MMM Group Limited

ENVIRONMENT ACT PROPOSAL
GRANNY'S POULTRY
LAND APPLICATION OF LAGOON SLUDGE
Blumenort, Manitoba

PREPARED FOR:
Manitoba Conservation and Water Stewardship

COMMUNITIES
TRANSPORTATION
BUILDINGS
INFRASTRUCTURE

SUBMITTED BY:

MMM GROUP

March 2015 | 3314347-000.100

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March 2, 2015 Ref.: 3314347-000.100.710

Ms. Tracy Braun, Director
Manitoba Conservation and Water Stewardship
Environmental Approvals
Suite 160, 123 Main Street
Winnipeg MB R3C 1A5

Dear Ms. Braun:

Re: Environment Act Proposal, Granny's Poultry Land Application of Lagoon Sludge

MMM Group Limited (MMM) has been retained by Granny's Poultry Cooperative Ltd. (Granny's) to submit a comprehensive Environment Act Proposal for the Land Application of Lagoon Biosolids from Cells 1 and 2, located on NE27-07-06EPM.

The objective of this Environment Act Proposal is to provide documentation in support of attainment of an Environment Act Licence for the land application of biosolid materials in an environmentally sustainable and agronomically suitable manner. Biosolid loading limits have been and will be determined to target available nitrogen and phosphorus levels for a soybean crop and set metal loading limits for the agricultural field in the application program. In addition the Environment Act Proposal outlines the process that will be taken to formally decommission the current emergency retention cells.

Granny's schedule is to complete the land application by the end of October, 2015 and therefore it would be greatly appreciated to have a final Environment Act Licence active by September 1, 2015; this will ensure Granny's schedule for the planned plant expansion on Site.

For your consideration, please find enclosed an electronic (USB drive) copy and four printed copies of the Environmental Act Proposal, the application form and application fee for $7,500.00 made out to the Minister of Finance. If you have any questions or concerns about this submission, please contact the undersigned at 204-272-2020.

Yours truly,

MMM Group Limited

Darren Keam, M.Sc., P.Ag.
Senior Soil Scientist, Associate
Environmental Management Services

Enclosures

DK/cs

EAP CoverLetter_2March2015

Environment Act Proposal Form

Manitoba
Conservation and Water Stewardship

Name of the development:
Granny's Poultry Land Application of Lagoon Sludge

Type of development per Classes of Development Regulation (Manitoba Regulation 164/88):
Class 2

Legal name of the applicant:
Granny's Poultry Cooperative Ltd.

Mailing address of the applicant: #4 Penner Drive

Contact Person: Richard Anderson

City: Blumenort | Province: Manitoba | Postal Code: R0A 0C0

Phone Number: 204-326-3448 | Fax: | email: RAnderson@granny

Location of the development: RM of Ste. Anne

Contact Person: Richard Anderson

Street Address: #4 Penner Drive

Legal Description: NE27-7-6EPM

City/Town: Blumenort | Province: Manitoba | Postal Code: R0A 0C0

Phone Number: 204-326-3448 | Fax: | email: RAnderson@granny

Name of proponent contact person for purposes of the environmental assessment:
Darren Keam

Phone: 204-272-2020
Fax:

Mailing address: 111-93 Lombard Ave., Wpg, MB, R3B 3B1

Email address: keamd@mmm.ca

Webpage address: www. mmmgrouplimited.ca

Date: FEB 27, 15

Signature of proponent, or corporate principal of corporate proponent:

Printed name: RICHARD ANDERSON

ENVIRONMENT ACT PROPOSAL
GRANNY'S POULTRY
LAND APPLICATION OF LAGOON SLUDGE
Blumenort, Manitoba

Project # 3314347-000

Prepared for:

Manitoba Conservation and Water Stewardship

Environmental Assessment and Licensing Branch

On Behalf Of:

Granny's Poultry Cooperative Ltd.

Prepared by:

MMM Group Limited

March 2, 2015

Prepared by:

Darren Keam, MSc., P.Ag.
Senior Soil Scientist
Dated: March 2, 2015

Reviewed by:

Danette Sahulka, M.Sc., P.Ag.
Senior Ecologist
Dated: March 2, 2015

EXECUTIVE SUMMARY

Introduction

This Environment Act Proposal (EAP) is submitted to the Manitoba Conservation and Water Stewardship (MCWS) Environmental Assessment and Licencing Branch (EALB), as required under the *Environment Act* for the purpose of obtaining a Class 2 Environment Act Licence (EAL) for land application of biosolids material from the Granny's Poultry Cooperative Ltd. (Granny's) wastewater treatment lagoon Cell 1 (west side of wastewater treatment site) and Cell 2 (east side of wastewater treatment site) located on the property of Granny's at NE quarter of Section 27, Township 7, Range 6 EPM in Blumenort, Manitoba.

Objective

The objective of this EAP is to provide documentation in support of attainment of an EAL for Granny's to:

1) Complete a land application of biosolid materials collected from their wastewater treatment lagoon in an agronomically and environmentally sustainable manner.

2) To outline the process that will be taken to formally decommission the current emergency holding cells.

Proponent

The proponent for this project is Granny's Poultry Cooperative Ltd., Maintenance and Environmental Manager, Mr. Richard Anderson.

Program Activities

- The biosolids material (Cell 1: 1,214 m^3 and Cell 2: 6,220 m^3) will be collected or dredged using heavy equipment allowing for continued dewatering of the material. The Biosolids will need to be physically blended together.

- To transport the biosolids to the application field, biosolids will be contained in such a manner to prevent loss of biosolids, and associated liquids during transport between the lagoon and application field, such as having the biosolids placed into tanker trucks and/or TerraGator® trucks.

- These materials will then be surfaced applied to the parcel of land in the program at the prescribed agronomic rates between September and November of 2015.

- The applied biosolid materials will be incorporated into the soil sub-surface for each parcel of land through cultivation within 48 hours of application.

- When the biosolids material has been excavated and applied to the agricultural land, the formal decommissioning of the lagoon cells will be initiated with environmental soil sampling of the existing liner for long-term management of the lagoon site (if required), develop a site plan that will integrate positive drainage, erosion and sediment control, deep rip clay liner, land level berms and revegetate with a perennial forage mix.

Regional and Local Study Areas

The Regional Study Area (RSA) is located approximately 40 km southwest of the City of Winnipeg, Manitoba within the R.M. of Hanover and Ste. Anne, Manitoba (Figure 1, Appendix A). The Granny's processing plant including the two lagoon cells are located in the town of Blumenort, Manitoba and the cooperating farm producer property is located in the R.M. of Ste. Anne north the Hamlet of Greenland. The Local Study Area (LSA) is defined as land parcel NW9-8-6EPM, and includes approximately 60 ha (160 acres) that are available for biosolids application (Figure 2, Appendix A). The application land is approximately 5.5 km northwest of Blumenort, Manitoba (3.5 km east on Hwy 311 and 4.0 km north on mile road Twin Creek Road). The RSA and LSA fall within the Red River Valley of Manitoba and are included in the Red River Valley Special Management Area (RRVSMA) as defined in Section 14.1 of *The Livestock Manure and Mortalities Management Regulation* of the *Environment Act*. Lands in this area are primarily used for agricultural production of small grain and forage crops.

Land Ownership and Management

Agricultural land owned by the farm producer within the LSA will be utilized for biosolids application for this project. Consultation with a land owner interested in receiving the biosolids material applied to his land was held in December 2014 at which time a land use agreement was formalized and access to land for soil sampling for assessment of land suitability for biosolids application was granted.

Proposed Biosolid Application Rates

Biosolids loading limits have been/will be determined to target optimum available nitrogen and phosphorus levels for small grain – oil seed crop (soybeans) and set metal loading limits for the agricultural field in the application program.

In 2015 it is planned that biosolids materials will be excavated from the bottom of the two lagoons and included in a land application program. The biosolids material will be applied onto privately owned agricultural fields located in the R.M. of Ste. Anne within a distance of 5 kilometres (km) from the lagoon site. Sampling for biosolids material from both lagoon cells

for nutrient and metal analysis was conducted on December 22, 2014 in order to provide information relating to nutrient loading rates and required land base area for this EAP submission. Soil samples will be collected from the agricultural land that is scheduled to receive the biosolids material, and soil samples will be analyzed for nutrients and trace elements approximately three weeks prior to land application.

A proposed prescription application rate was developed based on residual nitrogen and phosphorous concentrations and P_2O_5 crop removal for a blended material. The proposed prescription application rate is based on mean nutrient concentrations for both Cell 1 and Cell 2. Table 5.5, 5.6 and 5.7 outline the potential application rates for Cell 1 and Cell 2 individually and for a blending of materials from both cells, respectively, for nitrogen, 1 time crop removal and 2 times crop removal of phosphorous as P_2O_5.

Based on the proposed prescription application rates outlined in Table 5.5, 5.6 and 5.7 the preferred approach is to blend the biosolids material in order to achieve a uniform nutrient spread of the biosolids as possible, this is per the cooperating farm producer's request, and achieve the target nitrogen needs for the soybean crop. This approach allows for a nitrogen based application rate of 9.0 t ha^{-1} (dry) and provides an estimated 43 percent of the required P_2O_5, which is suitable for this land base. Detailed soil sample analysis will be obtained for the field and a detailed prescription rate will be provided to MCWS as promptly as possible for a timely approval prior to land application.

Summary

When applied at balanced agronomic rates, the land application of biosolids is a sustainable means to reuse nutrients within an agricultural system. The application of biosolids organic material enhances the water holding capacity, structure and tilth of soils thereby providing benefits to land utilized for agricultural production.

The proposed prescription application rate of the biosolids is based on residual nitrogen and phosphorous concentrations and P_2O_5 crop removal for a blended material from both Cell 1 and Cell 2. The preferred approach is to blend the biosolids material in order to achieve a uniform nutrient spread of the biosolids as possible, this is per the cooperating farm producer's request, and achieve the target nitrogen needs for the subsequent soybean crop of 2016. This approach allows for a nitrogen based application rate of 9.0 t ha^{-1} (dry) and provides an estimated 43 percent of the required P_2O_5, which is suitable for this land base. Detailed soil sample analysis will be obtained for the field and a detailed prescription rate will be provided to MCWS as promptly as possible for a timely approval prior to land application. This objective meets the principals of environmentally sustainable land applications outlined by MCWS and within the Canadian Council of Ministers of the Environment (CCME) *Guidance Document for the Beneficial Use of Municipal Biosolids, Municipal Sludge and Treated Septage* (December, 2012).

As rural villages and communities develop and grow, agricultural land is squeezed in with development and available land, within a reasonable distance of the private and municipal lagoons, is at premium when competing with suitable lands for livestock manure application and nutrient management. Setback distances for the land application of biosolids material from Cell 1 and Cell 2 are therefore proposed to be those outlined in the *Farm Practices Guidelines for Pig Producers in Manitoba (April 2007)*: 400 m from residential areas and 75 m from an occupied residence with incorporation of material within 48 hours of application. The proposed setback distances in this EAP are reasonable and within the practices established by other provincial regulators and livestock manure applicators.

In conclusion, applicable Manitoba Acts and Regulations, including The Environment Act and applicable regulations and the Water Protection Act and its applicable regulation will be observed. In-field at the time of land application the required setback distances from watercourses and developments will be witnessed and proposed prescription rates along with any specific requirements as outlined in the EAL to be applied to this proposed project.

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APPENDICES

INTRODUCTION

This Environment Act Proposal (EAP) is submitted to the Manitoba Conservation and Water Stewardship (MCWS) Environmental Assessment and Licencing Branch (EALB), as required under the *Environment Act* for the purpose of obtaining a Class 2 Environment Act Licence (EAL) for land application of biosolids material from the Granny's Poultry Cooperative Ltd. (Granny's) wastewater treatment lagoon Cell 1 (west side of wastewater treatment site) and Cell 2 (east side of wastewater treatment site) located in Blumenort, Manitoba.

1.1 Background

Granny's currently operates under EAL No.: 2583 issued December 4, 2002 for the construction, operation and maintenance of the Development:

> "being a poultry abattoir, process wastewater pre-treatment facility, wastewater storage pond and lift station located in NE27-7-6EPM in the Rural Municipality of Hanover and a force main connection to the RM of Hanover – Blumenort aerated wastewater treatment lagoon and with discharge of pretreated effluent to the RM of Hanover – Blumenort aerated wastewater treatment lagoon under normal operating conditions".

Within EAL No.: 2583 the two on-site lagoon cells are referenced as "wastewater storage pond" (defined as: "the component of the Development which consists of an impoundment into which pre-treated wastewater is discharged for temporary storage"). Clause 2 states; "Subject to Clauses 23 and 24 of the licence, the Licencee shall not discharge wastewater to the wastewater storage pond except during an emergency as determined by the Director when it is not possible to discharge such wastewater to the RM of Hanover – Blumenort aerated wastewater treatment lagoons".

Granny's is proposing to initiate a land application program for biosolids material from their wastewater treatment lagoons cells (Cell 1 and Cell 2), located on the property of Granny's at NE quarter of Section 27, Township 7, Range 6 EPM (Figure 1 and 2, Appendix A). Once the biosolids material is successfully removed and land applied, Granny's will then work towards decommissioning the two cells and potentially develop a new emergency holding cell on Site.

In 2015 it is planned that biosolids materials will be excavated from the bottom of the two lagoons and included in a land application program. The biosolids material will be applied onto privately owned agricultural fields located in the R.M. of Ste. Anne within a distance of 5 kilometres (km) from the lagoon site. Sampling for biosolids material from both lagoon cells

for nutrient and metal analysis was conducted on December 22, 2014 in order to provide information relating to nutrient loading rates and required land base area for this EAP submission. Soil samples will be collected from the agricultural land that is scheduled to receive the biosolids material, and soil samples will be analyzed for nutrients and trace elements approximately three weeks prior to land application.

1.2 Objective

The objective of this EAP is to provide documentation in support of attainment of an EAL for Granny's to:

1) Complete a land application of biosolid materials collected from their wastewater treatment lagoon in an agronomically and environmentally sustainable manner.

2) To outline the process that will be taken to formally decommission the current emergency retention cells.

Biosolids loading limits have been/will be determined to target optimum available nitrogen and phosphorus levels for small grain – oil seed crops and set metal loading limits for the agricultural field in the application program. This objective meets the principals of environmentally sustainable land applications outlined by MCWS and within the Canadian Council of Ministers of the Environment (CCME) *Guidance Document for the Beneficial Use of Municipal Biosolids, Municipal Sludge and Treated Septage* (December, 2012).

If the EAL approval is granted in a timely manner (August, 2015) by the EALB, it is anticipated that the biosolids application to the land base from the two lagoon cells will begin in early September 2015.

1.3 Proponent

The proponent for this project is Granny's Poultry Cooperative Ltd., Maintenance and Environmental Manager, Mr. Richard Anderson.

1.4 Description of Regulatory Requirements

The following Acts and Regulations apply to the project and will be adhered to throughout the project, including any requirements assigned in the subsequent EAL:

1. *The Environment Act C.C.S.M. c. E125 (1987)*
    a. Licensing Procedures Regulations 163/88
    b. Classes of Development Regulation 164/88
    c. Environment Act Fees Regulation 168/96

d. Livestock Manure and Mortalities Management Regulation 42/98

e. 14.1 Designation of Red River Valley Special Management Area

f. Environmental Regulations for Treatment and Disposal of Biosolids in Manitoba, Mike Van Den Bosch, P.Eng., Municipalities & Industrial Approvals, Manitoba Environment

2. *The Water Protection Act C.C.S.M. c. W65 (2005)*

a. Nutrient Management Regulation 62/2008

2.0 DESCRIPTION OF PROPOSED PROJECT

The proposed project involves:

2.1 Components and Activities

2.1.1 Program Components

- Biosolids quality (nutrient levels, salts and metals) and physical properties (conductivity, pH, solids) were assessed through laboratory analytical testing of biosolids samples collected on December, 22, 2014 from Cells 1 and 2.

- Suitable agricultural land (NE9-8-6EPM) has been identified for application of the biosolids material and the land owner agreement has been acquired from the cooperating farm producer (Appendix B).

- A review of the environmental considerations for this land was conducted through a desktop review including: agricultural capability, nutrient management requirements, and distance from sensitive features.

    - Based on anticipated residual soil fertility levels and phosphorous crop uptake and removal, it is estimated that approximately 59 hectares (ha) (145 acres) of agricultural land will be required for the land application of the biosolids. Lands in the program consist of annual croplands utilized to produce small grain, oil seed, and soybean.

    - Soil physical (texture) and chemical (pH, electrical conductivity, nutrients and metals) parameters will be assessed through a field sampling program and laboratory analytical testing, immediately after harvest or approximately three weeks prior to land application of biosolids material.

- Based on the soil and biosolids analytical results, the agronomically appropriate application rate for the land receiving these materials will be calculated. This information will be provided to MCWS EALB prior to land application.
- Appropriate record keeping for load application by parcel and on-site monitoring of the application program will be completed.
- Develop an outline for the process to formally decommission the current treatment lagoon and allow for redevelopment of a new emergency cell within a portion of the current foot print.

2.1.2 Program Activities

- The biosolids material will be collected or dredged using heavy equipment allowing for continued dewatering of the material.
- To transport the biosolids to the application field, biosolids will be contained in such a manner to prevent loss of biosolids, and associated liquids during transport between the lagoon and application field, such as having the biosolids placed into tanker trucks and/or TerraGator® trucks.
- These materials will then be surfaced applied to the parcels of land in the program at the prescribed agronomic rates between September and November of 2015.
- The applied biosolid materials will be incorporated into the soil sub-surface for each parcel of land through cultivation within 48 hours of application.
- When the biosolids material has been excavated and applied to the agricultural land, the formal decommissioning of the lagoon cells will be initiated with environmental soil sampling of the existing liner for long-term management of the lagoon site (if required), develop a site plan that will integrate positive drainage, erosion and sediment control, deep rip clay liner, land level berms and revegetate with a perennial forage mix.

2.2 Project Tasks and Schedule of Events

The project tasks and schedule of events for the proposed project are outlined below in Table 2.1.

Table 2.1 - Project Tasks and Schedule

Task	Timeline
Biosolid and sludge quality sample collection for laboratory analysis of physical and chemical parameters.	December 2014
Consultation with Local Study Area (LSA) farm producers for land use agreement formalization.	January 2015
Desktop review of land suitability in the LSA.	January 2015
Submission of EAP for the project.	March 2015
EAP approval and granting of EAL by MCWS.[1]	August 2015
Soil sample collection for laboratory analysis of physical and chemical parameters in order to calculate land application rates.	Post-harvest, September 2015
Land application of biosolid materials from Cells 1 and 2	September to November 10, 2015
Reporting of land application process to MCWS	December 2015
Final decommissioning of lagoon foot print	December 2016
Project completion and closure with client.	January 2017

2.3 Regional and Local Study Areas

The Regional Study Area (RSA) is located approximately 40 km southwest of the City of Winnipeg, Manitoba within the R.M. of Hanover and Ste. Anne, Manitoba (Figure 1, Appendix A). The Granny's processing plant including the two lagoon cells are located in the town of Blumenort, Manitoba and the cooperating farm producer property is located in the R.M. of Ste. Anne north the Hamlet of Greenland. The Local Study Area (LSA) is defined as land parcel NW9-8-6EPM, and includes approximately 60 ha (160 acres) that are available for biosolids application (Figure 2, Appendix A). The application land is approximately 5.5 km northwest of Blumenort, Manitoba (3.5 km east on Hwy 311 and 4.0 km north on mile road Twin Creek Road). The RSA and LSA fall within the Red River Valley of Manitoba and are included in the Red River Valley Special Management Area (RRVSMA) as defined in Section 14.1 of *The Livestock Manure and Mortalities Management Regulation* of the *Environment Act*. Lands in this area are primarily used for agricultural production of small grain and forage crops.

2.3.1 Land Ownership and Management

Agricultural land owned by the farm producer within the LSA will be utilized for biosolids application for this project. Consultation with a land owner interested in receiving the biosolids

[1] Based on current estimated review by the MCWS Technical Advisory Committee (TAC) and public review timeframe of 6 months.

material applied to his land was held in December 2014 at which time a land use agreement was formalized and access to land for soil sampling for assessment of land suitability for biosolids application was granted. Certificate of Title and the landowner agreement for the proposed receiving land are documented in Appendix B. The cooperating farm producer details are outlined in Table 2.2. Figure 2 (Appendix A) provides an overview of the agricultural field put forward for land application.

Table 2.2 - Field Available for Biosolids Application

Legal Land Location	Cooperating Farm Producer	Field Area	Manitoba Land Title #	Registered Owner
NE09-08-06EPM	Arnold Reimer	60 Ha*	1510380	Delmera Holsteins Inc.

* Note: Land area is less all applicable buffer zones.

2.3.2 Current Land Use Development Controls

The land base that will receive biosolids is located in NE09-08-06EPM (LSA) and is zoned as Agriculture under the R.M. of Ste. Anne Zoning By-Law No. 10-2010 (Figure 3, Appendix A). Under the Zoning By-law, Agricultural Zone is defined as: **"**provides for a wide range of agricultural activities on large parcels of land in a fairly unrestricted manner. Special and intensive agriculture uses may be allowed on smaller parcels of land."

Neighbouring land use zone for SE09-08-06EPM includes both Agriculture and a General Development Zone. The General Development zone is for the Hamlet of Greenland and provides areas for a mixture of residential, commercial and industrial uses. Residential uses such as low density, single family dwellings and multiple family dwellings will be considered as well as a variety of commercial and inoffensive industrial uses.

The identified land use zoning under the by-law established by the R.M. of Ste. Anne for the identified LSA and neighbouring properties do not prohibit the use of the land for spreading of biosolids or sludge material.

2.3.3 Granny's Wastewater Treatment Lagoon

The treatment lagoon consists of two cells – Cell 1 (west side of wastewater treatment site) and Cell 2 (east side of wastewater treatment site). The area of Cell 1 is approximately 16,650 m^2 and the area of Cell 2 is approximately 18,950 m^2. Granny's stopped actively using the two cells in 2002 when connection to the RM of Hanover's aerated treatment lagoon at NE32-7-6EPM was established. Cell 2 was used as the primary cell and Cell 1 was used as a secondary polishing cell. Currently, Cell 1 is used as a storm water retention pond and Cell 2 is an emergency overflow wastewater treatment cell.

Two historic reports regarding the lagoons have been published, they are:

1. Emergency Storage Lagoon and Sludge Land Application Pre-Design Report, April 2010, Prepared for Granny's Poultry Cooperative, Prepared by: Wardrop Engineering Ltd.
2. Granny's Poultry Cooperative Ltd. Lagoon – Geotechnical Investigation, October 1, 2013, Prepared for Granny's Poultry Cooperative Ltd., Prepared by: J.R. Cousin Consultants Ltd.

3.0 DESCRIPTION OF EXISITING ENVIRONMENT IN THE LOCAL STUDY AREA

3.1 Biophysical Environment

The proposed project is located within the Steinbach Ecodistrict of the Interlake Plain Ecoregion which is covered by the broader Boreal Plains Ecozone (Smith, Veldhuis, Mils, Eilers, Fraser and Lelyk 1998).

3.1.1 Climate

The Steinbach Ecodistrict lies in a more humid and cooler subdivision of the Subhumid Low Boreal Ecoclimatic Region. The ecodistrict is characterised by short, warm summers and cold winters with a mean average temperature of 2.4^0C (Smith, et al. 1998). The average crop growing season is 184 days with approximately 1700 growing degree-days. Mean annual precipitation is 510 mm, one fifth of which is in the form of snowfall. The Steinbach Ecodistrict has a moderately cold, humid, Cryoboreal to cool, subhumid Boreal soil climate with an average annual soil moisture deficit of approximately 200-250 mm (Smith, et al. 1998).

3.1.2 Physiography and Drainage

The general project area is situated within the southeastern lake terrace section of the Manitoba Plain. The physiography ranges from smooth, level glaciolacustrine plain to gently undulating, terraced plain with water-worked glacial till and glaciofluvial materials. The mean area elevation is 297 metres above sea level (masl). The overall slope for the ecodistrict is northwestward from the eastern edge of the district towards the Red River in the west (Smith, et al. 1998).

The designated drainage pathways to the north of the LSA include the Seine River Diversion, a 4^{th} order drain that is a tributary into the Red River as well as the River Lot Drain, a 2^{nd} order drain that drains to the Seine River Drain. Several second order and third order drains including the Youville Drain and North Lateral Drain are also found south of the LSA within the RSA (refer to Figure 4, Appendix A).

