CWS criteria are based on four land use categories: i) agricultural; ii) residential/parkland; iii) commercial; and iv) industrial. As the sludge is to be disposed of at the landfill site, the industrial land use category is utilized for assessing the sludge management.

3.4 Filter Strip Wetland

Treatment of raw sewage in new sewage lagoon in Arctic Bay will be combined with the utilization of a wetlands treatment as a final polishing. The area to be used as wetlands for the Arctic Bay treatment facility is a vegetated filterstrip wetland as described below.

The vegetated area between the lagoon and Victor Bay is incorporated into the sewage treatment process. The filterstrip wetland area is 11.2 hectare (approximately 700 m long and between 86 and 202 m wide) with a slope that varies between 6 to 13 %. Treatment of the pre-treated sewage in the filterstrip wetland area will include removal of TSS, BOD, nutrients and pathogens.

The soil in the filterstrip wetland area is comprised of a topsoil layer with peaty and organic content between 15 and 50 cm thick, silty sand and sand and gravel with permafrost at a depth of approximately 1 m in the summer months. This type of soil is suitable for infiltration processes and will facilitate the two main processes of contaminant removal from pre-treated sewage: uptake of contaminants and nutrients by plant roots and degradation by microorganisms in the rhizosphere.

The well established, native vegetation community will be used and alterations or modifications to the plant community composition are not necessary to increase removal of contaminants. The plant species present, which include willows, grasses, sedges and mosses, are suitable for the phytofiltration processes that will reduce BOD and TSS.

3.5 Filter Strip Protection

Arctic tundra and wetland vegetation communities are very sensitive to physical damage and take a long time to recover from disturbances. Arctic plant species have very slow growth rates and areas damaged by construction activities will not re-vegetate for many years. It is therefore important that construction equipment and trucks does not enter the wetland area. Damage to the wetland area would result in a decrease in treatment efficiency.

4 QA / QC

4.1 Quality Assurance and Quality Control Monitoring

A key component to the operations and maintenance of the sewage lagoon system is a sampling/monitoring program. The following quality assurance (QA) and quality control (QC) program should be implemented to ensure that the analytical results received are accurate and dependable. A QA/QC program is a system of documented checks that validates the reliability of the data collected regarding any given site. Quality Assurance is a system that ensures that quality control procedures are correctly performed and documented. Quality Control refers to the established procedures observed both in the field and in the laboratory, designed to ensure that the resulting end data meets intended quality objectives.

The proposed program will help monitor the treatment while verifying compliance with regulations. As well, it will model the treatment process which will help to understand the performance of the lagoon for future development and modifications to the current system.

It is important such a program be implemented by the Hamlet as a part of the annual operations for the facility. Local members of the community that operate the system are to be trained on the proper operation and procedure methods used in the sampling/monitoring program. In addition, quality control and safety training will also be included which will ensure that the data will be properly obtained.

4.2 Sampling Points

Monitoring the operation and efficiency of the system will be accomplished through the establishment of eight sampling points. Sampling will provide information regarding the performance of the system and help identify any degradation to the treatment provided. Table 4-1 provides coordinates of the sampling points.

Table 4-1: Monitoring Points

Monitoring Program Station Number	Description	Northing UTM	Easting UTM
ARC-3	Raw Wastewater Discharge (South Berm)	8105968m	562068m
ARC-4	Lagoon Pump Discharge (North Berm)	8106150m	561824m
ARC-6a	Sampling Well at end of Wetlands	8106769m	561091m
ARC-6b	Surface water near sampling well at end of Wetlands	8106769m	561091m
ARC-7	Water five (5) metres from effluent entering Victor Bay		
ARC-8	Sewage Sludge		

4.3 Sampling Frequency

The following outlines the Sampling Testing and Compliance requirements of the Wastewater Facility. Any other additional sampling during the year will be at the request of the regulatory agencies. Once collected, the samples will be shipped to the laboratory and analyzed using the same test/method/procedure. The flow rate of effluent discharge during the decanting period is required as well.

Table 4-2: Sampling Frequency

Monitoring Program Station Number	Description	Frequency
ARC-3	Raw Wastewater Discharge (South Berm)	Water Quality: Monthly and Annually
ARC-4	Lagoon Pump Discharge (North Berm)	Water Quality: Three Times Annually – Start, middle and end of decanting
ARC-6a	Sampling Well at end of Wetlands	Water Quality: Three Times Annually – Start, middle and end of decanting
ARC-6b	Surface water at the end of the Wetland Area	Water Quality: Three Times Annually – Start, middle and end of decanting
ARC-7	Water five (5) metres from effluent enters Victor Bay	Water Quality: Three Times Annually – Start, middle and end of decanting
ARC-8	Sewage Sludge	To be determined

Figure 4-3: Sampling Points

4.4 Sampling Parameters

Samples should be analyzed for the following parameters:

Biochemical Oxygen Demand – BOD_5	Faecal Coliforms
Total Suspended Solids	pH
Conductivity	Nitrate-Nitrite
Oil and Grease (visual)	Total Phenols
Magnesium	Calcium
Sodium	Potassium
Chloride	Sulphate
Total Hardness	Total Alkalinity
Ammonia Nitrogen	Total Zinc
Total Cadmium	Total Iron
Total Cobalt	Total Manganese

Total Chromium	Total Nickel
Total Copper	Total Lead
Total Aluminum	Total Arsenic
Total Mercury	Total Organic Carbon (TOC)q

4.5 Compliance Points

The water license has set the lagoon discharge as the compliance point for the new wastewater facility as it is the last point of measurement and control. The effluent released from the lagoon must meet the criteria list in Table 4-4. This criteria recognizes the treatment ability of the filter strip.

Table 4-4: Effluent Criteria at the Compliance Point

Parameter	Maximum Average Concentration
BOD_5	120 mg/L
Total Suspended Solids (TSS)	180 mg/L
Faecal Coliforms	1×10^6 CFU/100mL
Oil and Grease	No visible sheen
pH	Between 6 and 9

4.6 Laboratory Requirements

All analyses shall be performed by a laboratory certified by the Canadian Association for Laboratory Accreditation (CALA), or as otherwise approved by an Analyst.

4.7 Sampling Procedures

The sampling procedures should be as per “Quality Assurance (QA) and Quality Control (QC) Guidelines for use by Class “B” Licenses in Collecting Representatives water samples in the field”.

All sampling, sample preservation and analyses will be in accordance with methods described in the current edition of Standard Methods for the Examination of Water and Wastewater (American Public Health Association, American Water Works Association, and Water Environment Federation, most current edition).

To obtain meaningful results from the analysis, the following five factors are of particular importance:

- Sample collection at a designated time and location.
- Correct usage of container/sample bottle for the parameter being tested.
- Correct labeling of sample bottles and filling out record/field sheet.
- Correct procedure for field sampling.
- Proper and timely shipment of samples to the laboratory.

4.8 Lagoon Water and Sludge Sampling

Prior to sampling, the appropriate sample bottles/vials, along with coolers and ice packs should be requested from the analytical laboratory.

Latex or nitrile gloves should be worn during sampling and should be replaced with fresh gloves after all sample containers are filled at each sampling location. Sampling equipment such as sampling poles should be cleaned with soap and water after each sample is collected to prevent cross-contamination.

For lagoon water samples

Using a sampling pole, plunge the container into the lagoon water neck first. Immerse to a depth of 10 to 20 cm, depending on the depth of the lagoon. Fill the sampling container with the mouth facing slightly upwards.

For lagoon sludge samples

Using a sampling pole, plunge the container into the lagoon water neck first to maintain an air pocket within the container. Once contact with the sludge is felt, immerse container into sludge neck first to a depth of 5 to 10 cm. Fill the sampling container with sludge and raise sample bottle neck first to prevent sample spillage.

All sample containers should be tightly sealed and properly labeled with the sample ID, date and time of sample collection, location of sample collection and parameters to be analyzed. The outside of the bottles should be cleaned with soap and water prior to placing the samples in the cooler. The samples should be stored on ice in a cooler until delivery to the laboratory. A Chain of Custody Form should be filled out completely and be used to track the samples. Keep the last page and give it to the project manager along with the field notes.

4.9 Groundwater Sampling

In permafrost regions, water may be present for at least part of the year in the active layer. For the purposes of this document, this water is considered groundwater.

Dedicated Waterra™ pumps and tubing or bailers should be installed in each well. Dedicated sampling equipment minimizes the risk of cross-contamination.

Since, water standing in a well is generally not thought to be representative of the conditions within the water bearing formation, well purging is typically done to ensure formation water is sampled. However, in the case of permafrost regions, well purging is not recommended due to the limited amount of water likely to be present in the active layer. Instead, the available groundwater should be collected into the laboratory supplied sample containers and all sample containers should be tightly sealed and properly labeled with the sample ID, date and time of sample collection, location of sample collection and parameters to be analyzed. The samples should be stored on ice in a cooler until delivery to the laboratory. A Chain of Custody Form should be filled out completely and be used to track the samples. Keep the last page and give it to the project manager along with the field notes.

4.10 Quality Assurance and Quality Control Program

Prevention of Cross Contamination

Proper field protocols reduce the chances of cross contamination in the field. As outlined above, latex or nitrile gloves should be worn during sampling and should be replaced with fresh gloves after all sample containers are filled at each sampling location. Sampling equipment such as sampling poles should be cleaned after each sample is collected to prevent cross-contamination.

Proper Field Note Taking Procedures

Proper documentation of all aspects of the sampling program (i.e., field notes and Chain of Custody forms) is essential. Be sure to note any deviations that could potentially cause sampling bias (i.e., broken bottles). It is also important that field notes include the date and time of the sampling event, the

meteorological conditions at the time of sampling (ambient temperature, whether it is raining or snowing, etc.).

Quality Control Samples

Cross contamination is a common source of error in sampling procedures. QC samples help you identify when and how contamination might occur. There are various types of QC samples including: blind duplicates, field blanks, and trip blanks. A blind duplicate is a duplicate sample that is not labeled as such. The purpose of the blind duplicate sample is to ensure analytical precision. A field blank is a sample of analyte free (i.e., clean) water poured into the container in the field, preserved and shipped to the laboratory with field samples and is analyzed along with field samples to check contamination from field conditions during sampling. A trip blank is a clean water sample that stays unopened and that remains with collected samples during transportation and is analyzed along with field samples to check residual contamination (i.e. to determine if cross contamination occurs during shipping).

exp recommends the following number of quality control samples based on the number of samples collected:

- 10% field blanks
- 10% blind duplicates
- 1 trip blank per shipping container (cooler)

If the total number of samples collected is less than five, include at a minimum, one blind duplicate and one trip blank.

Sampling Containers, Preservation and Hold Times

Containers, preservatives, holding times, and sample volumes with respect to the target analyses should be selected in accordance with the appropriate protocols (Canadian Council for Ministers of the Environment or CCME). All water samples should be collected in laboratory approved containers with the proper preservative, where applicable.

Sample Identification Requirements

All sample containers must be labeled to prevent misidentification of samples. As mentioned above, the sample containers should be identified with the sample ID, the client ID, date and time of sample collection, location of sample collection and parameters to be analyzed.

Chain of Custody

A chain of custody must accompany the shipment of samples to the laboratory. A legal Chain of Custody is a special type of sample custody that requires the physical possession, transportation and storage of a sample be documented in writing. On the Chain of Custody, you indicate what analyses are to be done by the laboratory and who should receive the results. Keep the last page and give it to the project manager along with the field notes.

Sample Transmittal Documentation

All samples should be logged into the laboratory to verify that all records were complete, correct and entered into the sample custody records.

Initial Check of Samples and Documentation

The following checks are generally performed by the laboratory upon receipt:

- Verification of the integrity and condition of all sample coolers.
- Verification of the integrity and condition of all sample containers.
- Checks for leakage, cracked or broken closures or containers, evidence of grossly contaminated container exteriors or shipping cooler interiors, and obvious odors, etc.
- Verification of receipt of complete documentation for each container.

- Verification that sample identification numbers on sample transmittal forms correspond to sample identification numbers on the sample containers.
- Verifications that holding times were met and samples were kept cool during transit.

CADUCEON™
ENVIRONMENTAL LABORATORIES
Client committed. Quality assured.

Joeli Qamanirq
Senior Administration Officer
Hamlet of Arctic Bay
Box 150
Arctic Bay NU X0A0A0

Dear Joeli Qamanirq:

Caduceon Environmental Laboratories looks forward to aiding the Hamlet of Arctic Bay in their environmental analysis. The Caduceon staff has reviewed the PDF document entitled *"QAQC for the Hamlet of Arctic Bay"* that was provided to our Ottawa Laboratory.

Our Staff has read and understands the requirements found within this document and see no issues with providing you quality services and analysis. In addition, it has been noted that it is necessary that all testing be completed under CALA accreditation. Caduceon Environmental Laboratories are accredited for all of the parameters listed within the document.

I believe you have already peen provided with our CALA Scopes of Accreditation for your records. Should you require any further information please call either Mr. Gord Murphy (Lab Supervisor) or Greg Clarkin (Lab Manager) at the Ottawa office and they will be more than happy to assist you.

Again, thanks for the opportunity to work with the Hamlet of Arctic Bay.

Regards,

Damien Gilbert
Director of Business Development
Cc: Gord Murphy
Greg Clarkin

Appendix A – Water License

P.O. Box 119
Gjoa Haven, NU X0B 1J0
Tel: (867) 360-6338
Fax: (867) 360-6369

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NUNAVUT WATER BOARD
NUNAVUT IMALIRIYIN KATIMAYINGI
OFFICE DES EAUX DU NUNAVUT

File No.: 3BM-ARC0810 Amendment No. 1

April 16, 2009

Mr. Joeli Qamanirq
Senior Administrative Officer
Hamlet of Arctic Bay
P.O. Box 144
Arctic Bay NU X0A 0A0

RE: NWB Licence No. NWB3ARC0810 Amendment No. 1

Dear Mr. Qamanirq:

Please find attached Amendment No. 1 to Licence No. 3BM-ARC0810 Type "B" issued to the Hamlet of Arctic Bay by the Nunavut Water Board (NWB), (Motion 2008-24-L02) pursuant to its authority under Article 13 of the *Agreement between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in Right of Canada*. The terms and conditions of the original Licence related to water use and waste disposal remain an integral part of this approval.

The NWB strongly recommends that the Licensee consult the comments received from interested persons on issues identified. This information is attached for your consideration.

Sincerely,

Thomas Kabloona
Nunavut Water Board, Chair

TK/tla/kt

Enclosure: Licence No. 3BM-ARC0810 Amendment No.1
Comments: GN-DoE, GN-CLEY, Env.Can, INAC, BGC[1]

cc: Qikiqtani Distribution List

[1] Indian and Northern Affairs Canada (INAC) dated September 12, 2008; Government of Nunavut Department of Environment (GN-DoE) dated August 21, 2008; Government of Nunavut Department of Culture, Language, Elders and Youth (GN-CLEY) dated August 25, 2008; Environment Canada (EC) dated August 29, 2008; BGC Engineering Inc. (BGC) dated September 5, 2008 and December 10, 2008.

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REASONS FOR DECISION

I. BACKGROUND

The Hamlet of Arctic Bay (Hamlet or Applicant) has a population of approximately 855 and is located at the coordinates of 73° 02' north latitude and 83° 05' west longitude, on the north tip of Baffin Island within the Qikiqtani Region of Nunavut.

Currently, the community generates an estimated 33,600 cubic metres of sewage annually, which is treated in a sewage lagoon, ice pack area and associated wetland located 2.5 km east of the community. The existing lagoon is at the end of its useful life as it does not meet the storage needs of the community or the treatment requirements of the Hamlet's current water licence. Therefore, construction of a new sewage lagoon in a small valley northwest of the existing facility is proposed, with additional treatment through natural wetlands.

The new wastewater treatment facility has been designed for a twenty (20) year life with a projected annual sewage generation rate of 56,029 cubic metres.

II. PROCEDURAL HISTORY

The Nunavut Water Board (NWB) issued a municipal water licence to the Hamlet of Arctic Bay on November 1, 2002, to allow for the use of water and disposal of waste. Following application by the Hamlet, the NWB issued an amendment to the Licence on March 2, 2005 to allow for emergency remedial work required to prevent failure of the lagoon's containment berms, which could result in the release of waste into water and the environment surrounding the Hamlet's Sewage Disposal Facility.

Following the expiration of the water licence on October 31, 2007, a submission of a renewal application and a detailed assessment was received and the Board approved a water licence renewal on March 17, 2008, as Water Licence 3BM-ARC0810.

On August 22, 2008 the Nunavut Planning Commission indicated in an email to the NWB that no conformity determination was required for the Arctic Bay municipal project sewage lagoon. On February 27, 2008, the Nunavut Impact Review Board (NIRB) exempted from screening the construction of the new sewage lagoon.

The Hamlet of Arctic Bay, in conjunction with the Government of Nunavut, Department of Community and Government Services (GN-CGS), submitted an Application for Water Licence Amendment to the NWB on April 30, 2008. Following a preliminary review of the application, the NWB concluded that it met the requirements of section 48(1) of the *Nunavut Waters and Surface Rights Tribunal Act* (the Act) and advised the Applicant and distribution list accordingly on July 30, 2008.

Information contained in the April 30, 2008 submission and distributed for review included:

- Letter from GN-CGS to NWB, regarding *Application for the amendment of the existing Water licence for the Hamlet of Arctic Bay, Baffin Region, Nunavut: 3BM-ARC0810,* dated April 30, 2008;
- Drawings prepared by Trow Associates Inc. for the Government of Nunavut entitled *Government of Nunavut, Arctic Bay, Decommissioning Existing Lagoon*, Project No. OTCD00019054B, signed and stamped by a professional engineer registered in Nunavut;
- Report prepared by Trow Associates Inc. for the Government of Nunavut Community and Government Services Project Management Division – Baffin Region, entitled *Arctic Bay Sewage Lagoon Decommissioning*, dated April 2008, Project No. OTEN00019054C;
- Report prepared by Trow Associates Inc. for the Government of Nunavut Community and Government Services Project Management Division – Baffin Region, entitled *Design Brief New Sewage Lagoon for the Hamlet of Arctic Bay*, dated April 2008, Project No. OTCD00019054A;
- Report prepared by Trow Associates Inc. for the Government of Nunavut Community and Government Services Project Management Division – Baffin Region, entitled *Environmental Assessment Screening New Sewage Lagoon for the Hamlet of Arctic Bay Conducted in Compliance with the Canadian Environmental Assessment Act*, dated April 2008, Project No. HAEN00286312A;
- Report prepared by Trow Associates Inc. for the Government of Nunavut Community and Government Services Project Management Division – Baffin Region, entitled *Geotechnical Investigation Sewage Lagoon, Hamlet of Arctic Bay, NU*, dated April 24, 2008, Project No. OTGE00019054B;
- Report prepared by Naviq Consulting Inc. for Trow Associates Inc., entitled *Geothermal Analysis of Proposed Sewage Lagoon, Arctic Bay, NU.*, dated April 2008, Project No. J008 Revision 1;
- Drawings prepared by Trow Associates Inc. for the Government of Nunavut entitled *Government of Nunavut, Arctic Bay Wastewater Lagoon*, Project No. OTCD00019054A, signed and stamped by a professional engineer registered in Nunavut;
- Drawings prepared by Trow Associates Inc. for the Government of Nunavut entitled *Government of Nunavut, Arctic Bay Wastewater Lagoon Road*, Project No. OTCD00019054A, signed and stamped by a professional engineer registered in Nunavut;
- Letter from Hamlet of Arctic Bay to Community and Government Services regarding *Sewage Lagoon Project for Arctic Bay*, dated December 19, 2007;
- Report prepared by Rowan, Williams, Davies & Irwin Inc. (RWDI) for Trow Associates Inc., entitled *Snowdrift Assessment Proposed Wastewater Lagoon Arctic Bay, NU*, dated April 14, 2008, Project No. 08-1032A;

- Report prepared by Trow Associates Inc. for the Government of Nunavut Community and Government Services Project Management Division – Baffin Region, entitled *Vegetated Filter Strip Wetland Assessment, Hamlet of Arctic Bay, Nunavut*, dated April 2008, Project No. HAEN00286312A;
- Topographic Map prepared by Trow Associates Inc. for the Government of Nunavut entitled *Arctic Bay Wastewater Lagoon Topographic Map*, dated 11/02/2008, Project No. OTCD00019054A;
- English Summary entitled *Technical Report of the Wastewater Treatment Facility in Arctic Bay*;
- Inuktitut Summary; and
- Completed Water Licence Application form signed February 26, 2008.

The scope of the Application for Water Licence Amendment includes:

- Construction and operation of a new Wastewater Treatment Facility comprised of a single cell sewage lagoon and wetland treatment area;
- Construction of a new gravel access road from the existing lagoon to the new lagoon including stream crossings;
- Effluent release from the new lagoon to a 11.2 hectare Vegetated Filter Strip Wetland area that is approximately 700 metres long, between 86 and 202 metres wide and flows northwest into Victor Bay;
- Decommissioning of the existing Sewage Disposal Facility once the new Wastewater Treatment Facility is commissioned; and
- Quarrying from the Arctic Bay quarry.

The NWB publicly posted notice of this application, in accordance with Section 55.1 of the Act and Article 13 of the *Nunavut Land Claims Agreement* (NLCA), on July 30, 2008. This assessment process included the referral of the application to a variety of Federal, Territorial and local organizations for their review and comment.

As no public concern was expressed, the NWB waived the requirement to hold a public hearing and proceeded with the application process.

The NWB received comments on the application from interested parties including Environment Canada (EC), Indian and Northern Affairs Canada (INAC), the Government of Nunavut Department of Environment (GN-DoE) and the Government of Nunavut Department of Culture, Language, Elders, and Youth (GN-CLEY) on or before September 12, 2008. In addition, on September 5, 2008, BGC Engineering Inc. (BGC), at the request of the NWB, carried out a technical review on the geotechnical and geothermal aspects of the project and provided the NWB with a summary of findings.

Between October 27th, 2008 and November 10th, 2008, the NWB received a response from the Applicant. The response addressed comments from the interested parties and included the following documents:

- Letter from Trow Associates Inc. to GN-CGS regarding response to comments Arctic Bay Sewage Lagoon, Nunavut, dated November 10, 2008;
- Letter from Trow Associates Inc. to GN-CGS regarding response to BGC Letter of September 5, 2008 Geotechnical Investigation, Arctic Bay Sewage Lagoon, Arctic Bay, Nunavut, dated October 27, 2008;
- Letter from Trow Associates Inc. to GN-CGS regarding Sludge Accumulation, Arctic Bay Sewage Lagoon, Nunavut, dated November 10, 2008;
- Table 1: Summary of Review of Geotechnical and Geothermal issues;
- Report prepared by Naviq Consulting Inc., for Trow Associates Inc., entitled *Geothermal Analysis of Proposed Sewage Lagoon, Arctic Bay, NU* dated October 2008 as revision 2, project number J008; and
- Document prepared by Trow Associates Inc., entitled Arctic Bay Sewage Lagoon O&M Manual Outline, Project number OTCD00019054A.

This additional information was forwarded to BGC on November 13, 2008, for review, to provide the NWB with a final summary of issues, which was provided to the NWB on December 10, 2008.

Based upon the results of the detailed assessment, including consideration of any potential accidents, malfunctions, or impacts to water, that the overall project might have in the area, the Board approved the application and has amended Licence 3BM-ARC0810.

ISSUES

Compliance

The decision for the renewal of Licence 3BM-ARC0810, on March 17, 2008 indicated that there were several issues of non-compliance with conditions of the previous licence 3BM-ARC0207. These included:

- Unauthorized release of Effluent and failure to file a spill report;
- Unacceptable Effluent discharge quality, decant structure, erosion, dike failure, and available freeboard of lagoon;
- Failure to submit annual reports for 2002 to 2005 (2006 annual report received on April 7, 2007);
- The Licensee did not submit an Operations and Maintenance Plan during the Licence term; and
- Incomplete monitoring data.

In response to the above compliance issues, the Board then decided on a shorter two (2) year term for the licence renewal and as noted in its decision fully expected the Licensee to take immediate steps to come into full compliance with the licence requirements. In addition, the Board required, as a condition in Part B Item 10 of 3BM-ARC0810, the Licensee to submit a Plan for Compliance within the lesser of ninety (90) days or upon the filing of any application in relation to the Licence, that clearly demonstrates how the Licensee will achieve full compliance with the Licence conditions.

As part of the review of this Application for Water Licence Amendment, the NWB conducted a compliance assessment of the current licence 3BM-ARC0810. The results of this assessment indicate a number of additional, and continued compliance issues including:

- Failure to submit to the Board, a Plan for Compliance within ninety (90) days or upon the filing of the amendment application in accordance with Part B Item 10;
- Failure to submit to the Board for review, within six (6) months of the issuance of the Licence, a report identifying each Final Discharge Point in accordance with Part D Item 10; and
- Failure to submit to the Board for approval, within ninety (90) days of issuance of the Licence, an Operations and Maintenance Manual in accordance with Part F Item 1.

Plan for Compliance

As noted above, the Licensee to this date, has not complied with Part B, Item 10 of the current licence 3BM-ARC0810, requiring the Licensee to submit a Plan for Compliance that clearly

demonstrates the ways and means the Licensee will undertake to achieve full compliance with the conditions of the Licence, during the licence term.

The NWB is therefore maintaining this requirement, but has amended the condition in Part B Item 10 to require submission of the Plan within a time frame of **thirty (30) days** following issuance of this Licence Amendment, for approval by the Board in writing. In addition, this condition has been amended to require that the Plan clearly demonstrate the measures the Licensee will undertake, including an implementation schedule, to achieve full compliance with the conditions of this Licence, including the issues raised in the Inspector's reports.

Annual Report

As noted above, the Licensee's failure to submit annual reports has been an ongoing compliance issue.

The NWB will maintain the condition in the License to produce annual reports. These reports are important in ensuring that the NWB has an accurate annual update of municipal activities during a calendar year with respect to water use and waste disposal. This information is maintained on the public registry and is available to interested parties upon request. A *Standardized Form for Annual Reporting* is to be used by the Licensee and is available for use by the Licensee at the NWB's ftp site at ftp://nunavutwaterboard.org/ADMINISTRATION/Standardized%20Forms/. This standardized form should not limit the amount and quality of information provided by the Licensee, but is made available to assist in the preparation of the annual report.

Although an Annual Report has been received by the NWB for 2006, not all data that should have been generated under Part H, Monitoring Program was included. The Board is requiring the Licensee to submit all available data generated under the previous Licence NWB3ARC0207 and the Renewal, 3BM-ARC0810 Monitoring Program to the Board within thirty (30) days of issuance of this Licence Amendment.

Design Issues

A number of documents were submitted as part of the Application for Water Licence Amendment in support of the design of the new Wastewater Treatment Facility as indicated in the procedural history of this decision. These documents were reviewed by BGC, an expert reviewer retained by the Board. The results of BGC's review, submitted on September 5, 2008, identified a number of concerns related to the site description and the geothermal and stability analyses for the lagoon including:

- Inconsistency between the results of the geothermal analyses and the design;
- Description and justification for the derivation of parameters used in the slope stability analysis including effective cohesion for ice;

- Uncertainty with respect to the derivation of the design stratigraphic sections used in the stability analyses;
- Uncertainty with respect to the installation of the impermeable liner to be installed along side valleys of the lagoon impoundment to minimize lateral migration of effluent;
- Uncertainty with respect to the effects of predicted long term permafrost thaw and warming;
- Uncertainty with respect to the source, quality and specifications of borrow materials for construction; and
- Thermal, settlement and displacement monitoring.

INAC, in its September 12, 2008 comments also provided a number of recommendations related to the design of the Wastewater Treatment Facility including:

- Details of the installation of the liners to be placed along the upstream slopes of the northwest and southwest berms as well as each side of the valley forming the lagoon should be provided. Details should include (1) the type of liner; (2) how the liner will be incorporated into the cell to prevent seepage; and (3) a discussion on the quality assurance and quality control measures applied during installation;
- The use and location of thermistor cables and vertical slotted standpipes within the lagoon berms for monitoring temperature and effluent seepage should be described as part of the Operations and Maintenance Manual; and
- An explanation regarding the need for any proposed spillways should be provided.

On November 12, 2008, the Applicant submitted additional information in response to the issues raise by BGC, including:

- Letter from Trow Associates Inc. to GN-CGS regarding response to BGC Letter of September 5, 2008 Geotechnical Investigation, Arctic Bay Sewage Lagoon, Arctic Bay, Nunavut, dated October 27, 2008;
- Table 1: Summary of Review of Geotechnical and Geothermal issues; and
- Report prepared by Naviq Consulting Inc., for Trow Associates Inc., entitled *Geothermal Analysis of Proposed Sewage Lagoon, Arctic Bay, NU* dated October 2008 as revision 2, project number J008

In its final summary, BGC noted that a number of the issues were not addressed in the Applicant's response of November 12, 2008. The main issue of concern being the location of the key trench liner and potential impact of berm displacements on liner integrity. BGC therefore recommended that the location of the liner key trench, horizontally from the upstream toe of the berm, be as recommended in Naviq Consulting Inc.'s geothermal design report. Furthermore, BGC recommended that the proposed 2 metres penetration depth of the lined key trench be considered a minimum and that the construction specifications indicate that it be keyed into sound rock or ice-saturated permafrost mineral soils or rock. Based on these concerns, the Board

has decided to impose the recommendations provided by BGC as conditions of the amendment in Part E Items 8 and 9.

In addition, BGC recommended that a detailed Instrumentation Monitoring and Surveillance Plan be submitted to the NWB for review and approval as a condition of the amendment. BGC recommended that this Plan include details of the proposed instrumentation plan, describe frequency of measurements and identify trigger values or observations for remedial action. INAC similarly recommended that the Operations and Maintenance Manual should provide a description of the thermal and seepage monitoring requirements of the lagoon berms. As such, the Board is requiring the Licensee to submit to the Board as part of the Operations and Maintenance Manual required in Part F Item 1(h), a detailed Instrumentation Monitoring and Surveillance Plan.

The Board has also included a condition in the Licence, Part E, Item 11, requiring the Licensee to submit within sixty (60) days of construction of the Wastewater Treatment Facility, a Construction Summary Report. This Report is to include as-built drawings identifying the areas where field changes were made from the original design drawings, preferably in the form of a revision bubble and a brief note in the revisions section of the title block. Given BGC's concerns regarding the finalization of specifications for fill materials to be used for construction of the berms of the Wastewater Treatment Facility, the Report shall also include details of the fill materials specification for dike and key trench construction. Due to conflicting information regarding the location of the lined key trench in the Application for Water Licence Amendment (the recommended location as indicated in the report prepared by Naviq Consulting Inc., for Trow Associates Inc., entitled *Geothermal Analysis of Proposed Sewage Lagoon, Arctic Bay, NU* dated October 2008 was at a distance of approximately five (5) metres back from the upstream toe of the dike, whereas drawing DE-2 indicates three (3) metres), the Report shall also include the final location for the lined key trench and reasons for selecting the final location. To address INAC's comments regarding the spillway, the Board is also requiring this Report to include confirmation regarding the requirement for a spillway including a rationale. Lastly, to address INAC comments regarding liner installation, this Report shall include details regarding the installation of impermeable liners including the type of liner, how the liners were incorporated into the cell to prevent seepage, and a discussion of the quality assurance/ quality control measures applied during installation.

Operational Plans

Under the current water licence 3BM-ARC0810, Part F Item 1, the Licensee was required to submit an Operation and Maintenance (O&M) Manual covering the Water Supply Facility, the Sewage Disposal Facility and Solid Waste Disposal Facility including plans for sewage sludge management, spill contingency and Quality Assurance/Quality Control (QA/QC) within ninety (90) days of issuance of the licence. To date, this Manual has not been received.

The GN-DoE, INAC, and EC all commented on the need for an O&M Manual. The GN-DoE commented in its August 21, 2008 submission that an O&M Manual should be provided for the two sewage lagoons (the existing and the proposed).

All parties also commented on the need for a Sewage Sludge Management Plan providing detailed recommendations regarding the contents of the plan including the rate of sludge accumulation, the frequency of desludging, sludge characterization procedures, sludge disposal standards, and sludge disposal procedures.

Moreover, EC commented on the need for a Spill Contingency Plan and INAC commented on the need for a diagram that references Monitoring Program station numbers that could be appended to the Licence.

On November 12, 2008, in response to comments received, the Applicant provided additional information including:

- Document prepared by Trow Associates Inc., entitled *Arctic Bay Sewage Lagoon O&M Manual Outline*, Project number OTCD00019054A;
- Letter from Trow Associates Inc. to GN-CGS regarding *Response to Comments Arctic Bay Sewage Lagoon*, Nunavut, dated November 10, 2008; and
- Letter from Trow Associates Inc. to GN-CGS regarding *Sludge Accumulation, Arctic Bay Sewage Lagoon*, Nunavut, dated November 10, 2008.

With respect to sewage sludge, the additional information indicated that the sewage lagoon would not likely require desludging within the twenty year design life of the lagoon. However, it conceded that sampling should be used as an indicator of the build up of sludge and that guidelines for desludging would be provided as part of the O&M Manual.

The Board acknowledges the Applicant's submission of an O&M Manual outline, but agrees with reviewers that this Plan should be fully developed. The Board is therefore maintaining the requirement for the submission of an O&M Manual. As such, the Board has amended the condition in Part F Item 1 of licence 3BM-ARC0810, to require submission of the O&M Manual for Board approval in writing, within **sixty (60) days** following issuance of this Licence Amendment. The timing for submission of this Manual takes into consideration the Applicant's proposal to begin construction during the summer of 2009. This Manual is to be developed to the satisfaction of the Board and include the following plans:

a. Water Supply Facilities Operation and Maintenance Plan;
b. Solid Waste Operation and Maintenance Plan;
c. Sewage Operation and Maintenance Plan for the existing Sewage Disposal Facility and the new Wastewater Treatment Facility;
d. Sewage Sludge Management Plan;
e. Hazardous Waste Management Plan;

f. Spill Contingency Plan including a Spill Response Plan for Aggregate deposits;
g. Monitoring Program Quality Assurance/Quality Control Plan including a diagram that references Monitoring Program Station Numbers; and
h. Instrumentation Monitoring and Surveillance Plan (See Monitoring section below, as this Plan is due within thirty (30) days of issuance of this Licence Amendment).

Item (c) above is intended to address operation and maintenance for both the existing Sewage Disposal Facility as well as the new Wastewater Treatment Facility.

Given that procurement of material from the Hamlet quarry is required to complete the project, the Board is also requiring as part of the O&M Manual required in Part F Item 1 of the Licence Amendment, that the Licensee's Spill Contingency Plan address operations at the aggregate deposit(s). This condition is also a requirement of NIRB's 06UN036 screening determination which states that the Proponent shall have an NWB approved Spill Contingency Plan in place prior to commencement of construction activities and that this Plan shall address any additional fuel stored at the quarry site.

The purpose of the O&M Manual noted above is to assist Hamlet staff in carrying out the procedures relating to the waste disposal facilities. The O&M Manual should demonstrate to the NWB that the Hamlet is capable of operating and maintaining the infrastructure related to water use and waste disposal and to meet the requirements of the Licence. The O&M Manual should be based, at a minimum on the various NWB-approved guidelines available (i.e. *Guidelines for the Preparation of an Operations and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories*, Duong and Kent, 1996) and other regulatory guidelines.

Sewage

The new Wastewater Treatment Facility comprising a single cell sewage lagoon as the primary treatment system and a wetland as the secondary treatment system is proposed to be constructed in a small valley. This will replace the existing facility built in 1976 and expanded in 2003. Treated sewage effluent from the new lagoon will be pumped to the new 11 hectare Vegetated Filter Strip Wetland Area where it will be further treated and polished prior to runoff into Victor Bay. Victor Bay is a marine environment located approximately 700 metres away from the new lagoon.

The Application for Water Licence Amendment consists of a report, drawings, and recommendations prepared by Trow Associates Inc (Trow), retained by the GN-CGS on behalf of the Hamlet. However, the Applicant does not specify which of Trow's recommendations would be implemented. Thus, for greater certainty the NWB has included a new condition in Part E Item 6 of the Licence Amendment that requires the Licensee to implement the recommended options identified in the Application for Water Licence Amendment document entitled *Design Brief New Sewage Lagoon for the Hamlet of Arctic Bay*, dated April 2008, as

prepared by Trow, Project No. OTCD00019054A. In the event of a conflict between the conditions of this Licence Amendment and the above referenced document, the conditions of this License shall prevail.

The Board acknowledges that the Applicant predicts that effluent from the proposed Vegetated Filter Strip Wetland Area will meet the current licence effluent quality limits. However, due to uncertainty regarding the treatment efficiency of wetlands in the north, the Board has decided that the Final Discharge Point and point of compliance for the Wastewater Treatment Facility be located at the point of discharge from the lagoon to the Vegetated Filter Strip Wetland Area. In order to determine the performance of the Vegetated Filter Strip Wetland Area as a secondary treatment system, the Board further requires that the quality of effluent leaving the Vegetated Filter Strip Wetland Area be monitored and reported.

Furthermore, the Board has set effluent quality standards at the Final Discharge Point of the new Wastewater Treatment Facility at 120 mg/L for BOD_5 and 180 mg/L for TSS. In setting the effluent quality standards, the Board took into consideration EC's August 29th, 2008 comments as well as the *Guidelines for the Discharge of Treated Municipal Wastewater in the Northwest Territories, 1992*, (Guidelines). According to Table 4.1 of the Guidelines, for a wastewater flow greater than 600 lcd during summer months into a marine receiving environment, the discharge criteria for BOD_5 should be set at 80 mg/L and the discharge criteria for TSS should be 70 mg/L. Taking into consideration note (k) to Table 4.1 of the Guidelines which states that where wetlands are to be used as part of the treatment systems, limits may be chosen to suit the point of measurement and control, the Board has decided to set limits from the lagoon that are less strict than the 80/70 (BOD/TSS) standards to take into account the potential for treatment in the wetland area and to be consistent with other recently issued water licences with comparable systems such as Clyde River. The discharge criteria for the existing Sewage Disposal Facility includes Fecael Coliforms as a licensed parameter and the NWB is maintaining this requirement for the new Wastewater Treatment Facility.

The Board has also amended the effluent quality standards to meet criteria based on the maximum concentration of any grab sample, as opposed to maximum average concentrations which cannot be calculated annually if only three (3) samples are collected per year in accordance with the Monitoring Program.

In addition, due to logistical constraints brought to the Board's attention with respect to providing evidence under the Licence, the Board has removed the requirement for the Licensee to demonstrate that Effluent is non-acutely toxic. However, the Board advises the Licensee, that compliance with this Licence does not absolve the Licensee from the responsibility to comply with other applicable legislation and to ensure that any effluent discharged from the system's Final Discharge Point is in compliance with Section 36(3) of the Fisheries Act. According to Section 36(3) of the Fisheries Act, where the deposition of deleterious substances of any type, under any conditions where the deleterious substance, or any other deleterious substance that results from the deposit of the deleterious substance, may enter such water, is prohibited.

As noted earlier in this Decision, the Licensee has failed to submit to the Board a report identifying each Final Discharge Point for the existing Sewage Disposal Facility in accordance with Part D Item 10 of the current licence 3BM-ARC0810. Given that the existing Sewage Disposal Facility will remain in operation until commissioning of the new Wastewater Treatment Facility, the Board is maintaining this requirement and has amended the condition to require submission of the report within thirty (30) days of issuance of this Licence Amendment.

Stream Crossings

To access the new Wastewater Treatment Facility, a new access road approximately 1.25 km long is required to be constructed, extending from the road to the existing Sewage Disposal Facility to the new Wastewater Treatment Facility. The proposed road alignment is required to cross drainage paths. To accommodate the stream crossings, culverts will be installed at each crossing.

The Board has included a condition in Part E Item 7 prohibiting disturbance of any stream/lake bed or the banks of any definable watercourse unless authorized by the Department of Fisheries and Oceans (DFO).

In addition, the Licensee is reminded that a number of conditions of the original Licence 3BM-ARC0810 apply to stream crossings, including those conditions related to the requirement for as-built plans and drawings of any modifications in Part E Item 3 and the requirement for geotechnical inspections in Part F Item 3, as well as the conditions related to surface drainage, sediment and erosion control.

Quarry

On May 5, 2006, the NIRB issued a screening determination allowing the Arctic Bay Airport Redevelopment Project (NIRB File 06UN036) to proceed subject to terms and conditions. On November 21, 2007, the NIRB exempted the Hamlet's quarry permit application (QB07-001) from screening as it was understood that the application was previously screened under NIRB File 06UN036. On February 27, 2008 the NIRB exempted a revised Quarry Permit Application (QB07-0001) from the GN-CGS involving an additional amount of material to be removed from the Arctic Bay quarry. The additional material was to be used in part for the new sewage lagoon construction.

A new quarry permit (08-703-001) from GN-CGS was issued to the Hamlet on April 18th, 2008 authorizing the taking of 340,000 cubic metres of material from four (4) sites located approximately five (5) miles from the Hamlet. This quarry licence authorizes the taking of a sufficient amount of material for the completion of this project.

The Applicant is advised that the expansion of an existing quarry site or the creation of any new quarry site location requires screening by the NIRB in accordance with Article 12 of the NLCA.

The NWB cannot authorize water use or waste disposal associated with development of a new quarry deposit until NIRB has completed its review of the proposed activity. Finally, any new quarry development(s) that receive an approval to proceed from the NIRB will require an amendment to this Licence.

Those conditions of NIRB's screening decision 06UN036 related to the mandate of the NWB regarding the use of water and disposal of waste, have been incorporated into this Licence Amendment.

Abandonment and Restoration Plan

Under the current water licence 3BM-ARC0810 Part G Item 1, the Licensee was required to submit to the Board for approval at least six (6) months prior to abandoning any facilities or upon submission of the final design drawings for the construction of new facilities to replace existing ones, an Abandonment and Restoration Plan.

On April 30, 2008, the Applicant submitted a report prepared by Trow for the GN-CGS Project Management Division – Baffin Region, entitled *Arctic Bay Sewage Lagoon Decommissioning*, dated April 2008, Project No. OTEN00019054C. This report partially addresses the requirement of Part G Item 1 of the current water licence regarding the existing sewage lagoon. However, the NWB has identified that the report does not provide an implementation schedule, it does not address future area use, nor does it provide a proposal identifying measures by which restoration costs will be financed by the Licensee upon abandonment as required by sub-items (vi), (x), and (xii) respectively.

In its submission dated September 5, 2008, BGC noted that the *Arctic Bay Sewage Lagoon Decommissioning* report involves adding a cover of fill material over the sludge to encapsulate the sludge in permafrost. However, it was not clear whether maintaining the sludge in a permafrost condition was a design requirement. BGC recommended that if it is a requirement, that geothermal analyses be carried out to confirm that the proposed cover thickness of 1.5 metres is sufficient to encapsulate the sludge in permafrost and if so, for how long a design period considering the effects of climate change. BGC noted again in its December 10th comments, that this issue had not been addressed in the Applicant's November submission of additional information.

Therefore, the Board is requiring as a condition in Part G Item 2 of the Licence Amendment, that the Licensee submit to the Board for approval within ninety (90) days of Licence issuance a detailed Final Abandonment and Restoration Plan for the existing Sewage Disposal Facility. This Plan should incorporate, where applicable, the appropriate sections described in Part G Item 1 and address the concerns raised by BGC.

In its submission dated September 12, 2008, INAC recommended that as-built plans and drawings following the decommissioned existing Sewage Disposal Facility be provided. The

NWB agrees with INAC and is requiring the Licensee, as a condition in Part G Item 5, to submit to the Board within sixty (60) days of completion of decommissioning of the existing Sewage Disposal Facility, a Decommissioning Summary Report including stamped as-built plans and record drawings.

Monitoring Program

According to the report submitted by the Applicant, entitled *Design Brief New Sewage Lagoon for the Hamlet of Arctic Bay*, (Trow, April 2008), the new Wastewater Treatment Facility's earth berms are classified as dams under the Canadian Dam Safety Guidelines. Therefore, the Applicant has proposed ongoing monitoring for stability including temperature and seepage monitoring within the lagoon berms. Furthermore, BGC noted in its December 8, 2008 comments, that the designers have indicated that settlement of the upstream and downstream toes of the berms should be monitored, and that some maintenance of the berms may be required. As such, the Board has amended the Monitoring Program to include additional monitoring stations for the monitoring of temperature, seepage, and settlement of lagoon berms.

A number of geotechnical and geothermal concerns raised by BGC in its September 5, 2008 comments were not addressed by the Applicant in its submission of additional information including:

1. The description of the surficial geology of the proposed wastewater lagoon site;
2. Divergent ground temperature measurements from two borehole locations noted by NCI, 2008 and short thermistor string installation depths;
3. The potential warming influence of thick snow pack developing at the toe of the berms;
4. The depth of thermistor strings into the subgrade soils;
5. The location of the key trench liner from the toe of the berm;
6. The impact of displacements due to thaw settlement and creep strain on liner integrity; and
7. The design intent of a granular cover over sludge for the existing wastewater lagoon for decommissioning.

While items 5 and 7 have been dealt with as part of the construction and abandonment issues, items 1 - 4 and 6 must be dealt with through monitoring. Therefore, the Board is requiring as a condition in Part H Item 16 of the Licence amendment, that the Licensee submit to the Board for approval in writing, within thirty (30) days of issuance of this Licence Amendment, a detailed Instrumentation Monitoring and Surveillance Plan. This Plan is for inclusion in the O&M Manual and takes into consideration the Applicant's proposal to begin construction during the summer of 2009.

To assess the performance of the Wastewater Treatment Facility's lagoon structure, the Board is also requiring as a condition in Part H Item 15 of the Licence Amendment, that the Licensee

submit the monitoring results of thermistor, standpipe, and settlement monitoring semi-annually, due no later than July 31 and January 31 of each year for the first two (2) years of monitoring. In addition, the Licensee shall submit to the Board as an addendum to its Annual Report an annual assessment of the geotechnical and geothermal performance of the Wastewater Treatment Facility.

The Board has also amended the Monitoring Program to include Monitoring Program stations for the monitoring of Effluent from the Wastewater Treatment Facility, quarry runoff and sewage sludge.

Based upon comments received from INAC, GN-DOE and EC and the response from the Applicant on November 10, 2008, the Board has revised the monitoring frequency for effluent discharged from the Wastewater Treatment Facility from monthly between May and August, to three (3) times annually during decant (once and the onset, once during, and once at the end). The Board also notes EC's recommendation that monitoring should be sufficient to inform how the system can best be managed to optimize treatment.

The Board has included a new condition in Part H as Item 13, requiring the Licensee to submit to the Board as part of its O&M Manual, a QA/QC Plan. This Plan is to be developed immediately in consultation with a Canadian Association of Environmental Analytical Laboratories (CAEAL) approved laboratory, chosen to perform the analyses required under the Monitoring Program, to address both the field and laboratory requirements of monitoring this Licence. In addition, this Plan will need to be updated for inclusion in the O&M Manual for the new Wastewater Treatment Facility as required in Part F Item 1.

In addition, regarding effluent monitoring as discussed above under Sewage, the Board has removed the requirement to report all results of acute toxicity testing.

The Board has also removed the requirement that the Licensee measure and record the monthly and annual quantities of raw sewage offloaded from trucks. Raw water intake volumes are sufficient for the Board's purposes for estimating raw sewage generation volumes. However, the Board has included a condition in Part H Item 18 requiring the Licensee to measure and record the monthly and annual quantities of Effluent pumped from the Sewage Disposal Facility and the Wastewater Treatment Facility to account for any input from annual precipitation, runoff and potential losses through control structures and groundwater movement.

LICENCE AMENDMENT No. 1

Licencee:	**Hamlet of Arctic Bay**
Licence No:	**3BM-ARC0810 Type "B"**
Licence Issued:	**March 17, 2008**
Effective Date of Amendment No.1:	**April 16, 2009**

Pursuant to its authority under Article 13 of the *Agreement between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in Right of Canada* and the *Nunavut Waters* and the *Nunavut Surface Rights Tribunal Act*, the Nunavut Water Board hereby grants the following Licence amendment.

The Licence issued March 17, 2008 with an expiry date of March 31, 2010 shall be amended to include the following terms and conditions, with respect to the use of water and deposit of waste for a municipal undertaking in the Hamlet of Arctic Bay, located at the coordinates of 73° 02' north latitude and 83° 05' west longitude on north Baffin Island within the Qikiqtani Region of Nunavut.

New activities to be carried out include:

- Construction and operation of a new Wastewater Treatment Facility comprised of a single cell sewage lagoon and wetland treatment area;
- Construction of a new gravel access road from the existing lagoon to the new lagoon.
- Effluent release from the new lagoon to a 11.2 hectare Vegetated Filter Strip Wetland area that is approximately 700 metres long, 86-202 metres wide and flows northwest into Victor Bay
- Decommissioning of the existing Sewage Disposal Facility once the new Wastewater Treatment Facility is commissioned; and
- Quarrying from the Arctic Bay quarry.

The Licence shall be amended to reflect the following:

PART A: SCOPE AND DEFINITIONS

Insert
Item 2 **Definitions**

"Application for Water Licence Amendment" means the application filed by the Hamlet of Arctic Bay and GN-CGS with the NWB on April 30, 2008 including supporting documents;

"Construction" means any activities undertaken to construct or build any component of, or associated with, the new Wastewater Treatment Facility for the Hamlet of Arctic Bay, as described in the Application for Water Licence Amendment;

"**Dam Safety Guidelines**" means the *Canadian Dam Association (CDA) Dam Safety Guidelines (DSG), January 1999* or subsequent approved editions;

"Waste Disposal Facilities" means all facilities designated for the disposal of waste, and includes the Sewage Disposal Facility, the Wastewater Treatment Facility, and the Solid Waste Disposal Facility, as described in the Application for water licence renewal filed by the Applicant on October 9, 2007 including supporting documents, and as described in the Application for Water Licence Amendment filed by the Applicant on April 30th, 2008;

"Wastewater Treatment Facility" comprises the engineered sewage lagoon and decant structures designed to contain and treat sewage as described in the Application for Water Licence Amendment filed by the Applicant on April 30, 2008 and illustrated in construction drawings prepared by Trow Associates Inc. Project OTCD00019054A;

"Vegetated Filter Strip Wetland Area" comprises approximately 11.2 hectares of land immediately downstream of the sewage lagoon, for approximately 700 metres at a slope of 6 to 13% and includes the lagoon dewatering pump and infrastructure as described in the Application for Water Licence Amendment filed by the Applicant on April 30, 2008 and illustrated in construction drawings prepared by Trow Associates Inc. Project OTCD00019054A;

PART B: GENERAL CONDITIONS

Amend Item 1

The Licensee shall file an Annual Report with the Board no later than March 31st of the year following the calendar year reported which shall contain the following information:

i. tabular summaries of all data generated under the "Monitoring Program", including an interpretation and discussion of wastewater treatment levels of the Sewage Disposal Facilities and/or Wastewater Treatment Facilities, as well as the treatment efficiency of the Vegetated Filter Strip Wetland Area;

ii. any modifications to the Monitoring Program in accordance with Part H Item 12;

iii. the annual quantity in cubic metres or tonnes of sludge removed from the Sewage Disposal Facility along with the treatment/storage/disposal provided as required in Part H Item 10;

iv. the results of sampling and analyses of sewage sludge in accordance with the Operations and Maintenance Manuals referred to in Part F Item 1 and as required in Part H Item 14;

v. An assessment of the geotechnical and geothermal performance of the Wastewater Treatment Facility including an analyses of the results from the thermistor, standpipe and settlement monitoring stations, as required in Part H Item 15;

vi. the monthly and annual quantities in cubic metres of fresh water obtained from all sources;

vii. the monthly and annual quantities in cubic metres of each and all waste discharged;

viii. a summary of modifications and/or major maintenance work carried out on the Water Supply and Waste Disposal Facilities, including all associated structures and facilities;

ix. a list of unauthorized discharges and summary of follow-up action taken;

x. any updates or revisions for manuals and plans (i.e., Operations and Maintenance Manual) as required by changes in operation and/or technology;

xi. detailed minutes of any public consultation and participation with local organizations and the residents of the community regarding licence amendments;

xii. a summary of any abandonment and restoration work completed during the year and an outline of any work anticipated for the following year;

xiii. a summary of any studies, reports, and plans (e.g., Operations and Maintenance, Abandonment and Restoration, Quality Assurance/ Quality Control) requested by the Board that relate to waste disposal, water use or reclamation, and a brief description of any future studies planned; and

xiv. any other details on water use or waste disposal requested by the Board by

November 1st of the year being reported.

