



November 21, 2017

Mr. John Atkinson
Project Officer 2
Planning, Property and Development
City of Winnipeg

Dear Mr. Atkinson,

Subject **Hydrogeological Test Drilling Results and Analysis**
La Barrière Park – 4403 Waverley St. - City of Winnipeg, Manitoba

Friesen Drillers Limited is pleased to present this letter detailing the results and analysis of our hydrogeological test drilling for a potential groundwater supply for washroom facilities at La Barrière Park. The work included hydrogeological test drilling and groundwater sampling to confirm the on site hydrogeological conditions. The following paragraphs outline the results of the work undertaken.

Project Background and Site Setting

Friesen Drillers was retained by the City of Winnipeg to undertake a preliminary hydrogeological investigation for a potential groundwater supply for new public washroom facilities in the La Barrière Park. The preliminary desktop investigation indicated that the bedrock aquifers at the site were expected to produce salty groundwater. In addition, regional geologic mapping suggested a potential for inter till sand and gravel deposits to be present at the site.

Friesen Drillers was subsequently retained by the City of Winnipeg to conduct on site test drilling and water sampling to assess the local hydrogeological conditions. A Groundwater Exploration Permit (GEP) was obtained from Manitoba Sustainable Development (MSD) on behalf of the City of Winnipeg prior to the commencement of test drilling activities. A copy of the GEP is attached.

La Barrière Park is located along the La Salle River, a few miles south of the City of Winnipeg on Waverley Street. The park encompasses approximately 320 acres in a region with relatively low topographical relief. Surface drainage is towards the La Salle and the Red Rivers. The park is host to various amenities which include picnic shelters, nature trails, and baseball diamonds. It is our understanding that the existing park washrooms have been closed and that outhouses have been placed on site. The location of the park is shown below in Figure 1.



Figure 1 – La Barrière Park site along the La Salle River, south of the City of Winnipeg. (source – Google Earth, 2017)

Regional Geological/ Hydrogeological Setting

From regional maps, the geology underlying La Barrière Park consists of silty grey clay, approximately 40 to 50 feet thick, overlying a 5 to 10 foot thick deposit of calcareous grey clay till. The till is noted to contain some layers of sand and gravel. Underlying the clay till unit in some locations is a fractured carbonate rock rubble zone. The thickness of the rubble zone varies within a few feet across the area. Some karstic features have also been noted in the area. The rubble zone gradually changes into the more competent, fractured carbonate rock of the Fort Garry Member of the Red River Formation. The Red River formation typically consists of alternating layers of limestone and dolostone with basal shale layers. The Red River Formation is in turn underlain by the Winnipeg Formation clastic (sandstone and shale) unit, and Precambrian basal bedrock (Render, 1970). A geological cross section is shown below as Figure 2.

Some of the well logs in the area around La Barrière Park indicate the presence of a sand and gravel layer, up to 30 feet thick, that was intersected approximately 40 feet below grade. The sand and gravel is not likely to be continuous throughout the area.

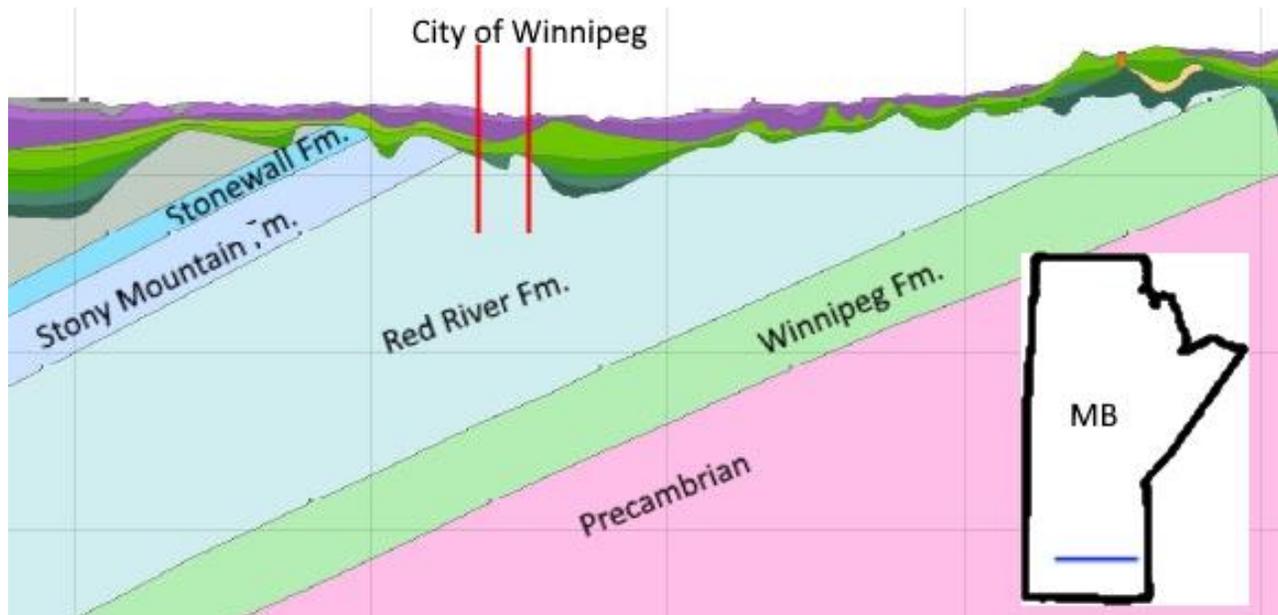


Figure 2 – Geological cross section through Southern Manitoba (source – Manitoba Geological Survey, 2013)

The general hydrogeological conditions of the area were determined from a review of the applicable hydrogeological reports and information available through Manitoba Sustainable Development (MSD). Groundwater aquifers in the Winnipeg area can be found in the overburden till (in specific places), the Red River Formation carbonate, and in the Winnipeg Formation sandstone (Betcher et. al, 1995). Regional mapping conducted in the area by Betcher (1995), identified a regional groundwater quality boundary in the major bedrock aquifers. The groundwater quality maps indicate that groundwater in the both the carbonate and sandstone bedrock aquifers is saline in the region west from the Red River.

From regional mapping it is apparent that La Barrière Park is located in an area where the groundwater quality in the bedrock aquifers is known to be brackish to saline. In these saline areas, groundwater quality typically deteriorates with increasing depth below the surface. It is therefore recommended to pursue a groundwater supply from either the intra-till sand and gravel deposits or the shallow carbonate bedrock aquifer.

Figure 3, shown on the following page, contains the general distribution of sand and gravel aquifers in the area south of the City of Winnipeg. From Figure 3, La Barrière Park is located in an area with few widely scattered sand and gravel aquifers. This result is supported by the sand and gravel layers intersected in some of the nearby private wells and not in others. It is further noted from Figure 3 that major buried sand and gravel aquifers appear to terminate in the area just north and west of the park.