3.1.3 Surficial and Bedrock Geology

Surficial deposits within the RSA consist of clay beds up to 24 m thick, underlain by glacial till. These surficial deposits are underlain by carbonate rock (limestone and dolostone) bedrock. Beneath the carbonate bedrock layer are sandstone and shale beds which occur at a depth of approximately 79 m near the City of Steinbach. These sandstone and shale beds are in turn underlain by granitic rock (Rutulis 1973).

3.1.4 Groundwater and Hydrological Description

Extensive aquifers underlie the R.M. of Hanover and Ste. Anne. Near the LSA, the carbonate aquifer that underlies the surficial deposits ranges in depth from 16 to 30 m with the static water level (flowing well area) occurring at up to 3 m above ground level (Rutulis 1974). This aquifer is formed by thick and extensive carbonate rock beds with minor shale beds (Rutulis 1986[1]). Most domestic wells in the R.M. draw their water from the carbonate aquifer and have been developed into the carbonate rock to a depth of 9 m or less (Rutulis 1973). Domestic wells in the carbonate aquifer yield more than 1.0 L/s (Rutulis 1986_1). Water quality in the carbonate aquifer is of good to excellent quality and can be used as a domestic supply without treatment. Total dissolved solids concentration and hardness is less than 400 parts per million (ppm) and 350 ppm respectively (Rutulis 1973).

In the area around the town of Blumenort as well as south of provincial highway #52, discontinuous sand and gravel aquifers also occur above the carbonate aquifer (Rutulis 1973). These aquifers range in size from less than a hectare to several square kilometres in size. These sand and gravel aquifers may occur at less than 15 m up to a depth of more than 30 m and average thicknesses may range from a few metres to greater than 30 m (Rutulis 1986[2]). These aquifers are common throughout most of the R.M. of Hanover but are not continuous; thus, some wells in the area may be developed into these aquifers, but most have been developed into the carbonate aquifer. Water quality is generally better in the sand and gravel aquifers compared to the carbonate aquifer (Rutulis 1973). Well yield ranges from less than 0.1 to more than 10 L/s (Rutulis 1986[2]).

A search of the Manitoba GWDrill (2012) logs for groundwater wells within the LSA found one groundwater well in the LSA (Table 3.1). Within the adjacent quarter sections to the LSA there are 15 wells logs within section NE, SE and SW09-08-06EPM, six well logs in S1/2 of 08-08-06EPM, two well logs within S1/2 16-08-06EPM and one well log within SE17-08-06EPM. The groundwater well search results are included in Appendix C.

Table 3.1 - Groundwater Use Well Records within the LSA

Legal Land Location	GWdrill Results (GWDrill, 2012)	Groundwater Use
NW09-08-06EPM	1	Domestic

3.1.5 Soils

Soils in the ecodistrict consist of well to imperfectly drained Dark Gray and Black Chernozems developed on thin, variably calcareous, discontinuous, sandy to loamy glaciolacustrine veneers. These veneers overlay extremely calcareous water–worked glacial till that are loamy to clayey in texture (Smith, et al. 1998). Sandy deposits and till ridges in the eastern area of the ecodistrict contain imperfectly and well drained Luvisol and some Eutric Brunisol soils (Smith, et al. 1998). Depressional lowland areas in the ecodistrict contain poorly drained peaty Gleysols and organic Mesisols (Smith, et al. 1998). Specific soil characteristics of the LSA are discussed in Land Suitability, Section 4.0.

3.1.6 Vegetation

The native vegetation of the Steinbach Ecodistrict originally consisted of trembling aspen and balsam poplar tree bluffs and tall grass prairie, with creeks and low-lying areas supporting willow and red-oiser dogwood shrubs as well as a variety of sedges. As a result of settlement, much of the native vegetation in the district has been replaced by agricultural crops (Smith, et al. 1998). Local pockets of natural vegetation can still be found in areas of unbroken land.

3.1.7 Wildlife Species

Habitat for wildlife species is limited within the RSA due to the predominance of agricultural production. Species which persist in the region and have adapted to the agricultural landscape include white-tailed deer, jack rabbit, racoon, skunks, red fox, voles and mice and various bird species such as crows, blackbirds and songbirds.

3.1.8 Surface Water Bodies

There are no natural lakes within the RSA and wetlands have been reduced to small ephemeral depressions and dugouts that are used for livestock watering. Historic drainage patterns in the region have been altered over time to accommodate agricultural production. To mitigate flooding to downstream communities the Seine River Diversion was developed in the early 1960s. The Seine River Diversion is located approximately 1.6 km north of the LSA and the Seine River is located approximately 3.5 km north of the LSA. The Seine River Diversion stretches east from St. Anne for approximately 36 km to its confluence with the Red River north

of St. Adolphe. Surface water within the LSA is expected to drain to the Seine River Diversion via the River Lot Drain.

3.1.9 Aquatic Life

Aquatic life in the RSA is restricted to the narrow vegetated buffer strips immediately adjacent to the Seine River Diversion, the Seine River and the tributaries and may include species such as frogs, dragonflies, turtles and garter snakes as well as various waterfowl species. An historic fishery study completed in the late 1990s documented the presence of up to 27 fish species in the Seine River itself (Cleator et al, 2010).

A survey conducted in 2006 by the City of Winnipeg Naturalists Services Branch for the presence of fish within certain upstream regions of Winnipeg creeks and streams identified that several minnow and fish species were observed to be entering Winnipeg drains and channels from the Seine River and tributaries including black bullhead and fathead minnows, common carp and white sucker (Penner, 2007).

3.2 Potential Species of Concern

An online request was made to the Manitoba Conservation and Water Stewardship Wildlife and Ecosystems Protection Branch, Manitoba Conservation Data Centre (MBCDC) on January 16, 2015 with respect to species of conservation concern within the RSA including Sections 3, 4, 5, 8, 9, 10, 15, 16, and 17 within Township 8, Range 6 EPM. Mr. Chris Friesen, Biodiversity Information Manager of the MBCDC examined database records and found occurrences of a species of conservation concern within the RSA boundaries (Appendix C) but not in the LSA, these listings include:

- NE 10-8-6E, NE 17-8-6E and NW 16-8-6E: Bobolink (*Dolichonyx oryzivorus*), S4, COSEWIC: Threatened

3.3 Parks and Protected Areas

The nearest green space and sports parks are located within the Village of Ste. Anne and Blumenort town boundaries, 3.6 km and 4.5 km southeast and northeast of the LSA, respectfully. Based on land ownership map (R.M. of Ste. Anne, July 2014) there are no municipal green spaces or sports parks in the Hamlet of Greenland and no protected areas or wildlife management areas were identified within the RSA (Figure 3, Appendix A).

3.4 Socioeconomic Environment

3.4.1 Population

The settled populations within and adjacent to the RSA include the Town of Blumenort with a population of approximately 1,133 individuals, the Hamlet of Greenland with an unreported population number and the Town of Ste. Anne with a population of 1,626 people (Statistics Canada, 2011).

3.4.2 Existing Land and Resource Uses

The parcel of land that is to receive the biosolids material is classified as agricultural and is used for the production of annual crops such as cereals, oilseeds, and soybeans. One rural residence is present within the NW09-08-06EPM and there are several rural residences within the section of land including a portion of the Hamlet of Greenland. Adjacent land use is agriculture cropping. All appropriate set back distances will be applied as required for adjacent and neighbouring land use and for third order drains (Figure 5, Appendix A).

3.4.3 Heritage Resources

A request was made to the Manitoba Historic Resources Branch (MHRB) on January 15, 2015 with respect to the location of heritage resources within the RSA including all Sections 3, 4, 5, 8, 9, 10, 15, 16 and 17 within Township 08, Range 06 EPM. Ms. Heather Docking, Heritage Resources Registrar with the MHRB examined branch records and found that there are no known archaeological sites or designated heritage sites within the RSA (Appendix C).

3.4.4 First Nation Communities

No First Nation communities are located within the RSA and no lands owned by First Nations are included in the LSA.

4.0 LAND SUITABILITY

In order to assess whether lands within the LSA are suitable to receive biosolids material, a desktop assessment of the LSA soils was completed that included a review of the dominant soil series, agricultural capability, nutrient management zone classes and agronomic practices of the participating landowner as outlined below.

4.1.1 Dominant Soil Series

Within the LSA there are a limited number of dominate soil series. Single soil series or compound map series and the applicable number of hectares are outlined in Table 4.1 and characteristics of the soil series are outlined in Table 4.2 and shown in Figure 7 (Appendix A).

Table 4.1 – Soil Series and the Aerial Extent within the LSA

Soil Series / Map Unit (percent area of polygon)	Aerial Extent (ha)
Osborne (80%) Red River (20%)	35
Red River (80%) Osborne (20%)	27

Table 4.2 - Classification of Soils within the LSA

Order	Great Group	Subgroup	Soil Series, Family Description
Chernozemic – Soils with chernozemic Ah horizon more than 10 cm thick and with B or C horizons of high base saturation divalent cations, calcium usually common. Well to imperfectly drained soil.	Black (A horizon with dry colour Munsell values darker than 3.5)	Gleyed Black	**Red River** (RIV) developed on moderately to strongly calcareous lacustrine clay, Imperfectly drained
Gleysolic - Poorly drained soils which may have an organic and/or an A horizon. The subsoil show gleying and are dull coloured, but may have brighter colored prominent mottles. Soils associated with wetness.	Humic Gleysol	Rego Humic	**Osborne** (OBO) developed on moderately to strongly calcareous lacustrine clay, poorly drained. Drained phase

Source: Hopkins, L.A., et al. 1993

4.1.2 Canada Land Inventory – Soil Capability for Agriculture

The Water Protection Act (C.C.sMc W65, 2005) Nutrient Management Regulation (62/2008) outlines nutrient application restrictions based on Canada Land Inventory Soil Capability Classification for agriculture ratings (Manitoba Water Stewardship, 2008). The Canada Land Inventory (CLI) is a dry-land agriculture capability inventory for rural Canada. The CLI limitations are based on climate, geology, soil chemical and physical characteristics (salinity and structure), droughtiness, inundation, erosion, stoniness and landscape topography of the soils.

The CLI groups mineral soils into seven classes with the same relative degree of limitation and then delineates subclasses within each class based on type of limitation (Frazer et al. 2001). Classes one to seven are based on increasing degree of limitation, the first three classes are capable of sustained cultivated crop production, class four is marginal for sustained arable cropping and class five is capable of pasture or hay, class six is capable of permanent pasture and class seven has no capability for arable crop or permanent pasture. There are thirteen different subclasses or limitations. Soils series within the LSA are identified as being of Class 2 and 3 with subclass designations of W (excess water). The class descriptions are as follows:

- Class 2 - Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The soils are deep and hold moisture well. The limitations are moderate and the soils can be managed and cropped with little difficulty. Under good management they are moderately high to high in productivity for a fairly wide range of crops.

- Class 3 - Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices. The limitations are more severe than for class 2 soils. They affect one or more of the following practices: timing and ease of tillage, planting and harvesting, choice of crops, and methods of conservation. Under good management, they are fair to moderately high in productivity for a fair range of crops.

The subclass descriptions are as follows:

- 'W' - Excess Water - this subclass includes soils where excess water other than brought about by inundation is a limitation to agricultural use. Excess water may result from inadequate soil drainage, a high water table, seepage or from runoff from surrounding areas.

4.1.3 Nutrient Management and Buffer Zones

The Water Protection Act (C.C.sMc W65, 2005) Nutrient Management Regulation (NMR) (62/2008) outlines criteria for the application of nutrients (nitrogen and phosphorous) to agricultural land. The purpose of the NMR is to protect water quality by encouraging responsible nutrient planning. The objective to regulate the application of substances containing nitrogen or phosphorous to land is a protective measure for sensitive water bodies and/or groundwater (Manitoba Water Stewardship, 2008).

Table 4.3 outlines the identified soil series, the associated CLI – soil capability for agriculture classes and subclasses, and the water quality management zone within the LSA and associated limitations for nutrient application. Figure 8 outlines the CLI-Agricultural Capability within the LSA for each soil polygon.

Table 4.3 - Soil Series, CLI Rating and Water Quality Management Zone within LSA

Soils Series	CLI Rating Agricultural Capability Class and subclass	Water Quality Management Zone
Red River	2W	N1
Osborne	3W	N1

Within the LSA there are approximately 35 ha of Class 2W land, 27 ha of 3W land (Figure 8, Appendix A). The Water Quality Management Zone nitrogen application limits within Zones N1 are summarized as a rate of application that results in a residual concentration of nitrate nitrogen within the top 0.6 m of soil at the end of the growing season, at any place within the application area no greater than:

- Zone N1: 157.1 kg/ha (140 lbs/acre)

The Water Quality Management Zone phosphorous application limits within zones N1 where soil test phosphorous levels (i.e., Olsen procedure) for any place in the application area is 60 ppm or more except at a rate of application that does not exceed:

- Two times the applicable phosphorous removal rate, if the soil test phosphorous levels are less than 120 ppm.
- The applicable phosphorous removal rate if the soil test phosphorous levels are 120 ppm or more but less than 180 ppm.

In order to minimize risk to human and environmental health and safety from the land application of biosolids materials, buffer zones will be established as outlined in the *Nutrient Management Regulation* (62/2008) under *The Water Protection Act (C.C.S.M. c. W65)* and the Farm Practices Guidelines for Pig Producers in Manitoba (April 2007). Buffer zones around residential areas, residences, groundwater wells and surface water drainage systems will be established as outlined in Table 4.4 (Figure 5, Appendix A).

Table 4.4 - Nutrient Buffer Zones to be Established for Biosolids Application

Description	Recommended Buffer Zone Distance (m)
A lake or reservoir designated as vulnerable	30 m (98 ft) if area is covered with permanent vegetation at the water body's high water mark **OR** 35 m (115 ft) if area is not covered with permanent vegetation the top of the outermost bank on that side of the water body
A roadside ditch of an Order 1 or 2 drain	No direct application to ditches and Order 1 and 2 drains
A river, creek or stream not designated as vulnerable An Order 3, 4, 5 or 6 drain A major wetland, bog, marsh or swamp A constructed stormwater retention pond.	3 m (10 ft) if area is covered with permanent vegetation **OR** 8 m (26 ft) if area is not covered with permanent vegetation
A groundwater feature, a lake or reservoir (not including a constructed storm water retention pond) not designated as vulnerable a river, creek or stream designated as vulnerable.	15 m (49 ft) if area is covered with permanent vegetation **OR** 20 m (66 ft) if area is not covered with permanent vegetation

4.1.4 Agronomy

Crops grown on the land receiving the biosolids material include cereals, oils seeds, and soybeans. Application of the biosolids material will increase soil health (water-holding capacity, tilth) and provide beneficial macro (nitrogen, phosphorus, potassium, sulfur) and micro nutrients (boron, copper, zinc, magnesium) to the soil for crop production. The farm producer participating in the project has been advised of the benefits of biosolids application and understands that the application of commercial fertilizers should only be completed to supplement nutrient levels from the biosolids at agronomically sustainable rates.

5.0 PROPOSED BIOSOLIDS APPLICATION RATES

It is anticipated that the biosolids will be applied in a semi-dry state with continued dewatering as the material is in a drying bed location. This means that the material will be surface spread and incorporated.

5.1 Biosolids Sampling Procedure

MMM staff completed a comprehensive sampling program on December 22, 2014 of the biosolids material in Cell 1 and Cell 2. MMM used an ice auger to core through the surface ice in each cell to access the biosolids material to allow for sample collection. In Cell 1, a composite sample was collected from eight sample points and in Cell 2, a composite sample was collected from 10 sample points. Each composite sample was thoroughly mixed, bagged, labelled and placed in coolers with a standard chain of custody document. The samples were then submitted the same day for analysis.

5.2 Biosolids Sample Analysis

For both Cell 1 and 2, one composite biosolids sample was collected and submitted for analysis to ALS Laboratory Group (ALS), an accredited laboratory by the Canadian Association for Laboratory Accreditation Inc. (CALA). The following analysis was completed on each sample to assess the biosolids quality:

- Physical characteristics: moisture content, total and volatile solids, organic matter content, total carbon, and specific gravity.
- Detailed salinity (chloride, calcium, potassium, magnesium, sodium, sulfur, SAR, E.C, and pH.
- Nutrient characteristics: nitrogen profile (total kjeldahl nitrogen, nitrate-nitrogen, ammonium-nitrogen), total and bi-carbonate phosphorous, potassium and sulfate-sulfur.
- Metals profile (20 metals, refer to Certificate of Analysis in Appendix D for a complete list).

5.3 Biosolids Quantity

In 2009, Granny's retained Wardrop Engineering to pre-pare a design report to address the decommissioning of the existing sewage lagoons. A component of the scope of work was to determine the volume of biosolids material retained in each cell. The volumes determined by Wardrop (2009) are presented in Table 5.1 and have been used to estimate the volume of biosolids for application and area of land that is required.

Table 5.1 - Estimated Biosolids Quantities

Location	Average Depth of Biosolids (m)	Approximate area of Bottom in Cell	Volume of Sludge (m^3)
Cell 1	0.095	12,738	1,214
Cell 2	0.498	12,490	6,220

Source: Wardrop, 2009

5.4 Biosolids Quality

The biosolids analytical Certificate of Analysis is presented in Appendix D.

5.4.1 Nutrient Content of Biosolids Material

To determine environmentally sustainable and agronomically appropriate biosolids prescription rates, it is important to determine nutrient quality for the biosolids material and then tailor the application rate based on targeted crop uptake and removal rates and soil fertility concentrations. The nutrient values currently determined will be utilized to evaluate the prescription rates and are outlined in Table 5.2.

Table 5.2 - Physical Characteristics, Nitrogen and Phosphorous Profiles for Biosolids

Parameter Name	Parameter Description	Units	Results	
			Cell 1	Cell 2
Reported Volume (plus 10% safety volume)	Survey	m^3	1,335	6,842
Specific Gravity	As Received	kg L^{-1}	1.18	1.13
Dry tonnes biosolid available	Dried Basis	tonnes	479	1,498
Moisture	As Received	%	65.5	78.3
Total Solids	As Received	%	35.9	21.9
Total Volatile Solids	Dry Basis	%	12	31
Organic Matter	Dry Basis	%	21.7	6.1
Nitrogen Profile				
Total Kjeldahl N	% Dried Basis	%	0.68	2.27
Total Kjeldahl N	Dried Basis	mg kg^{-1}	6,800	22,700
Total Kjeldahl N	Dried Basis	kg $Tonne^{-1}$	6.8	22.7
Ammonium - N	Dried Basis	mg kg^{-1}	111	337
Ammonium - N	Dried Basis	kg $Tonne^{-1}$	0.111	0.337
Available Nitrate	Dried Basis	mg kg^{-1}	Not detected	Not detected

Parameter Name	Parameter Description	Units	Results	
			Cell 1	Cell 2
Available Nitrate-N	Dried Basis	mg kg^{-1}	Not detected	Not detected
Organic N	Dried Basis	mg kg^{-1}	6,689	22,363
Organic N	Dried Basis	kg $Tonne^{-1}$	6.69	22.36
Method of Application:			Surface/ Incorporation	Surface/ Incorporation
Anticipated Weather			Cool/dry	Cool/dry
Anticipated Volatilization (Incorporation within 4 days)			15	15
Available Organic N	Dried Basis	kg $Tonne^{-1}$	1.67	5.59
Ammonium nitrogen available	Dried Basis	kg $Tonne^{-2}$	0.09	0.29
Total available nitrogen (Year 1)	Dried Basis	kg $Tonne^{-1}$	1.77	5.88
Mineralization N (Year 2)	Dried Basis	kg $Tonne^{-1}$	0.80	2.68
Mineralization N (Year 3)	Dried Basis	kg $Tonne^{-1}$	0.40	1.34
Phosphorous Profile				
Total Phosphorous	Dried Basis	mg kg^{-1}	1,680	1,480
Phosphorus	Dried Basis	kg $Tonne^{-1}$	1.68	1.48
P_2O_5 equivalent	Dried Basis	kg $Tonne^{-1}$	3.86	3.40
Total Available P_2O_5	Dried Basis	kg $Tonne^{-1}$	1.93	1.70
Phosphorous (Olsen)	Dried Basis	mg kg^{-1}	49.20	53.50
Phosphorus	Dried Basis	kg $Tonne^{-1}$	0.05	0.05
P_2O_5 equivalent	Dried Basis	kg $Tonne^{-1}$	0.11	0.12
Total Available P_2O_5 (50% available)	Dried Basis	kg $Tonne^{-1}$	0.06	0.06
Confirmation Characteristics				
Total Organic Carbon	Dry Basis	%	7.4	18.3
C:N Ratio	Dry Basis	x:1	10.9	8.1
C:P Ratio	Dry Basis	x:1	44.0	123.6
N:P Ratio	Dry Basis	x:1	4.0	15.3
pH	Saturated Paste		7.68	8.47

Notes:
Dry tonnes biosolids available = wet tonnes x %solids
Organic N (= TKN – Ammonium-N)
Total Phosphorous (Acid digestion)

When utilizing these sources of organic biosolids as a fertilizer, there is a recognizable difference in the nitrogen profile between the two cells. To achieve an even distribution of nutrient value for the cooperating farm producer the biosolids from Cell 1 and Cell 2 will need to be blended prior to land spreading. The biosolids material will need to be mechanically blended

together in the cells prior to exporting to the field; this is the means to provide the best means of spreading the nutrients evenly over the field.

In biosolids material there is only a portion of total nitrogen that is immediately available; this portion that is in the organic form must undergo a mineralization process to become available for uptake by crops. Mineralization is the conversion of organic nitrogen to ammonium nitrogen. Like hog manure, the anticipated mineralization rate for year one is 25 percent, for year two 12 percent and for year three 6 percent.

At a Carbon to Nitrogen (C:N) ratio that exceeds 30:1, N becomes a limiting nutrient for decomposer organisms, and this can reduce the rate of decomposition and results in N immobilization. The C:N ratio for the Cell 1 biosolids material is approximately 11:1 and for the Cell 2 biosolids material it is approximately 8:1, thus mineralization will continue at anticipated rates.

With a Carbon to Phosphorous (C:P) ratio between 200:1 and 300:1, mineralization and immobilization balance each other to result in no net release of P from the decomposing manure. When C:P is below this range, P is released and when above this range P will be tied up and not released for crop use. Cell 1 and Cell 2 biosolids material C:P ratio is 44:1 and 124:1, respectively; below the range (200:1 and 300:1) therefore it is anticipated that P will continue to be released.

When animal and municipal wastes have N:P ratios ranging from 1:1 to 1:2 and are applied based on N rates on soils, over time, P will accumulate. The Cell 1 and Cell 2 biosolids material N:P ratio is 4:1 and 15:1, thus it is anticipated that P will not accumulate.

5.4.2 Salinity

The biosolids material from Cell 1 has an electrical conductivity (E.C.) value of 2.6 dS m^{-1} and a Sodium Absorption Ratio (SAR) of 3.41. The biosolids material from Cell 2 has an electrical conductivity (E.C.) value of 3.38 dS m^{-1} and a Sodium Absorption Ratio (SAR) of 3.89. Based on the matrix for assessing salinity and sodicity hazards of irrigation water (Hillel, 2000) the biosolids materials may be considered a medium salinity hazard and a low sodium hazard and as such does pose a slight environmental risk for soil salinization. Comparatively, the reported salinity is less than or similar to hog manure as reported by Racz and Fitzgerald (2001), where it was found that the mean E.C of 145 Manitoba hog manure samples had a value of 16.0 dS m^{-1} and a SAR of 5.1. It is reported by Sullivan et al (2007) that repeated biosolid applications did not result in detrimental salt accumulations in soil even at locations with low precipitation and no irrigation. Sulivan et al (2007) reported that annual applications of dewatered cake biosolids (80 percent moisture) that have been made for over 10 years has not increased soil salinity above 1 mmho cm^{-1}. Salinity analysis results for both cells are found in Table 5.3 and Certificates of Analysis are included in Appendix D.

Table 5.3 - Detailed Salinity Biosolids Samples

Parameter Name (Saturated Paste)	Unit	Results		Mean values from Racz and Fitzgerald (2001)*
		Cell 1	Cell 2	
Electrical Conductivity (Dry)	dS m^{-1}	2.6	3.38	16.1
Sodium Absorption Ratio		3.41	3.89	5.1
% Saturation	mg kg^{-1}	Oversat	Oversat	-
Calcium (Wet)	mg kg^{-1}	93.8	173.0	-
Magnesium (Wet)	mg kg^{-1}	72.10	100.0	-
Sodium (Wet)	mg kg^{-1}	146.0	230.0	-
Chloride (Wet)	mg kg^{-1}	333.0	313.0	-
Potassium (Wet)	mg kg^{-1}	18.7	33.3	-
Sulfate-S (Wet)	mg kg^{-1}	90.0	183.0	-

* Mean values from 145 Manitoba Hog manure samples.