Amend
Item 10 The Licensee shall submit to the Board for approval in writing, within thirty (30) days of Licence issuance or upon the filing of any application in relation to the Licence within that time, a Plan for Compliance that clearly demonstrates the measures the Licensee will undertake, including an implementation schedule, to achieve full compliance with the conditions of this Licence, including the issues raised in the Inspector's Reports.

Amend
Item 11 The Licensee shall, for all Plans, Manuals and Reports submitted under this Licence, include a proposed timetable for implementation. Plans, Manuals and Reports submitted, cannot be undertaken without subsequent written Board approval and direction. The Board may alter or modify a Plan or Manual if necessary to achieve the legislative objectives and will notify the Licensee in writing of acceptance, rejection or alteration of the Plan.

Insert
Item 14 The Licensee shall, for all Plans, Manuals and Reports submitted under this Licence, implement the Plan as approved by the Board in writing.

Insert
Item 15 The Licensee shall submit to the Board for review, within thirty (30) days of Licence 3BM-ARC0810 Amendment No. 1 issuance, all available data generated under licence NWB3ARC0207 and subsequent renewal 3BM-ARC0810.

PART C: CONDITIONS APPLYING TO WATER USE

No changes

PART D: CONDITIONS APPLYING TO WASTE DISPOSAL

Amend
Item 1 Prior to commissioning the Wastewater Treatment Facility, the Licensee shall direct all Sewage to the Sewage Disposal Facility. Upon commissioning of the Wastewater Treatment Facility, the Licensee shall direct all Sewage to the Wastewater Treatment Facility, or as otherwise approved by the Board in writing.

Amend
Item 2 The Licensee shall provide notice to an Inspector at least ten (10) days prior to initiating any decant of the Sewage Disposal Facility or the Wastewater Treatment Facility.

Amend
Item 3 All Effluent discharged from the Sewage Disposal Facilities at Monitoring Program Station ARC-3 shall meet the following Effluent quality standards:

Parameter	Maximum Concentration of any Grab Sample
BOD_5	100 mg/L
Total Suspended Solids	120 mg/L
Faecal Coliforms	1×10^6 CFU/100mL
Oil and grease	No visible sheen
pH	between 6 and 9

Amend
Item 5 The Sewage Disposal Facility and Wastewater Treatment Facility shall be maintained and operated, to the satisfaction of an Inspector in such a manner as to prevent structural failure.

Remove
Item 6 All Effluent discharged from the Wetland Treatment Area Final Discharge Point (ARC-4) shall be demonstrated to be Not Acutely Toxic under the following tests to be conducted once annually approximately mid-way through discharge:

a. Acute lethality to Rainbow Trout, *Oncorhynchus mykiss* (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/13); and
b. Acute lethality to the crustacean, *Daphnia magna* (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/14).

Amend
Item 10 The Licensee shall submit to the Board for review within thirty (30) days of the issuance of this Licence amendment, a report identifying each Final Discharge Point of the existing Sewage Disposal Facility. The report shall at least include:

a. Plans, specifications, geographic coordinates and a general description of each Final Discharge Point; and
b. A description of how each Final Discharge Point is designed and maintained.

Amend
Item 11 If, during the term of this Licence, additional Final Discharge Points are

identified, the Licensee shall submit the information required by Part D Item 10 for each new Final Discharge Point, at least sixty (60) days prior to depositing Effluent from the new Final Discharge Point.

Insert
Item 12 All Effluent discharged from the Wastewater Treatment Facility at Monitoring Program Station ARC-8 shall not exceed the following Effluent quality standards:

Parameter	Maximum Concentration of any Grab Sample
BOD_5	120 mg/L
Total Suspended Solids	180 mg/L
Faecal Coliforms	1×10^6 CFU/100mL
Oil and grease	No visible sheen
pH	between 6 and 9

Insert
Item 13 The Licensee shall use clean material for construction, operation, and maintenance activities that is free of contaminants, obtained from an approved source and which has been demonstrated not to produce Acid Rock Drainage and to be non-Metal Leaching.

PART E: CONDITIONS APPLYING TO MODIFICATION AND CONSTRUCTION

Insert
Item 6 The Licensee shall implement the recommended options identified in the Water Licence Application document entitled *Design Brief New Sewage Lagoon for the Hamlet of Arctic Bay*, prepared by Trow Associates Inc., dated April 2008, Project No. OTCD00019054A. In the event of a conflict between the conditions of this Licence and the above referenced document, the conditions of this License shall prevail.

Insert
Item 7 The construction or disturbance of any stream/lake bed or the banks of any definable watercourse are not permitted unless authorization is obtained from the Department of Fisheries and Oceans Canada (DFO).

Insert
Item 8 The Licensee shall locate the Wastewater Treatment Facility's lined key trench horizontally from the upstream toe of the berm in accordance with the recommendations provided by Naviq Consulting in the application document

entitled *Geothermal Analysis of Proposed Sewage Lagoon, Arctic Bay, NU* prepared for Trow Associates Inc., Project J008, October 2008, Revision 2.

Insert
Item 9 The depth of the Wastewater Treatment Facility's lined key trench shall penetrate a minimum of 2 metres into sound rock or ice-saturated permafrost mineral soils or rock.

Insert
Item 10 The Licensee shall submit to the Board for approval in writing, prior to commencing construction or procurement of construction materials from the quarry, a Spill Contingency Plan that specifically addresses the quarry site operations and existing facilities. This Plan is to be incorporated into the Operations and Maintenance Manual referred to in Part F Item 1.

Insert
Item 11 Licensee shall, within sixty (60) days of completion of Construction of the Wastewater Treatment Facility, submit to the Board a Construction Summary Report along with stamped as-built plans and record drawings, providing explanation to reflect the deviations from construction drawings taking into account construction and field decisions and how they may affect the performance of the engineered facility. This Report is to include information on the following:

i. The as-built drawings must identify the areas where field changes were made from the original design drawings, preferably in the form of a revision bubble and a brief note in the revisions section of the title block;
ii. Details of the fill materials specifications for dike and key trench construction;
iii. The final location for the lined key trench and reasons for selecting the final location;
iv. Confirmation regarding the requirement for a spillway including a rationale;
v. Details regarding the installation of impermeable liners including the type of liner, how the liners were incorporated into the cell to prevent seepage, and a discussion of the quality assurance/ quality control measures applied during installation.

Insert
Item 12 The Licensee shall implement sediment and erosion control measures prior to and during Construction and blasting activities to prevent the release of sediment into any surrounding water bodies.

PART F: CONDITIONS APPLYING TO OPERATION AND MAINTENANCE

Amend
Item 1 The Licensee shall submit to the Board for approval in writing, within sixty (60) days of issuance of this Licence Amendment, an Operations and Maintenance Manual prepared where appropriate, in accordance with the *Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories; 1996.* This Manual shall take into considerations comments received during the application review process as well as any Inspector reports, and shall contain the following plans:

a. Water Supply Facilities Operation and Maintenance Plan;
b. Solid Waste Operation and Maintenance Plan;
c. Sewage Operation and Maintenance Plan for the existing Sewage Disposal Facility and the new Wastewater Treatment Facility;
d. Sewage Sludge Management Plan;
e. Hazardous Waste Management Plan;
f. Spill Contingency Plan including a Spill Response Plan for Aggregate deposits;
g. Monitoring Program Quality Assurance/Quality Control Plan including a diagram that references Monitoring Program Station Numbers; and
h. Instrumentation Monitoring and Surveillance Plan (This Plan is due within 30 days of issuance of this Licence Amendment. See Part H Item 16)

Amend
Item 3 An inspection of all engineered facilities related to the management of water and waste shall be carried out annually in July or August by a Geotechnical Engineer. The inspection shall be conducted in accordance with the *Canadian Dam Safety Guidelines* where applicable and shall include the decommissioned Sewage Disposal Facility. The engineer's report shall be submitted to the Board within sixty (60) days of the inspection, including a covering letter from the Licensee outlining an implementation plan addressing each of the Engineer's recommendations.

Amend
Item 5 If, during the period of this Licence, an unauthorized discharge of waste occurs, or if such a discharge is foreseeable, the Licensee shall:

a. employ the appropriate contingency measures as approved under the Operation and Maintenance Manual for the Hamlet of Arctic Bay;
b. report the incident immediately via the 24-Hour Spill Reporting Line at (867) 920-8130, to the Inspector at (867) 975-4295, and to the Government of Nunavut Department of Environment at (867) 975-7700; and

c. submit to the Inspector, a detailed report on each occurrence, not later than thirty (30) days after initially reporting the event, that provides the necessary information on the location (including the GPS coordinates), initial response action, remediation/clean-up, status of response (ongoing, complete), proposed disposal options for dealing with contaminated materials and any preventative measures to be implemented.

Insert
Item 6 The Licensee shall maintain an undisturbed buffer zone of at least one hundred (100) metres between any proposed quarry operation and the normal high water mark of any water body.

Insert
Item 7 The Licensee shall implement sediment and erosion control measures prior to and during activities carried out under this Part to prevent the release of sediment and minimize erosion.

Insert
Item 8 If water is encountered during permafrost excavation which requires pumping, the Licensee shall locate the discharge for the pumped water above the high water mark of any water body and implement erosion control measures at the point of discharge.

PART G: CONDITIONS APPLYING TO ABANDONMENT AND RESTORATION

Amend
Item 1 The Licensee shall submit to the Board for approval in writing, an Abandonment and Restoration Plan at least six (6) months prior to abandoning any facilities or upon submission of the final design drawings for the construction of new facilities to replace existing ones. Where applicable, the Plan shall include information on the following:

i. Water intake facilities;
ii. The water treatment and waste disposal sites and facilities;
iii. Petroleum and chemical storage areas;
iv. Any site affected by waste spills;
v. Leachate prevention;
vi. An implementation schedule;
vii. Maps delineating all disturbed areas, and site facilities;
viii. Stream crossings;
ix. Consideration of altered drainage patterns;
x. Type and source of cover materials;
xi. Future area use;

xii. Hazardous wastes; and
xiii. A proposal identifying measures by which restoration costs will be financed by the Licensee upon abandonment.

Insert
Item 2 The Licensee shall submit to the Board for approval in writing, within ninety (90) days of Licence issuance, a detailed Final Abandonment and Restoration Plan for the existing Sewage Disposal Facility. The Plan shall incorporate, where applicable, the appropriate sections as described in Part G Item 1 and address intervener comments raised during the review process, including specifications and purpose of cover materials over sludge remaining following decommissioning of the Sewage Disposal Facility.

Insert
Item 3 The Licensee shall practice progressive reclamation of the quarry development in accordance with the restoration guidelines outlined in Indian and Northern Affairs Canada's document entitled *Environmental Guidelines for Pits and Quarries, 1982.*

Insert
Item 4 For site reclamation purposes, the Licensee shall salvage topsoil for future restoration of the site to promote revegetation.

Insert
Item 5 The Licensee shall, within sixty (60) days of completion of decommissioning of the existing Sewage Disposal Facility, submit to the Board a Decommissioning Summary Report. This Report shall include stamped as-built plans and record drawings, providing explanation to reflect any deviations from original plans.

PART H: CONDITIONS APPLYING TO THE MONITORING PROGRAM

Amend
Item 1 The Licensee shall maintain Monitoring Program Stations at the following locations and implement the following Program:

Monitoring Program Station Number	Description	Frequency	Status
ARC-1	Raw water intake at Marcil Lake	Volume Monthly and Annually	Active (Volume)
ARC-2	Raw sewage from pump out truck	NA	Inactive

ARC-3	Effluent discharged from the Final Discharge Point of the existing Sewage Disposal Facilities	Volume Monthly and Annually Water Quality Three (3) times annually (once at the onset of decant; once during decant; and once at the end of decant)	Active*
ARC-4	Discharge Point of the existing Sewage Disposal Facility's Wetland Treatment Area	Water Quality Three (3) times annually (once at the onset of decant; once during decant; and once at the end of decant)	Active*
ARC-5	Ocean water five (5) metres from point where Effluent enters the ocean from existing Sewage Disposal Facility	Water Quality Three (3) times annually (once at the onset of decant; once during decant; and once at the end of decant)	Active*
ARC-6	Run-off from the Solid Waste Disposal Facility	Water Quality Annually during periods of runoff or seepage	Active
ARC-7	Runoff from Quarry Site	Water Quality Annually during periods of runoff or seepage	New (Water quality)
ARC-8	Effluent discharged from the Final Discharge Point of the Wastewater Treatment Facility (at the sewage lagoon pump)	Volume Monthly and Annually Water Quality Three (3) times annually (once at the onset of decant; once during decant; and once at the end of decant)	New (Volume and Water quality)

ARC-9	Discharge Point of the Wastewater Treatment Facility's Vegetated Filter Strip Wetland Area	Water Quality Three (3) times annually (once at the onset of decant; once during decant; and once at the end of decant)	New (Water quality)
ARC-10	Ocean water five (5) metres from point where Effluent enters the ocean from Wastewater Treatment Facility	Water Quality Three (3) times annually (once at the onset of decant; once during decant; and once at the end of decant)	New (Water Quality)
ARC-11	Thermistors in accordance with approved Instrumentation Monitoring and Surveillance Plan as required in Part H Item 16	TBD	New (Temperature)
ARC-12	Standpipes in accordance with approved Instrumentation Monitoring and Surveillance Plan as required in Part H Item 16	TBD	New (Seepage)
ARC-13	Settlement stations in accordance with approved Instrumentation Monitoring and Surveillance Plan as required in Part H Item 16	TBD	New (Location, Elevation)

* Active until the Sewage Disposal Facility is decommissioned.

Amend
Item 2 The Licensee shall sample water quality at Monitoring Program Stations ARC-3, ARC-4, ARC-5, ARC-8, ARC-9 and ARC-10 three (3) times annually (once at the onset of decant; once during decant; and once at the end of decant). Samples shall be analyzed for the following parameters:

Biochemical Oxygen Demand – BOD_5	Faecal Coliforms
Total Suspended Solids	pH
Conductivity	Nitrate-Nitrite
Oil and Grease (visual)	Total Phenols
Magnesium	Calcium

Sodium	Potassium
Chloride	Sulphate
Total Hardness	Total Alkalinity
Ammonia Nitrogen	Total Zinc
Total Cadmium	Total Iron
Total Cobalt	Total Manganese
Total Chromium	Total Nickel
Total Copper	Total Lead
Total Aluminum	Total Arsenic
Total Mercury	Total Organic Carbon (TOC)

Amend
Item 3 The Licencee shall sample at Monitoring Program Stations ARC-6 and ARC-7 annually during periods of runoff or seepage. Samples shall be analyzed for the following parameters:

TPH (Total Petroleum Hydrocarbons)
PAH (Polycyclic Aromatic Hydrocarbons)
BTEX (Benzene, Toluene, Ethylbenzene, Xylene)

BOD	Faecal Coliforms
pH	Conductivity
Total Suspended Solids	Oil and Grease
Nitrate-Nitrite	Ammonia Nitrogen
Total Phenols	Total Alkalinity
Total Hardness	Calcium
Magnesium	Potassium
Sodium	Sulphate
Total Arsenic	Total Cadmium
Total Copper	Total Chromium
Total Iron	Total Lead
Total Mercury	Total Nickel

Remove
Item 4 The Licensee shall report all results of acute toxicity testing as required under Part D, Item 6 within the Annual Report as per Part B, Item 1.

Remove
Item 6 The Licensee shall measure and record, in cubic metres, the monthly and annual quantities of raw sewage offloaded from trucks at Monitoring Program Station ARC-2, for all purposes.

Amend
Item 10 The Licensee shall measure and record the annual quantities of sludge removed

from the Sewage Disposal Facility and the Wastewater Treatment Facility along with the treatment/storage/disposal provided.

Amend Item 11

The Licensee shall include all of the data and information required by the Monitoring Program as well as an indication of wastewater treatment levels upstream and downstream of the Vegetated Filter Strip Wetland Area in the Licensee's annual report, as required *per* Part B Item 1, or as requested by an Inspector.

Amend Item 12

Modifications to the Monitoring Program may be made only upon written approval from the Board. Requests for changes to the Monitoring Program should be forwarded to the NWB in writing, and should include the justification and appropriate evidence to support the change.

Insert Item 13

The Licensee shall submit to the Board upon approval by an Analyst, for inclusion in the Operations and Maintenance Manual, required under Part F Item 1(g), a Quality Assurance/ Quality Control Plan. The Plan shall include up to date sampling methods to all applicable standards, acceptable to an accredited laboratory as required by Part H Item 8 and Part H Item 9. The Plan shall include a covering letter from the accredited laboratory and Analyst, confirming acceptance of the Plan for analyses to be performed under this Licence.

Insert Item 14

The Licensee shall sample and analyze sludge in accordance with the approved Operations and Maintenance Plan referred to in Part F Item 1. The results shall be reported within the Annual Report as per Part B Item 1.

Insert Item 15

The Licensee shall submit to the Board the monitoring results for thermistor, standpipe, and settlement stations at monitoring stations ARC-11, ARC-12, and ARC-13 semi-annually, due no later than July 31, and January 31 of each year, for the first two (2) years of monitoring. An annual assessment of the geotechnical and geothermal performance of the Wastewater Treatment Facility shall be provided as an addendum to the Annual Report required as per Part B Item 1. This assessment shall include:

i. an interpretation of unexpected monitoring results;
ii. an analyses of settlement station results on liner integrity; and
iii. an analyses of thermistor and seepage results on berm stability.

Insert
Item 16 The Licensee shall submit to the Board for approval in writing, within thirty (30) of issuance of this Licence Amendment, a detailed Instrumentation Monitoring and Surveillance Plan for inclusion in the O&M Manual, required under Part F Item 1(h). This Plan shall include:

i. Details of the proposed instrumentation plan, the frequency of measurements and trigger values or observations for remedial action;
ii. A review of geothermal monitoring plans including the number of thermistors to be installed, the location of thermistor installations, the installation of thermistors within the key trench, the depth of thermistor strings in subgrade soils, justification for the final chosen depth of thermistor strings, and the final detailed design of thermistor strings, taking into consideration reviewer comments; and
iii. Details of settlement monitoring at the upstream and downstream toes of the berms.

Insert
Item 17 The Licensee shall confirm the locations and GPS coordinates for all monitoring stations referred to in Part H Item 1 with an Inspector.

Insert
Item 18 The Licensee shall measure and record in cubic metres, the monthly and annual quantities of effluent pumped from Monitoring Program Stations ARC-3 and ARC-8.

All terms and conditions of Licence 3BM-ARC0810 Type "B" dated March 17th, 2008 still apply.

This Licence Amendment is issued and recorded at Gjoa Haven, NU on April 16, 2009

Approved by,

Thomas Kabloona
Nunavut Water Board, Chair

Appendix B – Spill Contingency Plan

Government of Nunavut

Spill Response Plan - Wastewater Treatment Site
Arctic Bay, Nunavut

Project Name:
Arctic Bay Waste Water Facility

Project Number:
OTCD00019054A

Prepared By:
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Date Submitted:
01/09/11

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List of Appendices

1.0 Introduction

Exp Services Inc. (**exp**) formerly Trow Associates Inc. was retained by the Government of Nunavut – Department of Community and Government Services to prepare a Spill Response Plan (SRP) as part of the operation and maintenance of the Hamlet of Arctic Bay's (Hamlet) wastewater treatment site (sewage lagoons). This SRP also demonstrates the Hamlet's stewardship in environmental management.

The purpose of the SRP is to address potential environmental spill incidents that may occur during the routine operation and maintenance activities of the wastewater treatment site. The SRP is designed to be protective of the local natural environment.

The SRP includes a review of appropriate Government acts and regulations, the identification of foreseeable spill scenarios, spill response procedures and general health, safety and emergency response requirements necessary when conducting activities that may require contact with the subsurface materials. The SRP does not replace any Health & Safety protocols, procedures, etc. already established by the Hamlet but rather is intended to be complimentary to existing protocols.

Situations may arise during the site work that are beyond the scope of the safety procedures stated in this document. In such a situation, it may be necessary to stop on-site work until a revised procedure or SRP is prepared to reflect the changing conditions.

It is recommended that all persons involved with on-site operations read the SRP. If there are any questions regarding any aspect to this document, individuals are encouraged to contact **exp** for additional information or clarification.

2.0 Site Description

The wastewater treatment site (sewage lagoon) in the vicinity of the Hamlet, for which this SRP was developed, is shown on Figure 1 (below) depicted by the lagoon cell. The sewage lagoon was constructed in a small valley overlooking the existing lagoons and Admiralty Inlet to the south and Victor Bay to the north. The vegetated area between the new lagoon and Victor Bay will be incorporated into the sewage treatment process as the filterstrip wetlands.

Figure 1: Location of the Wastewater Treatment Site, Arctic Bay, NU

3.0 Regulations

With respect to spills, the Guidelines for Spill Contingency Planning[1] and Environmental Protection Act (R-068-93) require that all spill response plans include:

- The name, address and job title of the owner or person in charge, management or control of the facility;
- The name, job title and 24-hour telephone number for the person(s) responsible for activating the spill response plan;
- A description of the facility, a description of the type and amount of contaminants normally stored at the facility and a site map of the facility;
- The steps to be taken to report, contain, clean up and dispose of contaminants in the case of a spill;
- The means by which the spill response plan is activated;
- A description of the training provided to employees to respond to a spill;
- An inventory of and the location of response and clean-up equipment available to implement the spill response plan; and,
- The date the spill response plan was prepared.

[1] Prepared by Water Resources Division Indian and Northern Affairs Canada Yellowknife, NT April 2007

4.0 Contacts & Regulatory Authorities

The following table includes the contact information for the persons responsible for the facility. The persons listed below should be contacted in the event of a spill.

Table 1: Contacts

Name	Job Title	24-Hour Telephone #

In each instance that a spill is identified, the Emergency Spill Hotline and the Aboriginal Affairs and Northern Development Canada Water Resources Inspector shall be contacted as soon as possible. A NT-NU Spill Report Form (included) should also be completed and faxed to the Emergency Spill Hotline. The necessity to contact the other agencies will be contingent upon direction from the Emergency Spill Hotline.

Emergency Spill Hotline: Phone: (867) 920-8130, Fax (867) 873-6924

Aboriginal Affairs and Northern Development Canada Water Resources Inspector: Phone: (867) 975-4295

In addition to the local contacts described above, the following table summarizes the additional regulatory authorities that have a vested interest in the event of a spill.

Table 2: Additional Agencies

Agency	Legislation	Contact Phone #
Nunavut Water Board	Nunavut Waters and Surface Right Tribunal Act	(867) 360-6338
Nunavut Impact Review Board	Nunavut Land Claims Agreement Act	(867) 983-2593
Environment Canada	Canadian Environmental Protection Act, 1999	(867) 975-4464
Transport Canada (Coast Guard)	Transportation of Dangerous Goods Act	(867) 979-5269
Department of Fisheries and Oceans	Fisheries Act	(867) 645-2871

5.0 Potential Contaminants and Spill Scenarios

Potential spill scenarios are dependent on the types and volumes of materials that are being used on the sites and the activities being carried out. For the purpose of this SRP, spill sizes are described as small (<10 litres), medium (>10 litres and <100 litres) or large (>100 litres).

The primary potential contaminants at the wastewater treatment site include raw sewage and sewage sludge. Other materials (potential contaminants) that are anticipated to be present on the site include gasoline, diesel fuel, hydraulic oil, motor oil and other lubricants, antifreeze and coolants from sewage delivery trucks and any heavy equipment in use for maintenance purposes. Spills may be the result of any of the following occurrences:

- Leaks or breaches of the sewage lagoon berms;
- Spill during transfer of liquids (sewage);
- Leaks or ruptures of vehicular fuel or hydraulic oil storage tanks;
- Valve or line failure in systems on vehicles or operating equipment;
- Heat expansion due to overfilling;
- Vehicular accidents; and/or,
- Vandalism.

6.0 Reportable Spill Quantities

In the event of a spill, the following table is to be used as a guide to determine if the spill should be reported to the proper authorities. Any spilled quantities that exceed the specified amounts must be reported to the **Emergency Spills Hotline**. Spills of any quantity that occur near or into fish-bearing waters or sensitive environment, wildlife or habitat must be reported. In addition, spills of any quantity that pose an imminent threat to human health or life or listed species at risk or critical habitat must also be reported. It is recommended that any spill of significant size be reported and the advice received should be followed.

Table 3: Reportable Quantities[1]

Item	TDGA[2] Class	Contaminant	Amount Spilled
1	2	Explosives	Any amount
2	2.1	Compressed Gas (flammable)	Any amount of gas from containers with capacity greater than 100 kg
3	2.2	Compressed Gas (non-corrosive, non-flammable)	Any amount of gas from containers with capacity greater than 100 kg
4	2.3	Compressed Gas (toxic)	Any amount
5	2.4	Compressed Gas (corrosive)	Any amount
6	3.1, 3.2, 3.3	Flammable Liquid	100 L
7	4.1	Flammable Solid	25 kg
8	4.2	Spontaneously Combustible Solids	25 kg
9	4.3	Water Reactant Solids	25 kg
10	5.1	Oxidizing Substances	50 L or 50 kg
11	5.2	Organic Peroxides	1 L or 1 kg
12	6.1	Poisonous Substances	5 L or 5 kg
13	6.2	Infectious Substances	Any amount
14	7	Radioactive	Any amount
15	8	Corrosive Substances	5 L or 5 kg
16	9.1(in part)	Misc. products or Substances Excluding PCB Mixtures	50 L or 50 kg
17	9.2	Environmentally Hazardous	1 L or 1 kg
18	9.3	Dangerous Wastes	5 L or 5 kg
19	9.1 (in part)	PCB Mixtures of 5 or More Parts Per Million	0.5 L or 0.5 kg
20	None	Other Contaminants	100 L or 100 kg

Notes:

[1)] *Environmental Protection Act*, Consolidation of Spill Contingency Planning and Reporting Regulations
[2)] TDGA Class – Transportation of Dangerous Goods Class under the *Transportation of Dangerous Goods Act*.

7.0 Spill Response Procedures

The following section describes the appropriate spill response procedures that should be followed in the event of a spill to various media (bedrock, gravel, soil, water, ice or snow).

7.1 Spills on Land

For spills on land (soil, gravel, sand, rock, and vegetation), the following procedure should be followed:

1. Extinguish all sources of ignition (i.e., shut off engines, no smoking).
2. If possible, identify the spilled material.
3. Make sure the area is safe for entry and the spill does not represent a threat to the health or safety of the responder or others at the spill site.
4. Assess whether the spill can be readily stopped or brought under control and if safe and possible, stop the source of the spill (i.e., plug hole, close valve, install upright container) or place tarp under spill source and build up tarp edges to contain spill.
5. If the spill is sufficiently large that it cannot be controlled with the materials at hand, the spill should be reported immediately.
6. Stop spilled liquids from spreading or entering waterways using absorbent materials or a soil dyke down slope from the spill.
7. Contact facility supervisor and report the spill.
8. If possible with materials at hand, clean up remaining spilled material and store in a secure container for disposal. Do not flush area with water.
9. If possible, pump any contained liquid into drums.
10. Complete a Spill Reporting Sheet.
11. Contact: Emergency Spill Hotline: Phone: (867) 920-8130, Fax (867) 873-6924 for additional advice.
12. Contact: Aboriginal Affairs and Northern Development Canada Water Resources Inspector: Phone: (867) 975-4295 to report the spill.
13. Submit to the Aboriginal Affairs and Northern Development Canada Water Resources Inspector, a detailed report including the GPS location of the spill, no later than thirty (30) days after initially reporting the event.

7.2 Spills on Water

For spills on water, the following procedure should be followed:

1. Extinguish all sources of ignition (i.e., shut off engines, no smoking).
2. If possible, identify the spilled material.
3. Make sure the area is safe for entry and the spill does not represent a threat to the health or safety of the responder or others at the spill site.
4. Assess whether the spill can be readily stopped or brought under control and if safe and possible, stop the source of the spill (i.e., plug hole, close valve, upright container).
5. If the spill is sufficiently large that it cannot be controlled with the materials at hand, spill report the spill immediately.

6. Use sorbant booms to contain spill for recovery, place sorbant sheets on water within boomed perimeter. For narrow waterways, place one or more booms across the waterway, down stream of the spill location and anchor boom ends on each bank. Store saturated sorbant sheets and booms in drums for disposal.
7. Contact facility supervisor and report the spill.
8. If possible with materials at hand, clean up remaining spilled material and store in a secure container.
9. Complete a Spill Reporting Sheet.
10. Contact: Emergency Spill Hotline: Phone: (867) 920-8130, Fax (867) 873-6924 for additional advice.
11. Contact: Aboriginal Affairs and Northern Development Canada Water Resources Inspector: Phone: (867) 975-4295 to report the spill.
12. Submit to the Aboriginal Affairs and Northern Development Canada Water Resources Inspector, a detailed report including the GPS location of the spill, no later than thirty (30) days after initially reporting the event.

7.3 Spills on Snow and Ice

Spills on ice present the potential for immediate access of the contaminants to water therefore, immediate response to the spill is essential. For spills on snow and ice, the following procedure should be followed:

1. Extinguish all sources of ignition (i.e., shut off engines, no smoking).
2. If possible, identify the spilled material.
3. Make sure the area is safe for entry (i.e., ice thickness) and the spill does not represent a threat to the health or safety of the responder or others at the spill site.
4. If the spill is sufficiently large that it cannot be controlled with the materials at hand, the spill should be reported immediately.
5. Assess whether the spill can be readily stopped or brought under control and if safe and possible, stop the source of the spill (i.e. plug hole, close valve, install upright container) or place tarp under spill source and build up tarp edges to contain spill.
6. Stop spilled liquids from spreading or entering waterways using absorbent materials or a snow/soil dyke.
7. Contact facility supervisor and report the spill.
8. If possible with materials at hand, clean up remaining spilled material and store in a secure container (i.e., drum, polyethylene bags). Store impacted snow in drums for disposal.
9. Contact: Emergency Spill Hotline: Phone: (867) 920-8130, Fax (867) 873-6924 for additional advice.
10. Contact: Aboriginal Affairs and Northern Development Canada Water Resources Inspector: Phone: (867) 975-4295 to report the spill.
11. Submit to the Aboriginal Affairs and Northern Development Canada Water Resources Inspector, a detailed report including the GPS location of the spill, no later than thirty (30) days after initially reporting the event.

7.4 Additional Spill Delineation/Monitoring

As a result of a large spill in which not all of the spilled material can be readily recovered as described above, additional delineation in the form of a subsurface investigation (i.e., test pits, boreholes, and monitoring wells) may be required to determine the lateral and vertical extents of the impacts to the subsurface soil and/or groundwater. The additional delineation/monitoring information will be used to develop an appropriate remediation plan. In such cases, a qualified environmental consultant should be retained to provide advice with respect to how to proceed with the additional assessment.

8.0 Spill Kit and Training Requirements

The following section presents the recommended minimum requirements for the content and number of spill kits that should be present.

8.1 Spill Kit

Each spill kit should be inspected regularly to ensure that it contains, as a minimum, the following:

- 1 – 205 litre, open top steel drum with a lid, bolting ring and gasket;
- 1 Spark proof shovel;
- 1 package of 10 disposable 5 mil polyethylene bags (approx. 65 cm x 100 cm);
- 4 – 12.5 cm (approx. 5") x 3 m (approx. 10') sorbant (oil-absorbing) booms;
- 10 kg bag of sorbant particulate;
- 1 bail of 50 cm x 50 cm (approx.) sorbant sheet (100 Sheets/bail);
- 1 x 5m x 5m approx. plastic tarp;
- 2 pairs of oil resistant gloves; and,
- 2 pairs of splash protective goggles.

8.2 Additional Spill Response Supplies

In addition to the materials contained in the spill kits, an inventory of the following supplies should be available for use if required.

- 10 – 205 litre, open top steel drum with a lid, bolting ring and gasket;
- 2 Spark proof shovels;
- 5 packages of 10 disposable 5 mil polyethylene bags (approx. 65 cm x 100 cm);
- 10 – 12.5 cm x 3 m sorbant (oil-absorbing) booms;
- 5 x 10 kg bags of sorbant particulate;
- 5 bails of 50 cm x 50 cm (approx.) sorbant sheet (100 Sheets/bail);
- 2 pairs of oil resistant gloves; and,
- 2 pairs of splash protective goggles.

8.3 Spill Kit Locations

The spill kit, with the exception of the shovel, can be contained within the 205 L drum which should be sealed securely to protect the contents. The drum should also be accessible without the use of tools (i.e., bolt ring only finger tight). The bolt ring should be inspected regularly to ensure that it turns freely and lubricated if it does not. At least one spill kit should be clearly identified and readily available during any maintenance work undertaken at the wastewater treatment facility.

8.4 Hamlet Spill Kit Availability

The number of spill kits available throughout the Hamlet and their storage locations should be determined during the preparation of an overall Spill Contingency Plan for the Hamlet. As indicated in Section 8.3 (above), at least one spill kit should be readily available during maintenance activities at the wastewater treatment facility.

8.5 Training

To ensure the effectiveness of the SRP, the following actions should be followed:

1. The SRP should be reviewed, as a minimum, on an annual basis and updated as required by changes in operation and/or technology.
2. The SRP should be distributed to the personnel on the site.
3. The personnel should be informed of the locations of all potentially hazardous materials and their associated Material Safety Data Sheets (MSDS).
4. The personnel should be trained in the use of the MSDS and the techniques and materials used to contain and remediate spilled materials.
5. The personnel should be informed as to the importance of first response with respect to the protection of human health and safety, the environment, property, wildlife and the ecosystem by reducing the impact of spills.

9.0 General Safety Practices and Site Rules

The following is a list of site rules that should be followed to maintain safe working conditions during a spill response:

1. Eating, drinking, chewing gum and smoking are prohibited in contaminated or potentially contaminated areas, or where the possibility for the transfer of contamination exists. This would include areas of active excavation and metal removal.
2. Personnel who have worked on-site shall wash their hands and face thoroughly with soap and water and remove themselves from the spill area prior to eating, drinking or smoking.
3. All field crew workers should be aware of potentially dangerous situations that they should avoid (i.e. the presence of strong, irritating or nauseating odours). Field crew workers should also be familiar with the physical characteristics of the site including:
    - wind direction in relation to areas of known contamination;
    - accessibility to equipment and vehicles;
    - communications; and,
    - site access.

Table 4: Outside Emergency Contacts

Agency	Function	Phone Number
Hamlet of Arctic Bay	On-site Supervisor	(867) 439-9917
Arctic Bay Health Centre	Medical Emergency	(867) 439-8816
Fire	Fire, Accident or Rescue	(867) 439-9999
RCMP (Arctic Bay)	Security, Vandalism	(867) 439-1111

10.0 Closure

This Spill Response Plan has been prepared for the Hamlet of Arctic Bay's wastewater treatment site. It does not replace, nor is intended to replace, the general provision of the applicable Federal and Territorial statutes regarding workplace safety or any protocols previously established by the Hamlet. Instead, it may be used to augment any existing plans.

Appendix 1 – NT-NU Spill Report Form

NT-NU SPILL REPORT

OIL, GASOLINE, CHEMICALS AND OTHER HAZARDOUS MATERIALS

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

REPORT LINE USE ONLY

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

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

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

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

REPORT LINE USE ONLY

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

LEAD AGENCY ☐ EC ☐ CCG ☐ GNWT ☐ GN ☐ ILA ☐ INAC ☐ NEB ☐ TC | SIGNIFICANCE ☐ MINOR ☐ MAJOR ☐ UNKNOWN | FILE STATUS ☐ OPEN ☐ CLOSED

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

Appendix C – Sampling Sheets

Thermistor Record Sheet

MONITORING SITE
(TEMPERATURE RECORDED IN DEGREES CELSIUS)

SENSOR	DEPTH (m)	1	2	3	4	5
1	0					
2	0.5					
3	1					
4	2					
5	4					
6	6					
7	8					
8	10					

INITIALS/SIGNATURE:

DATE:

Appendix D – Thermistor Data Collection

Quickstart for Installation Validation of the Thermistor String

1.0 Installation Validation Steps

- Installation of the loggernet software on the computer
- Connect the thermistor string to the test box (using the rectangular-shaped connector)
- Turn the power on with the terminal block blade
- Start the computer and the LoggerNet Software (setup the connection)
- Monitor data
- Collect data

2.0 LoggerNet Software

2.1 Description

The LoggerNet is a fullly featured Windows-based software package that allows direct communication with the test box using a RS-232 connection. A “Connect” screen provides real-time tools to set the datalogger clock in order to send the program to the datalogger and manually collect data using a computer. In addition, data can also be retrieved automatically, based on a predefined schedule. Measurements can be viewed in real-time on both numeric and graphical displays. In addition to these basic tools, the software package includes a datalogger program editor, a report generation tool and a data viewer with basic plotting capabilities.

This application note is intended to give the user a quickstart in getting the datalogger powered up and running. However, we strongly recommend that the user read the LoggerNet manual in order to get familiar with its features.

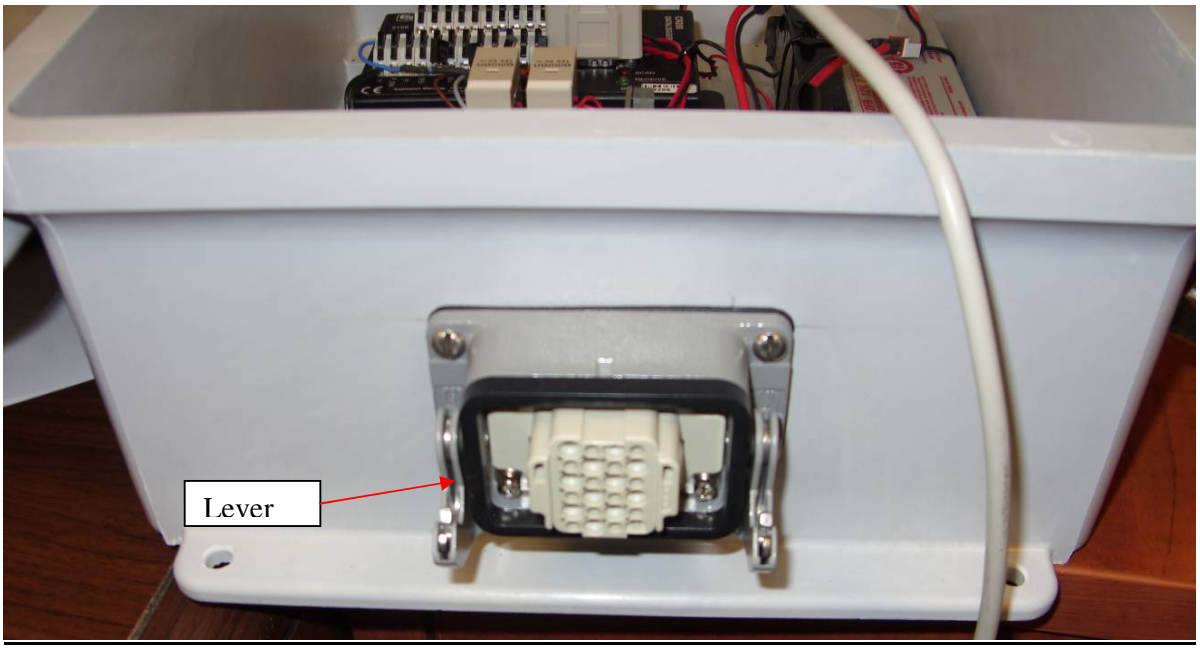
2.2 Software Installation

The LoggerNet is a collection of 32-bit programs designed for Intel-based computers running Microsoft Windows 2000, Windows XP or Vista.

As with all softwares, we strongly recommend that a back-up of critical files be performed before software installation. Place the installation disk in your computer’s CD/DVD drive. If autorun is enabled, LoggerNet installation will start. If it does not start, select START > RUN fom the Windows’s START menu. Locate the SETUP.EXE file on the CD/DVD drive and click OK. Follow the instructions on the screen. Refer to the LoggerNet manual for further details.

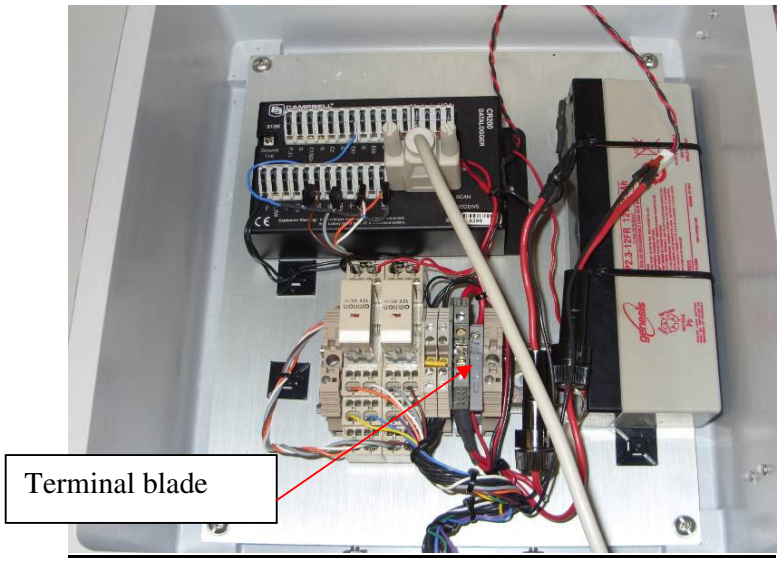
When the installation is done, a LoggerNet icon will be placed on your desktop.

3.0 Connection of the Thermistor String to the Test Box



Connect the connector to the mating on the test box and lift up the lever to secure the connector in place. *NOTE: make sure to seal back the connector of the thermistor string to avoid any water infiltration in the connector before the final installation.*

4.0 Turn the Power On on the Test Box



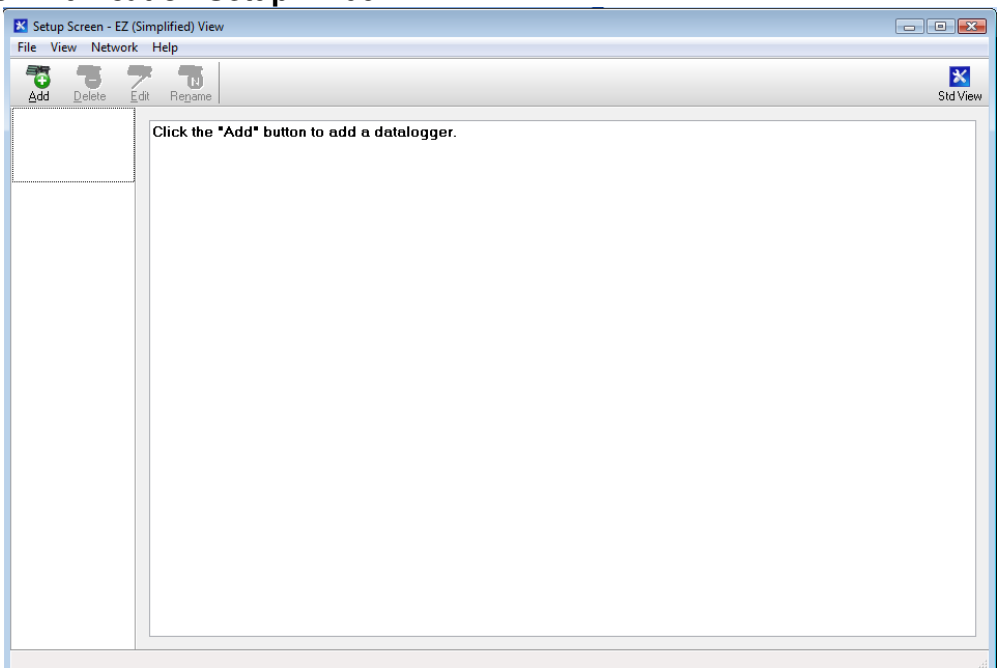
The terminal blade is used to turn the power OFF. Lower the blade to turn the unit ON. Make sure to raise the blade at the end of the test to avoid any battery drainage.

5.0 Setup the Connection

The hardware and software setups are done. The following steps describe the instructions to connect the datalogger, to collect or monitor data

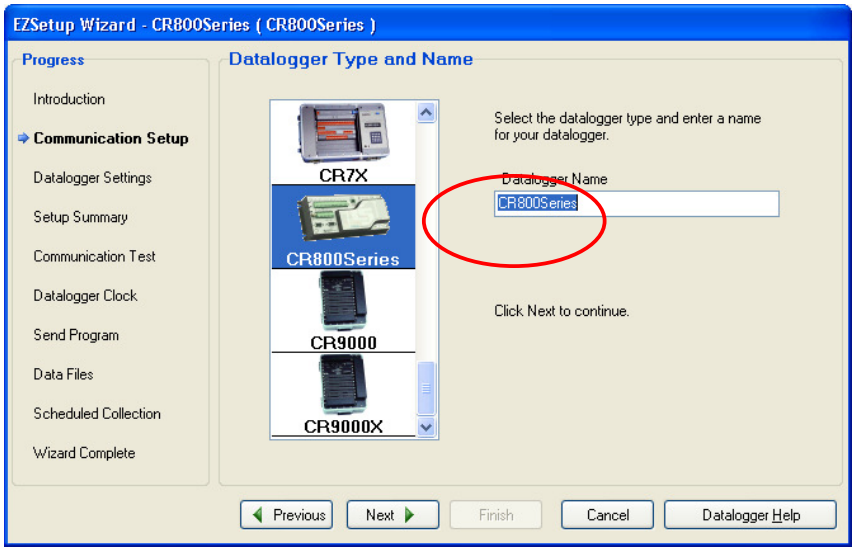
To start the LoggerNet, double click on the LoggerNet desktop icon.

- From the **MAIN** / **SETUP**, click **Add** and then click **Next**, which will get you to the **Communication Setup** window.

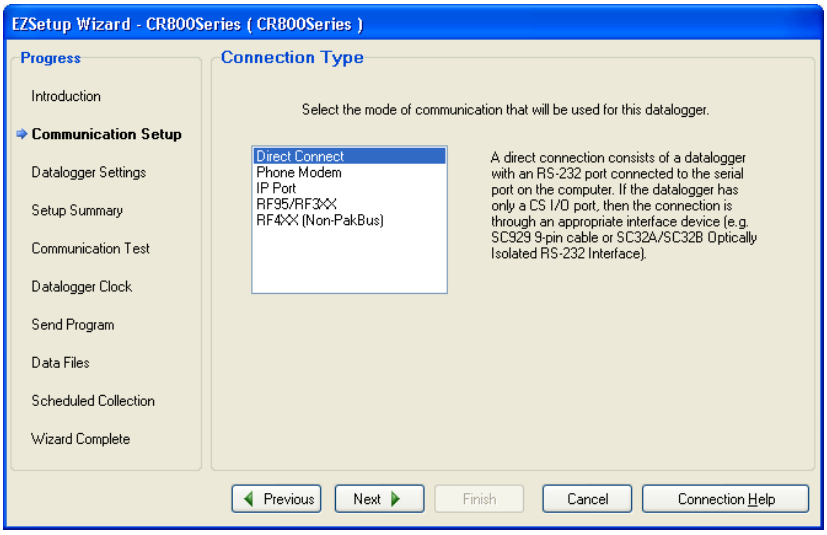


- Wait at least 15 seconds after powering up the unit before attempting to communicate with it.

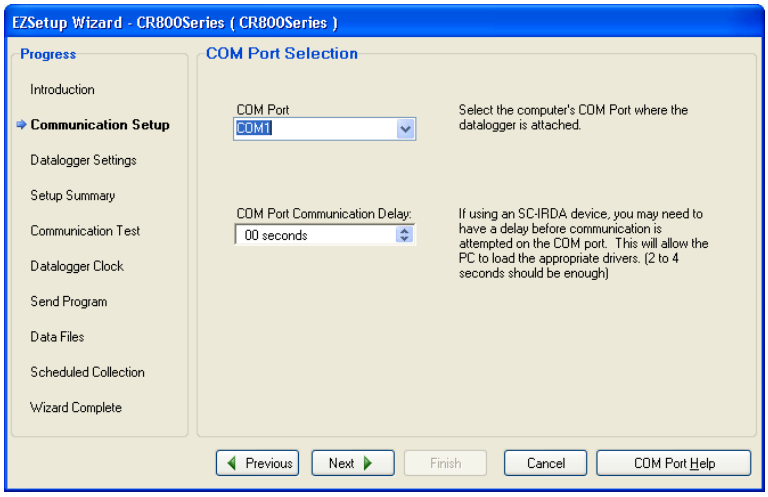
- Under **Datalogger Type and Name**, select **CR200 Series,** and next under **Datalogger Name**, choose a name that best represents your application. For example, type ***Thermistor*** and click **Next**. This datalogger name will be used later to connect to the Thermistor datalogger.



- Select **Direct Connect** and click **Next**.

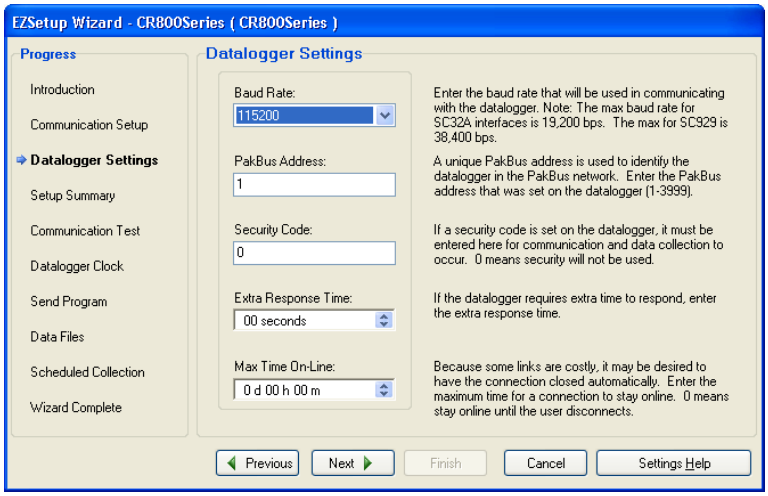


- Select the appropriate **COM port** on your computer. Usually, if you have a serial port on your computer, **COM 1** will be available. However, if you use a USB Serial adaptor, a virtual port will be created and a new COM port number will be assigned. Click **Next** when done.

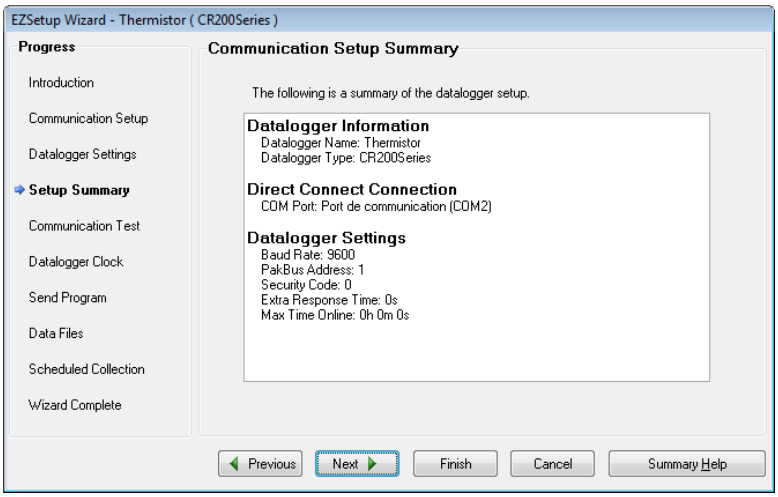


- Use the default parameters and click **Next**.

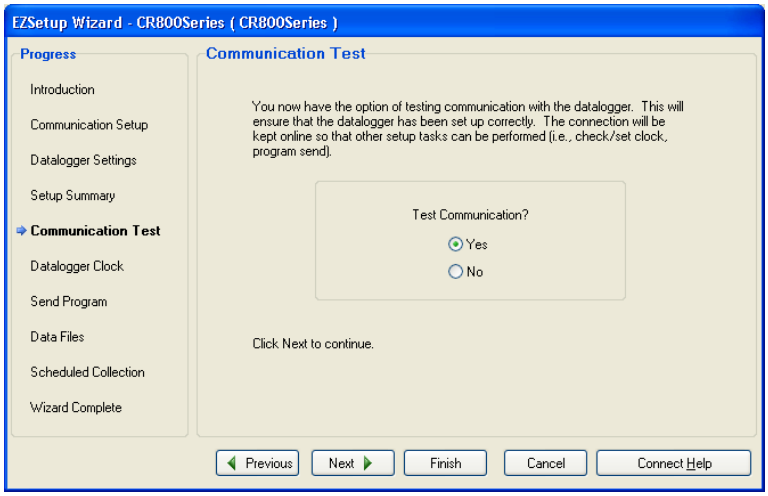
Note: If you use a USB Serial adapter you may need to lower the Baud Rate, in general **9600** works fine with the adapter.



