

Appendix A

Functional Design Report



Manitoba Hydro

Laurie River Generating Stations I and II Wastewater Treatment System Upgrade Functional Design Report

Prepared by:

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Project Number:

60265529.400

Date:

December, 2012





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December 19, 2012

Trevor Ouellette, P.Eng. Manitoba Hydro, Power Projects Department Engineering Services Division 360 Portage Avenue, 20th Floor Winnipeg, MB R3C 2P4

Dear Mr. Ouellette:

Project No: 60265529.400

Regarding: Laurie River Generating Stations I and II Wastewater Treatment System Upgrade Functional Design Report

The Functional Design Report for the Laurie River Generating Station I and II Wastewater Treatment System Upgrade is provided in the attached document. If you would like to discuss the document in person please call and we can arrange a meeting.

Sincerely, AECOM Canada Ltd.

arel Barso

Paul Barsalou, M.Sc.,P.Eng. Project Manager Paul.barsalou@aecom.com Encl. PB:td

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1. Introduction

1.1 Scope

Functional design and subsequent detailed work is underway for upgrades to the sewer and water services at the Laurie River Generation Stations I & II (GS1 and GS2) and the main camp adjacent to GS1. The work will include new sewer and water piping within the camp as well as a new wastewater lift station, forcemain and lagoon. Upgrading the two Generating Stations with bathroom facilities will also be important components in the project. The facility is to be commissioned by the fall of 2013.

1.2 Work Completed

In mid 2012, a visit was completed to collect information at the Laurie River sites. The following work was carried out as part of this functional design:

- Topographical Survey A detailed topographical survey helped identify all relevant features of the site including: existing roads, buildings, hydro lines and telephone lines, existing culverts, ditches or drainage courses, tree lines etc.
- Topographic maps have been developed showing the site and the proposed works.
- The proposed outfall route was traced through a natural drainage path and out to the receiving stream, downstream of GS1.
- Local bench marks were identified for a GPS survey which will be used during construction.
- The GPS survey picked up the location and elevation of areas around the lagoon and forcemain.
- The Environment Act Proposal is being completed based on the current functional design and upon information collected during the site visit.
- Photographs of the site were taken, with a focus on the proposed lagoon outfall route.
- All of the buildings were entered and the sewer and water lines were located. The services will be replaced, in addition to the main lines.

1.3 Design Codes and Criteria

The site redevelopment work is following current Manitoba practices including:

- Separation of sewer and watermains by 3 m horizontally.
- Sizing of sewer and water piping for domestic consumption.
- Fire water supply lines into the community will be provided as 150 mm, however, Manitoba Hydro is independently completing all work on the Fire Pumping system and the flow requirement estimates.
- The lagoon is being designed to produce high quality effluent similar to that recently licensed at the Keewatinoow Camp Lagoon.
- An Environment Act Proposal will be forwarded to Manitoba Conservation regarding the proposed development to obtain a licence.
- An application will be completed during detailed design to allow Manitoba Conservation to designate the operator level requirement for the lagoon and wastewater collection system.
- The site is in a remote location with cold weather. The systems will be designed specifically for the site conditions including items such as: dual heat tracing, recirculation systems, and insulation.

- A work permit application has been submitted to Manitoba Conservation for clearfelling, piling and burning.
- A land purchase application has been issue for the development area through Manitoba Hydro.
- This is a private access location that is not open to the public.

1.4 Location

Laurie River Generating Stations I and II are located on Laurie River approximately 64 km south of Lynn Lake in northwestern Manitoba. A location plan is provided in Appendix D.

2. Geotechnical Summary

2.1 Initial Site Assessment

The Conceptual Design Report, prepared by AECOM, recommended construction of a lift station and facultative lagoon at the Laurie River GS I camp. Further to this conceptual design report, the technical memorandum prepared in March 2011, provided preliminary lagoon sizing and preliminary construction estimates for a clay liner lagoon and a membrane lined lagoon.

A geotechnical report was submitted by AECOM to Manitoba Hydro in February 2011. It determined that there was ample clay to create a clay lined lagoon that will meet the provincial requirements of 1×10^{-7} cm/s. The clay would need to be excavated and re-worked to provide the required hydraulic conductivity. A synthetic liner was another option reviewed in the March 2011 technical memorandum. The cost difference between the two options was minimal as the majority of the cost for either option was mobilization. A clay lined lagoon was selected based on the long term durability and increased ease of future desludging. The February 2011 geotechnical report is included in **Appendix A**.

The clay required for construction will come from within the footprint of the lagoon and perimeter ditching, so additional borrow area will not be required for liner material.

2.2 Design Review by Geotechnical

The design underwent a geotechnical review because one of the berms was 3.5 m high. This is higher than the 3.0 m height recommended in the initial siting assessment. The high berm was included to accommodate the slope running across the site and the shallow bedrock. A review of the berm stability showed that the design has a good factor of safety and that there are no geotechnical concerns. A copy of the report is provided in **Appendix B**.

3. Wastewater Generation Estimates

A previous report, "Laurie River Generating Stations I & II, Wastewater System Final Conceptual Design Report - Summary" was prepared for Manitoba Hydro in March 2010 by AECOM. The population from the report was recently reassessed and increased from the original estimate. The main reason for the increase is recent experience in other Manitoba Hydro camps. It has been noted recently that the presence of a camp kitchen contributes more significantly to the wastewater flows being generated in the camp than originally estimated. Also, there is always some leaking in buildings that are unoccupied. A higher per capita flow rate was included for the kitchen at low occupancy in the camp to account for the base water consumption.

The design population is assumed to be 20 people for six months of the year and 5 people for six months of the year. **Table 1** breaks down the various wastewater flows to the lagoon based on the populations during each 6 month period. All wastewater flows from the two Laurie River Generation Stations will be trucked to the lagoon and the camp will be piped.

An allowance of 20% of additional process water flows has been included to account for an upgraded water treatment plant in the future.

Six Months (182 Days)						
Flow	Flow (Lpcd)	Population	Daily Flow (L/d)	Total Hydraulic Volume (L) Over 182 Days		
Population	250	20	5,000	910,000		
Kitchen Waste	100	20	2,000	364,000		
Truck Waste			100	18,200		
Water Treatment Plant Reject (assume 20%)			1,420	258,440		
		:	Sub-Total	1,550,640 L		
	Six Mor	ths (183 days	5)			
Flow	Flow (Lpcd)	Population	Flow (L/d)	Total Hydraulic Volume (L) Over 183 Days		
Population	250	5	1,250	228,750		
Kitchen Waste	200	5	1,000	183,000		
Truck Waste			100	18,300		
Water Treatment Plant Reject (assume 20%)			470	86,010		
Sub-Total 516,060 L						
2,066,700 L/yr Use 2,067,000 L/yr Total Or 2067 m³/yr						

Table 1: Annual Flow Distribution

Note:

1. No value for infiltration has been estimated as the piping will be all new.

4. Application to Province for Borrow Material

The site footprint will provide enough clay for construction of the lagoon. Clay will come from within the cell for re-compaction, and from the perimeter ditching. No application will be completed for clay borrow as it will be from the area being developed. Clay material will be reworked to form the liner.

Manitoba Hydro is currently preparing a new granulary quary development near Laurie River 2 Station. It is believed that this quarry will be in operation for June, 2013. The proposed new quarry location is given below.

NW Corner:	56 14 47N	101 8 18W
NE Corner:	56 14 41N	101 7 54W
SW Corner:	56 14 20N	101 8 34W
SE Corner:	56 14 20N	101 8 14W

A second site may also be used as a quarry, however, it is further away from the worksite and is not preferred. The site is identified as 18 kilometers away from the side towards the air field. It is unknown whether this site has ever been permitted, however it has historically been used as an aggregate source and has already been cleared.

As a backup, an application will be forwarded to the Province for use of approximately 700 m³ of granular materials at this existing second borrow. It has granular material that can be used for both road construction and pipe bedding. Some aggregate screening work will be required.

Approximately 100m³ of material is already stockpiled at the camp from previous works. This granular will be used first prior to use of borrow materials.

5. Lagoon Design

5.1 Lagoon Sizing

Due to the northern location of this lagoon, it is recommended that the primary cell be sized based on the *Federal Guidelines* for organic loading of 22 kg BOD/ha/day. *Provincial Guidelines* limit the amount of organic loading to 56 kg BOD/ha/day assuming an influent BOD loading rate of 0.076 kg BOD/person/day. By using the Federal guidelines, the primary cell will be larger but will also allow for increased primary treatment during the colder months. Further calculations make the actual size of the primary cell larger than the original design due to physical constructability in the field.

The organic loading is provided below:

•	Per capita loading	0.076 kg BOD / capita / day
•	Loading during 5 person period	0.38 kg BOD / day
•	Loading during 20 person period	1.52 kg BOD / day
•	Average loading	0.95 kg BOD / day
Pri	mary Cell Sizing	
•	Maximum design loading rate	22 kg BOD / hectare / day
•	Surface area required during average flow period	
	• 0.95 kg BOD / 22 *10,000m ² /hectare	432 m ² of surface area
•	Surface area required during maximum flow period	
	 1.52 kg BOD / 22 *10,000m²/hectare 	691 m ² of surface area

Although the primary cell area was calculated based on loading, a larger cell was selected based on physical constructability using heavy machinery.

Detailed calculations for the lagoon sizing are included in **Appendix C.** The primary and secondary cells are sized with the following characteristics:

- Liquid depth of primary and secondary cells 1.5 m
- Freeboard of 1 m
- Dike slope of 4:1
- Primary cell storage half of total cell volume
- Secondary cell storage top 1.2 m of 1.5 m depth
- Common berm width 3 m
- Perimeter berm width 3 m

The primary cell calculations result in the following dimensions:

• Volume (entire cell to 1.5 m depth)

747 m³

Storage Volume (½ volume of cell)	374 m ³
• Surface area not including freeboard (greater than 691 m ² for max flow)	819 m ²
The secondary cell size is:	
Total Volume of secondary cell	2,070 m ³
Total Storage volume (top 1.2 m)	1,759 m ³
Sludge Storage at bottom 0.3 m of cell	311 m ³
Surface area (not including 1 m freeboard)	1,848 m ²
 Total Storage volume (primary and secondary) 	
• 374 m ³ + 1759 m ³ (greater than the 2067 m ³ required)	2,133 m ³
Cell dimensions, based on the above calculations are as follows:	
Primary Cell area (inside top of berm)	1,375 m ²
 Secondary Cell Dimensions (inside top of berm) = 50 x 52 = 	2,600 m ²
 Total Lagoon Dimensions (including outside berms) = 56 x 88.5 = 	$4.956 \mathrm{m}^2$

Total Lagoon Dimensions (including outside berms) = $56 \times 88.5 =$

The area required for clearing and the design of the lagoon are presented in drawings within Appendix D.

5.2 Outfall

The outfall for the lagoon will be located near the northeast corner of the secondary cell. The outfall will consist of a 200 mm diameter HDPE pipeline that will drain the secondary cell into the drainage ditch, into a wetland area and subsequently to Laurie River via existing natural drainage channels. The outfall pipeline is approximately 50 m in length and will empty onto a rip-rap spillway pad, which will direct effluent into the natural drainage route. The drainage route will be cleared a distance of approximately 200 meters as it flows to the wetland area. The outfall will be sized to drain within a one week period, however with valves, the flow rate will be restricted to allow a "trickle" flow and a three week discharge period. Assuming the secondary cell is drained in 3 weeks the discharge rate will be 55 litres/minute. The discharge route is shown in the drawings within Appendix D.

5.3 **Truck Dump**

Two truck dump locations will be provided; one will be located near the lift station and a backup will be provided at the lagoon. A second dump location is being provided to account for inclement weather.

The lagoon truck dump will be located on the south side of the primary cell. It will consist of a 4 m x 14 m concrete splash pad leading into the lagoon. The lagoon fence will transition from the toe of slope to the top of slope in this area. A gate will be constructed with steel bars for the lower half which will allow sewage to pass through, permitting dumping without requiring the gate to be opened.

The primary truck dump will be the manhole located before the main lift station. The top of the manhole will have a 150 mm opening and a 75 mm camlock fitting for the operator to dispose of waste through. In winter this will be the main disposal location used.

5.4 Fencing

A chain link fence with a height of 1.8 m will be located at the toe of the dyke on both the primary cell and secondary cell. This fence will provide security against wildlife and potential vandalism as well as provide a measure of safety for people.

5.5 Phosphorus Control

Two methods of phosphorus reduction were examined closely for the project, including alum dosing and natural plant uptake.

5.5.1 Alum Dosing

Phosphorus removal (to below 1 mg/L) can be achieved by dosing with aluminum sulphate commonly known as alum. The precipitation method for phosphorus removal involves spraying concentrated alum onto the wastewater in the secondary cell and mixing the wastewater with an outboard motor boat in a grid like pattern. The phosphorus combines with the alum, forming a floc which precipitates to the bottom of the cell, contributing to the sludge bed accumulation. The chemical dosing application occurs approximately one week prior to lagoon discharge sampling in order to allow for adequate settling of the floc. Grab samples are taken from the effluent for quality testing, prior to discharging the cell to ensure that the License limits have been met. This procedure is a reliable method for phosphorus removal and is currently being used in numerous Manitoban and Ontario wastewater lagoons. Alum dose rates can vary from 50 mg/L to 175 mg/L and will vary based on water chemistry.

Personal protective equipment (PPE) is required for all operators during alum dosing. This includes Tyvek suits, facemasks, goggles and gloves. A first aid kit, complete with fresh water should always be nearby. Once all spraying is complete, all pumps, tanks, boat and motor and PPE need to be flushed with clean water, following Manitoba Hydro procedures. Discharge of the lagoon can occur once the allowable phosphorus level of 1 mg/L is shown on the laboratory samples.

This option of alum precipitation is effective but it is difficult in remote areas such as Laurie River. Items of significant concern include:

- Danger to the operator during application of alum and difficult plane access in case of emergency.
- Difficulty in transporting alum to the remote location

For these reasons, the option of alum precipation has not been recommended.

5.5.2 Natural Plant Uptake of Phosphorus

The discharge route is approximately 700 m in length, including flowing through a natural wetland area immediately prior to discharge. Phosphorus will be drawn out of solution along this drainage route by soil adsorption as well as plant uptake. It is anticipated that phosphorus levels will be below 3 mg/l when discharged and less than 1 mg/L prior to entering the receiving stream.

The option of natural phosphorus removal through a trickle discharge and natural plant uptake was selected over alum precipitation. Without the addition of alum, the sludge build up in the lagoon will be slower as well. This will extend the time required between lagoon desludging periods.

5.5.3 Phosphorus Control Recommendation

It is recommended that the natural phosphorus removal process be followed, primarily due to the potential hazards surrounding alum use and the long discharge route. It is believed that phosphorus will be

removed from solution over this discharge route, such that the effluent will have less than 1 mg/L of phosphorus.

Water samples can be collected as a baseline in the wet lands area, prior to commissioning and discharge of the lagoon to help confirm that phosphorus is being removed. It is also recommended that the discharge route vegetation be cut and removed every 5 to 10 year period to allow new vegetation to grow and uptake the phosphorus from the effluent.

5.6 Discharge

Effluent will not be discharged between the 1st day of November of any year and the 15th day of June the following year. The proposed wastewater treatment lagoon effluent will be discharged through a 50 m outfall onto a 10 m long riprap spillway. The effluent will then flow along approximately 200 m of drainage channel, and then 500 m of natural wetland and out to the receiving stream. A drawing showing the discharge route is provided in **Appendix D**.

Assuming the total 1,678m³ of wastewater is discharged from the secondary cell over a 3 week period, the total instantaneous discharge rate will be 55 L/minute or 3.3 m³/hour. The second step in discharging the lagoon includes release of half of the primary cell (389m³) to the secondary cell, which is then retested prior to discharge. As this volume of treated wastewater is significantly lower than the secondary cell, it will not exceed the 55 L/minute noted in the initial discharge of the secondary cell.

5.7 Sludge Disposal

This lagoon has been designed with low loading rates and a full 1 year of storage. For this reason, sludge buildup will be slow. It is anticipated that the sludge will not need to be removed for 25 years. At year 15, work should be done to confirm this estimate with completion of a sludge survey.

It is anticipated that the sludge will be dewatered in the future using large sludge filter bags (Geo Bags). With this method, lagoon sludge will be combined with a dewatering polymer and then pumped directly into a filter bag which retains the solids while allowing water to pass through small openings in the bag. The bag will be allowed to sit on the internal dyke of the lagoon, in the freeboard zone so that all free liquid drains back to the lagoon cells. After an estimated 6 month period, the retained material will be cut open and the sludge will be transported to an approved permitted landfill by truck and or rail. A separate licence will be required for the disposal of the sludge in the existing landfill or other location.

5.8 Lagoon Access Road

An access road is required to service the proposed lagoon site. The access road will be 6 m wide and its cross section will consist of compacted subgrade and a pit run gravel travel surface.

A perimeter access road will be installed on top of the berms for vehicle access. Pit run gravel wil also be used for this traffic surface.

6. Wastewater Lagoon Effluent Quality

The wastewater treatment lagoon has been designed to treat effluent to meet the effluent discharge limits as outlined in **Table 2**.

Parameter	Value			
TP ⁽¹⁾	1 mg/L			
BOD ₅	25 mg/L			
TSS	25 mg/L (excluding growing algae)			
Fecal Coliform	200 / 100mL			
Total Coliform	1,500 / 100mL			

Table 2: Anticipated Effluent Limits

Note: (1): Anticipated phosphorus level following natural uptake in drainage channel.

It is anticipated that at the time of discharge the effluent will have the following characteristics:

- 10 mg/L ammonia;
- 10 mg/L organic nitrogen;
- 1 mg/L nitrates;
- 20 mg/L total Kjeldahl nitrogen (TKN); and
- pH of 7-9.

The wastewater lagoon is designed for one year of storage and the primary cell is designed for a low loading rate. At times when there is limited camp activity during the year, the population will be lower and the lagoon may only partially fill, with an equivalent of significantly more than one year of storage. During these low use periods, the effluent quality will be better than noted. A yearly discharge will be encouraged at the facility so that the operators remain knowledgeable, even if only a portion of the lagoon contents are released.

7. Piping

7.1 General

The scope of this project focuses on wastewater collection and treatment; however; the potable water piping will also be replaced. Piping will be installed at a depth of 2.0 to 1.0 m, which will not consistently be below frost depth. Shallow bury was selected, as there is limited overburden and deep bury would require significant blasting. To mitigate freezing, all pipes will be insulated and heat traced. The components being replaced are discussed in the following sections. The site plans showing piping are given in **Appendix D**.

7.2 Raw Water Line

The raw water line will be replaced as it exits GS#1 – extending from the Station, across the exterior of the Station Dam Structure, through the camp and back to the GS where it enters the Station. This line will be looped, insulated and heat traced to reduce freezing potential. HDPE pipe is proposed as it is resilient and it can be thawed if it becomes frozen. Double heat tracing will be installed even though only one line will be energized. This will allow for an easy switch over to backup heat tracing incase the primary heat tracing stops working during winter conditions. Conventional hydrants will be placed on the raw water line.