Regional Geological/Hydrogeological Setting (cont'd)

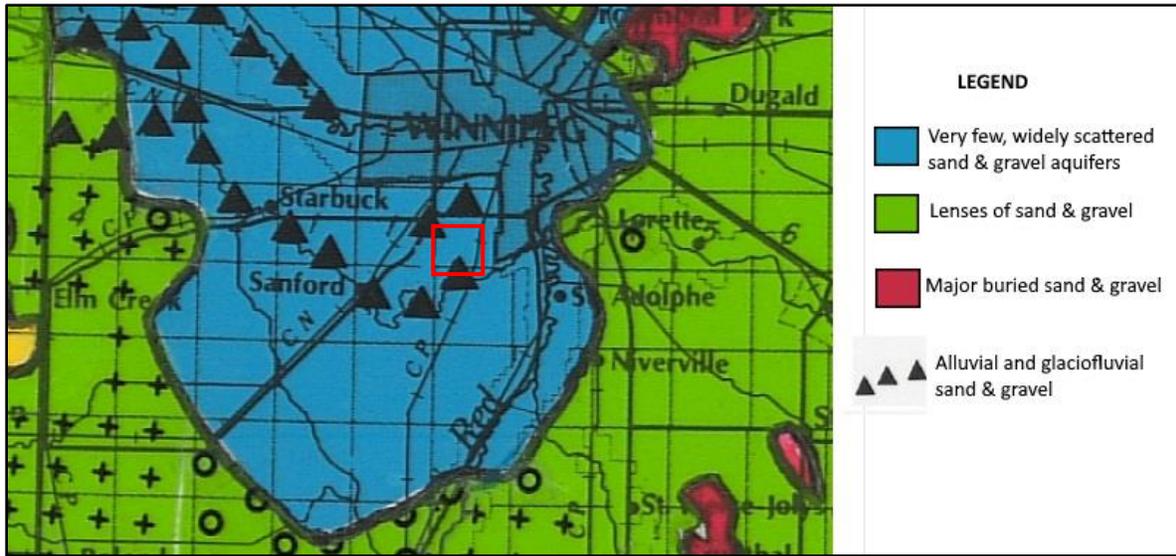


Figure 3 – Distribution of surficial sand and gravel aquifers in the Winnipeg area; location of La Barrière Park indicated in red. (source – Rutulis, 1986)

The nearest maintained monitoring station (G05OC020) to the park site is located approximately four miles east-southeast of the park along the Red River. Figure 4, shown below, contains a plot of the hydrograph record since the late 1980s. A review of the Figure 4 reveals seasonal fluctuations of groundwater levels, with a typical water level between 228 to 231 meters Geodetic. The approximate ground elevation is 233 m Geodetic. Over the past twenty years, the hydrograph record has reflected seasonal and climatic fluctuations, with water levels being relatively stable. Since 2000, water levels have been on a progressive rise, although there was a minor change into a slightly declining trend after 2011. Past 2012, water levels appear to be rising again.

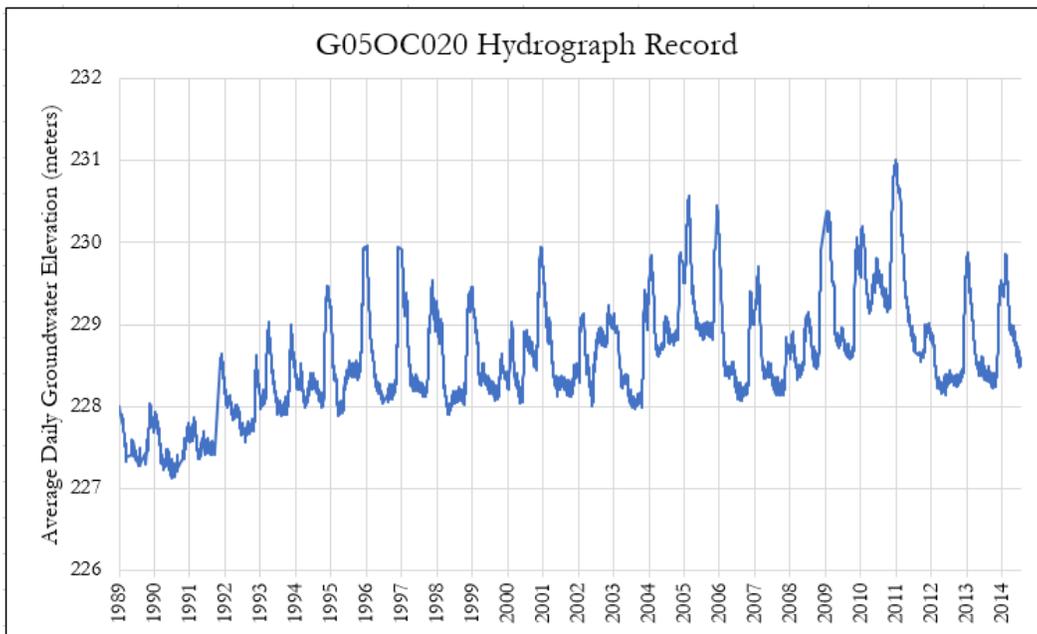


Figure 4 – Carbonate aquifer water level hydrograph – G05OC020 (source – MSD, 2016)

The geochemistry of groundwater in the carbonate aquifer was assessed through a review of available provincial and private monitoring wells, including the results from the closest provincial station (G05OC020). The groundwater from this analysis plots as chloride/sulfate type

Regional Geological/Hydrogeological Setting (cont'd)

groundwater, which indicates moderate-poor groundwater quality. It should be noted that G05OC020 is located east of the park and that groundwater quality in the bedrock aquifers generally deteriorates in the westerly direction and vertically with depth. In addition, groundwater quality often gets worse with pumping.

Field Investigations

Hydrogeological Test Drilling

Friesen Drillers mobilized to La Barriere Park on August 7-8, 2017, and drilled three test holes at the site. The locations of the test holes are shown below in Figure 5. Underground utility clearances were obtained prior to drilling activity. The first test hole (TH-01) was drilled near to the proposed location of the washroom facility. The two remaining test holes were drilled at locations away from TH-01 in an attempt to intersect suitable sand and gravel layers. The details of the test holes are shown below as Table 1. The drillers logs are also attached.



Figure 5 – Three test well locations at La Barriere Park. (source – Google Earth, 2017)

Table 1 Test Hole Details La Barrière Park – 4403 Waverley St. - City of Winnipeg, Manitoba								
Well ID	Casing Diameter	Depth Casing	Zone of Completion	Total Depth	Grout	Grout Placement	UTM X	UTM Y
TH-01	5 inch PVC	62 ft.	62-67 ft. Sand pack 55-71 ft.	71 ft.	Bentonite	0-95 ft.	631593.95 m E	5509088.34 m N
TH-02	N/A	N/A	N/A	66 ft.	Bentonite	0-66 ft.	631427.82 m E	5509098.76 m N
TH-03	N/A	N/A	N/A	76 ft.	Bentonite	0-76 ft.	631586.94 m E	5508694.39 m N

Table 1 - Test hole details – La Barriere Park.