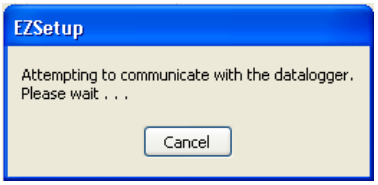
- The following window displays the Communication Setup Summary. Click **Next**.



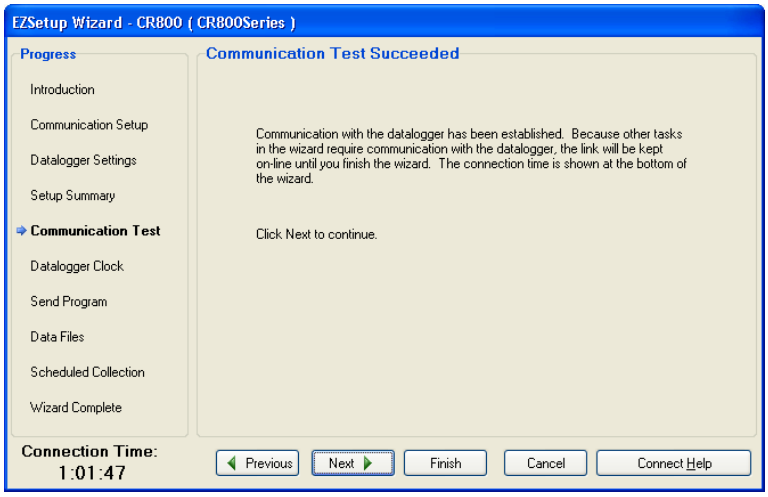
- To test the communication, select **Yes** and click **Next**.



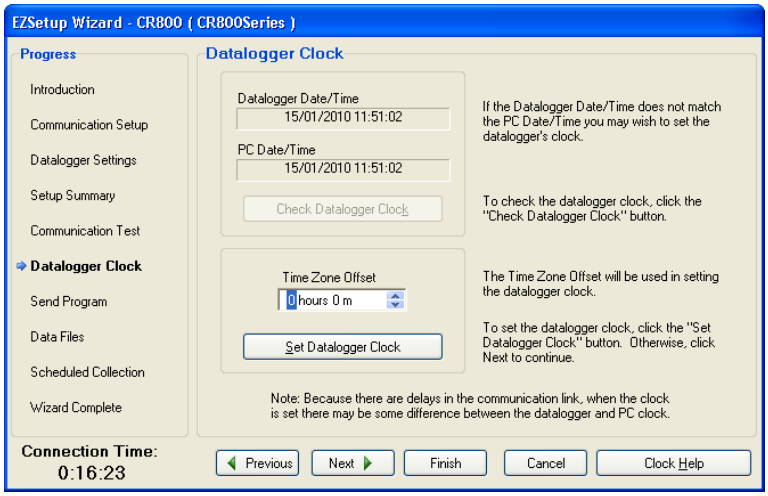
The following message will appear on the screen while your computer is attempting to communicate with the Thermistor datalogger.



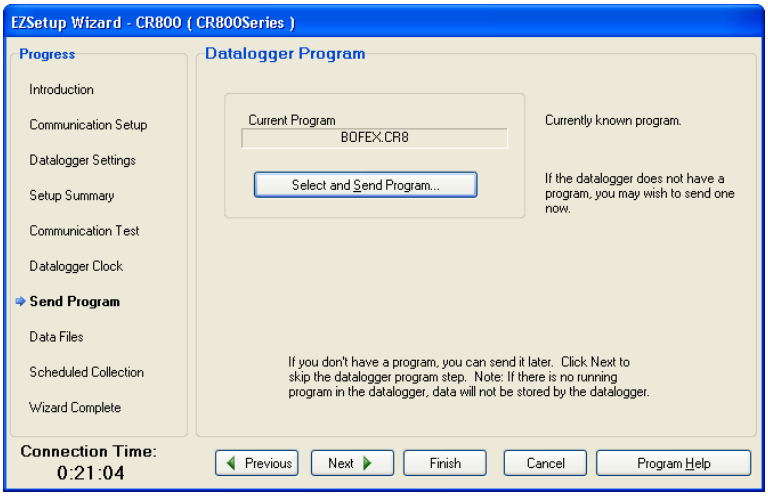
- The next windows will indicate if communication is successful. Click **Next**.



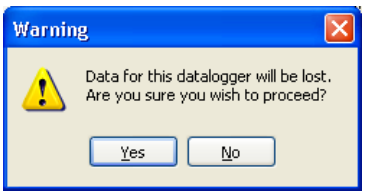
- Adjust the clock to set it at your local time zone. Make sure your computer is adjusted to your local time, then click **Set Datalogger Clock**. When done, click **Next**.



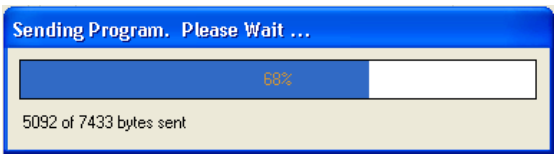
- The datalogger is usually shipped with the Application Program pre-loaded in the datalogger. The program will be displayed under **Current Program**. If it shows **no program** or if the program name shown is not for your application, you will need to upload your Application Program in the datalogger. Click **Finish** to save your settings. At this point, the datalogger setup is completed. To quit the **EZSetup** wizard, select **File** from the menu and click **Exit**. Proceed to section 4.2.



- To download your application program, click **Select and Send Program**. Locate the program on your computer's HD drive or on the one supplied by email, and click **Open**. The following warning message will be displayed on your screen. Click **Yes**.

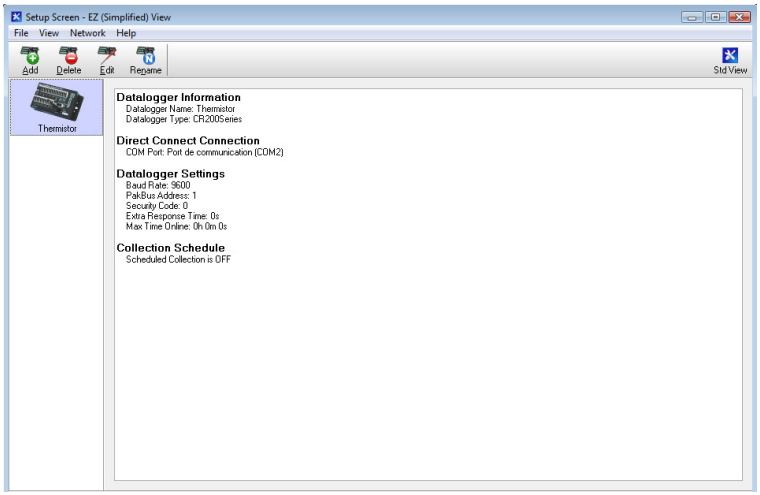


- A progress bar will display the download progress. If successful, a message will indicate it.



- Click **Finish** to save your settings. This completes the datalogger setup using the **EZSetup** wizard.

- To quit the **EZSetup**, select **File** from the **Menu**, and click **Exit.**

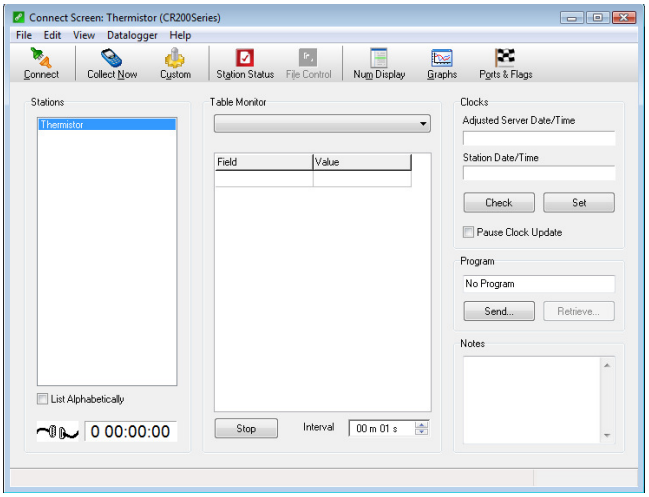


6.0 Monitoring Data With a Computer

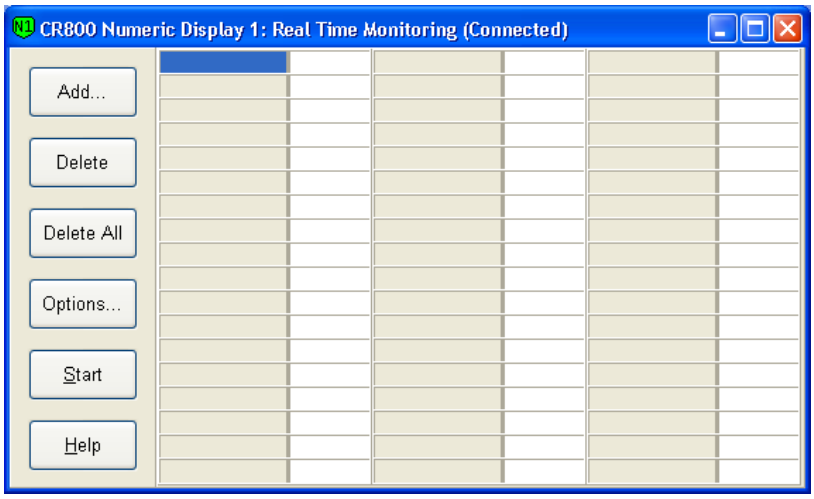
- Connect the supplied Serial Cable between the RS232 Input on the CR200 datalogger and your computer's serial port or USB Serial Adapter.

- Start the LoggerNet by double clicking on the LoggerNet desktop icon.

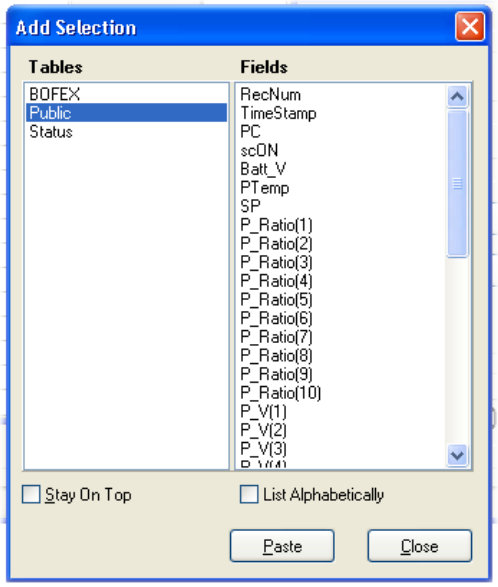
- From the **MAIN/CONNECT**, click on the station **Thermistor**, then **Connect**



- The cable at the bottom of the screen will be connected when the link will be established. Click **Num.Display/Display 1**. The following window should appear.



- Click the **Add** button and under **Tables**, highlight **Public**. The following window should appear.

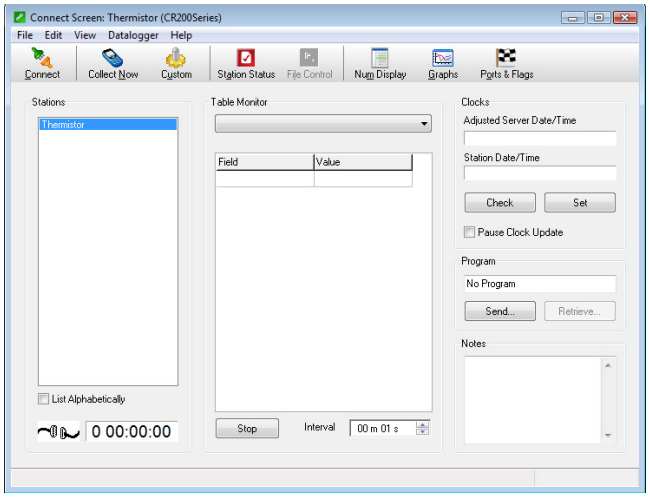


- Under **Fields**, select (highlight) the sensors (labels) you wish to view during the Test. You can use a combination of Shift & Ctrl keys on the computer's keyboard to select multiple labels. Next, on the **Display 1** window, highlight the location where you want to place the labels and finally, from the **Add Selection** window, click **Paste**. We recommend you to monitor the entire content in **Public**. The variable **Thermistor** represents the temperature and the value **Resistor** represents the resistor value of the thermistor.

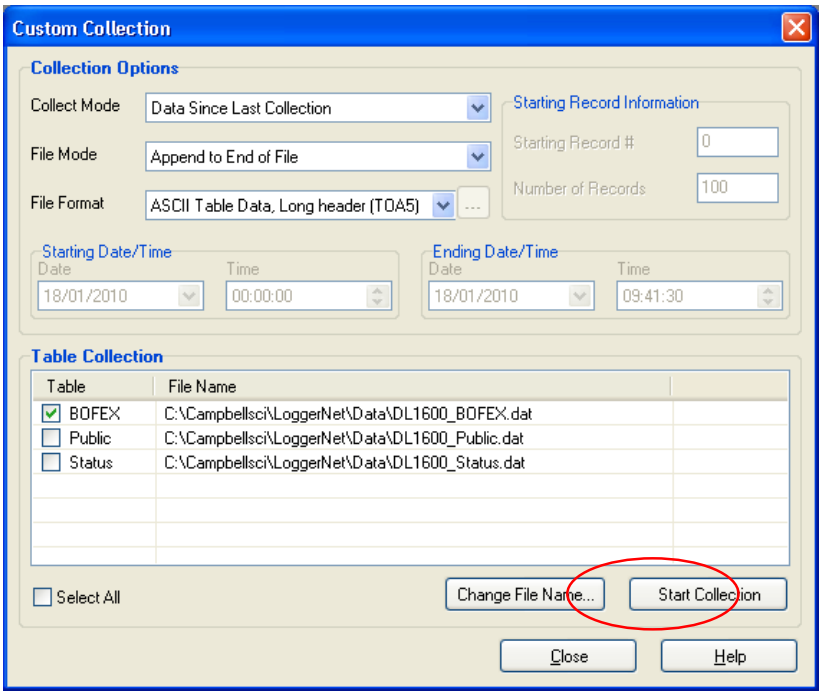
7.0 Collect Data

When a Test is completed, readings should be collected immediately. The following steps assume that the computer is already connected and that the LoggerNet is already running.

- From the **Connect Screen**, click the **Collect Now** button.



- Click on the Data_X.dat file to see the content. The records are displayed in a table.
- To modify the data output, click **Custom** in the connect screen. The following screen will appear.



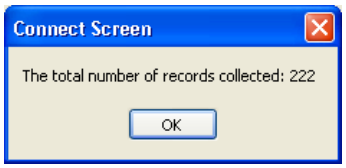
- Under **Collection Options**, make sure the following options are selected:
    - **Data Since Last Collection**
    - **Append to End of File**
    - **ASCII Table Data, Long header (TOA5)**

- Under **Table Collection**, make sure that **Data_X** is checked and that the file path where to save the file is defined. You do not need to check the **Public** and **Status** boxes.

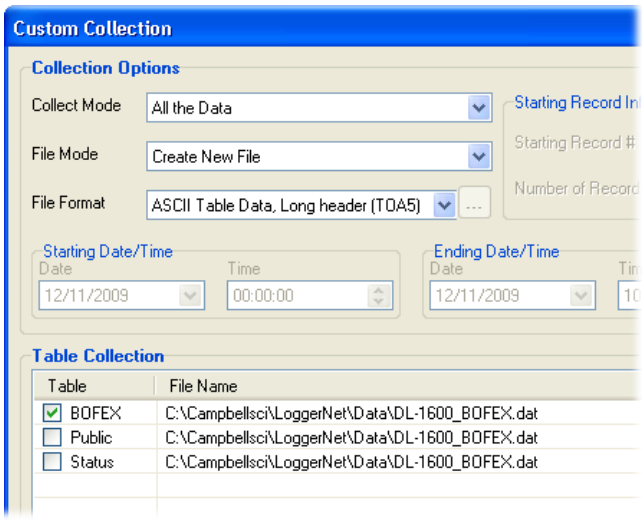
When collecting readings for the first time, you may need to collect all the data from the test box. This will set all memory pointers so that the next time you collect readings, the datalogger will know what readings were previously collected, and only new readings will be collected. All new readings will be appended to the previously collected file, or a new file will be created.

- Click **Start Collection**. The following message will appear, showing the collection progress and total records collected.

Note: A single record includes the timestamp, the record number, all sensors readings in Celcius degrees, and finally, the datalogger's battery voltage.



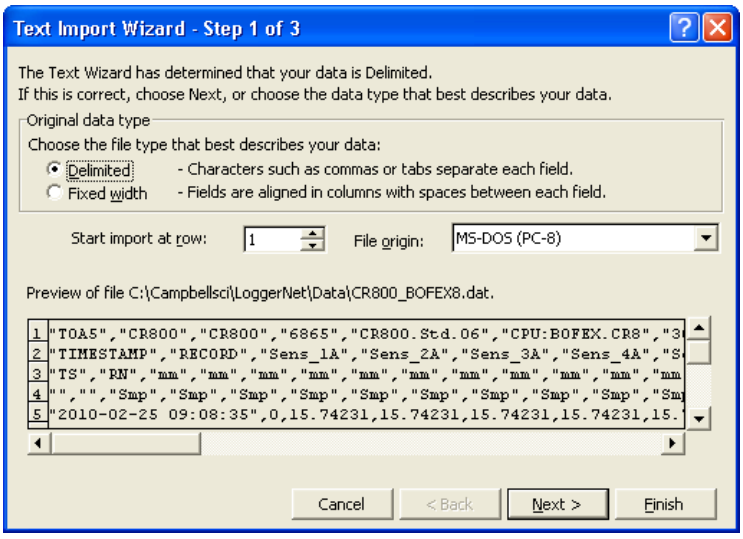
If the message window shows zero records collected, set the **Collection Options** as follow and do the **Start Collection** again.



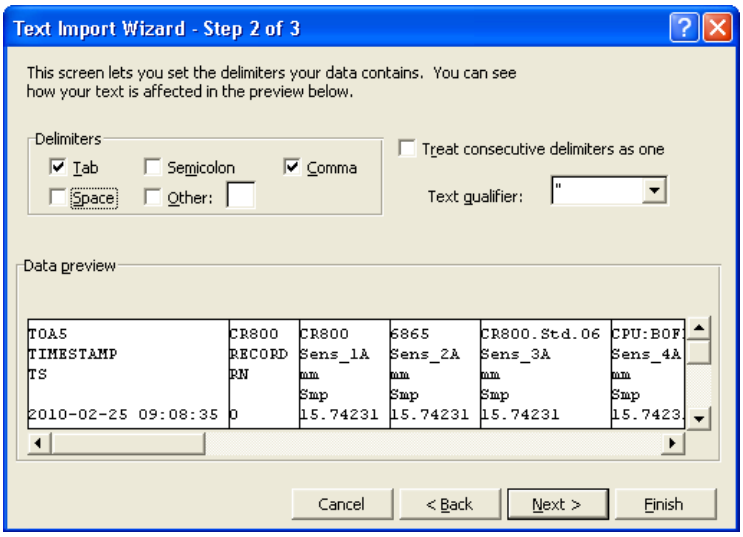
All collected readings are saved in the file specified under Table Collection. The readings saved with the file format **ASCII Table Data, Long header (TOA5)** are separated by commas (CSV) and can be imported into Microsoft Excel for data reduction.

7.1 Import Readings Into Excel

- Start Excel, go to **File** > **Open**, in the **Files of type** field, then select **All Files (*)**.
- Locate and select the file to import and click **Open**. The Text Import Wizard will open.



- Select **Delimited** and click **Next**.

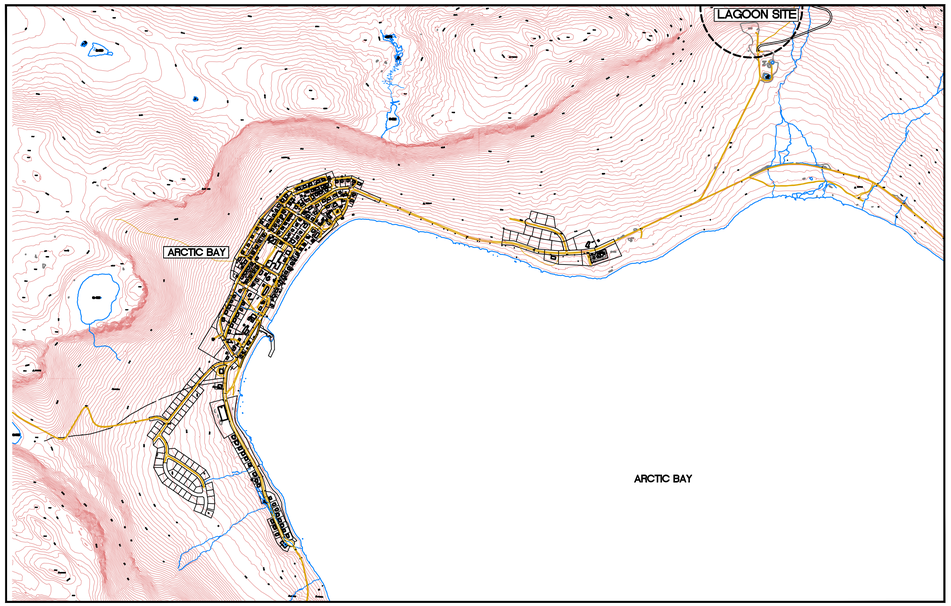


- Select **Tab**, **Comma** and click **Finish**.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	TOA5	CR800	CR800	6865	CR800.Stc	CPU:BOFI	3022	BOFEX						
2	TIMESTAMP	RECORD	Sens_1A	Sens_2A	Sens_3A	Sens_4A	Sens_5A	Sens_1B	Sens_2B	Sens_3B	Sens_4B	Sens_5B	S_Range	Load
3	TS	RN	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	
4			Smp	Smp	Smp	Smp	Smp	Smp	Smp	Smp	Smp	Smp	Smp	Smp
5	25/09/2009 09:08	0	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	50	0
6	25/09/2009 09:08	1	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	50	0
7	25/09/2009 09:08	2	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	50	0
8	25/09/2009 09:08	3	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	50	0
9	25/09/2009 09:08	4	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	50	0
10														

Appendix E – Record Drawings

GOVERNMENT OF NUNAVUT



INDEX OF INCLUDED DRAWINGS

DRAWING NO.	REVISION	DESCRIPTION
OTCD00019054A–OSP1	REV 4	OVERALL SITE PLAN
OTCD00019054A–ES1	REV 4	EXISTING SITE
OTCD00019054A–L1	REV 4	PROPOSED LAGOON
OTCD00019054A–TD1	REV 4	TRUCK DISCHARGE PLAN
OTCD00019054A–DE1	REV 4	DETAILS
OTCD00019054A–DE2	REV 4	DETAILS
OTCD00019054A–SLP1	REV 4	SIGNAGE LOCATION PLAN
OTCD00019054A–CS1	REV 4	CROSS SECTIONS

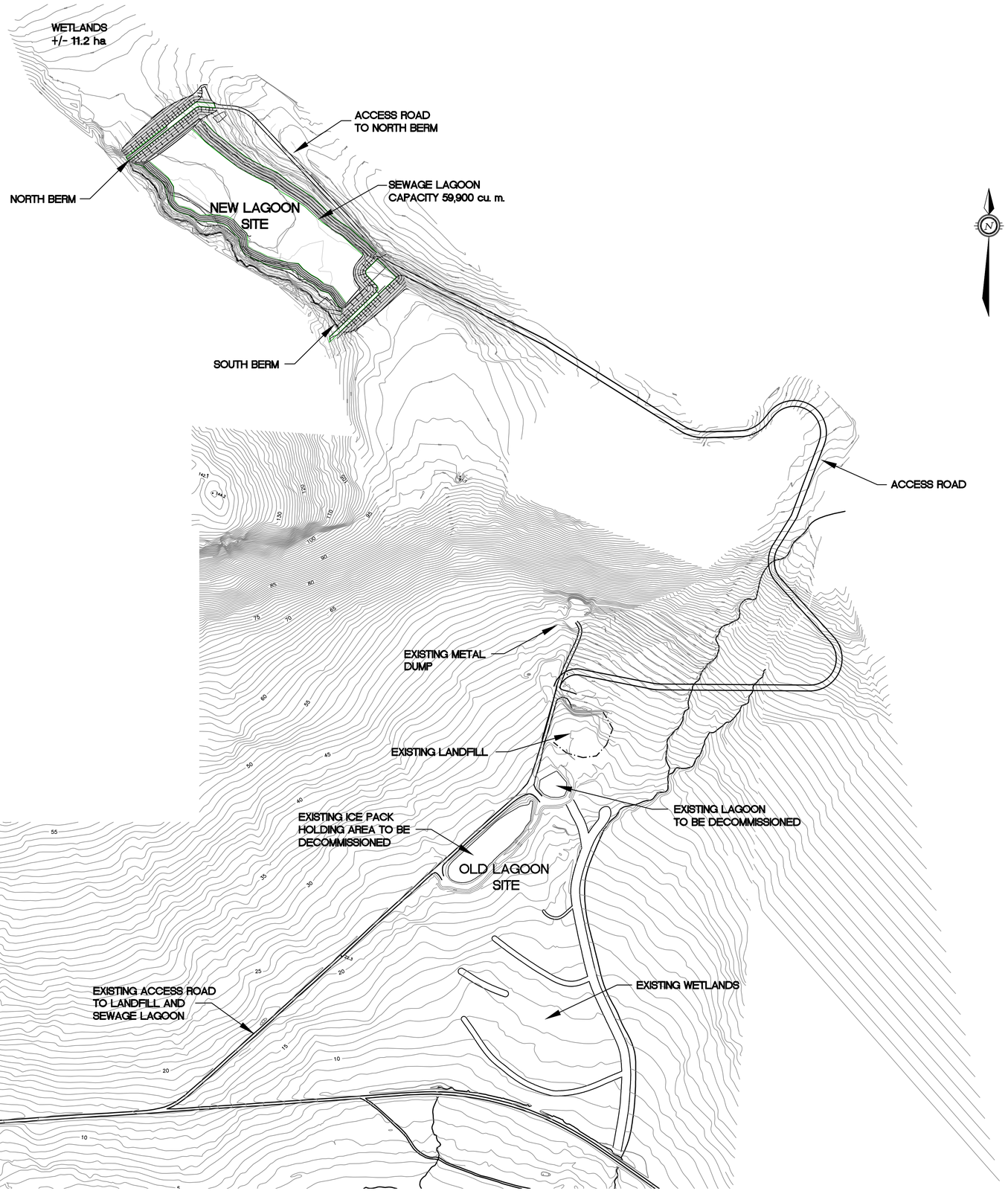
ARCTIC BAY
WASTEWATER LAGOON

Trow Associates Inc.
154 COLONNADE ROAD SOUTH PHONE (613) 225–9940
OTTAWA, ONTARIO K2E 7J5 FAX (613) 225–7337

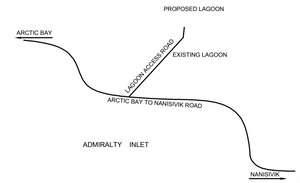
AS–BUILT INFORMATION PROVIDED BY KUDLIK CONSTRUCTION LTD. NOVEMBER 2011

AS-BUILT
DATE: NOVEMBER 30, 2011

PROJECT NO: OTCD19054A



KEY PLAN



LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 59.12

CONTOUR ELEVATIONS WERE DERIVED FROM NAD 83 CONTROL MONUMENT 7038914 LOCATED NORTH OF THE ARCTIC BAY AIRPORT UNDER CONSTRUCTION.

No.	DESCRIPTION	DATE	BY	APP'D
4	AS-BUILT	30/11/11	SAB	SLB
3	AS-CONSTRUCTED	17/11/11	MEB	SLB
2	TENDER SET	27/04/09	MMR	SLB
1	ISSUED FOR APPROVAL	24/04/08	MMR	SLB

REVISIONS

DRAWINGS ORIGINALLY SEALED BY S.L.BURDEN, P.eng. OF exp. SERVICES Inc. APRIL 27TH, 2009

Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ont. K2E 7J5
Tel:(613)225-9940
Fax:(613)225-7337

CLIENT

GOVERNMENT OF NUNAVUT

PROJECT

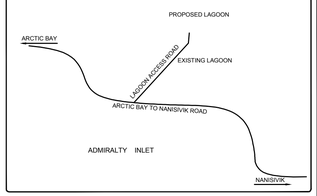
ARCTIC BAY WASTEWATER LAGOON

TITLE

OVERALL
SITE PLAN

design by	SAD	project no.	OTCD000190544
drawn by	MEB	drawing no.	OSP-1
checked by	SLB		
date	15/01/2008		
scale	HORIZ 1:2500		

KEY PLAN



LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 59.12

CONTOUR ELEVATIONS WERE DREIVED FROM NAD 83 CONTROL MONUMENT 7038914 LOCATED NORTH OF THE ARCTIC BAY AIRPORT UNDER CONSTRUCTION.

No.	DESCRIPTION	DATE	BY	APP'D
4	AS-BUILT	30/11/11	SAB	SLB
3	AS-CONSTRUCTED	17/11/11	MEB	SLB
2	TENDER SET	27/04/09	MMR	SLB
1	ISSUED FOR APPROVAL	24/04/08	MMR	SLB

REVISIONS

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CLIENT

GOVERNMENT OF NUNAVUT

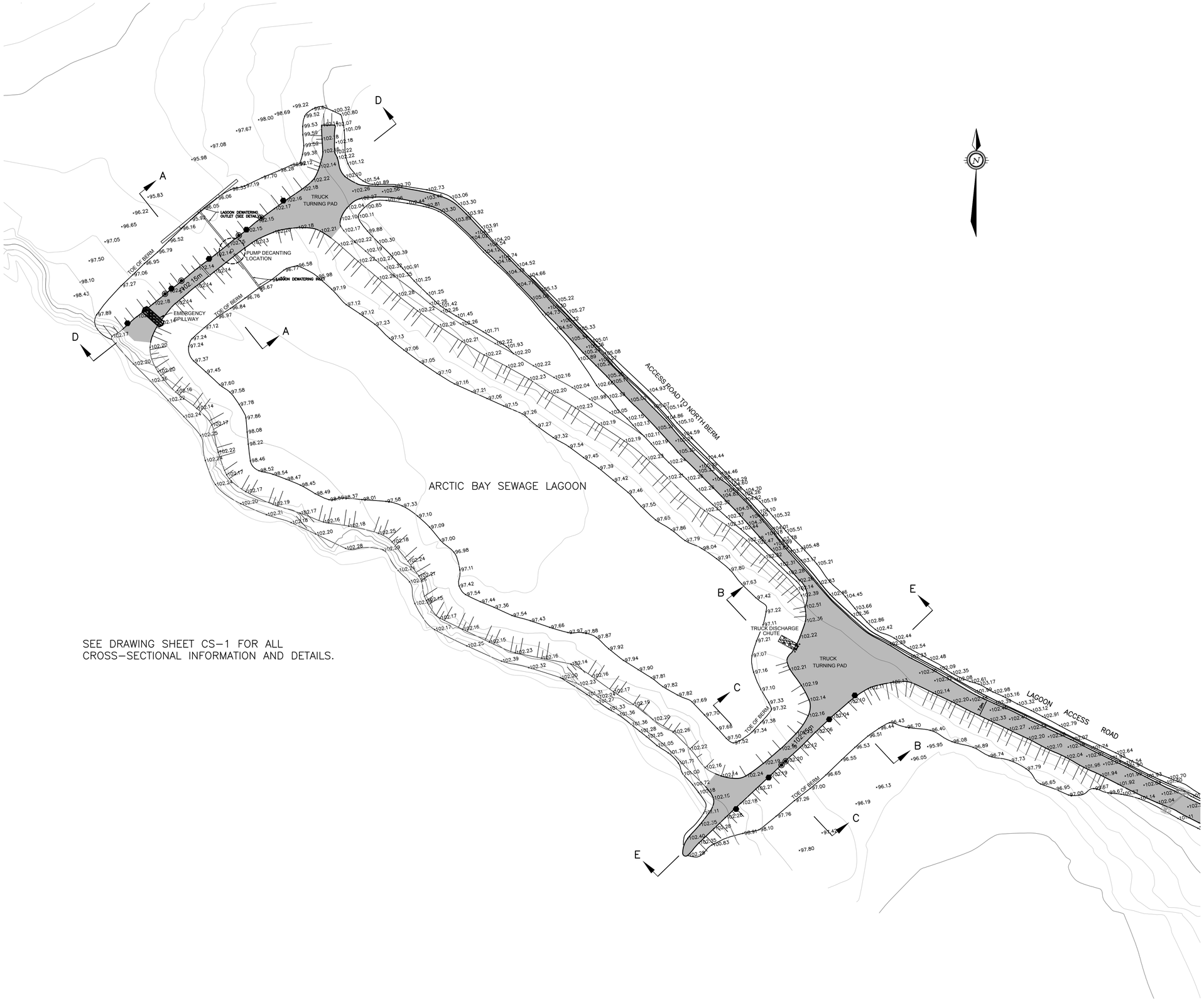
PROJECT

ARCTIC BAY WASTEWATER LAGOON

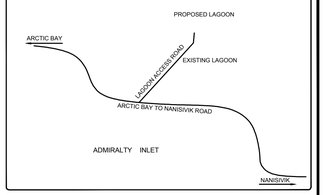
TITLE

EXISTING SITE

design by	SAD	project no.	OTCD000190544
drawn by	MEB	drawing no.	ES-1
checked by	SLB		
date	15/01/2008		
scale	HORIZ 1:1000		



KEY PLAN



LEGEND

- BERM CORE DETECTION - THERMISTOR CASING c/w THERMISTOR STRING AND DATA LOGGER CONNECTION.
- SAMPLING POINT

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 59.12

CONTOUR ELEVATIONS WERE DREIVED FROM NAD 83 CONTROL MONUMENT 7038914 LOCATED NORTH OF THE ARCTIC BAY AIRPORT UNDER CONSTRUCTION.

No.	DESCRIPTION	DATE	BY	APP'D
4	AS-BUILT	30/11/11	SAB	SLB
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1	ISSUED FOR APPROVAL	24/04/08	MMR	SLB

REVISIONS

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Fax:(613)225-7337

CLIENT

GOVERNMENT OF NUNAVUT

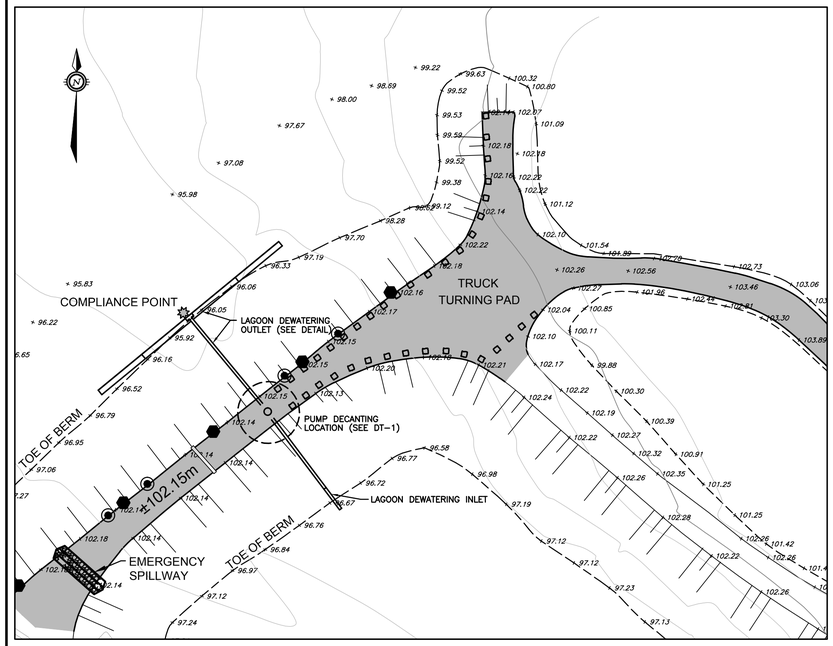
PROJECT

ARCTIC BAY WASTEWATER LAGOON

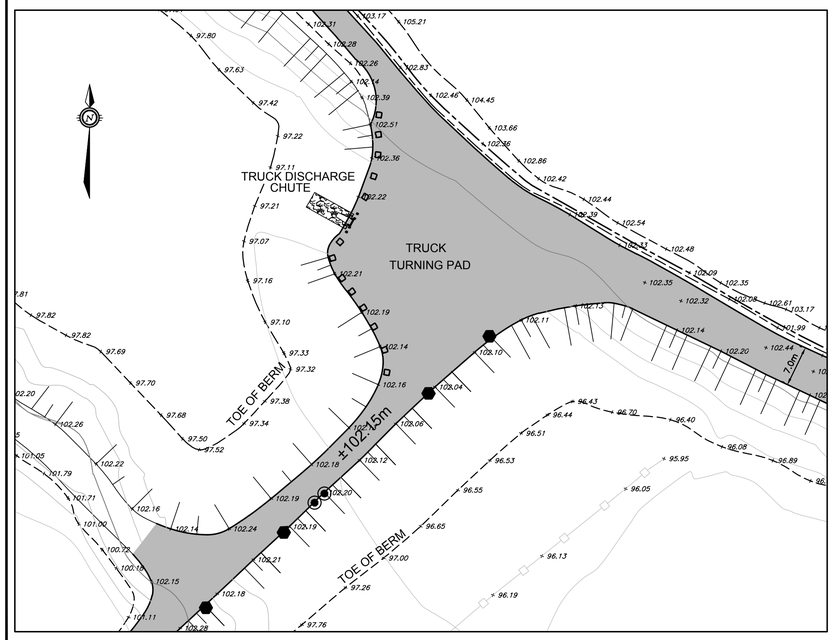
TITLE

PROPOSED LAGOON

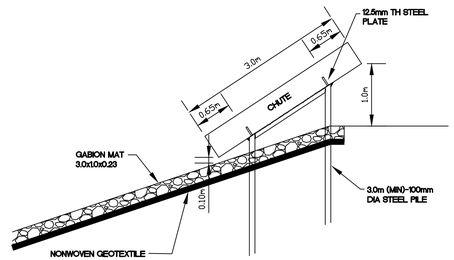
design by	SAD	project no.	OTCD000190544
drawn by	MEB	drawing no.	L-1
checked by	SLB		
date	15/01/2008		
scale	HORIZ 1:750		



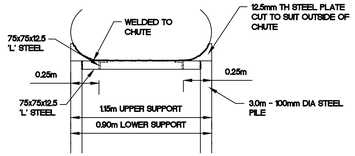
NORTH BERM DECANTING
SCALE 1:600



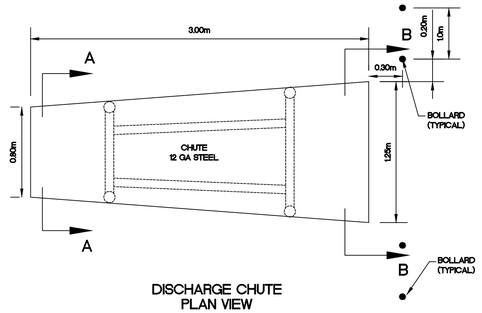
SOUTH BERM TRUCK DISCHARGE
SCALE 1:600



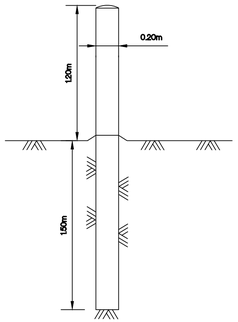
TRUCK DISCHARGE CHUTE
SECTION VIEW
SCALE 1:50



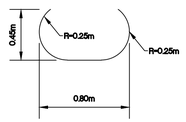
TRUCK DISCHARGE CHUTE
END VIEW
SCALE 1:25



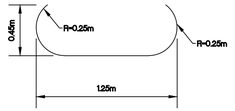
DISCHARGE CHUTE
PLAN VIEW
SCALE 1:25



BOLLARD DETAIL
SCALE 1:25

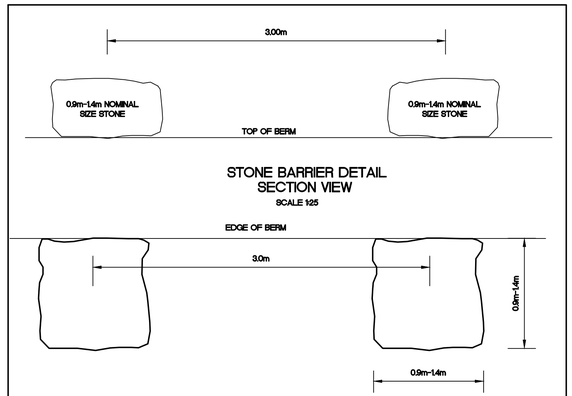


SECTION A-A
SCALE 1:25



SECTION B-B
SCALE 1:25

TRUCK DISCHARGE CHUTE DETAIL



STONE BARRIER DETAIL
SECTION VIEW
SCALE 1:25

STONE BARRIER DETAIL
PLAN VIEW
SCALE 1:25

KEY PLAN

LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 59.12

CONTOUR ELEVATIONS WERE DREIVED FROM NAD 83 CONTROL MONUMENT 7038914 LOCATED NORTH OF THE ARCTIC BAY AIRPORT UNDER CONSTRUCTION.

No.	DESCRIPTION	DATE	BY	APP'D
4	AS-BUILT	30/11/11	SAB	SLB
3	AS-CONSTRUCTED	17/11/11	MEB	SLB
2	TENDER SET	27/04/09	MMR	SLB
1	ISSUED FOR APPROVAL	24/04/08	MMR	SLB

REVISIONS

DRAWINGS ORIGINALLY SEALED BY S.L.BURDEN, P.eng. OF exp. SERVICES Inc. APRIL 27TH, 2009

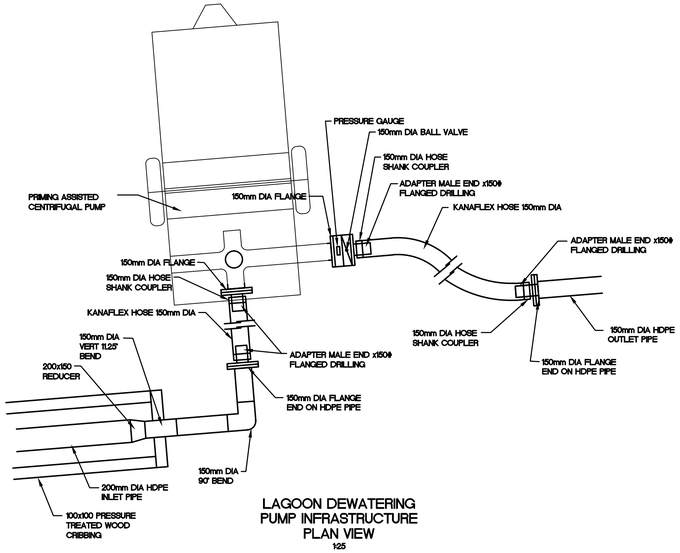
Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ont. K2E 7J5
Tel:(613)225-9940
Fax:(613)225-7337

CLIENT
GOVERNMENT OF NUNAVUT

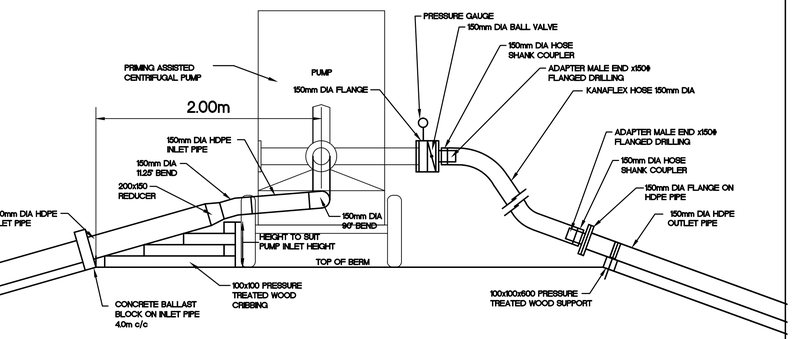
PROJECT
ARCTIC BAY WASTEWATER LAGOON

TITLE
LOCATION PLAN FOR TRUCK DISCHARGE AND DECANTING

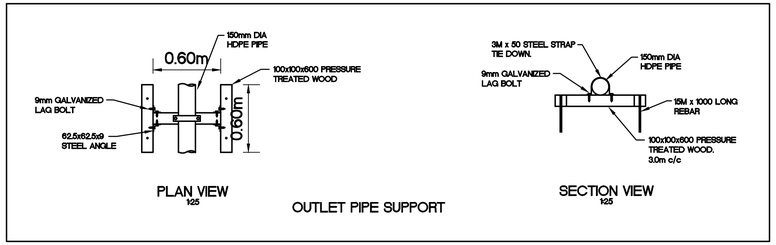
design by	SAD	project no.	OTCD000190544
drawn by	MEB	drawing no.	TD-1
checked by	SLB		
date	15/01/2008		
scale	HORIZ 1:500		



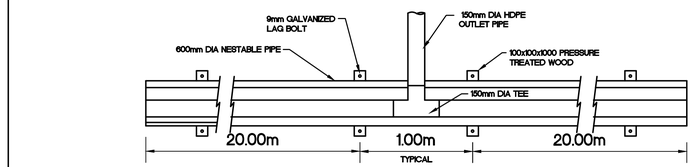
LAGOON DEWATERING
PUMP INFRASTRUCTURE
PLAN VIEW
1:25



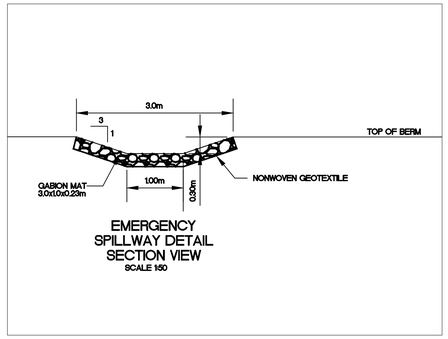
LAGOON DEWATERING
PUMP INFRASTRUCTURE
1:25



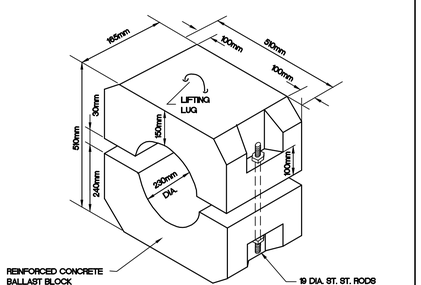
OUTLET PIPE SUPPORT



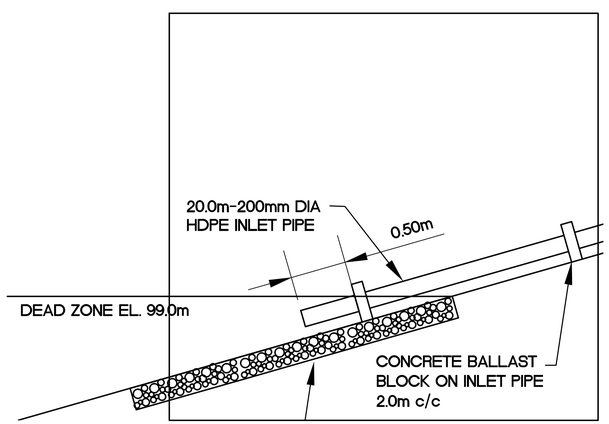
LAGOON DEWATERING
OUTLET INFRASTRUCTURE
PLAN VIEW
1:25

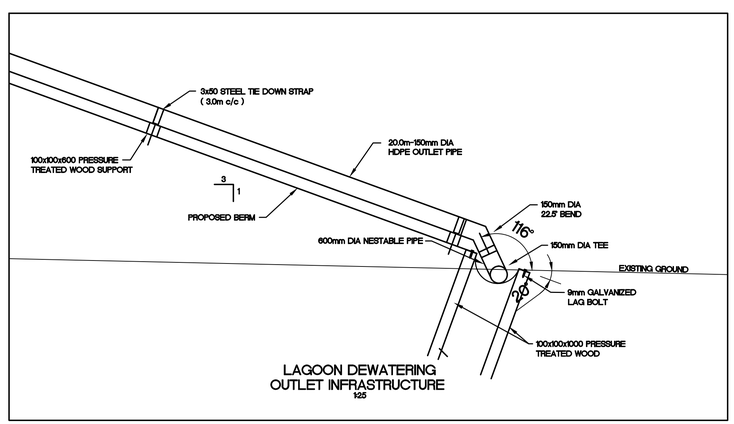


EMERGENCY
SPILLWAY DETAIL
SECTION VIEW
SCALE 1:50



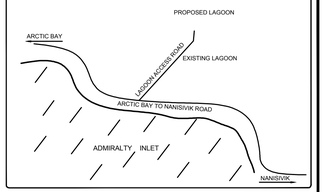
CONCRETE
BALLAST BLOCK
SCALE 1:10





LAGOON DEWATERING
OUTLET INFRASTRUCTURE
1:25

KEY PLAN



LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 59.12

CONTOUR ELEVATIONS WERE DREIVED FROM NAD 83 CONTROL MONUMENT 7038914 LOCATED NORTH OF THE ARCTIC BAY AIRPORT UNDER CONSTRUCTION.