7.3 Treated Water Line

At present, water treatment consists of chlorination at GS#1. In the future it is anticipated that the existing system will be replaced with a treatment plant adjacent to the main garage. To reduce future piping installation, a new looped, insulated and heat traced treated water line will be installed on site. The chlorinated water will be conveyed through this piping in the short term, until the new treatment plant is designed and constructed. When it is constructed, some site tie-in work will be required. Manitoba Hydro will be responsible for updating the fire pumping system in GS#1 and for confirming fire flows. It should be noted that although this project will replace the fire hydrants, the flow may not meet requirements until the Fire Pump system is upgraded.

As the water plant will not be installed right away, part of the newly installed watermains will be left dormant and isolated by valves for future use.

7.4 Gravity Sewer Piping

The main gravity sewer, running parallel to the main road, collects wastewater from the buildings and currently flows down hill towards the existing wastewater treatment facility (towards GS#1). The future gravity collection line will be directed away from the GS and a new lift station will be provided near the maintenance garage. The 150 mm gravity sewer piping will be HDPE, insulated and heat traced.

7.5 Forcemain Piping

Forcemain piping will be installed between the lift station and the lagoon site. Pipe will be HDPE and 75 mm in diameter. Insulation and heat tracing will be used on this line as well. It will be installed at approximately 1.8 m bury due to shallow bedrock. No air releases will be required.

7.6 Holding Tank Wastewater Hauling Removal GS#1

A short, 50 m long, forcemain will be installed at GS#1 so that wastewater can be removed from the small holding tank located in the Station. The forcemain will be 38 mm in diameter and will be both heat traced and insulated. It is required for pumping the Station holding tank contents to a hauling truck at the top of

the hill. It is not practical to back the hauling truck down the slope, adjacent to the Station due to frequent poor weather conditions and a steep access road. The short forcemain will be a combination of exposed and shallow buried installation. If possible, granular material will be mounded over the pipe to provide a degree of insulation.

The pumpout forcemain will terminate at the top of the hill in a locked camlock box. The box will be made of aluminum and will be approximately 300 mm by 300 m by 300 m.

7.7 Holding Tank Wastewater Hauling Removal GS#2

There will be no inground piping installed at GS#2. Wastewater will be hauled from the station holding tank located in the building and transferred to a hauling truck using a portable septic tank hose.

7.8 Truck Hauling of Wastewater

A trailer will be provided for hauling the wastewater. It will be fitted with an insulated 2 m³ tank with piped connections.

8. Services at Generating Station #1

Wastewater will be generated at GS 1. At present in the existing bathroom, the water fixtures have been disconnected and there is currently a composting toilet. This system will be replaced with the following works:

- Remove composting toilet.
- Install new toilet and reconnect bathroom sink to station untreated water supply system
- Provide a sign saying "Non-Potable Water Do not Drink".
- Reroute piping for the existing bathroom to a new enclosed holding tank lift station within the Generating Station.
- A self enclosed lift station is proposed, such as the Environment -1 units, as they are designed for low flow and high head and they are 120 volt.
- The lift station will be vented to the exterior and will have float controls. A high level alarm light will turn on when it is time to empty the system. The operator can plan to empty it every week or two.
- Due to the low water usage at the GS it is not practical to pipe potable water back to the Station from the camp and it is not practical to pump wastewater up the hill into the main camp wastewater system.

9. Services at Generating Station #2

Wastewater will be generated at GS#2. At present in the existing bathroom, the water fixtures have been disconnected and there is currently a composting toilet. This system will be replaced with the following works:

- Remove composting toilet.
- Install new toilet, shower and sink.
- Provide a sign saying "Non-Potable Water Do not Drink"
- Reroute piping for the modified bathroom to a new enclosed holding tank lift station within the Generating Station.
- A self enclosed lift station is proposed, such as the Environment -1 units, as they are designed for low flow and high head and they are 120 volt.
- The lift station will be vented to the exterior and will have float controls. A high level alarm light will turn on when it is time to empty the system. The operator can plan to empty it every week or two.
- The GS is very isolated so sewer and water services cannot be piped to the main camp.
- Install false floor under the new toilet area.
- Install a new booster pump complete with pressure tank to boost bathroom water pressure from approximately 13 psi to a range of 40 to 60 psi.
- Replace hot water tank with smaller 20 litre tank and suspend from wall.

10. Main Lift Station

A lift station will be used to transfer the wastewater collected in the gravity sewer mains out to the lagoon site. A concrete barrel duplex pump lift station will be used, complete with insulation and a heated head space. There will be a concrete lid will access ports for pump removal and repairs. Isolation and check valves will be provided on each pump. The control panel will be mounted on two 100 mm pressure treated posts. Power will be provided from the control panel for external equipment operation.

An all weather tent will be supplied for set up over the lift station in the event that maintenance needs to performed in poor weather.

11. Site Plans

The lagoon area and piping system site plans are presented in Appendix D.

12. Provincial Classification

An application will be made to Manitoba Conservation to classify the wastewater treatment and collection facility. It is anticipated that the lagoon will be classified as a small or Class 1 system, however this will only be determined once an application (typically at the end of design) has been submitted. The collection system will likely be listed as a small or Class 1 system as well.

13. Anticipated Operation and Maintenance

Maintenance activities will be required as noted below:

- Maintain fence and gate to keep animals out;
- Maintain the lift station;
- Maintain valves;
- Maintaining even grass cover on dykes, and mowing so that growth is less than 0.3 m in height;
- Removing all reeds, rushes and trees within the lagoon and on the dykes to below the low water line;
- Maintaining the discharge route and pipeline to allow proper drainage;
- Maintaining a program to prevent and remove burrowing animals;
- Maintaining the access road into the lagoon area; and
- Visually inspecting the interconnecting piping between the cells.

Site staff will have a schedule for significant maintenance periods and should be able to anticipate when a significant population is coming to site. If there are no plans for significant activity, the staff may choose to only discharge half of the lagoon in the fall, so that there is more water cover over the pipes and it is less likely to freeze.

14. Proposed Construction Schedule

The two main constraints at the site are that heavy equipment must be transported by train and the construction window is relatively short due to weather. Keeping this in mind, the anticipated schedule is provided below:

- Functional Design Completion December, 2012
- Environment Act Proposal Submission based on Functional design December, 2012
- Complete Detailed Design January, 2012
- Obtain Licence March, 2013
- Tender Construction Project February, 2013
- Mandatory Site Visit for contractors February, 2013
- Award Project April, 2013
- Construction Work May to September, 2013
- Confirmatory Liner Testing August, 2013
- Remove Construction Equipment September, 2013

15. Class C Cost Estimate

A mandatory site visit will be held on site, so that interested contractors see the proposed work locations and get a feel for the difficulty of site access. An estimate has been attached below for all aspects of the project including the piping, the lagoon and lift station and servicing the forcemains.

		1	2	3	4
Item	Component	Approx. Quantity	Units	Unit Price	Tender Amount
Α.	MOBILIZATION				
1	Mobilization and Demobilization	1.0	L.S.	\$200,000.00	\$200,000.00
	SUBTOTAL "A"				\$200,000.00
В.	WASTEWATER COLLECTION				
1	Supply and Install 200 mm SDR 35 PVC Wastewater Sewer, Separate Trench				
	a) Class 4 Backfill	170.0	М	\$250.00	\$42,500.00
2	Supply and Install SDR 35 PVC Wastewater Sewer Fittings				
	a) 200x100 mm Tee	9.0	Each	\$1,500.00	\$13,500.00
3	Supply and Install 1200 mm Manhole, c/w Frame and Cover	8.0	vt.m.	\$3,750.00	\$30,000.00
4	Supply and Install Truck Dump Manhole, Complete	1.0	Each	\$20,000.00	\$20,000.00
5	Bathroom Retrofit				
	a) Generating Station 1 (GS #1)	1.0	L.S.	\$10,000.00	\$10,000.00
	b) Generating Station 2 (GS #2)	1.0	L.S.	\$30,000.00	\$30,000.00
6	Associated Trenching - Wastewater Sewer	170.0	m	\$200.00	\$34,000.00
7	Associated Excavation – Manholes	3.0	Each	\$1,500.00	\$4,500.00
8	Associated Excavation - Truck Dump Manhole	1.0	Each	\$4,000.00	\$4,000.00
	SUBTOTAL "B"				\$189,500.00
C.	LIFT STATION AND FORCEMAIN				
1	Supply and Install Lift Station, Complete				
	a) Lift Station #1	1.0	L.S.	\$200,000.00	\$200,000.00
	b) Grinder Pump (GS #1)	1.0	L.S.	\$10,000.00	\$10,000.00
	c) Grinder Pump (GS #2)	1.0	L.S.	\$10,000.00	\$10,000.00
2	Supply and Install 75 mm DR 17 HDPE Forcemain, Separate Trench, Pre-Insulated				

Table 3: Cost Estimate for Clay Lined Lagoon

		1	2	3	4
Item	Component	Approx. Quantity	Units	Unit Price	Tender Amount
	a) Class 4 Backfill	210.0	М	\$200.00	\$42,000.00
3	Supply and Install 100 mm DR 17 HDPE Forcemain, Separate Trench, Pre-Insulated				
	a) Class 4 Backfill	40.0	М	\$200.00	\$8,000.00
4	Connection to Existing GS #1	1.0	Each	\$2,000.00	
5	Associated Trenching – Forcemain	260.0	М	\$200.00	\$52,000.00
6	Associated Excavation - Lift Station	1.0	Each	\$10,000.00	\$10,000.00
	SUBTOTAL "C"				\$332,000.00
D.	WATERMAIN				
1	Supply and Install 50 mm DR 11 HDPE Watermain, Heat Traced, Pre-Insulated				
	a) 50 mm Supply, Common Trench, Class 4 Backfill	145.0	М	\$100.00	\$14,500.00
	b) 50 mm Return, Common Trench, Class 4 Backfill	160.0	М	\$100.00	\$16,000.00
2	Supply and Install 150 mm DR 9 HDPE Raw Water Supply Line, Pre-Insulated, Heat Traced				
	a) Common Trench, Class 4 Backfill	140.0	М	\$100.00	\$14,000.00
	b) Surface, Anchored to Wall	115.0	М	\$500.00	\$57,500.00
3	Supply and Install 50 mm DR 11 HDPE Raw Water Return Line, Pre-Insulated, Heat Traced				
	a) Common Trench, Class 4 Backfill	140.0	М	\$150.00	\$21,000.00
	b) Surface, Anchored to Wall	115.0	М	\$400.00	\$46,000.00
4	Supply and Install HDPE Water Line Fittings, Pre-Insulated				
	a) 150 mm 45 deg Bend	2.0	Each	\$2,000.00	\$4,000.00
	b) 150 mm 90 deg Bend	1.0	Each	\$2,000.00	\$2,000.00
	c) 50 mm plug	2.0	Each	\$2,000.00	\$4,000.00
	d) 150 mm Blind Flange	1.0	Each	\$2,000.00	\$2,000.00
5	Supply and Install Gate Valve c/w Valve Box, Pre-Insulated				
	a) 150 mm	2.0	Each	\$5,000.00	\$10,000.00
6	Supply and Install Curb Stop c/w Valve Box, Pre- Insulated				
	a) 50 mm	4.0	Each	\$2,500.00	\$10,000.00
7	Supply and Install 150 mm On-line Hydrant	4.0	Each	\$15,000.00	\$60,000.00

		1	2	3	4
Item	Component	Approx. Quantity	Units	Unit Price	Tender Amount
	Assembly, Pre-Insulated				
8	Supply and Install Thermostatic Heat Trace Controller and Sensors	2.0	Each	\$5,000.00	\$10,000.00
9	Associated Trenching – Watermains	585.0	М	\$100.00	\$58,500.00
	SUBTOTAL "D"				\$329,500.00
E.	SERVICE CONNECTIONS				
1	Supply and Install HDPE Water Service c/w Pre- Insulated, Heat Traced				
	a) 25 mm, Class 4 Backfill	150.0	М	\$150.00	\$22,500.00
2	Supply and Install Electrofusion Tee, Pre- Insulated				
	a) 25 mm	9.0	Each	\$2,000.00	\$18,000.00
3	Supply and Install Curb Stop c/w Valve Box, Pre- Insulated				
	a) 25 mm	9.0	Each	\$3,000.00	\$27,000.00
4	Heat Trace Thermostatic Controller and Sensors - Water Services				
	a) Supply Complete Unit and Install Sensors	9.0	Each	\$2,000.00	\$18,000.00
5	Supply and Install 150 mm SDR 35 PVC Sewer Service, Pre-Insulated				
	a) Class 4 Backfill	130.0	М	\$200.00	\$26,000.00
6	Building Service Connection – Water	9.0	Each	\$4,000.00	\$36,000.00
7	Building Service Connection - Wastewater Sewer	9.0	Each	\$4,000.00	\$36,000.00
8	Associated Trenching – Services	280.0	М	\$200.00	\$56,000.00
	SUBTOTAL "E"				\$239,500.00
F.	LAGOON AND RELATED WORKS				
1	Composite Excavation				
	a) Roads	2,000.0	cu.m.	\$12.00	\$24,000.00
	b) Lagoon	10,000.0	cu.m.	\$12.00	\$120,000.00
2	Supply and Install Granular Base Course, Class				
	a) Roads	150.0	cu.m.	\$75.00	\$11,250.00
	b) Lagoon	150.0	cu.m.	\$75.00	\$11,250.00
3	Supply and Install Traffic Gravel, Class "D"	300.0	cu.m.	\$100.00	\$30,000.00
4	Supply and Install Corrugated Steel Culverts				
	a) 600 mm	30.0	М	\$400.00	\$12,000.00
5	Supply and Install Culvert Bedding Gravel	25.0	cu.m.	\$75.00	\$1,875.00

		1	2	3	4
Item	Component	Approx. Quantity	Units	Unit Price	Tender Amount
6	Clearing and Grubbing	2.0	Ha	\$10,000.00	\$20,000.00
7	250 mm PVC SDR 35 Interconnection	23.0	М	\$200.00	\$4,600.00
8	250 mm PVC SDR 35 Overflow	15.0	М	\$200.00	\$3,000.00
9	250 mm PVC SDR 25 Outfall	25.0	М	\$200.00	\$5,000.00
10	Fencing	400.0	М	\$30.00	\$12,000.00
11	Truck Dump	1.0	Each	\$30,000.00	\$30,000.00
12	Wastewater Hauling trailer and Shelter Tent	1	Each	10,000	\$10,000
	SUBTOTAL "F"				\$294,975.00
G.	MISCELLANEOUS				
1	Supply and Install Box Insulation	200.0	М	\$150.00	\$30,000.00
	SUBTOTAL "G"				\$30,000.00
	SUBTOTAL ESTIMATED PRICE				\$1,615,475.00
	10% Contingency				\$161,547.50
	Total Estimated Price				\$1,777,022.50



Appendix A

Geotechnical Report

ΑΞϹΟΜ

AECOM 99 Commerce Drive Winnipeg, MB, Canada R3P 0Y7 www.aecom.com

Memorandum

То	Paul Barsalou	Page 1
СС	Faris Khalil	
Subject	Proposed Laurie River Waste Site Feasibility	ewater Lagoon
From	Jeremy Fiebelkorn	
Date	February 8, 2011	Project Number 60157739 (500)

1. INTRODUCTION

A new wastewater treatment lagoon is being considered to service the Manitoba Hydro Laurie River Generating Station at Laurie River, MB. The size and location of the proposed facility is yet to be finalized, however the intent is to construct the proposed facility east of the existing fire hall. This memorandum summarizes the geotechnical investigation completed by AECOM at the above site. The purpose of the investigation is to assess the subsurface conditions and determine the suitability of the site for construction of the proposed facility.

2. FIELD INVESTIGATION

Twenty eight test pits were excavated on October 22, 2010 by Hartman Construction Ltd. using Komatsu PC220 LC excavator. Ten test pits (TP10-14 to TP10-23) were completed for the proposed tower location and detailed test pit logs have subsequently been submitted. Five test pits (TP10-24 to TP10-28) were completed along the proposed forcemain alignment, three test pits (TP10-01, TP10-02, TP10-13) were completed along two proposed outfall alignments, two test pits (TP10-11, TP10-12) were completed in an area previously identified as a potential clay borrow source, and eight test pits (TP10-03 to TP10-10) were completed within the footprint of the proposed wastewater lagoon. One standpipe piezometer (SP10-07) was installed within the footprint of the proposed facility to monitor groundwater levels.

In addition to the test pit exploration, forty three probe holes were completed using a steel rod to approximately identify the depth to bedrock. Nine probe-holes (TH10-201 to TH10-209) were completed along the initial proposed outfall alignment, twenty six probe-holes (TH10-01 to TH10-15, TH10-101 to TH10-111) were completed along the proposed forcemain alignment, and eight probe-holes (N1 to N8) were completed within the boundaries of the proposed facility. The locations of the test pits and probe-holes are shown on the Test Hole Locations Plan in Figure 01 of Appendix A. The test pits were advanced to the maximum reach of the excavator (approximately 3.0m) or to refusal. General site supervision and test pit logging was provided by AECOM personnel. Disturbed samples were collected at intervals such that moisture contents and material type changes are well represented, and undisturbed Shelby tube samples were collected from within the lagoon footprint.



The soil samples were transported to AECOM's Materials Testing Laboratory in Winnipeg for further visual classification and laboratory testing.

The laboratory testing program consisted of the determination of moisture contents, Atterberg limits, hydrometer analyses, Standard Proctor tests, and flexible wall permeability tests. Detailed logs have been prepared for each test pit to record the description and relative position of the various soil strata, location of samples obtained, field and laboratory test results, and other pertinent information, and are provided in Appendix B. A summary of the depth of bedrock contact in the probe-holes is provided in Appendix C.

3. SUBSURFACE CONDITIONS

3.1 Soil Profile

In descending order, the general soil profile is as follows:

- Topsoil
- Silty Clay (homogeneous and laminated)
- Silt
- Bedrock

These soils are described as follows:

Topsoil

Topsoil less than 200 mm thick was encountered at the ground surface in TP10-01 to TP10-24. The topsoil is generally brown, moist and contains rootlets.

Silty Clay

Silty clay of variable thickness was encountered at ground surface, or beneath the topsoil in all test pit locations. In some locations the clay is brown and homogeneous, in others it is laminated with layers of light brown clayey silt. Generally, the clay is moist and soft to firm. Moisture contents range from 19 to 30 percent with an average value of 27 percent. Atterberg limit tests were completed on representative samples, measured liquid and plastic limits range from 45 to 52 percent and 23 to 24 percent respectively

<u>Silt</u>

Low plasticity silt of variable clay and sand content was encountered in TP10-05 beneath the clay and in TP10-07 near the ground surface beneath the topsoil. The silt was grey in colour, and the moisture content measured 10 percent on a representative sample.

3.2 Groundwater Conditions

No seepage or sloughing was observed during the test pit exploration. SP10-07 was noted to be dry at the time of installation, subsequent piezometer readings should be completed as part of the detailed design phase.



4. GEOTECHNICAL CONSIDERATIONS

4.1 Floor of the Proposed Facility

The proposed site is considered feasible for a clay-lined or a geosynthetic-lined sewage lagoon facility. A clay lined facility may be viable if the floor elevation is selected so that it is underlain by at least 1m thick of soil. In this regard, the depth to bedrock should be considered, among other factors, in the selection of the facility floor elevation.