5.4.3 Trace Elements

In *The Effect of Biosolids on Crops, Soil and Environmental Quality, A Summary of the Research conducted by the Department of Soil Science at the University of Manitoba*, Fitzgerald and Racz (1999) reported that loading rates for City of Winnipeg biosolids (i.e., 0, 50, 100 and 200 tonnes per hectare [t ha^{-1}]) found that biosolid cadmium was not mobile and was not plant available and that very little of the cadmium was taken up by wheat plants. It was also reported that for concentrations of other heavy metals (e.g., copper, zinc, nickel and lead) no consistent effect on the heavy metal content of wheat grain due to increasing rates of added biosolids was observed. Fitzgerald and Racz concluded that heavy metals in the biosolids-treated soils was similar to that of wheat produced in the Canadian Prairies and that loading rates as high as 200 t ha^{-1} did not affect grain quality.

In the biosolids material, the trace elements or metals of principal concern to agriculture include: arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc. MCWS has established cumulative loading rates for each of these metals. The cumulative weight per hectare of each heavy metal in the soil is calculated by adding the amount of each metal in the biosolids at the prescription rate to the background soil level of the same metal. As this EAP has not determined actual soil metal concentrations for the LSA, trace element concentrations from the

EAP completed for the City of Steinbach Land Application of Lagoon Biosolids (2013) for field SE08-0706EPM were used as comparative values. Field SE08-0706EPM has a similar soil series (Osborne and Red River series) to that of NE09-08-06EPM in this EAP. Actual metal loading rates to the soil within the LSA will be determined based on in-field soil results and prescription application rates as discussed in Section 5.5. Based on an application rate of 38 t ha^{-1} and the mean concentrations of trace elements, the metal loading rates will be below the limit criteria. Table 5.4 reports the trace element concentrations for Cell 1 and Cell 2 and the soil loading rates and guidelines.

5.5 Receiving Land Soil Quality

To determine environmentally sustainable and agronomically appropriate biosolids loading limits, it is important to determine nutrient requirement for the agricultural field based on targeted crop uptake rates and residual soil fertility levels. The objective of determining application rates is to target the optimum available nitrogen and phosphorous removal for small grains, oil seeds and forage crops without exceeding nutrient management zone criteria (N1) for both nitrogen and phosphorous.

A benchmark soil sampling program will be conducted immediately after harvest, anticipated to be in late September of 2015 by MMM for land within the LSA. For each management parcel within NW09-08-06EPM one composite sample will be collected from the soil surface layer (0-15 cm) and submitted to ALS for analysis of nitrate-nitrogen, bicarbonate phosphorus, potassium, sulfate-sulphur, pH, E.C. and trace elements (metals). One composite sample will also be collected from the rooting soil zone (15-60 cm) and analyzed for nitrate-nitrogen and sulfate-sulfur. Based on the soil analytical results, gross application rates, prescriptive rates and nutrient budgets will be determined separately for Cell 1 and Cell 2. These proposed biosolids application rates will be forwarded to MCWS for review to fulfill the requirements of this EAP.

The cooperating farm producer provided a field soil test completed October 12, 2014 by AgVise Laboratories; the soil test indicates that the residual nitrogen is 27 lb/ac and residual phosphorous (Olsen) is 17 ppm (Certificate of Analysis in Appendix D). This indicates that the residual nutrient profile of this field is acceptable for the receipt of biosolids material.

5.6 Proposed Biosolid Application Rates

5.6.1 Prescriptive Rates and Nutrient Budgets

A proposed prescription application rate was developed based on residual nitrogen and phosphorous concentrations and P_2O_5 crop removal for a blended material. The proposed prescription application rate is based on mean nutrient concentrations for both Cell 1 and Cell 2. Table 5.5, 5.6 and 5.7 outline the potential application rates for Cell 1 and Cell 2 individually and for a blending of materials from both cells, respectively, for nitrogen, 1 time crop removal and 2 times crop removal of phosphorous as P_2O_5.

Based on the proposed prescription application rates outlined in Table 5.5, 5.6 and 5.7 the preferred approach is to blend the biosolids material in order to achieve a uniform nutrient spread of the biosolids as possible, this is per the cooperating farm producer's request, and achieve the target nitrogen needs for the soybean crop. This approach allows for a nitrogen based application rate of 9.0 t ha^{-1} (dry) and provides an estimated 43 percent of the required P_2O_5, which is suitable for this land base. Detailed soil sample analysis will be obtained for the field and a detailed prescription rate will be provided to MCWS as promptly as possible for a timely approval prior to land application.

Table 5.4 Trace Elements (Metals) Sample Results for Cell 1 West and Cell 2 East and Soil Metal Concentrations and Cumulative Metal Concentrations

Trace Element	Laboratory Detection Limit	Biosolids Analysis Cell 1 West		Biosolids Analysis Cell 2 East		Typical Soil Concentrations (Osborne / Red River Soil Series, 2013a)		Loading Rate		Cumulative Metal Concentration West Cell 1	Cumulative Metal Concentration East Cell 2	Cumulative Weight Allowed by Guideline[1]
								Cell 1 West Application Rate 9 T ha-1 (dry)	Cell 2 East Application Rate 9 T ha-1 (dry)			
	mg kg^{-1}	mg kg^{-1}	kg $tonne^{-1}$	mg kg-1	kg tonne-1	mg kg^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-2}	kg ha^{-1}	kg ha^{-2}	kg ha^{-1}
Aluminum (Al)	500	24500	24.5	21000	21.000	19600	811.4	220.5	189.0	1031.94	1000.44	
Antimony (Sb)	0.10	0.53	0.001	0.60	0.001	0.24	0.01	0.0	0.0	0.01	0.02	
Arsenic (As)	0.10	9.41	0.009	11.5	0.012	5.20	0.22	0.1	0.1	0.30	0.32	21.6
Barium (Ba)*	0.50	405	0.405	248	0.248	153	6.33	3.6	2.2	9.98	8.57	-
Beryllium (Be)	0.10	1.06	0.000	0.91	0.001	0.70	0.03	0.0	0.0	0.03	0.04	-
Bismuth (Bi)	0.020	0.297	0.000	0.295	0.000	<1.0	-	0.0	0.0	-	-	
Boron (Bo)	10	17	0.017	24	0.024	3.70	0.15	0.2	0.2	0.31	0.37	
Cadmium (Cd)	0.020	0.512	0.001	0.972	0.001	0.34	0.01	0.0	0.0	0.02	0.02	2.5
Calcium (Ca)	100	44500	44.500	24400	24.400	37800	1564.92	400.5	219.6	1965.42	1784.52	
Chromium (Cr)	1.0	39.4	0.039	38.3	0.038	30.6	1.27	0.4	0.3	1.62	1.61	115.2
Cobalt (Co)	0.020	13.3	0.013	12.4	0.012	8.8	0.36	0.1	0.1	0.48	0.48	-
Copper (Cu)*	1.0	50.9	0.051	135	0.135	17.9	0.74	0.5	1.2	1.20	1.96	113.4
Iron (Fe)	25	29100	29.100	26700	26.700	19100	790.74	261.9	240.3	1052.64	1031.04	
Lead (Pb)	0.20	17.1	0.017	19.2	0.019	9.2	0.38	0.2	0.2	0.53	0.55	126
Magnesium (Mg)	10	17500	17.500	12400	12.400	16100	666.54	157.5	111.6		778.14	
Lithium	0.50	527	0.527	245	0.245	19.4	0.80	4.7	2.2	5.55	3.01	
Mercury (Hg)-Total	0.050	0.108	0.000	0.257	0.000	0.0202	0.00	0.0	0.0	0.00	0.00	11.9
Molybdenum (Mo)	0.020	2.34	0.002	6.06	0.006	<1.0	-	0.0	0.1	-	-	-
Nickel (Ni)	0.50	37.8	0.038	37.5	0.038	22.3	0.92	0.3	0.3	1.26	1.26	90
Phosphorus (P)	100	1680	1.680	1480	1.480	1150	47.61	15.1	13.3		60.93	
Potassium (K)	25	4410	4.410	3760	3.760	3190	132.07	39.7	33.8		165.91	
Selenium (Se)	0.50	0.71	0.001	1.77	0.002	0.42	0.02	0.0	0.0	0.02	0.03	-
Silver (Ag)	0.10	0.11	0.000	0.12	0.000	<0.20	-	0.0	0.0	-	-	-
Sodium (Na)	10	793	0.793	1250	1.250	750	31.05	7.1	11.3		42.30	
Strontium	0.10	129	0.129	95.5	0.096	96.5	4.00	1.2	0.9	5.16	4.85	
Thallium (Tl)	0.10	0.25	0.000	0.26	0.000	0.19	0.01	0.0	0.0	0.01	0.01	-
Tin (Sn)	5.0	<5.0	-	<5.0	-	<2.0	-	-	-	-	-	-
Titanium (Ti)	0.50	60.0	0.060	51.8	0.052	117	4.84	0.5	0.5	5.38	5.31	
Uranium (U)	0.020	2.65	0.003	3.93	0.004	1.29	0.05	0.0	0.0	0.08	0.09	-
Vanadium (V)	0.50	73.6	0.074	69.1	0.069	56.7	2.35	0.7	0.6	3.01	2.97	-
Zinc (Zn)	10	148	0.148	323	0.323	80.9	3.35	1.3	2.9	4.68	6.26	360
Boron (B), Hot Water Ext.	0.20	1.73		2.19	0.002	-		0.0	0.0		0.02	

Notes:

a = Soil sample analysis based on SE08-07-06E an OBOd7-RIV3

Where laboratory analysis is less than detection, then cumulative calculation is not assumed.

Table 5.5. Field Prescription Application Rates for Cell 1 West Sludge

Field ID:	NW09-8-6E	
2015 Crop:	Soybeans	
2015 Target Yield (Bu):	40	
	lb/ac	kg/ha
Target Nitrogen recommended :	36	40
Fertilizer Phosphate (P_2O_5) Recommended:	35	39
1 x P_2O_5 Crop Removal @ target Yield:	33	37
2 x P_2O_5 Crop Removal @ target Yield:	66	74

Plant Available Nutrients Soil Test Data			
Sample Depth	0-15 cm	15-60 cm	Total Available
Units	mg kg^{-1}		kg ha-1
Available Nitrate-N	03.0	3.5	27
Available Phosphate-P	17.0		34
Available Potassium	401		802
Available Sulfate-S			-

Cell 1 West Sludge Characteristics and Analysis

Parameter Name	**Parameter Description**	**Unit**	**Biosolid Analysis (Cell 1)**
Reported Volume (plus 10% safety volume)	In-field	m^3	1,335
Specific Gravity	As Received	kg L^{-1}	1.18
Dry tonnes biosolids available	As Received	tonnes	479
Moisture	As Received	**%**	65.50
Total Solids	As Received	**%**	35.90
Total Volatile Solids	Dry Basis	%	12
Organic Matter	Dry Basis	%	21.70
Total Organic Carbon	Dry Basis	%	7.40
C:N Ratio	Dry Basis	x:1	10.88
C:P Ratio	Dry Basis	x:1	44.05
N:P Ratio	Dry Basis	x:1	4.05
pH	Saturated Paste		
Total Kjeldahl N	% Dried Basis	%	0.68
Total Kjeldahl N	Dried Basis	mg kg^{-1}	6,800
Total Kjeldahl N	Dried Basis	kg $Tonne^{-1}$	6.80
Ammonium - N	Dried Basis	mg kg^{-1}	111.00
Ammonium - N	Dried Basis	kg $Tonne^{-1}$	0.1110
Available Nitrate	Dried Basis	mg kg^{-1}	-
Available Nitrate-N	Dried Basis	mg kg^{-1}	-
Total Phosphorous	Dried Basis	mg kg^{-1}	1,680
Amount of Sludge Nitroge Available to Crop			
Organic N (=TKN-ammonium N)	Dried Basis	mg kg^{-1}	6,689.00
Organic N	Dried Basis	kg $Tonne^{-1}$	6.69
Method of Application:			Surface/Incorp.
Anticipated Weather			Warm/Dry
Anticipated Volatilization (%)	Incorp. within 48 hrs		15
Available Organic N	Dried Basis	kg $Tonne^{-1}$	1.67
Ammonium nitrogen available	Dried Basis	kg $Tonne^{-2}$	0.09
Total available nitrogen (Year 1) (@25%)	Dried Basis	kg $Tonne^{-1}$	1.77
Mineralization N Year 2 (@12%)	Dried Basis	kg $Tonne^{-1}$	0.80
Mineralization N Year 3 (@6%)	Dried Basis	kg $Tonne^{-1}$	0.40
Phosphorus	Dried Basis	kg $Tonne^{-1}$	1.68
P_2O_5 equivalent	Dried Basis	kg $Tonne^{-1}$	3.86
Total Available P2O5	Dried Basis	kg $Tonne^{-1}$	1.93
Phosphorous (Olsen)			
Phosphorous	Dried Basis	mg kg^{-1}	49.20
Phosphorus	Dried Basis	kg $Tonne^{-1}$	0.05
P_2O_5 equivalent	Dried Basis	kg $Tonne^{-1}$	0.11
Total Available P_2O_5	Dried Basis	kg $Tonne^{-1}$	0.06

Application Rate based on Nitrogen Target			**40**	**Land Area Required (Ha)**
Nitrogen based application rate	Dried Basis	tonnes ha^{-1}	23	**21**
Amount of Available P_2O_5 applied	Dried Basis	kg ha^{-1}	44	
P_2O_5 Application check		%	112	
Application Rate based on Phosphorous (1xCR)			**37**	**Land Area Required (Ha)**
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha^{-1}	19	**25**
Amount of Nitrogen applied	Dried Basis	kg ha^{-1}	34	
Additional Nitrogen required		kg ha^{-1}	7	
Application Rate based on Phosphorous (2xCR)			**74**	**Land Area Required (Ha)**
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha^{-1}	38	**13**
Amount of Nitrogen applied	Dried Basis	kg ha^{-1}	68	
Additional Nitrogen required		kg ha^{-1}	- 27	

Selected Application rate based on:		**2xCR**	**P2O5**
Selected Application rate based on P_2O_5	Dried Basis	tonnes ha^{-1}	**38**
		tons ac^{-1}	**17**
	Wet	tonnes ha^{-1}	106.58
		tons ac^{-1}	47.96

Notes

Available Ammonium N - Volatilization loss associated with different application methods (0% with Injection)

Organic N - TKN - Ammonium N

Available Organic N - Organic N x 0.25year 1

Mineralization of Year 2 = 12%, Year 3 = 6%

Plant Available Nitrogen= (NO3-N)+Volatilization factor (NH4-N)+Organic N Mineralization

Phosphorous Total and Olsen methods.

* See Estimates of Ammonium-N Retained After Biosolids application

Table 5.6. Field Prescription Application Rates for Cell 2 East Sludge

Field ID:	NW09-8-6E	
2015 Crop:	Soybeans	
2015 Target Yield:	40	
	lb/ac	kg/ha
Target Nitrogen recommended :	36	40
Fertilizer Phosphate (P_2O_5) Recommended:	35	39
1 x P2O5 Crop Removal @ target Yield:	33	37
2 x P2O5 Crop Removal @ target Yield:	66	74

Plant Available Nutrients Soil Test Data			
Sample Depth	0-15 cm	15-60 cm	Total Available
Units	mg kg^{-1}		kg ha-1
Available Nitrate-N	03.0	3.5	27
Available Phosphate-P	17.0		34
Available Potassium	401		802
Available Sulfate-S			-

Cell 2 West Sludge Characteristics and Analysis

Parameter Name	Parameter Description	Unit	Biosolids Analysis (Cell 2)
Reported Volume plus (10% safety volume)	In-field	m^3	6,842
Specific Gravity	As Received	kg L^{-1}	1.13
Dry tonnes biosolids available	Dried Basis	tonnes	1,498
Moisture	As Received	**%**	78.30
Total Solids	As Received	**%**	21.90
Total Volatile Solids	Dry Basis	%	31
Organic Matter	Dry Basis	%	6.10
Total Organic Carbon	Dry Basis	%	18.30
C:N Ratio	Dry Basis	x:1	8.06
C:P Ratio	Dry Basis	x:1	123.65
N:P Ratio	Dry Basis	x:1	15.34
pH	Saturated Paste		
Total Kjeldahl N	% Dried Basis	%	2.27
Total Kjeldahl N	Dried Basis	mg kg^{-1}	22,700
Total Kjeldahl N	Dried Basis	kg $Tonne^{-1}$	22.70
Ammonium - N	Dried Basis	mg kg^{-1}	337.00
Ammonium - N	Dried Basis	kg $Tonne^{-1}$	0.3370
Available Nitrate	Dried Basis	mg kg^{-1}	-
Available Nitrate-N	Dried Basis	mg kg^{-1}	-
		kg $Tonne^{-1}$	-
Total Phosphorous	Dried Basis	mg kg^{-1}	1,480

Amount of Biosolids Nutrient Available to Crop

Organic N	Dried Basis	mg kg^{-1}	22,363.00
Organic N	Dried Basis	kg $Tonne^{-1}$	22.36
Method of Application:			Surface/Incorp.
Anticipated Weather			Warm/Dry
Anticipated Volatilization (%)	Incorp within 48 hrs.		15
Available Organic N	Dried Basis	kg $Tonne^{-1}$	5.59
Ammonium nitrogen available	Dried Basis	kg $Tonne^{-2}$	0.29
Total available nitrogen (Year 1) (@25%)	Dried Basis	kg $Tonne^{-1}$	5.88
Mineralization N Year 2 (@12%)	Dried Basis	kg $Tonne^{-1}$	2.68
Mineralization N Year 3 (@6%)	Dried Basis	kg $Tonne^{-1}$	1.34
Phosphorus	Dried Basis	kg $Tonne^{-1}$	1.48
$P_2O_{5\ equivalent}$	Dried Basis	kg $Tonne^{-1}$	3.40
Total Available P2O5	Dried Basis	kg $Tonne^{-1}$	1.70
Phosphorous (Olsen)			
Phosphorous	Dried Basis	mg kg^{-1}	53.50
Phosphorus	Dried Basis	kg $Tonne^{-1}$	0.05
$P_2O_{5\ equivalent}$	Dried Basis	kg $Tonne^{-1}$	0.12
Total Available P_2O_5	Dried Basis	kg $Tonne^{-1}$	0.06

Application Rate based on Nitrogen Target			**40.32**	**Land Area Required (Ha)**
Nitrogen based application rate	Dried Basis	tonnes ha^{-1}	7	**218**
Amount of Available P_2O_5 applied	Dried Basis	kg ha^{-1}	12	
P2O5 Application check		%	30	
Application Rate based on Phosphorous (1xCR)			**37**	**Land Area Required (Ha)**
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha^{-1}	22	**69**
Amount of Nitrogen applied	Dried Basis	kg ha^{-1}	128	
Additional Nitrogen required		kg ha^{-1}	- 87	
Application Rate based on Phosphorous (2xCR)			**74**	**Land Area Required (Ha)**
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha^{-1}	43	**34**
Amount of Nitrogen applied	Dried Basis	kg ha^{-1}	255	
Additional Nitrogen required		kg ha^{-1}	- 215	

Selected Application rate based on:		**1xCR**	**P2O5**
Selected Application rate based on P_2O_5	Dried Basis	tonnes ha^{-1}	**21.72**
		tons ac^{-1}	**9.77**
	Wet	tonnes ha^{-1}	99.16
		tons ac^{-1}	44.62

Notes

Available Ammonium N - Volatilization loss associated with different application methods (0% with Injection)

Organic N - TKN - Ammonium N

Available Organic N - Organic N x 0.25year 1

Mineralization of Year 2 = 12%, Year 3 = 6%

Plant Available Nitrogen= (NO3-N)+Volatilization factor (NH4-N)+Organic N Mineralization

Phosphorous Total and Olsen methods.

* See Estimates of Ammonium-N Retained After Biosolids application

Table 5.7. Field Prescription Application Rates for Blended Biosolids

Field ID:	NW09-8-6E	
2015 Crop:	Soybeans	
2015 Target Yield (Bu):	40	
	lb/ac	kg/ha
Target Nitrogen recommended :	30	34
Fertilizer Phosphate (P_2O_5) Recommended:	35	39.2
1 x P_2O_5 Crop Removal @ target Yield:	33	37
2 x P_2O_5 Crop Removal @ target Yield:	66	74

Plant Available Nutrients Soil Test Data			
Sample Depth	0-15 cm	15-60 cm	Total Available
Units	mg kg^{-1}		kg ha-1
Available Nitrate-N	03.0	3.5	27
Available Phosphate-P	17.0		34
Available Potassium	401		802
Available Sulfate-S			-

Biosolids Characteristics and Analysis

Parameter Name	Parameter Description	Unit	Biosolid Analysis (Cell 1)	Biosolids Analysis (Cell 2)	Blended Nutrient Value (Cell 1 and Cell 2)
Reported Volume (plus 10% safety volume)	In-field	m^3	1,335	6,842	8,177
Specific Gravity	As Received	kg L^{-1}	1.18	1.13	1.16
Dry tonnes biosolids available	As Received	tonnes	479	1,498	1,977
Moisture	As Received	%	65.50	78.30	71.9
Total Solids	As Received	%	35.90	21.90	28.9
Total Volatile Solids	Dry Basis	%	12	31	21.5
Organic Matter	Dry Basis	%	21.70	6.10	13.9
Total Organic Carbon	Dry Basis	%	7.40	18.30	12.85
C:N Ratio	Dry Basis	x:1	10.88	8.06	8.71
C:P Ratio	Dry Basis	x:1	44.05	123.65	81.33
N:P Ratio	Dry Basis	x:1	4.05	15.34	9.34
pH	Saturated Paste		7.68	8.47	
Total Kjeldahl N	% Dried Basis	%	0.68	2.27	1.48
Total Kjeldahl N	Dried Basis	mg kg^{-1}	6,800	22,700	14,750
Total Kjeldahl N	Dried Basis	kg $Tonne^{-1}$	6.80	22.70	14.75
Ammonium - N	Dried Basis	mg kg^{-1}	111.00	337.00	338.00
Ammonium - N	Dried Basis	kg $Tonne^{-1}$	0.1110	0.3370	0.3380
Available Nitrate	Dried Basis	mg kg^{-1}	-	-	-
Available Nitrate-N	Dried Basis	mg kg^{-1}	-	-	-
Total Phosphorous	Dried Basis	mg kg^{-1}	1,680	1,480	1,580
Amount of Sludge Nitroge Available to Crop					
Organic N (=TKN-ammonium N)	Dried Basis	mg kg^{-1}	6,689.00	22,363.00	14,526.00
Organic N	Dried Basis	kg $Tonne^{-1}$	6.69	22.36	14.41
Method of Application:			Surface/Incorp	Surface/Incorp	Surface/Incorp.
Anticipated Weather			Warm/Dry	Warm/Dry	Warm/Dry
Anticipated Volatilization (%)	Incorp. within 48 hrs		15	15	15
Available Organic N	Dried Basis	kg $Tonne^{-1}$	1.67	5.59	3.60
Ammonium nitrogen available	Dried Basis	kg $Tonne^{-1}$	0.09	0.29	0.29
Total available nitrogen (Year 1) (@25%)	Dried Basis	kg $Tonne^{-1}$	1.77	5.88	3.89
Mineralization N Year 2 (@12%)	Dried Basis	kg $Tonne^{-1}$	0.80	2.68	1.73
Mineralization N Year 3 (@6%)	Dried Basis	kg $Tonne^{-1}$	0.40	1.34	0.86
Phosphorus	Dried Basis	kg $Tonne^{-1}$	1.68	1.48	1.58
P_2O_5 equivalent	Dried Basis	kg $Tonne^{-1}$	3.86	3.40	3.63
Total Available P2O5	Dried Basis	kg $Tonne^{-1}$	1.93	1.70	1.82
Phosphorous (Olsen)					
Phosphorous	Dried Basis	mg kg^{-1}	49.20	53.50	51.4
Phosphorus	Dried Basis	kg $Tonne^{-1}$	0.05	0.05	0.05
P_2O_5 equivalent	Dried Basis	kg $Tonne^{-1}$	0.11	0.12	0.12
Total Available P_2O_5	Dried Basis	kg $Tonne^{-1}$	0.06	0.06	0.06

Blended Application Rate based on Nitrogen Target			**34**	**Land Area Required (Ha)**
Nitrogen based application rate	Dried Basis	tonnes ha^{-1}	9	**55**
Amount of Available P_2O_5 applied	Dried Basis	kg ha^{-1}	17	
P_2O_5 Application check		%	43	
Blended Application Rate based on Phosphorous (1xCR)			**37**	**Land Area Required (Ha)**
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha^{-1}	20	**24**
Amount of Nitrogen applied	Dried Basis	kg ha^{-1}	79	
Additional Nitrogen required		kg ha^{-1}	- 46	
Application Rate based on Phosphorous (2xCR)			**74**	**Land Area Required (Ha)**
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha^{-1}	**41**	**12**
Amount of Nitrogen applied	Dried Basis	kg ha^{-1}	158	
Additional Nitrogen required		kg ha^{-1}	- 125	

Selected Application rate based on:			**Nitrogen**
Selected Application rate based on P_2O_5	Dried Basis	tonnes ha^{-1}	**9**
		tons ac^{-1}	**4**
	Wet	tonnes ha^{-1}	24.06
		tons ac^{-1}	10.83

Notes

Available Ammonium N - Volatilization loss associated with different application methods (0% with Injection)

Organic N - TKN - Ammonium N

Available Organic N - Organic N x 0.25year 1

Mineralization of Year 2 = 12%, Year 3 = 6%

Plant Available Nitrogen= (NO3-N)+Volatilization factor (NH4-N)+Organic N Mineralization

Phosphorous Total and Olsen methods.