No.	DESCRIPTION	DATE	BY	APP'D
4	AS-BUILT	30/11/11	SAB	SLB
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1	ISSUED FOR APPROVAL	24/04/08	MMR	SLB

R E V I S I O N S

DRAWINGS ORIGINALLY SEALED BY S.L.BURDEN, P.eng. OF exp. SERVICES Inc. APRIL 27TH, 2009

Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ont. K2E 7J5
Tel:(613)225-9940
Fax:(613)225-7337

CLIENT

GOVERNMENT OF NUNAVUT

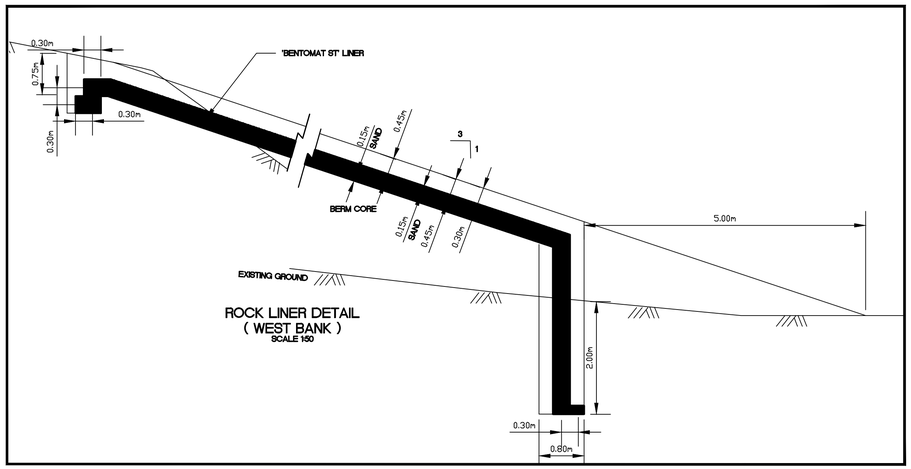
PROJECT

ARCTIC BAY WASTEWATER LAGOON

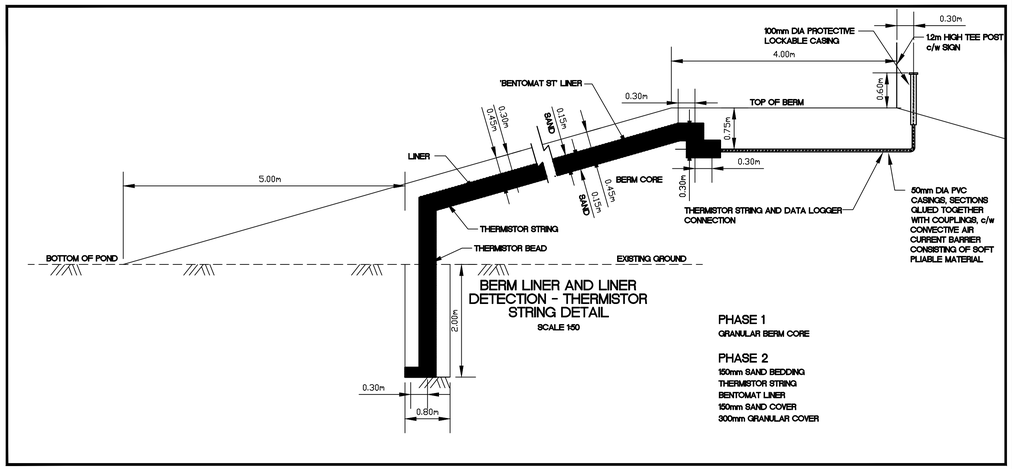
TITLE

DETAILS

design by	SAD	project no.	OTCD000190544
drawn by	MEB	drawing no.	DE-1
checked by	SLB		
date	15/01/2008		
scale			



ROCK LINER DETAIL
(WEST BANK)
SCALE 1:50

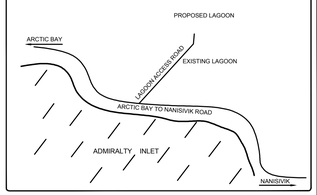


BERM LINER AND LINER DETECTION - THERMISTOR STRING DETAIL
SCALE 1:50

PHASE 1
GRANULAR BERM CORE

PHASE 2
150mm SAND BEDDING
THERMISTOR STRING
BENTOMAT LINER
150mm SAND COVER
300mm GRANULAR COVER

KEY PLAN



LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 59.12

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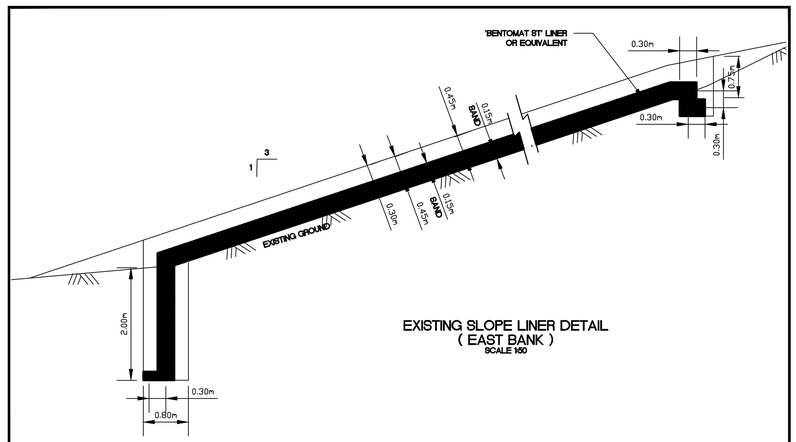
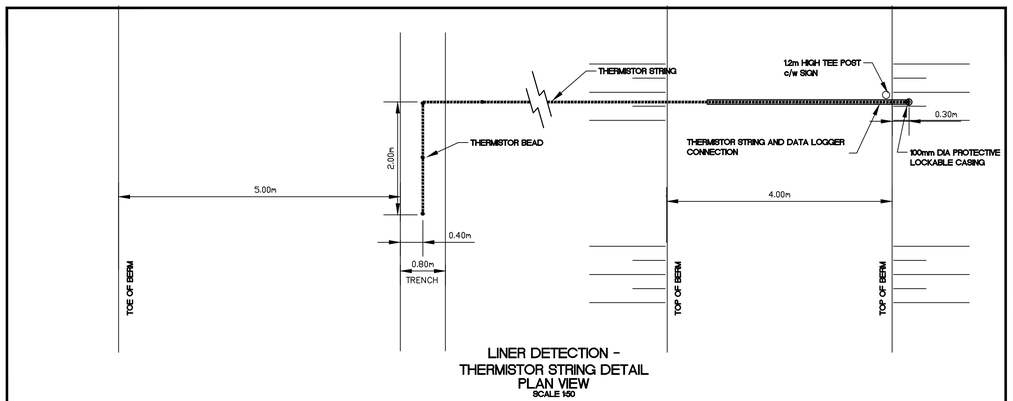


EXISTING SLOPE LINER DETAIL
(EAST BANK)
SCALE 1:50



LINER DETECTION -
THERMISTOR STRING DETAIL
PLAN VIEW
SCALE 1:50

4	AS-BUILT	30/11/11	SAB	SLB
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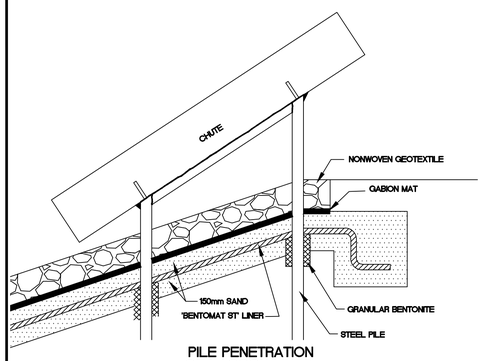
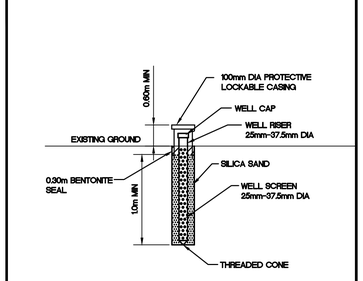
No.	DESCRIPTION	DATE	BY	APP'D

R E V I S I O N S

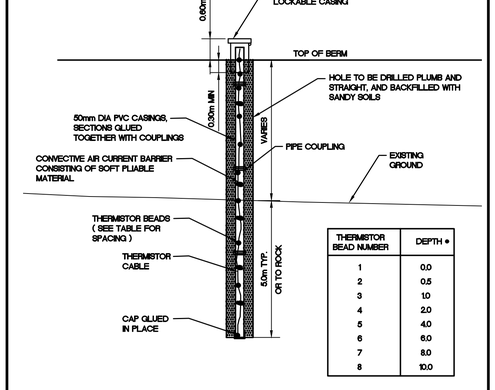
DRAWINGS ORIGINALLY SEALED BY S.L.BURDEN, P.eng. OF exp. SERVICES Inc. APRIL 27TH, 2009



PILE PENETRATION
OF LAGOON LINER
SCALE 1:25

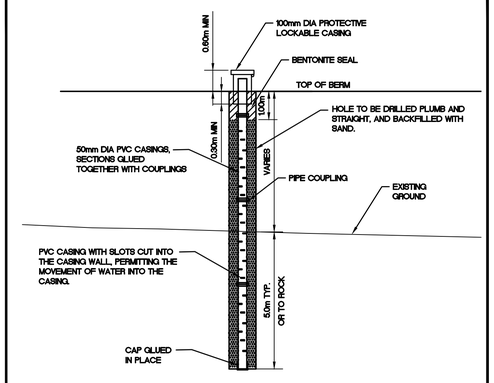


COMPLIANCE POINT
SAMPLING WELL DETAIL
SCALE NTS



THERMISTOR BEAD NUMBER	DEPTH *
1	0.0
2	0.5
3	1.0
4	2.0
5	4.0
6	6.0
7	8.0
8	10.0

BERM CORE DETECTION
THERMISTOR DETAIL



SEEPAGE MONITORING CASING
SCALE NTS

Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ont. K2E 7J5
Tel:(613)225-9940
Fax:(613)225-7337

CLIENT
GOVERNMENT OF NUNAVUT

PROJECT
ARCTIC BAY WASTEWATER LAGOON

TITLE
DETAILS

design by	SAD	project no.	OTCD000190544
drawn by	MEB	drawing no.	DE-2
checked by	SLB		
date	15/01/2008		
scale			

±360m

SIGN

SIGN

SIGN

SIGN

SIGN

SIGN

LIMIT OF EXISTING WETLANDS

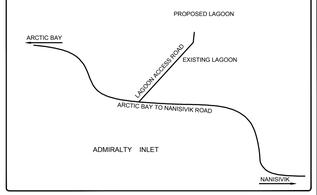
EXISTING WETLANDS
AREA= +/-11.2ha

ᑯᓕᐃᖅᓴᓕᐃᒃ
ᑲᑎᓐᓄᒋᑭᓴᓕᐅᔨᓗᐊᖅᓄᑦᑐᑎᒍᖅ
ᐅᓪᓗᓂᑦ
ᐊᓐᔪᓚᓕᐃᐅᔨᓗᐊᖅᓄᑦᑐᑎᒍᖅ

SEWAGE TREATMENT FACILITY

NO GATHERING OR HARVESTING

KEY PLAN



LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 59.12

CONTOUR ELEVATIONS WERE DREIVED FROM NAD 83 CONTROL MONUMENT 7038914 LOCATED NORTH OF THE ARCTIC BAY AIRPORT UNDER CONSTRUCTION.

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R E V I S I O N S

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Ottawa, Ont. K2E 7J5
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Fax:(613)225-7337

CLIENT

GOVERNMENT OF NUNAVUT

PROJECT

ARCTIC BAY WASTEWATER LAGOON

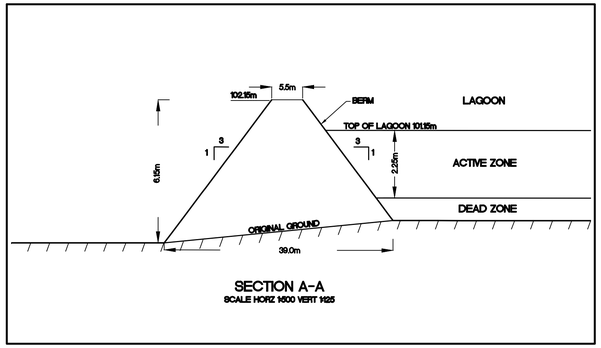
TITLE

SIGNAGE LOCATION PLAN

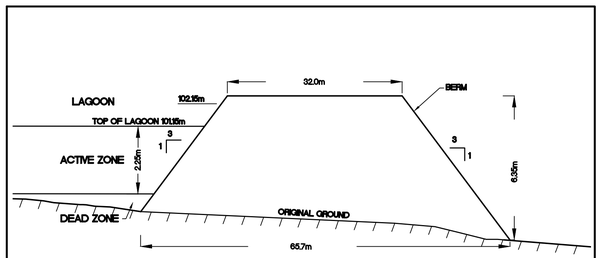
design by	SAD
drawn by	MEB
checked by	SLB
date	15/01/2008
scale	HORIZ 1:1500

project no. OTCD000190544

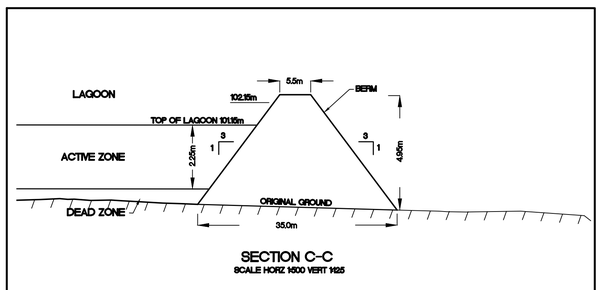
drawing no. SLP-1



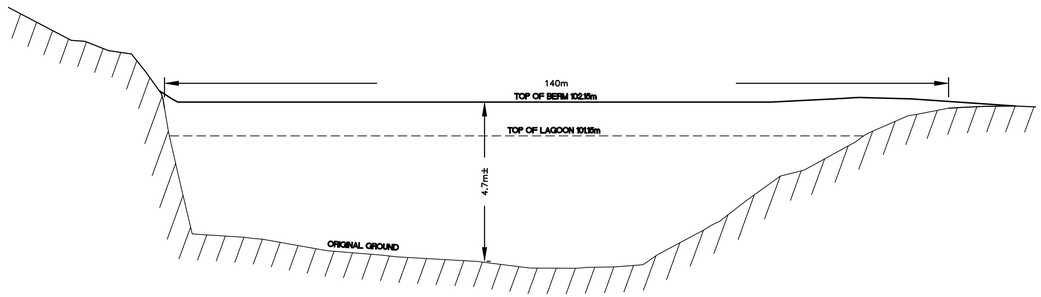
SECTION A-A
SCALE HORZ 1:500 VERT 1:25



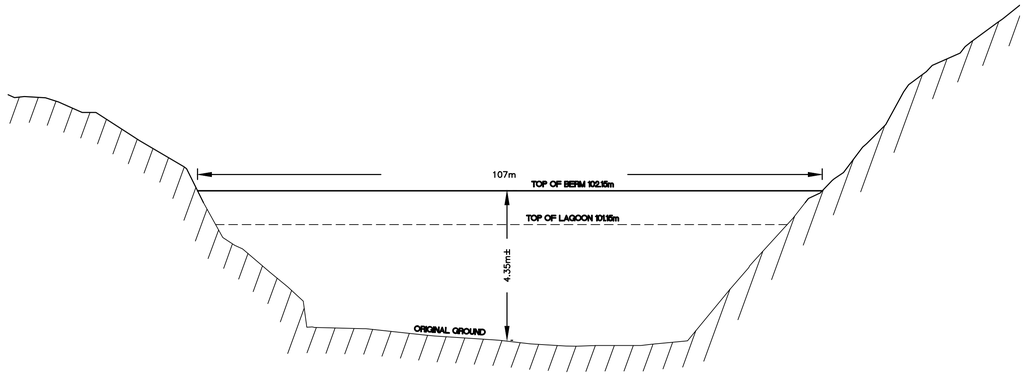
SECTION B-B
SCALE HORZ 1:500 VERT 1:25



SECTION C-C
SCALE HORZ 1:500 VERT 1:25

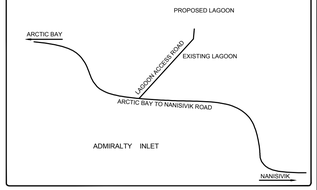


NORTH BERM
SECTION D-D
SCALE HORZ 1:500 VERT 1:100



SOUTH BERM
SECTION E-E
SCALE HORZ 1:500 VERT 1:100

KEY PLAN



LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 59.12

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REVISIONS

DRAWINGS ORIGINALLY SEALED BY S.L.BURDEN, P.eng. OF exp. SERVICES Inc. APRIL 27TH, 2009

Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ont. K2E 7J5
Tel:(613)225-9940
Fax:(613)225-7337

CLIENT

GOVERNMENT OF NUNAVUT

PROJECT

ARCTIC BAY WASTEWATER LAGOON

TITLE

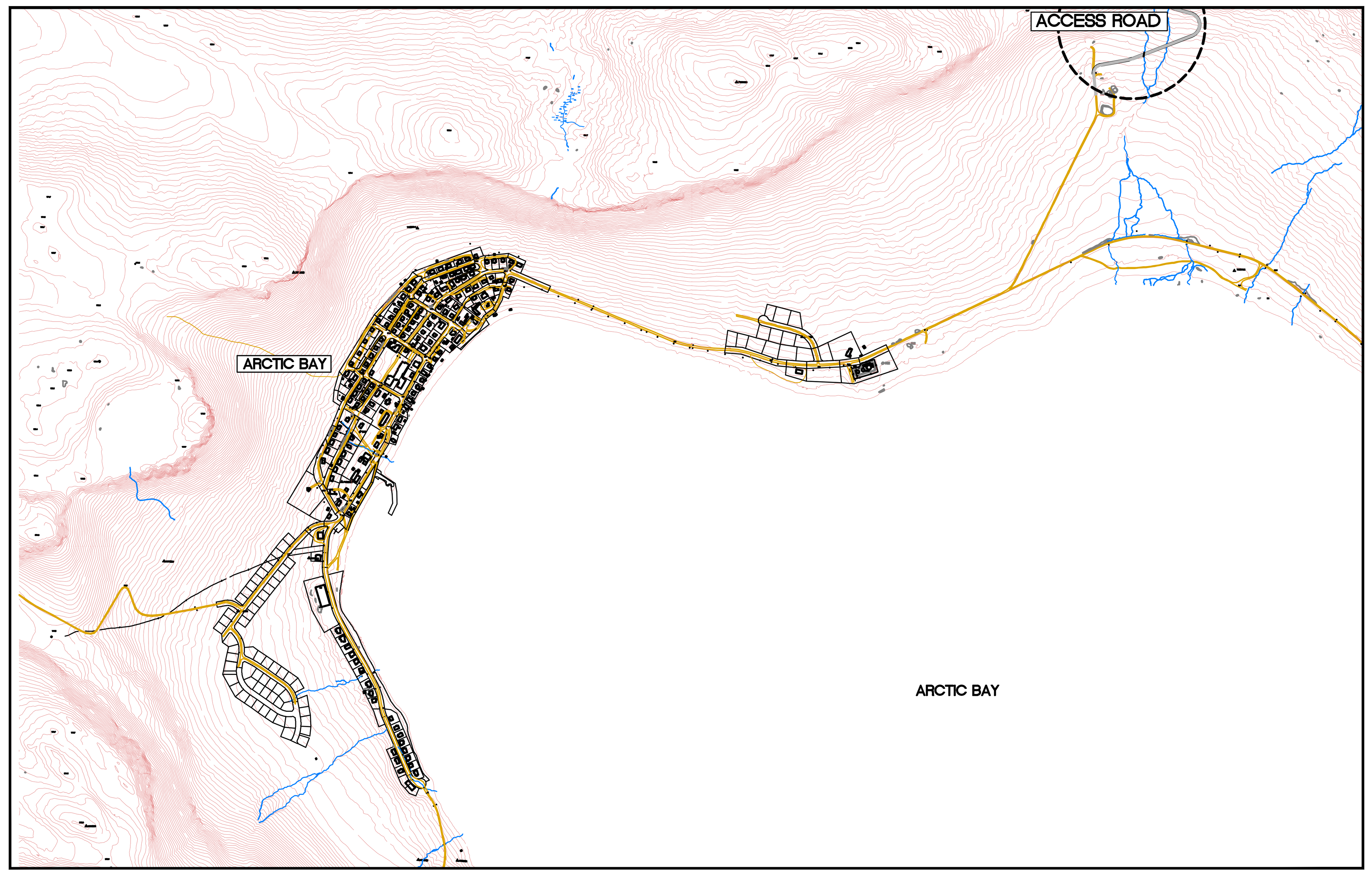
CROSS SECTIONS

design by	SAD
drawn by	MEB
checked by	SLB
date	15/01/2008
scale	

project no. OTCD000190544

drawing no. CS-1

GOVERNMENT OF NUNAVUT



INDEX OF INCLUDED DRAWINGS

DRAWING NO.	REVISION	DESCRIPTION
OTCD00019054A–SP1	REV 5	SITE PLAN
OTCD00019054A–PP1	REV 5	ACCESS ROAD PLAN & PROFILE
OTCD00019054A–PP2	REV 5	ACCESS ROAD PLAN & PROFILE
OTCD00019054A–PP3	REV 5	ACCESS ROAD PLAN & PROFILE
OTCD00019054A–PP4	REV 5	ACCESS ROAD PLAN & PROFILE
OTCD00019054A–PP5	REV 5	ACCESS ROAD PLAN & PROFILE
OTCD00019054A–PP6	REV 5	ACCESS ROAD SECOND BERM PLAN & PROFILE
OTCD00019054A–PP7	REV 5	ACCESS ROAD SECOND BERM PLAN & PROFILE
OTCD00019054A–DE1	REV 6	ROAD DETAILS

ARCTIC BAY
WASTEWATER LAGOON ROAD

Trow Associates Inc.
154 COLONNADE ROAD SOUTH PHONE (613) 225–9940
OTTAWA, ONTARIO K2E 7J5 FAX (613) 225–7337

AS–BUILT INFORMATION PROVIDED BY KUDLIK CONSTRUCTION LTD. NOVEMBER 2011

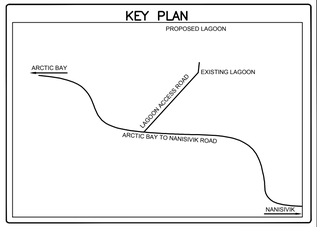
AS-BUILT

DATE: NOVEMBER 30, 2011

PROJECT NO: OTCD19054A

Filename: r:\19000\19000\19054 arctic bay septic lagoon\arctic bay as-builts-2012\road\19054-1 road cover sheet.dwg
Last Saved: 8/7/2012 2:35:25 PM
Last Plotted: 8/7/2012 2:36:17 PM Plotted by: butlers
Pen Table:: trow-dme-march2008.ctb
References:

KEY PLAN



LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 000.00

DESCRIPTION HERE

No.	DESCRIPTION	DATE	BY	APP'D
5	AS-BUILT	30/11/11	SAB	SLB
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REVISIONS

DRAWINGS ORIGINALLY SEALED BY S.L.BURDEN, P.eng. OF exp. SERVICES Inc. APRIL 27TH, 2009

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Ottawa, Ont. K2E 7J5
Tel:(613)225-9940
Fax:(613)225-7337

CLIENT

GOVERNMENT OF NUNAVUT

PROJECT

ARCTIC BAY
WASTE WATER LAGOON
ROAD

TITLE

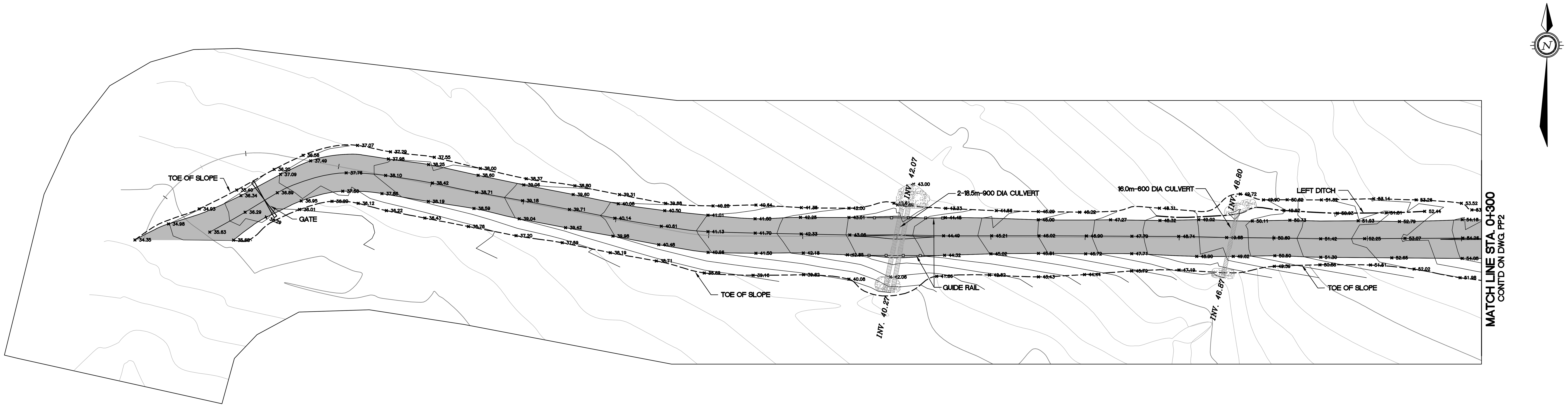
SITE PLAN

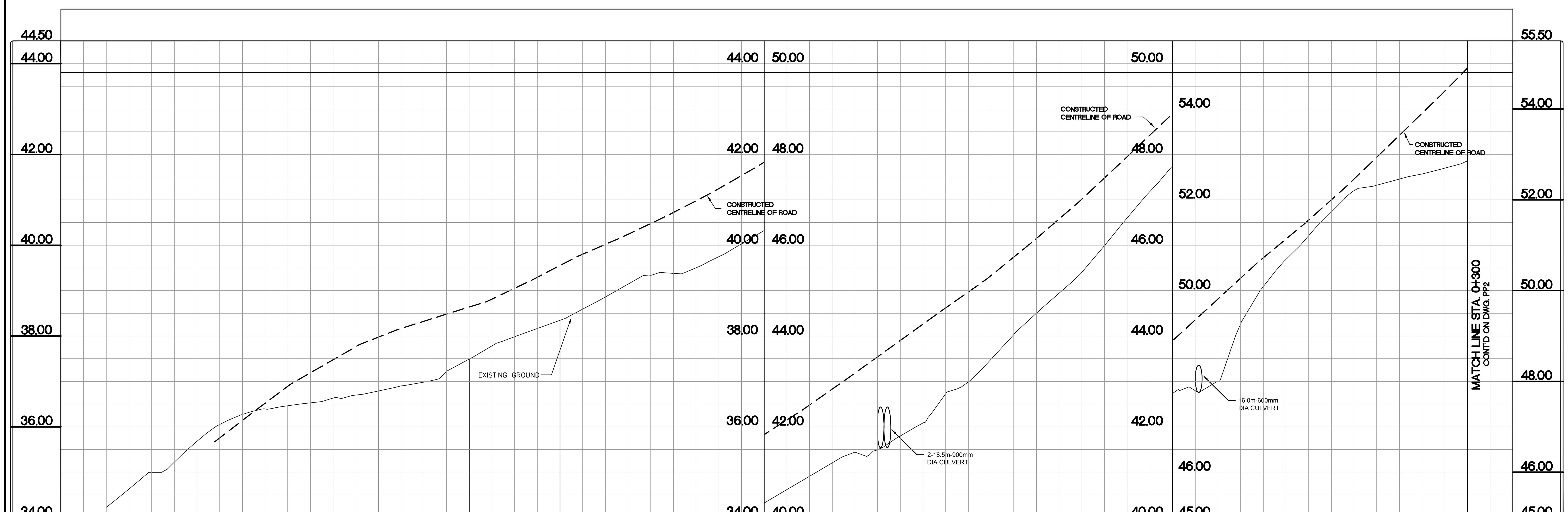
design by	S.A.D.
drawn by	M.M.R.
checked by	S.L.B.
date	10/09/2007
scale	HORIZ 1:2000

project no. OTCD000190544

drawing no. SP1

NOTES
CONTOUR INFORMATION WAS DERIVED BY TROW ASSOCIATES INC. SURVEY DATED AUGUST 23, 2007.
CONTOUR INTERVALS ARE SET AT 1.00m





CL Road	34.23	35.00	35.70 35.68	36.88	37.97 36.79	38.63 37.49	39.56 38.35	40.47 39.33	41.54 40.03	42.82 41.21	43.74	44.26 42.08	45.74 44.03	47.48 45.99	49.36 47.80		51.13 50.69			52.98 52.32	54.91
Stations		0+010.8	0+020	0+040	0+060	0+080	0+100	0+120	0+140	0+160	0+172.6	0+180	0+200	0+220	0+240	0+244.2	0+260	0+269.6	0+272.3	0+280 0+282.5	0+300

KEY PLAN

LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 000.00

DESCRIPTION HERE

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CLIENT

GOVERNMENT OF NUNAVUT

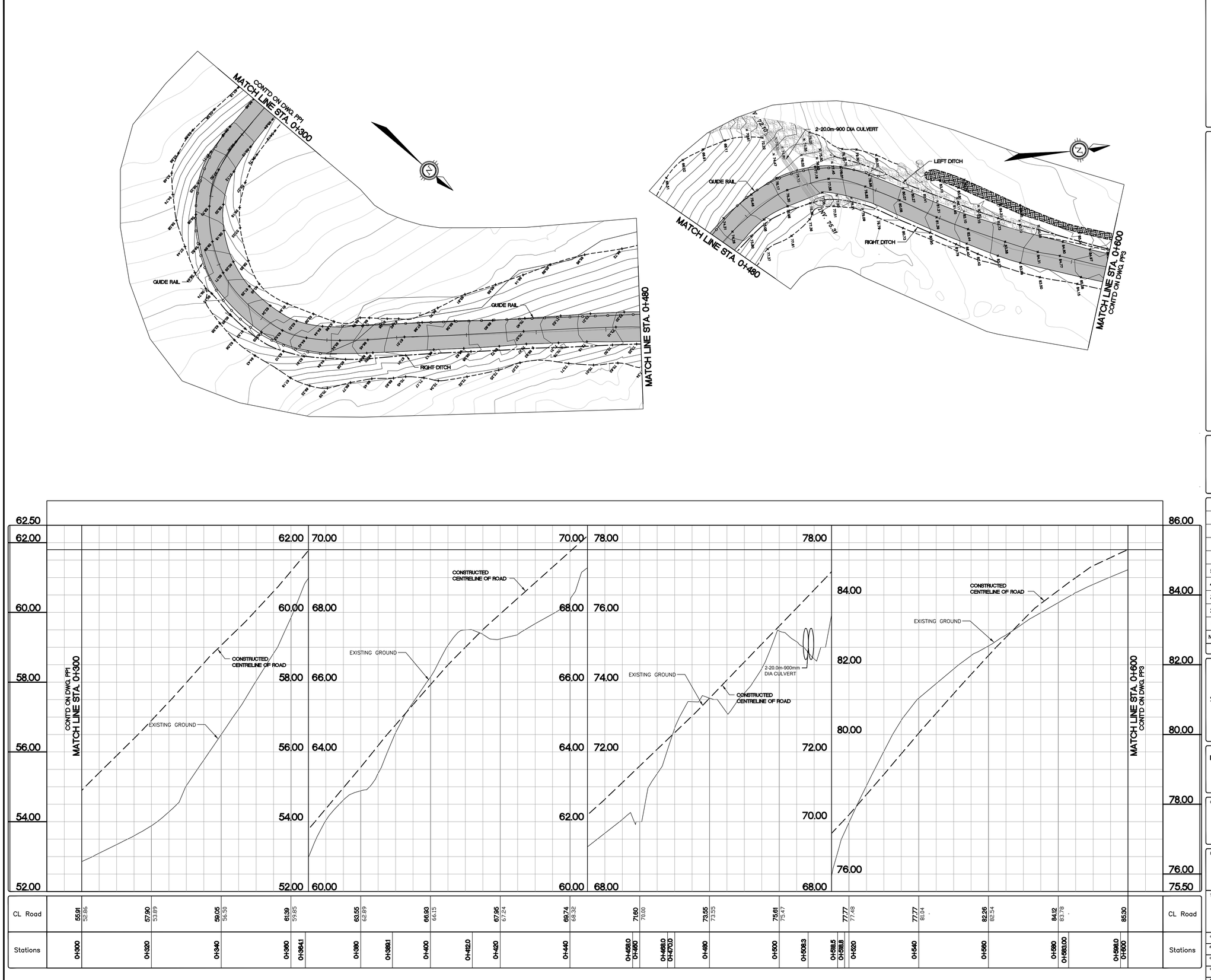
PROJECT

ARCTIC BAY
WASTE WATER
LAGOON ROAD

TITLE

ACCESS ROAD
PLAN & PROFILE
STA. 0+000 TO STA. 0+300

design by	S.A.D.	project no.	OTCD19054A
drawn by	M.M.R.	drawing no.	PP1
checked by	S.L.B.		
date	21/04/08		
scale	HORIZ 1:500 VERT 1:50		



Stations	CL Road	
0+300	55.91	52.86
0+320	57.90	53.89
0+340	59.05	56.50
0+360	61.39	59.85
0+364.1		
0+380	63.55	62.89
0+389.1		
0+400	66.93	66.15
0+412.0		
0+420	67.95	67.24
0+440	69.74	68.32
0+458.0		
0+460	71.60	70.00
0+468.0		
0+470.0		
0+480	73.55	73.55
0+500	75.61	75.47
0+508.3		
0+518.5		
0+518.8		
0+520	77.77	77.48
0+540	77.77	81.04
0+560	82.26	82.54
0+580	84.12	83.78
0+583.00		
0+598.0		
0+600	85.30	

KEY PLAN

LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 000.00
DESCRIPTION HERE

No.	DESCRIPTION	DATE	BY	APP'D
5	AS-BUILT	30/11/11	SAB	SLB
4	AS-CONSTRUCTED	17/11/11	MEB	SLB
3	ISSUED FOR CONSTRUCTION	14/09/09	MMR	SLB
2	TENDER SET	27/04/09	MMR	SLB
1	ISSUED FOR APPROVAL	24/04/08	MMR	SLB

R E V I S I O N S

DRAWINGS ORIGINALLY
SEALED BY
S.L.BURDEN, P.eng. OF
exp. SERVICES Inc.
APRIL 27TH, 2009

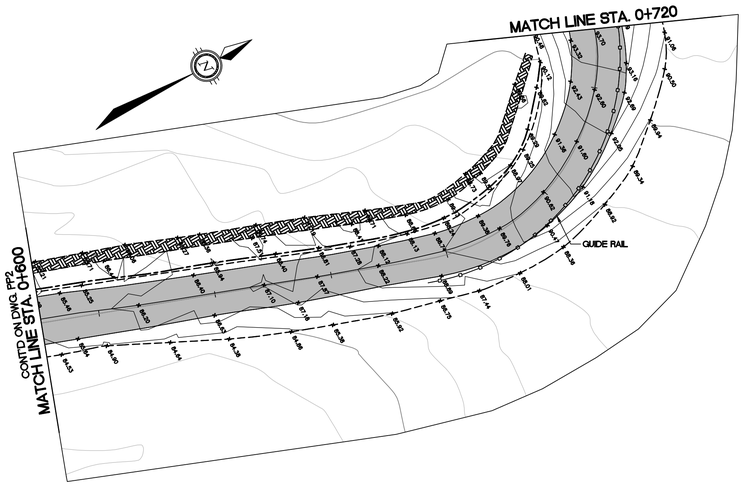
Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ont. K2E 7J5
Tel:(613)225-9940
Fax:(613)225-7337

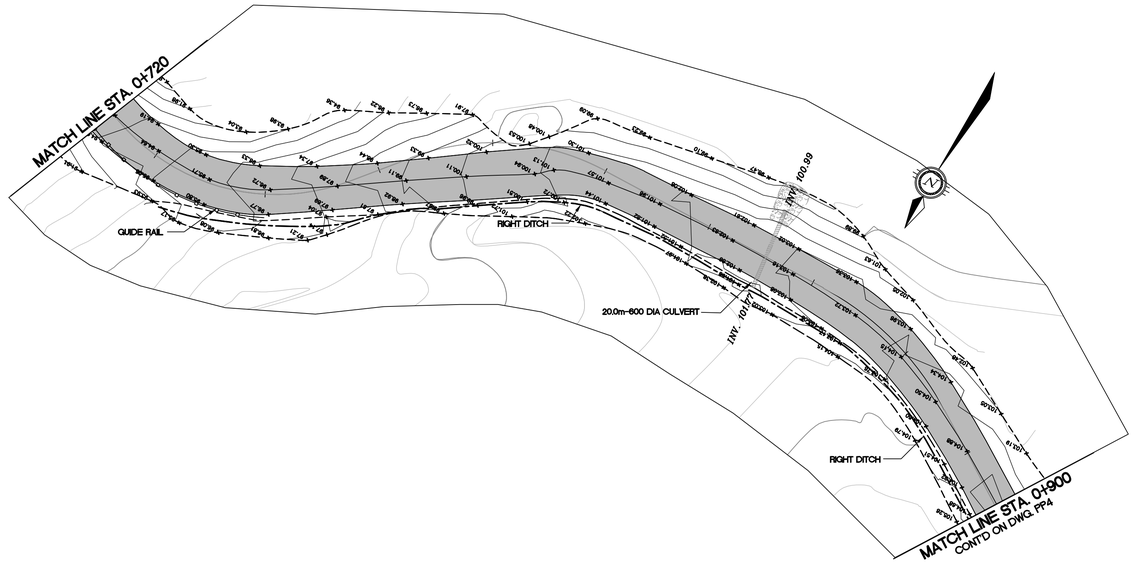
CLIENT
GOVERNMENT OF NUNAVUT

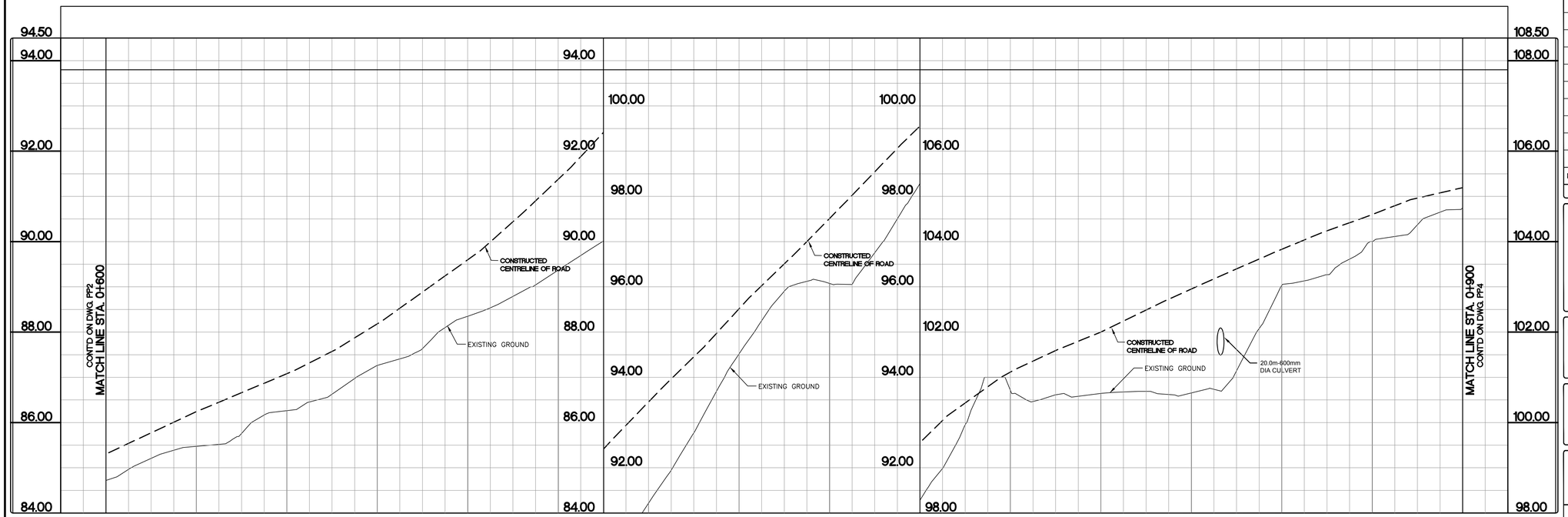
PROJECT
ARCTIC BAY
WASTE WATER
LAGOON ROAD

TITLE
ACCESS ROAD
PLAN & PROFILE
STA. 0+300 TO STA. 0+600

design by	S.A.D.	project no.	OTCD19054A
drawn by	M.M.R.	drawing no.	PP2
checked by	S.L.B.		
date	21/04/08		
scale	HORIZ 1:500 VERT 1:50		







CL Road	85.30 84.72	86.25 85.47	87.07 86.26	88.19 87.26	89.60 88.35	91.38 89.37	93.43 91.22	95.52 94.52	97.51 96.07	97.51 98.28	101.12 100.71	102.02 100.64	102.96 100.65	103.82 103.03	104.60 104.00	105.19	CL Road
Stations	0+600	0+620	0+640	0+660	0+680	0+700	0+720	0+740	0+760	0+780	0+800	0+820	0+840	0+860	0+880	0+900	Stations

KEY PLAN

LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 000.00
DESCRIPTION HERE

No.	DESCRIPTION	DATE	BY	APP'D
5	AS-BUILT	30/11/11	SAB	SLB
4	AS-CONSTRUCTED	17/11/11	MEB	SLB
3	ISSUED FOR CONSTRUCTION	14/09/09	MMR	SLB
2	TENDER SET	27/04/09	MMR	SLB
1	ISSUED FOR APPROVAL	24/04/08	MMR	SLB

REVISIONS

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APRIL 27TH, 2009

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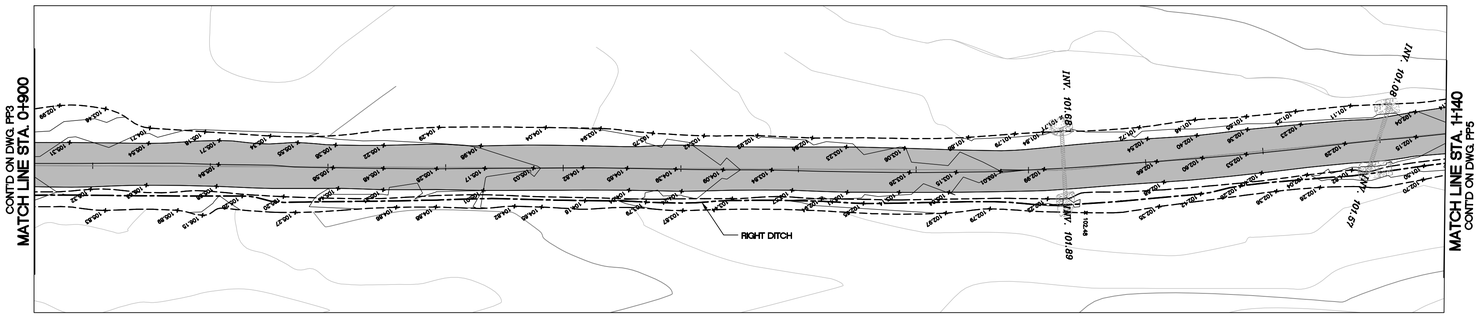
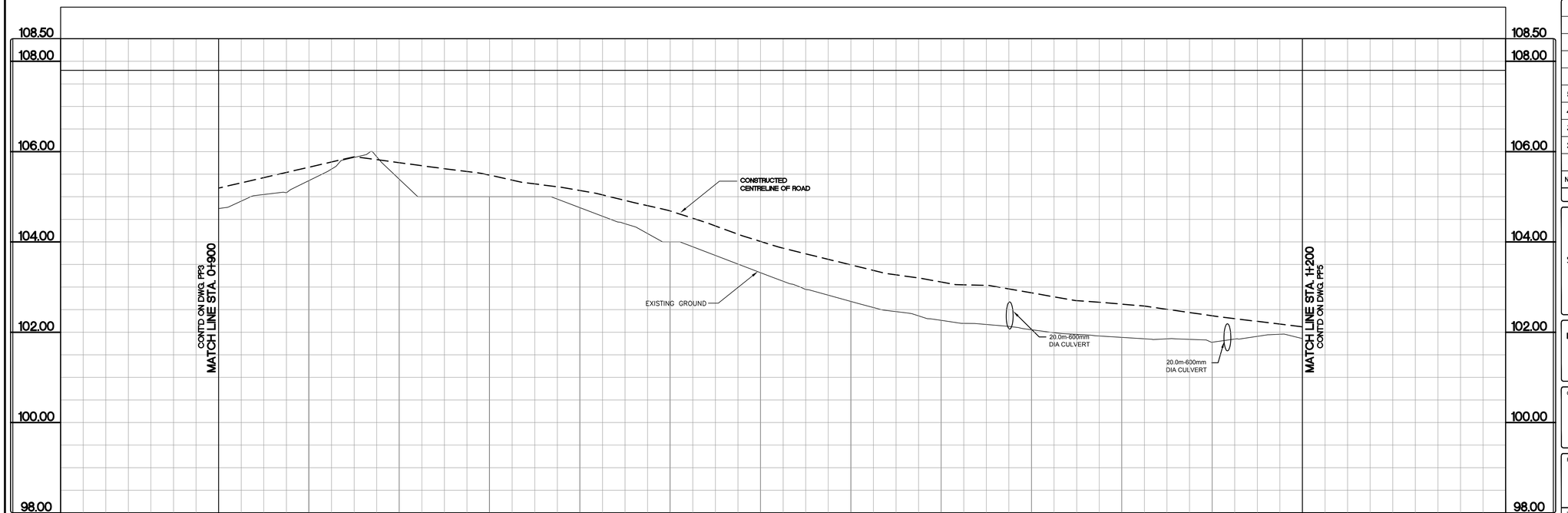
CLIENT
GOVERNMENT OF NUNAVUT

PROJECT
ARCTIC BAY
WASTE WATER
LAGOON ROAD

TITLE
ACCESS ROAD
PLAN & PROFILE
STA. 0+600 TO STA. 0+900

design by	S.A.D.	project no.	OTCD19054A
drawn by	M.M.R.	drawing no.	PP3
checked by	S.L.B.		
date	21/04/08		
scale	HORIZ 1:500 VERT 1:50		





KEY PLAN

LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK
BM 1 ELEV. = 000.00
DESCRIPTION HERE

CL Road	104.74	105.19 105.36	105.65 105.39	105.76 105.00	105.48 104.76	105.13 104.00	104.68 103.32	104.01 102.68	103.49 102.26	103.11 102.09	102.87 102.07	102.62 102.09	102.36 102.62	102.12 102.84	103.00	CL Road
Stations		0+900	0+920	0+940	0+960	0+980	1+000	1+020	1+040	1+060	1+080	1+100	1+120	1+140		Stations

No.	DESCRIPTION	DATE	BY	APP'D
5	AS-BUILT	30/11/11	SAB	SLB
4	AS-CONSTRUCTED	17/11/11	MEB	SLB
3	ISSUED FOR CONSTRUCTION	14/09/09	MMR	SLB
2	TENDER SET	27/04/09	MMR	SLB
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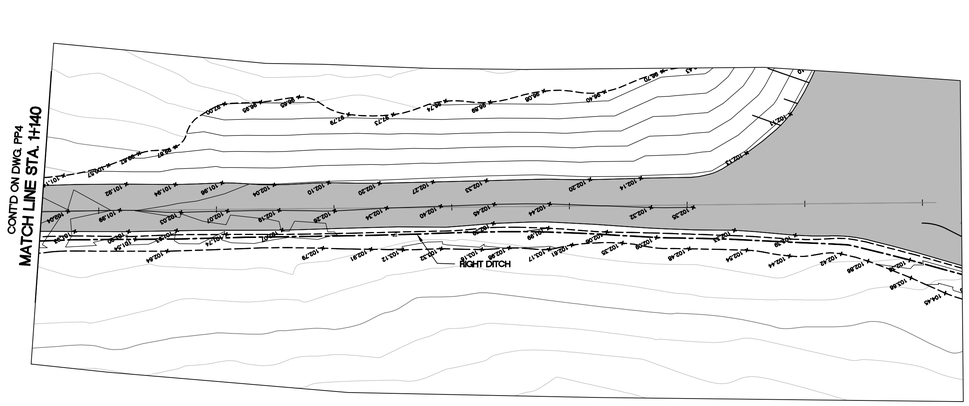
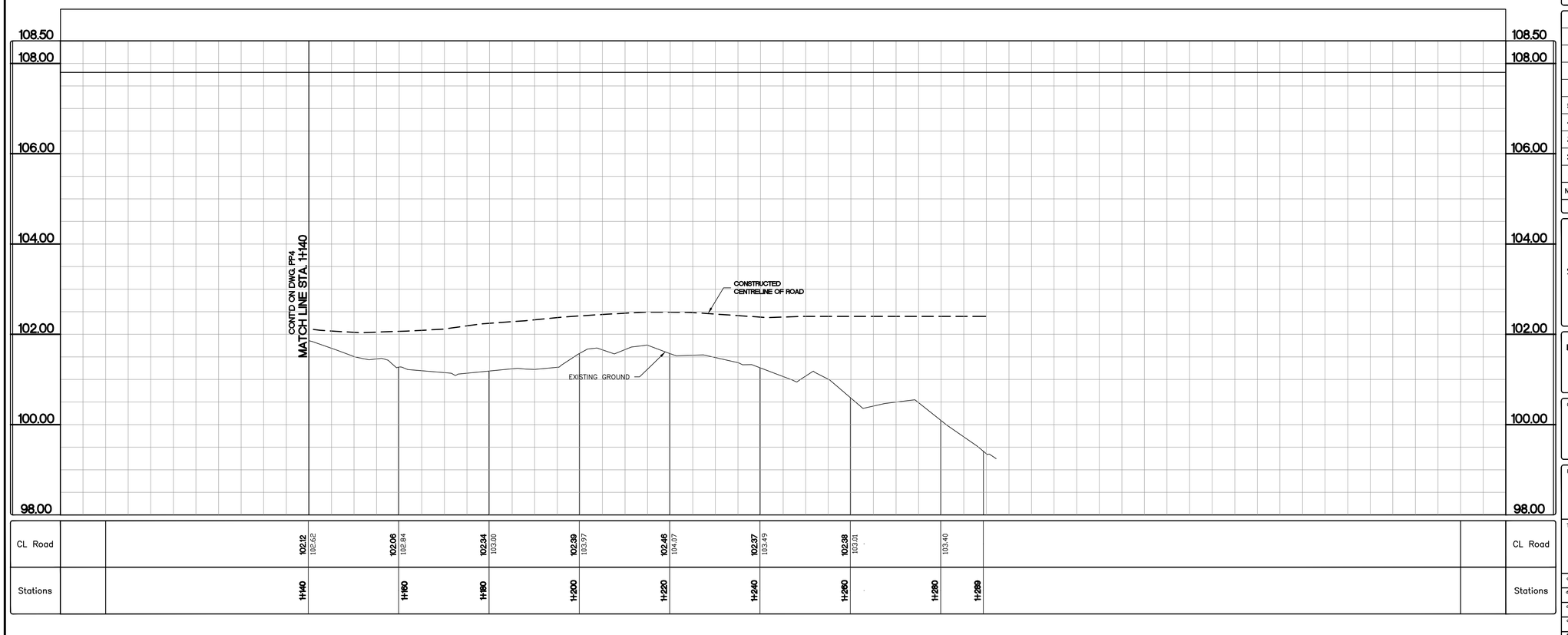
CLIENT
GOVERNMENT OF NUNAVUT

PROJECT
ARCTIC BAY
WASTE WATER
LAGOON ROAD

TITLE
ACCESS ROAD
PLAN & PROFILE
STA. 0+900 TO STA. 1+200

design by S.A.D.
drawn by M.M.R.
checked by S.L.B.
date 21/04/08
scale HORIZ 1:500 VERT 1:50
project no. OTCD19054A
drawing no. PP4





CL Road		102.12 102.62	102.06 102.84	102.34 103.00	102.39 103.97	102.46 104.07	102.37 103.49	102.38 103.01	103.40		CL Road
Stations		1+140	1+160	1+180	1+200	1+220	1+240	1+260	1+280	1+289	Stations

KEY PLAN

LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 000.00

DESCRIPTION HERE

No.	DESCRIPTION	DATE	BY	APP'D
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1	ISSUED FOR APPROVAL	24/04/08	MMR	SLB

REVISIONS

DRAWINGS ORIGINALLY SEALED BY S.L.BURDEN, P.eng. OF exp. SERVICES Inc. APRIL 27TH, 2009

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CLIENT

GOVERNMENT OF NUNAVUT

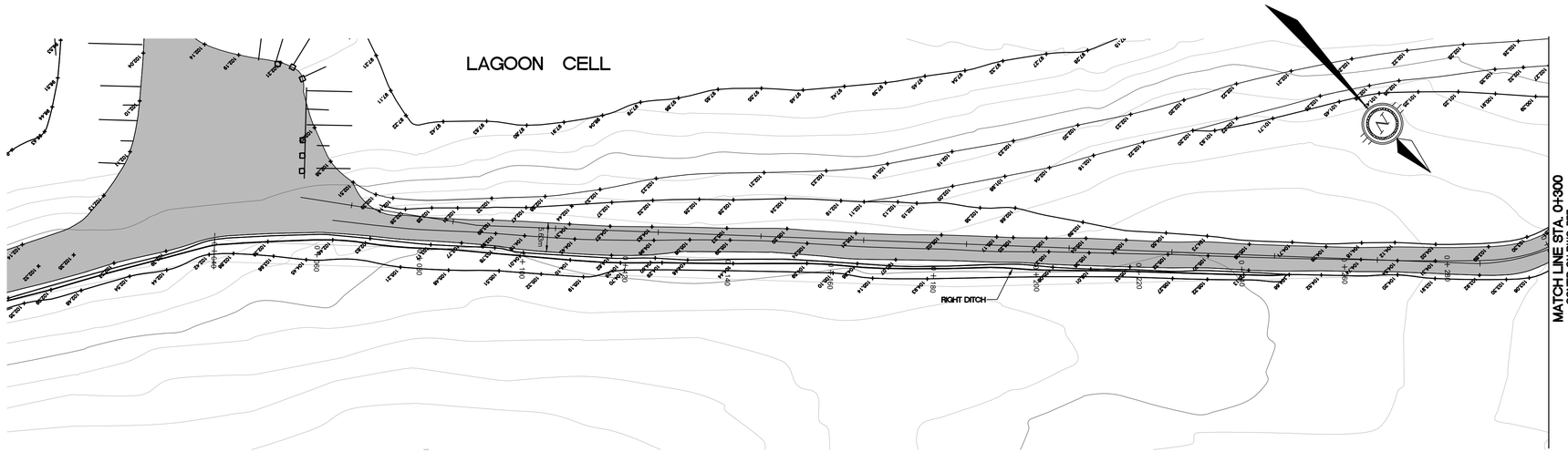
PROJECT

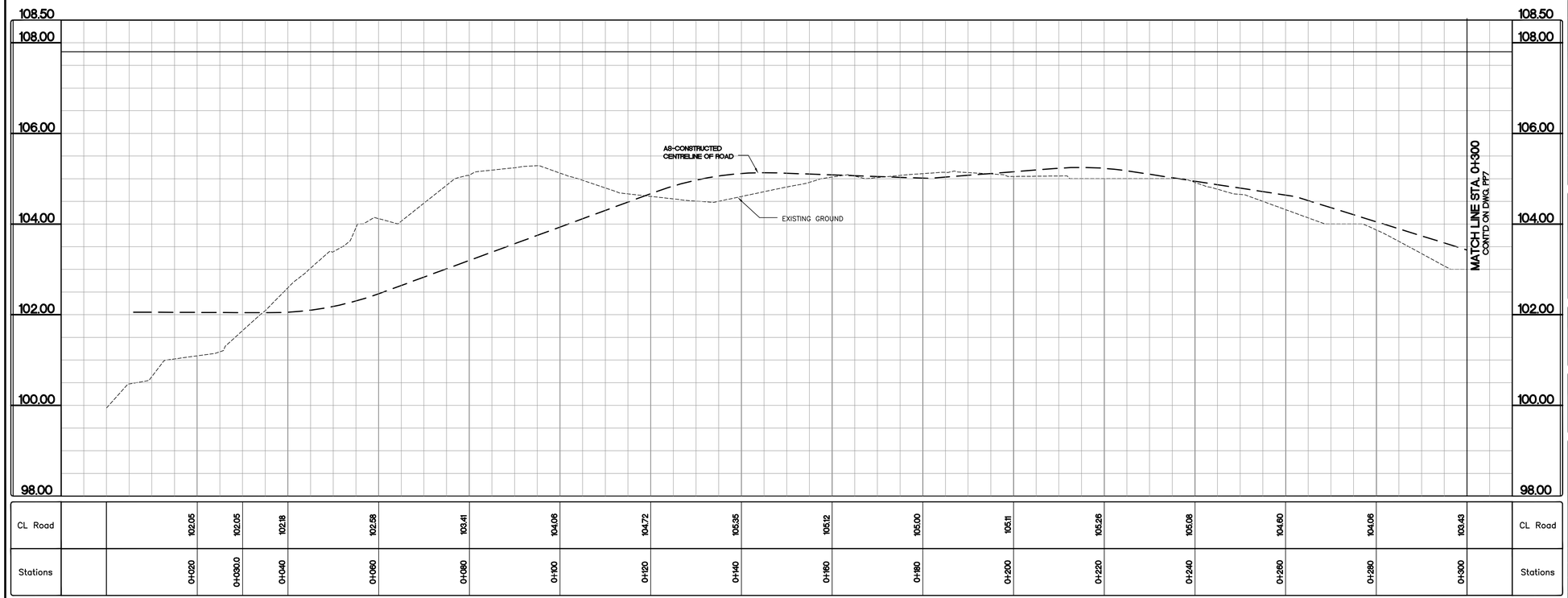
ARCTIC BAY
WASTE WATER
LAGOON ROAD

TITLE

ACCESS ROAD
PLAN & PROFILE
STA. 1+140 TO STA. 1+245

design by	S.A.D.	project no.	OTCD19054A
drawn by	M.M.R.	drawing no.	PP5
checked by	S.L.B.		
date	21/04/08		
scale	HORIZ 1:500 VERT 1:50		