The provincial guidelines for a clay-lined lagoon are to provide at least 1m thick clay seal having a hydraulic conductivity of 1×10^{-9} m/s underlies the floor and the interior surfaces of the facility. The insitu intermediate to high plastic clays encountered during the test pits exploration were found to have a hydraulic conductivity in the order of 10^{-7} m/s. However the reconstituted clay sample was found to have a hydraulic conductivity in the order of 10^{-10} m/s, results of the flexible wall permeability tests are provided in Appendix D. An effective clay liner can be constructed by excavating, re-working and compacting the readily available clay soil. The clay should be placed in layers not to exceed 300 mm non-compacted thickness at moisture content within 0 and +3 percent of the optimum moisture content and compacted to at least 95 percent Standard Proctor maximum dry density (SPMDD).

If a geosynthetic liner design is selected, the liner should be placed on a 200 mm thick layer of compacted bedding sand. The bedding sand layer should be placed on prepared subgrade. The subgrade preparation consists of re-working and compacting the top 300 mm.

Further design and construction recommendations can be provided once the liner type has been selected.

4.2 Dykes of the Proposed Facility

The subsurface conditions encountered within the outline of the proposed facility is anticipated to provide a suitable foundation for the proposed dykes provided the top 600 mm of the subgrade is excavated, re-placed in layers and compacted to at least 95 percent of SPMDD. The native clay encountered within the designated borrow sources and within the area of the proposed lagoon can be used to construct these dykes. Clay dykes not exceeding 3 m in height can be designed with side slopes not steeper than 4H:1V. Detailed stability analysis is required for slopes greater than 3 m high. The clay should be placed in layers not to exceed 300 mm non-compacted thickness at moisture content within 0 and +3 percent of the optimum moisture content and compacted to at least 95 percent Standard Proctor maximum dry density (SPMDD).

Erosion protection measures will be required on the slope surfaces of the proposed dykes. The exterior slopes can be protected using a suitable vegetation cover. A rip-rap protection layer can be used on the interior slopes to provide protection against rainfall, snowmelt, wave action, or any other erosive actions. Further recommendation can be provided as part of the detailed design phase.



Should you require any further assistance, please do not hesitate to contact the undersigned.

Respectfully submitted,

AECOM Canada Ltd.

R,

Jeremy Fiebelkorn, E.I.T. Geotechnical Engineering,

Reviewed By:

[/]Faris Khalil, P.Eng. Manager, Geotechnical Engineering



Appendix A Figures





AECOM



- TEST HOLE (BEDROCK PROBE-HOLE)
 - 🖶 TEST PIT

TH10-01 375624.210 6232916.080 298.120 TH10-02 375651.540 6232916.080 298.120 TH10-04 375561.540 6232923.300 297.960 TH10-06 375569.870 6232938.300 297.820 TH10-06 375569.900 6232938.310 297.900 TH10-07 375551.760 6232942.600 298.180 TH10-08 375551.920 6232949.370 297.830 TH10-10 375551.920 6232949.370 297.830 TH10-11 375558.970 6232974.220 298.620 TH10-12 375561.920 6232974.220 298.620 TH10-13 375528.500 6232978.970 297.900 TH10-14 375563.960 6232985.110 297.680 TH10-102 375738.490 6232880.790 300.200 TH10-102 375735.500 6232880.700 300.200 TH10-103 37588.470 6232784.300 300.000 TH10-104 375735.500 6232784.300 298.500 TH10	LOCATION	EASTING (m)	NORTHING (m)	ELEVATION (m
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TH10-12 375540.730 6232978.970 298.460 TH10-13 375563.960 6232908.970 298.460 TH10-14 375663.960 6232908.700 297.900 TH10-101 375741.080 6232807.900 300.250 TH10-102 375736.490 6232840.790 300.250 TH10-104 375729.530 6232840.790 300.000 TH10-104 375729.530 6232816.050 299.550 TH10-105 375711.180 6232870.200 298.720 TH10-106 375687.780 6232780.500 298.100 TH10-109 375672.580 6232778.900 297.040 TH10-110 375681.920 6232786.302 300.333 TH10-201 375746.71 6232780.02 297.040 TH10-202 375734.147 6232786.303 301.416 TH10-203 375740.165 6232785.033 301.416 TH10-204 375730.07 6232780.639 301.417 TH10-205 375730.07 6232779.6457 300.6489	TH10-11	375528.070	6232953.910	297.730
ITH10-13 373520-370 62232964.750 298.460 ITH10-14 375563.960 6232935.110 297.680 ITH10-101 375736.490 6232935.110 297.680 ITH10-102 375738.490 6232935.100 300.250 ITH10-101 375729.530 62328280.790 300.200 ITH10-104 375723.500 6232818.400 300.000 ITH10-104 375723.500 6232874.900 300.200 ITH10-106 375711.180 6232818.400 300.000 ITH10-107 375681.420 6232784.300 298.700 ITH10-108 375681.920 6232789.300 297.590 ITH10-101 375681.920 6232786.390 297.640 ITH10-101 375746.71 6232786.359 301.1416 ITH10-202 375743.783 6232786.359 301.1416 ITH10-204 375730.07 6232786.359 301.1416 ITH10-205 375730.07 6232784.837 300.132 ITH10-206 375736.73 6232784.2657 300.489 </td <td>TH10-12</td> <td>375540.730</td> <td>6232974.220</td> <td>298.620</td>	TH10-12	375540.730	6232974.220	298.620
TH10-15 375563.960 6232935.110 297.680 TH10-101 375741.080 6232805.790 300.250 TH10-102 375736.490 6232829.280 300.000 TH10-103 375729.530 6232829.280 300.000 TH10-104 375723.500 6232814.000 300.200 TH10-105 375711.180 6232879.400 298.720 TH10-106 375697.780 6232879.500 298.720 TH10-108 375682.470 6232780.500 298.100 TH10-108 375682.470 6232782.900 296.530 TH10-110 375681.920 6232785.00 296.530 TH10-201 375746.71 6232785.03 301.149 TH10-202 375741.71 6232785.033 301.149 TH10-203 37573.017 6232785.033 301.149 TH10-204 375773.017 6232784.837 300.132 TH10-205 375716.534 6232769.50 292.020 TH10-206 375716.534 6232869.50 292.020 <td< td=""><td>TH10-13</td><td>375659 820</td><td>6232978.970</td><td>298.460</td></td<>	TH10-13	375659 820	6232978.970	298.460
TH10-101 375741.080 6232880.790 300.250 TH10-102 375736.490 6232840.790 300.250 TH10-103 375729.530 6232840.790 300.200 TH10-104 375729.530 6232849.280 300.000 TH10-106 3756711.180 6232818.400 300.070 TH10-106 375677.80 6232879.290 298.500 TH10-107 375682.440 6232784.930 298.100 TH10-109 375672.580 6232789.800 296.530 TH10-101 375674.783 6232780.200 296.530 TH10-201 375746.71 6232785.033 301.149 TH10-202 375740.165 6232776.233 301.149 TH10-204 375730.07 6232776.265 300.689 TH10-206 375771.1534 6232764.637 300.132 TH10-207 375780.701 6232865.140 294.020 TH10-208 375718.534 6232769.657 300.0489 TH10-209 375768.77 6232876.567 300.0382	TH10-15	375563.960	6232935,110	297.680
TH10-102 375736.490 6232840.790 300.200 TH10-103 375729.530 6232829.280 300.000 TH10-104 375723.500 6232818.400 300.000 TH10-104 375723.500 6232818.400 300.000 TH10-105 375711.180 6232816.050 298.720 TH10-107 375688.470 6232780.500 298.700 TH10-109 375672.580 6232780.500 298.100 TH10-109 375672.580 6232786.900 297.640 TH10-110 375681.820 6232786.302 300.333 TH10-202 375743.783 6232786.359 301.416 TH10-203 375730.07 6232770.625 301.331 TH10-204 375773.07 6232770.625 301.337 TH10-207 375723.901 6232764.837 300.638 TH10-208 375718.534 6232779.4837 300.132 TH10-209 375765.411 6232779.455 300.688 TH10-208 375778.839 6232840.510 292.020	TH10-101	375741.080	6232850.790	300.250
TH10-103 375729.530 6232829.280 300.000 TH10-104 375723.500 6232818.400 300.070 TH10-105 375711.180 6232816.050 299.550 TH10-106 375697.780 6232874.930 298.720 TH10-107 375688.440 6232874.930 298.000 TH10-108 375682.470 6232782.240 297.580 TH10-110 375681.920 6232728.00 296.530 TH10-110 375681.920 6232726.900 296.530 TH10-202 375740.165 6232786.03 301.1416 TH10-203 375730.07 6232776.53 301.337 TH10-204 37573.1417 6232784.837 300.132 TH10-205 375730.07 6232764.837 300.132 TH10-206 375718.534 6232784.37 300.132 TH10-208 375718.534 6232865.140 294.020 TP10-01 375678.400 6232864.549 300.132 TP10-02 375783.392 6232846.549 300.392 <t< td=""><td>TH10-102</td><td>375736.490</td><td>6232840.790</td><td>300.200</td></t<>	TH10-102	375736.490	6232840.790	300.200
TH10-104 375723.500 6232816.600 299.550 TH10-106 375697.780 6232816.600 299.550 TH10-106 375697.780 6232816.600 298.720 TH10-107 375688.440 6232794.930 298.000 TH10-108 375682.400 6232739.800 297.040 TH10-110 375682.800 6232726.900 296.630 TH10-201 375746.71 6232788.02 300.353 TH10-202 375740.71 6232786.39 301.416 TH10-203 375740.165 6232776.39 301.416 TH10-204 375730.07 6232776.53 300.432 TH10-206 375710.511 6232761.837 300.1337 TH10-206 375710.511 6232761.925 299.49 TH10-208 375716.534 6232761.925 299.49 TH10-208 375716.534 6232685.50 292.020 TP10-01 375675.400 6232685.440 294.020 TP10-02 37568.77 6232815.674 298.526 TP10	TH10-103	375729.530	6232829.280	300.000
TH10-105 375711.180 6232816.050 299.550 TH10-106 375697.780 6232807.700 298.720 TH10-107 375688.440 6232794.930 298.000 TH10-109 375672.580 6232782.900 297.040 TH10-109 375672.580 6232739.800 296.530 TH10-201 375746.71 6232786.390 296.530 TH10-201 375740.165 6232789.00 296.530 TH10-202 375740.165 6232780.33 301.416 TH10-203 375740.165 6232780.33 301.149 TH10-204 375730.07 6232775.837 300.689 TH10-206 375727.198 6232754.837 300.132 TH10-207 375765.400 62326769.500 292.020 TH10-208 375716.534 6232754.837 300.132 TH10-209 375765.673 6232865.140 294.020 TP10-03 375766.877 6232876.533 300.046 TP10-04 375768.877 6232876.533 300.046 <	TH10-104	375723.500	6232818.400	300.070
IFI10-106 37589/.760 6222079.490 298.720 TH10-107 375688.440 623279.490 298.100 TH10-108 375672.580 6232789.490 298.100 TH10-110 375672.580 6232782.400 297.590 TH10-110 375681.920 6232780.800 297.590 TH10-201 375743.783 6232786.302 300.353 TH10-202 375743.783 6232778.023 301.416 TH10-204 375730.07 6232770.625 301.337 TH10-205 375730.07 6232770.625 301.337 TH10-206 375723.901 6232775.437 300.132 TH10-207 375723.901 6232775.437 300.132 TH10-208 375718.534 6232749.051 298.556 TP10-01 375678.673 6232840.1067 300.382 TP10-02 375783.392 6232841.649 300.122 TP10-03 37578.677 6232845.653 298.223 SP10-07 375878.877 6232845.614 298.223 <	TH10-105	375711.180	6232816.050	299.550
TH10-108 375682-470 6232780.500 288.100 TH10-109 375672.580 6232782.240 297.590 TH10-110 375681.920 6232782.600 296.530 TH10-111 375681.920 6232738.600 296.530 TH10-201 375746.71 6232788.02 300.383 TH10-202 375740.165 6232778.503 301.1416 TH10-203 375740.165 6232779.014 300.491 TH10-204 375730.07 6232770.625 301.337 TH10-205 375730.07 6232770.625 301.337 TH10-206 375721.198 6232764.837 300.132 TH10-208 375718.534 6232751.925 299.49 TH10-208 375718.534 6232805.50 292.020 TP10-01 375675.400 6232806.550 292.020 TP10-02 375697.800 6232806.563 300.346 TP10-03 375793.392 6232806.563 300.300 TP10-04 375793.392 6232806.563 300.322	TH10-100	375688 440	6232704 030	298.720
TH10-109 375672.580 6232762.240 297.940 TH10-110 375681.920 6232739.800 297.940 TH10-111 375682.800 6232728.900 296.530 TH10-201 375746.71 6232788.02 300.353 TH10-201 375746.71 6232786.033 301.416 TH10-202 375741.165 6232776.033 301.149 TH10-204 375774.147 6232779.014 300.491 TH10-206 375773.147 6232776.255 300.689 TH10-206 375772.198 6232754.837 300.132 TH10-207 375706.111 6232754.925 299.49 TH10-209 375706.111 6232764.857 300.0889 TH10-209 375706.111 6232765.102 280.202 TP10-01 375676.870 6232805.102 294.020 TP10-03 375766.873 6232805.102 294.020 TP10-04 375786.877 6232816.574 298.282 TP10-05 375867.877 6232816.574 298.223 <t< td=""><td>TH10-108</td><td>375682 470</td><td>6232780 500</td><td>298.100</td></t<>	TH10-108	375682 470	6232780 500	298.100
TH10-110 375681 920 6232738 800 297.040 TH10-111 375692.890 6232786.900 296.530 TH10-201 375746.71 6232788.02 300.353 TH10-202 375743.783 6232786.399 301.416 TH10-204 375730.07 6232779.014 300.491 TH10-205 375730.07 6232770.625 300.689 TH10-206 375727.198 6232785.037 300.689 TH10-206 375720.301 6232754.837 300.132 TH10-206 375718.534 6232754.837 300.132 TH10-209 375716.511 6232749.051 298.565 TP10-01 375675.400 6232680.1067 300.392 TP10-02 375786.877 6232815.674 294.020 TP10-03 375786.877 6232815.674 298.233 TP10-04 375876.877 6232815.674 298.233 SP10-07 375876.877 6232815.674 298.233 SP10-07 375876.877 6232815.674 298.233	TH10-100	375672.580	6232762.240	297.590
TH10-111 375692.890 6232726.900 226530 TH10-201 375743.783 6232786.02 300.353 TH10-202 375743.783 6232786.399 301.416 TH10-203 375740.165 6232785.033 301.149 TH10-204 375731.417 6232770.625 301.337 TH10-205 375730.07 6232770.625 301.337 TH10-206 375727.198 6232762.657 300.689 TH10-207 375723.901 6232764.837 300.132 TH10-208 375718.534 6232764.837 300.132 TH10-209 375675.400 6232669.550 292.020 TP10-01 375678.400 6232861.407 300.342 TP10-02 375783.392 6232841.057 300.342 TP10-04 375783.392 6232845.543 300.122 TP10-05 375876.877 6232815.674 298.223 SP10-07 375876.877 6232815.674 298.223 SP10-08 375848.232 6232776.833 300.612	TH10-110	375681.920	6232739.800	297.040
TH10-201 375746.71 6232788.02 300.353 TH10-202 375740.165 6232785.359 301.416 TH10-203 375740.165 6232785.353 301.149 TH10-204 375734.147 6232770.014 300.481 TH10-205 375730.07 6232770.25 301.337 TH10-206 375710.514 6232762.657 300.689 TH10-206 375716.534 6232764.837 300.132 TH10-208 375716.511 6232695.50 292.020 TP10-01 375676.400 6232689.50 292.020 TP10-02 375697.880 6232685.50 292.020 TP10-03 375768.673 6232804.649 300.132 TP10-04 375793.92 6232846.549 300.122 TP10-05 375876.877 6232815.674 298.223 SP10-07 375876.877 6232815.674 298.223 SP10-08 37584.877 6232876.140 300.1460 TP10-10 375878.839 6232770.89 300.612 TP10-11<	TH10-111	375692.890	6232726.900	296.530
TH10-202 375743.783 6232786.359 301.416 TH10-203 375740.165 6232785.033 301.149 TH10-204 375730.07 6232779.014 300.491 TH10-205 375730.07 6232770.625 301.337 TH10-206 375727.198 6232762.657 300.689 TH10-207 375723.901 6232754.837 300.132 TH10-208 375718.534 6232751.925 299.49 TH10-209 375705.111 6232769.501 298.556 TP10-01 375676.800 6232689.550 292.020 TP10-03 375768.673 6232869.563 300.122 TP10-04 375780.877 6232815.674 298.223 TP10-05 375681.109 6232815.674 298.223 TP10-06 375868.77 6232815.674 298.223 TP10-07 37587.877 6232815.674 298.233 TP10-08 375848.232 6232879.4632 299.036 TP10-09 375848.232 6232879.4632 299.036 TP	TH10-201	375746.71	6232788.02	300.353
IH10-203 375/40.165 6232/85.033 307.149 TH10-204 375730.07 6232770.625 301.337 TH10-205 375730.07 6232770.625 301.337 TH10-206 375723.901 6232770.625 300.689 TH10-207 375723.901 6232754.837 300.132 TH10-208 375718.534 6232751.925 299.49 TH10-209 375768.673 6232869.550 292.020 TP10-01 375678.673 6232861.067 300.382 TP10-03 375786.873 6232846.549 300.122 TP10-04 375786.877 6232846.549 300.122 TP10-05 375846.877 6232846.543 208.223 SP10-07 375876.877 6232815.674 298.223 SP10-07 375876.877 6232815.674 298.223 SP10-07 375846.232 6232776.832 209.036 TP10-08 375848.232 6232776.832 299.519 TP10-10 375849.230 6232776.832 300.612 TP1	TH10-202	375743.783	6232786.359	301.416
ITI0-204 37573-147 6222779.014 300.431 TH10-205 375730.07 6232776.625 301.337 TH10-206 375727.198 6232762.657 300.689 TH10-207 375723.901 6232762.657 300.689 TH10-208 375716.534 6232764.257 299.49 TH10-209 375705.111 6232769.257 299.49 TH10-201 375675.400 6232695.550 292.020 TP10-01 375676.673 6232695.550 292.020 TP10-04 375793.921 6232695.550 292.020 TP10-04 375793.392 6232695.563 300.346 TP10-04 375793.392 6232846.549 300.122 TP10-05 375841.109 6232876.533 300.461 TP10-06 375876.877 6232815.674 298.223 SP10-07 375876.877 6232876.163 300.412 TP10-08 375848.329 6232769.148 299.519 TP10-10 37580.477 6232864.10 301.460 TP10-1	TH10-203	3/5/40.165	6232785.033	301.149
TH10-206 375727.198 6232762.657 300.689 TH10-207 375723.901 6232764.857 300.689 TH10-209 375705.111 6232764.857 300.689 TH10-209 375705.111 6232754.837 300.132 TH10-209 375705.111 6232764.925 299.49 TH10-209 375705.111 6232695.100 292.020 TP10-01 375678.400 6232685.140 294.020 TP10-03 375768.673 6232845.140 294.020 TP10-04 375678.300 6232865.140 294.020 TP10-05 375841.109 6232876.533 300.046 TP10-06 375868.977 6232815.674 298.223 TP10-07 375876.877 6232876.1674 298.223 TP10-08 37581.839 6232777.081 301.460 TP10-10 375787.839 6232876.1674 298.223 TP10-10 375787.839 6232876.8270 296.440 TP10-11 37590.470 6233908.1020 304.020	TH10-204	375730.07	6232779.014	300.491
TH10-207 375723.901 6232754.837 300.132 TH10-208 375718.534 6232754.837 300.132 TH10-209 375718.534 6232749.637 299.49 TH10-209 375705.111 6232749.051 298.566 TP10-01 375676.400 6232689.550 292.020 TP10-02 375678.673 6232680.1067 300.392 TP10-03 375768.673 6232841.573 300.042 TP10-04 375686.932 6232845.563 298.223 TP10-05 375848.877 6232815.674 298.233 SP10-07 375876.877 6232815.674 298.233 SP10-08 375848.232 6232775.083 200.066 TP10-08 375848.232 6232774.632 299.036 TP10-10 375787.839 6232768.270 296.440 TP10-11 375894.500 6233049.500 304.910 TP10-13 37590.907.30 6233049.500 304.020 TP10-14 375781.500 6233008.670 303.700 T	TH10-205	375727 198	6232762 657	300.689
TH10-208 375718.534 6232751.925 299.49 TH10-209 375706.111 6232749.051 226.56 TP10-01 375675.400 6232695.550 229.020 TP10-02 375678.607 6232685.50 229.020 TP10-03 375788.673 6232885.140 224.020 TP10-04 375783.392 6232846.549 300.392 TP10-05 375868.973 6232846.549 300.122 TP10-06 375869.992 6232845.674 298.223 SP10-07 376876.877 6232815.674 298.223 SP10-08 375848.232 6232794.632 299.936 TP10-09 375823.470 6232796.432 299.936 TP10-108 375848.232 6232777.089 300.612 TP10-11 375894.700 6232896.140 301.460 TP10-12 375919.700 6233289.440 297.850 TP10-13 37590.940 6233049.50 304.910 TP10-14 375720.660 6233087.590 304.900 TP10-16 </td <td>TH10-207</td> <td>375723.901</td> <td>6232754.837</td> <td>300.132</td>	TH10-207	375723.901	6232754.837	300.132
TH10-209 375706.111 6232749.051 298.556 TP10-01 375675.400 6232659.500 292.020 TP10-02 375678.673 6232685.140 294.020 TP10-03 375768.673 6232865.140 294.020 TP10-04 375768.673 6232846.549 300.132 TP10-05 375684.109 6232842.563 300.046 TP10-07 375876.877 6232815.674 298.228 TP10-07 375876.877 6232815.674 298.228 TP10-08 375842.322 6232777.089 300.612 TP10-09 37582.320 6232894.632 299.036 TP10-10 37578.839 6232777.089 300.612 TP10-11 37594.500 6232896.140 297.850 TP10-12 375919.700 6232896.140 297.850 TP10-13 37500.470 6233041.020 304.020 TP10-14 37571.600 6233040.500 303.900 TP10-18 37574.020 6233040.20 304.010 TP10-19	TH10-208	375718.534	6232751.925	299.49
TP10-01 375675.400 6232689.550 292.020 TP10-02 375678.673 6232685.140 294.020 TP10-03 375786.673 6232685.140 294.020 TP10-04 375786.673 6232846.549 300.122 TP10-05 375841.109 6232846.543 300.122 TP10-06 375868.977 6232846.533 300.046 TP10-07 375876.877 6232815.674 298.223 SP10-07 375876.877 6232815.674 298.223 TP10-08 375848.232 6232876.1674 298.223 TP10-09 37587.837 6232876.1674 298.223 TP10-01 375787.839 6232876.164 299.036 TP10-10 375787.839 6232876.142 299.136 TP10-11 37590.700 6232859.440 297.850 TP10-13 37590.700 6233081.020 304.020 TP10-14 375710.600 6233008.07.500 303.700 TP10-15 37570.512 6233008.200 304.020 TP10-1	TH10-209	375705.111	6232749.051	298.556
TP10-02 375697.880 6232685.140 294.020 TP10-03 375786.673 6232801.057 300.392 TP10-04 375783.392 6232801.057 300.392 TP10-05 3758481.109 6232876.533 300.46 TP10-06 375868.992 6232845.633 208.828 TP10-07 375876.877 6232815.674 298.223 SP10-07 375876.877 6232815.674 298.223 SP10-07 375848.232 6232794.632 299.90.36 TP10-08 375848.232 6232794.632 299.036 TP10-10 375787.839 6232777.089 300.612 TP10-11 375894.560 6232896.140 301.460 TP10-12 37570.940 6233049.560 304.910 TP10-13 375994.700 6232878.270 296.440 TP10-14 37570.940 6233049.560 304.910 TP10-15 37550.120 6233008.7590 303.700 TP10-16 37558.750 6233008.7590 303.900 TP10-21	TP10-01	375675.400	6232659.550	292.020
IP10-03 375/68.673 6232801.057 300.382 TP10-04 375793.392 6232846.549 300.122 TP10-05 375841.109 6232876.533 300.464 TP10-06 375869.992 6232846.549 300.122 TP10-07 375876.877 6232815.674 298.828 TP10-08 375876.877 6232815.674 298.223 SP10-07 375876.877 6232876.632 299.036 TP10-08 375842.327 6232769.148 299.519 TP10-10 375819.700 6232876.140 301.460 TP10-11 375894.500 6232896.440 297.850 TP10-12 37570.940 6233049.560 304.910 TP10-13 37570.940 6233067.590 304.010 TP10-14 375720.940 6233067.590 304.010 TP10-17 37576.120 6233008.070 303.900 TP10-19 37574.0020 6233008.200 303.900 TP10-21 37564.150 6233008.200 303.900 TP10-23 <td>TP10-02</td> <td>375697.880</td> <td>6232685.140</td> <td>294.020</td>	TP10-02	375697.880	6232685.140	294.020
TP10-04 37578-3322 6222696-333 300.122 TP10-05 375841.109 6232842.563 300.122 TP10-07 375876.877 6232842.563 298.828 TP10-07 375876.877 6232842.563 298.828 TP10-07 375876.877 6232815.674 298.223 TP10-09 375876.877 6232815.674 298.223 TP10-09 375824.232 6232794.632 299.036 TP10-10 375787.839 62322777.089 300.612 TP10-11 375904.730 6232859.440 297.850 TP10-13 375904.730 6233289.400 297.850 TP10-14 375700.940 6233081.020 304.910 TP10-15 37570.0940 6233081.200 304.910 TP10-16 375686.820 6233008.020 303.700 TP10-18 375740.020 6233008.020 303.300 TP10-20 375574.4300 6233001.5800 300.630 TP10-21 375684.500 6233008.020 303.960 TP10	TP10-03	3/5/68.6/3	6232801.057	300.392
TP10-06 375869.992 6232842.563 286.828 TP10-07 375876.877 6232815.674 298.223 SP10-07 375876.877 6232815.674 298.223 TP10-08 375848.232 6232714.632 299.036 TP10-09 37587.837 6232716.081 299.132 TP10-09 375848.232 6232717.089 300.612 TP10-10 375787.839 6232769.148 299.519 TP10-11 375894.560 6232866.140 301.460 TP10-12 375919.700 6232859.440 297.850 TP10-13 375904.730 6232780.827 296.440 TP10-14 37570.660 6233041.020 304.020 TP10-15 37570.120 6233081.020 304.020 TP10-16 37568.520 6233008.070 303.700 TP10-17 375740.020 6233008.070 303.300 TP10-20 37578.750 6232907.940 303.150 TP10-21 37568.120 6233008.090 300.630 TP10-22	TP10-04	375841 109	6232876 533	300.122
TP10-07 375876.877 6232815.674 298.223 SP10-07 375876.877 6232815.674 298.223 SP10-08 375848.232 6232794.632 299.230 TP10-09 375823.470 6232794.632 299.519 TP10-10 375823.470 6232796.432 299.519 TP10-11 375894.560 6232796.432 299.519 TP10-11 375894.560 6232896.140 301.460 TP10-12 375919.700 6232895.440 297.850 TP10-13 37590.940 6233049.560 304.910 TP10-14 375720.660 6233049.560 304.910 TP10-16 375686.820 6233087.590 304.020 TP10-16 375686.820 6233008.070 303.400 TP10-19 375791.560 6233008.070 303.900 TP10-20 375684.150 6233008.00 300.630 TP10-21 375684.150 6233008.00 300.630 TP10-22 375684.150 6233008.00 303.960 TP10-23 <td>TP10-06</td> <td>375869.992</td> <td>6232842.563</td> <td>298.828</td>	TP10-06	375869.992	6232842.563	298.828
SP10-07 375876.877 6232815.674 298.223 TP10-08 375848.232 6232794.632 229.036 TP10-09 375828.3470 6232769.148 299.036 TP10-10 375787.839 6232779.148 299.036 TP10-11 375787.839 6232777.089 300.612 TP10-11 375894.730 6232789.148 299.7850 TP10-12 375919.700 6232859.440 297.850 TP10-13 375904.730 6233248.270 296.440 TP10-15 37570.940 6233049.560 304.910 TP10-15 37570.940 6233049.560 304.020 TP10-16 375791.560 6233087.590 304.010 TP10-18 375791.560 6233087.400 303.150 TP10-20 375784.750 6233030.20 303.360 TP10-21 375684.150 623300.20 303.960 TP10-23 375574.4300 6232887.400 299.000 TP10-24 376677.530 6232887.400 299.380 TP10-25 </td <td>TP10-07</td> <td>375876.877</td> <td>6232815.674</td> <td>298.223</td>	TP10-07	375876.877	6232815.674	298.223
TP10-08 375848.232 6232794.632 299.036 TP10-09 375823.470 6232769.148 299.036 TP10-10 375787.839 6232777.089 300.612 TP10-11 375914.730 6232869.148 299.736 TP10-12 375919.700 6232869.140 297.850 TP10-13 375904.730 6232876.270 296.440 TP10-14 37570.940 6233041.020 304.910 TP10-15 37570.940 6233041.020 304.020 TP10-16 37568.20 6233040.670 303.700 TP10-18 375740.020 6233047.590 303.900 TP10-20 37578.750 6232897.940 303.180 TP10-21 375684.150 6233010.5800 298.4700 TP10-23 375574.4300 6232807.940 303.180 TP10-24 375677.530 6232887.940 303.800 TP10-23 375574.4300 6232887.940 309.830 TP10-24 375677.530 6232887.950 298.4700 TP10-24	SP10-07	375876.877	6232815.674	298.223
TP10-09 375823.470 6232769.148 229.519 TP10-10 375787.839 6232777.069 300.612 TP10-11 375894.560 6232896.140 301.460 TP10-12 375919.700 6232896.140 301.460 TP10-13 375904.730 6232869.440 297.850 TP10-14 375720.660 6233049.560 304.910 TP10-15 375700.940 6233049.560 304.910 TP10-16 375686.820 6233008.7500 303.4020 TP10-17 375756.120 6233008.7500 303.700 TP10-18 375740.602 6233008.670 303.300 TP10-20 37578.750 6233008.202 303.900 TP10-21 375684.150 6233008.090 300.630 TP10-22 375654.150 6233008.090 300.630 TP10-23 375728.490 6232897.500 298.470 TP10-24 375671.500 6232807.500 298.610 TP10-27 375728.490 6232807.500 298.600 TP10-	TP10-08	375848.232	6232794.632	299.036
IPT0-10 375/87.839 6232/77.089 300.612 TP10-11 375894.560 6232896.140 301.460 TP10-12 375919.700 6232896.140 301.460 TP10-13 375904.700 6232896.140 297.850 TP10-14 375700.940 6233049.560 304.910 TP10-15 375700.940 6233018.660 299.000 TP10-16 375686.820 6233018.680 299.000 TP10-17 375701.940 6233018.550 303.900 TP10-18 37571.560 6233008.7590 304.010 TP10-20 375758.750 6233008.670 303.900 TP10-21 375654.150 6233008.090 303.650 TP10-23 375574.4300 6233008.220 303.960 TP10-24 375677.530 6232897.500 298.4700 TP10-25 375691.800 6232892.290 299.000 TP10-26 375710.900 6232895.420 299.380 TP10-27 375725.490 6232897.500 298.610 TP10-	TP10-09	375823.470	6232769.148	299.519
TP10-11 375394.300 6222859.440 297.850 TP10-12 375519.700 6232768.270 296.440 TP10-13 375700.940 6232768.270 296.440 TP10-14 375700.940 6232768.270 296.440 TP10-15 375700.940 6233049.560 304.910 TP10-16 37570.940 6233049.560 304.020 TP10-16 37579.561.20 6233067.590 304.010 TP10-18 37579.560 6233090.670 303.700 TP10-20 37578.750 6233030.20 303.960 TP10-21 375684.300 6233030.20 303.960 TP10-23 375574.4300 6232897.940 303.150 TP10-24 375674.4300 6232807.940 303.360 TP10-23 375574.4300 6232887.500 288.4700 TP10-24 376677.530 6232887.430 299.900 TP10-25 37574.310 6232887.430 299.300 TP10-26 375714.2310 6232887.430 299.900 TP10-2	TP10-10 TP10_11	3/5/8/.839	6232777.089	300.612
TP10-13 375504.730 6232768.270 226.440 TP10-14 375720.660 6233049.500 304.910 TP10-15 375700.940 6233049.500 304.910 TP10-16 375686.820 6233049.200 304.020 TP10-17 37576.120 6233098.1020 304.010 TP10-18 375791.500 6233098.7590 303.900 TP10-19 375740.020 6233098.7590 303.900 TP10-20 37578.750 6223090.670 303.100 TP10-21 375684.150 6233001.5800 298.4700 TP10-23 375674.4300 6232087.900 298.4700 TP10-24 375677.530 6232885.420 299.300 TP10-25 375742.310 6232885.420 299.300 TP10-26 375774.2310 6232887.430 300.330 TP10-27 375774.2310 6232887.430 300.330 TP10-28 375874.2310 6232887.430 300.330 TP10-27 375725.490 6232887.430 300.330 <td< td=""><td>TP10-11 TP10-12</td><td>375919 700</td><td>6232859.140</td><td>297.850</td></td<>	TP10-11 TP10-12	375919 700	6232859.140	297.850
TP10-14 375720.680 6233049.560 304.910 TP10-15 375700.940 6233049.560 304.910 TP10-16 375568.820 623308.680 299.000 TP10-17 375756.120 623309.670 303.700 TP10-18 375740.920 623309.670 303.700 TP10-19 375740.020 623309.670 303.700 TP10-20 37578.750 6232987.940 303.150 TP10-21 375684.150 6233008.020 303.960 TP10-22 375654.150 6233008.090 300.630 TP10-23 375757.500 6232897.500 298.4700 TP10-24 375671.530 6232897.500 298.4700 TP10-25 375691.800 6232892.290 299.000 TP10-26 3757125.490 6232897.500 298.610 TP10-27 375725.490 6232897.500 299.800 TP10-28 375742.310 6232897.530 299.9950 TP10-28 375850.866 6232817.025 298.633 N2	TP10-13	375904,730	6232768.270	296.440
TP10-15 375700.940 6233081.020 304.020 TP10-16 375686.820 6233087.590 304.020 TP10-17 375756.120 6233067.590 304.010 TP10-18 375791.560 6233097.590 304.010 TP10-19 375750.120 6233067.590 303.700 TP10-19 375740.020 6233018.550 303.900 TP10-20 375757.570 6232087.940 303.150 TP10-21 375654.150 6233010.5800 298.4700 TP10-23 375574.4300 6232897.500 298.610 TP10-24 375677.530 6232897.500 298.610 TP10-26 375710.900 6232887.420 299.380 TP10-26 375710.900 6232879.530 299.950 TP10-28 375869.846 6232874.380 300.330 N1 375869.384 6232871.025 298.603 N2 375850.865 6232817.025 298.903 N3 375851.865 6232817.025 298.903 N3 <td< td=""><td>TP10-14</td><td>375720.660</td><td>6233049.560</td><td>304.910</td></td<>	TP10-14	375720.660	6233049.560	304.910
TP10-16 375686.820 6233108.680 299.000 TP10-17 37576.120 6233067.590 304.010 TP10-18 375791.560 6233096.670 303.700 TP10-19 375740.020 6233018.550 303.900 TP10-20 375768.750 6233030.220 303.960 TP10-21 375684.150 6233010.5800 298.4700 TP10-23 375574.300 6232887.500 298.4700 TP10-24 375671.500 6232882.290 299.000 TP10-25 37574.310 6232887.420 299.380 TP10-26 375724.310 6232887.430 209.380 TP10-27 375724.310 6232887.420 299.380 TP10-28 37574.310 6232874.380 300.330 N1 375862.934 6232873.630 299.960 TP10-28 375742.310 6232874.380 300.330 N1 375863.865 6232817.025 298.903 N3 375841.425 6232817.025 298.903 N3 37	TP10-15	375700.940	6233081.020	304.020
I +10-17 375756.120 6233067.590 304.010 TP10-18 375791.560 6233090.670 303.700 TP10-19 375740.020 6233090.670 303.700 TP10-20 37578.750 6223987.940 303.150 TP10-21 37568.750 6233008.090 300.630 TP10-22 375654.150 6233008.090 300.630 TP10-23 375574.4300 6232087.500 298.4700 TP10-24 375671.530 6232897.500 298.610 TP10-25 375725.490 6232887.500 299.000 TP10-26 375725.490 6232887.530 299.900 TP10-27 375725.490 6232807.430 300.330 N1 375862.934 6232807.425 299.980 TP10-28 375742.310 6232807.425 299.980 TP10-28 37584.9425 6232807.425 298.603 N1 375862.934 6232807.361 299.986 N3 375841.425 6232807.361 299.385 N5 3	TP10-16	375686.820	6233108.680	299.000
IP10-18 375/91.560 623308.0670 303.700 TP10-19 375740.020 6233018.550 303.900 TP10-20 375758.750 6232987.940 303.150 TP10-21 375684.150 6233018.550 303.900 TP10-22 376654.150 6233008.090 300.630 TP10-23 375574.4300 6233010.5800 298.4700 TP10-24 375677.530 6232897.500 298.4700 TP10-24 375677.530 6232892.290 299.000 TP10-25 375691.800 6232895.420 299.300 TP10-26 375710.900 6232879.530 299.950 TP10-27 375725.490 6232874.380 300.330 N1 375850.865 6232874.300 300.330 N2 375850.865 6232871.025 298.683 N2 375850.865 6232807.381 299.385 N3 375841.425 6232807.381 299.385 N4 375815.856 6232807.381 299.385 N5 375823.5	TP10-17	375756.120	6233067.590	304.010
IP10-19 375740.220 6233016.350 303.900 TP10-20 375756.750 6232987.940 303.150 TP10-21 375689.390 6233008.020 303.960 TP10-22 375674.150 6233008.090 300.630 TP10-23 375574.4300 6233010.5800 298.4700 TP10-24 375671.530 6232897.500 298.610 TP10-25 375691.800 6232887.500 299.000 TP10-26 375710.900 6232887.420 299.380 TP10-27 375754.210 6232879.530 299.950 TP10-28 375850.865 6232817.025 298.603 N1 375862.934 6232827.342 299.380 N2 375850.865 6232817.025 298.603 N3 375841.425 6232807.31 299.385 N3 375823.664 6232801.426 299.385 N5 375823.664 6232801.426 299.385 N6 375815.856 6232701.448 299.385 N6 375815.856	TP10-18	375791.560	6233090.670	303.700
TP10-21 375689.390 6233030.220 303.960 TP10-21 375689.390 6233030.220 303.960 TP10-22 375671.4300 6233010.5800 306.3960 TP10-23 375574.4300 6232807.500 298.4700 TP10-24 375677.530 6232897.500 298.610 TP10-25 375691.800 6232882.290 299.000 TP10-26 375710.900 6232882.420 299.380 TP10-27 375725.490 6232879.530 299.900 TP10-28 375742.310 6232874.330 300.330 N1 375680.865 6232817.025 298.903 N2 375850.865 6232817.025 298.903 N3 375841.425 6232817.025 298.903 N3 375823.564 6232801.426 299.385 N5 375823.664 6232801.426 299.385 N5 375823.664 6232801.426 299.638 N6 375815.856 6232701.448 299.87 N7 375808.656	TP10-19	375758 750	6232087 040	303.900
TP10-22 375654.150 6233008.090 300.630 TP10-23 375574.4300 6233010.6800 298.4700 TP10-24 375677.530 6232897.500 298.610 TP10-25 375691.800 6232897.500 298.610 TP10-26 375710.900 6232897.500 299.000 TP10-27 375725.490 6232897.530 299.950 TP10-28 375742.310 6232807.4380 300.330 N1 375850.866 6232802.462 298.683 N2 375850.866 6232817.025 288.903 N3 375841.425 6232807.361 299.385 N4 375843.703 6232807.381 299.385 N5 375825.664 6232807.426 299.658 N6 375815.856 6232701.426 299.658 N6 375815.856 6232701.426 299.658 N6 375815.856 6232701.426 299.658 N6 375815.856 6232701.426 299.837	TP10-21	375689.390	6233030.220	303,960
TP10-23 375574.4300 6233010.5800 298.4700 TP10-24 375677.530 6232897.500 298.610 TP10-25 375691.800 6232892.290 299.000 TP10-26 375710.900 6232892.290 299.000 TP10-27 375725.490 6232879.530 299.950 TP10-28 375742.310 6232874.380 300.330 N1 375862.934 6232871.025 298.603 N2 375850.865 6232871.025 298.900 N3 375841.425 6232813.049 299.194 N4 375833.703 6232801.426 299.385 N5 375823.564 6232811.426 299.385 N6 375815.856 6232801.426 299.658 N6 375815.856 6232801.426 299.851 N7 375808.656 6232801.426 299.851	TP10-22	375654.150	6233008.090	300.630
TP10-24 375677.530 6232897.500 298.610 TP10-25 375691.800 6232892.290 299.000 TP10-26 375710.900 6232885.420 299.380 TP10-27 375725.490 6232879.530 299.950 TP10-28 375742.310 6232874.380 300.330 N1 375862.934 6232871.025 298.603 N2 375850.865 6232817.025 298.903 N3 375841.425 6232817.025 299.194 N4 375833.703 6232801.426 299.385 N5 375823.564 6232801.426 299.385 N6 375815.856 6232801.426 299.851 N7 375808.656 6232801.426 299.837	TP10-23	375574.4300	6233010.5800	298.4700
TP10-25 375691.800 6232882.290 299.000 TP10-26 375710.900 6232885.420 299.380 TP10-27 375725.490 6232879.530 299.960 TP10-28 375742.310 6232874.380 300.330 N1 375862.934 6232820.462 298.683 N2 375850.865 6232817.025 299.990 N3 375841.425 6232817.025 299.993 N4 375833.703 6232807.481 299.385 N5 375823.564 6232801.426 299.658 N6 375815.856 6232801.426 299.658 N6 375816.856 6232801.426 299.658 N6 375815.856 6232701.448 299.837	TP10-24	375677.530	6232897.500	298.610
TP10-26 375710.900 6232885.420 299.380 TP10-27 375726.490 6232879.530 299.950 TP10-28 375742.310 6232879.530 299.950 N1 375850.865 6232870.202 296.683 N2 375850.865 6232817.025 298.903 N3 375841.425 6232817.025 298.903 N4 375832.564 6232807.381 299.385 N5 375825.664 6232801.426 299.668 N6 375815.856 6232701.426 299.684 N7 375808.665 6232701.426 299.837	TP10-25	375691.800	6232892.290	299.000
IPTU-27 375725.49U 6232879.530 2299.950 TP10-28 375742.310 6232874.380 300.330 N1 375662.934 6232820.462 298.963 N2 375850.865 6232817.025 298.903 N3 375841.425 6232813.049 299.194 N4 375833.703 6232807.381 299.385 N5 375823.564 6232801.426 299.658 N6 375815.856 6232801.426 299.658 N7 375808.665 6232801.426 299.875	TP10-26	375710.900	6232885.420	299.380
IF ID=20 375742.31U 6222674.33U 320.33U N1 375662.934 6232820.462 298.683 N2 375850.865 6232817.025 298.903 N3 375841.425 6232817.025 299.194 N4 375833.703 6232807.381 299.385 N5 375823.564 6232801.426 299.858 N6 375815.856 6232701.428 299.837 N7 375808.665 6232701.428 299.87	TP10-27	3/5/25.490	6232879.530	299.950
N1 01/5002-000 0222050-002 02500-002 0	N1	375862 934	6232820 462	298.683
N3 375841.425 6222813.049 299.194 N4 375833.703 6232807.381 299.385 N5 375823.564 6232201.426 299.685 N6 375815.856 6232796.427 299.831 N7 375808.665 6232701.148 299.87	N2	375850 865	6232817 025	298 903
N4 375833.703 6232807.381 299.385 N5 375823.664 6232801.426 299.658 N6 375815.856 6232796.427 299.831 N7 375808.665 6233791.148 299.872	N3	375841.425	6232813.049	299.194
N5 375823.564 6232801.426 299.658 N6 375815.856 6232796.427 299.831 N7 375808.665 6232791.148 299.872	N4	375833.703	6232807.381	299.385
N6 375815.856 6232796.427 299.831 N7 375808.665 6232791.148 299.872	N5	375823.564	6232801.426	299.658
N7 375808.665 6232791.148 299.872		375815 856	6232796.427	299.831
200.012	N6	010010.000		