Hydrogeological Test Drilling (Cont'd)

The bedrock aquifers underlying La Barriere Park are known to produce saline groundwater. Consequently, the highest quality groundwater in the area will be from either local sand and gravel deposits which may or may not be present in the overburden, or from the shallowest regions of the carbonate bedrock aquifer. Based on these conditions, the first test hole (TH-01) was drilled proximal to the washroom facility to reduce any potential hookup costs. Since the drilling of TH-01 did not intersect sand and gravel layers, a PVC test well was installed into the rubble zone at the top of the bedrock to test the groundwater quality and capacity of the bedrock at the site. As hydrogeological data on the bedrock aquifer would be available from TH-01, the following test holes (TH-02 and TH-03) did not require PVC wells to be constructed, and the test holes were drilled down to the bedrock in an attempt to intersect sand and gravel. If test holes, TH-02 or TH-03 would have intersected sand and gravel, a screened well would have been constructed. In the absence of sand and gravel, TH-02 and TH-03 were sealed as per provincial regulations.

The test holes were drilled until either a sand layer or the carbonate bedrock was intersected, resulting in total borehole depths of 66-77 feet. The stratigraphy between the test holes was similar and generally consisted of clay from surface down to 40 feet below grade. Below the clay, a layer of glacial till was intersected, with a total thickness of approximately 25-30 feet, which lay directly upon the carbonate bedrock. The depth to bedrock was shown to increase towards the south of the site. It should be noted that there were no significant sand or gravel deposits intersected during the test drilling.

A rubble zone was encountered at the upper bedrock surface in TH-01 and TH-02. This rubble zone was screened off in the construction of test well TH-01. There was no significant rubble zone intersected in TH-03.

Test hole TH-01 was constructed using 5 inch diameter PVC casing through the overburden and was drilled open hole in the carbonate bedrock to final depth. The PVC casing was grouted in place with bentonite. A 4 inch diameter, 15 slot, stainless steel wire wound screen was installed in the rubble zone over the interval of 62 to 67 feet below grade. The screen was set in place and a sand pack was poured into the annular space over the interval of 55 to 71 feet below grade. Based on manufacturers specifications, the screen is designed for a maximum flow rate of 44 U.S. Gallons Per Minute (U.S.G.P.M.). This flow rate assumes a maximum entrance velocity of 0.1 ft./second. Pumping at higher rates may cause sand and other sediment to be pumped through the screen.

Upon completion of the test drilling work, test holes TH-02 and TH-03 were sealed according to provincial regulations.

Pumping Test and Aquifer Characterization

Following the installation of TH-01, a short term pumping test was conducted to assess the well capacity. The results of the test are summarized below in Table 2. The pumping test was conducted using a 1 HP pump, with power supplied by an on site generator. The discharge rate was measured by timing known volumes of discharged water. The water levels in the well were measured manually at regular intervals using a depth sounder.

Pumping Well	Static Water Level	Pumping Water Level	Pumping Rate	Drawdown	Specific Capacity
TH-01	20.6 ft.	55.8 ft.	24 U.S.G.P.M.	35.2 feet	0.68 U.S.G.P.M./ft.

Table 2 - Pumping test parameters for TH-01, La Barriere Park.

The pumping test results indicate that the well should be capable of producing approximately 25 U.S.G.P.M. This estimate assumes a static groundwater level of 21 feet below grade and a pump set at the bottom of the casing. It is likely that this amount of water would be sufficient for the proposed washroom facilities.

An estimation of aquifer transmissivity was undertaken as part of the site assessment. The specific capacity results from TH-01 were applied using the method developed by Razack and Huntley (1991) to estimate the transmissivity of the carbonate aquifer at La Barriere Park. The calculated results are shown in Table 3, shown on the following page.

Pumping Test and Aquifer Characterization

Table 3 Aquifer Transmissivity La Barrière Park – 4403 Waverley St. - City of Winnipeg, Manitoba			
Method	Pumping Rate	Specific Capacity	Transmissivity
Razack and Huntley (1991)	24 U.S.G.P.M.	0.68 U.S.G.P.M./ft.	6,800 U.S.G.P.D./ft.
Regional Mapping (Baracose, 1988)	-	-	10,000-20,000 U.S.G.P.D./ft.

Table 3 – Estimate of transmissivity from specific capacity; regional transmissive values provided for comparison -La Barrière Park.