CL Road		102.05	102.05	102.18	102.58	103.41	104.08	104.72	105.35	105.12	105.00	105.11	105.26	105.08	104.60	104.06	103.43		CL Road
Stations		0+020	0+030.0	0+040	0+060	0+080	0+100	0+120	0+140	0+160	0+180	0+200	0+220	0+240	0+260	0+280	0+300		Stations

KEY PLAN

LEGEND

AS-BUILT

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BENCH MARK

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CLIENT

GOVERNMENT OF NUNAVUT

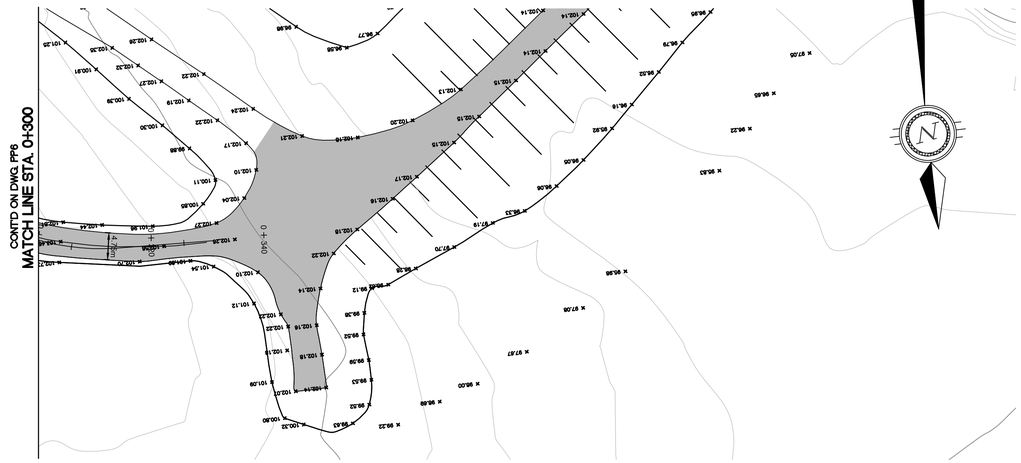
PROJECT

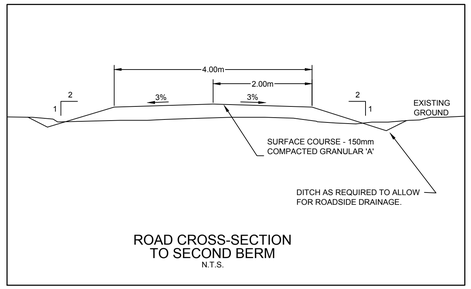
ARCTIC BAY
WASTE WATER LAGOON

TITLE

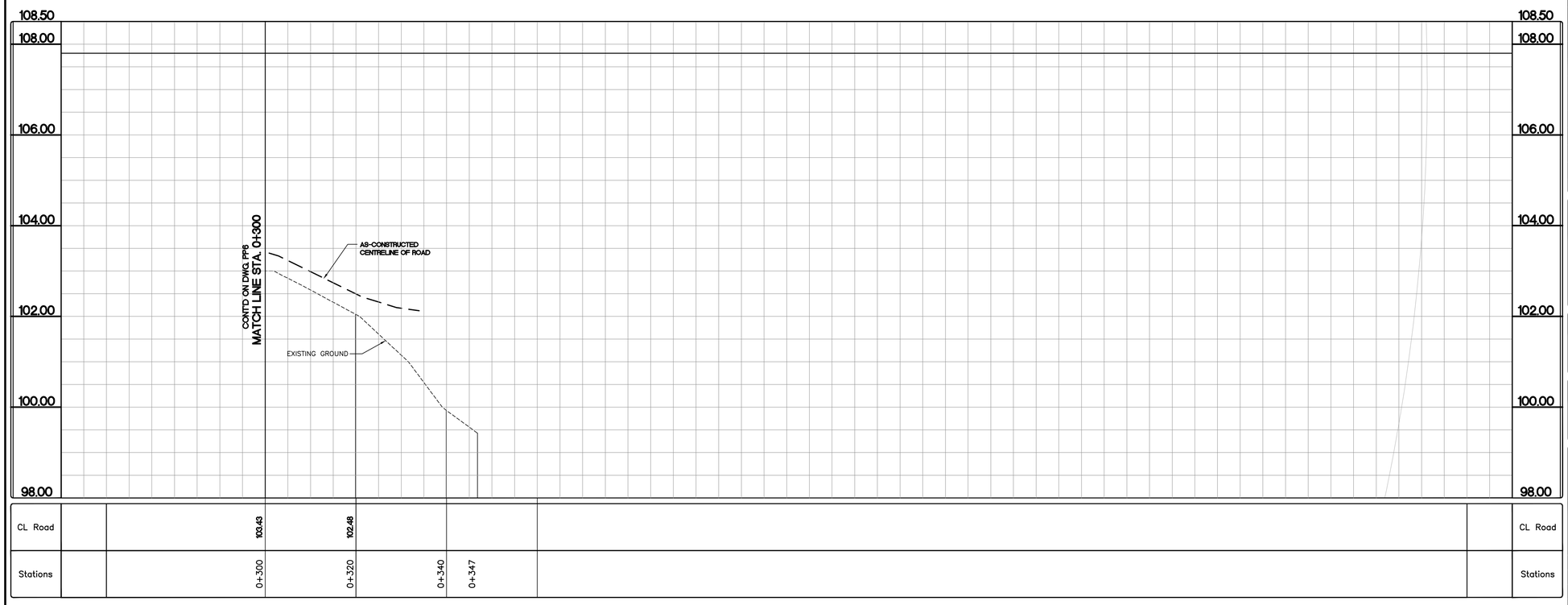
ACCESS ROAD
SECOND BERM
PLAN & PROFILE

design by	S.A.D.	project no.	OTCD19054A
drawn by	M.M.R.	drawing no.	PP6
checked by	S.L.B.		
date	07/12/07		
scale	HORIZ 1:500 VERT 1:50		





ROAD CROSS-SECTION
TO SECOND BERM
N.T.S.



KEY PLAN

LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 000.00

DESCRIPTION HERE

No.	DESCRIPTION	DATE	BY	APP'D
5	AS-BUILT	30/11/11	SAB	SLB
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3	ISSUED FOR CONSTRUCTION	14/09/09	MMR	SLB
2	TENDER SET	27/04/09	MMR	SLB
1	ISSUED FOR APPROVAL	24/04/08	MMR	SLB

REVISIONS

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CLIENT

GOVERNMENT OF NUNAVUT

PROJECT

ARCTIC BAY
WASTE WATER LAGOON

TITLE

ACCESS ROAD
SECOND BERM
PLAN & PROFILE

design by	S.A.D.	project no.	OTCD19054A
drawn by	M.M.R.	drawing no.	PP7
checked by	S.L.B.		
date	07/12/07		
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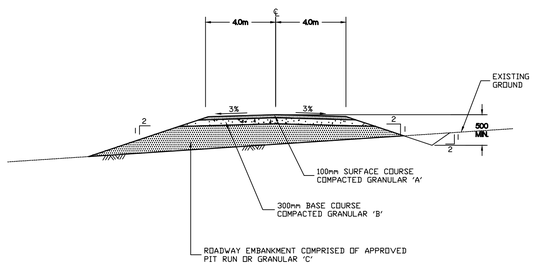
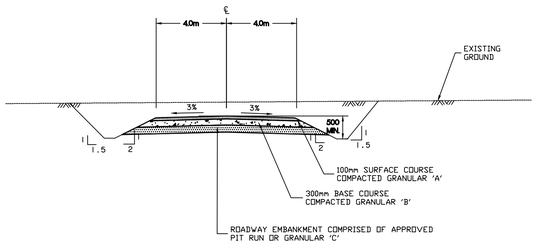
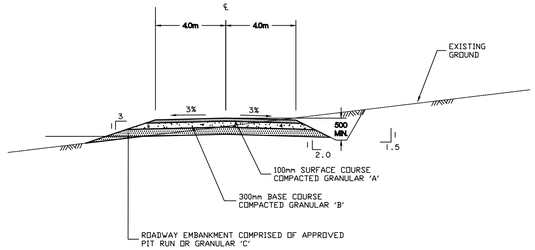


LOCAL ROAD SECTION FOR EMBANKMENT CONSTRUCTION
N.T.S.



LOCAL ROAD SECTION IN CUT AREA WITH ROADSIDE DITCHES ON BOTH SIDES
N.T.S.



LOCAL ROAD SECTION IN CUT AREA
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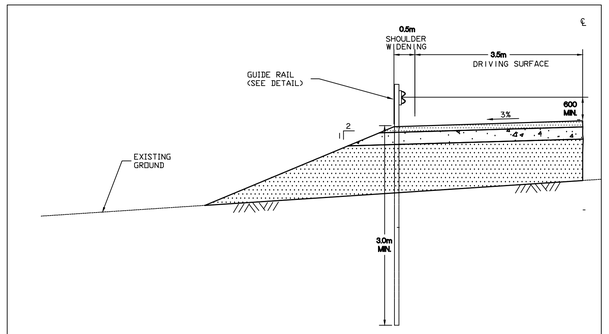
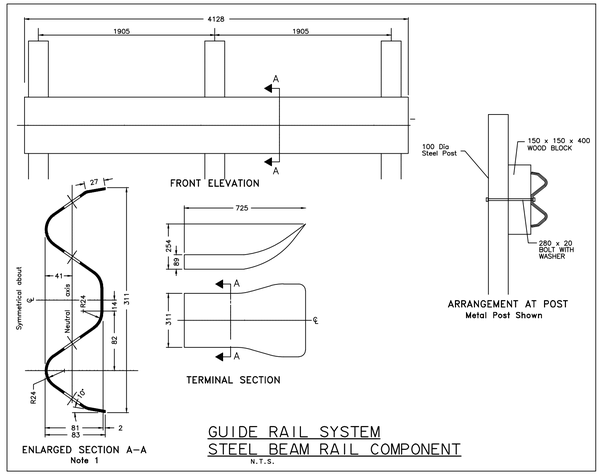
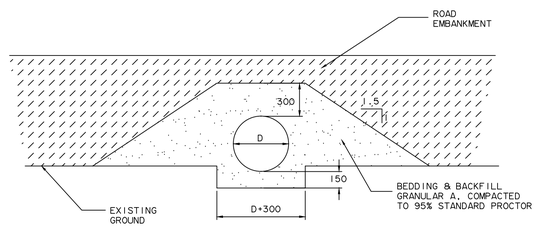


LOCAL ROAD WIDENING AT GUIDE RAIL LOCATIONS
N.T.S.



GUIDE RAIL SYSTEM
STEEL BEAM RAIL COMPONENT
N.T.S.



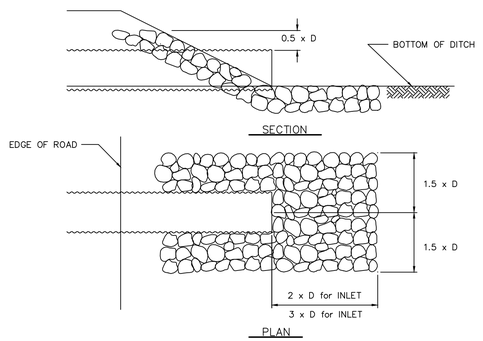
NOTES:

1. MINIMUM COVER 450mm IN ROADS

2. INVERT OF CULVERT O.ID BELOW EXISTING GROUND.

3. SEE DRAWING T-6 FOR CULVERT APRON DETAIL.

PIPE CULVERT IN AN EMBANKMENT
N.T.S.



CULVERT APRON DETAIL
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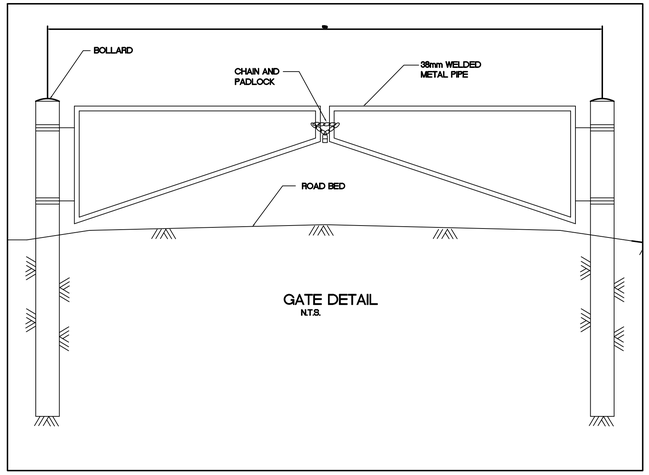

GATE DETAIL
N.T.S.

KEY PLAN

LEGEND

AS-BUILT

DATE: NOVEMBER 30, 2011

BENCH MARK

BM 1 ELEV. = 000.00

DESCRIPTION HERE

No.	DESCRIPTION	DATE	BY	APP'D
6	AS–BUILT	30/11/11	SAB	SLB
5	AS–CONSTRUCTED	17/11/11	MEB	SLB
4	ISSUED FOR CONSTRUCTION	14/09/09	MMR	SLB
3	TENDER SET	27/04/09	MMR	SLB
2	REVISED GUARD RAIL SYSTEM DETAIL	26/01/09	MMR	SLB
1	ISSUED FOR APPROVAL	24/04/08	MMR	SLB

R E V I S I O N S

DRAWINGS ORIGINALLY SEALED BY S.L.BURDEN, P.eng. OF exp. SERVICES Inc. APRIL 27TH, 2009

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Ottawa, Ont. K2E 7J5
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Fax:(613)225–7337

CLIENT

GOVERNMENT OF NUNAVUT

PROJECT

ARCTIC BAY
WASTE WATER LAGOON

TITLE

ROAD DETAILS

design by	S.A.D.	project no.	OTCD19054A
drawn by	M.M.R.	drawing no.	DE–1
checked by	S.L.B.		
date	14/12/07		
scale	AS SHOWN		

Government of Nunavut

Operation and Maintenance Manual

Volume II

Type of Document:
Final

Project Name:
Arctic Bay Waste Water Facility

Project Number:
OTCD00019054A

Prepared By:
exp
100-2650 Queensview Drive
Ottawa, ON K2B 8H6
Canada
T: 613 688-1899
F: 613 225-7337
www.exp.com

Date Submitted:
July 2012

Table of Contents

Manufacturing Data and Service Information

Appendix A - Technical Specifications Pump

A C D E U

Prime Aire®

Diesel Engine Driven

Priming Assisted Centrifugal Pump w/Autostart

Model PA6C60–4045D

Size 6” x 6”

2 YEAR WARRANTY — 2 PRIMING-ASSIST

Total Head		Capacity of Pump in U.S. Gallons per Minute (GPM) at Continuous Performance				
P.S.I.	Feet					
63.3	146	200	200	200	200	200
60.7	140	400	400	400	400	400
52.0	120	820	1000	1000	1000	1000
43.4	100	960	1380	1420	1420	1420
34.7	80	1040	1500	1770	1770	1770
26.0	60	1100	1510	1815	2050	2050
17.4	40	1140	1505	1820	2120	2250
8.7	20	1200	1550	1820	2150	2360
Suction Lift		25’	20’	15’	10’	5’

PUMP SPECIFICATIONS

Size: 6” x 6” (152 mm x 152 mm) Flanged.
Casing: Ductile Iron No. 65-45-12. Maximum Operating Pressure 100 psi (690 kPa).*
Open Type, Two Vane Impeller: Ductile Iron No. 65-45-12. Handles 3” (76,2 mm) Diameter Spherical Solids.
Impeller Shaft: Stainless Steel No. 17-4 PH.
Replaceable Wear Plate: Ductile Iron No. 80-60-03.
Removeable Cleanout Cover Plate: Gray Iron No. 30.
Intermediate Bracket: Gray Iron No. 30.
Seal Plate: Gray Iron No. 30.
Seal: Mechanical, Oil-Lubricated. Silicon Carbide Rotating and Stationary Faces. Stainless Steel No. 316 Stationary Seat. Fluorocarbon Elastomers (DuPont Viton® or Equivalent). Stainless Steel No. 18-8 Cage and Spring. Maximum Temperature of Liquid Pumped, 160°F (71°C).*
Shaft Sleeve: Stainless Steel No. 17-4 PH.
Priming Chamber: Gray Iron No. 30.
Discharge Check Valve: Gray Iron No. 30 Housing w/Buna-N Flapper.
Radial and Thrust Bearings: Open Double Ball.
Bearing and Seal Cavity Lubrication: SAE No. 30 Non-Detergent Oil.
Flanges: Gray Iron No. 30.
Gaskets: Resistant Synthetic Rubber, Cork, PTFE, Vegetable Fiber, and Compressed Synthetic Fibers.
Hardware: Standard Plated Steel.
Bearing and Seal Cavity Oil Level Sight Gauges.

**Consult Factory for Applications Exceeding Maximum Pressure and/or Temperature Indicated.*

Standard Equipment: Gear-Driven Air Compressor. Hoisting Bail. Combination Skid Base w/Fuel Tank. Strainer. Single Ball Type Float Switch.**

***50 Ft. (15 m) Standard Length; Dual Switches and Alternate Cable Lengths Available From the Factory.*

Optional Equipment: Battery. High Speed (55 MPH/89 KM/H) Wheel Kit with ST225/75R15 Pneumatic Tires. Over-the-Road Trailer (Meets D.O.T. and Transport Canada Requirements) Available w/Either Electric or Hydraulic Surge Brakes, Running Lights, Two Trailer Jack Stands and Safety Chains. EPS w/Submersible Transducer Liquid Level Sensor (50 Ft. [15 M] Cable Standard, Alternate Lengths Available).

SHOWN WITH OPTIONAL NPT SUCTION AND DISCHARGE FLANGES

WARNING!

Do not use in explosive atmosphere or for pumping volatile flammable liquids.

ENGINE SPECIFICATIONS

Model: John Deere 4045D “Power Tech”.
Type: Four Cylinder, Four Cycle, Liquid Cooled Diesel Engine.
Displacement: 276 Cu. In. (4,5 liters).
Governor: Mechanical.
Lubrication: Forced Circulation.
Air Cleaner: Dry Type.
Oil Reservoir: 9 U.S. Qts. (8,5 liters) Dry; 8 U.S. Qts. (7,6 liters) Refill.
Fuel Tank: 88 U.S. Gals. (330 liters).
Full Load Operating Time: 26.1 Hrs.
Starter: 12V Electric.

Standard Features: Low Oil Pressure, High Coolant Temperature and Start Failure Safety Shut Down Switches/Indicators. Throttle Control. Autostart Instrument Panel Includes: Tachometer, Voltmeter, Hourmeter, Coolant Temperature and Oil Pressure Indicators, Manual/Stop/Auto Key Switch, 10 Amp Fuse, Audible Startup Warning Delay. Muffler w/Guard and Weather Cap.

JOHN DEERE PUBLISHED PERFORMANCE:

Maximum Continuous BHP 76 (57 kW) @ 2500 RPM
Maximum Dynamic BHP 80 (60 kW) @ 2500 RPM

GORMAN-RUPP PUMPS

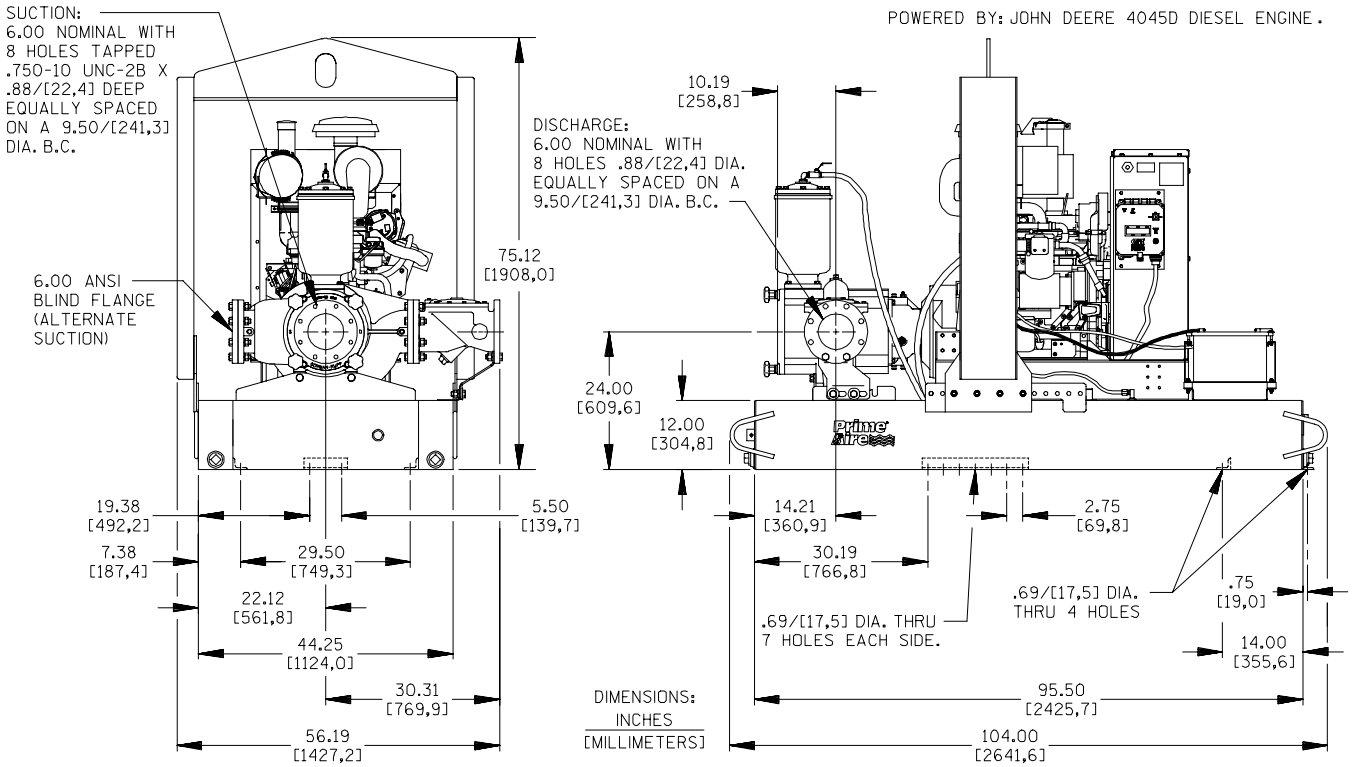
THE GORMAN-RUPP COMPANY ● MANSFIELD, OHIO
GORMAN-RUPP OF CANADA LIMITED ● ST. THOMAS, ONTARIO, CANADA
www.grpumps.com
Specifications Subject to Change Without Notice
Printed in U.S.A.

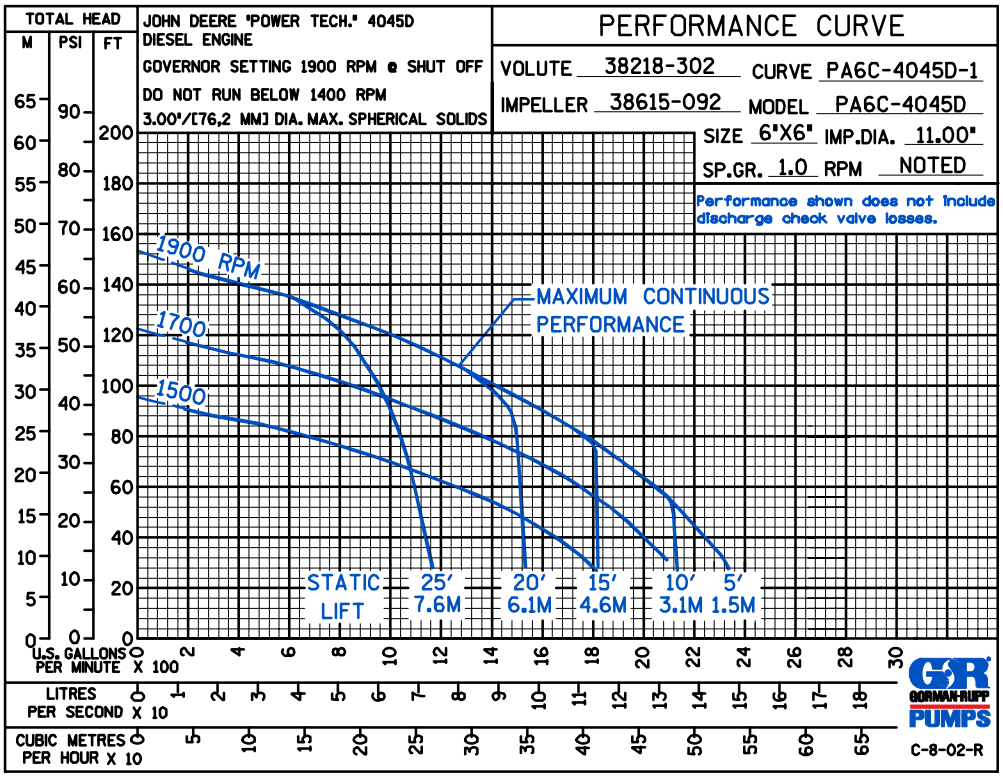
Specification Data

SECTION 42, PAGE 1100

APPROXIMATE DIMENSIONS and WEIGHTS

	SKID BASE	2-WHEEL
NET WEIGHT:	3310 LBS. (1501 KG.)	3600 LBS. (1633 KG.)
SHIPPING WEIGHT:	3460 LBS. (1569 KG.)	3600 LBS. (1633 KG.)
EXPORT CRATE SIZE:	247 CU. FT. (7 CU. M.)	



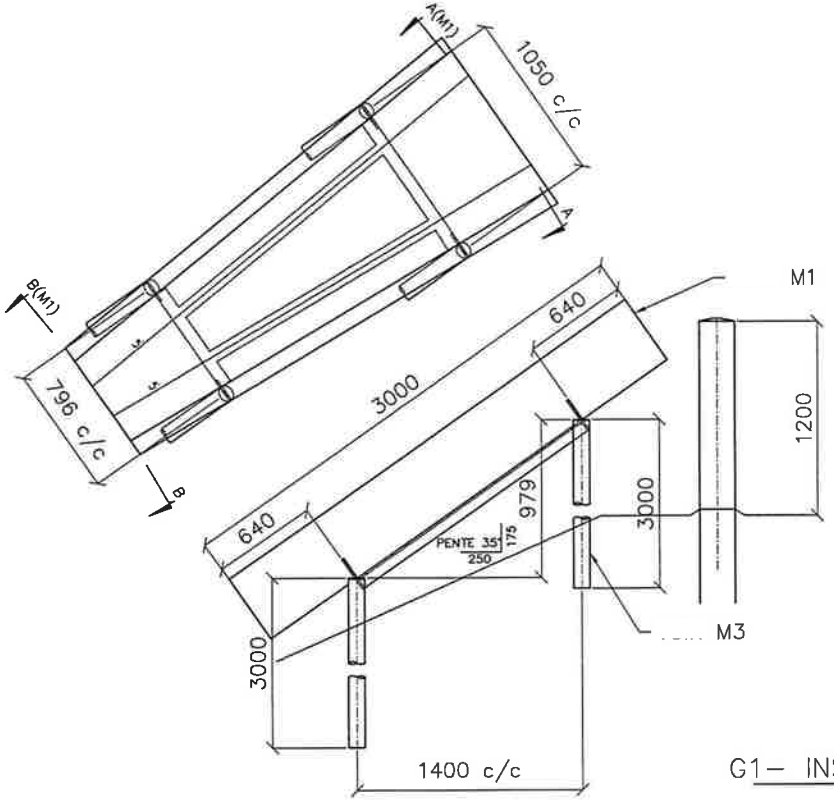


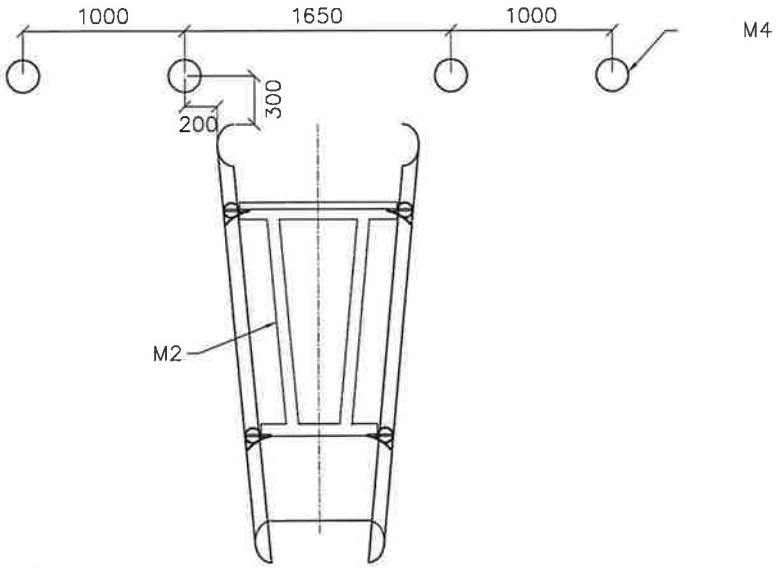
GORMAN-RUPP PUMPS

THE GORMAN-RUPP COMPANY ● MANSFIELD, OHIO

GORMAN-RUPP OF CANADA LIMITED ● ST. THOMAS, ONTARIO, CANADA

Appendix B - Technical Specifications Truck Discharge





G1– INSTALLATION

DESSIN #G1 A

REVISIONS

A	08.08.11	EMIS POUR APPROBATION	

NOTES

LISTE DE MATÉRIEL

QUANTITÉ CONT.	QUANTITÉ ASS.	MQE	DESCRIPTION	LONG.	GRADE	REMARQUE	MASSE
						ASS.	

MASSE UNITAIRE ASSEMBLAGE: 281.2 Kg TOTAL: 561.4 Kg

SERVICES TECHNIQUES DCE
1808 RTE DE L'AÉROPORT
STE-FOY, QUÉ G2G 2P7
TEL: 418-872-5218 FAX: 418-872-6804
dce@dce-qc.com

CLIENT: **Kudlik Construction Ltd**

PROJET: **Clyde River**

TITRE: Truck discharge

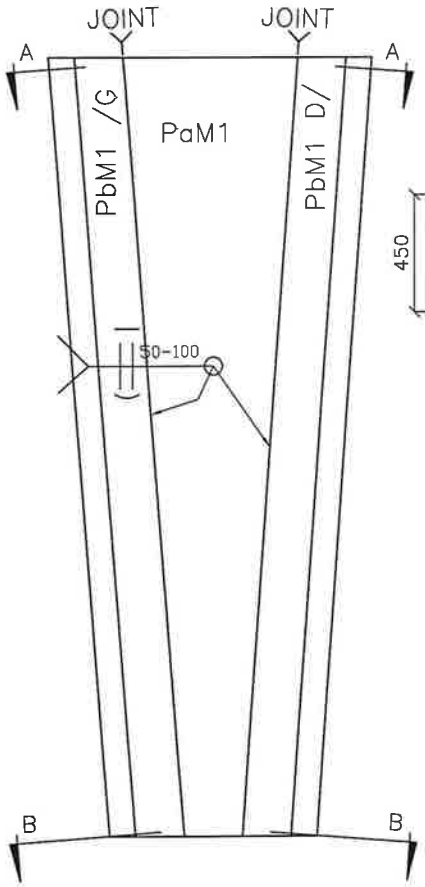
DESSINÉ: Serge Desbiens

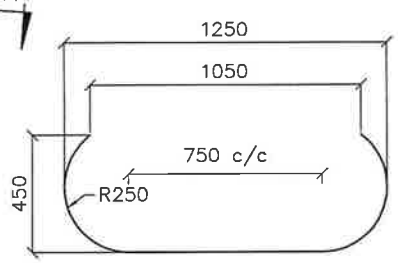
VÉRIFIÉ:

DATE: AOÛT 2008

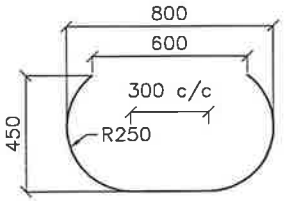
RAPPORT:

PROJET #: **12350**

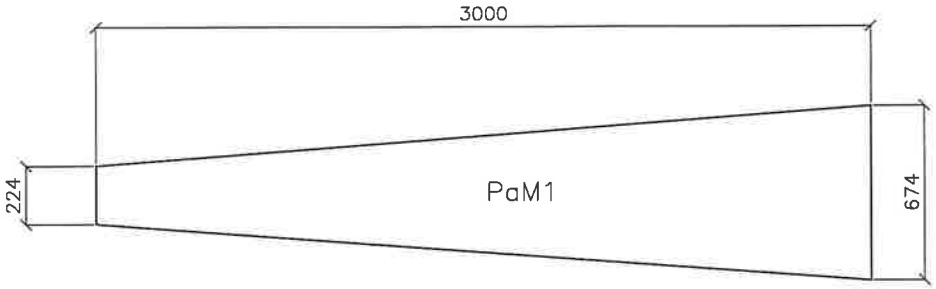


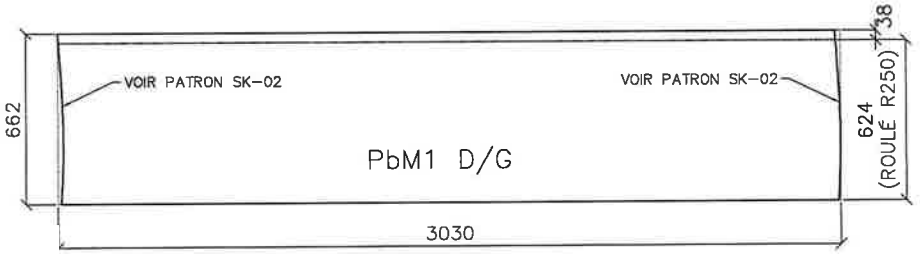


COUPE A–A



COUPE B–B





M1 Drawing

REVISIONS				
	A	08.08.11	EMIS POUR APPROBATION	

NOTES

LISTE DE MATÉRIEL

QUANTITÉ CONT.	QUANTITÉ ASS.	MQE		DESCRIPTION	LONG.	GRADE	REMARQUE	MASSE
12	UN	PaM1	PL.	674 x 12G	3000	NOIR	ASS. M1	31.6
12	UN/UN	PbM1	PL.	662 x 12G	3030	NOIR		96.8

MASSE UNITAIRE ASSEMBLAGE: 90.0 Kg TOTAL: 1080 Kg

DESSIN #M1 A

SERVICES TECHNIQUES DCE
ISO 9001
1808 RTE DE L'AÉROPORT
STE-FOY, QUÉ G2G 2P7
TEL: 418-872-5218 FAX: 418-872-6804
dce@dce-qc.com

CLIENT: Kudlik Construction Ltd

PROJET: Clyde River

TITRE: Truck discharge

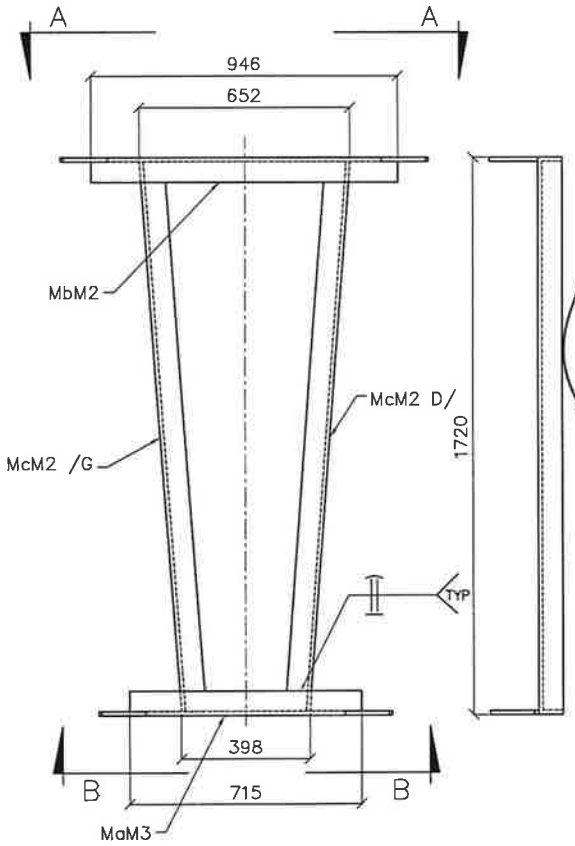
DESSINÉ: Serge Desbiens

VÉRIFIÉ:

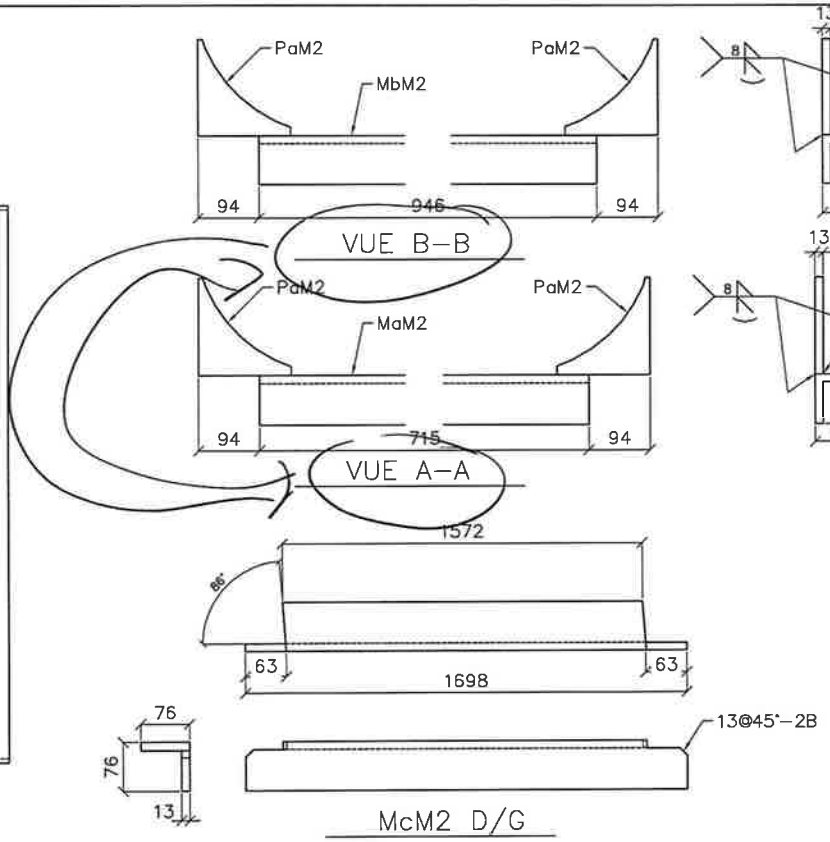
DATE: AOÛT 2008

RAPPORT:

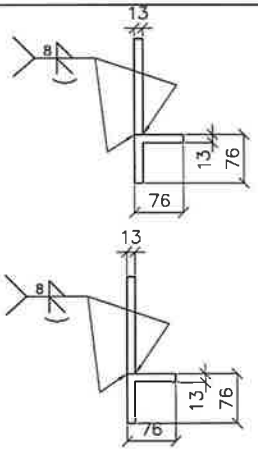
PROJET #: 12350

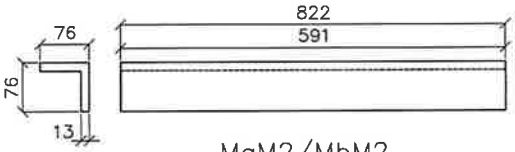


M2– 3 REQUIS

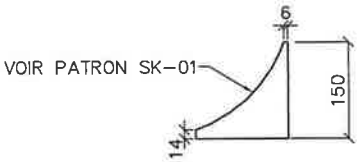


McM2 D/G





MaM2/MbM2



PaM2

DESSIN #M2 A

REVISIONS			
A	08.08.11	EMIS POUR APPROBATION	

NOTES

LISTE DE MATÉRIEL

QUANTITÉ CONT.	QUANTITÉ ASS.	MQE		DESCRIPTION	LONG.	GRADE	REMARQUE	MASSE
12	4	PaM2	PL	143x12,7	250	NOIR	ASS. M2	12.1
3	UN	MaM2	L	76x76x12,7	946	NOIR		11.5
3	UN	MbM2	L	76x76x12,7	715	NOIR		8,3
3	UN	McM2	L	76x76x12,7	1698	NOIR		47,6

MASSE UNITAIRE ASSEMBLAGE: 79.5 Kg TOTAL: 238.5 Kg

SERVICES TECHNIQUES DCE
1808 RTE DE L'AÉROPORT
STE-FOY, QUÉ G2G 2P7
TEL: 418-872-5218 FAX: 418-872-6804
dce@dce-qc.com

CLIENT: **Kudlik Construction Ltd**

PROJET: **Clyde River**

TITRE: Truck Discharge(rack)

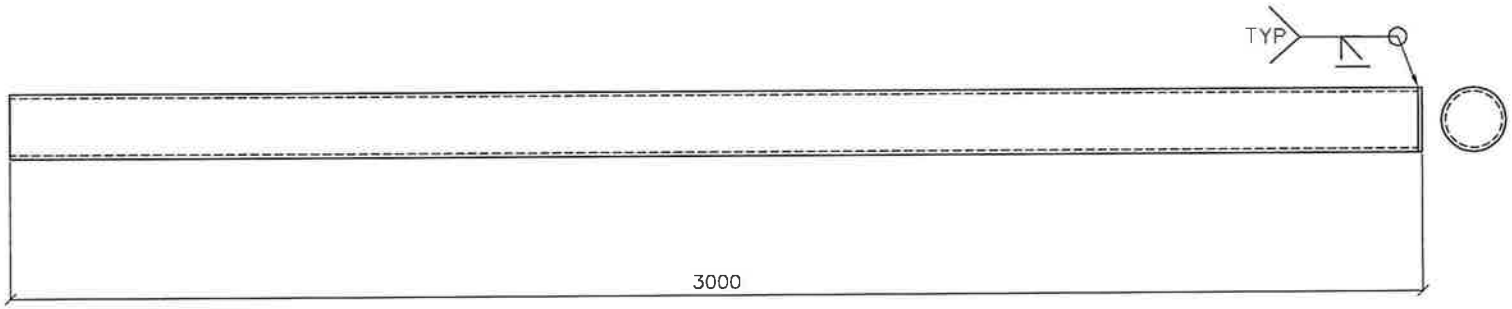
DESSINÉ: Serge Desbiens

VÉRIFIÉ:

DATE: AOÛT 2008

RAPPORT:

PROJET #: **12350**



M3-12

DESSIN #M3 A

REVISIONS				
	A	08.08.11	EMIS POUR APPROBATION	.

NOTES

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LISTE DE MATÉRIEL

QUANTITÉ CONT.	QUANTITÉ ASS.	MQE		DESCRIPTION	LONG.	GRADE	REMARQUE	MASSE
12	UN	M3	HSS	ø100 EXT.-CÉD. 40	2994	NOIR	ASS. M3	53.0
12	UN	paM3	PL.	PL. ø100x6	.	NOIR		.2

MASSE UNITAIRE ASSEMBLAGE: 53.2 Kg TOTAL: 212.8 Kg

SERVICES TECHNIQUES DCE
1808 RTE DE L'AÉROPORT
STE-FOY, QUÉ G2G 2P7
TEL: 418-872-5218 FAX: 418-872-6804
dce@dce-qc.com

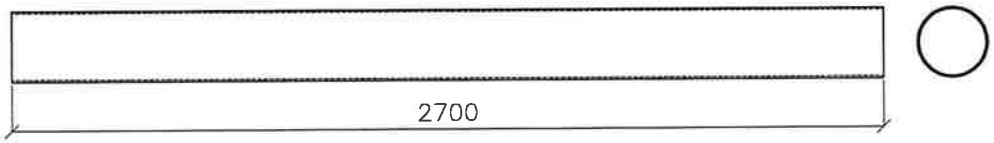
CLIENT: **Kudlik Construction Ltd**

PROJET: **Clyde River**

TITRE: Truck Discharge(steel pile)

DESSINÉ: Serge Desbiens | VÉRIFIÉ: .

DATE: AOÛT 2008 | RAPPORT: | PROJET #: **12350**



GALVANISÉ
SOUDURES ETANCHES
PRÉVOIR TROUS NÉCESSAIRES

M4–12

DESSIN #M4 A

REVISIONS

A	08.08.11	EMIS POUR APPROBATION

NOTES

LISTE DE MATÉRIEL

QUANTITÉ CONT.	QUANTITÉ ASS.	MQE		DESCRIPTION	LONG.	GRADE	REMARQUE	MASSE
12	UN	M4	HSS	ø219 EXT.–CÉD.20	2700	NOIR	ASS. M4	90.0

MASSE UNITAIRE ASSEMBLAGE: 90.0 Kg TOTAL: 1080 Kg

SERVICES TECHNIQUES DCE
1808 RTE DE L'AÉROPORT
STE-FOY, QUÉ G2G 2P7
TÉL: 418-872-5218 FAX: 418-872-6804
dce@dce-qc.com

CLIENT: **Kudlik Construction Ltd**

PROJET: **Clyde River**

TITRE: Truck Discharge **(Bollard)**

DESSINÉ: Serge Desbiens

VÉRIFIÉ:

DATE: AOÛT 2008

RAPPORT:

PROJET #: **12350**

Appendix C - Technical Specifications HDPE Pipe

For more information and technical
assistance contact:

Performance Pipe, a division of
Chevron Phillips Chemical Company LP
P.O. Box 269006
Plano, TX 75026-9006
800.527.0662

DriscoPlex®
PE3608 / (PE3408) Pipe
Pipe and Fittings Data Sheet

Typical Material Physical Properties of DriscoPlex® PE3608 / (PE3408)

High Density Polyethylene Materials

Property	Unit	Test Procedure	Typical Value
Material Designation	---	PPI TR-4	PE3608
Cell Classification	---	ASTM D3350	345464C
Pipe Properties			
Density	gms / cm^3	ASTM D1505	0.955 (black)
Melt Index Condition 190 / 2.16	gms / 10 minutes	ASTM D1238	0.08
Hydrostatic Design Basis 73°F (23°C)	psi	ASTM D2837	1600
Hydrostatic Design Basis 140°F (60°C)	psi	ASTM D2837	800
Color: UV Stabilizer [C] [E]	---	ASTM D3350	Min 2% carbon Black Color UV Stabilizer
Material Properties			
Flexural Modulus 2% Secant - 16:1 span; depth, 0.5 in / min	psi	ASTM D790	>110,000
Tensile Strength at Yield	psi	ASTM D638 Type IV	3200
Elongation at Break 2 in / min., Type IV bar	%	ASTM D638	>700
Elastic Modulus	psi	ASTM D638	>150,000
Hardness	Shore D	ASTM D2240	62
PENT	hrs	ASTM F1473	>100
Thermal Properties			
Vicat Softening Temperature	°F	ASTM D1525	256
Brittleness Temperature	°F	ASTM D746	-103
Thermal Expansion	in / in / °F	ASTM D696	1.0×10^{-4}

For more information and technical assistance contact:

Performance Pipe, a division of
Chevron Phillips Chemical Company LP
P.O. Box 269006
Plano, TX 75026-9006
800.527.0662

SUGGESTED INDUSTRIES AND APPLICATIONS

Potable Water Mains	Horizontal Directional Drilling (HDD)	Marine Service
Sliplining	Water transmission Lines	Pipe Bursting
Industrial Water Mains	Ash, Tailings & Abrasives	Mining
Municipal Water Utilities	Open-cut and Bury	Culverts
Rural Water Distribution	River Crossings	Plow-in
Mun. & Ind. Sewer	Trenchless Technologies	Crude oil
Fire Main Piping	Rural Water Distribution	Plow-in

Butt Fusion Conditions

- 60-90 psig (4.14-6.21 bar) interfacial fusion pressure.
- 400-450° (204-232°C) heater surface temperature range.
- Please refer to Performance Pipe's PE3608 (PE3408) fusion procedure, Bulletin PP 750.

Available Sizes

- ¾" through 54" IPS
- 4" through 36" DIPS

Specification Data

The resin, pipe and fitting listed may comply with one or more of the standards below.

Applicable Standards	DriscoPlex® Pipe Series	PE3608 (PE3408)	PE4710 (d_f)
ASTM F714, NSF 61, ASTM D3035	4000, 4100, 4200, 4300, 4400, 4500, 4600, 4700	0.5	0.63
AWWA C906, AWWA C901	4000, 4100, 4200, 4300, 4400, 4500, 4600, 4700	0.5	0.63
FMA, AWWA, F714	1500, 1600	0.5	---
API 15LE, ASTM D2513			0.63

For more information and technical
assistance contact:

Performance Pipe, a division of
Chevron Phillips Chemical Company LP
P.O. Box 269006
Plano, TX 75026-9006
800.527.0662

	6400	0.5	

PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

Revised 03-17-2008

IPS Size and Dimension Data

PE3608 (PE3408)

DriscoPlex® Municipal & Industrial & Energy Series/IPS Pipe Data

Pressure Ratings are calculated using 0.50 design factor for HDS at 73°F as listed in PPI TR-4 for PE 3608 materials.
Temperature, Chemical, and Environmental use considerations may require use of additional design factors.