- APPROXIMATE PROPOSED OUTFAL ALIGNMENT

Manitoba Hydro MB Hydro Laurie River

Test Hole Location Plan

Figure - 01


Appendix B Test Pit Logs

AECOM Canada Ltd.

GENERAL STATEMENT

NORMAL VARIABILITY OF SUBSURFACE CONDITIONS

The scope of the investigation presented herein is limited to an investigation of the subsurface conditions as to suitability for the proposed project. This report has been prepared to aid in the evaluation of the site and to assist the engineer in the design of the facilities. Our description of the project represents our understanding of the significant aspects of the project relevant to the design and construction of earth work, foundations and similar. In the event of any changes in the basic design or location of the structures as outlined in this report or plan, we should be given the opportunity to review the changes and to modify or reaffirm in writing the conclusions and recommendations of this report.

The analysis and recommendations presented in this report are based on the data obtained from the borings and test pit excavations made at the locations indicated on the site plans and from other information discussed herein. This report is based on the assumption that the subsurface conditions everywhere are not significantly different from those disclosed by the borings and excavations. However, variations in soil conditions may exist between the excavations and, also, general groundwater levels and conditions may fluctuate from time to time. The nature and extent of the variations may not become evident until construction. If subsurface conditions differ from those encountered in the exploratory borings and excavations, are observed or encountered during construction, or appear to be present beneath or beyond excavations, we should be advised at once so that we can observe and review these conditions and reconsider our recommendations where necessary.

Since it is possible for conditions to vary from those assumed in the analysis and upon which our conclusions and recommendations are based, a contingency fund should be included in the construction budget to allow for the possibility of variations which may result in modification of the design and construction procedures.

In order to observe compliance with the design concepts, specifications or recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated, we recommend that all construction operations dealing with earth work and the foundations be observed by an experienced soils engineer. We can be retained to provide these services for you during construction. In addition, we can be retained to review the plans and specifications that have been prepared to check for substantial conformance with the conclusions and recommendations contained in our report.

EXPLANATION OF FIELD & LABORATORY TEST DATA

		_			UMA	USCS			Laborator	y Classification Crite	eria
		Descr	ption		Log Symbols	Classification	Fines (%)	5	Grading	Plasticity	Notes
		CLEAN GRAVELS	Well grade sandy grave or no	ed gravels, els, with little fines	22	GW	0-5		C _U > 4 1 < C _C < 3		
	GRAVEL (More that 50% of	S (Little or n in fines)	Poorly grad sandy grave or no	led gravels, els, with little fines		GP	0-5		Not satisfying GW requirements		Dual symbols if 5-
OILS	fraction gravel size)	of DIRTY GRAVELS	Silty gravels gra	s, silty sandy vels		GM	> 12			Atterberg limits below "A" line or W _P <4	12% fines. Dual symbols if above "A" line and
AINED SC		(With som fines)	e Clayey gra sandy	vels, clayey gravels		GC	> 12			Atterberg limits above "A" line or W _P <7	4 <w<sub>P<7</w<sub>
ARSE GR		CLEAN SANDS	Well grad gravelly san or no	ed sands, ds, with little fines		SW	0-5		C _U > 6 1 < C _C < 3		$C_{U} = \frac{D_{60}}{D_{10}}$
COA	SANDS (More that 50% of	(Little or n fines)	Poorly gra gravelly san or no	ded sands, ds, with little fines	000	SP	0-5		Not satisfying SW requirements		$C_C = \frac{(D_{30})^2}{D_{10} x D_{60}}$
	coarse fraction sand siz	of e) DIRTY SANDS	Silty s sand-silt	ands, mixtures		SM	> 12			Atterberg limits below "A" line or W _P <4	
		(With som fines)	e Clayey sand-clay	sands, mixtures		SC	> 12			Atterberg limits above "A" line or W _P <7	
	SILTS (Below ' line	, W _L <50	Inorganic s clayey fine slight p	ilts, silty or sands, with lasticity		ML					
	negligib organic content	e W _L >50	Inorganic s plas	silts of high ticity		МН					
SOILS	CLAYS	W _L <30	Inorganic clays, san low plasticit	clays, silty dy clays of /, lean clays		CL					
GRAINED	(Above) line negligibl organic	a ∋ 30 <w∟<50< td=""><td>Inorganic cl clays of plas</td><td>ays and silty medium ticity</td><td></td><td>CI</td><td></td><td></td><td></td><td>Classification is Based upon Plasticity Chart</td><td></td></w∟<50<>	Inorganic cl clays of plas	ays and silty medium ticity		CI				Classification is Based upon Plasticity Chart	
FINE (content	W _L >50	Inorganic c plasticity	lays of high fat clays	\mathbb{Z}	СН					
	ORGAN SILTS &	C W _L <50	Organic organic silty plas	silts and clays of low ticity		OL					
	(Below ' line)	^{∧'} W _L >50	Organic cl plas	ays of high ticity	11	ОН					
H		GAINIC SOILS	Peat and organ	other highly c soils		Pt	Cla	Vor assific	n Post cation Limit	Strong colour o fibrou	r odour, and often s texture
		Asphalt			Till						
		Concrete		E (Undi	Bedrock fferentiated)					AE	COM
×	\bigotimes	Fill		E (Li	Bedrock mestone)						

When the above classification terms are used in this report or test hole logs, the designated fractions may be visually estimated and not measured.



LEGEND OF SYMBOLS

Laboratory and field tests are identified as follows:

- qu undrained shear strength (kPa) derived from unconfined compression testing.
- T_v undrained shear strength (kPa) measured using a torvane
- pp undrained shear strength (kPa) measured using a pocket penetrometer.
- L_v undrained shear strength (kPa) measured using a lab vane.
- F_v undrained shear strength (kPa) measured using a field vane.
- γ bulk unit weight (kN/m³).
- SPT Standard Penetration Test. Recorded as number of blows (N) from a 63.5 kg hammer dropped 0.76 m (free fall) which is required to drive a 51 mm O.D. Raymond type sampler 0.30 m into the soil.
- DPPT Drive Point Pentrometer Test. Recorded as number of blows from a 63.5 kg hammer dropped 0.76 m (free fall) which is required to drive a 50 mm drive point 0.30 m into the soil.
- w moisture content (W_L, W_P)

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Su (kPa)	CONSISTENCY
<12	very soft
12 – 25	soft
25 - 50	medium or firm
50 - 100	stiff
100 – 200	very stiff
200	hard

The resistance (N) of a non-cohesive soil can be related to compactness condition as follows

	COMPACTNECC
N – BLOWS/0.30 M	COMPACTNESS
0 - 4	very loose
4 - 10	loose
10 - 30	compact
30 - 50	dense
50	very dense

PROJ	ECT:	Proposed Lagoon Geotechnical Investi	gation (CLI	ENT	T: Ma	anitol	ba Hy	/dro						TE	STHOLE NO: TP10-0	1
LOCA	TION:	Proposed Outfall Alignment 1 - 37567	5.400m E 6232659	9.55	0m	N									PR	OJECT NO.: 6015773	39
CONT		UR: Hartman Construction - Excavatio		ME ∕∕∖∽	<u>ТНС</u>)D: 1	<u>Koma</u>	itsu F		20 L	С					EVATION (m): 292.02	
DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTIO			SAMPLE #	SPT (N)	P ◆ SP 0 2 16 17 P	ENETR * E Dyna T (Star (Blow 0 4(T tota (Blow 0 4(18 astic	ATION Becker amic C ndard I vs/300 0 6 al Unit kN/m ³) 19 MC	I TEST → ₩ cone ¢ Pen Te mm) 0 8 Wt ■ 20 Liqui	S est) ◆ 0 100 0 21 d	UNDRA	INED SH + Torv × Q □ Lab ' △ Pocke ● Field (kf	EAR STR vane + $U \times$ Vane \Box et Pen. Δ Vane \textcircled{P} Pa)	ENGTH	COMMENTS	ELEVATION
0		TOPSOIL - organics/rootlets throughout			+		2	0 40	0 6	0 8	0 100		i0 10	00 15	50 200		-
		-brown, moist CLAY - silty, trace rootlets to ~0.8m													•••••		
157739 - LAURE RIVER LAGOON TH-TP LOGS - 22-NOV-10.GPJ UMA WINN.GDT 28/11		END HOLE AT 3.0m IN CLAY Notes: 1. No seepage observed; 2. No sloughing observed.															291 -
								· · · · · · · ·	· · · · · ·			······	· · · · ·	· · · · · · · · · · · · · · · · · · ·			
ц Ц							LOG	GED	BY:	Matt	Loted	ki Fish		C	OMPLI	ETION DEPTH: 3.05 m	
000		AECOM					REV			r: Je ⊇IN⊏	remy	Fiebel	IKOM		OMPL	ETION DATE: 10/22/10	1 of 1
										~			3.30.01	~		i uye	

PROJ	ECT:	Proposed Lagoon Geotechnical Investigation	С	LIEN	IT: M	anito	ba I	lydr	c						TES	STHOLE NO: TP10-0	2
LOCA	TION	Proposed Outfall Alignment 1 - 375697.880m E 62326	685.	140n	ηN			-							PR	OJECT NO.: 6015773	39
CONT	RAC	OR: Hartman Construction - Excavation	N	1ETH	OD:	Kom	atsu	PC	220	LC					ELE	EVATION (m): 294.02	
SAMF		PE GRAB SHELBY TUBE		SPL	T SPO	ON			BULK	<				NO RE	COVEF		
DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	♦ S 0 16	PENE	FRATIC EBECK Candario Cows/30 40 Dotal Ur (kN/n 18 MC 40 40 4	DN TE er # Cone d Pen 00mm 60 nit Wt 1 ³) 19 Li 60	STS → Test) → 0 10 	● 00 21 00	NDRAIN	VED SHE + Torv × Q Lab \ Pocke Field ' (kF	EAR STR rane + U × /ane □ t Pen. △ Vane ⊕ Pa) 15	2 200	COMMENTS	ELEVATION
0		TOPSOIL - organics/rootlets throughout -black_moist															-
_		CLAY - silty, trace rootlets to ~0.8m	-				 	•			• • • •						-
		 -brown, moist, soft -intermediate to high plasticity -homogeneous -laminated (<5mm thick) -alternating brown clay/grey silt layers, moist, firm -low to intermediate plasticity 															293 - - - - - - - - - - - - - - - - - -
EST HOLE 60157739 - LAURIE RIVER LAGOON TH TP LOGS - 22-NOV-10 GPJ L		END HOLE AT 3.0m IN CLAY Notes: 1. No seepage observed; 2. No sloughing observed.															291
	· 1	A = 00 1 1	•	•	•	LO	GGE	D BY	: Ma	att Lot	eck	i		C	OMPL	ETION DEPTH: 3.05 m	
jo DG		A=COM				RE	VIEV		3Y: .	Jerem	iy Fi	iebell	korn	C	OMPLI	ETION DATE: 10/22/10	4 . 5 4
2						PR	OJE(ji El	NGIN	IEER:	Pa	aul Ba	irsalou	1 L		Page	1 of 1

PROJ	ECT:	Proposed Lagoon Geotechnical Investigation	С	LIEN	IT: M	anito	ba H	ydro						TES	STHOLE NO: TP10-0	3
LOCA	TION:	: Proposed Lagoon - 375768.673m E 6232801.057m N	1											PR	OJECT NO.: 6015773	89
CONT			<u>N</u>		OD:	Kom	atsu	PC 2	2 <u>20 L</u>	.C			100 0		EVATION (m): 300.39	
DEPTH (m)	SOIL SYMBOL		SAMPLE TYPE	SAMPLE #	(N) TAS	◆ SI 0	PENETI * Dyn PT (Sta (Blo 20 4 To 7 1 Plastic	RATION Becke amic C ndard ws/300 tal Unit (kN/m ³ 8 1 MC	ULK r ₩ Cone < Pen T Omm) 50 8 t Wt ■ 9 2 Liqu	TS > est) ♦ 80 100 1 1 0 21 id	UNDRA	INED SF + Tor × (□ Lab △ Pock ♥ Field (k	HEAR ST vane + QU X Vane C et Pen I Vane G Pa)			ELEVATION
0	<u>}</u> }}	TOPSOIL - moss and rootlets throughout	_				20 4	ю — е	50 • 8	30 100		50 1 :	100 1 :	150 200 :		
-		-brown, moist CLAY - silty, trace rootlets -laminated - alternating brown clay/light brown silt layers, moist, firm to stiff -intermediate to high plasticity		T01								· · · · · · · · · · · · · · · · · · ·				-
- -1 - - - - - - - -		REFUSAL - END HOLE AT 1.2m ON BEDROCK Notes: 1. No seepage observed; 2. No sloughing observed.		G01			24.3									- - - - - - - - - - - - - - - - - - -
55 - 22-NOV-10.GPJ UMA WINN.GDT 2/8/1												······				298 -
THOLE 60157739 - LAURIE RIVER LAGOON TH-TP-LOC												· · · · · · · · · · · · · · · · · · ·				
	. 1	ΔΞΟΟΜ		1	1	LO RF	GGED) BY: FD B	Mati Y: 4	t Lote	cki Fiehe	lkorn			ETION DEPTH: 1.22 m	
LOG						PR	OJEC	T EN	GINE	ER:	Paul E	Barsalc	ou C		Page	1 of 1