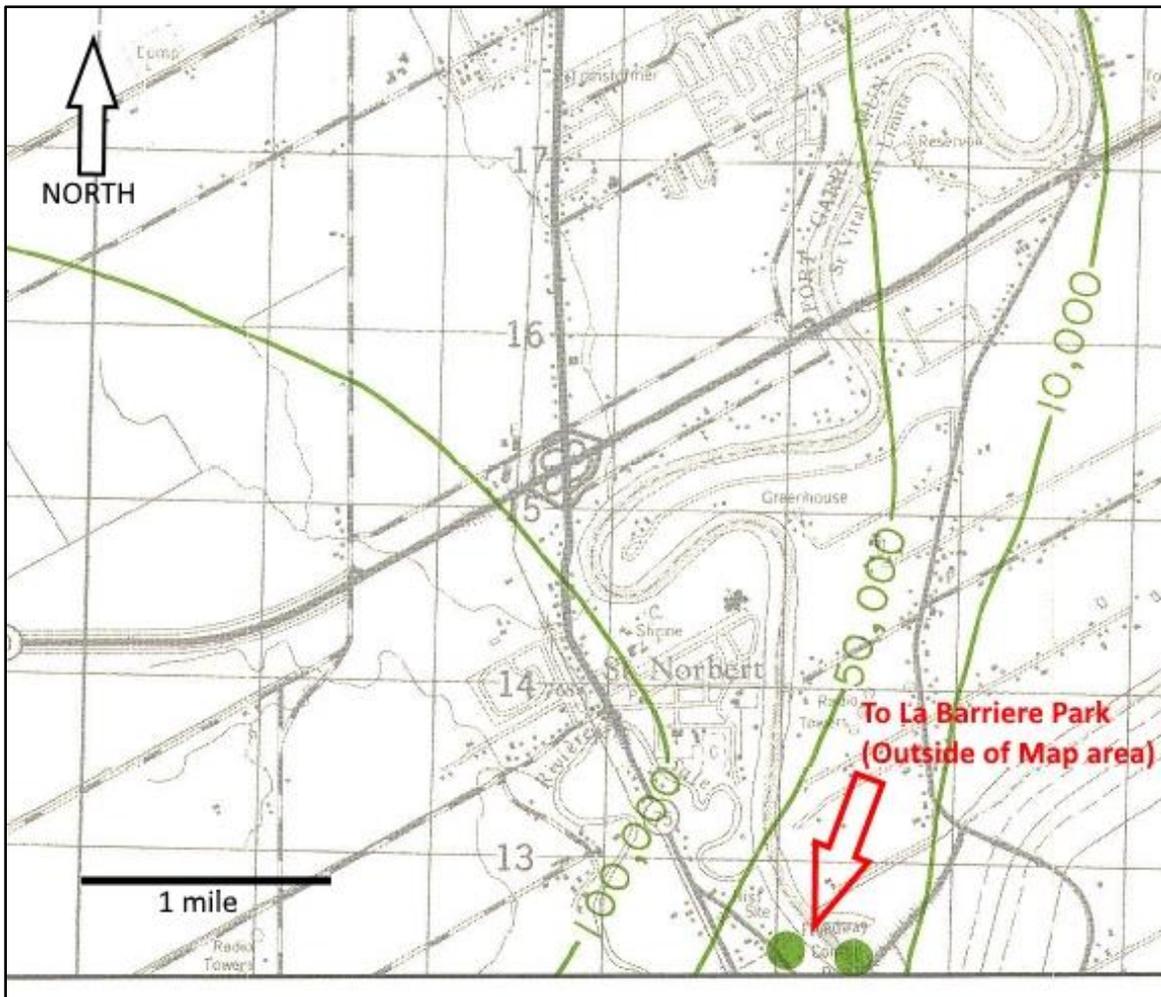


Figure 6 – Regional transmissivity (U.S.G.P.D./ft.) mapping of the Winnipeg area; Location of La Barrière Park is a few miles outside the map area to the south as indicated by red arrow. (source – Baracose, 1983)

The results of the transmissivity estimation from TH-01 are similar, though somewhat lower than the results indicated by the regional transmissivity mapping. The lower transmissivity value could be attributed to a number of factors. First, the construction of TH-01 is designed to essentially skim the shallowest groundwater from the aquifer. Consequently, the well does not intersect many water bearing fractures and would likely underestimate the aquifer transmissivity. Second, the regional mapping was conducted for the Winnipeg area, with the results extrapolated to the La Barrière Park site. It is possible, given the apparent trend of the isograd lines in Figure 6, that regional mapping at the site may estimate transmissivity to be below 10,000 U.S.G.P.D./ft. Ultimately, a transmissivity value in the range of 10,000 U.S.G.P.D./ft. is considered to be reasonable for the La Barrière Park site.

To fulfill the conditions set out in the GEP, an inventory of all private and commercial wells within a one mile radius of the location of test drilling was conducted. The inventory was conducted using the MSD GWDRILL database (2016). The results of the inventory are shown below in Table 4. In total, one domestic well was identified within the mile radius from TH-01. It should be noted that the current status of the identified well is not known and the location of the well was not verified.

The well log indicates steel casing to a depth of 96 feet below grade and have a total depth of 109 ft. The bedrock aquifer was noted to become salty at 105 feet below grade.

Table 4 Well Inventory – 1 mile radius La Barrière Park – 4403 Waverley St. - City of Winnipeg, Manitoba										
No.	Location	Owner	Driller	Well Use	Depth of Casing (ft.)	Date	Depth (ft.)	S.W.L. (ft.)	P.W.L. (ft.)	Rate igpm
1	NW-36-8-2E	M Sherwood	Mondor Drillers	P	96.0	1970	109.0	21.0	24.0	6.0
Notes	All information sourced from Manitoba Sustainable Development – GWDRILL, (2016 edition) Friesen Drillers Limited has not verified or field confirmed any data present in this table. All yields and static water levels are as reported and have not been verified by Friesen Drillers Limited. Current well use or operations are unknown for all wells listed. S.W.L. – Static water level; P.W.L. – Pumping water level; N.A. – Not provided or not available; P – Production;									

Table 4 – Well inventory results, 1 mile radius. (Source- MSD, 2016)

Groundwater Analytical Sampling

A groundwater sample collected from TH-01 was sent to an accredited laboratory for routine geochemical analysis. A trilinear plot of major ion concentrations is shown on the following page as Figure 6. The groundwater chemistry from a nearby provincial monitoring well is included for comparison. A copy of the laboratory report is also attached (L1972633).

The samples plot as moderate to poor quality sodium/potassium/chloride type groundwater. Highlights of the results are as follows:

- Total Dissolved Solids – 4,990 mg/L
- Chloride – 2,210 mg/L
- Hardness – 1,440 mg/L (analysis may be biased high as per laboratory comments)
- Iron – 2.7 mg/L

The concentration of nitrate was below detection limits in the sample from TH-01. The confined aquifer conditions at the site offer good protection to the bedrock aquifers in the tested area.

Results from the testing indicate that groundwater quality at the site is saline and relatively poor. The suitability of the groundwater quality for use at the site should be assessed by those designing the washroom facility. It should also be noted that the water quality could get worse with pumping.

Groundwater Analytical Sampling (Cont'd)

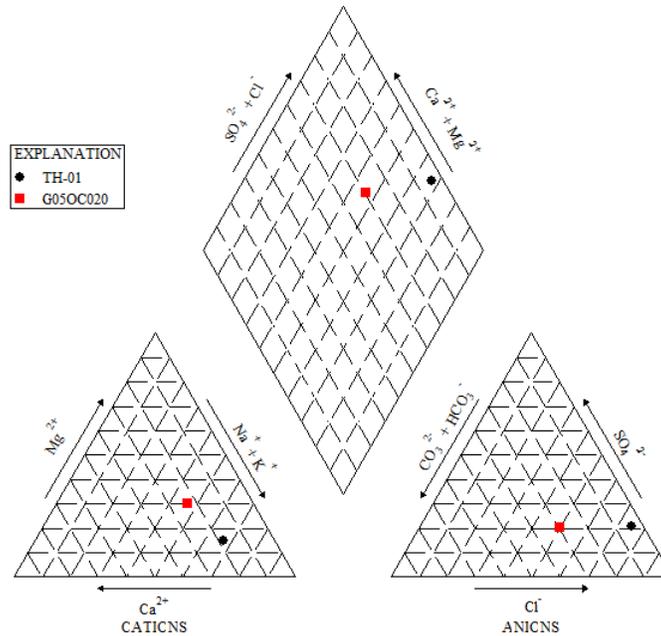


Figure 6 – Trilinear plot of water sample collected from TH-01. (source – ALS Laboratories, L1972633; MSD, 2017))

Conclusions and Recommendations

Based on the results of the hydrogeological test drilling, the following conclusions and recommendations can be made with regard to a potential groundwater supply at La Barrière Park:

- La Barrière Park is located in a region where the underlying bedrock aquifers are saline. Consequently, the best options for a groundwater supply are the intra-till sand and gravel deposits (if present) or the shallow carbonate bedrock aquifer.
- Test drilling at the site did not intersect any significant deposits of sand and gravel.
- Test well TH-01 was constructed with a screened section through the rubble zone at the upper bedrock surface.
- Based on the pumping test conducted on TH-01, the well should be capable of producing up to 25 U.S.G.P.M.
- Results from the groundwater sample analysis confirm that saline conditions are present in the bedrock aquifer at the site. Although the groundwater quality is poor, it may be suitable for certain uses at the site. The chemistry results should be reviewed by the designers of the facility. All aspects of the piping and processing should make this point paramount. The system will produce saline water that will be very hard on connected plumbing fixtures.
- It should be noted that the groundwater from TH-01 is likely to be the best quality groundwater available at the site. Due to the site conditions, it is possible that groundwater quality may become worse with pumping, as deeper, saltier groundwater may be drawn up into the well.
- If the well is to be mechanized, the pumping rate should be kept as low as possible to reduce the upwelling of poorer quality groundwater.
- The on site conditions should be monitored regularly for changes in groundwater levels and groundwater quality.
- The well will likely require maintenance from time to time.
- The well should remain permanently vented.

Conclusions and Recommendations (Cont'd)

- A copy of this report should be sent to MSD- Water Use Licensing Section.

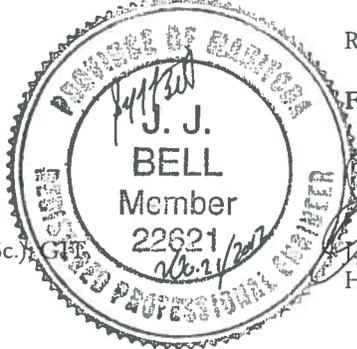
We thank you for the opportunity to be of service to the City of Winnipeg and to work with you on this project.

Should you require anything further or have any additional questions, please call me at 204-326-2485.

Sincerely

Friesen Drillers Limited

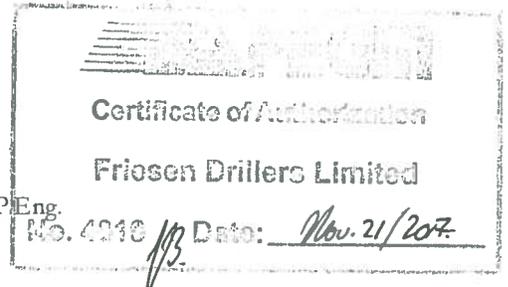
J.E. (Justin) Neufeld, B.Sc. (G.Sc.), C.G.P.
Groundwater Geologist



Reviewed by:

Friesen Drillers Limited

J. (Jeff) Bell, B.Sc. (G.E.), P.Eng.
Hydrogeological Engineer



Attachments Groundwater Exploration Permit – City of Winnipeg
Drillers Logs – Friesen Drillers Limited
Groundwater Chemistry Analysis Report – ALS Laboratories (L1972633)

References

- Baracose, A., 1983. Transmissivity of the Upper Carbonate Aquifer: Geological Engineering Report for Urban Development Winnipeg. *University of Manitoba*.
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Limitations

The scope of this report is limited to the matters expressly covered and is intended solely for the client to whom it is addressed. Friesen Drillers Limited makes no warranties, expressed or implied, including without limitation, as to the marketability of the site, or fitness to a particular use. The assessment was conducted using standard engineering and scientific judgment, principles, and practices, within a practical scope and budget. It is based partially on the observations of the assessor during the site visit in conjunction with archival information obtained from a number of sources, which is assumed to be correct. Except as provided, Friesen Drillers Limited has made no independent investigations to verify the accuracy or completeness of the information obtained from secondary sources or personal interviews. Generally, the findings, conclusions, and recommendations are based on a limited amount of data (e.g. number of boreholes drilled or water quality samples submitted for laboratory analysis) interpolated between sampling points and the actual conditions on the site may vary from that described above. Any findings regarding the site conditions different from those described above upon which this report was based will consequently change Friesen Drillers Limited's conclusions and recommendations.

Disclaimer

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Manitoba



Sustainable Development

Water Use Licensing Section
Box 16, 200 Saulteaux Crescent
Winnipeg, Manitoba, Canada R3J 3W3
T 204-945-6118 F 204-948-2357
Rob.Matthews@gov.mb.ca

July 26, 2017

File: Winnipeg, The City of -43

John Atkinson
Project Officer, City of Winnipeg
4th Floor, 185 King Street,
Winnipeg, MB R3B 1J1

Dear Mr. Atkinson:

Attached herewith is a **Groundwater Exploration Permit** issued in response to an application you submitted on behalf of the City of Winnipeg, registered on July 13, 2017, for a licence to construct well(s) and divert groundwater on **Outer Two Mile Lot 059 to 065, Parish of St. Norbert, La Barriere Park, La Salle, Manitoba, for other - recreation purposes.**

The Groundwater Exploration Permit authorizes The City of Winnipeg to carry out exploration test well drilling, install wells and conduct pumping test. The purpose of the pump testing is to determine if sufficient water is available from the aquifer to support the project and to determine water level impacts on existing local wells and/or registered projects with earlier precedence dates than the proposed project. Please note that during testing, pumping must cease if any local water supplies are negatively impacted as a result of testing. The City of Winnipeg would further be responsible to correct any water supply problems or provide temporary water supply to anyone whose water supplies are negatively impacted as a result of testing the aquifer. Please familiarize yourself with the terms and conditions of the Groundwater Exploration Permit.

A licensing decision on this project will be held pending submission of the required information. Please note that diversion of water without a Water Rights Licence or written authorization would constitute a violation of *The Water Rights Act* and may be subject to enforcement.

One important condition of any licence that may be issued for this project, in due course, is that a water use monitoring device must be installed on the pipeline from the supply well(s), positioned to accurately measure instantaneous pumping rate and accumulative withdrawals.

Please contact Ronaldo Miranda directly at 204-945-6475 should you have any questions regarding the requirements outlined in this letter and the attached permit or the water rights licensing aspects of this project.

Yours truly,

A handwritten signature in black ink that reads "Rob Matthews". The signature is stylized and written in a cursive-like font.