Pressure Rating		100 psi DR 17.0			80 psi DR 21.0			65 psi DR 26.0			50 psi DR 32.5			
IPS Pipe Size	Nominal OD (in)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	Minimum Wall (in)	Average ID (in)	Weight (lbs/ft)	IPS Pipe Size
1 1/4"	1.660													1 1/4"
1 1/2"	1.900													1 1/2"
2"	2.375	0.140	2.078	0.43										2"
3"	3.500	0.206	3.063	0.93										3"
4"	4.500	0.265	3.938	1.54	0.214	4.046	1.26							4"
→ 6"	6.625	0.390	5.798	3.34	0.315	5.957	2.74	0.255	6.084	2.23	0.204	6.193	1.80	6"
8"	8.625	0.507	7.550	5.66	0.411	7.754	4.64	0.332	7.921	3.78	0.265	8.063	3.05	8"
10"	10.750	0.632	9.410	8.79	0.512	9.665	7.20	0.413	9.874	5.88	0.331	10.048	4.74	10"
→ 12"	12.750	0.750	11.160	12.36	0.607	11.463	10.13	0.490	11.711	8.27	0.392	11.919	6.67	12"
14"	14.000	0.824	12.253	14.90	0.667	12.586	12.22	0.538	12.859	9.97	0.431	13.086	8.04	14"
16"	16.000	0.941	14.005	19.47	0.762	14.385	15.96	0.615	14.696	13.02	0.492	14.957	10.51	16"
18"	18.000	1.059	15.755	24.64	0.857	16.183	20.20	0.692	16.533	16.48	0.554	16.826	13.30	18"
20"	20.000	1.176	17.507	30.42	0.952	17.982	24.94	0.769	18.370	20.35	0.615	18.696	16.42	20"
22"	22.000	1.294	19.257	36.81	1.048	19.778	30.17	0.846	20.206	24.62	0.677	20.565	19.86	22"
24"	24.000	1.412	21.007	43.80	1.143	21.577	35.91	0.923	22.043	29.30	0.738	22.435	23.64	24"
26"	26.000	1.529	22.759	51.41	1.238	23.375	42.14	1.000	23.880	34.39	0.800	24.304	27.74	26"
28"	28.000	1.647	24.508	59.62	1.333	25.174	48.87	1.077	25.717	39.88	0.862	26.173	32.17	28"
30"	30.000	1.765	26.258	68.44	1.429	26.971	56.11	1.154	27.554	45.78	0.923	28.043	36.93	30"
32"	32.000	1.882	28.010	77.87	1.524	28.769	63.84	1.231	29.390	52.09	0.985	29.912	42.02	32"
34"	34.000	2.000	29.760	87.91	1.619	30.568	72.06	1.308	31.227	58.80	1.046	31.782	47.44	34"
36"	36.000	2.118	31.510	98.55	1.714	32.366	80.79	1.385	33.064	65.92	1.108	33.651	53.19	36"
42"	42.000	2.471	36.761	134.14	2.000	37.760	109.97	1.615	38.576	89.73	1.292	39.261	72.39	42"
48"	48.000	2.824	42.013	175.21	2.286	43.154	143.63	1.846	44.086	117.19	1.477	44.869	94.55	48"
54"	54.000				2.571	48.549	181.78	2.077	49.597	148.32	1.662	50.477	119.67	54"

Performance Pipe can produce to specialized pipe dimensions. Check with your Performance Pipe contact for availability of dimensions not listed.
Visit www.performancepipe.com for the most current literature.

Elbow Design Information and End Options

The design basis for forge-molded elbows and fabricated segment elbows is well known. A 90 degree elbow is one-fourth of a torus (doughnut). The wedge removed from the straight pipe to make a miter-curve causes a force imbalance within the elbow. The ell tries to straighten out, sort of like a kink in a pressurized fire-hose. The ell must be derated or extra mass added to maintain the same pressure rating as the pipe itself. The heat-fusion welds are a focus point for the bending stress trying to straighten the ell. Continuous bend pipe without mitered fusion joints offer a higher pressure rating because there is no stress intensification factor (SIF) (i.e., no joints). Forge molded ells offer the same tight radius, no fusion joint flow turbulence, no miter joint stress intensification, and full pressure rating. Fabricated miter-ells have about the same radius of curvature, 4 turbulence amplifying fusion joints close together, and must be re-rated for WPR. The END OPTIONS for elbows include butt-end, flanged, and DIMJA.

ASME B31.3-1996 Edition

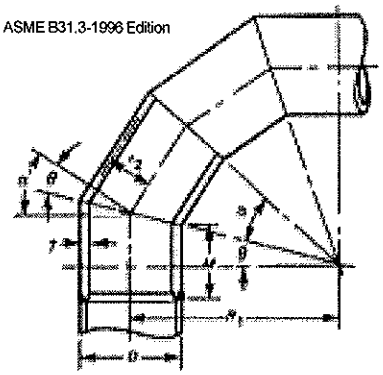


FIG. 304.23 NOMENCLATURE FOR MITER BENDS

The following nomenclature is used in the equations for pressure design of straight pipe.

tm = minimum required thickness, including mechanical, corrosion, and erosion allowances

t = pressure design thickness, as calculated in accordance with pare. 304.1.2 for internal pressure or as determined in accordance with pare. 304.1.3 for external pressure

c = the sum of the mechanical allowances (thread or groove depth) plus corrosion and erosion allowance". For threaded components, the nominal thread depth (dimension h of ASME BI.20.1, or equivalent) shall apply. For machined surfaces or grooves where the tolerance is not specified, the tolerance shall be assumed to be 0.5 mm (0.02 in.) in addition to the specified depth of the cut.

T = pipe wall thickness (measured or minimum per purchase specification)

d = inside diameter of pipe. For pressure design calculation, the inside diameter of the pipe is the maximum value allowable under the purchase specification.

P = internal design gage pressure

D = outside diameter of pipe as listed in tables of standards or specifications or as measured

E = quality factor from Table A-IA or A-IB

S = stress value for material from Table A-I

Y= coefficient from Table 304.1.1, valid for t < D/6 and for materials shown. The value of Y may be interpolated for intermediate temperatures. For t ≥ D/6.

$$y = \frac{d + 2c}{D + d + 2c}$$

Multiple Miter Bends. The maximum allowable internal pressure shall be the lesser value calculated from Eqs. (4a) and (4b). These equations are not applicable when θ exceeds 22.5 deg.

$$P_m = \frac{SE\,(T - c)}{r_2}\left(\frac{T - c}{(T - c) + 0.643 \tan\theta\sqrt{r_2(T - c)}}\right) \quad (4a)$$

$$P_m = \frac{SE\,(T - c)}{r_2}\left(\frac{R_1 - r_2}{R_1 - 0.5r_2}\right) \quad (4b)$$

(b) Single Miter Bends

(1) The maximum allowable internal pressure for a single miter bend with angle a not greater than 22.5 deg. shall be calculated by Eq. (4a).

(2) The maximum allowable internal pressure for a single miter bend with angle a greater than 22.5 deg. shall be calculated by Eq. (4c):

$$P_m = \frac{SE\,(T - c)}{r_2}\left(\frac{T - c}{(T - c) + 1.25 \tan\theta\sqrt{r_2(T - c)}}\right) \quad (4c)$$

c) The miter pipe wall thickness *T* used in Eqs. (4a), (4b), and (4c) shall extend a distance not less than M from the inside crotch of the end miter welds where

M = the larger of $2.5(r_2\,T)^{0.5}$ or $\tan\theta\,(R_1 - r_2)$

The length of taper at the end of the miter pipe may be included in the distance M.

(d) The following nomenclature is used in Eqs. (4a), (4b), and (4c) for the pressure design of miter bends:

c = same as defined in para. 304.1.1

E = same as defined in para. 304.1.1

P_m = maximum allowable internal pressure for miter bends

r_2 = mean radius of pipe using nominal wall *T*

R_1 = effective radius of miter bend, defined as the shortest distance from the pipe centerline to the intersection of the planes of adjacent miter Joints

S = same as defined in pare. 304.1.1

T = miter pipe wall thickness (measured or minimum per purchase specification)

θ = angle of miter cut

α = angle of change in direction at miter joint = 2θ

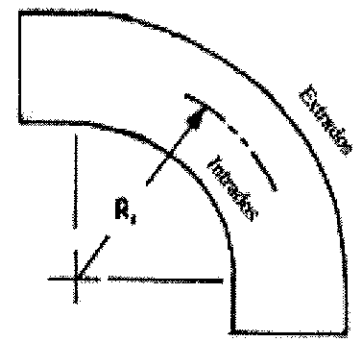
For compliance with this Code, the value of R_1 shall be not less than that given by Eq. (5):

$$R_1 = \frac{A}{\tan\theta} + \frac{D}{2} \quad (5)$$

where A has the following empirical values:

for U.S. customary units:

(T - c), in.	A
≤ 0.5	1.0
0.5 < (T - c) < 0.88	2(T - c)
≥0.88	[2(T - c)/3] + 1.17



$$t = \frac{PD}{((SE/I) + PY)}$$

where at the intrados (inside bend radius)

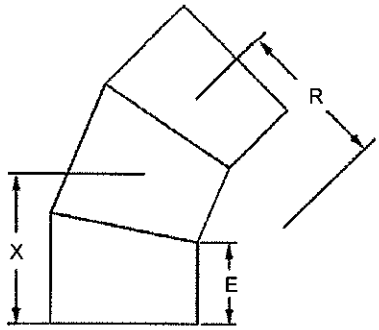
$$I = \frac{4(R/D) - 1}{4(R/D) - 2}$$

where at the extrados (outside bend radius)

$$I = \frac{4(R/D) - 1}{4(R/D) - 2}$$

and at the sidewall on the bend centerline radius, I=1.0.

R_1 = centerline radius of bend or elbow



IPS 45°
3 Segment Elbow
Fabricated (1/8 Bend)

(Dimensions in Inches)

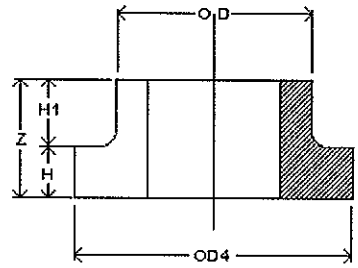
IPS Size	R/D Ratio	R	X	E	SDR	WPR (psi)	Weight (lbs)
2"	5.4	12.7	6.6	4.0	7 9 11&17	200 160 128/80	1.5 1 1
3"	3.8	13.2	6.8	4.0	7 9 11&17	200 160 128/80	3 2 2
4"	3.0	13.7	7.0	4.0	7 9 11&17	200 160 128/80	6 5 4
6"	2.2	14.7	9.4	6.0	7 9 11&17	200 160 128/80	1 11 9
8"	1.8	16.0	10.3	6.5	7 9 11 17	200 160 128 80	24 19 16 12
10"	1.6	17.0	10.7	8.0	7 9 11 17	200 160 128 80	39 32 26 18
12"	1.5	19.1	12.8	8.0	7 9 11 17	200 160 128 80	62 51 43 29
14"	1.5	21.0	13.2	8.0	7 9 11 17	200 160 128 80	79 64 53 36
16"	1.5	24.0	14.0	8.0	7 9 11 17	200 160 128 80	112 91 76 51
18"	1.5	27.0	14.7	8.0	7 9 11 17	200 160 128 80	146 119 101 68

• IPS 3 Segment 45's Continued Next Page •

Other sizes, DR's and custom radius ell's not listed are available - Call For Quick Quote

Sizes 24" and smaller meet AWWA C906 fitting requirements, sizes 26" and larger are quoted per fitting.

Stub Ends - Butt Fusion (Molded)

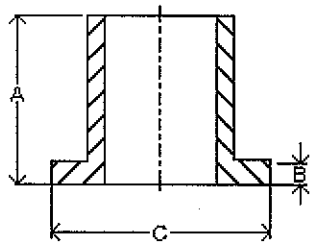


Dimensions

Nominal Pipe Size	OD	OD4	Z	H1	H	Rahn Part #: HDPE3408 Black	DR
1-¼" IPS	1.660	2.750	1.400	1.125	0.250	SE-125	DR9
1-½" IPS	1.900	3.000	1.500	1.250	0.250	SE-150	DR9
2" IPS	2.375	3.894	1.750	1.350	0.400	SE-2	DR7
3" IPS	3.500	4.900	2.250	1.560	0.690	SE-3	DR7
4" IPS	4.500	6.630	1.732	0.748	0.984	SE-4	DR9
5" IPS	5.563	7.543	2.008	1.024	0.984	SE-5	DR9
6" IPS	6.625	8.535	2.008	0.945	1.063	SE-6	DR9
8" IPS	8.625	10.760	2.244	0.984	1.260	SE-8	DR9
10" IPS	10.750	13.133	2.717	1.217	1.500	SE-10	DR7
12" IPS	12.750	15.525	3.150	1.400	1.750	SE-12	DR9
14" IPS	14.000	17.354	3.843	2.093	1.750	SE-14	DR9
16" IPS	16.000	19.317	3.937	1.575	2.362	SE-16	DR9
18" IPS	18.000	21.171	4.528	1.772	2.756	SE-18	DR9
20" IPS	20.000	23.435	4.724	1.968	2.756	SE-20	DR9

- Specify SDR required when ordering.

Flange Adapter - Butt Fusion (Molded)

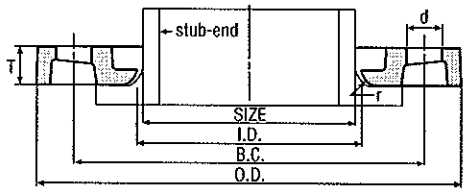


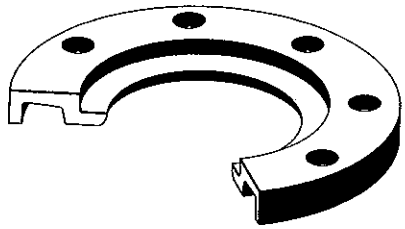
Dimensions

Nominal Pipe Size	A	B	C	Rahn Part #: HDPE3408 Black	DR
1-¼" IPS	6.000	0.250	2.750	3158B-125	DR9
1-½" IPS	6.000	0.275	3.125	3158B-150	DR9
2" IPS	6.000	0.450	3.875	3158B-2	DR7
3" IPS	6.000	0.600	5.000	3158B-3	DR5
4" IPS	6.000	1.000	6.600	3158B-4	DR5
4" DIPS	6.000	1.000	6.600	3158B-4-DIPS	DR9
5" IPS	8.000	1.100	7.515	3158B-5	DR9
6" IPS	8.000	1.100	8.500	3158B-6	DR5
6" DIPS	8.000	1.100	8.500	3158B-6-DIPS	DR9
8" IPS	9.000	1.500	10.600	3158B-8	DR7
10" IPS	12.000	1.500	12.750	3158B-10	DR9
12" IPS	12.000	1.775	15.500	3158B-12	DR9

BUP-SDR

Convoluted Flange/Backup Ring





- **Description** Utilizes the patented IPP Deltaflex® flange cross section.
- **Utilization** HDPE and PP thermoplastic piping systems.
- **Materials** Ductile iron, ASTM A536-84.
- **Dimensions** Mate with all 150 lb flanges, ANSI B16.5, B16.47, B16.1 AWWA C207.
- **Finish** Red oxide primed, hot dip galvanized, epoxy coated.

Pipe Diameter	IPP Product Code	Outside Dia. O.D.	Flange Thickness T	Inside Dia. I.D.	Bolt Count N	Dia. Bolt Hole B.D.	Bolt Circle B.C.	Radius r	Weight lbs/pc	Operating[1] Pressure
1/2"	BUP-SDR7-0050C	3.50	0.50	0.90	4	0.63	2.38	0.13	1.0	267
3/4"	BUP-SDR7-0075C	3.88	0.50	1.11	4	0.63	2.75	0.13	1.0	267
1"	BUP-SDR7-01C	4.25	0.56	1.38	4	0.63	3.13	0.13	1.0	267
1 1/4"	BUP-SDR7-0125C	4.63	0.63	1.72	4	0.63	3.50	0.19	2.0	267
1 1/2"	BUP-SDR7-0150C	5.00	0.69	1.97	4	0.63	3.88	0.25	2.0	267
2"	BUP-SDR7-02C	6.00	0.75	2.46	4	0.75	4.75	0.31	3.0	267
2"	BUP-SDR11-02B	6.00	0.50	2.63	4	0.75	4.75	0.20	1.5	160
2 1/2"	BUP-SDR7-0250C	7.00	0.88	2.97	4	0.75	5.50	0.31	4.0	267
3"	BUP-SDR7-03C	7.50	0.94	3.60	4	0.75	6.00	0.40	4.0	267
3"	BUP-SDR11-03B	7.50	0.53	3.75	4	0.75	6.00	0.28	2.5	160
4"	BUP-SDR7-04C	9.00	0.94	4.60	8	0.75	7.50	0.40	5.5	267
4"	BUP-SDR11-04B	9.00	0.55	4.75	8	0.75	7.50	0.28	3.5	160
5"	BUP-SDR7-05C	10.00	0.94	5.69	8	0.88	8.50	0.44	6.0	267
6"	BUP-SDR7-06C	11.00	1.00	6.75	8	0.88	9.50	0.40	7.0	267
6"	BUP-SDR11-06B	11.00	0.63	6.88	8	0.88	9.50	0.28	4.5	160
8"	BUP-SDR7-08C	13.50	1.12	8.75	8	0.88	11.75	0.40	11.0	267
8"	BUP-SDR11-08B	13.50	0.85	8.88	8	0.88	11.75	0.28	8.0	160
10"	BUP-SDR7-10C	16.00	1.19	10.92	12	1.00	14.25	0.40	16.0	267
10"	BUP-SDR11-10B	16.00	0.98	11.00	12	1.00	14.25	0.31	12.0	160
12"	BUP-SDR7-12C	19.00	1.50	12.92	12	1.00	17.00	0.40	23.0	267
12"	BUP-SDR9.3-12B	19.00	1.25	13.13	12	1.00	17.00	0.31	22.0	192
12"	BUP-SDR11-12B	19.00	1.25	13.13	12	1.00	17.00	0.28	20.0	160
14"	BUP-SDR7-14C	21.00	1.63	14.18	12	1.13	18.75	0.40	37.0	267
14"	BUP-SDR11-14B	21.00	1.38	14.38	12	1.13	18.75	0.31	30.0	160
16"	BUP-SDR7-16C	23.50	1.88	16.19	16	1.13	21.25	0.40	49.0	267

1. Operating pressure on an HDPE stub-end with a safety factor of 2.

Continued for sizes 16" through 63" on pg. 12

Appendix D - Technical Specifications Gabion

GABION
GALVANIZED & PVC COATED

FORWARD

This document has been issued by MACCAFERRI CANADA LTD. in response to requests by customers for standard specifications and methods of measurement and payment and is intended as a guide only. These notes cover standard materials only. Certain clauses may not apply in their entirety to special materials. Maccaferri reserves the right to amend product specifications without notice and specifiers are requested to check as to the validity of the specifications they are using.

NOTES:

The following items have been changed or updated from previous versions. The current date of this specification is August 2005.

The following ASTM standards and specifications have been added or updated:

ASTM A975-97	Standard Specification for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire with Polyvinyl Chloride (PVC) Coating)
ASTM A641/A641M-03	Specification for Zinc Coated (Galvanized) Carbon Steel Wire
ASTM A370-97a	Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A313/A313M-98	Specification for Chromium-Nickel Stainless and Heat-Resisting Steel Spring Wire
ASTM A764-95(2001)	Specification for Steel Wire, Carbon, Drawn Galvanized and Galvanized at Size for Mechanical Springs
ASTM B117-97	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D1242-95a	Standard Test Methods for Resistance of Plastic Materials to Abrasion
ASTM D1499-99	Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Plastics
ASTM D2240-04	Standard Test Method for Rubber Property—Durometer Hardness
ASTM D412-98a	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension
ASTM D746-04	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D792-00	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM G152-00	Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Non-metallic Materials
UL 746B	Polymeric Materials-Long Term Property Evaluation

Gabion – Galvanized & PVC Coated
August 2005

1.0 Description

This work shall consist of furnishing, assembling, and filling woven wire mesh gabions with rock as specified in the contract to the dimensions, lines and grades shown on the plans, or as determined by the engineer. These specifications are in accordance with ASTM A975-97 and include gabions as manufactured for Maccaferri Canada Ltd.

2.0 Materials

2.1 Woven Mesh Gabions

2.1.1 Wire (Zinc Coated):

All tests on the wire must be performed prior to manufacturing the mesh.

- *Tensile strength*: both the wire used for the manufacture of gabions and the lacing wire, shall have a maximum tensile strength of 515 MPa, in accordance with ASTM A641/A641M-03.
- *Elongation*: the test must be carried out on a sample at least 300 mm long. Elongation shall not be less than 12%, in accordance with ASTM A370-97a.
- *Zinc coating*: minimum quantities of zinc according to ASTM A641/A641M-03, Class III soft temper coating.
- *Adhesion of zinc coating*: the adhesion of the zinc coating to the wire shall be such that, when the wire is wrapped six turns around a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with the bare fingers, in accordance with ASTM A641/A641M-03.

2.1.2 PVC (Polyvinyl Chloride) Coating

- *Specific gravity*: 1.30-1.35 kg/dm^3, in accordance with ASTM D792-00, Table 1;
- *Hardness*: between 50 and 60 Shore D, according to ASTM D 2240-04;
- *Tensile strength*: not less than 20.6 MPa, according to ASTM D412-98a;
- *Modulus of elasticity*: not less than 18.6 MPa, according to ASTM D412-98a;
- *Abrasion resistance*: the percentage of the weight loss shall be less than 12%, according to ASTM D1242-95a.
- *Heat Aging Test*: prior to UV and abrasion degradation, the PVC polymer coating shall have a projected durability life of 60 years when tested in accordance with UL 746B.

The accelerated aging tests are:

- *Salt spray test*: test period 3,000 hours, test method ASTM B117-97;
- *Exposure to UV rays*: test period 3,000 hours at 63°C, test method ASTM D1499-99 and ASTM G152-00;
- *Brittleness temperature*: no higher than - 9°C, or lower temperature when specified by the purchaser, when tested in accordance with ASTM D746-04.

The properties after aging tests shall be as follows:

- *Appearance of coated mesh*: no cracking, stripping or air bubbles, and no appreciable variation in color;
- *Specific gravity*: variations shall not exceed 6%;
- *Hardness*: variations shall not exceed 10%;
- *Tensile strength*: variations shall not exceed 25%;
- *Modulus of elasticity*: variations shall not exceed 25%;
- *Abrasion resistance*: variations shall not exceed 10%;
- *Brittleness temperature*: shall not exceed +18°C.

2.1.3 Galvanized and PVC coated wire mesh gabions (8 x 10 mesh type):

- *PVC coating thickness:* Nominal – 0.5 mm, Minimum – 0.38 mm
- *Mesh Wire*: Diameter – 2.70 mm internal, 3.70 mm external
- *Selvedge Wire*: Diameter – 3.40 mm internal, 4.40 mm external
- *Mesh Opening*: Nominal Dimension D = 83 mm, as per Fig. 1.

2.1.4 Galvanized and PVC coated lacing wire and internal stiffeners:

- *PVC coating thickness:* Nominal – 0.5 mm, Minimum – 0.38 mm
- *Lacing wire*: Diameter – 2.20 mm internal, 3.20 mm external
- *Cross Tie/Stiffener wire*: Diameter - 2.20 mm internal, 3.20 mm external
- *Preformed Stiffener:* Diameter – 3.40 mm internal, 4.40 mm external

2.1.5 Steel Mesh properties

- *Mesh Tensile Strength:* shall have a minimum strength of 42.3 kN/m when tested in accordance with ASTM A975 section 13.1.1.
- *Punch Test Resistance:* shall have a minimum resistance of 23.6 kN/m when tested in accordance with ASTM A975 section 13.1.4.
- *Connection to selvedges:* shall have a minimum resistance of 17.5 kN/m when tested in accordance with ASTM A975.

2.1.6 Spenax Fasteners (Overlapping Fasteners):

Overlapping stainless steel fasteners may be used in lieu of, or to complement, lacing wire for basket assembly and installation. The spacing of the fasteners during all phases of assembly and installation shall be in accordance with spacing based on 17.5 kN/m, pull apart resistance for PVC coated mesh tested in accordance with ASTM A975 section 13.1.2 and with a nominal spacing of 100 mm, and not to exceed 150 mm.

- *Stainless steel fasteners*: diameter: 3.05 mm, according to ASTM A313/A313M-98, Type 302, Class I.
- *Tensile strength:* 1530 to 1744 MPa in accordance with ASTM A313/A313M-98.
- *Proper installation of rings:* A properly formed Spenax fastener shall have a nominal overlap of 25mm after closure (Fig. 2).

2.2 Tolerances

- *Wire*: Zinc coating, in accordance with ASTM A641/A641M-03, Class III soft temper coating.
- *Gabions*: ± 5 % on the length, width, and height.
- *Mesh opening*: Tolerances on the hexagonal, double twisted wire mesh opening shall not exceed ± 10% on the nominal dimension D values (see Fig.1):

Fig. 1

Mesh Type	Nominal Dimension D
8 x 10	83 mm

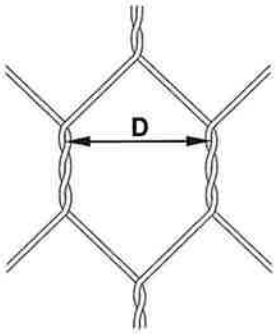
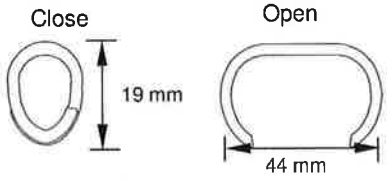


Fig. 2



Normal overlap of 25 mm after closure

2.3 Standard Unit Size

Table of sizes for gabions			
L=Length (m)	W=Width (m)	H=Height (m)	# of cells
2	1	1	2
3	1	1	3
4	1	1	4
2	1	0.5	2
3	1	0.5	3
4	1	0.5	4
2	1	0.3	2
3	1	0.3	3
4	1	0.3	4

All sizes and dimensions are nominal. Tolerances of ± 5% of the width, and length height, of the gabions shall be permitted.

2.4 Fabrication

Gabions shall be manufactured and shipped with all components mechanically connected at the production facility. The front, base, back and lid of the gabions shall be woven into a single unit. The ends and diaphragm(s) shall be factory connected to the base. All perimeter edges of the mesh forming the basket and top, or lid, shall be selvedged with wire having a larger diameter.

The gabion is divided into cells by means of diaphragms positioned at approximately 1 m centers. The diaphragms shall be secured in position to the base so that no additional lacing is necessary at the jobsite. See Figure 3.

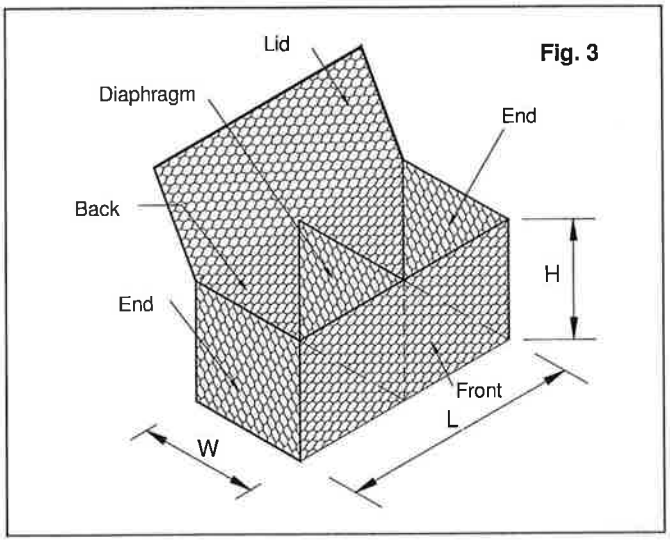


Fig. 3

2.5 Rock

The rock for gabions shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure. Gabion rocks shall range between 100 mm and 200 mm. The range in sizes shall allow for a variation of 5% oversize and/or 5% undersize rock, provided it is not placed on the

gabion exposed surface. The size shall be such that a minimum of three layers of rock must be achieved when filling a 1m high gabion.

3.0 Construction Requirements

3.1 Assembly

Gabions are supplied folded flat and packed in bundles. The units are assembled individually by erecting the sides, ends, and diaphragms, ensuring that all panels are in the correct position, and the tops of all sides are aligned. The four corners shall be connected first, followed by the internal diaphragms to the outside walls. All connections should use lacing wire or fasteners as previously described in Section 2.1.4 and Section 2.1.6.

The procedure for using lacing wire consists of cutting a sufficient length of wire, and first looping and/or twisting to secure the lacing wire to the wire mesh. Proceed to lace with alternating double and single loops through every mesh opening approximately every 150 mm, pulling each loop tight and finally securing the end of the lacing wire to the wire mesh by looping and/or twisting.

The use of fasteners shall be in accordance with the manufacturer's recommendations as specified in Section 2.1.6.

3.2 Installation

After initial assembly, the gabions are carried to their final position and are securely joined together along the vertical and top edges of their contact surfaces using the same connecting procedure(s) described in Section 3.1. Whenever a structure requires more than one layer, the upper empty baskets shall also be connected to the top of the lower layer along the front and back edges of the contact surface using the same connecting procedure(s) described in Section 3.1.

3.3 Filling

Gabions shall be filled with rock as specified in Section 2.4. During the filling operation some manual stone placement is required to minimize voids. The exposed faces of vertical structures shall be carefully hand placed to give a neat, flat, and compact appearance. Care shall be taken when placing fill material to ensure that the sheathing on the PVC coated baskets is not damaged.

The cells shall be filled in stages so that local deformation may be avoided. That is, at no time shall any cell be filled to a depth exceeding 300 mm higher than the adjoining cell. It is also recommended to slightly overfill the baskets by 25 to 50 mm to allow for settlement of the rock. Behind gabion walls, compact the backfill material simultaneously to the same level as the filled gabions.

3.4 Internal Connecting Wires

MacTie preformed stiffeners or lacing wire can be used as internal connecting wires when a structure requires more than one layer of gabions to be stacked on top of each other. Internal Connecting Wires with lacing wire shall connect the exposed face of a cell to the opposite side of the cell. Internal Connecting Preformed stiffeners shall connect the exposed face of a cell to the adjacent side of the cell. Preformed stiffeners are installed at 45° to the face/side of the unit, extending an equal distance along each side to be braced (approximately 300 mm). An exposed face is any side of a gabion cell that will be exposed or unsupported after the structure is completed.

3.4.1 1 m High Gabions

1 m high gabions shall be filled in three layers, 300 mm at a time. Connecting wires/bracings shall be installed after the placement of each layer, that is, at 300 mm high and 600 mm high.

3.4.2 0.5 m High Gabions

0.5 m high gabions do not require connecting wires/bracings unless the baskets are used to build vertical structures. In some cases, these units shall be filled in two layers, 250 mm at a time. Connecting wires shall be installed after the placement of the first layer, which is at 250 mm high.

3.5 Lid Closing

Once the gabion baskets are completely full, the lids will be pulled tight until the lid meets the perimeter edges of the basket. A tool such as a lid closer can be used. The lid must then be tightly laced and/or fastened along all edges, ends and tops of diaphragm(s) in the same manner as described in Section 3.1.

3.6 Mesh cutting and folding

Where shown on the drawings or otherwise directed by the engineer, the gabions shall be cut, folded and fastened together to suit site conditions. The mesh must be cleanly cut and surplus mesh either folded back or overlapped so that it can be securely fastened together with lacing wire or fasteners in the manner described in Section 3.1. Any reshaped gabions shall be assembled, installed, filled and closed as specified in the previous sections.

4.0 Method of Measurement

4.1 The payment quantities for excavation shall be determined by the outside limits of the gabion structure. Quantities will be determined from cross sections and the linear distance, and paid for under the appropriate excavation bid items.

4.2 The quantity to be paid for "In place gabions" shall be the number of cubic meters of gabions measured in their final position. Project conditions and material availability will determine the actual size of gabions to be used.

4.3 Excavated material beyond the limits of the gabions shall be backfilled with gravel, crushed rock or other material approved by the engineer.

4.4 This bid price shall include the installed in place cost of all materials, equipment, and labor, including gabions, rock, and backfill material.

5.0 Basis of Payment

Accepted gabions will be paid for at the unit price for each pay item included in the contract.

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MACCAFERRI

Maccaferri Canada Ltd.

TECHNICAL DATA SHEET

MACTEX
MX225S NONWOVEN GEOTEXTILE

MacTex MX225S is a needle-punched nonwoven geotextile made of 100% polypropylene staple fibres, which are formed into a random network for dimensional stability. MacTex MX225S resists ultraviolet deterioration, rotting, biological degradation, naturally encountered basics and acids. Polypropylene is stable within a pH range of 2 to 13. MacTex MX225S conforms to the physical property values listed below:

PROPERTY	TEST METHOD	UNIT	M.A.R.V. (Minimum Average Roll Value)
Weight (Typical)	ASTM D 5261	g/m^2	203
Grab Tensile	ASTM D 4632	kN	0.711
Grab Elongation	ASTM D 4632	%	50
Trapezoid Tear Strength	ASTM D 4533	kN	0.289
Puncture Resistance	ASTM D 4833	kN	0.40
Mullen Burst Strength	ASTM D 3786	kPa	2170
Permittivity*	ASTM D 4491	sec^{-1}	1.6
Water Flow*	ASTM D 4491	$l/min/m^2$	4480
AOS*	ASTM D 4751	US Sieve (mm)	70 (0.212)
UV Resistance	ASTM D 4355	%/hrs	70/500

PACKAGING	
Roll Dimensions (W x L) – m	3.81 x 109.8/ 4.57 x 91.5
Square Metres Per Roll	418
Estimated Roll Weight – kgs	88.6

* At the time of manufacturing. Handling may change these properties.

Seller makes no warranty, express or implied, concerning the product furnished hereunder other than at the time of delivery it shall be of the quality and specifications stated herein. *ANY IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE IS EXPRESSLY EXCLUDED AND, TO THE EXTENT THAT IT IS CONTRARY TO THE FOREGOING SENTENCE ANY IMPLIED WARRANTY OF MERCHANTABILITY IS EXPRESSLY EXCLUDED.* Any recommendations made by the Seller concerning uses or applications of said product are believed reliable, and Seller makes no warranty of results to be obtained. The technical information supplied for this product type is subject to change at any time without notice.

This Data Sheet supercedes all previous Data Sheets for this style and is subject to change without notice.

MTEX-MX225S 09/04

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MACCAFERRI

PRODUCT STANDARD SPECIFICATIONS

Rev: 01, Issue Date 19.04.2006

GABION MAT
GALVANIZED & PVC COATED

FORWARD

This document has been issued by MACCAFERRI CANADA LTD. in response to requests by customers for standard specifications and methods of measurement and payment and is intended as a guide only. These notes cover standard materials only. Certain clauses may not apply in their entirety to special materials. Maccaferri reserves the right to amend product specifications without notice and specifiers are requested to check as to the validity of the specifications they are using.

NOTES:

The following items have been changed or updated from previous versions. The current date of this specification is April 2006.

The following ASTM standards and specifications have been added or updated:

ASTM A313/A 313M-98	Standard Specification for Stainless Steel Spring Wire
ASTM A370-97a	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A641/A641M-03	Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM B117-97	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D1242-95a	Standard Test Methods for Resistance of Plastic Materials to Abrasion
ASTM D1499-99	Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Plastics
ASTM D2240-04	Standard Test Method for Rubber Property—Durometer Hardness
ASTM D412-98a	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension
ASTM D746-04	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D792-00	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM G152-00	Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Non-metallic materials.
UL 746B	Polymeric Materials- Long Term Property Evaluation

Gabion Mat-Galvanized & PVC Coated
April 2006

1.0 Description

This work shall consist of furnishing, assembling and filling woven wire mesh containers with rock to form gabion mats as specified in the contract in conformity with the dimensions, lines and grades shown on the plans, or as determined by the engineer and manufacturer.

2.0 Materials

2.1 Woven Mesh Gabion Mats

2.1.1 Wire (Zinc Coated)

All tests on wire must be performed prior to manufacturing the mesh.

- *Tensile strength:* both the wire used for the manufacture of gabion mats and the lacing wire, shall have a maximum tensile strength of 38 – 48 kg/mm^2, in accordance with ASTM A641-97.
- *Elongation:* the test must be carried out on a sample at least 30 cm long. Elongation shall not be less than 12%, in accordance with ASTM A370-97a.
- *Zinc coating:* minimum quantities of zinc according to ASTM A641/A641M-03, Class III soft temper coating.
- *Adhesion of zinc coating:* the adhesion of the zinc coating to the wire shall be such that, when the wire is wrapped six turns round on a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with the bare fingers, in accordance with ASTM A641/A641M-03 for zinc coating.

2.1.2 PVC (Polyvinyl Chloride) Coating

When specified in the plans:

- *Specific gravity:* 1.30-1.35 kg/dm^3, in accordance with ASTM D792-00, Table 1,
- *Hardness:* between 50 and 60 Shore D, according to ASTM D2240-04,
- *Tensile strength:* not less than 20.6 MPa, according to ASTM D412-98a,
- *Modulus of elasticity:* not less than 18.6 MPa, in accordance with ASTM D412-98a,
- *Abrasion resistance:* the percentage of the weight loss shall be less than 12%, according to ASTM D1242-95a.
- *Heat Aging Test*: prior to UV and Abrasion degradation, the PVC polymer coating shall have a projected durability life of 60 years when tested in accordance with UL 746B.

The accelerated aging tests are:

- *Salt spray test:* test period 3,000 hours, test method ASTM B117-97,
- *Exposure to UV rays:* test period 3,000 hours at 63°C, test method ASTM D1499-99 and ASTM G152-00.
- *Brittleness temperature:* no higher than - 9°C, or lower temperature when specified by the purchaser, when tested in accordance with ASTM D746-04.

The properties after aging tests shall be as follows:

- *Appearance of coated mesh:* no cracking, stripping or air bubbles, and no appreciable variation in color;
- *Specific gravity:* variations shall not exceed 6%;
- *Hardness:* variations shall not exceed 10%;
- *Tensile strength:* variations shall not exceed 25%;
- *Modulus of elasticity:* variations shall not exceed 25%;
- *Abrasion resistance:* variations shall not exceed 10%;
- *Brittleness temperature:* shall not exceed +18°C.

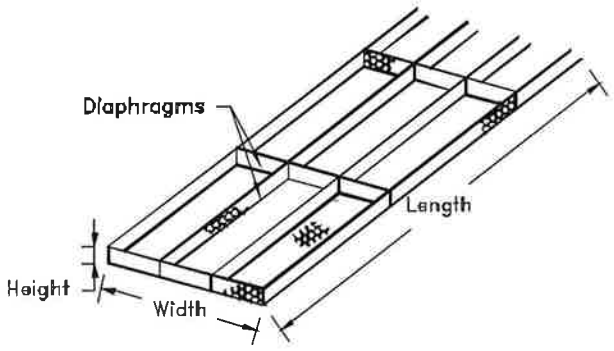
2.3 Standard Unit Size

Table of sizes for gabion mats			
L=Length (m)	W=Width (m)	H=Height (m)	# of cells
30	2	0.23	20
30	3	0.23	30
30	2	0.3	20
30	3	0.3	30

2.4 Fabrication

Gabion mattresses shall be manufactured with all components mechanically connected at the production facility with the exception of the lid, which is produced separately from the base. The base, sides and ends of the gabion mats shall be woven into a single unit. The diaphragms are connected to the base in the factory. All perimeter edges of the mesh forming the base and lid shall be selvedged with selvedge wire.

The gabion mat is divided into cells by means of diaphragms. The diaphragms create cells of 1 m by 3 m. The diaphragms shall be secured in position of the base so that no additional tying is necessary at the jobsite.



2.5 Rock

All rock shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure. Also, the size shall be such that a minimum of two layers of rock can be achieved when filling any gabion mat. Any rock smaller than the minimum size can not be less than 5% by weight; any rock greater than the maximum size can not be greater than 5% by weight, provided it is not on the exposed surface of the gabion mat.

- Gabion Mat rock shall be in the full range size of the lower and upper limits - 100-200 mm.

3.0 Construction Requirements

3.1 Assembly

Gabion mats are supplied in rolls, the base in one roll and the lid in another. The units shall be assembled individually by erecting the sides, ends and diaphragms ensuring that all panels are in the correct position and the tops of all sides are aligned. The four corners of the unit shall be connected first, followed by the internal diaphragms to the sides. All connections should be accomplished using lacing wire or fasteners as previously described in Section 2.1.4 and Section 2.1.5.

The recommended procedure to apply lacing wire consists of first cutting a sufficient length of wire. Secure one end of the wire by looping and twisting, then proceed to lace with alternating single and double loops every mesh opening (approximately every 100 mm) and securely fasten the other end of the lacing wire.
The installation of the fasteners specified in Section 2.1.5 shall be in accordance with the manufacturer's recommendations.

3.2 Installation

Initial assembly should occur with the gabion mats in their final position. The adjacent empty mats must be securely joined together using the same connecting procedure(s) described in Section 3.1 along the vertical and top edges of their contact surfaces.

3.3 Filling

Gabion mats shall be filled with rock as specified in Section 2.5. During the filling operation or placement some manual stone is required to minimize voids. Care shall be taken when placing fill material to ensure that the PVC sheathing is not damaged.

The cells in any row shall be filled in stages so that local deformation may be avoided. It is also recommended to slightly overfill the baskets 25 to 50 mm to allow for settlement of the rock.

3.4 Lid Closing

Once the mats are completely full, the lids shall be pulled tight using a tool such as a lid closer until the lid meets the perimeter edges of the mattress. The lid shall then be tightly laced and/or fastened along all edges, ends and tops of diaphragms in the same manner as described in Section 3.1.

3.4 Mesh cutting and folding

Where shown on the drawings or otherwise directed by the engineer, the gabion mat mesh shall be cut, folded and fastened together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh folded back and neatly wired to an adjacent gabion mat. The cut edges of the mesh shall be securely fastened together with lacing wire or fasteners in the manner described in Section 3.1. Any reshaped gabion mats shall be assembled, installed, filled and closed as specified in the previous sections.

4.0 Method of Measurement

4.1 The pay limits for excavation of gabion mats shall be a line coincident with the bottom and non-exposed side of the mattresses. Excavation quantities will be determined from the cross sections and paid for under the appropriate classified excavation items.

4.2 The quantity to be paid for "In Place Gabion Mats" shall be the number of square meters of mattresses measured in their final position. Job conditions and availability will determine the actual size of gabion mats to be used.

4.3 Excavated material beyond the limits of the mats shall be backfilled with gravel, crushed rock or other material meeting the approval of the engineer.

4.4 This bid price shall include the cost of furnishing all labor, materials, and equipment including mattresses, rock, and backfill material installed in place.

5.0 Basis of Payment

Accepted gabion mats will be paid for at the unit price for each of the pay items included in the contract.

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Appendix E - Technical Specifications Bentofix Liner

BENTOFIX TECHNOLOGIES, INC.

23 Truman Road
Barrie, ON L4M 6E7 Canada

Tel: 705-725-1938
Fax: 705-725-8860

BENTOFIX® MANUFACTURING CERTIFICATION

CUSTOMER: TERRAFIX GEOSYNTHETICS, INC.

PROJECT: TERRAFIX- QUEBEC CITY **# ROLLS:** 80

ORDER NO.: BH-07-24/08 **PRODUCT TYPE:** BENTOFIX® NWL

Bentofix Technologies, Inc. hereby certifies that the Bentofix® Geosynthetic Clay Liner purchased and shipped for the above referenced project does meet or exceed Bentofix Technologies, Inc.'s specifications for Bentofix®.

The Bentofix® product has been continuously inspected for the presence of needles and is certified to be needle free.

BENTONITE testing was performed as follows:

Swell Index	ASTM D 5890	1/100,000 lbs (50,000 kg)
Moisture Content	ASTM D 4643	1/100,000 lbs (50,000 kg)
Fluid Loss	ASTM D 5891	1/100,000 lbs (50,000 kg)

GEOTEXTILE testing on the raw materials was performed as follows:

Mass Per Unit Area	ASTM D 5261	1/200,000 ft² [20,000 mt²]

GEOSYNTHETIC CLAY LINER testing on the finished product was performed as follows:

Bentonite Mass Per Unit Area	ASTM D 5993	1/40,000 ft² [4,000 mt²]
Grab Tensile/Elongation / Peel Strength	ASTM D 4632	1/40,000 ft² [4,000 mt²]
Hydraulic Conductivity	ASTM D 5084	Weekly
Index Flux	ASTM D 5887	Weekly
**certified to meet the required specification of < 1x 10^{-9} $m^3/m^2/s$*		
Internal Shear	ASTM D 6243	Periodically
** hydrated 24 hours and sheared under 200 psf normal stress is certified to be 500 psf*		

The LOT and ROLL numbers for this shipment are as follows:

LOT# 18072504---

ROLL# ---- SEE ATTACHED----

BENTOFIX LAB APPROVAL

7-29-08.
DATE

BENTOFIX TECHNOLOGIES, INC.

23 TRUMAN ROAD
BARRIE, ON L4M 6E7

TEL: 705-725-1938
FAX: 705-725-8860

BENTOFIX ROLL LIST

PROJECT: TERRAFIX-QUEBEC CITY
LOT # 18072504
STYLE: NWL
DATE: JULY 28, 2008.

	BENTOFIX ROLL #	LENGTH (m)	WIDTH (m)
1	110301	45.72	4.72
2	110302	45.72	4.72
3	110303	45.72	4.72
4	110304	45.72	4.72
5	110305	45.72	4.72
6	110306	45.72	4.72
7	110307	45.72	4.72
8	110308	45.72	4.72
9	110309	45.72	4.72
10	110310	45.72	4.72
11	110311	45.72	4.72
12	110312	45.72	4.72
13	110313	45.72	4.72
14	110314	45.72	4.72
15	110315	45.72	4.72
16	110316	45.72	4.72
17	110317	45.72	4.72
18	110318	45.72	4.72
19	110319	45.72	4.72
20	110320	45.72	4.72
21	110321	45.72	4.72
22	110322	45.72	4.72
23	110323	45.72	4.72
24	110324	45.72	4.72
25	110325	45.72	4.72
26	110326	45.72	4.72
27	110327	45.72	4.72
28	110328	45.72	4.72
29	110329	45.72	4.72
30	110330	45.72	4.72

[redacted]

BENTOFIX TECHNOLOGIES, INC.

23 TRUMAN ROAD
BARRIE, ON L4M 6E7

TEL: 705-725-1938
FAX: 705-725-8860

BENTOFIX ROLL LIST

PROJECT: TERRAFIX-QUEBEC CITY
LOT # 18072504
STYLE: NWL
DATE: JULY 28, 2008.

	BENTOFIX ROLL #	LENGTH (m)	WIDTH (m)
31	110331	45.72	4.72
32	110332	45.72	4.72
33	110333	45.72	4.72
34	110334	45.72	4.72
35	110335	45.72	4.72
36	110336	45.72	4.72
37	110337	45.72	4.72
38	110338	45.72	4.72
39	110339	45.72	4.72
40	110340	45.72	4.72
41	110341	45.72	4.72
42	110342	45.72	4.72
43	110343	45.72	4.72
44	110344	45.72	4.72
45	110345	45.72	4.72
46	110346	45.72	4.72
47	110347	45.72	4.72
48	110348	45.72	4.72
49	110349	45.72	4.72
50	110350	45.72	4.72
51	110351	45.72	4.72
52	110352	45.72	4.72
53	110353	45.72	4.72
54	110354	45.72	4.72
55	110355	45.72	4.72
56	110356	45.72	4.72

[redacted]

BENTOFIX TECHNOLOGIES, INC.

23 TRUMAN ROAD
BARRIE, ON L4M 6E7

TEL: 705-725-1938
FAX: 705-725-8860

BENTOFIX ROLL LIST

PROJECT: TERRAFIX-QUEBEC CITY
LOT # 18072504
STYLE: NWL
DATE: JULY 28, 2008.

	BENTOFIX ROLL #	LENGTH (m)	WIDTH (m)
57	110357	45.72	4.72
58	110358	45.72	4.72
59	110359	45.72	4.72
60	110360	45.72	4.72
61	110361	45.72	4.72
62	110362	45.72	4.72
63	110363	45.72	4.72
64	110364	45.72	4.72
65	110365	45.72	4.72
66	110366	45.72	4.72
67	110367	45.72	4.72
68	110368	45.72	4.72
69	110369	45.72	4.72
70	110370	45.72	4.72
71	110371	45.72	4.72
72	110372	45.72	4.72
73	110373	45.72	4.72
74	110374	45.72	4.72
75	110375	45.72	4.72
76	110376	45.72	4.72
77	110377	45.72	4.72
78	110378	45.72	4.72
79	110379	45.72	4.72
80	110380	45.72	4.72

[redacted]

BENTOFIX TECHNOLOGIES INC.

Quality Control Certificate

Lot #	Roll #	Date Produced	Product	Length	Width	BOL#
18072504	110301	7/25/2008	BENTOFIX NWL	150.00 ft 45.72 m	15.5 ft 4.72 m	

FINISHED PRODUCT

	Type	NWL	
GCL Mass Per Unit Area ASTM D 5993	5,009	g/m²	1.025 lb/ft²
Grab Tensile Strength ASTM D 4632	106	kg	233.7 lb
Elongation	113	%	
Peel Strength ASTM D 4632 mod	15.2	kg	33.5 lb
Hydraulic Conductivity ASTM D 5887	$<5x10^{-9}$	cm/s	
Index Flux ASTM D 5887	$<1x10^{-8}$	m³/m²/s	

TOP LAYER

Type	Non-Woven		
Lot #	080716205B-2		
Mass Per Unit Area ASTM D 5261	249	g/m²	7.34 oz/yd²

BOTTOM LAYER

Type	Non-Woven		
Lot #	080717215B		
Mass Per Unit Area ASTM D 5261	221	g/m²	6.52 oz/yd²

BENTONITE

Lot #	422193		
Moisture Content ASTM D 4643	7.50	%	
Swell Index ASTM D 5890	30.0	ml	
Fluid Loss ASTM D 5891	15.6	ml	
Bentonite Mass Per Unit Area @ 0% mc ASTM D 5993	4,199	g/m²	0.859 lb/ft²

[redacted]

BENTOFIX TECHNOLOGIES INC.

Quality Control Certificate

Lot #	Roll #	Date Produced	Product	Length	Width	BOL#
18072504	110301	7/25/2008	BENTOFIX NWL	150.00 ft 45.72 m	15.5 ft 4.72 m	

FINISHED PRODUCT

Type	NWL	
GCL Mass Per Unit Area ASTM D 5993	5,009 g/m²	1.025 lb/ft²
Grab Tensile Strength ASTM D 4632	106 kg	233.7 lb
Elongation	113 %	
Peel Strength ASTM D 4632 mod	15.2 kg	33.5 lb
Hydraulic Conductivity ASTM D 5887	$<5x10^{-9}$ cm/s	
Index Flux ASTM D 5887	$<1x10^{-8}$ m³/m²/s	

TOP LAYER

Type	Non-Woven	
Lot #	080716205B-2	
Mass Per Unit Area ASTM D 5261	249 g/m²	7.34 oz/yd²

BOTTOM LAYER

Type	Non-Woven	
Lot #	080717215B	
Mass Per Unit Area ASTM D 5261	221 g/m²	6.52 oz/yd²

BENTONITE

Lot #	422193	
Moisture Content ASTM D 4643	7.50 %	
Swell Index ASTM D 5890	30.0 ml	
Fluid Loss ASTM D 5891	15.6 ml	
Bentonite Mass Per Unit Area @ 0% mc ASTM D 5993	4,199 g/m²	0.859 lb/ft²

[redacted]

BENTOFIX TECHNOLOGIES INC.

Quality Control Certificate

Lot #	Roll #	Date Produced	Product	Length	Width	BOL#
18072504	110349	7/28/2008	BENTOFIX NWL	150.00 ft 45.72 m	15.5 ft 4.72 m	

FINISHED PRODUCT

Type	NWL	
GCL Mass Per Unit Area ASTM D 5993	4,937 g/m²	1.011 lb/ft²
Grab Tensile Strength ASTM D 4632	96 kg	211.6 lb
Elongation	101 %	
Peel Strength ASTM D 4632 mod	15.1 kg	33.3 lb
Hydraulic Conductivity ASTM D 5887	$<5x10^{-9}$ cm/s	
Index Flux ASTM D 5887	$<1x10^{-8}$ m³/m²/s	

TOP LAYER

Type	Non-Woven	
Lot #	080722205B	
Mass Per Unit Area ASTM D 5261	250 g/m²	7.37 oz/yd²

BOTTOM LAYER

Type	Non-Woven	
Lot #	080717215B	
Mass Per Unit Area ASTM D 5261	221 g/m²	6.52 oz/yd²

BENTONITE

Lot #	422193	
Moisture Content ASTM D 4643	7.50 %	
Swell Index ASTM D 5890	30.0 ml	
Fluid Loss ASTM D 5891	15.6 ml	
Bentonite Mass Per Unit Area @ 0% mc ASTM D 5993	4,131 g/m²	0.846 lb/ft²

[redacted]

BENTOFIX TECHNOLOGIES INC.

Quality Control Certificate

Lot #	Roll #	Date Produced	Product	Length	Width	BOL#
18072504	110365	7/28/2008	BENTOFIX NWL	150.00 ft 45.72 m	15.5 ft 4.72 m	

FINISHED PRODUCT

Type	NWL		
GCL Mass Per Unit Area ASTM D 5993	4,970 g/m²	1.017 lb/ft²	
Grab Tensile Strength ASTM D 4632	92 kg	202.8 lb	
Elongation	116 %		
Peel Strength ASTM D 4632 mod	9.5 kg	20.9 lb	
Hydraulic Conductivity ASTM D 5887	$<5x10^{-9}$ cm/s		
Index Flux ASTM D 5887	$<1x10^{-8}$ m³/m²/s		

TOP LAYER

Type	Non-Woven		
Lot #	080722205B		
Mass Per Unit Area ASTM D 5261	250 g/m²	7.37 oz/yd²	

BOTTOM LAYER

Type	Non-Woven		
Lot #	080717215B		
Mass Per Unit Area ASTM D 5261	221 g/m²	6.52 oz/yd²	

BENTONITE

Lot #	422193		
Moisture Content ASTM D 4643	7.50 %		
Swell Index ASTM D 5890	30.0 ml		
Fluid Loss ASTM D 5891	15.6 ml		
Bentonite Mass Per Unit Area @ 0% mc ASTM D 5993	4,162 g/m²	0.852 lb/ft²	

[redacted]

BENTOFIX TECHNOLOGIES, INC.