PROJ	ECT:	Proposed Lagoon Geotechnical Investigation	С	LIEN	T: M	anit	oba	Hy	dro								TES	STHOLE NO: TP10-04	4
LOCA	TION:	Proposed Lagoon - 375793.392m E 6232846.549m N															PR	OJECT NO.: 6015773	89
CONT	RACT	OR: Hartman Construction - Excavation	M	ETH	OD:	Kon	nats	u P	<u>C 2</u>	20 L	C				7		ELE	<u>-VATION (m): 300.12</u>	
SAMP		PE GRAB IIISHELBY TUBE		JSPLI	T SPO	ON T		E		JLK						RECO	JVEF		
DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	♦ S 0 16	PEN	ETRA * Be Dynar Stanc Blows 40 Total (kl 18 ic 40	ATION ecker mic C dard I s/300 6 Unit N/m ³ 19 MC 6	ITES * ** cone < Pen T mm) 0 Wt Liqu 0	TS isolation = 1 isolation = 1 i	● 00 21 00	NDRA	INED S + Tc × □ Lat △ Pocl ● Fiel (HEAR S rvane QU X Vane ket Per d Vane kPa) 100	STREN + n. △ e ●	200	COMMENTS	ELEVATION
0		TOPSOIL - rootlets throughout													:		200		
-		CLAY - silty, trace rootlets -laminated - alternating brown clay/light brown silt layers, moist, soft -intermediate to high plasticity										· · · ·		· · · · · · · · · · · · · · · · · · ·		· · · · · · · · · · · · · · · · · · ·			
-				T02				0.1				· · · ·		· · · · · · · ·					-
1 - -				G02								+ 	_ 	· · · · · · · · · · · · · · · · · · ·					- 299 — -
- - -				G03			- 20	.4.				·	 	· · · · · · · · ·					-
		REFUSAL - END HOLE AT 1.8m ON BEDROCK Notes: 1. No seepage observed; 2. No sloughing observed.										 			· · · · · · · · · · · · · · · · · · ·				- - 298 — - -
P LOGS - 22-NOV-10.GP												· · · · ·	· · · · · ·	· · · · · · · · · · · · · · · · · · ·					-
												 		· · · · · · · · · · · · · · · · · · ·					- 297 – -
HOLE 60157739 - LAURI														· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·				-
4 S						1	066		RV.	Mat	t I of		 ri			0	/PI 6		
- 5		AECOM				RE	VIE	WE	D B	17: J	erem	iy F	iebe	lkorn		CON	MPLE	ETION DATE: 10/22/10	
DO						PF	ROJE	ECT	EN	GINE	ER:	Pa	aul B	arsal	ou			Page	1 of 1

PROJEC	T:	Proposed Lagoon Geotechnical Investigation	С	LIEN	T: Ma	anito	ba I	lydr	0						TE	STHOLE NO: TP10-0	5
LOCATIO	ON:	Proposed Lagoon - 375841.109m E 6232876.533m N	-												PR	OJECT NO.: 6015773	89
CONTRA			M		<u>DD: I</u>	Kom	atsu	PC	220	<u>) L(</u>)			7100 0		EVATION (m): 300.05	
DEPTH (m)		SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	◆ S 0 16	PENE [™]	FRATIC E Beck namic andar ows/30 40 otal Ur (kN/r 18 MC 40	DN TI cer # con d Pei 00mr 60 nit W n ³) 19 c I	ESTS ESTS ie ◇ n Te: n) 80 it ■ 20 Liquid 80	st) ◆ 100 21	UNDRA	INED S + Tc ∠ Lat △ Pocl ● Fiel (HEAR ST orvane + QU × o Vane C ket Pen. d Vane (kPa)	RENGTH □ Δ 150 200		ELEVATION
0	}}	TOPSOIL - organics/rootlets throughout									100			:	:		300 -
		CLAY - silty, trace sand, trace gravel -brown, moist, stiff becoming firm with depth -intermediate to high plasticity -laminated - alternating brown clay/light brown silt layers		G04 T03 G05			27.7						+			Tube pushed ~2m from TP10-05 Sample G05 - Gravel-0.2%.	- - - - - - - - - - - - - - - - - - -
		SILT - trace to some sand -grey, moist, firm -low plasticity to non-plastic REFUSAL - END HOLE AT 2.3m ON BEDROCK		G06		.9.6						+				Sand-2.4%, Silt-33.1%, Clay-64.3%	
		Notes: 1. No seepage observed; 2. No sloughing observed.															
		AECOM				LO RE PR	GGE VIEV OJF(D BY /ED I CT FI	': M BY: NGI	latt I Jer	Loteo emy ER: 1	cki Fiebe Paul F	lkorn		Compli	ETION DEPTH: 2.29 m ETION DATE: 10/22/10 Page	1 of 1

PROJ	ECT:	Proposed Lagoon Geotechnical Investigation	С	LIEN	T: M	anit	oba	Нус	lro							TE	STHOLE NO: TP10-0)6
LOCA	TION	Proposed Lagoon - 375969.992m E 6232842.563m N	I													PF	ROJECT NO.: 601577	39
CONT	RACI	OR: Hartman Construction - Excavation		IETH	OD:	Kon	natsi	J PC	22	<u>20 L</u>	<u>.</u> C					EL	EVATION (m): 298.83	3
DEPTH (m)	SOIL SYMBOL		SAMPLE TYPE	SAMPLE #	(N) TPR	◆ 5 0	PENE	TRAT # Be ynam itanda lows/ 40 Total (kN 18 2 40 40 18 2 40	TION cker nic Co ard F /300r (300r 00 Unit 1/m ³) 19 MC 60	JLK TES one < Pen T mm) 2 { Liqu	TS est) ● 80 10 1 0 2 id 80 10	UNE		VED SH + Tor 2 Lab Pock Field (k	INO K IEAR S vane + QU X Vane [et Pen. Vane Pa) 00	TRENGTH - □ △ €		ELEVATION
0		TOPSOIL - organics/rootlets throughout -brown, moist																
- - - - - - - - - - - - - - - -		CLAY - silty -brown, moist, firm to stiff -intermediate to high plasticity -laminated - alternating brown clay/light brown silt layers		G07 T04														298 -
		-stiff REFUSAL - END HOLE AT 2.0m ON BEDROCK Notes: 1. No seepage observed; 2. No sloughing observed.		G08			28.	7						+				297 -
		AECOM				LC RE PF	OGGE	ED B WED	BY: D BY ENC	Mati ': Je GINE	t Lote erem	ecki y Fie Pau	ebelk	korn Irsalo	<u> </u>	Compl Compl	ETION DEPTH: 1.98 m ETION DATE: 10/22/10 Page	

PR	OJE	CT:	Prop	osed Lagoon Geotechr	nical Investigation	(IT: M	anitok	ba Hy	/dro				TE	STHOLE NO: TP10-0	7
LO	CAT	ION	: Prop	oosed Lagoon - 37587	6.877m E 6232815.674m	N				•					PR	OJECT NO.: 601577	39
CO	NT	RAC	TOR:	Hartman Construction	- Excavation	Ν		IOD:	Koma	itsu F	PC 220	LC			EL	EVATION (m): 298.22	2
SA	MPL	ET	YPE	GRAB	SHELBY TUBE	\geq	SPL	IT SPC	ON		BULK	<		∠ NO	RECOVE	RY CORE	
BAG	CKF	ILL	TYPE	BENTONITE	GRAVEL]]SLO	UGH			GRO	UT		CU	TTINGS	SAND	
DEPTH (m)		SOIL SYMBOL		Soil de	SCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	P ◆ SP ⁻ 0 2(16 17 Pi 2(ENETR * E > Dyna T (Star (Blow) 40 T Tota (I 18 astic	ATION TES Becker # amic Cone ndard Pen vs/300mm 0 60 al Unit Wt kN/m ³) 19 MC Lii 0 60	STS (◆ Test) ◆) 80 100 ■ 20 2' quid 100 100		IED SHEAR + Torvane × QU × Lab Vane Pocket Pe Field Van (kPa)	STRENGTH + :-+ : : : : : :	COMMENTS	ELEVATION
0				TOPSOIL - organics/rootle	ets throughout						:	:		:	:		-
-				SILT - clayey, trace rootle -brown/grey, dry to moist, -low plastic CLAY - silty, trace sand -brown, moist, firm -intermediate to high plast	ts hard ticity		G09			28.7.							- 298 — - - -
- - 1 -				-laminated - alternating la	yers of brown clay/light brown sil	t	G10			.29.7.			+			Sample G10 - Gravel-0.0%, Sand-2.7%, Silt-21.1%, Clay-76.2%	- - - 297 —
5DT 2/8/11				-weathered (crumbly soil)			T05 G11			29.1 • • •			+	<			-
4 TH-TP LOGS - 22-NOV-10. GPJ UMA WINN.																	296 — - - - - - - - - - - - -
ST HOLE 60157739 - LAURIE RIVER LAGOON				REFUSAL - END HOLE A Notes: 1. No seepage observed; 2. No sloughing observed 3. SP10-07 installed, dry a	T 3.0m ON BEDROCK												- 295 - - - - - - - - - - - - - - - - - -
ЕTE				1-00					LOG	GED	BY: Ma	att Lote	cki		COMPL	ETION DEPTH: 3.05 m	
000				A=CO	[V]				REV			Jeremy	Fiebelk	orn	COMPL	ETION DATE: 10/22/10	1 ~ 4
<u> Ц</u>									I LKO	JECI	ENGIN	ICEK:	raul Ba	ISalou		Page	IOII

PROJ	ECT:	Proposed Lagoon Geotechnical Investigation	С	LIEN	IT: M	anit	oba	Hyd	lro							TES	STHOLE NO: TP10-0	8
LOCA	TION	: Proposed Lagoon - 375848.232m E 6232794.632m	N													PR	OJECT NO.: 6015773	39
CONT	RAC	TOR: Hartman Construction - Excavation	Ν	<u>IETH</u>	OD:	Kon	nats	u PC	<u>22</u>	20 L	.C					ELE	EVATION (m): 299.04	ŀ
SAMP		(PE GRAB SHELBY TUBE		SPLI	T SPC	ON			BU	ILK		1		Zn	io re	ECOVEF	RY CORE	
DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	♦ S 0	PENE	TRAT # Be ynam Standa Slows/ 40 Fotal I (kN 18 c N 40	FION cker iic Cc ard P (300n 60 Unit \ Unit \ I/m ³) 19 AC 60	TEST * one < ren Ten nm) * ten transformed * ten *	S est) ♦ 0 10 0 2 id 30 10	UNDF	AINED + 1 □ L △ Pc ⊕ F) SHE Torva X QU .ab V .ab V V .ab V .ab V .ab V .ab V .ab V .ab V V V V V V V V V V V V V V V V V V V	AR STI ine + I × ane □ Pen. ∠ 7ane € a) 1 1	RENGTH	COMMENTS	ELEVATION
0		TOPSOIL -organics/rootlets throughout				1												299 -
		CLAY - silty, trace rootlets to ~0.8m	_															-
-		-brown, moist, stiff becoming firm with depth -intermediate to high plasticity														· · · · · · · · · · · · · · · · · · ·		-
-							: 23.8	÷						-				
F				G12									··· +					
-		-laminated - alternating layers of brown clay/light brown silt																
-		-nm																298 -
-				012				2										
-				GI3														
-																		
		REFUSAL - END HOLE AT 1.5m ON BEDROCK										•						
-		Notes:						•••								:		
-		 No seepage observed; No sloughing observed. 																
8/11																		
2 –2 10																		297 -
NN.G								•••••••••••••••••••••••••••••••••••••••										
MA MA																		
/-10.G																		
2-NO/										• • • •								
GS - 2								•••										-
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±3																		296 -
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E RIC								•••										.
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QLE -								••••••										.
4 153										 Ma#								-
- T		AECOM				RE	VIE	NED) BY	: Je	erem	/ Fieb	elkor	'n	0	OMPLE	ETION DATE: 10/22/10	
POG						PF	OJE	CT	ENG	SINE	ER:	Paul	Barsa	alou			Page	1 of 1

PROJ	ECT:	Proposed Lagoon Geotechnical Investigation	С	LIEN	T: M	anito	ba H	lydro)					TE	STHOLE NO: TP10-09	9
LOCA	TION	Proposed Lagoon - 375823.470m E 6232769.148m N	_											PR	OJECT NO.: 6015773	9
CONT	RAC	OR: Hartman Construction - Excavation	M	IETH	OD:	Kom	atsu	PC 2	<u>220 L</u>	<u>.</u> C			1	ELE	EVATION (m): 299.52	
SAMF				SPL	T SPC	ON			BULK			\checkmark	JNO RE	ECOVER		
DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	♦ SI 0	PENETI	RATIO Becke amic Indard ws/30 tal Uni (kN/m 8 1 MC	N TES er # Cone < Pen 1 0mm) 60 it Wt it Wt it Wt it Ut it uq	TS i est) ◆ i est) ◆ 80 100 100 100 100 100 100 100 100	UNDRA	INED SH + Tou × (□ Lab △ Pock ● Field (k	HEAR STI Tvane + QU × Vane □ et Pen. 4 J Vane 4 Pa)	RENGTH	COMMENTS	ELEVATION
0		TOPSOIL - organics/rootlets throughout -black, moist				+			:				:			
-		CLAY - silty, trace rootlets -brown, moist, firm -intermediate to high plasticity REFUSAL - END HOLE AT 0.6m ON BEDROCK	-	G14			23.2	 			+		· · · · · · · · · · · · · · · · · · ·			- - - 299 — -
- - -1 - -		Notes: 1. No seepage observed; 2. No sloughing observed.														-
																298 -
+TP LOGS - 22-NOV-10, GPJ UMA WINN GD																- - - - - - - - - - - - - - - - - - -
T HOLE 6015739 - LAURIE RIVER LAGON TH																- - - - - - - - - - - - - - - - - - -
. TES				•	•	LO	GGEL) BY:	Mat	t Lote	cki	1	C	OMPL	ETION DEPTH: 0.61 m	
р С		A=COM				RE	VIEW	ED B	Y: J	eremy	Fiebe	lkorn	C	OMPLI	ETION DATE: 10/22/10	
2						PR	DIEC	T EN	IGINE	ER:	Paul B	arsalo	u		Page	1 of 1

PROJ	ECT:	Proposed Lagoon Geotechnical Investiga	ation	CL	IEN	T: Ma	anito	oa Hy	dro						TES	STHOLE NO: TP10-1	0
LOCA	TION	Proposed Lagoon - 375787.839m E 62	232777.089m N					•							PR	OJECT NO.: 6015773	39
CONT	RAC	OR: Hartman Construction - Excavation	1	ME	THO	DD: I	Koma	atsu P	PC 22	20 L	С				ELE	EVATION (m): 300.61	
SAMF		(PE GRAB SH	IELBY TUBE	<u>ک</u> و	SPLIT	r spo	ON		BL	JLK			\square	NO RE	COVEF	RY CORE	
DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTIO		SAMPLE IYPE	SAMPLE #	SPT (N)	F ◆ SP 0 2 16 1; F	ENETR/	ATION ecker mic Co dard F s/300r I Unit SN/m ³) 19 MC	TEST → one → Pen Te mm) → 8 Wt 2 Liquia	S est) ✦ 0 100 0 21 d	UNDRAI	INED SH + Tor ∠ C □ Lab △ Pocku ● Field (k	EAR ST vane + QU × Vane □ et Pen. 4 Vane 4 Pa)	RENGTH	COMMENTS	ELEVATION
0	<u> </u>	TOPSOIL - organics/rootlets throughout		-			2	0 40	60	8 (0 100		50 1	00 1 :	50 200		-
-		-brown, moist															-
		-laminated - alternating layers of brown clay/light	brown silt, moist,														
_		intermediate to high plasticity							į								
-																	
-					215			25.5.									300 -
-					310												
-		REFUSAL - END HOLE AT 0.8m ON BEDROCK	(•				-
		Notes: 1 No seepage observed:						•••••	····:				;	;			-
		2. No sloughing observed.															
-								:	:						:		
-								•••••				•••••		:			
-													: : :				-
-																	299 -
F														······			-
-								•••••	····					; :	:		-
2/8/11													: ; ;				-
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N.N.																	-
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-10.G									:						:		-
20- 2-												• • • • • • •					298 -
S - 22													• • • • • • • •				-
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- LAGO																	
ZER -															:		-
RE F																	-
- LAU													:	:	:		-
1																	297
6015													•				-
- QLE																	-
4 EST										Mott				<u></u>			
Ч Ч		A=COM					REV	IEWE	D BY	': Je	remy	Fiebel	lkorn		OMPLE	ETION DATE: 10/22/10	
LOG							PRC	JECT	ENG	SINE	ER: I	Paul B	arsalo	u		Page	1 of 1

LOCATION: Borrow Source - 375894.560m E 6232896.140m N PROJECT NO.: CONTRACTOR: Hartman Construction - Excavation METHOD: Komatsu PC 220 LC ELEVATION (m SAMPLE TYPE GRAB SHELBY TUBE SPLIT SPOON BULK NO RECOVERY ICC (E) UNDRAINED SHEAR STRENGTH * Becker * * Oparatic Cone * UNDRAINED SHEAR STRENGTH * COMME (E) UNDRAINED SHEAR STRENGTH * COMME * COMME * COMME COMME	60157739 :: 301.46 PRE NTS
CONTRACTOR: Hartman Construction - Excavation METHOD: Komatsu PC 220 LC ELEVATION (m SAMPLE TYPE GRAB SHELBY TUBE SPLIT SPOON BULK NO RECOVERY CO (i) I) I) <td>NTS</td>	NTS
SAMPLE TYPE GRAB SHELBY TUBE SPLIT SPOON BULK NO RECOVERY CO (i) I	NTS RE
(E) BOUL DESCRIPTION UNDERVISED ALL DESCRIPTION	ELEVATION STN
$\begin{bmatrix} \begin{matrix} c \\ d \\$	
0 CONTRACTOR CONTRACTO	
0 0 <td>301 - 300 - 299 -</td>	301 - 300 - 299 -
	298 -
	· 1.52 m
A COMPLETION DEPTH B REVIEWED BY: Mall Lolecki COMPLETION DEPTH B COMPLETION DEPTH	10/22/10
PROJECT ENGINEER: Paul Barsalou	Page 1 of 1