* See Estimates of Ammonium-N Retained After Biosolids application

6.0 DESCRIPTION OF ENVIRONMENTAL EFFECTS AND MITIGATION MEASURES OF THE PROPOSED PROJECT

6.1 Potential Soil Impacts

6.1.1 Management of Nitrogen and Phosphorus

Of primary concern associated with the land application of biosolids material is the leaching and/or surface runoff of nitrogen and phosphorus into ground or surface water if application rates exceed crop removal rates and soil storing capacity.

When applied at balanced rates, the land application of biosolids is a sustainable means to reuse nutrients within an agriculture system as the application of biosolid organic material enhances the water holding capacity, structure and tilth of soils thereby providing benefits to land utilized for agricultural production. The objective of the proposed project is to manage nitrogen and phosphorus based on beneficial farm management practices and following prescription rates for the Red River Valley Management Area and applicable regulations. Biosolids will be applied based on nutrient requirements for the agricultural field as outlined in Sections 5.5.1 and 5.5.2. Prescribed nitrogen and phosphorus rates will target uptake ability of small grains, oil seed, corn, and soybean crops to a maximum of 34 kg ha^{-1} without exceeding the nutrient management regulatory criteria in zones N1.

Leaching to groundwater is not a significant concern (refer to Section 4.4) within the LSA as the soil texture is a clay. In addition, by applying the biosolids at prescribed rates that optimize crop uptake and by establishing buffer zones around sensitive features, the risk of surface runoff into the River Lot Drain and Seine River Diversion drainage system will be minimized.

6.1.2 Metals

To prevent overloading of heavy metals into soils, the prescribed application rates provide cumulative weight criteria for metals that are below the permitted concentrations. The loading rates for heavy metals in the biosolids from lagoon Cell 1 and Cell 2 has been determined based on the theoretical maximum application of 9 dry t ha^{-1} of a blended application as presented in Table 5.4. These calculated heavy metal loading rates to the soil in the LSA are all below the cumulative weight criteria.

6.1.3 Salinity and Sodicity

The biosolids material may be considered a medium salinity hazard and a low sodium hazard and as such does pose a slight environmental risk for soil salinization, as soil E.C., soluble ions (e.g., sodium, potassium, chloride and sulfate) and SAR increase directly with rate application. The biosolids salinity is considered to be less than hog manure (Racz and Fitzgerald, 2001). It is reported by Sullivan et al (2007) that repeated biosolid applications in soil have not resulted in detrimental salt accumulations in soil even at locations with low precipitation and no irrigation.

The land base within the LSA is non-saline. (Figure 7, Appendix A) and the cumulative effect of salinity is not considered significant with the limited application of the biosolids.

6.1.4 Soil Compaction

Soil compaction is the clasping together of soil particles, reducing the space available for air and water thus increasing the density of the soil. Soil compaction impacts water and air movement, seedling emergence, root growth and may reduce yield potential of a field. The soil series identified within the LSA are highly susceptible to physical compaction due to the clay texture and small pore spaces.

Soil compaction may occur at entrances to the fields within the LSA due to heavy equipment traffic entering fields for biosolids application. As these entrances are typically utilized by farm producers with heavy farm equipment for crop production activities, soil compaction in these areas is likely not of great concern. In addition, winter frost action also aids in the mitigation of soil compaction. However, if the farm producer raises a concern with the potential compaction, field entrances may be deep ripped in order to mitigate compaction.

It should also be noted that the field equipment utilized to complete the land spreading of the biosolids material is equipped with large floatation tires to minimize the compaction potential.

6.2 Potential Wildlife Impacts

Potential impacts to wildlife include habitat disruption and vehicle/wildlife collisions. However the impact to wildlife habitat is considered to be low as land within the LSA primarily consists of cultivated land with minimal natural vegetative cover available as habitat. In addition, the timing of biosolids application will occur in the fall, outside of the breeding bird window. Equipment traffic associated with the transfer of biosolids from the lagoon cells to the receiving fields will be below posted speed limits thus reducing the possibility of wildlife collisions.

The Manitoba CDC did identify occurrences of Bobolink (*Dolichonyx oryzivorus*) in neighbouring quarter sections of land, however not within the LSA. Since the land application of biosolids is occurring on previously disturbed agricultural land, in the fall, outside of the breeding bird window there is minimal risk to the identified species of concern.

6.3 Potential Surface Water and Fisheries Impacts

Potential impacts to surface water and fish within the Seine River Diversion and drainage system include nutrient loading from surface runoff. The potential impact to surface water and fish is considered negligible as biosolids material will be applied at agronomically appropriate rates and will be incorporated into the soil within 48 hours of application thereby minimizing the potential of overland flow to the drainage system. Appropriate setback distances of 8 m will be established around all Order 3 or higher drains (Figure 4, Appendix A).

6.4 Potential Groundwater Impacts

Groundwater pollution within the R.M. of Ste. Anne is possible in areas where sand and gravel deposits are at or near the ground surface and where sand and gravel aquifers are used as a domestic water supply (Rutulis 1973) (Figure 6, Appendix A). However, based on the groundwater pollution hazard map developed by Rutulis (1973) for the R.M. of Ste. Anne, the LSA has a zero to minimal pollution hazard risk as the domestic well within the LSA and surrounding quarter sections draws water from the carbonate aquifer which is overlain by thick clay and/or till deposits that act as barriers to movement of contaminates to the aquifer.

Application of the biosolids materials at agronomically appropriate rates for nitrogen and phosphorous will ensure plant uptake of these nutrients over the growing season, thereby further minimizing the potential of leaching to the groundwater. If surface applied, incorporation of the biosolids material within 48 hours of application will minimize the potential of overland flow to groundwater wells. In addition appropriate setback distances will be established around all residences and domestic wells as outlined in Table 6.2 and no application would occur on soil where there is less than 1.5 meters between the soil surface and water table.

6.5 Potential Heritage Resource Impacts

The project will have no impact on the heritage resources in the area, as land application of the biosolids material will occur on agricultural land that does not contain any of these resources.

6.6 Greenhouse Gas Considerations

Greenhouse gas (GHG) emissions within the context of this biosolids land application program consist of carbon dioxide, methane and nitrous oxide. The activities related to GHG contributions are limited to the equipment emissions that will be used to transport, land apply and incorporate the biosolids material as well as the natural decomposition of land applied organic matter in the soil. Land application of biosolids provides significant benefits through the reduction of GHG production that occurs with landfill disposal, carbon sequestration in soil organic matter and reduced use of inorganic commercial fertilizers from petroleum based

sources within the LSA. These three benefits are reported to counter balance the potential emissions due to mechanical needs for the land application program (CCME, 2012).

6.7 Socioeconomic Effects

The application of biosolids to agricultural land provides a positive economic benefit to both the farm producer and Granny's Poultry. The objective of providing prescription application rates for biosolids to crop specifics is to provide an organic source for nutrient management. As outlined, biosolids provide macro nutrients (nitrogen, phosphorous, potassium, and sulfur) and micro-nutrients (boron, copper, iron, chloride, manganese, molybdenum and zinc), all of which provide economic value to the farm producer. Based on arbitrary fertilizer commodity price as of April 2013 for Urea (46-0-0) and Triple Super Phosphate (0-45-0), the following economic value for the biosolids application is presented in Table 6.1.

Table 6.1 - Economic Value for Nitrogen and Phosphorous in Applied Biosolids

Target Application	Source of Material	Anticipated Application Rate (t ha^{-1})	Arbitrary Nutrient Value ($/ha)		Cumulative Value
			Nitrogen ($0.81 kg^{-1})	P_2O_5 Equivalent ($0.98 kg^{-1})	
Nitrogen Based Rate	Cell 1	23	32	43	$75 ha^{-1}
	Cell 2	5	28	8	$30 ha^{-1}
	Blended	9	27	17	$44 ha^{-1}
Phosphorous (1x crop removal)	Cell 1	19	28	36	$64 ha^{-1}
	Cell 2	22	104	36	$140 ha^{-1}
	Blended	20	64	36	$100 ha^{-1}
Phosphorous (2x crop removal	Cell 1	38	55	73	$128 ha^{-1}
	Cell 2	43	224	72	$296 ha^{-1}
	Blended	41	139	73	$211 ha^{-1}

The biosolids material is being provided at no charge to the farm producer, thus reducing his fertilizer bill, based on a nitrogen based application of blended material this is approximately $44 per ha (Table 6.1). Based on the nitrogen application of blended material approximately 55 ha are required for the land application this equates to approximately $2,420 for just nitrogen and phosphorous fertilizer and does not account for the added benefit of potassium, sulfur and micro-nutrients. Hence the economic benefit to the farm producer is substantial based on the

savings the farm producer will incur for crop fertilizer amendments. It should also be noted that the economic benefit to Granny's is recognized from no land use fees being paid to the farm producer for the application of the biosolids; whereas, if the biosolids were disposed in the local landfill the tipping fee would represent a significant cost to the proponent.

6.8 Public Safety and Health Risks

6.8.1 Biological Pathogens and Odour Management

Biological pathogens such as *E. coli* and fecal coliforms as well as nuisance odour associated with land application of biosolids may be considered to pose a public health and safety risk. However these human health and safety risks will be managed through the application of the biosolids material onto private lands that have restricted public access. In addition, incorporation of the biosolids material within 48 hours or less of surface application will minimize odour and eliminate human exposure to pathogens. Pathogens from biosolids are often killed by exposure to sunlight, drying conditions, unfavorable pH and other macro and micro environmental conditions. Lands that receive sludge / biosolids material will also be managed on a crop rotation system for three years that includes non-root/vegetable crops.

6.8.2 Metal Accumulation in Crops

Heavy metal bioaccumulation in agricultural crops consumed by humans poses a minimal human health risk as uptake, removal and accumulation of metals by the harvested portions of crops is minimal. Harb (1999) concluded that the health risk to humans from the consumption of heavy metals in wheat and oats grown on land treated with biosolids is negligible and that there are environmental and economic benefits.

6.8.3 Additional Applicable Buffer Zones

In order to minimize risk to humans, environmental health and safety and control odour from the land application of biosolids material, buffer zones will be established as outlined in the *Nutrient Management Regulation* (62/2008) under *The Water Protection Act (C.C.S.M. c. W65)* and the *Farm Practices Guidelines for Pig Producers in Manitoba* (April 2007). Buffer zones around residential areas, residences, groundwater wells and surface water drainage systems will be established as outlined in the Table 6.2.

Buffer zones presented are adapted from the *Farm Practices Guidelines for Pig Producers in Manitoba (April 2007)* published by Manitoba Agriculture, Food and Rural Development (MARFD). Personal Communication (February 2015) with a Livestock Environment Specialist with MAFRD outlined that the setback distances published in the *Farm Practices Guidelines for Pig Producers in Manitoba* were established on reasonableness and effectiveness for

minimizing nuisance odours and have not be edited as there have been limited number of public complaints when these setbacks have been followed by pig manure applicators.

The Canadian Council of Ministers of the Environment (CCME) published *A Review of the Current Canadian Legislative Framework for Wastewater Biosolids, PN 1446, (2010)* which includes a summary of separation requirements for land application of biosolids across Canada. A summary of provincial set back distances that are provided in the CCME review are summarized as follows:

- Alberta set-back distances: With subsurface application; 165 m from residential areas, 20 m occupied dwellings, 3 m from public building perimeter, 66 m from schools in session and 7 m out of session and 66 m from parks and playgrounds.
- Saskatchewan set-back distances: 450 m from residential area, 90 m from individual residence, 200 m from hospitals, 90 m from commercial land use, 200 m from schools and 90 m from parks and playgrounds.
- Manitoba set-back distances: 1 km from residential areas and 300 m from occupied residence.
- Ontario set-back distances: 450 m from residential areas, 90 m from individual residences (generic).
    - Ontario further defines setback distances for on non-agricultural source materials (NASM), including biosolids, and is based on an odour classification.

To address potential odour issues associated with the beneficial use of NASM, the Ontario *Regulation 267/03* approach under the *Nutrient Management Act, 2002*, sets out an odour classification system for NASM that are applied to agricultural land. There are three odour categories:

- OC1 has an odour detection threshold of less than 500 units per cubic metre.
- OC2 has an odour detection threshold equal to or greater than 500 units per cubic metre and less than 1500 units per cubic metre.
- OC3 has an odour detection threshold equal to or greater than 1500 units per cubic metre and less than 4500 units per cubic metre.

The Ontario *Reg. 267/03* further classifies material into the three odour categories (OC1, OC2 and OC3) in *Table 3. NASM Odour Category Table*, an applicable summary is provided below:

- OC 1 - NASM that are less than 500 odour units:
    - Liquid anaerobically digested sewage biosolids from a municipal sewage treatment plant or its off-site storage facility.
        - Residential dwelling: no application <25 m.
- OC 2 - NASM that are equal to or greater than 500 odour units but less than 1500 odour units:
    - Liquid aerobically digested sewage biosolids from a municipal sewage treatment plant or its off-site storage facility.
        - Residential dwelling: no application <25 m, 25-90 m injection or spreading and incorporation within 6 hours, >90 m no restrictions.
- OC 3 - NASM that are equal to or greater than 1500 odour units but less than 4500 odour units:
    - Sewage biosolids which have been dewatered by a centrifuge operated at 2000 or higher revolutions per minute (rpm).
    - Sewage biosolids which have been dewatered and stored for 30 days or more after the dewatering process is completed.
        - No application <100 m, 100-450 m injection or if injection not possible spreading & incorporation with 6 hours, >450 m injection & incorporation within 24 hours.

Cells 1 and Cell 2 are considered to be anaerobically digested sewage treatment and therefore under the Ontario *Reg. 267/03* an OC1 category would be applicable. This would establish the setback distances as: no application <25 m from a residential dwelling.

The examples from Ontario, Saskatchewan and Alberta demonstrate that the setback distance from residential development is 450 m or less in other provincial jurisdictions and 90 m or less from dwellings and that Manitoba has the greatest setback distances with 1 km for residential development and 300 m for occupied residences.

As rural villages and communities develop and grow, agricultural land is squeezed in with development and available land, within a reasonable distance of the private and municipal lagoons, is at premium when competing with suitable lands for livestock manure application and nutrient management. Setback distances for the land application of biosolids material from Cell

1 and Cell 2 are therefore proposed to be those outlined in the *Farm Practices Guidelines for Pig Producers in Manitoba (April 2007)*: 400 m from residential areas and 75 m from an occupied residence with incorporation of material within 48 hours of application. The proposed setback distances in this EAP are reasonable and within the practices established by other provincial regulators and livestock manure applicators.

Table 6.2 - Buffer Zones to be Established for Biosolid Application

Description	Recommended Buffer Zone Distance
Identified groundwater well	50 m (164 ft)
Designated Residential area	400 m[1] (1312 ft)
Occupied Residence (other than the residence occupied by the owner of the land on which the biosolids are to be applied)	75 m[1] (246 ft)
Property line with residence	10 m[1] (33 ft)
Property line without residence	1.0 m[1] (3.3 ft)

Notes:

[1] Based on *Farm Practices Guidelines for Pig Producers in Manitoba (April 2007)* if surface applied and incorporated within 48 hours

7.0 MONITORING AND REPORTING FOR LAND APPLICAITON

This project is of limited duration (less than two years) and therefore limited monitoring and reporting are recommended including:

1. Completion of an on-site project start up meeting between MMM, the Proponent (Granny's) and the Applicator to review the requirements of the EAL and procedure for the land application of the biosolids.

2. Determination of the moisture and dry tonnes of the biosolids material in Cell 1 and Cell 2 to ensure consistent application at prescribed rates.

3. Recording of each scaled truck load and net biosolid weight.

4. Completion of daily on-site inspections and monitoring of biosolids application including:

    a. Monitoring adherence by the Applicator to buffer zones.

    b. Monitoring of application rates.

5. Providing a summary report to MCWS EALB on behalf of Granny's that summarizes soil fertility analytical results, prescribed biosolids application rates, and application activities completed for the project and the final land application area.

8.0 LAGOON CELL DECOMMISSIONING

8.1 Final Objectives for the Site

There are two final objectives for the lagoon site that include:

1. A portion of the area within Cell 1 foot print be redeveloped as a new emergency cell.
2. The remaining area to be rehabilitated to rough grass available for redevelopment at a later time.

The objective of this section is to outline the steps that will be taken to finalize the decommissioning of the current lagoon foot print. Steps to meet the final objectives are outlined except for the details for the new emergency lagoon. The details for a new emergency lagoon will be managed in another submission to MCWS. An outline for the order of operations will be developed and scheduled to ensure the plant is not without emergency backup capacity.

8.2 Post Biosolids Removal

When the biosolids material has been excavated and applied to the agricultural land, the following steps to decommission the lagoon cells will be executed:

- Sample the top 0.15 m of clay liner in both Cell 1 and Cell 2 for potential contaminants of concern, including:
  - Detailed salinity (chloride, calcium, potassium, magnesium, sodium, sulfur, SAR, E.C, and pH)
  - Metals profile (CCME metals)
- Sample the top 0.6 m of the clay liner in both Cell 1 and Cell 2 for residual nutrients in the clay liner including:
  - Nutrient characteristics: nitrogen profile (total kjeldahl nitrogen, nitrate-nitrogen, ammonium-nitrogen), total and bi-carbonate phosphorous, potassium and sulfate-sulfur.

The analysis will provide a baseline for long-term management of the lagoon site, including future soil management recommendations at the time of redevelopment. The salinity and nutrient profile will also allow for a more successful revegetation of the lagoon cells.

Depending upon the plans for development of the new emergency cell, the following steps would be considered for rehabilitating the lagoon foot print:

- Develop a site plan that will integrate positive drainage and erosion and sediment control.
    - Applicable permits will be obtained for on-site water management and drainage.
- Deep rip the clay liner of each cell, this will allow for improved root penetration of the revegetated portions of the site.
- Land level the berms of the lagoon and allow for positive drainage off site.
- Prepare the soil bed for revegetation of the site and amend the soil with organic material (e.g., green manure or straw) to initiate soil structure and seed bed suitability.
- Establish the site with a perennial forage mix hay to provide an aesthetically pleasing landscape and rejuvenate the site. The perennial forage mix should be amenable to the soil salinity profile and nutrient profile. The forage hay will not be harvested for a period of three years, after which the site could be reused for agricultural cropping.

9.0 SUMMARY

When applied at balanced agronomic rates, the land application of biosolids is a sustainable means to reuse nutrients within an agricultural system. The application of biosolids organic material enhances the water holding capacity, structure and tilth of soils thereby providing benefits to land utilized for agricultural production. The objective of this EAP is to provide documentation in support of attainment of an EAL for Granny's to;

1) Complete a land application of biosolid materials collected from their wastewater treatment lagoon in an agronomically and environmentally sustainable manner.
2) To outline the process that will be taken to formally decommission the current treatment cells.

The proposed prescription application rate of the biosolids is based on residual nitrogen and phosphorous concentrations and P_2O_5 crop removal for a blended material from both Cell 1 and Cell 2. Based on the proposed prescription application rates outlined in Table 5.5, 5.6 and 5.7

the preferred approach is to blend the biosolids material in order to achieve a uniform nutrient spread of the biosolids as possible, this is per the cooperating farm producer's request, and achieve the target nitrogen needs for the subsequent soybean crop of 2016. This approach allows for a nitrogen based application rate of 9.0 t ha^{-1} (dry) and provides an estimated 43 percent of the required P_2O_5, which is suitable for this land base. Detailed soil sample analysis will be obtained for the field and a detailed prescription rate will be provided to MCWS as promptly as possible for a timely approval prior to land application. This objective meets the principals of environmentally sustainable land applications outlined by MCWS and within the Canadian Council of Ministers of the Environment (CCME) *Guidance Document for the Beneficial Use of Municipal Biosolids, Municipal Sludge and Treated Septage* (December, 2012).

As rural villages and communities develop and grow, agricultural land is squeezed in with development and available land, within a reasonable distance of the private and municipal lagoons, is at premium when competing with suitable lands for livestock manure application and nutrient management. Setback distances for the land application of biosolids material from Cell 1 and Cell 2 are therefore proposed to be those outlined in the *Farm Practices Guidelines for Pig Producers in Manitoba (April 2007)*: 400 m from residential areas and 75 m from an occupied residence with incorporation of material within 48 hours of application. The proposed setback distances in this EAP are reasonable and within the practices established by other provincial regulators and livestock manure applicators.

In conclusion, applicable Manitoba Acts and Regulations, including The Environment Act and applicable regulations and the Water Protection Act and its applicable regulation will be observed. In-field at the time of land application the required setback distances from watercourses and developments will be witnessed and proposed prescription rates along with any specific requirements as outlined in the EAL to be applied to this proposed project.

10.0 CLOSURE

This report has been prepared for use by Granny's Poultry Cooperative Ltd., in accordance with generally accepted agricultural and environmental investigation practices by qualified professional and technical staff. The Standard Limitations pertaining to the use of this report are presented in Appendix E.