Rob Matthews
Manager
Water Use Licensing Section

Cc: Justin Neufeld, G.I.T., Friesen Drillers Ltd.
Ronaldo Miranda (SD)

Groundwater Exploration Permit

Pursuant to The Water Rights Act

The City of Winnipeg (La Barriere Park)

is hereby permitted to explore for and construct a groundwater well or wells on the following described lands, **Outer Two Mile Lot 059 to 065, Parish of St. Norbert, La Barriere Park, La Salle, Manitoba**, for **other – recreation purposes**, subject, however, to the following conditions:

1. The permittee must have legal access to the site where the exploration work and project wells are to be located.
2. This Authorization is not transferable or assignable to any other party.
3. Prior to undertaking any work or construction of any works authorized by this permit the permittee is required to retain the services of a hydrogeologist registered with Association of Professional Engineers and Geoscientists of Manitoba (APEGM), who would be required to:
 - Plan and supervise the drilling of boreholes, test wells, production and observation well(s) and well pump testing as authorized by this permit.
 - Conduct a constant rate pumping test on proposed production well(s) in accordance with Form H (http://www.gov.mb.ca/conservation/waterstewardship/licensing/wlb/pdf/form_h_july_2013.pdf).
 - Conduct a recovery test for a period equal to pump test or 90% recovery.
 - Carry out an inventory of private and commercial wells within a 1 mile radius of the project well site. The inventory may need to be expanded based on the assessment of the expected area of water level drawdown impact resulting from future pumping.
 - Prepare and submit to the Water Use Licensing Section a technical report on drilling of boreholes and wells, pump testing of well, well inventory and water quality sampling. The report would contain, but not limited to, such things as: well driller's reports for test wells, production and observation wells; a plan showing the location of these wells on the property and/or GPS locations of the wells; an analysis of aquifer pumping tests; calculations of transmissivity; and a description of the amount of water level interference that would be expected to occur at existing local wells that are located within a 1 mile radius of the project well site. Two copies of the report shall be submitted, one hardcopy and one digital copy.
4. During any pumping tests that may be conducted, pumping must cease immediately if any local water supplies are negatively impacted as a result of the tests. The permittee is also responsible to correct any water supply problems or provide temporary water supply to anyone whose water supplies are negatively impacted as a result of the tests.
5. This permit expires within twelve (12) months of the date of issuance.
6. Please note that diversion of water without a Water Rights Licence or written authorization would constitute a violation of *The Water Rights Act* and may be subject to enforcement.

Issued at the City of Winnipeg in the Province of Manitoba, this 26th day of July, A.D. 2017



for The Honourable Minister of Sustainable Development



FRIESEN DRILLERS LTD
ATTN: JEFF BELL
307 PTH 12 N
STEINBACH MB R5G 1L9

Date Received: 10-AUG-17
Report Date: 15-AUG-17 11:24 (MT)
Version: FINAL

Client Phone: 204-326-2485

Certificate of Analysis

Lab Work Order #: L1972633
Project P.O. #: NOT SUBMITTED
Job Reference: BARRIERE PARK
C of C Numbers:
Legal Site Desc:

Barb Bayer, B.Sc.
General Manager, Winnipeg

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ADDRESS: 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2J 3T4 Canada | Phone: +1 204 255 9720 | Fax: +1 204 255 9721
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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1972633-1 TH-01							
Sampled By: CL on 09-AUG-17 @ 13:30							
Matrix: WATER							
ROU4W total							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	210		1.2	mg/L		14-AUG-17	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		14-AUG-17	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		14-AUG-17	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	172		1.0	mg/L		11-AUG-17	R3796362
Chloride in Water by IC							
Chloride (Cl)	2210		10	mg/L		10-AUG-17	R3797626
Conductivity							
Conductivity	7130		1.0	umhos/cm		11-AUG-17	R3796362
Fluoride in Water by IC							
Fluoride (F)	0.45	DLM	0.40	mg/L		10-AUG-17	R3797626
Hardness Calculated							
Hardness (as CaCO3)	1440	HTC	1.3	mg/L		15-AUG-17	
Nitrate in Water by IC							
Nitrate (as N)	<0.40	DLM	0.40	mg/L		10-AUG-17	R3797626
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.45		0.45	mg/L		14-AUG-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.20	DLM	0.20	mg/L		10-AUG-17	R3797626
Sulfate in Water by IC							
Sulfate (SO4)	822		6.0	mg/L		10-AUG-17	R3797626
TDS calculated							
TDS (Calculated)	4990		5.0	mg/L		15-AUG-17	
Total Metals by ICP-MS							
Calcium (Ca)-Total	322		0.50	mg/L	14-AUG-17	14-AUG-17	R3799320
Iron (Fe)-Total	2.17		0.10	mg/L	14-AUG-17	14-AUG-17	R3799320
Magnesium (Mg)-Total	155		0.050	mg/L	14-AUG-17	14-AUG-17	R3799320
Manganese (Mn)-Total	0.0959		0.0010	mg/L	14-AUG-17	14-AUG-17	R3799320
Potassium (K)-Total	33.2		0.50	mg/L	14-AUG-17	14-AUG-17	R3799320
Sodium (Na)-Total	1340		0.50	mg/L	14-AUG-17	14-AUG-17	R3799320
Turbidity							
Turbidity	101		0.10	NTU		11-AUG-17	R3796768
pH							
pH	7.89		0.10	pH units		11-AUG-17	R3796362

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
LPML	Lab-Preserved for Total Metals. Sample received with pH > 2 and preserved at the lab. Total Metals results may be biased low.

Sample Parameter Qualifier Key:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO ₃ ²⁻ /L.			
ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO ₃ ⁻ /L.			
ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH ⁻ /L.			
ALK-TITR-WP	Water	Alkalinity, Total (as CaCO ₃)	APHA 2320B
The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO ₃ ⁻ and H ₂ CO ₃ endpoints indicated electrometrically.			
CL-IC-N-WP	Water	Chloride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-WP	Water	Conductivity	APHA 2510B
Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.			
ETL-SOLIDS-CALC-WP	Water	TDS calculated	CALCULATION
F-IC-N-WP	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HARDNESS-CALC-WP	Water	Hardness Calculated	APHA 2340B
Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO ₃ equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.			
IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E
Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.			
Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance (as % difference) cannot be calculated accurately for waters with very low electrical conductivity (EC), and is reported as "Low EC" where EC < 100 uS/cm (umhos/cm). Ion Balance is calculated as:			
Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]			
MET-T-MS-WP	Water	Total Metals by ICP-MS	EPA 200.2/6020A (mod.) High LOR
Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
NO2+NO3-CALC-WP	Water	Nitrate+Nitrite	CALCULATION
NO2-IC-N-WP	Water	Nitrite in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-IC-N-WP	Water	Nitrate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH-WP	Water	pH	APHA 4500H
The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.			
SO4-IC-N-WP	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)
Turbidity in aqueous matrices is determined by the nephelometric method.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

*mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.*

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Well Construction Report



Sheet 1 of 1

For PDF submission: Report must be printed on legal size paper (8.5 x 14 inches) and be signed in ink.