23 Truman Road
Barrie, ON
L4M 6E7 Canada

TEL: 705-725-1938
FAX: 705-725-8860

PROJECT: TERRAFIX-QUEBEC CITY
LOT # : 18072504

BENTONITE LABORATORY ANALYSIS

DATE:	July 25, 2008.	**RAILCAR #:**	BNSF 422193
SUPPLIER:	LOVELL, WY.	**TYPE:**	BARAKADE LD 30

SAMPLE #: 1

1. Moisture content according to ASTM D2216 mod:

   % of moisture = 7.5

2. Swell Test according to ASTM D5890:

   Swell Index = 30 ml/2g

3. Fluid loss according to ASTM D5891:

   Fluid Loss = 15.6 ml

SAMPLE #: 2

1. Moisture content according to ASTM D2216 mod:

   % of moisture = 8.7

2. Swell Test according to ASTM D5890:

   Swell Index = 31 ml / 2g

3. Fluid loss according to ASTM D5891:

   Fluid Loss = 16.0 ml

TESTING COMPLETED BY: DAMON WHEELER

[redacted]

Appendix F - Technical Specifications Thermistors

INSTRUCTION MANUAL

THERMISTOR STRING

Model TH-C

Tel.: 1.450.465.1113 • 1.877.ROCTEST (Canada, USA) • 33 (1) 64.06.40.80 (Europe) • www.roctest.com • www.telemac.fr

E1133E-17062010

TABLE OF CONTENTS

1 PRODUCT

1.1 GENERAL DESCRIPTION

Roctest manufactures a thermistor string to measure the temperature at different deepness's. The thermistor string is a multi-conductor cable with individual temperature sensors distributed along the cable. The chains can be submerged underwater as well as underground. The cable is flexible even at low temperature. The thermistor arrays are customizable to the customer needs.

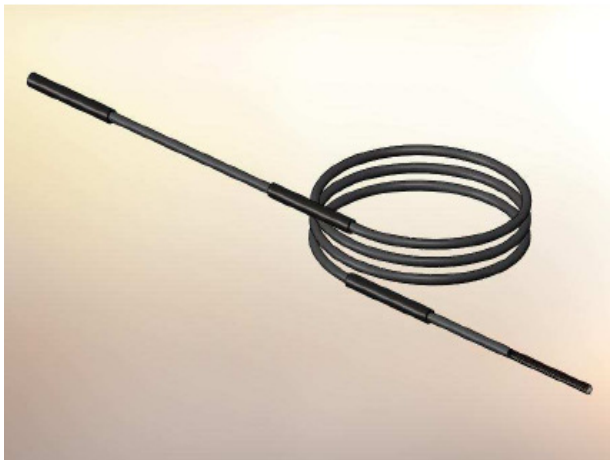

Figure 1: TH-C Thermistor String

The string is made of a thermistor embedded in a PVC cable. The sensor location is reinforced to mechanically protect the assembly. The encapsulation is flexible in order to compensate for the pressure and the deformation of the cable insulation. This compensation is required in order to be submersible, according to IP68. The thermistor used in the string has a good stability over time. The temperature value can be obtained from a portable handheld readout instrument or a complete datalogger system.

1.2 SPECIFICATIONS

- Operating temperature range: -40°C to +85°C
- Submersible up to 200m deep (IP68)
- Can be buried underground
- Accuracy up to ± 0.05°C (depends on the choice of the thermistor)
- Up to 22 sensors per cable
- Temperature drift at 25°C: less than 0.01°C after 100 months
- Rugged assembly
- Maximum diameter of the string cable: 20mm

1.3 OPERATION PRINCIPLE

The heart of the TH-C is a miniature thermistor. Temperature changes affect the resistance of the device, following a law described later in the manual.

Note: The standard thermistor used in the TH-C sensor is a 3 kΩ thermistor.

2 READING PROCEDURE

Different readout procedures can be used to get the temperature from the sensor resistance.

2.1 MB-6T READOUT UNIT

The MB-6T(L) readout unit reads the thermistor integrated in the gage, then converts the resistance value into temperature and displays the temperature in °C and °F.

Connect the jumper cable into the sockets on the front panel of the MB-6T(L). Connect the alligator clips on the jumper cable to the TH-C cable according to the pinout in the drawing provided with the equipment. The pinout and the layout is subject to change depending on the number of thermistor

Connect the shield socket on the MB-6T(L) front to the cable shield using the single lead jumper cable.

The jumper cable should never be short-circuited when it is connected to the readout unit front panel.

Depending of the type of thermistor used in the gage, switch the thermistor selector on the MB-6T(L) to the correct position, using the following table. Otherwise, position the selector on D and record the resistance value. The latter is to be converted subsequently, using conversion tables or polynomial equation appropriate to the thermistor type.

Selector position	Function
A	2 kΩ thermistor
B	3 kΩ thermistor
C	10 kΩ thermistor
D	Ohmmeter mode

Table 2: Thermistor type or function vs. Selector position

For complete details about the MB-6T(L) readout, please refer to its instruction manual.

2.2 OHMMETER

An ohmmeter may also be used to monitor the TH-C gage. Zero the ohmmeter by connecting together its two connecting wires.

Measure the resistance between the thermistor wires (refer to the drawing provided with the equipment). Convert the reading in ohms to temperature using conversion tables or polynomial equation appropriate to the thermistor type.

2.3 SENSLOG DATA ACQUISITION SYSTEM

The TH-C can also be read using a SENSLOG data acquisition system. The latter reads a V_{out} output, then converts it in ohms according to the following relation:

$$R_T = R_{25} \cdot \left(\frac{A}{V_{out}} - B \right)$$

where R_T = resistance in ohms

R_{25} = resistance in ohms at 25°C depending of the type of thermistor used (2 000, 3 000 or 10 000 Ω)

A, B = conversion factors depending on the type of thermistor

V_{out} = voltage output in volts

	Thermistor type		
	2 kΩ	**3 kΩ**	**10 kΩ**
A	6.25	4.17	1.25
B	3.0	2.0	0.6

Table 3: Conversion factors vs. Thermistor types

Example:

With V_{out} = 1.00 V

R_{25} = 3 000 Ω (3 kΩ thermistor)

We get $R_T = 3000 \cdot \left(\frac{4.17}{1.00} - 2.0 \right) =$ 6 510 Ω

2.4 QUICK VERIFICATION OF MEASUREMENTS

On site, even before converting raw readings into engineering values, several checks can be done to prevent a bad measurement.

- Compare readings to previous ones. Are they in the same range? Are they changing slowly or abruptly? Consider external factors that can affect the measurements like construction activities, excavations or fills…

- In any case, it is advised to take several readings to confirm the measurement. Then, repeatability can be appreciated and dummy readings erased.

3 CONVERSION OF RESISTANCE READINGS

A temperature reading is obtained from a resistance reading using one of the following relations.

3.1 POLYNOMIAL APPROXIMATION

The following polynomial approximation can be use:

$$T = C_0 + C_1X + C_2X^2 + C_3X^3 + C_4X^4 \text{ with } X = \ln\frac{R_T}{R_{25}}$$

where T = temperature in degrees Celsius

R_T = resistance in ohms

R_{25} = resistance in ohms at 25°C depending of the type of thermistor used (2 000, 3 000 or 10 000 Ω)

C_0 = 25.032

C_1 = -22.756

C_2 = 1.4997

C_3 = -0.1196

C_4 = 0.0114

Example:

With R_T = 5 500 Ω

R_{25} = 3 000 Ω (3 kΩ thermistor)

We get X = 0.6061 and T = 11.8°C

3.2 ANOTHER RELATION

Please note that many formulae can be used to transform ohm readings in temperature readings. One of the most accurate one is:

$$T = \frac{1}{A + B \cdot \ln R_T + C \cdot \ln^3 R_T} - 273.15$$

where T = temperature in degrees Celsius

$\ln R_T$ = natural logarithm of the resistance in ohms

A, B, C = constant factors

A, B, C have been determined following empirical measurements. These factors will vary according to the type of thermistor (refer to table below).

The accuracy of this formula is ± 0.15 °C with a range of -50°C to +150°C.

	Thermistor type (from Dale Electronics)		
	2 kΩ	**3 kΩ**	**10 kΩ**
A	$1{,}49896.10^{-3}$	$1{,}4051.10^{-3}$	$1{,}1303.10^{-3}$
B	$2{,}3781.10^{-4}$	$2{,}369.10^{-4}$	$2{,}339.10^{-4}$
C	$1{,}0668.10^{-7}$	$1{,}019.10^{-7}$	$8{,}863.10^{-8}$

Table 4: Conversion factors

4 TROUBLESHOOTING

Periodically check cable connections and terminals. The transducers themselves are sealed and cannot be opened for inspection.

4.1 UNSTABLE READING

- Check if the same troubles occur with other gages. If so, compare cable routes or check the readout unit.

- Is the shield drain wire correctly connected to the readout unit?

- Check the battery of the readout unit.

- The sensor body may be shorted to the shield. Check the resistance between the shield drain and the sensor housing.

- Check the integrity of the cable.

4.2 NO READING

- Check the battery of the readout unit.

- Check if the same troubles occur with other instruments. If so, the readout unit may be suspected and the factory should be consulted.

- The sensor body may be shorted to the shield. Check the resistance between the shield drain and the sensor housing.

- Check the cable resistance. An estimation of its resistance can be calculated: the resistance of a 22 gage copper cable is approximately 0.07Ω/m. Having an idea of the temperature, convert it into ohms (using chart below for example) and add the cable resistance twice.
    - If the resistance is high or infinite, a cut cable must be suspected.
    - If the resistance is close to zero, a short must be suspected.

- Cuts or shorts are located, the cable may be spliced in accordance with recommended procedures.

5 MISCELLANEOUS

	To Convert From	To	Multiply By
LENGTH	Microns	Inches	3.94E-05
	Millimetres	Inches	0.0394
	Meters	Feet	3.2808
AREA	Square millimetres	Square inches	0.0016
	Square meters	Square feet	10.7643
VOLUME	Cubic centimetres	Cubic inches	0.06101
	Cubic meters	Cubic feet	35.3357
	Litres	U.S. gallon	0.26420
	Litres	Can–Br gallon	0.21997
MASS	Kilograms	Pounds	2.20459
	Kilograms	Short tons	0.00110
	Kilograms	Long tons	0.00098
FORCE	Newtons	Pounds-force	0.22482
	Newtons	Kilograms-force	0.10197
	Newtons	Kips	0.00023
PRESSURE AND STRESS	Kilopascals	Psi	0.14503
	Bars	Psi	14.4928
	Inches head of water*	Psi	0.03606
	Inches head of Hg	Psi	0.49116
	Pascal	Newton / square meter	1
	Kilopascals	Atmospheres	0.00987
	Kilopascals	Bars	0.01
	Kilopascals	Meters head of water*	0.10197
TEMPERATURE	Temp. in °F = (1.8 x Temp. in °C) + 32 Temp. in °C = (Temp. in °F – 32) / 1.8		

* at 4 °C

Table 5: Conversion factors E6TabConv-990505

APPENDIX 1

CONVERSION TABLE: THERMISTOR RESISTANCE vs. TEMPERATURE

Temp. ℃	Reading in Ohms			Temp. ℃	Reading in Ohms		
	With a 2K Thermistor	With a 3K Thermistor	With a 10K Thermistor		With a 2K Thermistor	With a 3K Thermistor	With a 10K Thermistor
-50		201100	670500	1	6208	9310	31030
-49		187300	670500	2	5900	8851	29500
-48		174500	624300	3	5612	8417	28060
-47		162700	581700	4	5336	8006	26690
-46		151700	542200	5	5080	7618	25400
-45		141600	440800	6	4836	7252	24170
-44		132200	472000	7	4604	6905	23020
-43		123500	411700	8	4384	6576	21920
-42		115400	384800	9	4176	6265	20880
-41		107900	359800	10	3980	5971	19900
-40	67320	101000	336500	11	3794	5692	18970
-39	63000	94480	315000	12	3618	5427	18090
-38	59000	88460	294900	13	3452	5177	17260
-37	55280	82870	276200	14	3292	4939	16470
-36	51800	77660	258900	15	3142	4714	15710
-35	48560	72810	242700	16	3000	4500	15000
-34	45560	68300	227700	17	2864	4297	14330
-33	42760	64090	213600	18	2736	4105	13680
-32	40120	60170	200600	19	2614	3922	13070
-31	37680	56510	188400	20	2498	3748	12500
-30	35400	53100	177000	21	2388	3583	11940
-29	33280	49910	166400	22	2284	3426	11420
-28	31300	46940	156500	23	2184	3277	10920
-27	29440	44160	147200	24	2090	3135	10450
-26	27700	41560	138500	25	2000	3000	10000
-25	26080	39130	130500	26	1915	2872	9574
-24	24580	36860	122900	27	1833	2750	9165
-23	23160	34730	115800	28	1756	2633	8779
-22	21820	32740	109100	29	1682	2523	8410
-21	20580	30870	102900	30	1612	2417	8060
-20	19424	29130	97110	31	1544	2317	7722
-19	18332	27490	91650	32	1481	2221	7402
-18	17308	25950	86500	33	1420	2130	7100
-17	16344	24510	81710	34	1362	2042	6807
-16	15444	23160	77220	35	1306	1959	6532
-15	14596	21890	72960	36	1254	1880	6270
-14	13800	20700	69010	37	1203	1805	6017
-13	13052	19580	65280	38	1155	1733	5777
-12	12352	18520	61770	39	1109	1664	5546
-11	11692	17530	58440	40	1065	1598	5329
-10	11068	16600	55330	41	1024	1535	5116
-9	10484	15720	52440	42	984	1475	4916
-8	9932	14900	49690	43	945	1418	4725
-7	9416	14120	47070	44	909	1363	4543
-6	8928	13390	44630	45	874	1310	4369
-5	8468	12700	42340	46	840	1260	4202
-4	8032	12050	40170	47	808	1212	4042
-3	7624	11440	38130	48	778	1167	3889
-2	7240	10860	36190	49	748	1123	3743
-1	6876	10310	34370	50	720	1081	3603
0	6532	9796	32660	51	694	1040	3469

Table 6: Conversion table (continued)

Temp. ℃	Reading in Ohms			Temp. ℃	Reading in Ohms		
	With a 2K Thermistor	With a 3K Thermistor	With a 10K Thermistor		With a 2K Thermistor	With a 3K Thermistor	With a 10K Thermistor
52	668	1002	3340	102	128	192.2	640.3
53	643	965.0	3217	103	125	186.8	622.1
54	620	929.6	3099	104	121	181.5	604.4
55	597	895.8	2986	105	118	176.4	587.5
56	576	863.3	2878	106	114	171.4	571.0
57	555	832.2	2774	107	111	166.7	555.1
58	535	802.3	2675	108	108	162.0	540.0
59	516	773.7	2580	109	105	157.6	524.9
60	498	746.3	2488	110	102	153.2	510.7
61	480	719.9	2400	111	99	149.0	496.4
62	463	694.7	2316	112	97	145.0	483.1
63	447	670.4	2235	113	94	141.1	469.8
64	432	647.1	2157	114	91	137.2	457.4
65	416	624.7	2083	115	89	133.6	444.9
66	402	603.3	2011	116	87	130.0	433.4
67	388	582.6	1942	117	84	126.5	421.8
68	375	562.8	1876	118	82	123.2	410.7
69	363	543.7	1813	119	80	119.9	399.6
70	350	525.4	1752	120	78	116.8	389.4
71	339	507.8	1693	121	76	113.8	379.2
72	327	490.9	1636	122	74	110.8	369.4
73	316	474.7	1582	123	72	107.9	360.1
74	306	459.0	1530	124	70	105.2	350.8
75	296	444.0	1479	125	68	102.5	341.9
76	286	429.5	1431	126	67	99.9	333.0
77	277	415.6	1385	127	65	97.3	324.6
78	268	402.2	1340	128	63	94.9	316.6
79	260	389.3	1297	129	62	92.5	308.6
80	251	376.9	1255	130	60	90.2	301.1
81	243	364.9	1215	131	59	87.9	293.5
82	236	353.4	1177	132	57	85.7	286.0
83	228	342.2	1140	133	56	83.6	279.3
84	221	331.5	1104	134	54	81.6	272.2
85	214	321.2	1070	135	53	79.6	265.5
86	208	311.3	1036	136	52	77.6	259.3
87	201	301.7	1004	137	51	75.8	253.1
88	195	292.4	973.8	138	49	73.9	246.9
89	189	283.5	944.1	139	48	72.2	241.1
90	183	274.9	915.2	140	47	70.4	235.3
91	178	266.6	887.7	141	46	68.8	229.6
92	172	258.6	861.0	142	45	67.1	224.2
93	167	250.9	835.3	143	44	65.5	218.9
94	162	243.4	810.4	144	43	64.0	214.0
95	157	236.2	786.4	145	42	62.5	208.7
96	153	229.3	763.3	146	41	61.1	203.8
97	148	222.6	741.1	147	40	59.6	199.4
98	144	216.1	719.4	148	39	58.3	194.5
99	140	209.8	698.5	149	38	56.8	190.1
100	136	203.8	678.5	150	37	55.6	185.9
101	132	197.9	659.0				

Table 6: Conversion table

CERTIFICATE OF QUALITY & CONFORMITY
THERMISTOR STRING

Model: **Thermistor string**

Serial number: **133E10001** **Total length: 12m**

Thermistor located at (m)	Color code	Pin code
10 (bottom)	Black & White-Black	15-16
8	Black & Blue/Black	13-14
6	Black & Orange-Black	11-12
4	Red & Gray-Red	9-10
2	Red & White-Red	7-8
1	Green & Red-Green	5-6
0,5	Red & Orange-Red	3-4
0 (ground level)	Blue & White-Blue	1-2

We certify that the following product(s) complies with specifications published in our technical documents and, when applicable, in the documents related to the customer order.

In order to ensure a high level of quality, our products are manufactured and tested according to our business process, which satisfy the requirements of ISO 9001 standards.

Certificate no: E7133E-100617-24271

Certified by: Melina Morales Date: 6/17/2010

CERTIFICATE OF QUALITY & CONFORMITY
THERMISTOR STRING

Model: **Thermistor string**

Serial number: **133E10002** **Total length: 12m**

Thermistor located at (m)	Color code	Pin code
10 (bottom)	Black & White-Black	15-16
8	Black & Blue/Black	13-14
6	Black & Orange-Black	11-12
4	Red & Gray-Red	9-10
2	Red & White-Red	7-8
1	Green & Red-Green	5-6
0,5	Red & Orange-Red	3-4
0 (ground level)	Blue & White-Blue	1-2

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Certificate no: E7133E-100617-24271

Certified by: Melina Morales Date: 6/17/2010

CERTIFICATE OF QUALITY & CONFORMITY
THERMISTOR STRING

Model: **Thermistor string**

Serial number: **133E10003** **Total length: 12m**

Thermistor located at (m)	Color code	Pin code
10 (bottom)	Black & White-Black	15-16
8	Black & Blue/Black	13-14
6	Black & Orange-Black	11-12
4	Red & Gray-Red	9-10
2	Red & White-Red	7-8
1	Green & Red-Green	5-6
0,5	Red & Orange-Red	3-4
0 (ground level)	Blue & White-Blue	1-2

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Certificate no: E7133E-100617-24271

Certified by: Melina Morales Date: 6/17/2010

CERTIFICATE OF QUALITY & CONFORMITY
THERMISTOR STRING

Model: **Thermistor string**

Serial number: **133E10004** **Total length: 12m**

Thermistor located at (m)	Color code	Pin code
10 (bottom)	Black & White-Black	15-16
8	Black & Blue/Black	13-14
6	Black & Orange-Black	11-12
4	Red & Gray-Red	9-10
2	Red & White-Red	7-8
1	Green & Red-Green	5-6
0,5	Red & Orange-Red	3-4
0 (ground level)	Blue & White-Blue	1-2

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In order to ensure a high level of quality, our products are manufactured and tested according to our business process, which satisfy the requirements of ISO 9001 standards.

Certificate no: E7133E-100617-24271

Certified by: Melina Morales Date: 6/17/2010

CERTIFICATE OF QUALITY & CONFORMITY
THERMISTOR STRING

Model: **Thermistor string**

Serial number: **133E10005** **Total length: 12m**

Thermistor located at (m)	Color code	Pin code
10 (bottom)	Black & White-Black	15-16
8	Black & Blue/Black	13-14
6	Black & Orange-Black	11-12
4	Red & Gray-Red	9-10
2	Red & White-Red	7-8
1	Green & Red-Green	5-6
0,5	Red & Orange-Red	3-4
0 (ground level)	Blue & White-Blue	1-2

We certify that the following product(s) complies with specifications published in our technical documents and, when applicable, in the documents related to the customer order.

In order to ensure a high level of quality, our products are manufactured and tested according to our business process, which satisfy the requirements of ISO 9001 standards.

Certificate no: E7133E-100617-24271

Certified by: Melina Morales Date: 6/17/2010

CERTIFICATE OF QUALITY & CONFORMITY
THERMISTOR STRING

Model: **Thermistor string**

Serial number: **133E10006** **Total length: 29m**

Thermistor located at (m)	Color code	Pin code
27 (bottom)	Black & White-Black	1 - 2
26	Blue & White/Blue	3 - 4
25	Red & Orange-Red	5 - 6
24	Green & Red-Green	7 - 8
23	Black & Blue-Black	9 - 10
22	Orange & Orange-Black	11 - 12
21	Red & Gray-Red	13 - 14

We certify that the following product(s) complies with specifications published in our technical documents and, when applicable, in the documents related to the customer order.

In order to ensure a high level of quality, our products are manufactured and tested according to our business process, which satisfy the requirements of ISO 9001 standards.

Certificate no: E7133E-100617-24271

Certified by: Melina Morales Date: 6/17/2010

Quickstart for Installation Validation of the Thermistor String

1.0 Installation Validation Steps

- Installation of the loggernet software on the computer
- Connect the thermistor string to the test box (using the rectangular-shaped connector)
- Turn the power on with the terminal block blade
- Start the computer and the LoggerNet Software (setup the connection)
- Monitor data
- Collect data

2.0 LoggerNet Software

2.1 Description

The LoggerNet is a fullly featured Windows-based software package that allows direct communication with the test box using a RS-232 connection. A “Connect” screen provides real-time tools to set the datalogger clock in order to send the program to the datalogger and manually collect data using a computer. In addition, data can also be retrieved automatically, based on a predefined schedule. Measurements can be viewed in real-time on both numeric and graphical displays. In addition to these basic tools, the software package includes a datalogger program editor, a report generation tool and a data viewer with basic plotting capabilities.

This application note is intended to give the user a quickstart in getting the datalogger powered up and running. However, we strongly recommend that the user read the LoggerNet manual in order to get familiar with its features.

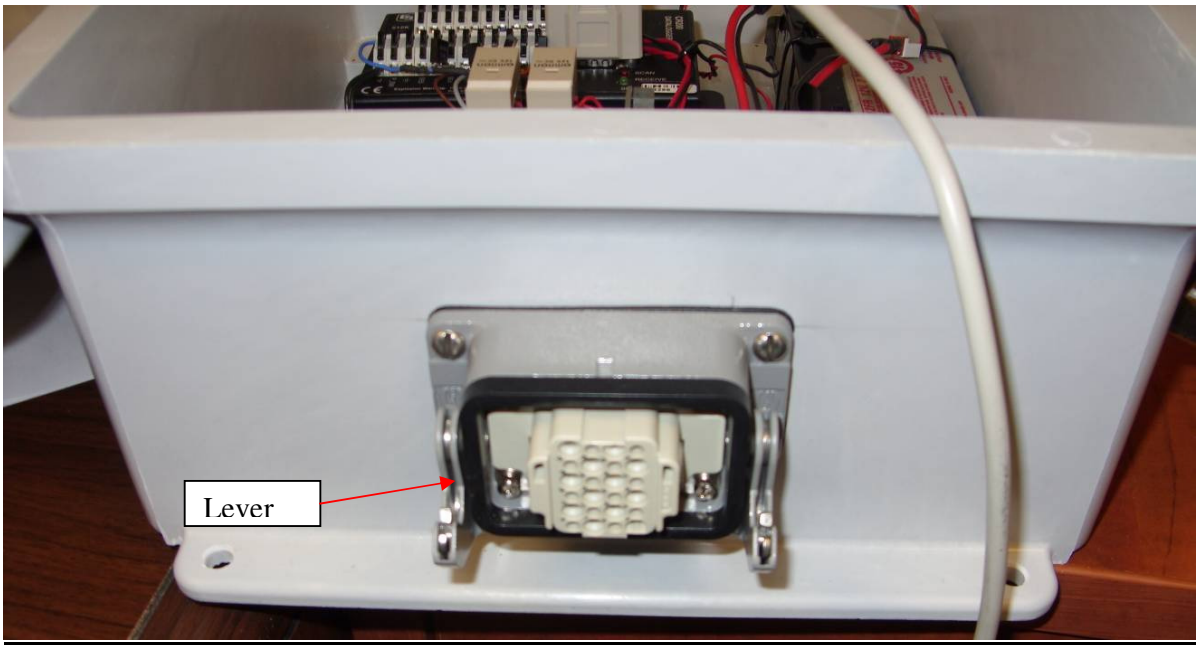
2.2 Software Installation

The LoggerNet is a collection of 32-bit programs designed for Intel-based computers running Microsoft Windows 2000, Windows XP or Vista.

As with all softwares, we strongly recommend that a back-up of critical files be performed before software installation. Place the installation disk in your computer’s CD/DVD drive. If autorun is enabled, LoggerNet installation will start. If it does not start, select START > RUN fom the Windows’s START menu. Locate the SETUP.EXE file on the CD/DVD drive and click OK. Follow the instructions on the screen. Refer to the LoggerNet manual for further details.

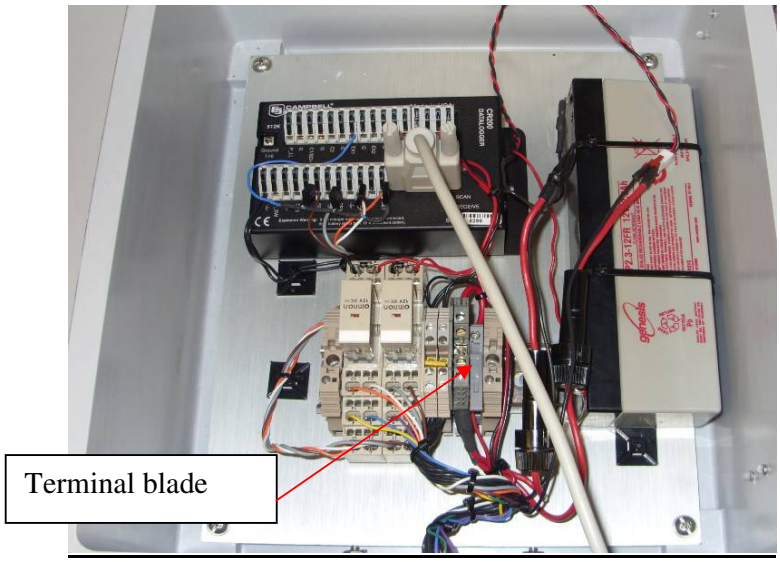
When the installation is done, a LoggerNet icon will be placed on your desktop.

3.0 Connection of the Thermistor String to the Test Box



Connect the connector to the mating on the test box and lift up the lever to secure the connector in place. *NOTE: make sure to seal back the connector of the thermistor string to avoid any water infiltration in the connector before the final installation.*

4.0 Turn the Power On on the Test Box



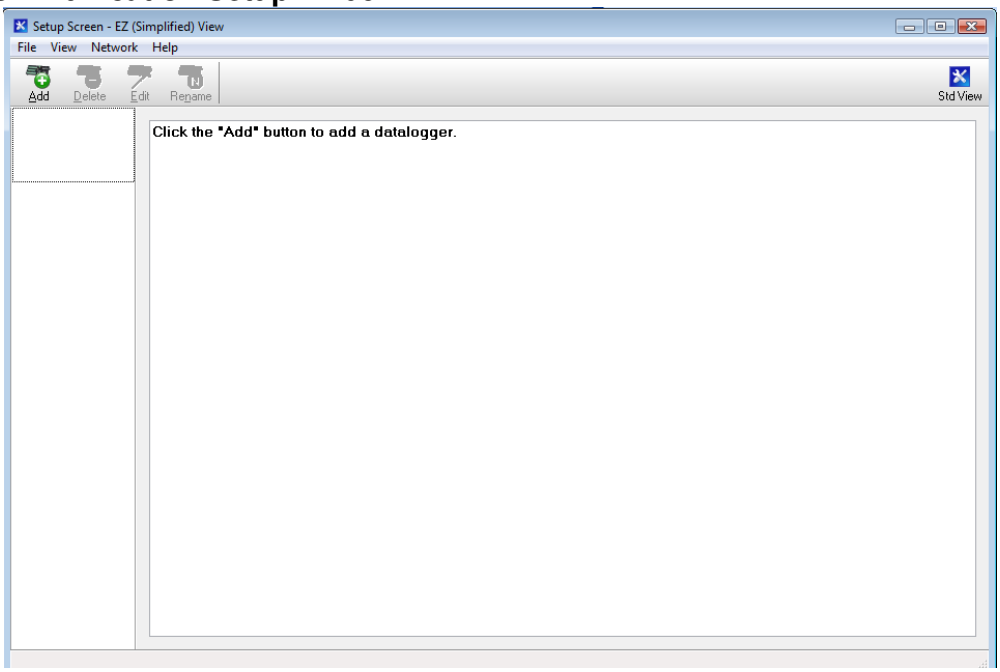
The terminal blade is used to turn the power OFF. Lower the blade to turn the unit ON. Make sure to raise the blade at the end of the test to avoid any battery drainage.

5.0 Setup the Connection

The hardware and software setups are done. The following steps describe the instructions to connect the datalogger, to collect or monitor data

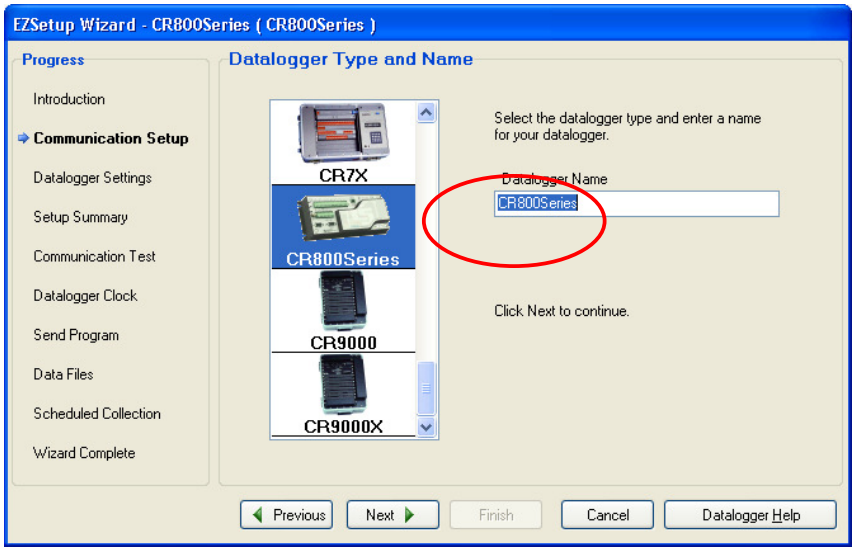
To start the LoggerNet, double click on the LoggerNet desktop icon.

- From the **MAIN** / **SETUP**, click **Add** and then click **Next**, which will get you to the **Communication Setup** window.

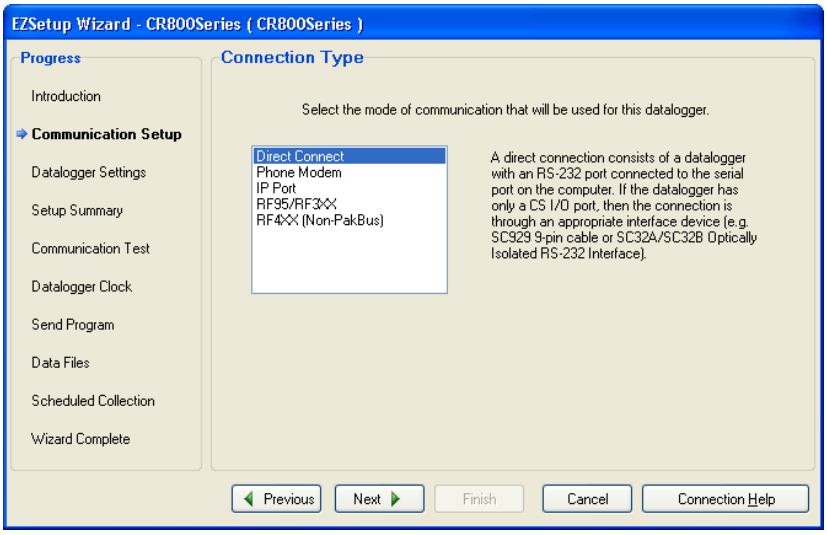


- Wait at least 15 seconds after powering up the unit before attempting to communicate with it.

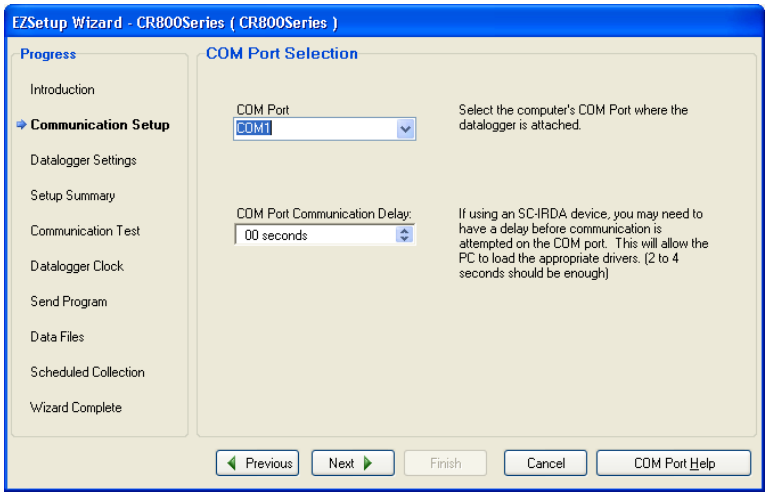
- Under **Datalogger Type and Name**, select **CR200 Series,** and next under **Datalogger Name**, choose a name that best represents your application. For example, type ***Thermistor*** and click **Next**. This datalogger name will be used later to connect to the Thermistor datalogger.



- Select **Direct Connect** and click **Next**.

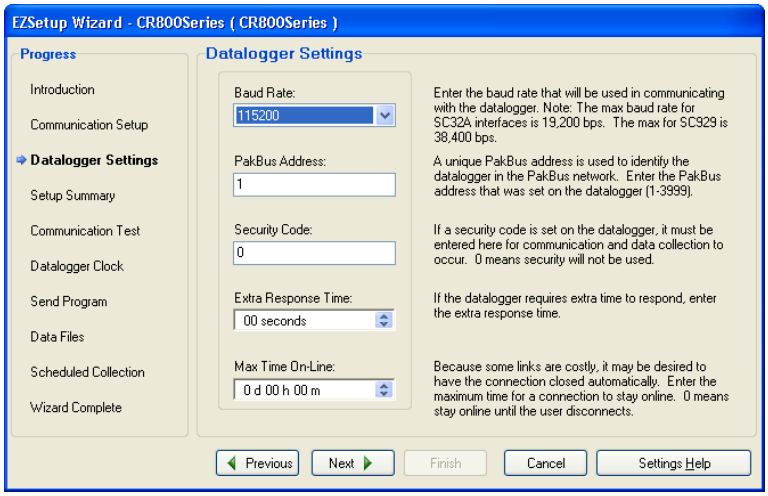


- Select the appropriate **COM port** on your computer. Usually, if you have a serial port on your computer, **COM 1** will be available. However, if you use a USB Serial adaptor, a virtual port will be created and a new COM port number will be assigned. Click **Next** when done.

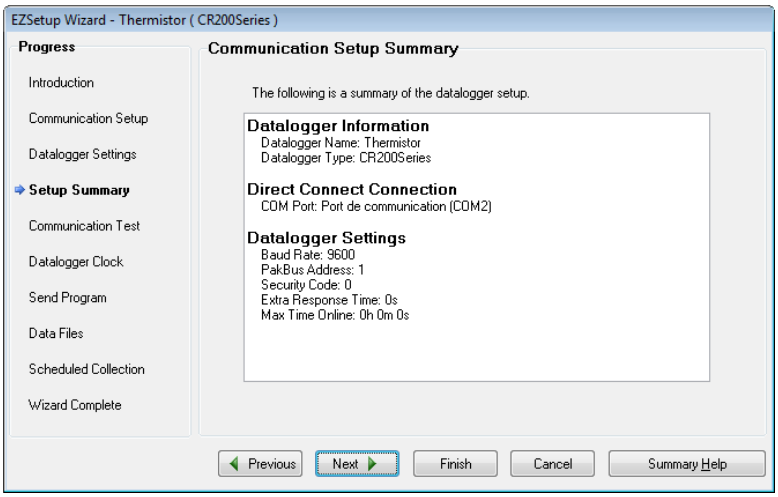


- Use the default parameters and click **Next**.

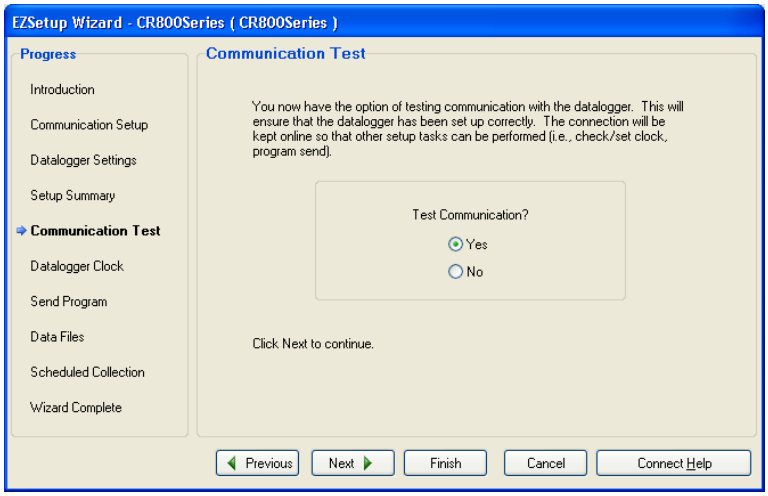
Note: If you use a USB Serial adapter you may need to lower the Baud Rate, in general **9600** works fine with the adapter.



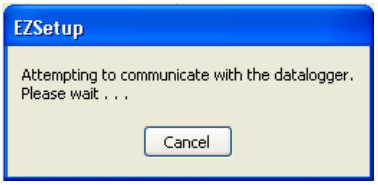
- The following window displays the Communication Setup Summary. Click **Next**.



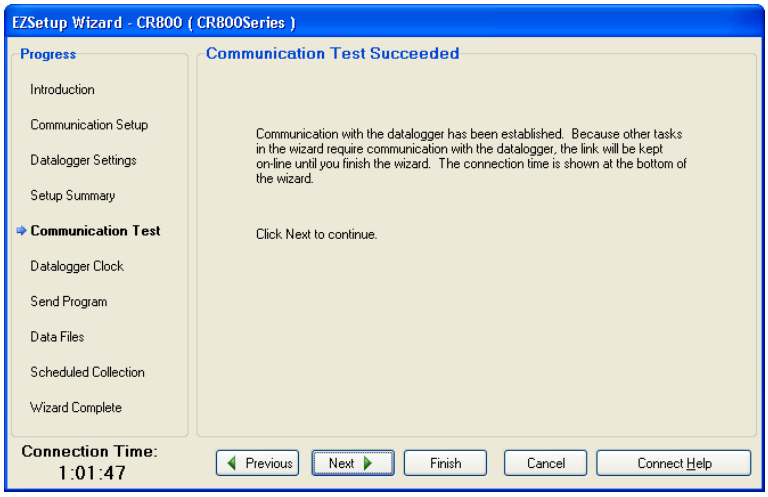
- To test the communication, select **Yes** and click **Next**.



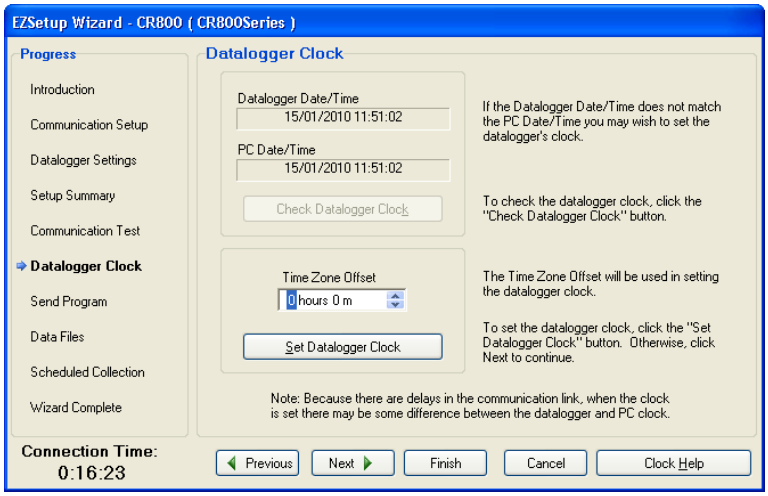
The following message will appear on the screen while your computer is attempting to communicate with the Thermistor datalogger.



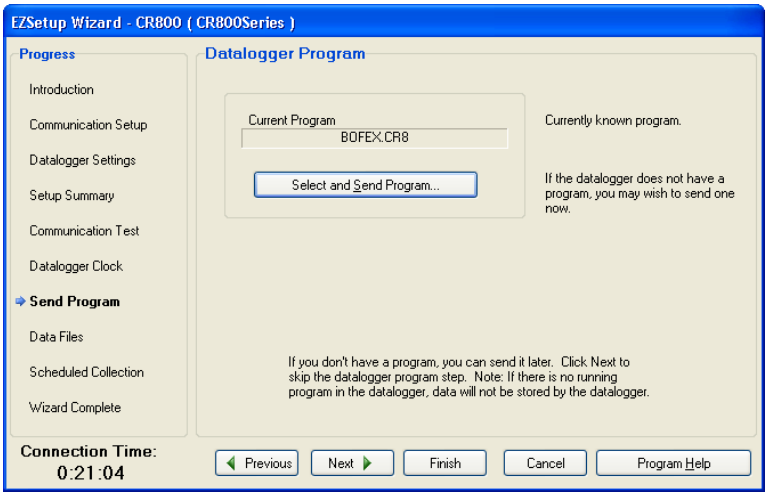
- The next windows will indicate if communication is successful. Click **Next**.



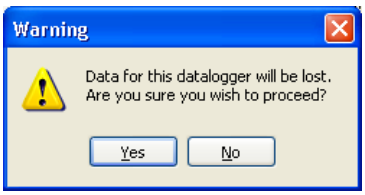
- Adjust the clock to set it at your local time zone. Make sure your computer is adjusted to your local time, then click **Set Datalogger Clock**. When done, click **Next**.



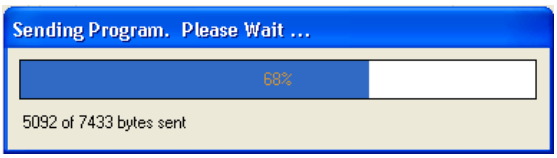
- The datalogger is usually shipped with the Application Program pre-loaded in the datalogger. The program will be displayed under **Current Program**. If it shows **no program** or if the program name shown is not for your application, you will need to upload your Application Program in the datalogger. Click **Finish** to save your settings. At this point, the datalogger setup is completed. To quit the **EZSetup** wizard, select **File** from the menu and click **Exit**. Proceed to section 4.2.



- To download your application program, click **Select and Send Program**. Locate the program on your computer's HD drive or on the one supplied by email, and click **Open**. The following warning message will be displayed on your screen. Click **Yes**.

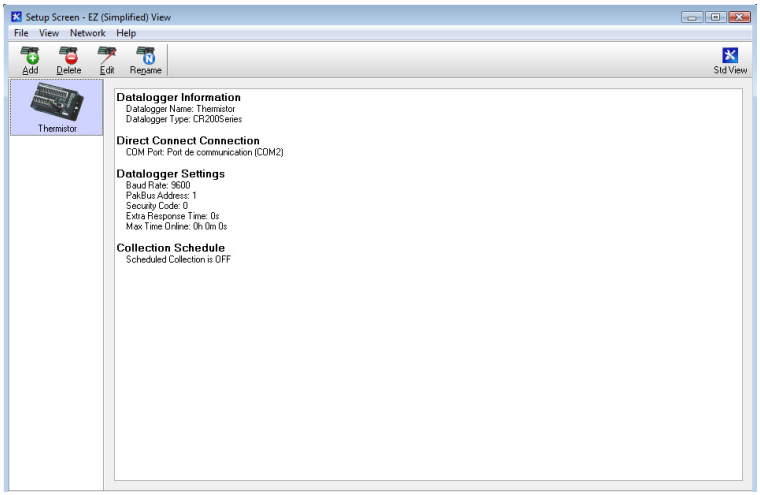


- A progress bar will display the download progress. If successful, a message will indicate it.



- Click **Finish** to save your settings. This completes the datalogger setup using the **EZSetup** wizard.

- To quit the **EZSetup**, select **File** from the **Menu**, and click **Exit.**

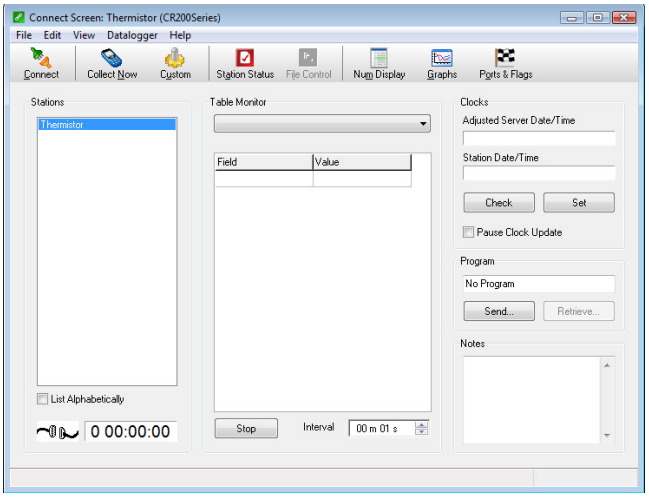


6.0 Monitoring Data With a Computer

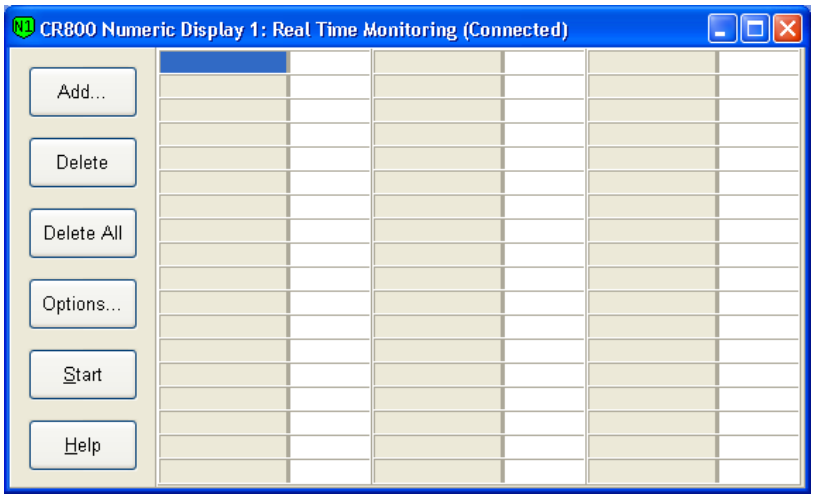
- Connect the supplied Serial Cable between the RS232 Input on the CR200 datalogger and your computer's serial port or USB Serial Adapter.

- Start the LoggerNet by double clicking on the LoggerNet desktop icon.

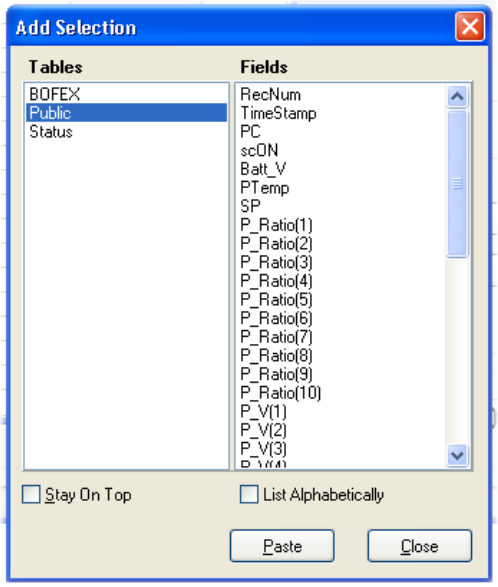
- From the **MAIN/CONNECT**, click on the station **Thermistor**, then **Connect**



- The cable at the bottom of the screen will be connected when the link will be established. Click **Num.Display/Display 1**. The following window should appear.



- Click the **Add** button and under **Tables**, highlight **Public**. The following window should appear.

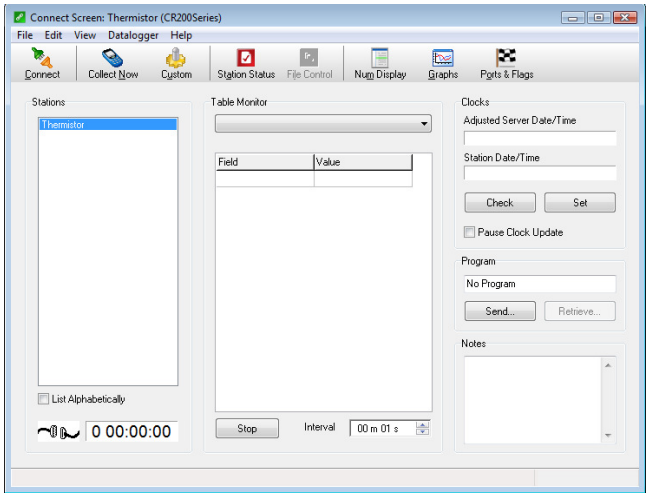


- Under **Fields**, select (highlight) the sensors (labels) you wish to view during the Test. You can use a combination of Shift & Ctrl keys on the computer's keyboard to select multiple labels. Next, on the **Display 1** window, highlight the location where you want to place the labels and finally, from the **Add Selection** window, click **Paste**. We recommend you to monitor the entire content in **Public**. The variable **Thermistor** represents the temperature and the value **Resistor** represents the resistor value of the thermistor.

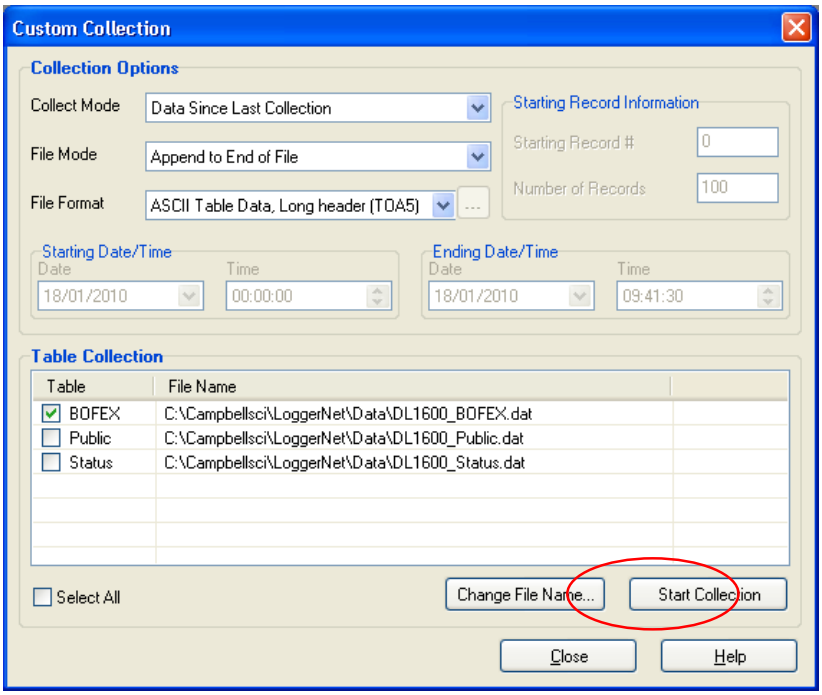
7.0 Collect Data

When a Test is completed, readings should be collected immediately. The following steps assume that the computer is already connected and that the LoggerNet is already running.