11.0 REFERENCES

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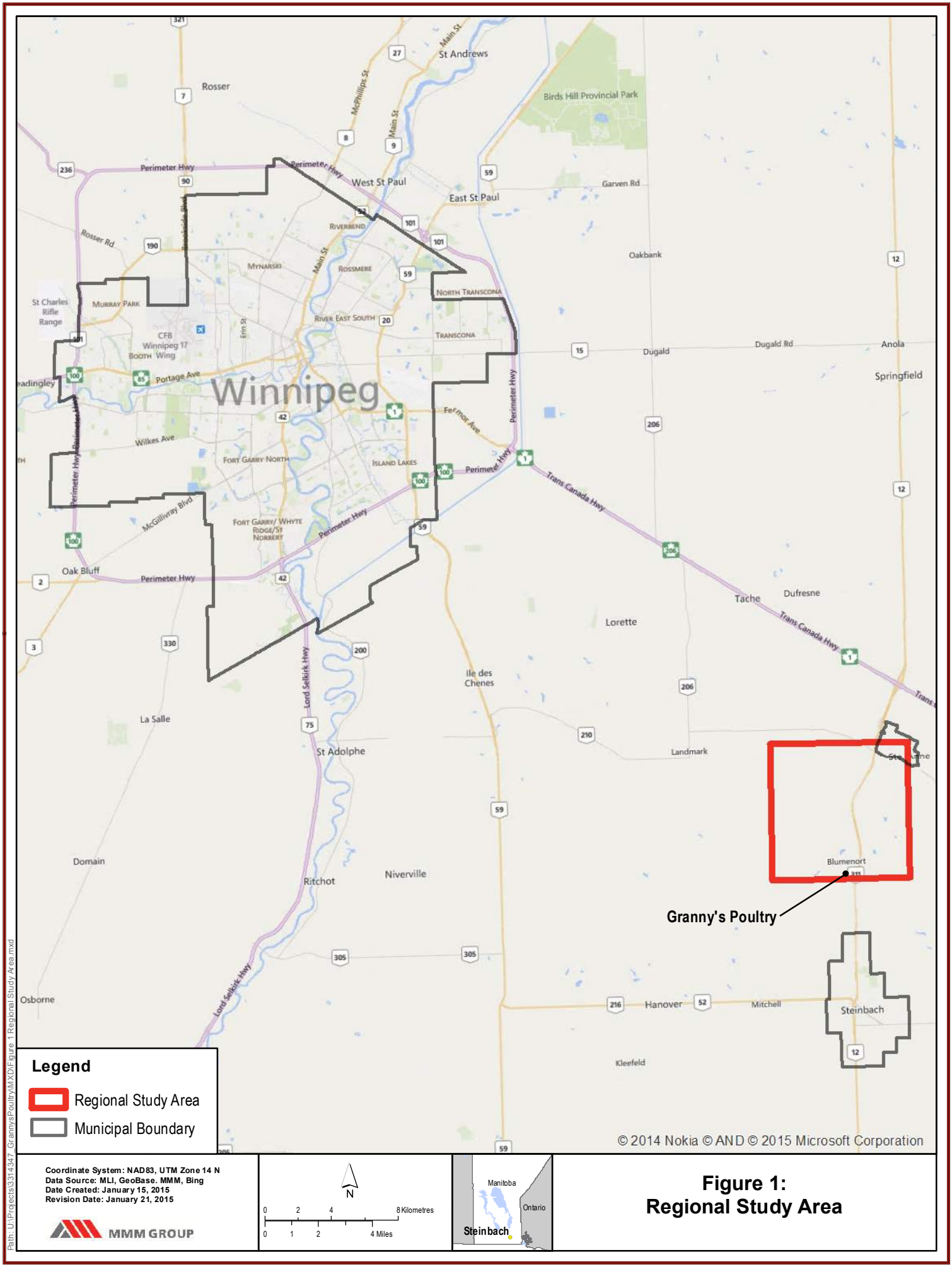
APPENDIX A – Figures


Winnipeg
St Andrews
Rosser
West St Paul
East St Paul
Birds Hill Provincial Park
Garven Rd
Oakbank
Dugald
Dugald Rd
Anola
Springfield
Transcona
North Transcona
Riverbend
Rossmere
Mynarski
Murray Park
St Charles Rifle Range
CFB Winnipeg 17 Booth Wing
Portage Ave
Wilkes Ave
Fort Garry North
Island Lakes
Fort Garry/ Whyte Ridge/St Norbert
Fermor Ave
Perimeter Hwy
Trans Canada Hwy
McGillivray Blvd
Oak Bluff
Tache
Dufresne
Lorette
Ile des Chenes
Landmark
La Salle
St Adolphe
Lord Selkirk Hwy
Domain
Ritchot
Niverville
Blumenort
Granny's Poultry
Osborne
Hanover
Mitchell
Steinbach
Kleefeld
Legend
Regional Study Area
Municipal Boundary
© 2014 Nokia © AND © 2015 Microsoft Corporation
Coordinate System: NAD83, UTM Zone 14 N
Data Source: MLI, GeoBase. MMM, Bing
Date Created: January 15, 2015
Revision Date: January 21, 2015
MMM GROUP
N
0 2 4 8 Kilometres
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Manitoba
Ontario
Steinbach
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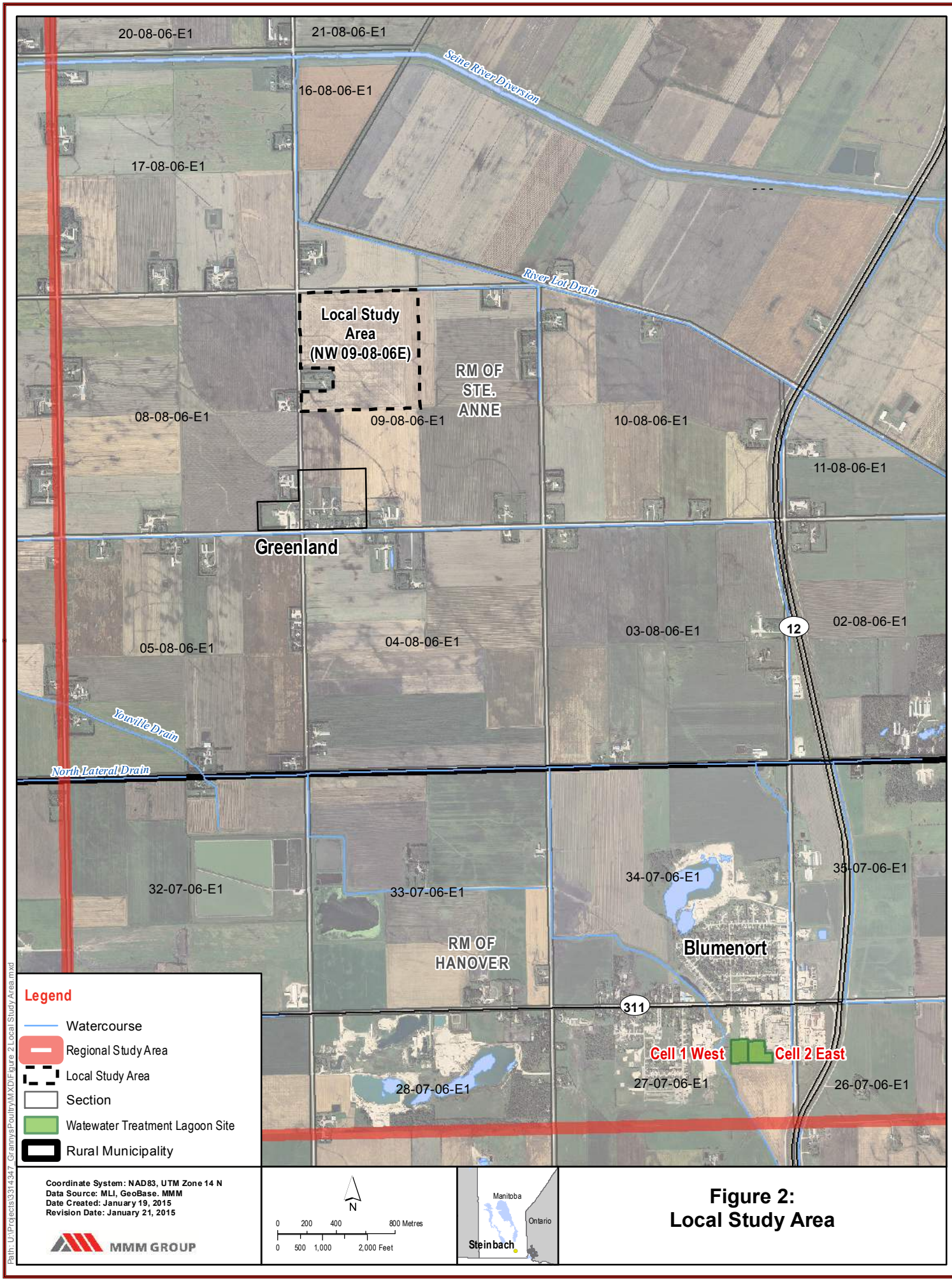


Figure 2:
Local Study Area

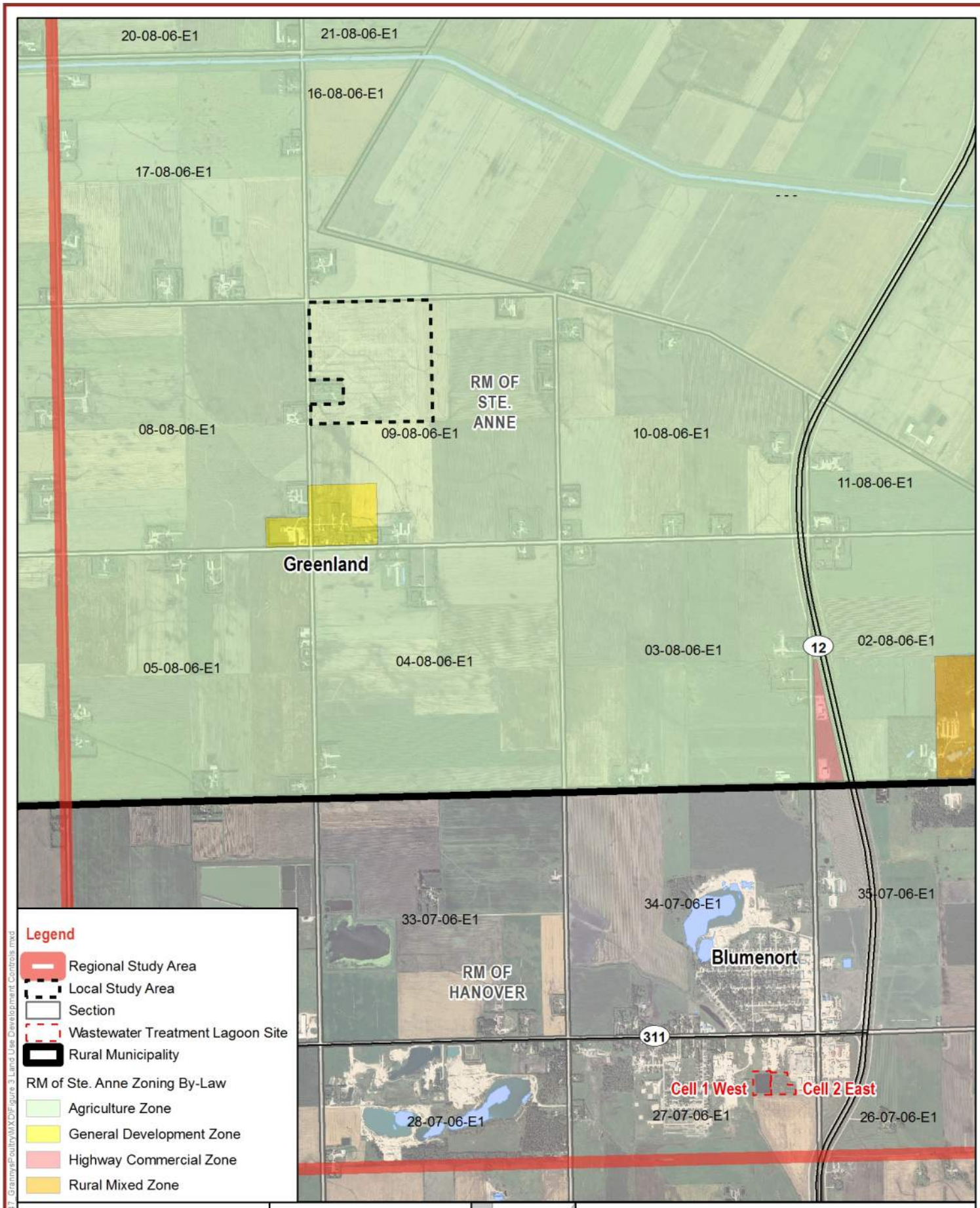
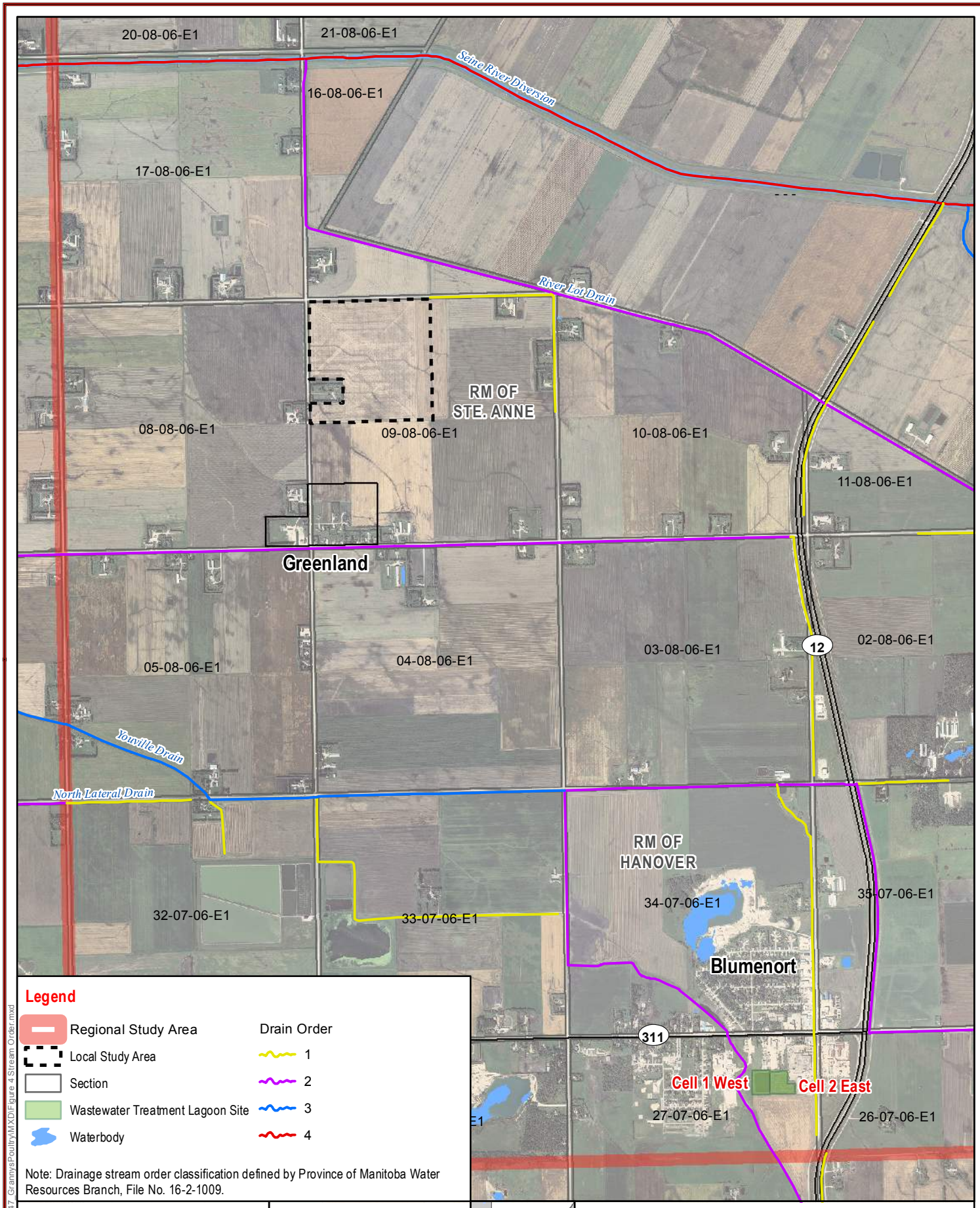


Figure 3: Land Use Development Controls



Legend

- Regional Study Area
- Local Study Area
- Section
- Wastewater Treatment Lagoon Site
- Waterbody

Drain Order

- 1
- 2
- 3
- 4

Note: Drainage stream order classification defined by Province of Manitoba Water Resources Branch, File No. 16-2-1009.

Coordinate System: NAD83, UTM Zone 14 N
Data Source: MLI, GeoBase. MMM, Bing
Date Created: January 16, 2015
Revision Date: January 21, 2015

MMM GROUP

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0 200 400 800 Metres

0 500 1,000 2,000 Feet

Manitoba
Ontario
Steinbach

Figure 4: Designated Drains and Stream Order

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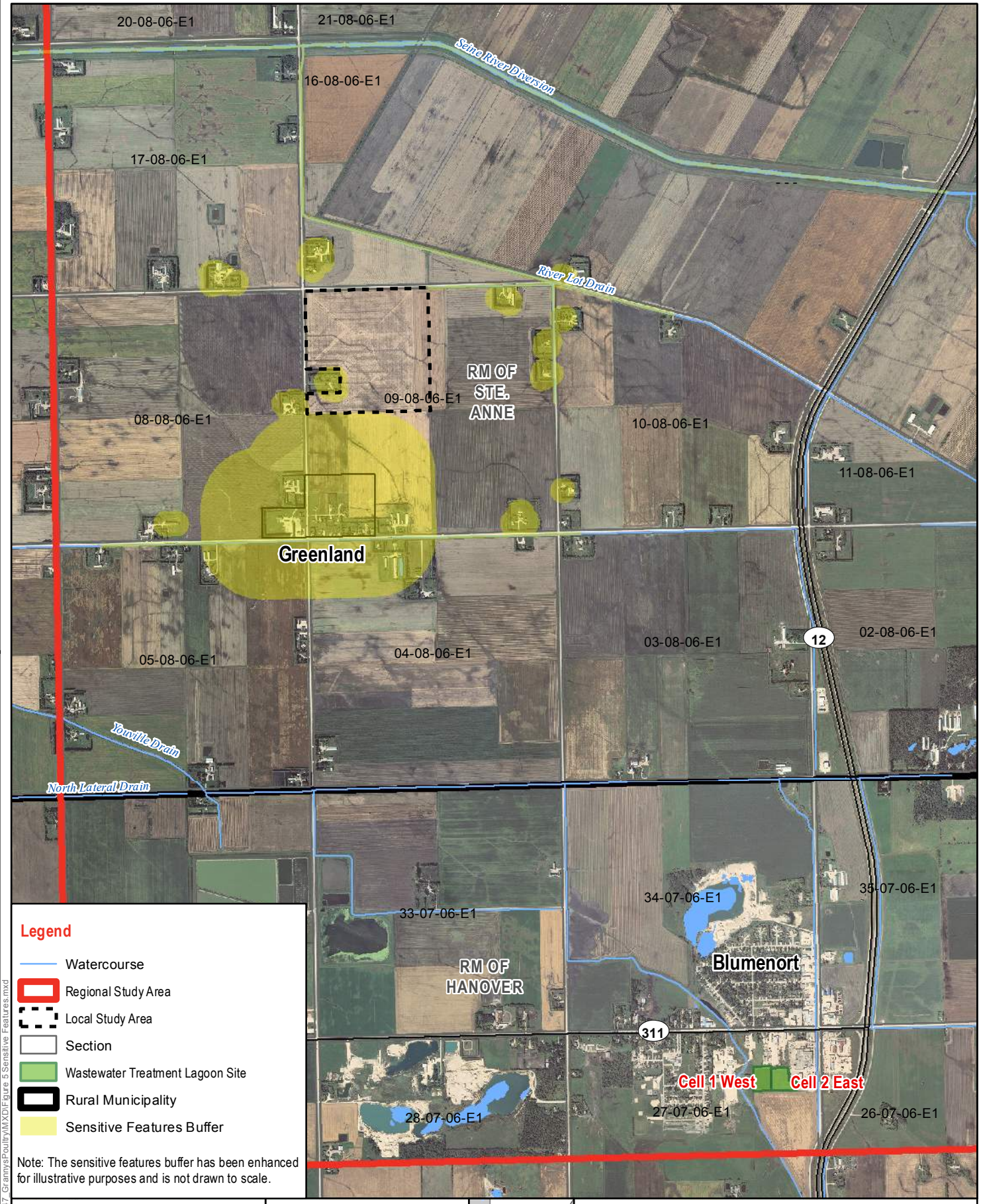
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21-08-06-E1
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16-08-06-E1
17-08-06-E1
River Lot Drain
RM OF STE. ANNE
09-08-06-E1
08-08-06-E1
10-08-06-E1
11-08-06-E1
Greenland
05-08-06-E1
04-08-06-E1
03-08-06-E1
12
02-08-06-E1
Youville Drain
North Lateral Drain
34-07-06-E1
35-07-06-E1
33-07-06-E1
RM OF HANOVER
Blumenort
311
Cell 1 West
Cell 2 East
28-07-06-E1
27-07-06-E1
26-07-06-E1
Legend
Watercourse
Regional Study Area
Local Study Area
Section
Wastewater Treatment Lagoon Site
Rural Municipality
Sensitive Features Buffer
Note: The sensitive features buffer has been enhanced for illustrative purposes and is not drawn to scale.
Coordinate System: NAD83, UTM Zone 14 N
Data Source: MLI, GeoBase. MMM
Date Created: January 16, 2015
Revision Date: January 21, 2015
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Figure 5:
Sensitive Features
Setback Distances
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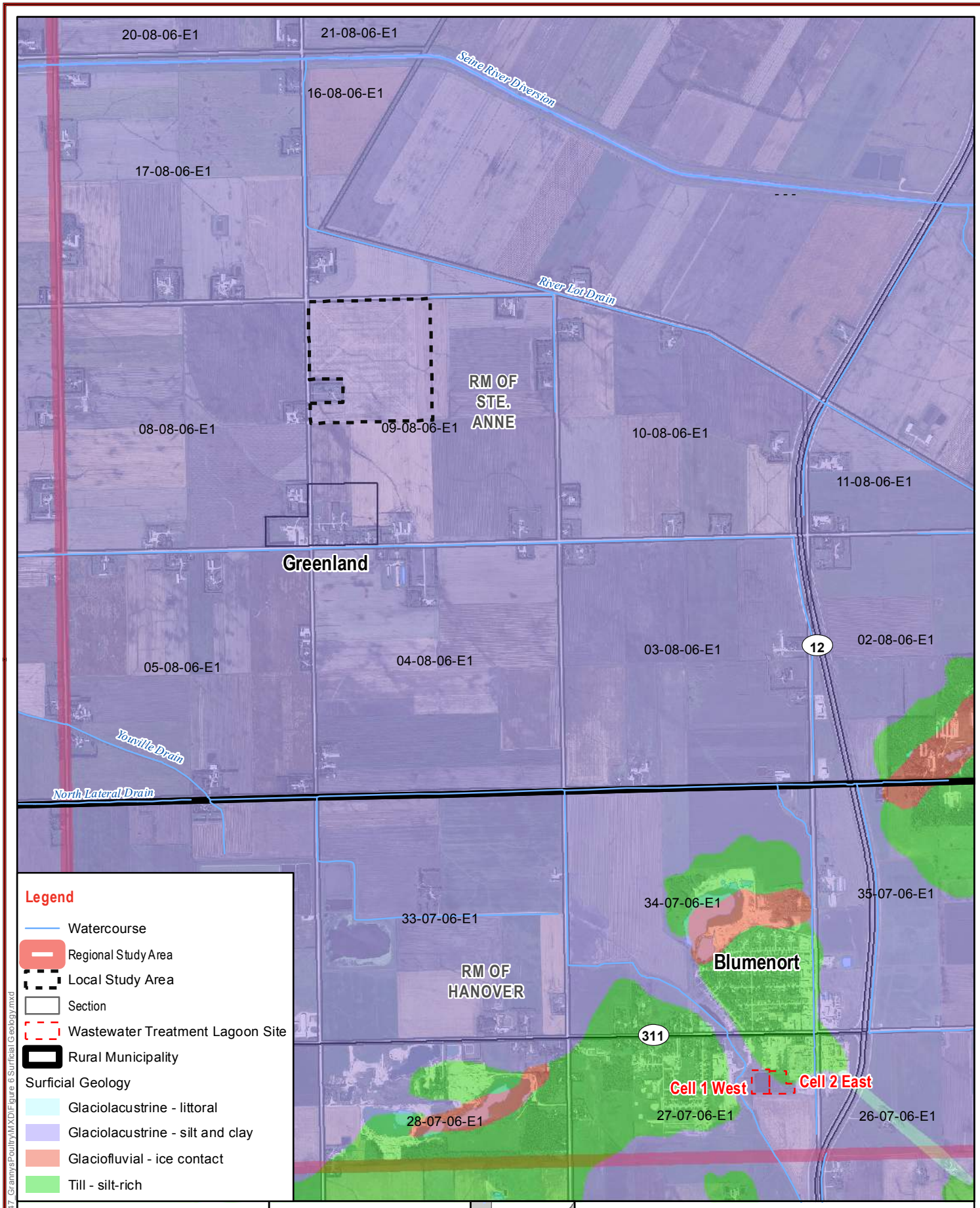
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21-08-06-E1
16-08-06-E1
17-08-06-E1
Seine River Diversion
River Lot Drain
RM OF STE. ANNE
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09-08-06-E1
10-08-06-E1
11-08-06-E1
Greenland
05-08-06-E1
04-08-06-E1
03-08-06-E1
02-08-06-E1
12
Youville Drain
North Lateral Drain
33-07-06-E1
34-07-06-E1
35-07-06-E1
RM OF HANOVER
Blumenort
311
Cell 1 West
Cell 2 East
28-07-06-E1
27-07-06-E1
26-07-06-E1
Legend
Watercourse
Regional Study Area
Local Study Area
Section
Wastewater Treatment Lagoon Site
Rural Municipality
Surficial Geology
Glaciolacustrine - littoral
Glaciolacustrine - silt and clay
Glaciofluvial - ice contact
Till - silt-rich
Coordinate System: NAD83, UTM Zone 14 N
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Date Created: January 19, 2015
Revision Date: January 21, 2015
MMM GROUP
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Manitoba
Ontario
Steinbach
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Surficial Geology
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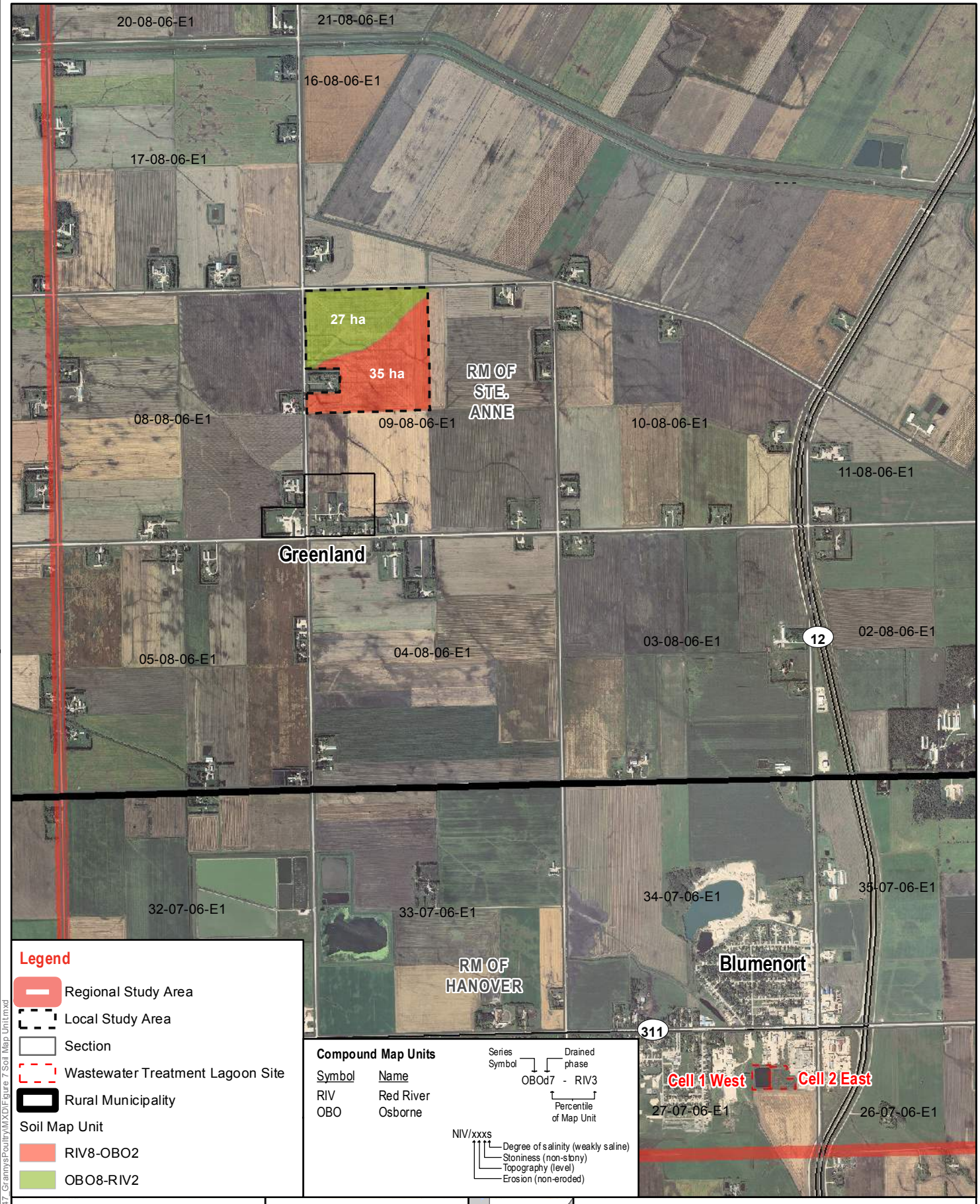
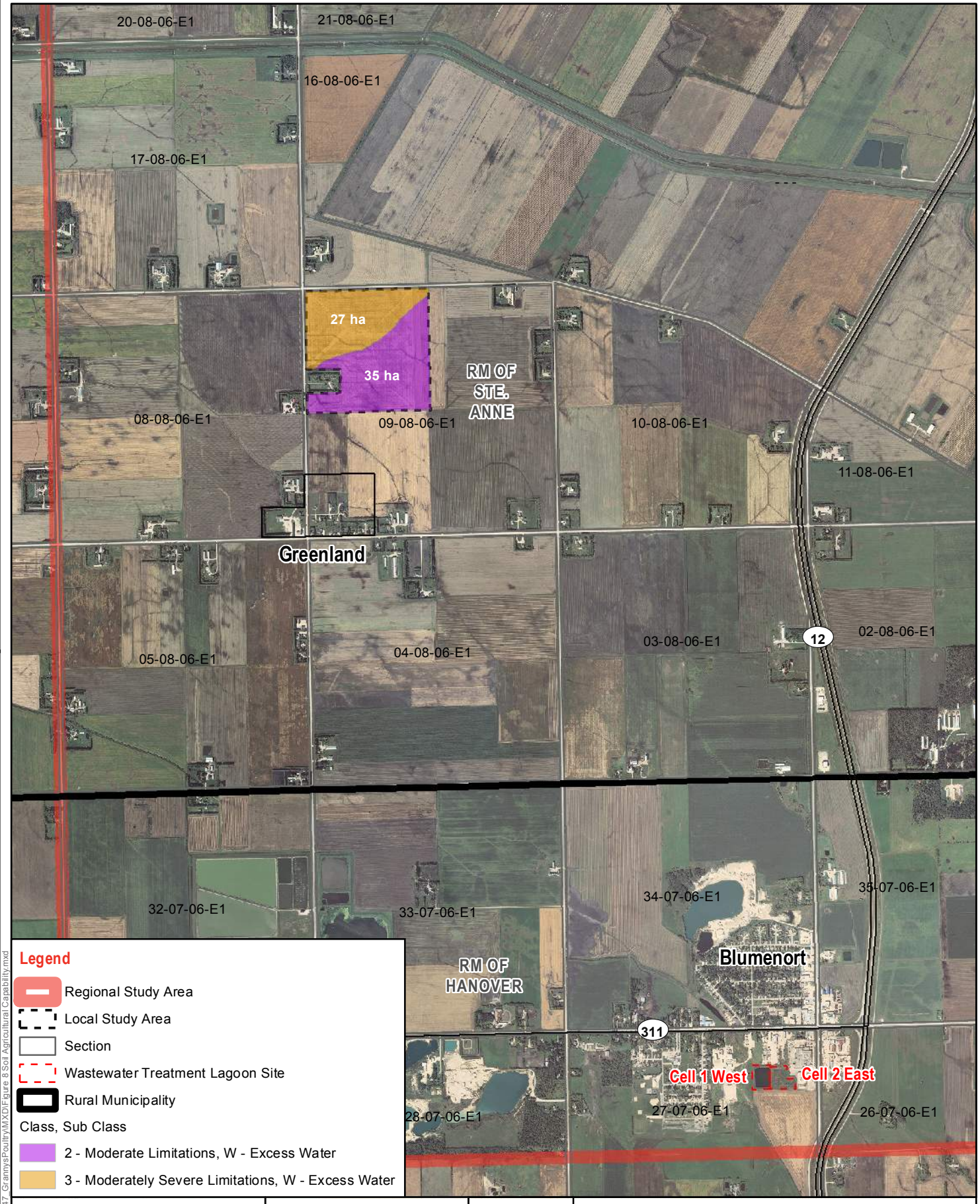