Form No. WELLCON-V01-PDF

Owner Name: City of Winnipeg
 First _____ Last _____
 Mailing Address 105 - 1155 Pacific Avenue
 Town/City Winnipeg, MB
 Postal Code R3E 3P1 Phone _____
 Email _____

Well Location: (see note 3; attach sketch if necessary)
 Civic Address 4430 Waverley Street, Winnipeg
 (if different than mailing address)
 Quarter _____ Section _____ Township _____ Range _____ E W
 Parish _____ Type & Lot No. _____

Well Name: (if applicable) La Barrier Park TH-01
 Well Identification Tag Number 574
 Location of Tag Attached to casing stick-up
 Other (specify) _____

GPS: (see note 4), Accuracy +/- 24 feet metres
 Latitude (decimal degrees) 49.71990
 Longitude (decimal degrees) 97.17435
Rockwood Sensitive Area: Yes - Permit No. _____ No

Test Hole (see note 5) - Sealed Yes No **or**
Well Use: test well - Sealed Yes No
 production/source recharge/return
 monitoring dewatering geotechnical
 other (specify) _____

Method of Construction:
 auger bored backhoe/dug
 rotary (mud) rotary (air)
 dual rotary driven jetted
 other (specify) _____

Water Use: (Check all that apply)
 domestic public/semi-public irrigation
 commercial/industrial livestock/poultry
 earth energy (heating/cooling)
 other (specify) _____

Lithologic Description: (see notes 6 and 7) - Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Colour	Material Description (use recommended names on guide)	Observations
0	43	Grey	Clay	
43	64	Brown	Till	
64	67	Brown	Limestone Rubble	
67	71	Brown	Limestone	
71			Bottom of Hole	
0				
0				
0				
0				

Well Construction: (see note 8) - Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Borehole	Casing	Liner	Open Hole	Well Screen	Surface Seal	Annular Fill	Filter Pack	ID (inches)	OD (inches)	Type of Material (ex: casing and screen material, screen type and slot size, use of shale traps, packers, screen blanks or tail pipes, and type and size of surface seal/annular fill/filter pack material)	Method of Placement (ex: poured, tremie)
0	71	<input checked="" type="checkbox"/>								7 7/8			
0	62		<input checked="" type="checkbox"/>							5	5 1/2	Insert Glued PVC	
62	67				<input checked="" type="checkbox"/>					4	4 1/2	Stainless Steel Wirewound - 15 Slot	
55	71							<input checked="" type="checkbox"/>				Silica Sand	Poured
0	55					<input checked="" type="checkbox"/>						Envirgrout	Poured

Well Completion: Day 8 Month August Year 20 17
 Top of casing 18 inches ags bgs; Well vented: Yes No
 Well disinfected: Yes No; Well cover installed: Yes No
 Pitless adapter/unit installed at _____ feet bgs; Not installed

Source of Drilling Water: Groundwater Surface water
 Water contains a minimum of 10 mg/L free chlorine: Yes No
 Name/Location of water source Friesen Drillers Ltd.

Drilling Additives Used: Yes (list type & quantity) 1 Bag Wyo-Ben Extra High Yield Bentonite No

Well Yield Test (see note 9),
 Date of Test: Day 8 Month August Year 20 17
 Same as date of well completion
Static Water Level Before Test 20.7 feet bgs ags
 Method of Test: pumping air lift bailing recovery
 other (specify) _____
 Water level at end of test 55.9 feet bgs ags
 Length of test 4 hours _____ minutes
 Estimated rate of discharge 20 IGPM USGPM

Well Development: air lifting surging pumping jetting
 bailing hydrofracturing other (specify) _____
Water Quality Characteristics: fresh salty clear cloudy
 sediment odour (specify) _____
Flowing Artesian Well No Yes - If yes, estimated rate of artesian flow _____ IGPM USGPM Annular space cemented: Yes No
 Flow control device installed: Yes No
 Does water leak from around the outside of the casing: Yes No

Recommended Pumping Rate: 15 IGPM USGPM with pump intake at 58 feet bgs;
 Will your company be installing a pump?: Yes No

Remarks (see note 10) Iron: 0.6 Well must be vented.

Well Drilling Contractor: Company Name Friesen Drillers Ltd Licence No. 607-17
 Well Driller: Print Name Chris Loepky Signature _____

Declaration: I certify that to the best of my knowledge the information provided herein is accurate and true and complies with The Groundwater and Water Well Act.

Well Construction Report



Sheet 1 of 1

For PDF submission: Report must be printed on legal size paper (8.5 x 14 inches) and be signed in ink.

Form No. WELLCON-V01-PDF

Owner Name: City of Winnipeg
 First _____ Last _____
 Mailing Address 105 - 1155 Pacific Avenue
 Town/City Winnipeg, MB
 Postal Code R3E 3P1 Phone _____
 Email _____

Well Location: (see note 3; attach sketch if necessary)
 Civic Address 4430 Waverley Street, Winnipeg
 (if different than mailing address)
 Quarter _____ Section _____ Township _____ Range _____ E W
 Parish _____ Type & Lot No. _____

Well Name: (if applicable) La Barrier Park TH-02
 Well Identification Tag Number 0
 Location of Tag Attached to casing stick-up
 Other (specify) _____

GPS: (see note 4), Accuracy +/- 50 feet metres
 Latitude (decimal degrees) 49.72003
 Longitude (decimal degrees) 97.17665

Rockwood Sensitive Area: Yes - Permit No. _____ No

Test Hole (see note 5) - Sealed Yes No **or**
Well Use: test well - Sealed Yes No
 production/source recharge/return
 monitoring dewatering geotechnical
 other (specify) _____

Method of Construction:
 auger bored backhoe/dug
 rotary (mud) rotary (air)
 dual rotary driven jetted
 other (specify) _____

Water Use: (Check all that apply)
 domestic public/semi-public irrigation
 commercial/industrial livestock/poultry
 earth energy (heating/cooling)
 other (specify) _____

Lithologic Description: (see notes 6 and 7) - Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Colour	Material Description (use recommended names on guide)	Observations
0	43	Grey	Clay	
43	61	Brown	Till	
61	65		Limestone Rubble	
65	66	Orange	Limestone	
66			Bottom of Hole	
0				
0				
0				
0				
0				

Well Construction: (see note 8) - Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Type of Material										Method of Placement (ex: poured, tremie)		
		Borehole	Casing	Liner	Open Hole	Well Screen	Surface Seal	Annular Fill	Filter Pack	ID (inches)	OD (inches)			
													(ex: casing and screen material, screen type and slot size, use of shale traps, packers, screen blanks or tail pipes, and type and size of surface seal/annular fill/filter pack material)	

Well Completion: Day 9 Month August Year 2017
 Top of casing _____ inches ags bgs; Well vented: Yes No
 Well disinfected: Yes No; Well cover installed: Yes No
 Pitless adapter/unit installed at _____ feet bgs; Not installed

Source of Drilling Water: Groundwater Surface water
 Water contains a minimum of 10 mg/L free chlorine: Yes No
 Name/Location of water source Friesen Drillers Ltd.