PROJ	ECT:	Proposed Lagoon Geotechnical Investigation	С	LIEN	IT: M	anite	ba H	lydro)					TE	STHOLE NO: TP10-12	2
LOCA	TION	Borrow Source - 375919.700m E 6232859.440m N												PR	OJECT NO.: 6015773	89
CONT	RAC	FOR: Hartman Construction - Excavation	M	IETH	OD:	Kom	atsu	PC 2	220 I	C			1	ELI	EVATION (m): 297.85	
SAMP		PE GRAB IIIISHELBY TUBE		JSPL	T SPO		PENET			TS			JNO RE	COVER		
DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	◆ S 0 16		Becken amic (andard ws/300 40 (tal Uni (kN/m 8 1 MC 40 40	er ₩ Cone Pen 1 0mm) 60 t Wt ■ Liq 60	♦ Fest) ● 80 10 20 2 uid 80 10		+ To × □ Lab △ Pock ● Field (I	rvane + QU X > Vane □ xet Pen. 2 d Vane 4 (Pa) 100 1	50 200	COMMENTS	ELEVATION
0		TOPSOIL - organics/rootlets throughout -black_moist							:							
		CLAY - silty -brown, moist, fim -intermediate to high plasticity -laminated - alternating layers of brown clay/light brown silt		G17 G18			93 9 3 9									297 -
1 HOLE 6015739 - LAUKIE KIVEK LAGOON 11+ 1F LUGS - 22-NUV-10.6FJ UMA WINN.0D1 2 		REFUSAL - END HOLE AT 2.4m ON BEDROCK Notes: 1. No seepage observed; 2. No sloughing observed.														295 - 294 -
	<u> </u>	AECOM	1	I		L0 RE	ggel View) BY: ED B	Mat Y: J	tt Lote erem	y Fiebe	elkorn	C C	ompl ompl	ETION DEPTH: 2.44 m ETION DATE: 10/22/10	1
		/				PR	OJEC	T EN	GIN	EER:	Paul B	Barsalo	ou		Page	1 of 1

PRO	JECT:	Proposed Lagoon Geotechnical I	nvestigation	CI	LIEN	T: M	anito	ba H	ydro						TE	STHOLE NO: TP10-1	3
LOC	ATION	Proposed Outfall Alignment 2 - 3	375904.730m E 623276	68.2	270m	N									PR	OJECT NO.: 6015773	39
CON	TRAC	OR: Hartman Construction - Exc	avation	М	ETH	OD:	Kom	atsu	<u> </u>	20 L	С				ELI	EVATIO <u>N (</u> m): 296.44	
SAM	PLE T	(PE GRAB		\boxtimes	SPLI	T SPO	ON		В	ULK			\angle	NO RE	COVE	RY CORE	
DEPTH (m)	SOIL SYMBOL	SOIL DESCRI	PTION	SAMPLE TYPE	SAMPLE #	SPT (N)	● SF 0 2 16 1 F	PENETF	ATION Becker amic C andard vs/300 0 6 al Unit kN/m ³ 3 19 MC 0 6 6	N TEST r ₩ Cone Pen Te Dmm) 0 8 CWt 2 Liquid 0 8 2 2 2 2 2 2 2 2 2 2 2 2 2	S est) ◆ 0 100 0 21 d 0 100	UNDRAI	INED SH + Tor ∠ C □ Lab △ Pocke ♥ Field (kl	IEAR STI vane + QU × Vane □ et Pen. 2 Vane ₽ Pa) 00 1	RENGTH	COMMENTS	ELEVATION
0		TOPSOIL - organics/rootlets throughout											· · · · · · · · · · · · · · · · · · ·				-
WINN.GDT 2/8/11		-black, moist CLAY - silty, trace sand -brown, moist, firm -intermediate to high plasticity -weathered (crumbly soil) -laminated - alternating layers of brown of REFUSAL - END HOLE AT 2.1m ON BE	clay/light brown silt		G19 G20			27.1 • 24.6.								Sample G20 - Gravel-0.0%, Sand-4.1%, Silt-46.5%, Clay-49.4%	296
ST HOLE 60157739 - LAURIE RIVER LAGOON TH-TP LOGS - 22-NOV-10. GPJ UMA W		Notes: 1. No seepage observed; 2. No sloughing observed.															294 - - - - - - - - - - - - - - - - - -
LOG OF TE.		AECOM					LOC REV PRC	GED /IEWE DJEC	BY: ED B' T EN	Matt Y: Je GINE	Loteo remy ER: I	cki Fiebel Paul B	lkorn arsalo	C C u	OMPL OMPL	ETION DEPTH: 2.13 m ETION DATE: 10/22/10 Page	1 of 1

PROJ	ECT:	Proposed Lagoon Geotechnical	Investigation	С	LIEN	T: M	anito	ba H	ydro						TES	STHOLE NO: TP10	-24
LOCA	TION:	Proposed Forcemain Alignmer	nt - 375677.530m E 623	289	7.50	Om N									PR	OJECT NO.: 60157	739
CONT	RACI	OR: Hartman Construction - Ex	cavation	M	IETH	OD:	Koma	atsu	PC 2	20 L	С				ELE	EVATION (m): 298.0	61
SAMF		GRAB GRAB			SPLI	T SPO	ON		В	ULK			\angle	NO RE	COVEF		
DEPTH (m)	SOIL SYMBOL	SOIL DESCR	RIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	● SF 0 2 16 1	PENETF	RATION Beckel amic C ndard ws/300 0 6 al Unit (kN/m ³ 3 1 <u>MC</u> 0 6	N TEST r ₩ Cone < Pen Tr Dmm) 60 & t Wt ■ 9 2 Liqu Liqu 60 €	S est) ◆ 0 100 0 21 id 30 100	UNDRA	INED SH + Tor ∠ C □ Lab △ Pocke ♥ Field (kl	EAR STR vane + tU X Vane □ et Pen. △ Vane ⊕ Pa) 00 15	ENGTH	COMMENTS	ELEVATION
0 - - - - -		CLAY - silty -brown, moist, firm -intermediate to high plasticity															
- - 1 - - -																	
J UMA WINN.GDT 2/8/11																	297
HOLE 60157739 - LAURIE RIVER LAGOON TH-TP LOGS - 22-NOV-10.GR.	~~~	REFUSAL - END HOLE AT 2.4m ON Notes: 1. No seepage observed; 2. No sloughing observed.	BEDROCK														296 - - - - - - - - - - - - - - - - - - -
4 LEST							LOC	GED	BY:	Matt	Lote	cki			OMPLI	 ETION DEPTH: 2.44 n	<u> </u> า
50		AECOM					RE\	/IEWI	ED B'	Y: Je	eremy	Fiebe	lkorn	C	OMPLI	ETION DATE: 10/22/1	0
Ĭ						PRO	JEC	T EN	GINE	ER:	Paul B	arsalo	u 🗌		Pag	e 1 of 1	

PROJECT: Proposed Lagoon Geotechnical Investigation	С	LIEN	T: M	ani	toba	a Hy	/dro								TE	STHOLE NO: TP10-	25
LOCATION: Proposed Forcemain Alignment - 375691.800m E 623	289	2.29	0m N												PR	OJECT NO.: 60157	739
	M	IETH	OD:	Kor	nat	su F		20	LC				7.00			EVATION (m): 299.0	00
SAMPLE TYPE GRAD (iii) Iog SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	(N) TAS	• 0 16	PEI ◆ SPT 20 17 Pla: 20	NETR WE Dyna (Star (Blov 40 18 stic 40	ATIOI Becke amic (ndard vs/300 0 6 al Unig kN/m 1 MC 0 6	N TES r # Pen 0mm) 0 t Wt I 9 Lic 00	STS Crest 80 20 20 20 20 20 20 20 20 20 2	:) ◆ 100 21 100	JNDR4	⊥ ↓ T ↓ T ↓ La △ Poo ④ Fie 50	SHEAR orvane (QU X b Vane ket Pe eld Van (kPa) 100	STRE = + α = □ en. Δ he ⊕ 150	NGTH 200	COMMENTS	ELEVATION
CLAY - sitty aminated - alternating layers of brown clay/light brown silt, moist, firm intermediate to high plasticity 1 1 																	298 - 297 - 296 -
	<u>1 </u>	I	I	L(Ri Pi	DGC EVII ROJ	GED EWE	BY: D Β Γ ΕΝ	Ma Y: C GIN	itt Lo Jere	otec my R: F	ki Fiebe Paul B	elkorn Barsa	lou	CO CO	MPL	ETION DEPTH: 2.74 m ETION DATE: 10/22/10 Pag) e 1 of 1

PROJECT:	Proposed Lagoon Geotechnical Investigation	С	LIEN	T: M	anit	oba	Hyd	lro						TE	STHOLE NO: TP10-2	6
	: Proposed Forcemain Alignment - 375710.900m E 623	3288	35.420	0m N										PR	OJECT NO.: 601577	39
		N	<u>1ЕТН</u> 1 _{СРП}	OD: T SPO	Kon	natsi	u PC	<u>) 22</u> Тві	20 L	С					EVATION (m): 299.38 BY \square CORE	3
DEPTH (m) SOIL SYMBOL		SAMPLE TYPE	SAMPLE #	SPT (N)	◆ S 0	PENE	TRAT We Benynam Standa Standa Standa Standa (kN 18 c N	TION cker ic Co ard F 300r (300r 00 Unit V //m ³) 19 10	TEST * one < Pen Tr mm) * Wt Liqu	S est) ♦ 0 100 0 21	UNDR	LZ AINED \$ + T(X □ La A Poot € Fie	SHEAR S orvane - QU X b Vane kket Pen kket Pen kket Pen kket Pen		COMMENTS	ELEVATION
DLE 60157739 - LAURIE RIVER LAGON TH-TP LOGS - 22-NOV-10.GPJ UMA WINN.GDT 2/8/11	CLAY - sity -laminated - alternating layers of brown clay/light brown silt, moist, firm -intermediate to high plasticity REFUSAL - END HOLE AT 2.1m ON BEDROCK Notes: 1. No seepage observed; 2. No sloughing observed.											50				
4	AECOM	<u> </u>	<u> </u>		LO RE PR	GGE VIE	ED B NED	Y: BY ENC	Matt ': Je GINE	Lote remy ER:	cki Fiebo Paul I	elkorn Barsal	lou	COMPL COMPL	ETION DEPTH: 2.13 m ETION DATE: 10/22/10 Page	1 of 1

PROJ	ECT:	Proposed Lagoon Geotechnical Investigation	С	LIEN	IT: M	anito	oba	Hydr	°O						TE	STHOLE NO: TP10-2	7
LOCA	TION:	Proposed Forcemain Alignment - 375725.490m E 623	3287	79.53	0m N										PR	OJECT NO.: 6015773	39
SAME			N	<u>1ЕТН</u> 1 ₉ рг і	OD:	Kom	atsu		22(<u>א ר</u>	2					EVATION (m): 299.95)
DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	♦ S 0 16	PENE PT (S 20 PT (T Plastic	TRATI K Becl ynamic tandar lows/3 40 otal U (kN/r 18 	ON TI ker # c Con rd Per 00mr 60 nit W m ³) 19	ESTS en Te m) 80 /t 20 Liquic	S st) ♦ 0 100 21	UNDRA	L + Tor × (□ Lab △ Pock ♥ Field (k	IEAR ST vane + QU × Vane ⊑ et Pen. 4 Vane € Pa)	RENGTH	COMMENTS	ELEVATION
0		CLAY - silty				+	20	40 :	60 :	80) 100		50 1 :	00 1 :	150 200 :		
		-laminated - alternating layers of brown clay/light brown silt, moist, firm													: : :	_	
-		-intermediate to high plasticity															
-																	
-							-	:	-					-			
							÷	• • • • •	• • • •	••••					••••••		
-														 	 	_	
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-1																	200
									-								
-																-	
-								•••••	•						 		
-																	
_																	
5-																	208 -
2/8 1		REFUSAL - END HOLE AT 2.0m ON BEDROCK					÷	• • • • •	• • • •	••••				·····	·•••••		290
ID.N.		Notes:															
IN V		2. No sloughing observed.															
N L																	
-10.G							-		-				•				
2-NOV										••••							
3S - 2									•	••••							
9 1 2								•							÷		207
불_3																	297 -
009									-					-			
																•	
								• • • • •	•					; :			
LAUF																	
1 12																	
6015																	
HOLE																	000
4 ISBI						LO	GGF	D B	/: M	1att	Lote	cki			COMPL	ETION DEPTH: 1.98 m	296 -
GOF		AECOM				RE	VIEV	VED	BY:	Jer	emy	Fiebe	elkorn	C	COMPL	ETION DATE: 10/22/10	
2						PR	OJE	CT E	NGI	NE	ER:	Paul E	Barsalo	u		Page	1 of 1

PROJ	ECT:	Proposed Lagoon Geotechnical Investigation	С	LIEN	IT: M	anito	ba H	lydro)					TES	STHOLE NO: TP10-2	28
LOCA	TION:	Proposed Forcemain Alignment - 375742.310m E 623	3287	4.38	0m N									PR	OJECT NO.: 601577	39
				1ETH	OD:	Kom	atsu		<u>220 l</u>	_C					EVATION (m): 300.33	3
DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	◆ S 0	PENET * Dy PT (Sta (Blo 20 To Plastic 20	RATIC Beckinamic andarc ows/30 40 obtal Un (kN/m 18 MC 40	N TES er # Cone - Pen 1 0mm) 60 it Wt 19 19 19	TS ← Fest) ◆ 80 100 100 100 100 100 100 100 100		INED SH + Tor ∠ C □ Lab △ Pocke ♥ Field (kl	EAR STR /ane + NU × Vane □ vane □ vane Φ Pa) 15 15 15 15 15 15 15 15 15 15	ENGTH	COMMENTS	ELEVATION
(GOON TH-TP LOGS - 22-NUX-10.GPJ UMA WINN GDT 2/8/11		CLAY - silty -laminated - alternating layers of brown clay/light brown silt, moist, firm - intermediate to high plasticity REFUSAL - END HOLE AT 2.4m ON BEDROCK Notes: 1. No seepage observed; 2. No sloughing observed.					20			80 100		50 1	20 15	0 200		300 -
T HOLE 60157739 - LAURIE RIVER LAG																297 -
			1	I		LO	GGEI	D BY	Mat	t Lote	cki			OMPLI	ETION DEPTH: 2.44 m	1
Ч		AECOM				RE	VIEW	ED E	BY: J	eremy	· Fiebe	lkorn	C	OMPLI	ETION DATE: 10/22/10	
POG						PR	OJEC	T EN	IGIN	EER:	Paul B	arsalo	u		Page	1 of 1



Appendix C Bedrock Probe-Holes

Bedrock Probe-Holes

Test Hole ID	Location	Inferred Depth to Bedrock (m)
TH10-01	Proposed Force Main Alignment	1.07
TH10-02	Proposed Force Main Alignment	2.44
TH10-03	Proposed Force Main Alignment	2.44
TH10-04	Proposed Force Main Alignment	2.44
TH10-05	Proposed Force Main Alignment	2.44
TH10-06	Proposed Force Main Alignment	2.74
TH10-07	Proposed Force Main Alignment	1.52
TH10-08	Proposed Force Main Alignment	2.29
TH10-09	Proposed Force Main Alignment	Not encountered
TH10-10	Proposed Force Main Alignment	2.29
TH10-11	Proposed Force Main Alignment	2.13
TH10-12	Proposed Force Main Alignment	1.83
TH10-13	Proposed Force Main Alignment	1.22
TH10-14	Proposed Force Main Alignment	1.98
TH10-15	Proposed Force Main Alignment	2.74
TH10-101	Proposed Force Main Alignment	1.52
TH10-102	Proposed Force Main Alignment	1.52
TH10-103	Proposed Force Main Alignment	1.22
TH10-104	Proposed Force Main Alignment	1.22
TH10-105	Proposed Force Main Alignment	1.37
TH10-106	Proposed Force Main Alignment	1.22
TH10-107	Proposed Force Main Alignment	1.52
TH10-108	Proposed Force Main Alignment	1.52
TH10-109	Proposed Force Main Alignment	1.52
TH10-110	Proposed Force Main Alignment	1.22
TH10-111	Proposed Force Main Alignment	1.52
TH10-201	Proposed Outfall Alignment	1.52
TH10-202	Proposed Outfall Alignment	0.91
TH10-203	Proposed Outfall Alignment	0.30
TH10-204	Proposed Outfall Alignment	0.30
TH10-205	Proposed Outfall Alignment	0.30
TH10-206	Proposed Outfall Alignment	0.30
TH10-207	Proposed Outfall Alignment	0.30
TH10-208	Proposed Outfall Alignment	0.30
TH10-209	Proposed Outfall Alignment	0.30
N1	Proposed Lagoon Centreline (approx.)	2.44
N2	Proposed Lagoon Centreline (approx.)	1.85
N3	Proposed Lagoon Centreline (approx.)	1.65
N4	Proposed Lagoon Centreline (approx.)	2.13
N5	Proposed Lagoon Centreline (approx.)	1.85
N6	Proposed Lagoon Centreline (approx.)	2.44
N/	Proposed Lagoon Centreline (approx.)	1.85
N8	Proposed Lagoon Centreline (approx.)	1.35

AECOM

Appendix D Flexible Wall Perm. Results

HYDRAULIC CONDUCTIVITY DETERMINATION FLEXIBLE WALL (ASTM D 5084)



MATERIALS LABORATORY

99 Commerce Drive, Winnipeg, MB R3P 0Y7 Canada tel (204) 477-5381 fax (204) 284-2040

Client: Project: Job# Technician:	Manitoba H Laurie River GS 6015773 M. Lotec	ydro 5 Lagoon 9 ki	Sample: Test Hole: Depth: Date:		G1 TP10- January (-03 6, 2011		
		Material and	Test Desc	ription				
Material:	Clay-Silty	N	Iold Size:		Flexible	Wall		
Color:	Brown	Compactio	on Level Req.:	·	-			
Composition:		Moisture	Content Req.:		-			
Structure			Fluid Used		Deaired	Water		
Consistency:		FI	ulu Reservoir.		Bureti	les		
REMARKS: Rec	compacted							
Initial Wa	ter Content			Initial D	ensity M	easuren	nents	
Tare ID.	A33	Wt. s	ample wet	628.3	g			
Wet+Tare:	261.9 g		-		-			
Dry+Tare	208.3 g		1	2	3	4		
Tare:	8.10 g	Diam. (mm.)	72.30	72.30	72.40	72.40	Avg.=	72.35
Wt. Water	53.6 g	Length (mm)	77.40	77.40	77.30	77.00	Avg.=	77.28
Wt. Dry:	200.20 g							
	00 770/	Area=	41.11	cm^2		Gs =	2.7	
water Content	20.77%	Volume=	317.69	CM/3 Ma/m^2		e = Sr _	0.731	
		Dry Density=	1.560	Mg/m^3		n =	0.422	
Final Wa	ter Content			Final De	ensity Me	easurem	ents	
Tare ID.	R4	Wt. s	ample wet	633.40	g			
Wet+Tare:	995.6 g							
Dry+Tare	857.5 g	<u> </u>						
Tare:	362.60 g	Diam. (mm.)	72.40	72.50	72.60	72.60	Avg.=	72.53
Wt. Water	138.1 g	Length (mm)	76.60	77.00	77.50	77.20	Avg.=	77.08
vvt. Dry:	<i>494.90</i> g	A roo	11 21	cm∆2		<u>Ca</u> –	27	
Water Cont	27 90%	Area =	41.31 212 10	cm/3		GS =	2.1 0 736	
	21.30/0	Wet Density –	1 QRQ	Ma/m^3		е = Sr =	102 4%	
		Dry Density =	1.555	Mg/m^3		n =	0.424	

Consolidation Readings:

Cell Pressure:	20	psig.
Bottom Back Pressure:	15	psig.
Top Back Pressure:	15	psig.