Figure 7: Soil Map Unit within Local Study Area



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Date Created: January 19, 2015
Revision Date: January 21, 2015

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Figure 8:
Canada Land Inventory
Soil Agricultural Capability
within Local Study Area

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APPENDIX B – Landowner Agreements and Certificate of Title

Land Use Agreement

Dear Farm Producer

Granny's Poultry Cooperative requires agricultural land to apply sludge from the two retention cells at the plant. Applying sludge to agricultural land is a beneficial and sustainable means to manage this organic material. This is a letter agreement to allow land application to occur on the land parcels outlined below. The following outlines the points of this agreement.

1. Each parcel of land will need to be soil sampled for nutrients, metals and salts. Soil sampling will be completed by truck. Soil sample results are required for prescription rates of application.
2. Soil sampling may need to occur more than one occasion and will occur prior to spring seeding or post-harvest.
3. Land application of sludge will be completed with heavy field equipment and will need good access to the land parcel(s) after crop harvest or prior to spring seeding.
4. If applicable, buffer zones may be left with no biosolid application near property lines, homes, groundwater wells and surface water features as required by the Manitoba Environment Act.
5. Sludge will target appropriate agronomic crop uptake requirements.
6. Sludge application will require tillage incorporation immediately after application depending upon the application method.
7. There are no fees to be paid from Granny's to the landowner or lessee for:
    a. Sludge or nutrients
    b. Use of land
    c. Application process
    d. Tillage requirements
8. Volume of sludge is not exact, not all the land may be required for application.
9. The landowner has the right to pull out of the program, with sufficient notice (4 weeks).
10. Manitoba Conservation imposes cropping restrictions, the following crops are allowed to be grown after sludge application; cereal crops, oil seed crop, forage, field peas or lentils (including soybeans).
11. Manitoba Conservation requires three years of follow-up soil sampling, access will be required for the subsequent three years, post-harvest.

Legal land location (quarter/section/township/range) for each parcel:

NW 9-8-6E	

Signature: _____ Date: JAN 7/15

Farm Producer Contact Information

Project:_____

Name:	ARNOLD REIMER
Business/Farm Name:	DELMERA HOLSTEINS INC
Mailing Address:	R.R.1, BOX 78A STE ANNE MB R5H 1R1
Phone #:	204 355 4218
Cell #:	204 346 2252
Fax/email:	acreimer@yahoo.ca

Pertinent Agronomic Information

Legal Land Location	NW Quarter / Section / Township / Range 9-8-6E
Land Area (Acres):	Own 132 Lease____
Does this field receive manure?	No
Is this field key to your manure management plan?	No

Year	Typical Crop	Target Yield (bu/ac)	Total N	Total P	K / S
2014	WINTER WHEAT	70	111	28	13 5
2013	CANOLA	40	111	32	15 5
2012	SOYBEANS	Ø	Ø	Ø	Ø
2011	SOYBEANS	Ø	Ø	Ø	Ø

AGVISE LABORATORIES

Soil Analysis by Agvise Laboratories
(http://www.agvise.com)
Northwood: (701) 587-6010
Benson: (320) 843-4109

SOIL TEST REPORT

FIELD ID **11 N and S**
SAMPLE ID
FIELD NAME **11 N and S**
COUNTY
TWP **8** RANGE **6E**
SECTION **9** QTR **NW** ACRES **132**
PREV. CROP **Wheat-Winter**

N / W / E / S

SUBMITTED FOR:
Delmera
, MB

SUBMITTED BY: **TE2728**
RICHARDSON PIONEER-LANDMA
231 MAIN STREET
BOX 70
LANDMARK, MB **ROA OXO**

REF # **960643** BOX # **0**
LAB # **NW88407**

Date Sampled | Date Received **10/07/2014** | Date Reported **12/10/2014**

			1st Crop Choice			2nd Crop Choice		3rd Crop Choice	
			Soybeans						
0-6"	6 lb/ac		YIELD GOAL			YIELD GOAL		YIELD GOAL	
6-24"	21 lb/ac	*****	40 BU			0		0	
0-24''	27 lb/ac		SUGGESTED GUIDELINES			SUGGESTED GUIDELINES		SUGGESTED GUIDELINES	
Nitrate			Band/Maint.						
			LB/ACRE		APPLICATION	LB/ACRE	APPLICATION	LB/ACRE	APPLICATION
Olsen	17 ppm	**********	N	***		N		N	
Phosphorus									
Potassium	401 ppm	**********	P_2O_5	35	Band *	P_2O_5		P_2O_5	
			K_2O	0		K_2O		K_2O	
Chloride									
0-6"	24 lb/ac	**********	Cl			Cl		Cl	
6-24"	60 lb/ac	**********							
Sulfur			S	5	Band (Trial)	S		S	
Boron			B			B		B	
Zinc	0.68 ppm	**********	Zn	2	Band (Trial)	Zn		Zn	
Iron			Fe			Fe		Fe	
Manganese			Mn			Mn		Mn	
Copper			Cu			Cu		Cu	
Magnesium	2981 ppm	**********							
Calcium	5650 ppm	**********	Mg	0		Mg		Mg	
Sodium	131 ppm	**********	Lime			Lime		Lime	
Org.Matter	5.8 %	**********							
Carbonate(CCE)									
0-6"	0.77 mmho/cm	**********							
6-24"	0.66 mmho/cm	**********							
Sol. Salts									

Soil pH	Buffer pH	Cation Exchange Capacity	% Base Saturation (Typical Range)				
			% Ca	% Mg	% K	% Na	% H
0-6" **7.7** 6-24" **8.3**		**54.7 meq**	(65-75) **51.7**	(15-20) **45.4**	(1-7) **1.9**	(0-5) **1.0**	(0-5)

General Comments: Texture is not estimated on high pH soils.

Crop 1: * Caution: Seed Placed Fertilizer Can Cause Injury * Many crops may respond to a starter application of P & K even on high soil tests. Crop Removal: P2O5 = 35 K2O = 60 AGVISE Band/Maintenance guidelines will build P & K test levels to the medium range over many years and then maintain them. Soybeans may respond to nitrogen on fields testing less than 60 lb/ac with a limited soybean history.

DATE: 2015/01/12
TIME: 15:02

MANITOBA

TITLE NO: 1510380/1

STATUS OF TITLE

STATUS OF TITLE..... ACCEPTED
ORIGINATING OFFICE... WINNIPEG
REGISTERING OFFICE... WINNIPEG
REGISTRATION DATE.... 1997/07/10
COMPLETION DATE..... 1997/07/21

PRODUCED FOR.. MMM GROUP LTD
ADDRESS..... 111-93 LOMBARD AVE
WPG MB R3B 3B1

CLIENT FILE... 3314347
PRODUCED BY... M.DERKSEN

LEGAL DESCRIPTION:

DELMERA HOLSTEINS INC.

IS REGISTERED OWNER SUBJECT TO SUCH ENTRIES RECORDED HEREON, IN THE FOLLOWING DESCRIBED LAND:

PARCEL 1: W 1/2 OF NW 1/4 OF 9-8-6 EPM
EXC, SLY 495 FEET PERP OF NLY 2203 FEET PERP OF WLY 710 FEET PERP.

PARCEL 2: W 1/2 OF LEGAL SUBDIVISIONS 11 AND 14 OF 9-8-6 EPM.

PARCEL 3: WEST HALVES OF EAST HALVES OF LEGAL SUBDIVISIONS 11 AND 14 OF 9-8-6 EPM.

ACTIVE TITLE CHARGE(S):

248452/1 ACCEPTED CAVEAT **REG'D:** 1977/11/09
FROM/BY: MAN. TELEPHONE SYSTEM
TO:
CONSIDERATION: **NOTES:** WLY 16.5' P OF LS 12 & 13

3922682/1 ACCEPTED MORTGAGE **REG'D:** 2010/05/05
FROM/BY: DELMERA HOLSTEINS INC.
TO: STEINBACH CREDIT UNION LIMITED
CONSIDERATION: $1,000,000.00 **NOTES:**

ADDRESS(ES) FOR SERVICE:

EFFECT	NAME AND ADDRESS	POSTAL CODE
ACTIVE	DELMERA HOLSTEINS INC. BOX 78A, R.R. 1 ST. ANNE, MB.	R5H 1R1

ORIGINATING INSTRUMENT(S):

REGISTRATION NUMBER	TYPE	REG. DATE	CONSIDERATION	SWORN VALUE
2161244/1	T	1997/07/10	$95,000.00	$95,000.00

PRESENTED BY: C. RUTH MCNEILL LAW OFFICE
FROM: LEONARD "P" DUECK AND VERNON "P" DUECK
TO: DELMERA HOLSTEINS INC.

CERTIFIED TRUE EXTRACT PRODUCED FROM THE LAND TITLES DATA STORAGE SYSTEM ON 2015/01/12 OF TITLE NUMBER 1510380/1

********** STATUS OF TITLE 1510380/1 CONTINUED ON NEXT PAGE **********

STATUS OF TITLE.....	ACCEPTED	PRODUCED FOR..	MMM GROUP LTD
ORIGINATING OFFICE...	WINNIPEG	ADDRESS.....	111-93 LOMBARD AVE
REGISTERING OFFICE...	WINNIPEG		WPG MB R3B 3B1
REGISTRATION DATE....	1997/07/10		
COMPLETION DATE.....	1997/07/21		
		CLIENT FILE...	3314347
		PRODUCED BY...	M.DERKSEN

FROM TITLE NUMBER(S):

1007381/1 BAL 1510334/1 ALL

LAND INDEX:

LOT	QUARTER SECTION	SECTION	TOWNSHIP	RANGE
	NW	9	8	6E

NOTE: PART W 1/2, W 1/2 & W 1/2 OF E 1/2 OF LS 11 AND 14

**ACCEPTED THIS 10TH DAY OF JULY, 1997
BY G.BILODEAU FOR THE DISTRICT REGISTRAR OF
THE LAND TITLES DISTRICT OF WINNIPEG.**

CERTIFIED TRUE EXTRACT PRODUCED FROM THE LAND TITLES DATA
STORAGE SYSTEM ON 2015/01/12 OF TITLE NUMBER 1510380/1.

********** END OF STATUS OF TITLE 1510380/1 **********

APPENDIX C – Database Search Results

Darren Keam

From: McClean, Heather (TCHSCP) <Heather.McClean@gov.mb.ca>
Sent: January-16-15 12:02 PM
To: Darren Keam
Cc: Smith, Brian (TCHSCP); Butterfield, David (TCHSCP)
Subject: RE: Historic Resources search request

Hi Darren – a search of the database reveals that there are no known heritage sites located within the sections, township and range in question.

Thank you.

Heather McClean
Heritage Resources Registrar
Historical Assessment Services
Historic Resources Branch
Main Floor, 213 Notre Dame Avenue
Winnipeg MB R3B 1N3
Heather.McClean@gov.mb.ca
Phone: (204) 945-7146
Fax: (204) 948-2384

From: Darren Keam [mailto:KeamD@mmm.ca]
Sent: January-15-15 3:42 PM
To: McClean, Heather (TCHSCP)
Subject: Historic Resources search request

Heather,

I would like to request a historic resources search request for the following section of land; 3, 4, 5, 8, 9, 10, 15, 16, and 17 of twp 8 and range 6E. The area is southwest of Ste. Anne, and northeast of Blumenort, the hamlet of Greenland is in the centre of the search area.

I acknowledge and accept your waiver. The data will be utilized in an environment act proposal submitted to Manitoba Conservation.

Respectfully,

Darren Keam

Darren Keam, M.Sc., P.Ag.
Senior Soil Scientist, Environmental Management Associate
MMM Group Limited
111 - 93 Lombard Avenue
Winnipeg, MB Canada R3B 3B1
direct: 204-272-2020 | office: 204.943.3178 x3891
f: 204.943.4948 | c: 204.250.4010
keamd@mmm.ca

Darren Keam

From: Danette Sahulka
Sent: January-28-15 3:20 PM
To: Darren Keam
Subject: FW: Granny's Poultry Environment Act Proposal

Follow Up Flag: Follow up
Flag Status: Flagged

Danette Sahulka, M.Sc., P.Ag.
Senior Ecologist, Project Manager
Environmental Management
MMM Group Limited
t: 204.943.3178 ext. 3890 | f: 204.943.4948 | c: 204.330.6078 sahulkad@mmm.ca

-----Original Message-----
From: Friesen, Chris (CWS) [mailto:Chris.Friesen@gov.mb.ca]
Sent: January-28-15 1:46 PM
To: Danette Sahulka
Subject: Granny's Poultry Environment Act Proposal

Danette

Thank you for you information request. I completed a search of the Manitoba Conservation Data Centre database for your area of interest and found occurrences on the following quarter sections:

NE 17-8-6E
Bobolink (Dolichonyx oryzivorus), S4, COSEWIC: Threatened

NW 16-8-6E
Bobolink (Dolichonyx oryzivorus), S4, COSEWIC: Threatened

NE 10-8-6E
Bobolink (Dolichonyx oryzivorus), S4, COSEWIC: Threatened

Further information on this ranking system can be found on our website at http://www.gov.mb.ca/conservation/cdc/consranks.html and this designation at http://www.cosewic.gc.ca.

The information provided in this letter is based on existing data known to the Manitoba Conservation Data Centre of the Wildlife and Ecosystem Protection Branch at the time of the request. These data are dependent on the research and observations of our scientists and reflects our current state of knowledge. An absence of data does not confirm the absence of any rare or endangered species. Many areas of the province have never been thoroughly surveyed, therefore, the absence of data in any particular geographic area does not necessarily mean that species or ecological communities of concern are not present. The information should not be regarded as a final statement on the occurrence of any species of concern, nor should it substitute for on-site surveys for species or environmental assessments. Also, because our Biotics database is continually updated and because information requests are evaluated by type of action, any given response is only appropriate for its respective request.

Please contact the Manitoba CDC for an update on this natural heritage information if more than six months passes before it is utilized.

Third party requests for products wholly or partially derived from our Biotics database must be approved by the Manitoba CDC before information is released. Once approved, the primary user will identify the Manitoba CDC as data contributors on any map or publication using data from our database, as the Manitoba Conservation Data Centre; Wildlife Branch, Manitoba Conservation and Water Stewardship.

This letter is for information purposes only - it does not constitute consent or approval of the proposed project or activity, nor does it negate the need for any permits or approvals required by the Province of Manitoba.

We would be interested in receiving a copy of the results of any field surveys that you may undertake, to update our database with the most current knowledge of the area.

If you have any questions or require further information contact me directly at (204) 945-7747.

Chris Friesen
Biodiversity Information Manager
Manitoba Conservation Data Centre
204-945-7747
chris.friesen@gov.mb.ca
http://www.gov.mb.ca/conservation/cdc/

-----Original Message-----
From:
Sent: January-16-15 8:58 AM
To: Friesen, Chris (CWS)
Subject: WWW Form Submission

Below is the result of your feedback form. It was submitted by WWW Information Request () on Friday, January 16, 2015 at 08:58:30

DocumentID: Manitoba_Conservation

Project Title: Granny's Poultry Environment Act Proposal

Date Needed: 2015/01/30

Name: Danette Sahulka

Company/Organization: MMM Group Limited

Address: 111-93 Lombard Avenue

City: Winnipeg

Province/State: Manitoba

Phone: 204-943-3178

Fax: 204-943-4948

Email: sahulkad@mmm.ca

Project Description: The project involves the submission of an Environment Act Proposal (EAP)for the land application of biosolid materials from two on-site wastewater lagoons owned and operated by Granny's Poultry Cooperative in Blumenort, Manitoba.

Information Requested: Search of the CDC database for any listings of rare element occurrences including plant and animal species and plant communities for parcels of land that may be put forward in the EAP submission to receive biosolids.

Format Requested: Format: Excel Spreadsheet and ArcView Shapefile

Send by: e-mail

Location: General are is around Blumenort, MB and includes Sections 3, 4, 5, 8, 9, 10, 15, 16, and 17 of Township 8 and Range 6E.

action: Submit

LOCATION: 9-8-6E

Well_PID: 42962
Owner: V TREWS
Driller: mondor drillers
Well Name:
Well Use: PRODUCTION
Water Use: Domestic, Livestock
UTMX: 664570.022
UTMY: 5501254.88
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1981 Dec 01

WELL LOG

From (ft)	To (ft)	Log
0	23.0	BLACK CLAY
23.0	31.0	MIX SAND
31.0	53.0	BLACK CLAY
53.0	77.9	HARDPAN
77.9	78.4	HARD GREY LIMESTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	77.9	casing	4.00			INSERT	BLACK IRON
77.9	78.4	Open hole					

Top of Casing: ft. below ground

PUMPING TEST

Date: 1981 Dec 01

Flowing Rate: Imp. gallons/minute

Water level before pumping: ft. below ground

Pumping level at end of test: ?? ft. below ground

Test duration: hours, minutes

Water temperature: ?? degrees F

LOCATION: NE9-8-6E

Well_PID: 56182
Owner: B TOENS
Driller: Friesen Drillers Ltd.
Well Name:
Well Use: PRODUCTION
Water Use: Domestic, Livestock
UTMX: 664965.443
UTMY: 5501672.16
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1986 Jun 05

WELL LOG

From (ft)	To (ft)	Log
0	18.0	CLAY
18.0	79.9	TILL
79.9	224.9	LIMESTONE
224.9	239.8	SHALE
239.8	259.8	SANDSTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	82.9	casing	4.10			INSERT	BLACK IRON
82.9	259.8	Open hole	4.00				

Top of Casing: 2.0 ft. above ground

PUMPING TEST

Date: 1986 Jun 05
Pumping Rate: 35.0 Imp. gallons/minute
Water level before pumping: 3.0 ft. below ground
Pumping level at end of test: 15.0 ft. below ground
Test duration: hours, minutes
Water temperature: ?? degrees F

LOCATION: NE9-8-6E

Well_PID:	160975
Owner:	LAURA TOEWS
Driller:	UNKNOWN
Well Name:	HOUSE WELL
Well Use:	PRODUCTION
Water Use:	
UTMX:	665330
UTMY:	5501675
Accuracy XY:	1 EXACT [<5M] [GPS]
UTMZ:	246
Accuracy Z:	4 FAIR - Shuttle at Centroid
Date Completed:	2009 Jan 01

No well log data for this well.