Drilling Additives Used: Yes (list type & quantity) _____ No

Well Yield Test (see note 9),
 Date of Test: Day _____ Month _____ Year 20 _____
 Same as date of well completion
Static Water Level Before Test _____ feet bgs ags
 Method of Test: pumping air lift bailing recovery
 other (specify) _____
 Water level at end of test _____ feet bgs ags
 Length of test _____ hours _____ minutes
 Estimated rate of discharge _____ IGPM USGPM

Well Development: air lifting surging pumping jetting
 bailing hydrofracturing other (specify) _____
Water Quality Characteristics: fresh salty clear cloudy
 sediment odour (specify) _____
Flowing Artesian Well No Yes - If yes, estimated rate of artesian flow _____ IGPM USGPM Annular space cemented: Yes No
 Flow control device installed: Yes No
 Does water leak from around the outside of the casing: Yes No

Recommended Pumping Rate: _____ IGPM USGPM with pump intake at _____ feet bgs;
 Will your company be installing a pump?: Yes No

Remarks (see note 10) No well constructed.

Well Drilling Contractor: Company Name Friesen Drillers Ltd Licence No. 607-17
 Well Driller: Print Name Chris Loepky Signature _____

Declaration: I certify that to the best of my knowledge the information provided herein is accurate and true and complies with The Groundwater and Water Well Act.

Well Construction Report



Sheet 1 of 1

For PDF submission: Report must be printed on legal size paper (8.5 x 14 inches) and be signed in ink.

Form No. WELLCON-V01-PDF

<p>Owner Name: City of Winnipeg First _____ Last _____ Mailing Address 105 - 1155 Pacific Avenue Town/City Winnipeg, MB Postal Code R3E 3P1 Phone _____ Email _____</p>	<p>Well Location: (see note 3; attach sketch if necessary) Civic Address 4430 Waverley Street, Winnipeg (if different than mailing address) Quarter _____ Section _____ Township _____ Range _____ <input type="checkbox"/> E <input type="checkbox"/> W Parish _____ Type & Lot No. _____</p>
<p>Well Name: (if applicable) La Barrier Park TH-03 Well Identification Tag Number <u>0</u> Location of Tag <input checked="" type="checkbox"/> Attached to casing stick-up <input type="checkbox"/> Other (specify) _____</p>	<p>GPS: (see note 4), Accuracy +/- <u>27</u> <input checked="" type="checkbox"/> feet <input type="checkbox"/> metres Latitude (decimal degrees) <u>49.71636</u> Longitude (decimal degrees) <u>97.17458</u> Rockwood Sensitive Area: <input type="checkbox"/> Yes - Permit No. _____ <input checked="" type="checkbox"/> No</p>

<p>Test Hole (see note 5) - Sealed <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <u>or</u> Well Use: <input type="checkbox"/> test well - Sealed <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> production/source <input type="checkbox"/> recharge/return <input type="checkbox"/> monitoring <input type="checkbox"/> dewatering <input type="checkbox"/> geotechnical <input type="checkbox"/> other (specify) _____</p>	<p>Method of Construction: <input type="checkbox"/> auger <input type="checkbox"/> bored <input type="checkbox"/> backhoe/dug <input checked="" type="checkbox"/> rotary (mud) <input type="checkbox"/> rotary (air) <input type="checkbox"/> dual rotary <input type="checkbox"/> driven <input type="checkbox"/> jetted <input type="checkbox"/> other (specify) _____</p>	<p>Water Use: (Check all that apply) <input checked="" type="checkbox"/> domestic <input type="checkbox"/> public/semi-public <input type="checkbox"/> irrigation <input type="checkbox"/> commercial/industrial <input type="checkbox"/> livestock/poultry <input type="checkbox"/> earth energy (heating/cooling) <input type="checkbox"/> other (specify) _____</p>
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Lithologic Description: (see notes 6 and 7) - Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Colour	Material Description (use recommended names on guide)	Observations
0	39	Grey	Clay	
39	76	Brown	Till & Gravel	
76	77	Orange	Limestone	
77			Bottom of Hole	
0				
0				
0				
0				
0				
0				

Well Construction: (see note 8) - Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Borehole	Casing	Liner	Open Hole	Well Screen	Surface Seal	Annular Fill	Filter Pack	ID (inches)	OD (inches)	Type of Material (ex: casing and screen material, screen type and slot size, use of shale traps, packers, screen blanks or tail pipes, and type and size of surface seal/annular fill/filter pack material)	Method of Placement (ex: poured, tremie)

<p>Well Completion: Day <u>9</u> Month <u>August</u> Year 20<u>17</u> Top of casing _____ inches <input checked="" type="checkbox"/> ags <input type="checkbox"/> bgs; Well vented: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Well disinfected: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No; Well cover installed: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pitless adapter/unit installed at _____ feet bgs; <input type="checkbox"/> Not installed</p>	<p>Source of Drilling Water: <input checked="" type="checkbox"/> Groundwater <input type="checkbox"/> Surface water Water contains a minimum of 10 mg/L free chlorine: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Name/Location of water source <u>Friesen Drillers Ltd.</u></p>
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Drilling Additives Used: Yes (list type & quantity) _____ No

<p>Well Yield Test (see note 9), Date of Test: Day _____ Month _____ Year 20 _____ <input type="checkbox"/> Same as date of well completion Static Water Level Before Test _____ feet <input checked="" type="checkbox"/> bgs <input type="checkbox"/> ags Method of Test: <input type="checkbox"/> pumping <input type="checkbox"/> air lift <input type="checkbox"/> bailing <input type="checkbox"/> recovery <input type="checkbox"/> other (specify) _____ Water level at end of test _____ feet <input checked="" type="checkbox"/> bgs <input type="checkbox"/> ags Length of test _____ hours _____ minutes Estimated rate of discharge _____ <input checked="" type="checkbox"/> IGPM <input type="checkbox"/> USGPM</p>	<p>Well Development: <input type="checkbox"/> air lifting <input type="checkbox"/> surging <input type="checkbox"/> pumping <input type="checkbox"/> jetting <input type="checkbox"/> bailing <input type="checkbox"/> hydrofracturing <input type="checkbox"/> other (specify) _____ Water Quality Characteristics: <input type="checkbox"/> fresh <input type="checkbox"/> salty <input type="checkbox"/> clear <input type="checkbox"/> cloudy <input type="checkbox"/> sediment <input type="checkbox"/> odour (specify) _____ Flowing Artesian Well <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes - If yes, estimated rate of artesian flow _____ <input type="checkbox"/> IGPM <input type="checkbox"/> USGPM Annular space cemented: <input type="checkbox"/> Yes <input type="checkbox"/> No Flow control device installed: <input type="checkbox"/> Yes <input type="checkbox"/> No Does water leak from around the outside of the casing: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p>
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Recommended Pumping Rate: _____ IGPM USGPM with pump intake at _____ feet bgs;
 Will your company be installing a pump?: Yes No

Remarks (see note 10) No well constructed.

Well Drilling Contractor: Company Name Friesen Drillers Ltd Licence No. 607-17
 Well Driller: Print Name Chris Loepky Signature _____
Declaration: I certify that to the best of my knowledge the information provided herein is accurate and true and complies with The Groundwater and Water Well Act.