		Room	Burette	e Readings	
Date	Time	Temp (deg C)	Top (ml)	Bottom (ml)	Cell (ml)
9-Dec-10	17:45	24.9	5.12	5.84	22.90
10-Dec-10	09.15	25.5	5.48	6.28	23 30
10-Dec-10	14:00	25.5	5.52	6.20	23.40
10-Dec-10	10:00	25.5	5.52	6.50	23.40
11-Dec-10	19:00	23.4	5.76	0.50	24.00
13-Dec-10	07:49	24.3	6.01	6.65	24.50
13-Dec-10	15:45	25.1	6.03	6.67	24.60
14-Dec-10	10:40	26.2	6.12	6.70	24.70
15-Dec-10	16:00	25.5	6.22	6.76	24.90
16-Dec-10	17:00	25.4	6.34	6.80	25.00
17-Dec-10	14:40	24.9	6.44	6.86	25.30
19-Dec-10	15:20	25.5	6.56	6.90	25.50
20-Dec-10	09.10	26.3	6.56	6.90	25.50
20-Dec-10	03.10	20.3	0.00	0.50	23.30
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Consolidation Results:

Cell Press. =	137.90	kPa
Bottom=	103.42	kPa
Top=	103.42	kPa
Pressure		
Difference	0.00	kPa

	Тор	Bottom		Cell	Total	
Elapsed	Volume	Volume		Volume	Volume	Volume
Time	Change	Change		Change	Change	Strain
(DAYS)	(CC)	(22)		(CC)	(CC)	(%)
0	0	0		0	0	0
0.646	-0.36	-0.44		-0.40	-1.20	-0.38
0.844	-0.40	-0.46		-0.50	-1.36	-0.43
2.052	-0.66	-0.66		-1.10	-2.42	-0.76
3.586	-0.89	-0.81		-1.60	-3.30	-1.04
3.917	-0.91	-0.83		-1.70	-3.44	-1.08
4.705	-1.00	 -0.86		-1.80	 -3.66	-1.15
5.927	-1.10	-0.92		-2.00	-4.02	-1.27
6.969	-1.22	-0.96		-2.10	 -4.28	-1.35
7.872	-1.32	-1.02		-2.40	 -4.74	-1.49
9.899	-1.44	-1.06		-2.60	 -5.10	-1.61
10.642	-1.44	-1.06		-2.60	 -5.10	-1.61
-						
<u> </u>						
<u> </u>						

Permeation Readings:

Cell Press. =	20	psi
Bottom=	16	psi
Top=	14	psi

	I		Burette F	Readings	
Date	Time	Temp (deg C)	Top(ml)	Bottom (ml)	Cell (ml)
20-Dec-10	10:35	26.2	9.88	0.14	25.50
20-Dec-10	17:00	25.0	9.42	0.66	25.60
21-Dec-10	08:00	23.9	8.44	1.74	25.90
21-Dec-10	14:26	23.5	7.96	2.24	25.90
22-Dec-10	08:06	23.9	6.94	3.33	26.10
22-Dec-10	16:00	24.3	6.45	3.81	25.90
24-Dec-10	11:30	24.1	4.02	6.30	26.30
	Avg	Гетр 24.4 С			

Permeation Results:

Cell Press. =	137.90	kPa
Bottom=	110.32	kPa
Top=	96.53	kPa
Pressure		
Difference	13.79	kPa

Elapsed	Change	Change	Diff.	Diff.	Ratio	0	Average
Time	Тор	Bottom	Тор	Bottom	Bot./T	ор	Volume
(DAYS)	(ml)	(ml)	(ml)	(ml)			(ml)
	Тор	Bottom					
0.000	0.00	0.00	-	-	-		0.00
0.267	0.46	0.52	-	-	-		0.49
0.892	1.44	1.60	1.44	1.60	0.90		1.52
1.160	1.92	2.10	1.46	1.58	0.92		2.01
1.897	2.94	3.19	1.50	1.59	0.94		3.07
2.226	3.43	3.67	1.51	1.57	0.96		3.55
4.038	5.86	6.16	2.92	2.97	0.98		6.01
Regression Output:				Data from 0.0 to	o 4.038 days		
					,		
Std Err of Y Est	0 129403			Degrees of Free	dom	4	
R Squared	0.996668			Trend Slope	, aont		ml/dav
No. of Observations	7			Std Err of Coef.		0.038359	ini, ady
				010 20 00 00000			
Hydraulic Conductivity		•					
	y Result	5					
Q = 1.72E-11	m^3/sec	5	i =	18.19			
$\Delta = 1.11E_{-0.2}$	m^2	-	K(+) _	2 30F-10	m/sec		
A = 4.772-03 dh = 1.41	m	Ri	+(21 7) -	2.30L-10 0 901222	11/300		
dl = 0.077075	m		$\mathbf{k}(2\mathbf{n}) =$	2 07E 10	m/soc		
u = 0.077275	111.		r(20) =	2.07 - 10	11/366		

HYDRAULIC CONDUCTIVITY DETERMINATION FLEXIBLE WALL (ASTM D 5084)



MATERIALS LABORATORY AECOM

99 Commerce Drive, Winnipeg, MB R3P 0Y7 Canada tel (204) 477-5381 fax (204) 284-2040

Client: Project: Job# Technician:	Manitoba Hydro Laurie River GS Lag 60157739 M. Lotecki	goon	Sample: Test Hole: Depth: Date:	C	T4 TP10- 2' December	- <u>11</u> 20, 2010		
	Μ	aterial and	Test Desc	ription				
Material:	Clav-Silty W/alternating silt lav	ers	Mold Size:		Flexible	Wall		
Color:	Brown / It. brown	Compact	ion Level Req.:	:	-	-		
Composition:		Moisture	Content Req.:	:	-			
			Fluid Used		Deaired V	Water		
Structure:	Layered	F	luid Reservoir:		Burett	es		
Consistency:	Firm - easily crumbled							
REMARKS								
Initial	Water Content			Initial D	ensity M	easuren	nents	
Tare ID.	L58	Wt. s	sample wet	548.3	a			
Wet+Tare:	296.7 g				9			
Drv+Tare	230.8 g		1	2	3	4		
Tare:	5.50 g	Diam. (mm.)	72.10	72.10	72.20	72.00	Avg.=	72.10
Wt. Water	65.9 g	Length (mm)	72.20	72.00	72.10	72.00	Avg.=	72.08
Wt. Dry:	225.30 g	-						
		Area=	40.83	cm^2		Gs =	2.7	
Water Content	29.25%	Volume=	294.27	cm^3		e =	0.873	
		Wet Density=	1.863	Mg/m/3		Sr =	90.5%	
		Dry Density=	1.442	Mg/m^3		n =	0.400	
Final V	Water Content			Final De	ensity Me	asurem	ents	
Tare ID	X41	\ \/ t	sample wet	558 80	a			
Wet+Tare	658 a	vvl			3			
Dry+Tare	517.5 a							
Tare:	99.30 g	Diam. (mm.)	71.00	71.70	72.20	72.00	Avg.=	71.73
Wt. Water	<u> </u>	Length (mm)	71.50	71.60	71.80	71.80	Avg.=	71.68
Wt. Dry:	<i>418.20</i> g			1	•		-	
		Area =	40.40	cm^2		Gs =	2.7	
Water Cont.	33.60%	Volume =	289.60	cm^3		e =	0.869	
		Wet Density =	1.930	Mg/m^3		Sr =	104.3%	
		Dry Density =	1.444	Mg/m^3		n =	0.465	

Consolidation Readings:

Cell Pressure:	20	psig.
Bottom Back Pressure:	15	psig.
Top Back Pressure:	15	psig.

		Room	Burette	Readings	
Date	Time	Temp (deg C)	Top (ml)	Bottom (ml)	Cell (ml)
8-Dec-10	16:45	26.2	6.02	5.96	14.00
9-Dec-10	08:40	26.0	6.46	6.48	14.50
10-Doc-10	00:40	25.5	6.96	6 99	15.00
10-Dec-10	14:00	25.5	0.00	0.00	15.00
10-Dec-10	14:00	25.5	0.09	0.92	15.10
11-Dec-10	19:00	25.4	7.12	7.16	15.70
13-Dec-10	07:49	24.3	7.32	7.34	15.70
13-Dec-10	15:45	25.1	7.33	7.35	15.70
14-Dec-10	10:40	26.2	7.36	7.40	15.70
15-Dec-10	16:00	25.5	7.42	7.46	15.80
16-Dec-10	17:00	25.4	7.46	7.50	15.90
17-Dec-10	14:40	24.9	7.52	7.54	16.20
19-Dec-10	15:20	25.5	7.54	7.56	16.30
20-Dec-10	09:10	26.3	7.54	7.56	16.30
					
┣━━━━━┥					
┣━━━━━┥					
├ ────┤					
					_
1					

Consolidation Results:

Cell Press. =	137.90	kPa
Bottom=	103.42	kPa
Top=	103.42	kPa
Pressure		
Difference	0.00	kPa

	Тор	Bottom		Cell	Total		
Elapsed	Volume	Volume		Volume	Volume		Volume
Time	Change	Change		Change	Change		Strain
(DAYS)	(00)	(00)		(CC)	(CC)		(%)
0	0	0		0	0		0
0.663	-0.44	-0.52		-0.50	-1.46		-0.50
1.688	-0.84	-0.92		-1.00	-2.76		-0.94
1.885	-0.87	-0.96		-1.10	-2.93		-1.00
3.094	-1.10	-1.20		-1.70	-4.00		-1.36
4.628	-1.30	-1.38		-1.70	-4.38		-1.49
4.958	-1.31	-1.39		-1.70	-4.40		-1.50
5.747	-1.34	-1.44		-1.70	-4.48		-1.52
6.969	-1.40	-1.50		-1.80	-4.70		-1.60
8.010	-1.44	-1.54		-1.90	-4.88		-1.66
8.913	-1.50	-1.58		-2.20	-5.28		-1.79
10.941	-1.52	-1.60		-2.30	-5.42		-1.84
11.684	-1.52	-1.60		-2.30	-5.42		-1.84
<u> </u>		 			 		
			1			I	

Permeation Readings:

Cell Press. =	20	psi
Bottom=	16	psi
Top=	14	psi

		Burette Readings				
Date	Time	Temp (deg C)	Top(ml)	Bottom (ml)	Cell (ml)	
20-Dec-10	10:00	26.2	9.66	0.40	16.30	
20-Dec-10	10:01	26.2	8.76	1.22	16.30	
20-Dec-10	10:02	26.2	7.64	2.14	16.30	
20-Dec-10	10:04	26.2	6.44	3.60	16.30	
20-Dec-10	10:06	26.2	5.08	4.74	16.30	
20-Dec-10	10:08	26.2	3.64	6.16	16.30	
20-Dec-10	10:10	26.2	2.72	7.26	16.30	
20-Dec-10	10:12	26.2	1.60	8.28	16.30	
20-Dec-10	10:16	26.2	-1.02	10.90	16.30	
20-Dec-10	10:18	26.2	-2.56	12.44	16.30	
20-Dec-10	10:20	26.2	-3.90	13.80	16.30	
20-Dec-10	10:22	26.2	-5.14	15.02	16.30	
20-Dec-10	10:24	26.2	-6.36	16.14	16.30	
20-Dec-10	10:26	26.2	-7.22	17.08	16.30	
20-Dec-10	10:28	26.2	-8.12	17.86	16.30	
20-Dec-10	10:30	26.2	-8.94	18.78	16.30	
Avg Temp 26.2 C						

Permeation Results:

Cell Press. =	137.90	kPa
Bottom=	110.32	kPa
Top=	96.53	kPa
Pressure		
Difference	13.79	kPa

Elapsed	Change	Change	Diff.	Diff.	Ratio	Average
Time	Тор	Bottom	Тор	Bottom	Bot./Top	Volume
(DAYS)	(ml)	(ml)	(ml)	(ml)		(ml)
	Тор	Bottom				
0.000	0.00	0.00	-	-	-	0.00
0.001	0.90	0.82	-	-	-	0.86
0.001	2.02	1.74	2.02	1.74	1.16	1.88
0.003	3.22	3.20	2.32	2.38	0.97	3.21
0.004	4.58	4.34	2.56	2.60	0.98	4.46
0.006	6.02	5.76	2.80	2.56	1.09	5.89
0.007	6.94	6.86	2.36	2.52	0.94	6.90
0.008	8.06	7.88	2.04	2.12	0.96	7.97
0.011	10.68	10.50	3.74	3.64	1.03	10.59
0.013	12.22	12.04	4.16	4.16	1.00	12.13
0.014	13.56	13.40	2.88	2.90	0.99	13.48
0.015	14.80	14.62	2.58	2.58	1.00	14.71
0.017	16.02	15.74	2.46	2.34	1.05	15.88
0.018	16.88	16.68	2.08	2.06	1.01	16.78
0.019	17.78	17.46	1.76	1.72	1.02	17.62
0.021	18.60	18.38	1.72	1.70	1.01	18.49
De anno e cleare Ocatavata						
Regression Output:				Data from 0.0 to	o 0.021 days	
Std Err of Y Est	0.377711			Degrees of Free	edom 4	
R Squared	0.99668			Trend Slope	897.1863	3 ml/day
No. of Observations	16			Std Err of Coef.	13.84001	
Hydraulic Conductivity Results						
Q = 1.04E-08	m^3/sec	5	i =	19.50		
A = 4.08E-03	m^2		K(t) =	1.30E-07	m/sec	
dh = 1.41	m.	Rt	t(21.7) =	0.865491		
dl = 0.072075	m.		K(20) =	1.13E-07	m/sec	



Appendix B

Berm Stability Report


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Memorandum

То	Paul Barsalou	Page 1
СС	Greg Grahn, Omar Al-Khayat	
Subject	Proposed Laurie River Waste Dyke Stability	water Lagoon
From	Mustafa Alkiki	
Date	November 26, 2012	Project Number 60265529 (402)

1. INTRODUCTION

This memorandum summarizes the findings of an additional stability analysis for dykes greater than 3.0 m high at the proposed wastewater treatment lagoon in Manitoba Hydro Laurie River Generating Station at Laurie River, MB. Originally, AECOM memorandum dated February 08, 2011 discussed the findings from October 2010 sub-surface investigation and provided recommendations related to the design and construction of the proposed facility. The previous analysis was limited to 3.0 m high dykes.

2. Dykes Stability

A stability analysis was completed using GeoStudio 2007 software package for the proposed 3.5 m high dykes. The analysis consider short term condition (end of construction) and long term condition for two scenarios, the full reservoir level at 1 m freeboard and minimum reservoir level at 2 m freeboard, as follows:

- Steady state case of full reservoir at 1 m freeboard (Figure 01).
- Steady state case of min. reservoir at 2 m freeboard (Figure 02).
- Short term End of Construction Condition (Figure 03).

An adequate factor of safety (FS) against slope instabilities should be achieved for the proposed dykes. In this regard, a design objective FS of 1.50 and 1.30 has been selected for long and short term conditions, respectively. Analysis was completed using a soil profile based on the 2010 investigation. The surface geometry is based on existing cross section (as provided from water group) and 3.5 m high clay fill with side slopes of 4H:1V. The strength parameters assigned to the subsoil and fill material are presented in Table 01 and were based on correlations with soil index parameters and past experience



Table 01 – Soil Properties for Stability Modelling

Soil	Unit Weight (kN/m3)	Cohesion (kPa)	Friction Angle (Degrees)		
Clay Fill	18	5	17		
Silty Clay	18	5	17		

The results of the stability analysis indicate that current configuration design (up to 3.5 m high and 4H:1V side slopes) would achieve the objective FS of 1.50 under the long term and 1.30 under the short term. The results of stability analysis are presented graphically in attached figures.

Should you require any further assistance, please do not hesitate to contact the undersigned.

Respectfully submitted,

AECOM Canada Ltd.

Mapert

Mustafa Alkiki, E.I.T. Geotechnical Engineering

Reviewed By:

Faris Khalil, P.Eng. Manager, Geotechnical Engineering



Appendix A Figures



Figure 01



Figure 02



Figure 03



Appendix C

Detailed Lagoon Stability Calculations

Waste Stabilization Pond - Design Check Laurie River - Option 1

Design Parameters

Piped Flow Population (Based on 2 six-month periods)

	- 1st Period Population (182 days)	20 persons
	- 2nd Period Population (183 days)	5 persons
Hydraulic	Loading Loading Rate Kitchen Waste Rate for 1st Period Kitchen Waste Rate for 2st Period Total	250 L / Capita / Day 100 L / Capita / Day 200 L / Capita / Day 1,685,750 litres / year 1,686 m ³ / year
	Truck Waste (from Power House) - for 365 days	100 L / Day 37 m ³ / year
	WTP Back Wash	20% Percent of total Loading 344 m ³ / year
	Estimated Infiltration	0 L / mm pipe diam / km pipe / day
	Total Hydraulic Loading	2,067 m ³ / year
Organic Lo	Dading <u>Average Loading</u> Based on average of the 2 periods	0.076 kg BOD / capita / day 13 persons 0.952 kg / day
	Average Total Organic Loading	0.95 kg BOD / day
	Maximum Loading Maximum Loading	0.076 kg BOD / capita / day 20 persons 1.520 kg / day
	Maximum Total Organic Loading	1.52 kg BOD / day
Primary C	ell Design Average Loading Maximum loading	0.95 kg BOD / day 1.52 kg BOD / day Design for Average
Check Sur	face Area a required Average 0.95 kg BOD/d / 22 kg/day *10000m2/ha Maximum	431 m ²
	1.52 kg BOD/d / 22 kg/day * 10000m2/ha	691 m ²
	Objective is 691 m ² but modify the area based or	Physical Constructability

Design Dimensions

Primar	y Cell :	Secondary	Cell:		
- Recta	 Rectangular shaped 				
- 7.5m	- 32m x 30m Bottom				
- 1.5m	- 1.2m Depth of liquid				
- Stora	- 0.3m of Sludge Storage = 31				
- 1m F	- 1m Free board				
- 4:1 S	ide slopes	- 4:1 Side s	slopes		
Bottom Area = 225	m ²	960	m ²		
Surface Area = 819	m ² (Larger than required)	1848	m ²		
Total Volume = 747	m ³	2,070	m ³		
Storage Volume = 374	m ³ (1/2 the total)	1,759	m ³		
Total Storage Volume =	2,133 m ³ > Required Storag	e = 2072 m ³			



Common Berm Width = 3m

 $V_{Primary} =$ 747 m³

Outside Berm Width = 3m

Detailed Calculations:

	V =	h [(ab)+4 [(a+hs) (b+hs)+(a+2hs) (b+2hs)]]						
Primary Cell:		6 Secondary Cell:			Secondary C	ell:		
Length (a) =	7.5	Length (a) =	32		Length (a) =	34.4	l	(0.3m above bottom)
Width (b) =	30	Width (b) =	30		Width (b) =	32.4	٦	
Slope (s) =	4	:1 Slope (s) =		4 :1	Slope (s) =		4 :1	
Depth (h) =	1.5	Depth (h) =	1.5		Depth (h) =	1.2		

2,070 m³

V_{Secondary} = 1,759 m³

V_{Secondary} =