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
			4.00				steel

Top of Casing: 0.0

No pump test data for this well.

REMARKS

INVENTORIED BY SEINE RAT RIVER CD 2009. DRILLER AND DRILL DATE

UNKNOWN. WELL IS LOCATED SOUTH OF HOUSE. RM OF STE. ANNE.

LOCATION: NW9-8-6E

Well_PID:	109389
Owner:	SHROEDER-MCNEIL AG TECH SERVICES
Driller:	Echo Drilling Ltd.
Well Name:	
Well Use:	PRODUCTION
Water Use:	Domestic
UTMX:	664157.774
UTMY:	5501651.09
Accuracy XY:	
UTMZ:	
Accuracy Z:	
Date Completed:	1998 Feb 04

WELL LOG

From (ft)	To (ft)	Log
0	20.0	CLAY
20.0	83.0	TILL
83.0	235.0	LIMESTONE
235.0	239.0	SHALE
239.0	260.0	SANDSTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	88.0	casing	5.00			INSERT	PVC
88.0	260.0	Open hole	4.00				
0	88.0	Casing Grout					Bentonite

Top of Casing: 2.0 ft. above ground

PUMPING TEST

Date:	1998 Feb 04
Pumping Rate:	30.0 Imp. gallons/minute
Water level before pumping:	7.0 ft. below ground
Pumping level at end of test:	30.0 ft. below ground
Test duration:	??? hours, ?? minutes
Water temperature:	?? degrees F

LOCATION: SE9-8-6E

Well_PID: 30949
Owner: C PENNER
Driller: EMIL MANKEY & SON
Well Name:
Well Use: PRODUCTION
Water Use: Domestic,Livestock
UTMX: 664980.482
UTMY: 5500865.7
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1977 Jun 01

WELL LOG

From (ft)	To (ft)	Log
0	12.0	YELLOW SANDY CLAY
12.0	61.0	GREY SANDY CLAY
61.0	88.9	SAND AND GRAVEL WITH CLAY
88.9	168.9	LIMESTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	88.9	casing	4.25			INSERT	BLACK IRON
88.9	186.9	Open hole	4.00				

Top of Casing: ft. below ground

PUMPING TEST

Date:
Flowing Rate: 15.0 Imp. gallons/minute
Water level before pumping: ft. below ground
Pumping level at end of test: 30.0 ft. below ground
Test duration: hours, minutes
Water temperature: ?? degrees F

LOCATION: SE9-8-6E

Well_PID:	50699
Owner:	GREENLAND CHURCH
Driller:	Friesen Drillers Ltd.
Well Name:	
Well Use:	PRODUCTION
Water Use:	Domestic
UTMX:	664980.482
UTMY:	5500865.7
Accuracy XY:	UNKNOWN
UTMZ:	
Accuracy Z:	
Date Completed:	1984 Feb 14

WELL LOG

From (ft)	To (ft)	Log
0	144.9	NOT REPORTED

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	86.9	casing	4.30			INSERT	BLACK IRON
86.9	144.9	Open hole	4.00				

Top of Casing: 2.0 ft. above ground

PUMPING TEST

Date:	1984 Feb 14
Pumping Rate:	15.0 Imp. gallons/minute
Water level before pumping:	13.0 ft. below ground
Pumping level at end of test:	24.0 ft. below ground
Test duration:	4 hours, minutes
Water temperature:	?? degrees F

LOCATION: SE9-8-6E

Well_PID:	50700
Owner:	GREENLAND CHURCH
Driller:	Friesen Drillers Ltd.
Well Name:	
Well Use:	PRODUCTION
Water Use:	Domestic
UTMX:	664980.482
UTMY:	5500865.7
Accuracy XY:	UNKNOWN
UTMZ:	
Accuracy Z:	
Date Completed:	1984 Mar 07

WELL LOG

From (ft)	To (ft)	Log
0	144.9	NOT REPORTED
144.9	236.8	LIMESTONE
236.8	246.8	SHALE
246.8	289.8	SANDSTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	86.9	casing	4.50			INSERT	BLACK IRON
86.9	289.8	Open hole	4.00				

Top of Casing: 2.5 ft. above ground

PUMPING TEST

Date:	1984 Mar 07
Pumping Rate:	30.0 Imp. gallons/minute
Water level before pumping:	12.0 ft. below ground
Pumping level at end of test:	?? ft. below ground
Test duration:	hours, minutes
Water temperature:	?? degrees F

LOCATION: SE9-8-6E

Well_PID:	69336
Owner:	A KOOP
Driller:	Perimeter Drilling Ltd.
Well Name:	
Well Use:	PRODUCTION
Water Use:	Domestic
UTMX:	664980.482
UTMY:	5500865.7
Accuracy XY:	UNKNOWN
UTMZ:	
Accuracy Z:	
Date Completed:	1990 Apr 29

WELL LOG

From (ft)	To (ft)	Log
0	40.0	CLAY
40.0	91.9	TILL
91.9	207.9	LIMESTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	93.6	casing	5.00			INSERT	PVC
93.6	207.9	Open hole	4.60				

Top of Casing: 1.5 ft. below ground

PUMPING TEST

Date:	1990 Apr 25
Pumping Rate:	20.0 Imp. gallons/minute
Water level before pumping:	15.0 ft. below ground
Pumping level at end of test:	15.0 ft. below ground
Test duration:	hours, 30 minutes
Water temperature:	?? degrees F

REMARKS

MUERIAL ROAD 32

LOCATION: SE9-8-6E

Well_PID:	66029
Owner:	D REMPEL
Driller:	Echo Drilling Ltd.
Well Name:	
Well Use:	PRODUCTION
Water Use:	Livestock
UTMX:	664980.482
UTMY:	5500865.7
Accuracy XY:	UNKNOWN
UTMZ:	
Accuracy Z:	
Date Completed:	1989 Jul 25

WELL LOG

From (ft)	To (ft)	Log
0	19.0	BROWN CLAY
19.0	47.0	BROWN TILL
47.0	53.0	FINE GRAVEL
53.0	80.9	GREY TILL WITH GRAVEL STRINGERS
80.9	89.9	COARSE GRAVEL
89.9	95.9	GREY TILL
95.9	230.8	LIMESTONE
230.8	237.8	RED SHALE
237.8	242.8	BLUE GREEN SHALE
242.8	279.8	SANDSTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	97.9	casing	5.25			INSERT	BLACK IRON
98.9	279.8	Open hole	4.75				

Top of Casing: 2.0 ft. below ground

PUMPING TEST

Date:	1989 Jul 25
Pumping Rate:	25.0 Imp. gallons/minute
Water level before pumping:	7.0 ft. below ground
Pumping level at end of test:	12.0 ft. below ground
Test duration:	1 hours, minutes
Water temperature:	?? degrees F

LOCATION: SW9-8-6E

Well_PID: 125721
Owner: ART KOOP
Driller: Echo Drilling Ltd.
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
UTMX: 664173.543
UTMY: 5500845.5
Accuracy XY:
UTMZ:
Accuracy Z:
Date Completed: 2003 Dec 05

WELL LOG

From (ft)	To (ft)	Log
0	2.0	FILL
2.0	13.0	CLAY
13.0	66.0	TILL WITH SAND AND GRAVEL STRINGERS
66.0	79.0	CLAY
79.0	91.0	TILL
91.0	140.0	LIMESTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	93.0	casing	5.00	5.50		INSERT	PVC
91.0	140.0	Open hole	4.00				
10.0	90.0	Casing grout					BENTONITE

Top of Casing: 2.0 ft. above ground

PUMPING TEST

Date: 2003 Dec 05
Pumping Rate: 30.0 Imp. gallons/minute
Water level before pumping: 12.0 ft. below ground
Pumping level at end of test: 55.0 ft. below ground
Test duration: ??? hours, ?? minutes
Water temperature: ?? degrees F

REMARKS

GREENLAND RD. WELL MUST BE

LOCATION: SW9-8-6E

Well_PID: 56183
Owner: E PENNER
Driller: Friesen Drillers Ltd.
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
UTMX: 664173.543
UTMY: 5500845.5
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1986 Oct 16

WELL LOG

From (ft)	To (ft)	Log
0	22.0	CLAY
22.0	75.0	TILL; GREY
75.0	83.9	TILL; LIGHT GREY
83.9	234.8	LIMESTONE
234.8	241.8	SHALE
241.8	271.8	SANDSTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	86.9	casing	4.2			INSERT	BLACK IRON
26.9	271.8	Open hole	4.00				

Top of Casing: 2.0 ft. above ground

PUMPING TEST

Date: 1986 Oct 16
Pumping Rate: 30.0 Imp. gallons/minute
Water level before pumping: 5.0 ft. below ground
Pumping level at end of test: 35.0 ft. below ground
Test duration: 1 hours, minutes
Water temperature: ?? degrees F

LOCATION: SW9-8-6E

Well_PID:	76300
Owner:	J WARKENTIN
Driller:	Echo Drilling Ltd.
Well Name:	
Well Use:	PRODUCTION
Water Use:	Domestic
UTMX:	664173.543
UTMY:	5500845.5
Accuracy XY:	UNKNOWN
UTMZ:	
Accuracy Z:	
Date Completed:	1993 Apr 23

WELL LOG

From (ft)	To (ft)	Log
0	2.0	TOPSOIL
2.0	18.0	CLAY
18.0	90.9	TILL
90.9	237.8	LIMESTONE
237.8	256.8	SANDSTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	93.9	casing	5.00			INSERT	PVC
9..9	256.8	Open hole	4.75				

Top of Casing: 1.0 ft. above ground

PUMPING TEST

Date:	1993 Apr 23
Pumping Rate:	50.0 Imp. gallons/minute
Water level before pumping:	ft. below ground
Pumping level at end of test:	?? ft. below ground
Test duration:	hours, minutes
Water temperature:	?? degrees F

REMARKS

LOT 13

LOCATION: SW9-8-6E

Well_PID:	159063
Owner:	MICHELLE AND YVES SAUVE
Driller:	Echo Drilling Ltd.
Well Name:	
Well Use:	PRODUCTION
Water Use:	Domestic
UTMX:	663840.97
UTMY:	5500603.884
Accuracy XY:	1 EXACT [<5M] [GPS]
UTMZ:	245
Accuracy Z:	4 FAIR - Shuttle at Centroid
Date Completed:	2010 Jul 14

WELL LOG

From (ft)	To (ft)	Log
0	17.0	CLAY
17.0	86.0	TILL
86.0	236.0	LIMESTONE
236.0	241.0	SHALE
241.0	300.0	SANDSTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	88.0	casing	5.00			INSERT	PVC
88.0	300.0	Open hole	4.75				
10.0	80.0	Casing grout					BENTONITE

Top of Casing: 2.0 ft. above ground

PUMPING TEST

Date:	2010 Jul 14
Pumping Rate:	50.0 Imp. gallons/minute
Water level before pumping:	5.0 ft. below ground
Pumping level at end of test:	80.0 ft. below ground
Test duration:	1 hours, minutes
Water temperature:	?? degrees F

LOCATION: SW9-8-6E

Well_PID: 137245
Owner: DON TREMAINE
Driller: Echo Drilling Ltd.
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
UTMX: 663842
UTMY: 5500614
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ:
Accuracy Z:
Date Completed: 2005 Sep 13

WELL LOG

From (ft)	To (ft)	Log
0	22.0	CLAY
22.0	82.0	TILL
82.0	220.0	LIMESTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	85.0	casing	5.00	5.00		INSERT	PVC
85.0	220.0	Open hole	4.00				
10.0	60.0	Casing grout					CEMENT

Top of Casing: 2.0 ft. above ground

PUMPING TEST

Date: 2005 Sep 13
Pumping Rate: 30.0 Imp. gallons/minute
Water level before pumping: 12.0 ft. below ground
Pumping level at end of test: 75.0 ft. below ground
Test duration: ??? hours, ?? minutes
Water temperature: ?? degrees F

REMARKS

STE. ANNE. SUPPLY WELL. WELL MUST BE VENTED.

LOCATION: SW9-8-6E

Well_PID: 137244
Owner: DON TREMAINE
Driller: Echo Drilling Ltd.
Well Name:
Well Use: RECHARGE
Water Use:
UTMX: 663822
UTMY: 5500614
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ:
Accuracy Z:
Date Completed: 2005 Sep 13

WELL LOG

From (ft)	To (ft)	Log
0	22.0	CLAY
22.0	75.0	TILL
75.0	220.0	LIMESTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	78.0	casing	5.00	5.50		INSERT	PVC
78.0	220.0	Open hole	4.00				
10.0	60.0	Casing Grout					CEMENT

Top of Casing: 2.0 ft. above ground

PUMPING TEST

Date: 2005 Sep 13
Pumping Rate: 30.0 Imp. gallons/minute
Water level before pumping: 12.0 ft. below ground
Pumping level at end of test: 75.0 ft. below ground
Test duration: ??? hours, ?? minutes
Water temperature: ?? degrees F

REMARKS

STE. ANNE. REURN WELL. WELL MUST BE VENTED.

LOCATION: SW9-8-6E

Well_PID: 14459
Owner: ED P WARKENTINE
Driller: MANKEY, EMIL
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
UTMX: 664173.543
UTMY: 5500845.5
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1970 Jul 24

WELL LOG

From (ft)	To (ft)	Log
0	16.0	BLUE CLAY
16.0	35.0	GREY, SANDY CLAY
25.0	87.9	YELLOW CLAY AND PEBBLES
87.9	89.8	SAND AND GRAVEL

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	89.9	casing	4.00				

Top of Casing: ft. below ground

PUMPING TEST

Date: 1970 Jul 24
Pumping Rate: 5.0 Imp. gallons/minute
Water level before pumping: 3.0 ft. below ground
Pumping level at end of test: 26.0 ft. below ground
Test duration: 30 hours, minutes
Water temperature: ?? degrees F

LOCATION: NE8-8-6E

Well_PID:	159121
Owner:	MURRY WARKENTIN
Driller:	Echo Drilling Ltd.
Well Name:	
Well Use:	PRODUCTION
Water Use:	Domestic
UTMX:	663323
UTMY:	5501627
Accuracy XY:	3 ACCURATE [50-350M] [WITHIN 1/4-SECTION]
UTMZ:	303
Accuracy Z:	4 FAIR - Shuttle at Centroid
Date Completed:	2010 Jun 07

WELL LOG

From (ft)	To (ft)	Log
0	21.0	BROWN CLAY
21.0	82.0	BROWN GRAVELY TILL
82.0	112.0	BROKEN LIMESTONE AND BLUE SHALE
112.0	254.0	LIMESTONE
254.0	268.0	SHALE
268.0	345.0	RED SANDSTONE
345.0	250.0	BLUE SHALE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	87.0	Casing	5.00			INSERT	PVC
87.0	330.0	Casing	2.00			INSERT	PVC
270.0	330.0	Perforations	0.100				PVC
85.0	350.0	Gravel Pack					Sandpack
0	50.0	Casing Grout					Bentonite

Top of Casing: 2.0 ft. above ground

PUMPING TEST

Date:	2010 Jun 07
Pumping Rate:	25.0 Imp. gallons/minute
Water level before pumping:	16.0 ft. below ground
Pumping level at end of test:	21.0 ft. below ground
Test duration:	1 hours, minutes
Water temperature:	?? degrees F

REMARKS

BLUMENORT

LOCATION: NE8-8-6E

Well_PID:	76417
Owner:	E J REIMER
Driller:	Echo Drilling Ltd.
Well Name:	
Well Use:	PRODUCTION
Water Use:	Livestock
UTMX:	663320.974
UTMY:	5501631.37
Accuracy XY:	UNKNOWN
UTMZ:	
Accuracy Z:	
Date Completed:	1993 Mar 10

WELL LOG

From (ft)	To (ft)	Log
0	239.8	OLD WELL
239.8	279.8	SANDSTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	239.8	casing					
239.8	279.8	Open hole	4.00				

Top of Casing: 0.2 ft. above ground

PUMPING TEST

Date:	1993 Mar 10
Pumping Rate:	50.0 Imp. gallons/minute
Water level before pumping:	9.0 ft. below ground
Pumping level at end of test:	50.0 ft. below ground
Test duration:	2 hours, minutes
Water temperature:	?? degrees F

LOCATION: NE8-8-6E

Well_PID:	160969
Owner:	LES DUECK
Driller:	Kiansky Bros. Ltd.
Well Name:	HOUSE WELL
Well Use:	PRODUCTION
Water Use:	
UTMX:	663685
UTMY:	5501272
Accuracy XY:	1 EXACT [<5M] [GPS]
UTMZ:	246
Accuracy Z:	4 FAIR - Shuttle at Centroid
Date Completed:	1960 Jan 01

No well log data for this well.

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
			5.00				GALVANIZED

Top of Casing: 0.0

No pump test data for this well.

REMARKS

INVENTORIED BY SEINE RAT RIVER CD 2009. DRILL DATE UNKNOWN - MAY BE

EARLY 60s. WELL IS LOCATED WEST OF HOUSE. RM OF STE. ANNE.

LOCATION: SE8-8-6E

Well_PID:	28602
Owner:	E REIMER
Driller:	EMIL MANKEY & SON
Well Name:	
Well Use:	PRODUCTION
Water Use:	Domestic,Livestock
UTMX:	663336.743
UTMY:	5500825.77
Accuracy XY:	UNKNOWN
UTMZ:	
Accuracy Z:	
Date Completed:	1976 Jul 21

WELL LOG

From (ft)	To (ft)	Log
0	10.0	YELLOW CLAY
10.0	30.0	BLUE CLAY
30.0	78.9	SANDY GREY CLAY
78.9	246.8	LIMESTONE
246.8	251.8	SILICA SAND

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	92.9	casing	4.20			INSERT	BLACK IRON
92.9	251.8	Open hole	4.00				

Top of Casing: ft. below ground

PUMPING TEST

Date:	
Pumping Rate:	30.0 Imp. gallons/minute
Water level before pumping:	4.0 ft. below ground
Pumping level at end of test:	10.0 ft. below ground
Test duration:	hours, minutes
Water temperature:	?? degrees F

LOCATION: SE8-8-6E

Well_PID:	125776
Owner:	MELVIN WARKENTINE
Driller:	Echo Drilling Ltd.
Well Name:	
Well Use:	PRODUCTION
Water Use:	Domestic
UTMX:	663336.743
UTMY:	5500825.77
Accuracy XY:	
UTMZ:	
Accuracy Z:	
Date Completed:	2003 Nov 13

WELL LOG

From (ft)	To (ft)	Log
0	19.0	CLAY
19.0	93.0	TILL
93.0	238.0	LIMESTONE
238.0	244.0	SHALE
244.0	280.0	SANDSTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	95.0	Casing	5.00	5.50		INSERT	PVC
95.0	280.0	Open hole	4.00				
15.0	45.0	Casing Grout					CEMENT

Top of Casing: 2.0 ft. above ground

PUMPING TEST

Date:	2003 Nov 13
Pumping Rate:	100.0 Imp. gallons/minute
Water level before pumping:	7.0 ft. below ground
Pumping level at end of test:	75.0 ft. below ground
Test duration:	??? hours, ?? minutes
Water temperature:	?? degrees F

REMARKS

GREENLAND, WELL MUST BE VENTED.

LOCATION: SE8-8-6E

Well_PID:	7788
Owner:	P D GOOSEN
Driller:	MANKEY, EMIL
Well Name:	
Well Use:	PRODUCTION
Water Use:	Domestic
UTMX:	663336.743
UTMY:	5500825.77
Accuracy XY:	UNKNOWN
UTMZ:	
Accuracy Z:	
Date Completed:	1965 May 19

WELL LOG

From (ft)	To (ft)	Log
0	30.0	BLUE CLAY
30.0	96.9	SANDY CLAY MIXED WITH GRAVEL
96.9	100.9	LIMESTONE, WATER AT 101 FEET

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	96.9	casing	4.00				
96.9	100.9	Open hole					

Top of Casing: ft. below ground

PUMPING TEST

Date:	1965 May 19
Pumping Rate:	4.0 Imp. gallons/minute
Water level before pumping:	4.0 ft. below ground
Pumping level at end of test:	15.0 ft. below ground
Test duration:	12 hours, minutes
Water temperature:	?? degrees F

REMARKS

67 FT W + 490 FT N OF SEC LINE, NACL=150 PPM, FE=<0.1 PPM, H=5 GPG
GROUND LEVEL ELEV EST 820 FT

LOCATION: SE16-8-6E

Well_PID:	160972
Owner:	BRUCE TOEWS
Driller:	Friesen Drillers Ltd.
Well Name:	HOUSE WELL
Well Use:	PRODUCTION
Water Use:	
UTMX:	665066
UTMY:	5501985
Accuracy XY:	1 EXACT [<5M] [GPS]
UTMZ:	246
Accuracy Z:	4 FAIR - Shuttle at Centroid
Date Completed:	1986 Jan 01

No well log data for this well.

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
			4.00				STEEL

Top of Casing: 0.0

No pump test data for this well.

REMARKS

INVENTORIED BY SEINE RAT RIVER CD 2009. DRILL DATE UNKNOWN - MAY BE 1986. WELL IS LOCATED EAST OF HOUSE. RM OF STE. ANNE.