- From the **Connect Screen**, click the **Collect Now** button.



- Click on the Data_X.dat file to see the content. The records are displayed in a table.
- To modify the data output, click **Custom** in the connect screen. The following screen will appear.



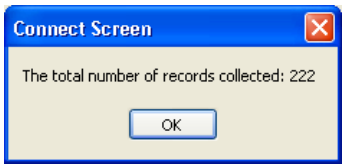
- Under **Collection Options**, make sure the following options are selected:
    - **Data Since Last Collection**
    - **Append to End of File**
    - **ASCII Table Data, Long header (TOA5)**

- Under **Table Collection**, make sure that **Data_X** is checked and that the file path where to save the file is defined. You do not need to check the **Public** and **Status** boxes.

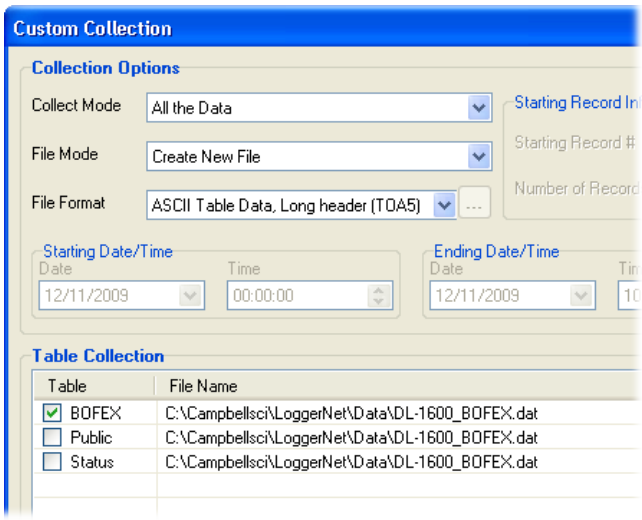
When collecting readings for the first time, you may need to collect all the data from the test box. This will set all memory pointers so that the next time you collect readings, the datalogger will know what readings were previously collected, and only new readings will be collected. All new readings will be appended to the previously collected file, or a new file will be created.

- Click **Start Collection**. The following message will appear, showing the collection progress and total records collected.

Note: A single record includes the timestamp, the record number, all sensors readings in Celcius degrees, and finally, the datalogger's battery voltage.



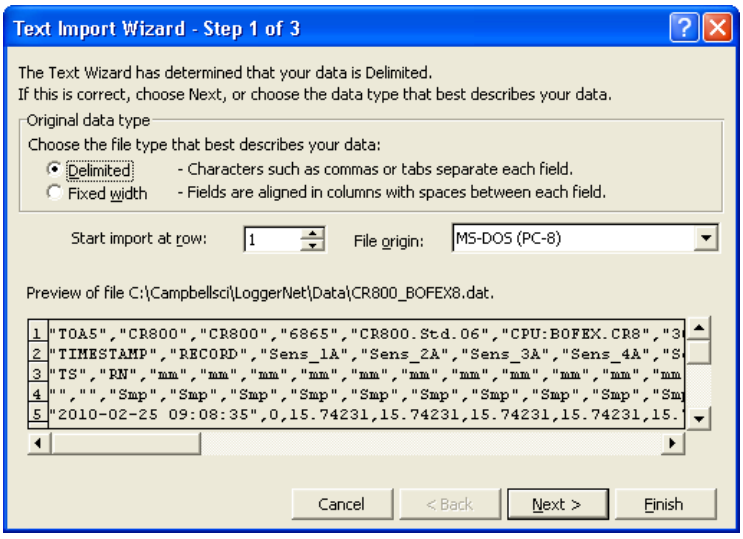
If the message window shows zero records collected, set the **Collection Options** as follow and do the **Start Collection** again.



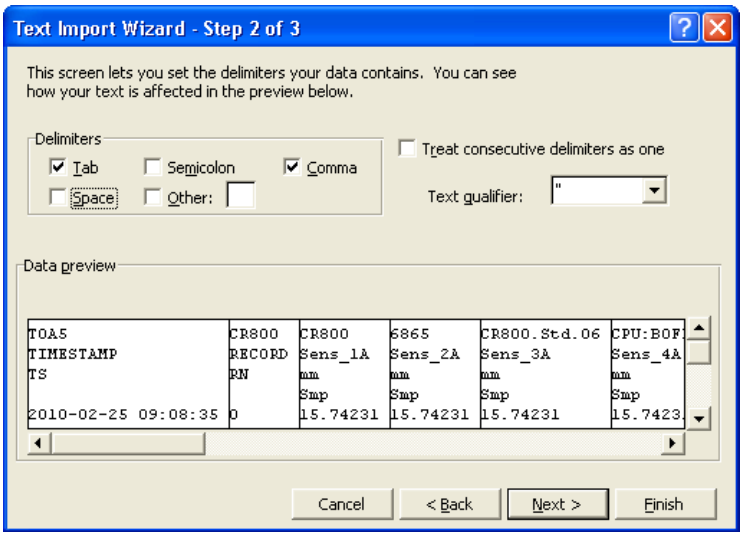
All collected readings are saved in the file specified under Table Collection. The readings saved with the file format **ASCII Table Data, Long header (TOA5)** are separated by commas (CSV) and can be imported into Microsoft Excel for data reduction.

7.1 Import Readings Into Excel

- Start Excel, go to **File** > **Open**, in the **Files of type** field, then select **All Files (*)**.
- Locate and select the file to import and click **Open**. The Text Import Wizard will open.

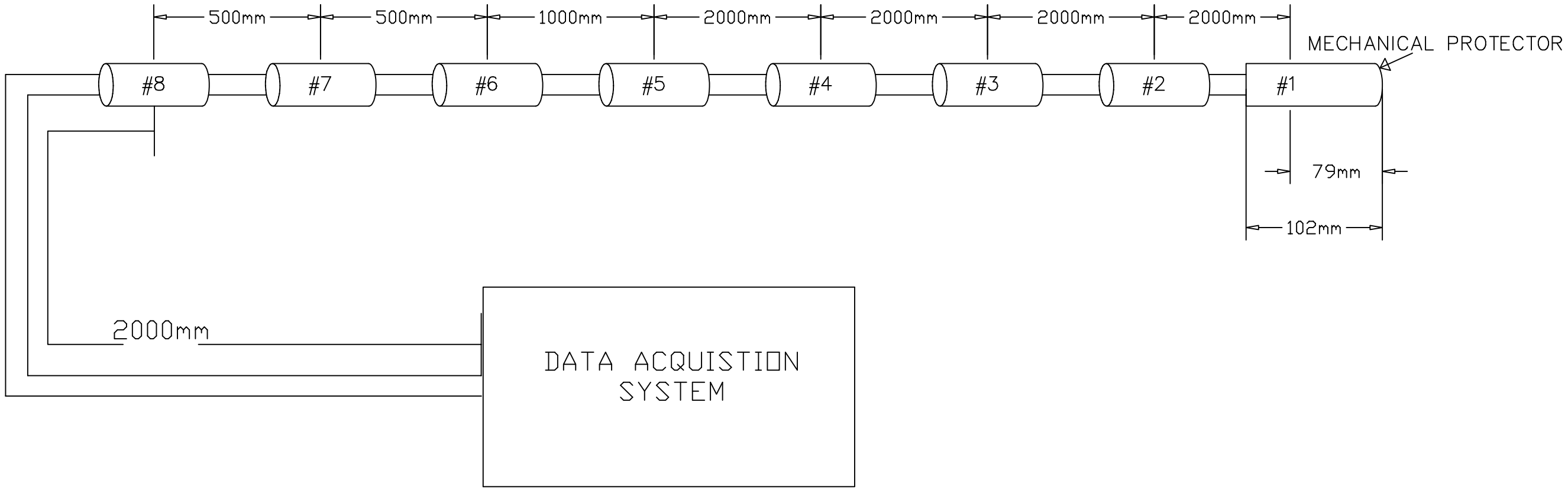


- Select **Delimited** and click **Next**.



- Select **Tab**, **Comma** and click **Finish**.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	TOA5	CR800	CR800	6865	CR800.Stc	CPU:BOFI	3022	BOFEX						
2	TIMESTAMP	RECORD	Sens_1A	Sens_2A	Sens_3A	Sens_4A	Sens_5A	Sens_1B	Sens_2B	Sens_3B	Sens_4B	Sens_5B	S_Range	Load
3	TS	RN	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	
4			Smp	Smp	Smp	Smp	Smp	Smp	Smp	Smp	Smp	Smp	Smp	Smp
5	25/09/2009 09:08	0	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	50	0
6	25/09/2009 09:08	1	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	50	0
7	25/09/2009 09:08	2	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	50	0
8	25/09/2009 09:08	3	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	50	0
9	25/09/2009 09:08	4	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	15.74231	50	0
10														



Position / wire color	Connector pin
10 m color: black - white/black	15-16
8 m color: black - blue/black	13-14
6 m color: black - orange/black	11-12
4 m color: red - gray/red	9-10
2 m color: red - white/red	7-8
1 m color: green - red/green	5-6
0.5m color: red - orange/red	3-4
0 m color: blue - white/blue	1-2

ROCTEST

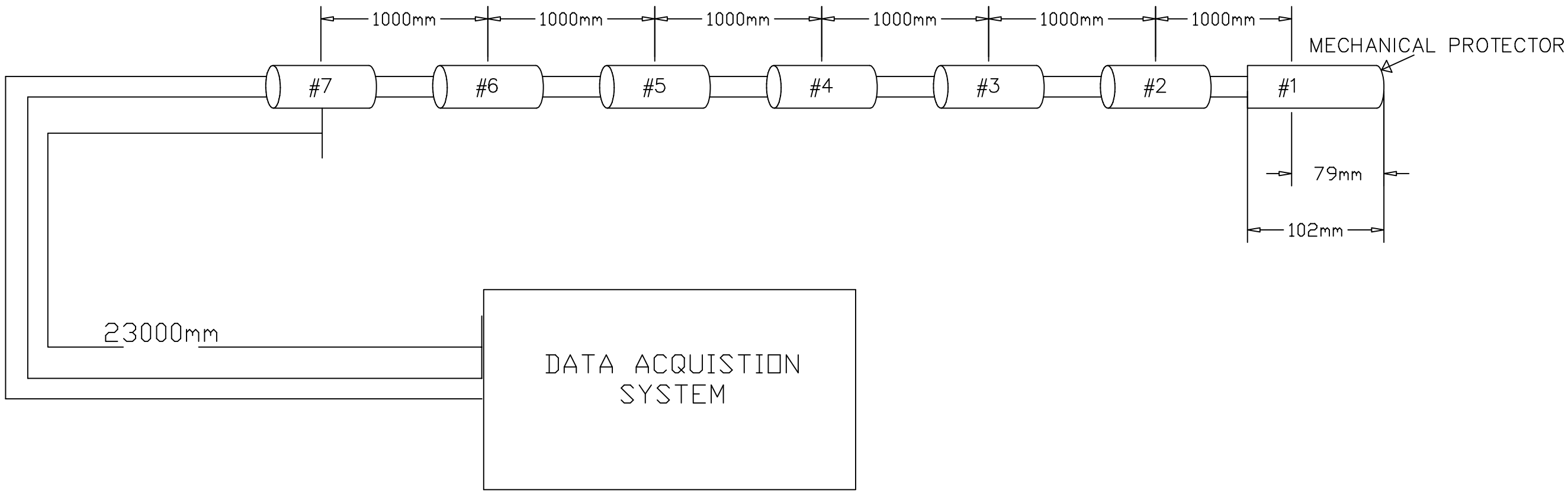
APPLICATION: THERMISTOR STRING 12 meters

TITLE: WIRING SCHEMATIC TO DAS

REVISION NO.	DESCRIPTION	DATE	APPR.

DRAW	D.LABRE	10-06-18
CHECK	D.LABRE	10-06-18
DESIGNED	D.LABRE	10-06-18
APPROVED	D.LABRE	10-06-18

PAGE 1 OF 1 | SCALE N/A | CODE NO. 137 | DRAWING NO. 60499_1 | REV. NO. 0



Position / wire color	Connector pin
27 m color: black - white/black	1-2
26 m color: blue - white/blue	3-4
25 m color: red - orange/red	5-6
24 m color: green - red/green	7-8
23 m color: black - blue/black	9-10
22 m color: black - orange/black	11-12
21 m color: red - gray/red	13-14

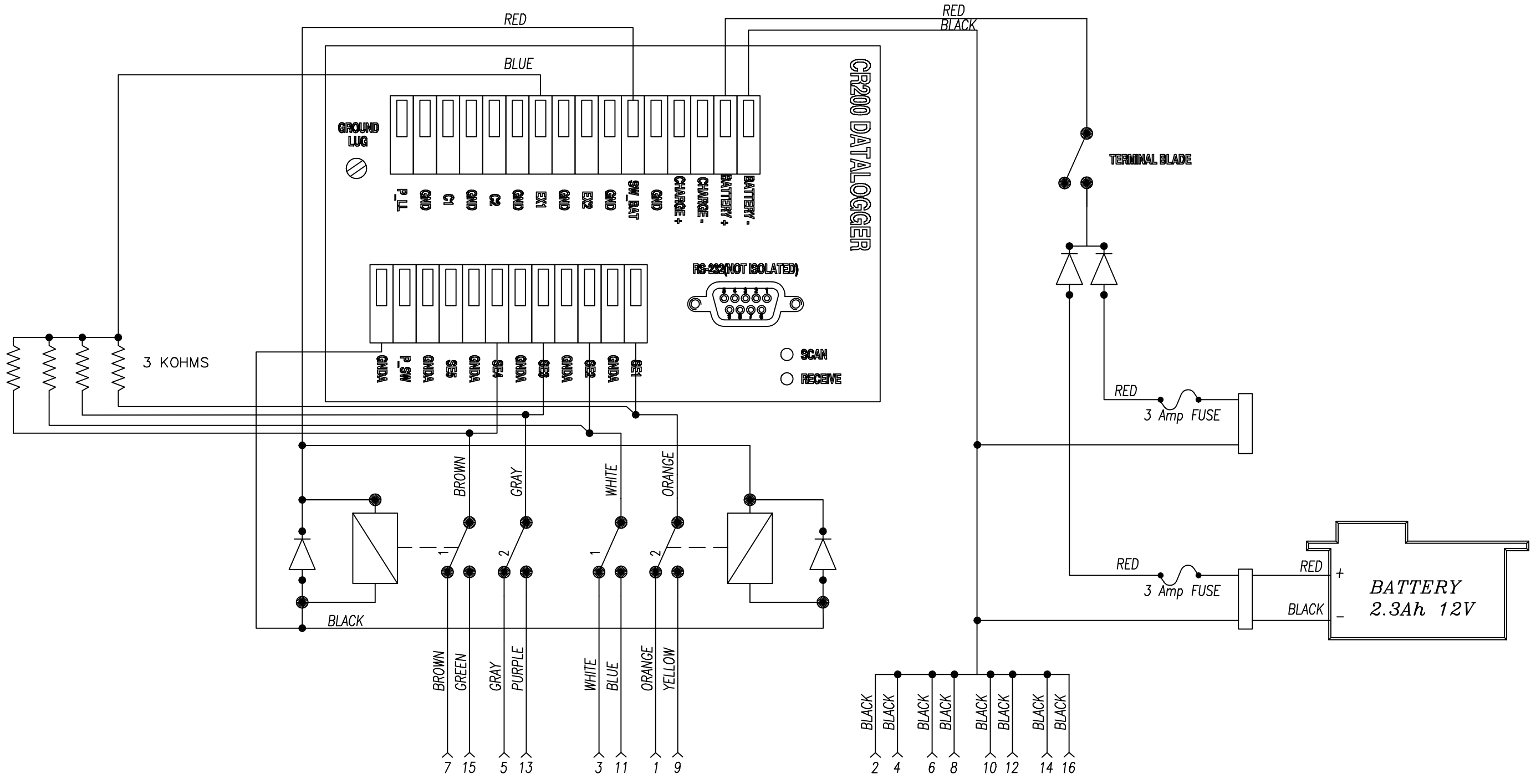
REVISION					
NO.	DESCRIPTION	DATE	APPR.		
				DRAW D.LABRE	10-06-18
				CHECK D.LABRE	10-06-18
				DESIGNED D.LABRE	10-06-18
				APPROVED D.LABRE	10-06-18

ROCTEST

APPLICATION: THERMISTOR STRING 29 meters

TITLE: WIRING SCHEMATIC TO DAS

PAGE 1 OF 1	CODE NO.	DRAWING NO.	REV. NO.
SCALE N/A	137	60499_2	0



REVISION					
NO.	DESCRIPTION	DATE	APPR.		
				DRAW D.LABRE	10-06-18
				CHECK D.LABRE	10-06-18
				DESIGNED D.LABRE	10-06-18
				APPROVED D.LABRE	10-06-18

ROCTEST

APPLICATION: DATA ACQUISITION SYSTEM

TITLE: WIRING SCHEMATIC

PAGE 1 OF 1	CODE NO.	DRAWING NO.	REV. NO.
SCALE N/A	137	60499_3	0

Appendix G - Technical Specifications Facility Sign

14 X

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SEWAGE TREATMENT FACILITY

NO GATHERING OR HARVESTING

PANNEAU 60 X 45 CM X 3,2 MM

TEXTE ET BORDURE NOIRS

SUR FOND BLANC G.I.

Appendix H - Technical Specifications Monitoring Wells

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Well Caps

Locking well

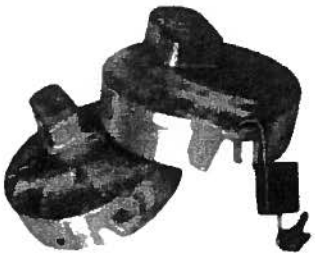
	ITEM	Ø	WEIGHT
→	412LKWC	4-1/2"	1.7 lb (0.8 kg)
→	658LKWC	6-5/8"	2.1 lb (1 kg)
	834LKWC	8-3/4"	2.7 lb (1.2 kg)
	1034LKWC	10-3/4"	5.4 lb (2.5 kg)
	1234LKWC	12-3/4"	6.5 lb (2.9 kg)

ACCESSORIES

→	HDPE-4	DR-21 HDPE pipe, size 4-1/2"
→	HDPE-6	DR-21 HDPE pipe, size 6-5/8"
	834-102	40mm padlock #834

caps

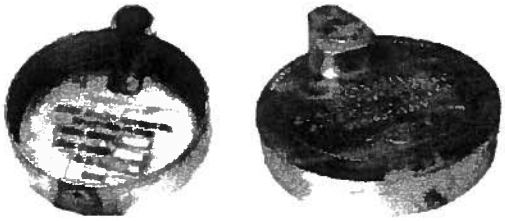
Locking conduit well caps



ITEM	DIAM.	CONDUIT
6LKCC1	6"	1"
834LKCC1	8¾"	1"
10LKCC1	10"	1"

Locking watertight conduit well

ITEM	DIAM.	CONDUIT
558CC1	5-5/8"	1"
658CC1	6-5/8"	1"
834CC1	8-3/4"	1"



caps

Watertight well caps

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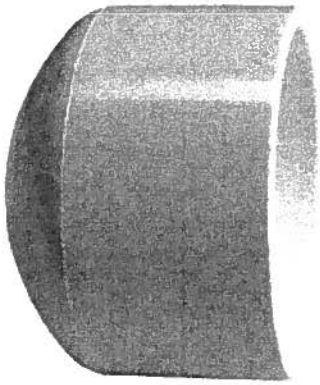
Tread flush joint

MALE CAPS

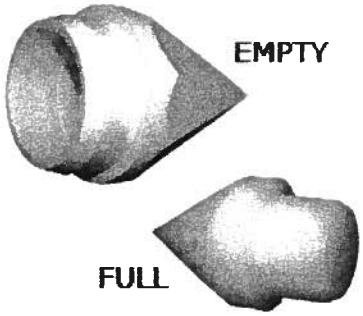
ITEM	DIAMETER	TYPE
CMS-007	¾"	Insert
CMS-010	1"	Insert
CMS-015	1½"	Insert
CMS-020	2"	Insert
CMS-030	3"	Insert
CMS-040	4"	Insert
CMS-050	5"	Insert
CMS-060	6"	Insert
CMS-080	8"	Insert

FEM CAPS

ITEM	DIAMETER	TYPE
CF447005	½"	Insert
CF447007	¾"	Insert
CF447010	1"	Insert
CF447015	1½"	Insert
→ CF447020	2"	Insert
CF447030	3"	Insert
CF447040	4"	Insert
CF447060	6"	Insert
CF447080	8"	Insert



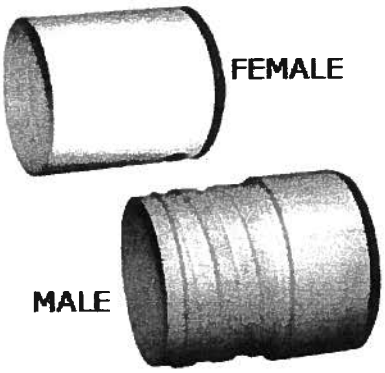
INSERTION POINT



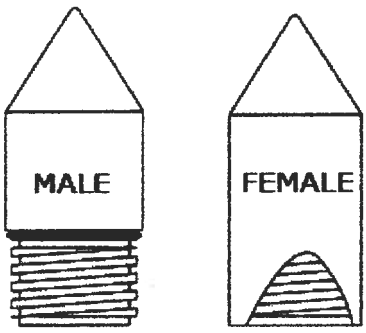
ITEM	DIAMETER	TYPE
PIP-007	¾"	Full
PI-010	1"	Empty
PIP-010	1"	Full
PI-015	1½"	Empty
PIP-015	1½"	Full
PI-020	2"	Empty
PIP-020	2"	Full

TFJ CAPS

ITEM	DIAMETER	TYPE
CTFJ-007M	¾"	TFJ male
CTFJ-007F	¾"	TFJ female
CTFJ-010M	1"	TFJ male
CTFJ-010F	1"	TFJ female
CTFJ-015M	1½"	TFJ male
CTFJ-015F	1½"	TFJ female
CTFJ-020M	2"	TFJ male
CTFJ-020F	2"	TFJ female



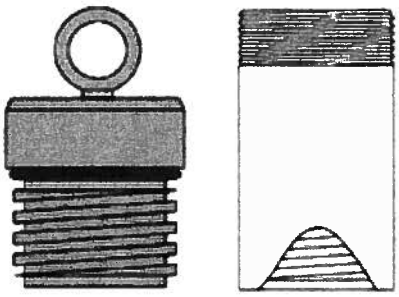
TFJ POINT



ITEM	DIAMETER	TYPE
PTFJ-007M	¾"	TFJ male
PTFJ-007F	¾"	TFJ female
PTFJ-010M	1"	TFJ male
PTFJ-010F	1"	TFJ female
PTFJ-015M	1½"	TFJ male
PTFJ-015F	1½"	TFJ female
PTFJ-020M	2"	TFJ male
PTFJ-020F	2"	TFJ female

TFJ ACCESS.

ITEM	DIAMETER	TYPE
MLTFJ-020	2"	TFJ male
MLTFJ-040	4"	TFJ male
MLTFJ-060	6"	TFJ male
NPTTFJ-007	¾"	NPT / TFJ
NPTTFJ-010	1"	NPT / TFJ
NPTTFJ-015	1½"	NPT / TFJ
NPTTFJ-020	2"	NPT / TFJ
NPTTFJ-040	4"	NPT / TFJ



ITEM	DESCRIPTION
CMS-007	Insertion male caps 3/4".
CMS-010	Insertion male caps 1".
CMS-015	Insertion male caps 1-1/2".
CMS-020	Insertion male caps 2".

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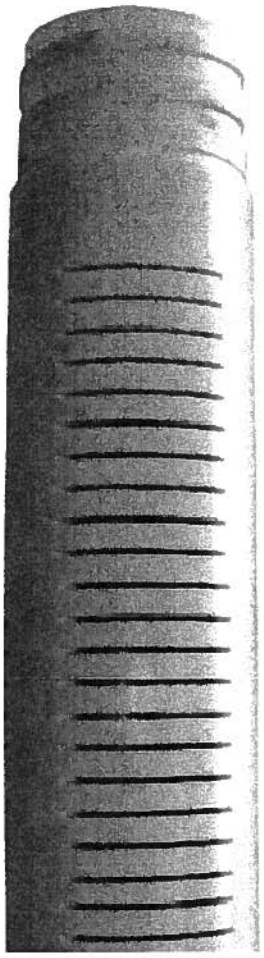
Intake Screens



Aquamerik Threaded Flush Joint is manufactured on "CNC" computer controlled machines.

Close machining tolerances are maintained to ensure an exact fit every time. A taper and relief area is designed into every end to allow the joints to be positioned and started easily without cross threading.

Flush Joints eliminate the need for couplings allowing the pipe to be assembled without the use of solvents. Flush Joints also help to prevent bridging of the backfill materials and can be installed in small diameter openings.

Hybrid wells can be constructed using PVC, Stainless Steel and other materials.

Construction: PVC (standard), CPVC, HDPE, PP
Pipe length: more than 20 feet (10 feet standard)
Pipe diameter: 1/2" to 24".
Construction: Sch40 (standard) -Sch80 - SDR
Slot Sizes: 0.006" & + (0.010" standard)
Slot Spacing: 0.100" & + (0.250" standard)

*Consult factory for pipe sizes available.

Please consult us for your specific requirements. Some materials may not be available in all sizes.

DISCOUNT AVAILABLE ON QUANTITY, DON'T HESITATE TO CALL

TOOL FREE: (888) 278-4776

ITEM	DESCRIPTION
WS075-5-10	3/4" x 5' x 0.01" screen TFJ PVC sch 40
WS075-10-10	3/4" x 10' x 0.01" screen TFJ PVC sch 40
WS100-5-10	1" x 5' x 0.01" screen TFJ PVC sch 40
WS100-10-10	1" x 10' x 0.01" screen TFJ PVC sch 40
WS100-10-20	1" x 10' x 0.02" screen TFJ PVC sch 40
WS100-10-40	1" x 10' x 0.04" screen TFJ PVC sch 40
WS150-5-10	1½" x 5' x 0.01" screen TFJ PVC sch 40
WS150-10-10	1½" x 10' x 0.01" screen TFJ PVC sch 40
WS150-10-20	1½" x 10' x 0.02" screen TFJ PVC sch 40

WS150-10-40	1½" x 10' x 0.04" screen TFJ PVC sch 40
WS200-5-10	2" x 5' x 0.01" screen TFJ PVC sch 40
WS200-10-10	2" x 10' x 0.01" screen TFJ PVC sch 40
WS200-10-20	2" x 10' x 0.02" screen TFJ PVC sch 40
WS200-10-40	2" x 10' x 0.04" screen TFJ PVC sch 40
WS200-10-80	2" x 10' x 0.08" screen TFJ PVC sch 40
WS300-5-10	3" x 5' x 0.01" screen TFJ PVC sch 40
WS300-10-10	3" x 10' x 0.01" screen TFJ PVC sch 40
WS300-10-20	3" x 10' x 0.01" screen TFJ PVC sch 40
WS300-10-40	3" x 10' x 0.01" screen TFJ PVC sch 40
WS400-5-10	4" x 5' x 0.01" screen TFJ PVC sch 40
WS400-10-10	4" x 10' x 0.01" screen TFJ PVC sch 40
WS400-10-20	4" x 10' x 0.02" screen TFJ PVC sch 40
WS400-10-40	4" x 10' x 0.04" screen TFJ PVC sch 40
WS600-5-10	6" x 5' x 0.01" screen TFJ PVC sch 40
WS600-10-10	6" x 10' x 0.01" screen TFJ PVC sch 40
WS600-10-20	6" x 10' x 0.02" screen TFJ PVC sch 40
WS600-10-40	6" x 10' x 0.04" screen TFJ PVC sch 40
WS800-10-10	8" x 10' x 0.01" screen TFJ PVC sch 40
WS800-10-20	8" x 10' x 0.02" screen TFJ PVC sch 40
WS800-10-40	8" x 10' x 0.04" screen TFJ PVC sch 40
WS075-5	Screen PVC 3/4" diam. x 5'
WS075-10	Screen PVC 3/4" diam. x 10'
WS100-5	Screen PVC 1" diam. x 5'
WS100-10	Screen PVC 1" diam. x 10'
WS150-5	Screen PVC 1 1/2" diam. x 5'
WS150-10	Screen PVC 1 1/2" diam. x 10'
WS200-5	Screen PVC 2" diam. x 5'
WS200-10	Screen PVC 2" diam. x 10'
WS300-5	Screen PVC 3" diam. x 5'
WS300-10	Screen PVC 3" diam. x 10'
WS400-5	Screen PVC 4" diam. x 5'
WS400-10	Screen PVC 4" diam. x 10'
WS600-5	Screen PVC 6" diam. x 5'
WS600-10	Screen PVC 6" diam. x 10'
WS800-5	Screen PVC 8" diam. x 5'
WS800-10	Screen PVC 8" diam. x 10'

Last Update: January 20, 2010

www.aquamerik.com

Bentonite

ITEM	DESCRIPTION
MEDIUM	Holeplug 3/8", bag of 50 lb.
COARSE	Holeplug 3/4", bag of 50 lbs.
B313	Quik-gel 200 mesh, bag of 50 lbs.
B304	Benseal #8, bag of 50 lbs.
GRA-38	Granular bentonite, 3/8", bucket of 50 lbs.

Last Update: January 29, 2010

TABLEAU DE RÉFÉRENCE

PRODUIT	DESCRIPTION	SURFACTANT	RÉDUCTEUR DE FILTRANT	VISCOSITÉ / ÉPAISSISSANT	FORAGE AIR / MOUSSE	CIMENTATION ET COLMATAGE	COLMATAGE DE BASSIN	STABILISATION DES SOLS	HOMOLOGUÉ NSF	PUITS D'EAU	TROUS DE TIRS SISMIQUES	EXPLORATION MINÉRALE	FORAGE HORIZONTAL	PUITS FORÉS ET FOND	PUITS DE CONTRÔLE	PUITS DE REMÉDIATION	EAU DOUCE	EAU SAUMÂTRE	EAU SALÉE
Agent de scellement et de colmatage																			
Pellets 1/4" ®	Granule de bentonite sodique					■				■									
Pellets 3/8" ®	Granule de bentonite sodique					■				■									
Pellets 1/2" ®	Granule de bentonite sodique					■				■									
Coarse	Ben. sodique calibrée -3/4" + 3/8"					■			■	■	■	■	▪			▪		▪	
Holeplug ®	Ben. sodique calibrée -3/8" + 1/4"					■			■	■	■	■	▪			▪		▪	
Casina Seal ®	Mélange ben. sodique (cal. 8 à 14)					■	■	■					■			■		▪	
Agent de cimentation souterraine																			
Aquaguard ®	Ciment de bentonite sodique (cal.30)					■			■	■		■	■			▪	▪		
Produit gélifiant; améliorant la viscosité (ht rend.)																			
Quick Gel ®	Bentonite sodique traitée, haut rend.		■	■					■	■	■	■	■				▪		
Produit gélifiant; améliorant la viscosité																			
Aqua Gel ®	Montmorillonite sod. traitée (cal. 200)		■	■			■		■	▪	▪	▪	■		▪		▪		
Agent moussant																			
Drill Foam ®	Agent moussant biodégradable				■					■	■	■	▪				▪		
Agent stabilisateur; améliorant la viscosité																			
E-Z Mud ®	Émulsion de polymères liquide PHPA		▪	■	■				■	■	■	■	■			■	■	■	▪
Agent de mouillage																			
Con Det ®	Surfactant soluble dans l'eau	■			▪					■	■	■	■				■	■	■
Fluide de forage horizontal																			
Boregel ®	Fluide de forage		■	■					■	■	■	■	■			▪	■		

■ Fonction principale ▪ Fonction secondaire

AUSSI DISPONIBLE:

- ENVIROPLUG GRANULE
- ENVIROPLUG GROUT
- DÉTERGENT
- THERM-EX GROUT
- PERCOL 728
- PRO-YIELD
- ZETAG 7692
- TRUBORE
- WYOMING GEL
- PRO-FARM
- PRO-PAC
- POLY-PRO
- HYDROGEL
- SODA-ASH

TABLEAU DU TAUX D'APPLICATION DES PRODUITS ENVIROPLUG

Diamètre du trou	Aquaguard		Holeplug		Coarse	
	Gal. / pied de trou	Pied de trou / sac	LB / pied de trou	Pied de trou / sac	LB / pied de trou	Pied de trou / sac
2.50"	0.25	68.00	2.50	20.00	NR	NR
3.50"	0.50	34.00	5.50	10.00	4.25	11.75
4.00"	0.65	26.00	6.50	7.50	5.50	9.00
4.50"	0.83	20.50	8.50	5.75	7.00	7.00
5.00"	1.00	17.00	10.75	5.00	8.75	5.75
5.50"	1.23	13.80	12.50	4.00	10.50	5.50
6.00"	1.50	11.30	15.50	3.25	12.50	4.00
6.50"	1.70	10.00	20.50	2.50	14.75	3.50
8.00"	2.60	6.50	28.00	1.75	22.50	2.25
8.50"	2.90	5.90	32.00	1.50	25.25	2.00
10.00"	4.10	4.10	41.00	1.25	34.75	1.50
12.00"	5.90	2.90	60.00	0.75	50.00	1.00
16.00"	10.40	1.60	94.00	0.50	89.00	0.50

www.aquamerik.com

Filtration sands and gravels

The Aquamerik filtration Sand is composed of silica whole grains crystalline of a great hardness.

They are durable and dense, which enables them to be resistant to degradation.

Each grade is washed, dried and classified according to the most strict quality control. This sand is adequate for the use in the filters with pressure and density. it is also used in the filters of swimming pool like in various industrial processes and auxiliary applications.

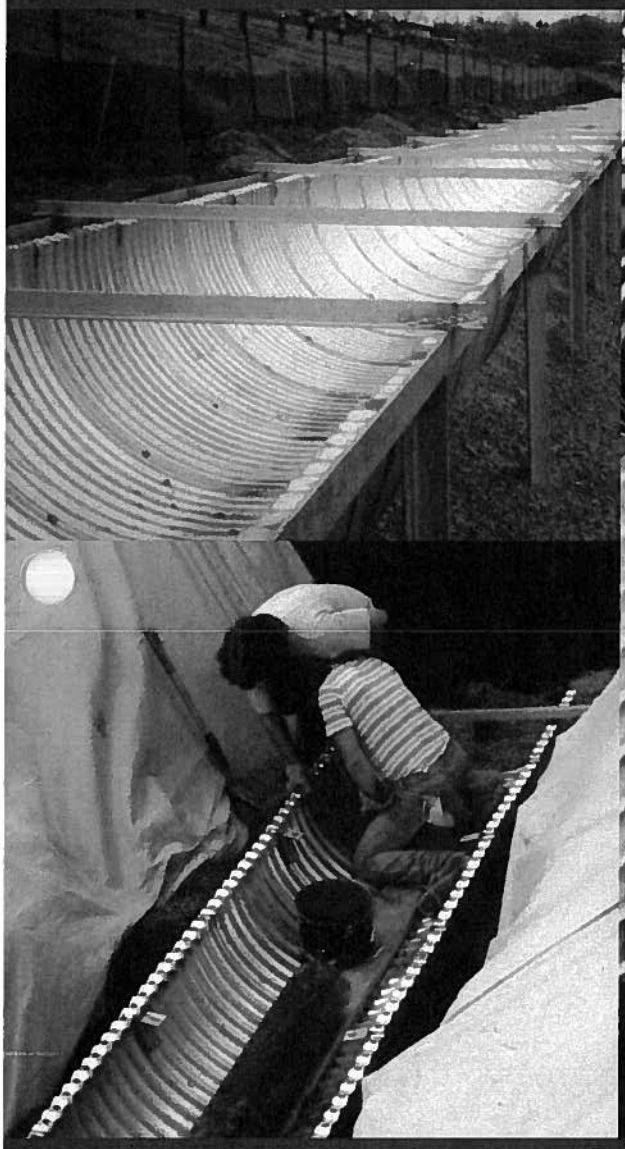
Moreover, our sands meet AWWA B-100, ANSI and NSF-61 standards. Shipped in 50 and 100 lbs bags, 3000 lbs available upon request.

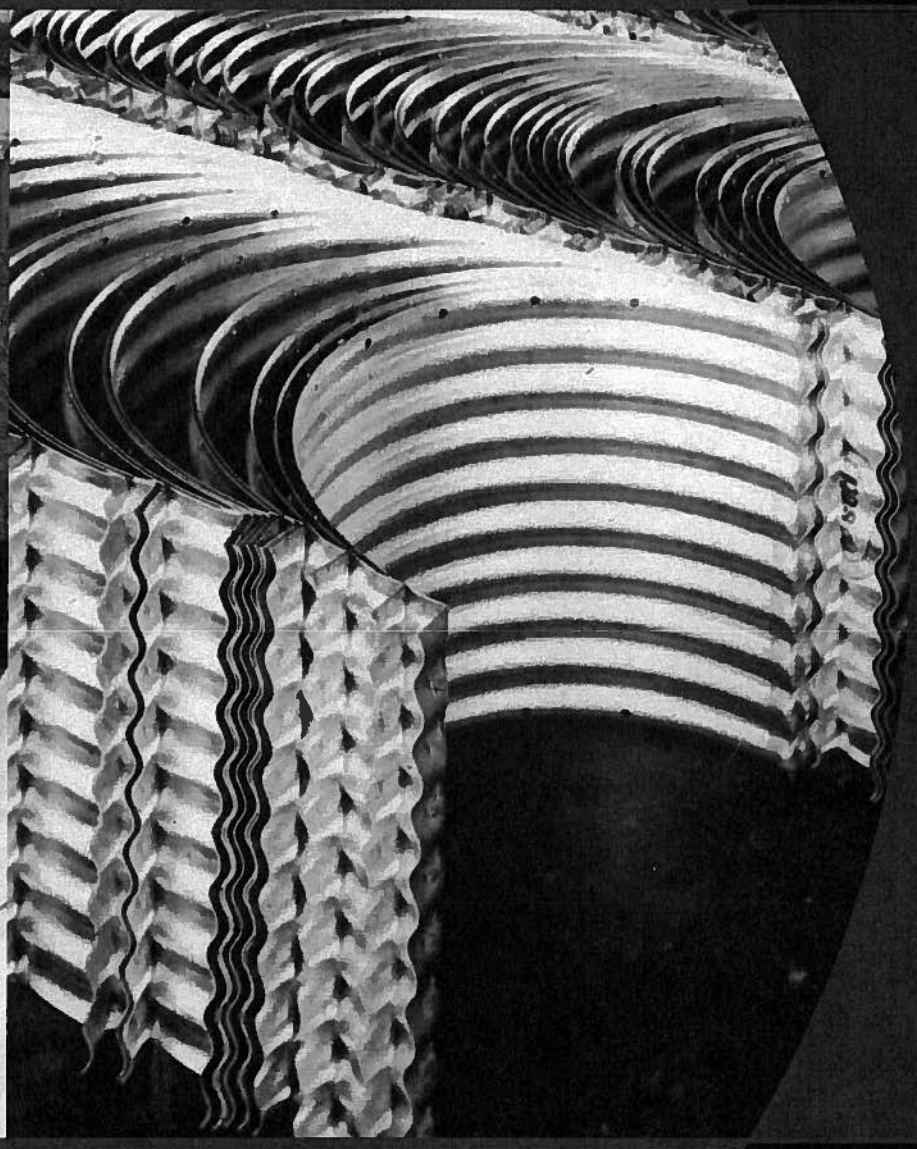
These sands can also be used in the systems of industrial and municipal drinking water filtration. They are available in granulometry going from: 0.40mm, 1.5mm to 1/16"

ITEM	DESCRIPTION
507-22	Filtration sand, 0.45 - 0.55 mm (0.017 - 0.021"), 50 lbs.
507-45	Filtration sand, 0.45 - 0.55 mm (0.017 - 0.021"), 100 lbs.
520-22	Filtration sand, 0.65 mm (0.025"), 50 lbs.
→ SA-1	Filtration sand, 0.65 - 0.75 mm (0.025 - 0.029"), 50 lbs.
521-22	Filtration sand, 0.75 mm (0.029"), 50 lbs.
521-45	Filtration sand, 0.75 mm (0.029"), 100 lbs.
516-22	Filtration sand, 0.80 - 1.2 mm (0.031 - 0.047"), 50 lbs.
516-45	Filtration sand, 0.80 - 1.2 mm (0.031 - 0.047"), 100 lbs.
509-22	Filtration sand, 0.90 - 1.6 mm (0.035 - 0.063"), 50 lbs.
509-45	Filtration sand, 0.90 - 1.6 mm (0.035 - 0.063"), 100 lbs.
530-22	Filtration sand, 1.4 mm (0.055"), 50 lbs.
529-22	Filtration sand, 1.4 - 1.66 mm (0.035 - 0.065"), 50 lbs.
529-45	Filtration sand, 1.4 - 1.66 mm (0.035 - 0.065"), 100 lbs.
510-22	Filtration sand / gravel, 1.6 - 3.2 mm (1/16 - 1/8"), 50 lbs.
510-45	Filtration sand / gravel, 1.6 - 3.2 mm (1/16 - 1/8"), 100 lbs.
525-22	Filtration sand/gravel, 1.7 - 3.35 mm (0.067 - 0.131"), 50 lbs.
524-22	Filtration sand / gravel, 2.00 - 4.75 mm (0.078-0.187"), 50 lbs.
512-22	Filtration gravel, 3.2 - 6.4 mm (1/8 - 1/4"), 50 lbs.
512-45	Filtration gravel, 3.2 - 6.4 mm (1/8 - 1/4"), 100 lbs.

Appendix I - Technical Specifications Nested Pipe

FLANGED NESTABLE CORRUGATED STEEL PIPE





arm

FLANGED NESTABLE CORRUGATED STEEL PIPE

Flanged Nestable Corrugated Steel Pipe consists of half-round sections with side flanges that can be easily bolted together to form a circular corrugated steel pipe.

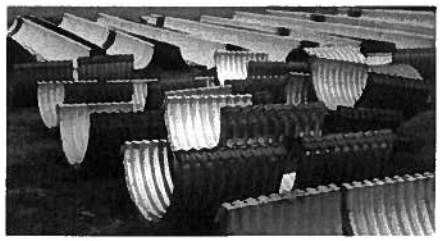
Flanged Nestable Pipe has many uses – as culverts, storm sewers, drains, casing and utilidors. The product is especially useful where a casing is to be installed around an existing utility without disturbing its operation.

The 610 mm long sections, all galvanized to Z 610, provide a product that is highly durable under normal conditions and which has proven itself since it was first produced in the early 1930's. Flanged Nestable is also available in Aluminized Steel Type II for added durability.

The sections are shipped nested and bundled together to save space during shipping. This results in cost savings, especially where the product is being shipped long distances to remote northern areas or overseas.

FASTENING METHOD: Flanged Nestable Pipe is easily assembled and no special instructions are necessary. Simple tools such as spud or socket wrenches are all that is required.

FLANGED NESTABLE PIPE SPECIFICATIONS: Half round sections are manufactured from 68 mm x 13 mm corrugated galvanized or Aluminized Type II in accordance with CSA G401 corrugated steel pipe products. Five corrugation long pieces are used on the top at both ends to introduce a circumferential seam stagger. The 50 mm wide flanges have slotted holes spaced at 68 mm centre to centre on both sides and are bolted together using galvanized 10 mm diameter bolts and nuts. All circumferential laps should be in the direction of flow.



H20 Live Load Steel Thickness of Flanged Nestable Pipe (mm)

DIAMETER	AREA	HEIGHT OF COVER ABOVE TOP OF PIPE IN METRES				
mm	m^2	3	4.5	6.0	7.5	9.0
300	.07	1.6	1.6	1.6	1.6	1.6
400	.13	1.6	1.6	1.6	1.6	1.6
450	.16	1.6	1.6	1.6	2.0	2.0
500	.20	1.6	1.6	1.6	2.0	2.0
→ 600	.28	1.6	1.6	2.0	2.0	2.0
700	.38	2.0	2.0	2.0	2.0	2.8
800	.50	2.0	2.0	2.0	2.8	2.8
900	.64	2.0	2.0	2.0	2.8	2.8
1000	.79	2.0	2.0	2.8	2.8	2.8
1200	1.13	2.8	2.8	2.8	2.8	3.5
1400	1.51	2.8	2.8	2.8	3.5	3.5
1600	2.01	2.8	2.8	3.5	3.5	3.5

Note: 1. Minimum Cover is 300 mm up to 1200 mm diameter and 500 for 1400 mm and1600 mm diameter.
2. Structures should be backfilled with well compacted granular backfill to a minimum of 95% Standard Proctor Density.

Approximate Weights kg/m

DIAMETER	WALL THICKNESS mm			
mm	1.6	2.0	2.8	3.5
300	18	22	31	39
400	22	28	39	49
450	24	31	43	54
500	27	34	48	60
→ 600	31	39	54	68
700	36	45	62	79
800	41	51	70	89
900	45	56	77	97
1000	48	61	83	101
1200	59	74	102	126
1400	68	85	118	146
1600	78	97	134	166

Head Office: 370 Speedvale Ave. W., P.O. Box 3000, Guelph, Ontario N1H 6P2
www.armtec.com

Sales Offices:
Nanaimo, Prince George, Langley, Edmonton, Calgary, Lethbridge, Saskatoon, Winnipeg, Thunder Bay, Sudbury, Guelph, Toronto, Peterborough, Chesterville, Forest, Orangeville, Comber, Montreal, Quebec City, St. Clet, Sackvile, Truro, Summerside, Bishop's Falls and St. John's.

FNP/BP/30C/0607

Appendix J - Technical Specifications Geotextile

FICHE TECHNIQUE TEXEL

7612

Texel® A DIVISION OF UNE DIVISION DE ADS INC.

IDENTIFICATION DU PRODUIT		EMBALLAGE ET EXPÉDITION	
Nom et code du produit:	7612 / 21902	Format:	Rouleaux
Description:	7612 3.50M PP GR H 100M BNQ 701	Dimensions[2]:	3.50 m X 100 m (ASTM D461.8 et .9)
Type de produit: model	Non-tissé aiguilleté, Monofilament court	Emballage:	Sac de plastique
Type de fibre:	Polypropylène	Étiquetage:	Des étiquettes identifiant le produit sont placées sur la queue du sac, sur le coté du rouleau et dans le tube.
Armature:	Aucune		

FONCTION PREMIÈRE ☑ Séparation ☐ Filtration ☐ Imperméabilisation ☐ Drainage ☐ Protection ☐ Renforcement

SPÉCIFICATIONS DU PRODUIT

PROPRIÉTÉS	MÉTHODE DE TEST	FRÉQUENCE	RÉSULTATS	MIN[1]-MOY-MAX
Physiques				
Épaisseur[2]	ASTM D5199	Standard	1.4 mm	MIN
Mécaniques				
Tension (SP)	ONGC 148.1-7.3	Standard	800 N	MIN
Tension (ST)	ONGC 148.1-7.3	Standard	800 N	MIN
Allongement à la rupture (SP)	ONGC 148.1-7.3	Standard	56% - 84%	MIN-MAX
Allongement à la rupture (ST)	ONGC 148.1-7.3	Standard	56% - 84%	MIN-MAX
Déchirure (SP)	ONGC 4.2-12.2	Standard	360 N	MIN
Déchirure (ST)	ONGC 4.2-12.2	Standard	360 N	MIN
Résistance à l'éclatement (Mullen)	ONGC 4.2-11.1	Standard	2275 kPa	MIN
Hydrauliques				
Diamètre d'ouverture de filtration (FOS)	ONGC 148.1-10	1 / an	70 µm - 130 µm	MIN-MAX
Permittivité	ONGC 148.1-4	1 / an	0.96 s-1	MIN
Perméabilité[2]	ONGC 148.1-4	1 / an	0.20 cm/s	MIN

MIN[1] : valeurs minimales de la tolérance 95 de la spécification GCTTG 3001-06 en fonction de la valeur nominale de certification.

[2]: Cette caractéristique ne fait pas partie de la certification à la spécification GCTTG 2001-06.

- Cette information technique provient du manufacturier et a été transcrite par Texel Géosol. L'utilisateur est par conséquent invité à s'assurer d'obtenir la dernière mise à jour.
- Le manufacturier n'offre aucune garantie et n'assume aucune responsabilité relative à l'usage, à l'installation et/ou à la convenance d'utilisation.
- Le manufacturier doit être informé de tout défaut ou non-conformité du produit avant son installation. Sa responsabilité se limite au remplacement du produit non-conforme ou défectueux.
- La conformité aux spécifications est basée sur un intervalle de confiance de 95% sur un lot.

- Les produits Texel sont fabriqués au Québec depuis 1967 et sont contrôlés par un service de qualité certifiée.

Veuillez consulter notre représentant technique pour plus d'informations sur les produits Texel Géosol et sur les projets réalisés depuis près de 45 ans avec les géosynthétiques Texel Géosol.

Pour le service de coupe et couture en usine ou au chantier, veuillez consulter nos représentants.

distribué par:

Texel GÉOSOL ADS INC.
Certifié ISO 9001 : 2008

• Tél.: (418) 658-0200 / 1 800 463-0088 • Téléc.: (418) 658-0477
• www.texelgeosol.com • info@texelgeosol.com

MISE À JOUR CHEZ TEXEL GÉOSOL
EN DATE DU: 2008-08-19 / 2010-09-07
VÉRIFIÉ PAR: RT

TEXEL TECHNICAL DATA SHEET

7612

Texel®
A DIVISION OF ADS INC.
UNE DIVISION DE

PRODUCT IDENTIFICATION		PACKING AND SHIPPING	
Product name and code:	7612 / 21902	Format:	Rouleaux
Description:	7612 3.50M PP GR H 100M BNQ 701	Dimensions[2]:	3.50 m X 100 m (ASTM D461.8 et .9)
Product type:	Needleounched nonwoven, short staple fiber	Packing:	Plastic bag
Fiber composition:	Polypropylene	Labeling:	Tags identifying the product are placed: on the tail of the bag, on one side of the roll and in the core
Reinforcement:	None		

FIRST FUNCTION ☒ Separation ☐ Filtration ☐ Proofing ☐ Drainage ☐ Protection ☐ Reinforcement

PRODUCT SPECIFICATIONS				
PROPERTIES	TEST METHOD	FREQUENCY	RESULTS	MIN[1]-MOY-MAX
Physical				
Thickness[2]	ASTM D5199	Standard	1.4 mm	MIN
Mechanical				
Elongation at break (CD)	CGSB 148.1-7.3	Standard	800 N	MIN
Elongation at break (MD)	CGSB 148.1-7.3	Standard	800 N	MIN
Tensile strength (CD)	CGSB 148.1-7.3	Standard	56% - 84%	MIN-MAX
Tensile strength (MD)	CGSB 148.1-7.3	Standard	56% - 84%	MIN-MAX
Tear strength (CD)	CGSB 4.2-12.2	Standard	360 N	MIN
Tear strength (MD)	CGSB 4.2-12.2	Standard	360 N	MIN
Bursting strength (Mullen)	CGSB 4.2-12.2	Standard	2275 kPa	MIN
Hydraulic				
Diamètre d'ouverture de filtration (FOS)	CGSB 148.1-10	1 / yr	70 µm - 130 µm	MIN-MAX
Permittivité	CGSB 148.1-4	1 / yr	0.96 s-1	MIN
Perméabilité[2]	CGSB 148.1-4	1 / yr	0.20 cm/s	MIN

MIN[1] : minimum values of tolerance 95 specification GCTTG 3001-06 based on the nominal value of certification.

[2]: This feature is not part of the certification specification GCTTG 2001-06.

- This technical information comes from the manufacturer and was transcribed by Texel Geosol. The user is consequently invited to ensure himself to obtain the last update.
- The manufacturer does not offer any guarantee and does not assume any comparative responsability with use, the installation and/or the suitability of use.
- The manufacturer must be informed of any default or nonconformity of the product before its installation. Its responsibility is limited to the replacement of the product not-in conformity or defective.
- The conformity to the specifications is based on a confidence level of 95% within a lot.

- Texel products are manufactured in Quebec since 1967 and are controlled by a certified quality service.

Please consult our technical representative for more information on Texel Geosol products and the projects carried out for more than 45 years with Texel Geosol's geosynthetics.

For our cutting and sewing services at our warehouse or on your jobsite, please consult our representatives.

distributed by:

Texel GEOSOL

Certified ISO 9001 : 2008

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