LOCATION: SW16-8-6E

Well_PID:	74917
Owner:	G WARKENTIN
Driller:	Echo Drilling Ltd.
Well Name:	
Well Use:	PRODUCTION
Water Use:	Domestic, Livestock
UTMX:	663902.92
UTMY:	5502378.56
Accuracy XY:	UNKNOWN
UTMZ:	
Accuracy Z:	
Date Completed:	1992 May 27

WELL LOG

From (ft)	To (ft)	Log
0	24.0	CLAY
24.0	81.9	TILL
81.9	239.8	LIMESTONE
239.8	247.8	SHALE
247.8	259.8	SANDSTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	84.9	casing	5.25			INSERT	BLACK IRON
84.9	259.8	Open hole	4.50				

Top of Casing: 1.5 ft. above ground

PUMPING TEST

Date:	1992 May 27
Pumping Rate:	50.0 Imp. gallons/minute
Water level before pumping:	12.0 ft. below ground
Pumping level at end of test:	40.0 ft. below ground
Test duration:	2 hours, minutes
Water temperature:	?? degrees F

LOCATION: SE17-8-6E

Well_PID:	59243
Owner:	P BARKMAN
Driller:	Echo Drilling Ltd.
Well Name:	
Well Use:	PRODUCTION
Water Use:	Domestic, Livestock
UTMX:	663306.804
UTMY:	5502467.11
Accuracy XY:	UNKNOWN
UTMZ:	
Accuracy Z:	
Date Completed:	1987 Mar 19

WELL LOG

From (ft)	To (ft)	Log
0	18.5	CLAY
18.5	81.9	TILL, FIRM
81.9	244.8	LIMESTONE
244.8	251.8	SHALE
251.8	279.8	SANDSTONE

WELL CONSTRUCTION

From (ft)	To (ft)	Casing Type	Inside Dia. (in)	Outside Dia. (in)	Slot Size (in)	Type	Material
0	91.9	casing	4.20			INSERT	BLACK IRON
91.9	279.8	Open hole	4.00				

Top of Casing: 2.0 ft. below ground

PUMPING TEST

Date:	1987 Mar 19
Pumping Rate:	23.0 Imp. gallons/minute
Water level before pumping:	9.0 ft. below ground
Pumping level at end of test:	11.0 ft. below ground
Test duration:	hours, minutes
Water temperature:	?? degrees F

APPENDIX D – Certificates of Analysis

MMM Group Ltd.
ATTN: DARREN KEAM
111-93 Lombard Ave
Winnipeg MB R3B 3B1

Date Received: 22-DEC-14
Report Date: 13-JAN-15 15:34 (MT)
Version: FINAL REV. 2

Client Phone: 204-272-2020

Certificate of Analysis

Lab Work Order #: L1561401

Project P.O. #: 3314347
Job Reference: 3314347
C of C Numbers:
Legal Site Desc:

Comments: ADDITIONAL 08-JAN-15 12:38 OM-LOI added

Craig Riddell
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1561401-1 CELL 1 WEST							
Sampled By: CLIENT on 22-DEC-14 @ 11:30							
Matrix: GRAB							
Miscellaneous Parameters							
Boron (B), Hot Water Ext.	1.73		0.20	mg/kg	31-DEC-14	31-DEC-14	R3126806
Note: Sample analyzed on as received sample - reported on dry matter							
Available Phosphate-P	49.2		1.0	mg/kg	31-DEC-14	31-DEC-14	R3126898
Note: Sample analyzed on as received sample - reported on dry matter							
Available Potassium	990		20	mg/kg	31-DEC-14	31-DEC-14	R3126902
Note: Sample analyzed on as received sample - reported on dry matter							
Available Sulfate-S	26.2		3.0	mg/kg	31-DEC-14	31-DEC-14	R3126805
Note: Sample analyzed on as received sample - reported on dry matter							
Mercury (Hg)-Total	0.108		0.050	mg/kg	30-DEC-14	02-JAN-15	R3127127
% Moisture	65.5		0.10	%	29-DEC-14	29-DEC-14	R3126058
% Saturation	Oversat		1.0	%	30-DEC-14	30-DEC-14	R3126323
Special Request	See Attached					07-JAN-15	R3128672
Specific Gravity	1.18		0.010	kg/L		05-JAN-15	R3127643
Total Carbon by Combustion	7.4		0.1	%	29-DEC-14	29-DEC-14	R3126256
Note: Sample analyzed on as received sample - reported on dry matter							
Total Kjeldahl Nitrogen	0.680		0.020	%	30-DEC-14	31-DEC-14	R3126897
Note: Sample analyzed on as received sample - reported on dry matter							
Organic Matter by LOI at 375 deg C.							
Organic Matter	21.7		1.0	%	08-JAN-15	09-JAN-15	R3129523
Loss on Ignition @ 375 C	27.5		1.0	%	08-JAN-15	09-JAN-15	R3129523
Total Solids and Total Volatile Solids							
Total Solids	35.9		0.10	%	31-DEC-14	31-DEC-14	R3126717
Total Volatile Solids (dry basis)	12.3		0.10	%	31-DEC-14	31-DEC-14	R3126717
pH and EC (1:2 Soil:Water Extraction)							
Conductivity (1:2)	1.52		0.050	dS m-1	31-DEC-14	31-DEC-14	R3126687
pH (1:2 soil:water)	7.68		0.10	pH	31-DEC-14	31-DEC-14	R3126687
Detailed Salinity in dry-weight mg/kg							
Chloride (Cl)	965		19	mg/kg dwt		31-DEC-14	
Calcium (Ca)	272		19	mg/kg dwt		31-DEC-14	
Magnesium (Mg)	209		19	mg/kg dwt		31-DEC-14	
Potassium (K)	54.2		9.5	mg/kg dwt		31-DEC-14	
Sodium (Na)	424		38	mg/kg dwt		31-DEC-14	
Sulfur (as SO4)	262		47	mg/kg dwt		31-DEC-14	
Detailed Salinity in wet-weight mg/kg							
Chloride (Cl)	333		6.6	mg/kg wwt		31-DEC-14	
Calcium (Ca)	93.8		6.6	mg/kg wwt		31-DEC-14	
Magnesium (Mg)	72.1		6.6	mg/kg wwt		31-DEC-14	
Potassium (K)	18.7		3.3	mg/kg wwt		31-DEC-14	
Sodium (Na)	146		13	mg/kg wwt		31-DEC-14	
Sulfur (as SO4)	90		16	mg/kg wwt		31-DEC-14	
Metals							
Aluminum (Al)	24500	DLA	500	mg/kg	30-DEC-14	30-DEC-14	R3126586
Antimony (Sb)	0.53		0.10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Arsenic (As)	9.41		0.10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Barium (Ba)	405		0.50	mg/kg	30-DEC-14	30-DEC-14	R3126586
Beryllium (Be)	1.06		0.10	mg/kg	30-DEC-14	30-DEC-14	R3126586

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1561401-1 CELL 1 WEST							
Sampled By: CLIENT on 22-DEC-14 @ 11:30							
Matrix: GRAB							
Metals							
Bismuth (Bi)	0.297		0.020	mg/kg	30-DEC-14	30-DEC-14	R3126586
Boron (B)	17		10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Cadmium (Cd)	0.512		0.020	mg/kg	30-DEC-14	30-DEC-14	R3126586
Calcium (Ca)	44500		100	mg/kg	30-DEC-14	30-DEC-14	R3126586
Chromium (Cr)	39.4		1.0	mg/kg	30-DEC-14	30-DEC-14	R3126586
Cobalt (Co)	13.3		0.020	mg/kg	30-DEC-14	30-DEC-14	R3126586
Copper (Cu)	50.9		1.0	mg/kg	30-DEC-14	30-DEC-14	R3126586
Iron (Fe)	29100		25	mg/kg	30-DEC-14	30-DEC-14	R3126586
Lead (Pb)	17.1		0.20	mg/kg	30-DEC-14	30-DEC-14	R3126586
Magnesium (Mg)	17500		10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Manganese (Mn)	527		0.50	mg/kg	30-DEC-14	30-DEC-14	R3126586
Molybdenum (Mo)	2.34		0.020	mg/kg	30-DEC-14	30-DEC-14	R3126586
Nickel (Ni)	37.8		0.50	mg/kg	30-DEC-14	30-DEC-14	R3126586
Phosphorus (P)	1680		100	mg/kg	30-DEC-14	30-DEC-14	R3126586
Potassium (K)	4410		25	mg/kg	30-DEC-14	30-DEC-14	R3126586
Selenium (Se)	0.71		0.50	mg/kg	30-DEC-14	30-DEC-14	R3126586
Silver (Ag)	0.11		0.10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Sodium (Na)	793		10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Strontium (Sr)	129		0.10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Thallium (Tl)	0.25		0.10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Tin (Sn)	<5.0		5.0	mg/kg	30-DEC-14	30-DEC-14	R3126586
Titanium (Ti)	60.0		0.50	mg/kg	30-DEC-14	30-DEC-14	R3126586
Uranium (U)	2.65		0.020	mg/kg	30-DEC-14	30-DEC-14	R3126586
Vanadium (V)	73.6		0.50	mg/kg	30-DEC-14	30-DEC-14	R3126586
Zinc (Zn)	148		10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Total Available N & NO3-N, NO2-N & NH4							
Available Ammonium-N							
Available Ammonium-N	111	DLM	1.6	mg/kg	31-DEC-14	31-DEC-14	R3126909
Note: Sample analyzed on as received sample - reported on dry matter							
Available Ammonium-N - Calculation							
Total Available Nitrogen	111		4.3	mg/kg		31-DEC-14	
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrite-N	1.28	DLM	0.80	mg/kg	31-DEC-14	31-DEC-14	R3126904
Nitrate+Nitrite-N	<4.0	DLM	4.0	mg/kg	31-DEC-14	31-DEC-14	R3126904
Nitrate-N	<4.0	DLM	4.0	mg/kg	31-DEC-14	31-DEC-14	R3126904
Note: Sample analyzed on as received sample - reported on dry matter							
Detailed Salinity -over sat'd waste							
Chloride (Cl)							
Chloride (Cl)	508	DLA	10	mg/L	30-DEC-14	30-DEC-14	R3126357
SAR and Cations (over sat'd)							
Calcium (Ca)	143	DLA	10	mg/L	30-DEC-14	30-DEC-14	R3126302
Potassium (K)	28.5	DLA	5.0	mg/L	30-DEC-14	30-DEC-14	R3126302
Magnesium (Mg)	110	DLA	10	mg/L	30-DEC-14	30-DEC-14	R3126302
Sodium (Na)	223	DLA	20	mg/L	30-DEC-14	30-DEC-14	R3126302
Sulfur (as SO4)	138	DLA	25	mg/L	30-DEC-14	30-DEC-14	R3126302
SAR	3.41		0.10	SAR	30-DEC-14	30-DEC-14	R3126302
pH and Conductivity							
pH	7.32		0.10	pH	30-DEC-14	30-DEC-14	R3126323
Conductivity (EC)	2.60		0.010	dS m-1	30-DEC-14	30-DEC-14	R3126323

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1561401-2 CELL 2 EAST							
Sampled By: CLIENT on 22-DEC-14 @ 14:00							
Matrix: GRAB							
Miscellaneous Parameters							
Boron (B), Hot Water Ext.	2.19		0.20	mg/kg	31-DEC-14	31-DEC-14	R3126806
Note: Sample analyzed on as received sample - reported on dry matter							
Available Phosphate-P	53.5		1.0	mg/kg	31-DEC-14	31-DEC-14	R3126898
Note: Sample analyzed on as received sample - reported on dry matter							
Available Potassium	843		20	mg/kg	31-DEC-14	31-DEC-14	R3126902
Note: Sample analyzed on as received sample - reported on dry matter							
Available Sulfate-S	40.6		3.0	mg/kg	31-DEC-14	31-DEC-14	R3126805
Note: Sample analyzed on as received sample - reported on dry matter							
Mercury (Hg)-Total	0.257		0.050	mg/kg	30-DEC-14	02-JAN-15	R3127127
% Moisture	78.3		0.10	%	29-DEC-14	29-DEC-14	R3126058
% Saturation	Oversat		1.0	%	30-DEC-14	30-DEC-14	R3126323
Special Request	See Attached					07-JAN-15	R3128672
Specific Gravity	1.13		0.010	kg/L		05-JAN-15	R3127643
Total Carbon by Combustion	18.3		0.1	%	29-DEC-14	29-DEC-14	R3126256
Note: Sample analyzed on as received sample - reported on dry matter							
Total Kjeldahl Nitrogen	2.27		0.020	%	30-DEC-14	31-DEC-14	R3126897
Note: Sample analyzed on as received sample - reported on dry matter							
Organic Matter by LOI at 375 deg C.							
Organic Matter	6.1		1.0	%	08-JAN-15	09-JAN-15	R3129523
Loss on Ignition @ 375 C	7.5		1.0	%	08-JAN-15	09-JAN-15	R3129523
Total Solids and Total Volatile Solids							
Total Solids	21.9		0.10	%	31-DEC-14	31-DEC-14	R3126717
Total Volatile Solids (dry basis)	31.4		0.10	%	31-DEC-14	31-DEC-14	R3126717
pH and EC (1:2 Soil:Water Extraction)							
Conductivity (1:2)	1.56		0.050	dS m-1	31-DEC-14	31-DEC-14	R3126687
pH (1:2 soil:water)	8.47		0.10	pH	31-DEC-14	31-DEC-14	R3126687
Detailed Salinity in dry-weight mg/kg							
Chloride (Cl)	1440		36	mg/kg dwt		31-DEC-14	
Calcium (Ca)	795		36	mg/kg dwt		31-DEC-14	
Magnesium (Mg)	461		36	mg/kg dwt		31-DEC-14	
Potassium (K)	154		18	mg/kg dwt		31-DEC-14	
Sodium (Na)	1060		72	mg/kg dwt		31-DEC-14	
Sulfur (as SO4)	842		90	mg/kg dwt		31-DEC-14	
Detailed Salinity in wet-weight mg/kg							
Chloride (Cl)	313		7.8	mg/kg wwt		31-DEC-14	
Calcium (Ca)	173		7.8	mg/kg wwt		31-DEC-14	
Magnesium (Mg)	100		7.8	mg/kg wwt		31-DEC-14	
Potassium (K)	33.3		3.9	mg/kg wwt		31-DEC-14	
Sodium (Na)	230		16	mg/kg wwt		31-DEC-14	
Sulfur (as SO4)	183		20	mg/kg wwt		31-DEC-14	
Metals							
Aluminum (Al)	21000	DLA	500	mg/kg	30-DEC-14	30-DEC-14	R3126586
Antimony (Sb)	0.60		0.10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Arsenic (As)	11.5		0.10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Barium (Ba)	248		0.50	mg/kg	30-DEC-14	30-DEC-14	R3126586
Beryllium (Be)	0.91		0.10	mg/kg	30-DEC-14	30-DEC-14	R3126586

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1561401-2 CELL 2 EAST							
Sampled By: CLIENT on 22-DEC-14 @ 14:00							
Matrix: GRAB							
Metals							
Bismuth (Bi)	0.295		0.020	mg/kg	30-DEC-14	30-DEC-14	R3126586
Boron (B)	24		10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Cadmium (Cd)	0.972		0.020	mg/kg	30-DEC-14	30-DEC-14	R3126586
Calcium (Ca)	24400		100	mg/kg	30-DEC-14	30-DEC-14	R3126586
Chromium (Cr)	38.3		1.0	mg/kg	30-DEC-14	30-DEC-14	R3126586
Cobalt (Co)	12.4		0.020	mg/kg	30-DEC-14	30-DEC-14	R3126586
Copper (Cu)	135		1.0	mg/kg	30-DEC-14	30-DEC-14	R3126586
Iron (Fe)	26700		25	mg/kg	30-DEC-14	30-DEC-14	R3126586
Lead (Pb)	19.2		0.20	mg/kg	30-DEC-14	30-DEC-14	R3126586
Magnesium (Mg)	12400		10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Manganese (Mn)	245		0.50	mg/kg	30-DEC-14	30-DEC-14	R3126586
Molybdenum (Mo)	6.06		0.020	mg/kg	30-DEC-14	30-DEC-14	R3126586
Nickel (Ni)	37.5		0.50	mg/kg	30-DEC-14	30-DEC-14	R3126586
Phosphorus (P)	1480		100	mg/kg	30-DEC-14	30-DEC-14	R3126586
Potassium (K)	3760		25	mg/kg	30-DEC-14	30-DEC-14	R3126586
Selenium (Se)	1.77		0.50	mg/kg	30-DEC-14	30-DEC-14	R3126586
Silver (Ag)	0.12		0.10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Sodium (Na)	1250		10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Strontium (Sr)	95.5		0.10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Thallium (Tl)	0.26		0.10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Tin (Sn)	<5.0		5.0	mg/kg	30-DEC-14	30-DEC-14	R3126586
Titanium (Ti)	51.8		0.50	mg/kg	30-DEC-14	30-DEC-14	R3126586
Uranium (U)	3.93		0.020	mg/kg	30-DEC-14	30-DEC-14	R3126586
Vanadium (V)	69.1		0.50	mg/kg	30-DEC-14	30-DEC-14	R3126586
Zinc (Zn)	323		10	mg/kg	30-DEC-14	30-DEC-14	R3126586
Total Available N & NO3-N, NO2-N & NH4							
Available Ammonium-N							
Available Ammonium-N	337	DLM	3.2	mg/kg	31-DEC-14	31-DEC-14	R3126909
Note: Sample analyzed on as received sample - reported on dry matter							
Available Ammonium-N - Calculation							
Total Available Nitrogen	337		8.6	mg/kg		31-DEC-14	
Nitrate, Nitrite and Nitrate+Nitrite-N							
Nitrite-N	1.7	DLM	1.6	mg/kg	31-DEC-14	31-DEC-14	R3126904
Nitrate+Nitrite-N	<8.0	DLM	8.0	mg/kg	31-DEC-14	31-DEC-14	R3126904
Nitrate-N	<8.0	DLM	8.0	mg/kg	31-DEC-14	31-DEC-14	R3126904
Note: Sample analyzed on as received sample - reported on dry matter							
Detailed Salinity -over sat'd waste							
Chloride (Cl)							
Chloride (Cl)	400	DLA	10	mg/L	30-DEC-14	30-DEC-14	R3126357
SAR and Cations (over sat'd)							
Calcium (Ca)	220	DLA	10	mg/L	30-DEC-14	30-DEC-14	R3126302
Potassium (K)	42.5	DLA	5.0	mg/L	30-DEC-14	30-DEC-14	R3126302
Magnesium (Mg)	128	DLA	10	mg/L	30-DEC-14	30-DEC-14	R3126302
Sodium (Na)	293	DLA	20	mg/L	30-DEC-14	30-DEC-14	R3126302
Sulfur (as SO4)	233	DLA	25	mg/L	30-DEC-14	30-DEC-14	R3126302
SAR	3.89		0.10	SAR	30-DEC-14	30-DEC-14	R3126302
pH and Conductivity							
pH	7.00		0.10	pH	30-DEC-14	30-DEC-14	R3126323
Conductivity (EC)	3.38		0.010	dS m-1	30-DEC-14	30-DEC-14	R3126323

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

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLM	Detection Limit Adjusted due to sample matrix effects.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
B-HOTW-SK	Soil	Available Boron, Hot Water	SSSA (1996) P. 610-611
Hot water is used to extract the plant-available and potentially plant-available boron from soil. Boron in the extract is determined by ICP-OES.			
C-TOT-LECO-SK	Soil	Total Carbon by combustion method	SSSA (1996) P. 973-974
The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.			
CL-COL-SK	Waste	Chloride (Cl)	APHA 4110B
ETL-N-TOT-AVAIL-SK	Soil	Available Ammonium-N - Calculation	Soil Methods of Analysis (1993) CSSS
HG-200.2-CVAF-WP	Soil	Mercury in Soil by CVAFS	EPA 200.2/1631E (mod)
Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAFS.			
K-AVAIL-SK	Soil	Available Potassium	Comm. Soil Sci. Plant, 25 (5&6)
Plant available potassium is extracted from the soil using Modified Kelowna solution. Potassium in the soil extract is determined by flame emission at 770 nm.			
MET-200.2-MS-WP	Soil	Metals	EPA 200.2/6020A
Samples for analysis are homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve, and a representative subsample of the dry material is weighed. The sample is then digested by block digester (EPA 200.2). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A). Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may become "environmentally available." By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.			
MOIST-SK	Soil	Moisture Content	ASTM D2216-80
The weighed portion of soil is placed in a 105°C oven overnight. The dried soil is allowed to cooled to room temperature, weighed and the % moisture is calculated. Reference: ASTM D2216-80			
N-TOTKJ-COL-SK	Soil	Total Kjeldahl Nitrogen	CSSS (1993) 22.2.3
The soil is digested with sulfuric acid in the presence of CuSO4 and K2SO4 catalysts. Ammonia in the soil extract is determined colrimetrically at 660 nm.			
N2/N3-AVAIL-SK	Soil	Nitrate, Nitrite and Nitrate+Nitrite-N	APHA 4500 NO3F
Available Nitrate and Nitrite are extracted from the soil using a dilute calcium chloride solution. Nitrate plus Nitrite is quantitatively reduced to nitrite by passage of the sample through a copperized cadmium column. The nitrite (reduced nitrate plus original nitrite) is then determined by diazotizing with sulfanilamide followed by coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. The resulting water soluble dye has a magenta color which is measured at colorimetrically at 520nm. Nitrite is determined on the same extract by following the same instrumental procedure without a cadmium column. Reference: Recommended Methods of Soil Analysis for Canadian Prairie Agricultural Soils. Alberta Agriculture (1988) p. 19 and 28			
NH4-AVAIL-SK	Soil	Available Ammonium-N	CSSS(1993) 4.2/COMM SOIL SCI 19(6)
Ammonium (NH4-N) is extracted from the soil using 2 N KCl. Ammonium in the extract is mixed with hypochlorite and salicylate to form indophenol blue, which is determined colorimetrically by auto analysis at 660 nm.			
OM-LOI-SK	Soil	Organic Matter by LOI at 375 deg C.	CSSS (1978) p. 160
The dry-ash method involves the removal of organic matter by combustion at 375 degrees C for a minimum of 16 hours. Samples are dried prior to combustion. Reference: McKeague, J.A. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1978) method 4.23			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
PH,EC-1:2-SK	Soil	pH and EC (1:2 Soil:Water Extraction)	CSSC 3.13/CSSS 18.3.1
1 part dry soil and 2 parts de-ionized water (by volume) is mixed. The slurry is allowed to stand with occasional stirring for 30 - 60 minutes. After equilibration, pH of the slurry is measured using a pH meter. Conductivity of the filtered extract is measured by a conductivity meter.			
PH/EC-SK	Waste	pH and Conductivity	APHA 4500-H,2510
PO4-AVAIL-OLSEN-SK	Soil	Available Phosphate-P by Olsen	CSSS (1993) 7.2,7.3.1
Plant available phosphorus is extracted from the sample with sodium bicarbonate. PO4-P in the filtered extract is determined colorimetrically at 880 nm.			
SAL-D50-DRYCALC-SK	Waste	Detailed Salinity in dry-weight mg/kg	Calculation
Conversion of Saturation Extract soluble ions from units of mg/L to dry-weight mg/kg. For over-saturated wastes: mg/kg dwt = mg/L * % Moisture / (100% - % Moisture) For under-saturated wastes: mg/kg dwt = mg/L * (% Saturation / 100%)			
SAL-D50-WETCALC-SK	Waste	Detailed Salinity in wet-weight mg/kg	Calculation
Conversion of Saturation Extract soluble ions from units of mg/L to wet-weight mg/kg. For over-saturated wastes: mg/kg wwt = mg/L * % Moisture / 100% For under-saturated wastes: mg/kg wwt = mg/L * (% Saturation / 100%) * (100% - % Moisture) / 100%			
SALINITY-INTCHECK-SK	Soil		CSSS 18.4-Calculation
SAR-CALC-SK	Waste	SAR and Cations (over sat'd)	APHA 3120B
SAT-PCNT-SK	Soil	Saturated Paste	CSSS (1993) 18.2.2
SO4-AVAIL-SK	Soil	Available Sulfate-S	REC METH SOIL ANAL - AB. AG(1988)
Plant available sulfur in the soil is extracted with a weak calcium chloride solution. Total S in the extract is then determined by ICP-OES.			
SOLIDS-TOT/TOTVOL-SK	Manure	Total Solids and Total Volatile Solids	APHA 2540G
A well-mixed sample is evaporated in a weighed dish and dried to constant weight in an oven at 103-105"C. The increase in weight over that of the empty dish represents the Total Solids. The crucible is then ignited at 550"–10"C for 1 hour. The remaining solids represent the Total Fixed Solids, while the weight lost on ignition represents the Total Volatile Solids.			
SPECGRAV-CL	Soil	Specific Gravity	CSSS-Gravimetric
SPECIAL REQUEST-SK	Misc.	Special Request Sask Lab	SEE SUBLET LAB RESULTS

** 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
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

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.

Quality Control Report

Client: MMM Group Ltd.
111-93 Lombard Ave
Winnipeg MB R3B 3B1
Contact: DARREN KEAM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
B-HOTW-SK	**Soil**							
Batch R3126806								
WG2020859-2 IRM		**SAL814**						
Boron (B), Hot Water Ext.			108.5		%		70-130	31-DEC-14
WG2020859-1 MB								
Boron (B), Hot Water Ext.			<0.20		mg/kg		0.2	31-DEC-14
C-TOT-LECO-SK	**Soil**							
Batch R3126256								
WG2020012-2 IRM		**08-109_SOIL**						
Total Carbon by Combustion			100.1		%		80-120	29-DEC-14
WG2020012-5 IRM		**08-109_SOIL**						
Total Carbon by Combustion			96.2		%		80-120	29-DEC-14
WG2020012-3 MB								
Total Carbon by Combustion			<0.1		%		0.1	29-DEC-14
WG2020012-6 MB								
Total Carbon by Combustion			<0.1		%		0.1	29-DEC-14
HG-200.2-CVAF-WP	**Soil**							
Batch R3127127								
WG2021533-2 CRM		**CANMET TILL-1**						
Mercury (Hg)-Total			0.115		mg/kg		0.048-0.148	02-JAN-15
WG2021533-4 DUP		**L1561401-1**						
Mercury (Hg)-Total		0.108	0.100		mg/kg	8.1	40	02-JAN-15
WG2021533-3 IRM		**ALS MET IRM2**						
Mercury (Hg)-Total			125.2		%		70-130	02-JAN-15
WG2021533-1 MB								
Mercury (Hg)-Total			<0.050		mg/kg		0.05	02-JAN-15
K-AVAIL-SK	**Soil**							
Batch R3126902								
WG2020661-3 IRM		**FARM2005**						
Available Potassium			105.9		%		70-130	31-DEC-14
WG2020661-2 MB								
Available Potassium			<20		mg/kg		20	31-DEC-14
MET-200.2-MS-WP	**Soil**							
Batch R3126586								
WG2020889-2 CRM		**CANMET TILL-1**						
Aluminum (Al)			104.1		%		70-130	30-DEC-14
Antimony (Sb)			104.2		%		70-130	30-DEC-14
Arsenic (As)			106.6		%		70-130	30-DEC-14
Barium (Ba)			101.7		%		70-130	30-DEC-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-MS-WP	**Soil**							
Batch R3126586								
WG2020889-2 CRM		**CANMET TILL-1**						
Beryllium (Be)			98.5		%		70-130	30-DEC-14
Bismuth (Bi)			102.5		%		70-130	30-DEC-14
Cadmium (Cd)			105.5		%		70-130	30-DEC-14
Calcium (Ca)			113.4		%		70-130	30-DEC-14
Chromium (Cr)			103.6		%		70-130	30-DEC-14
Cobalt (Co)			102.4		%		70-130	30-DEC-14
Copper (Cu)			101.6		%		70-130	30-DEC-14
Iron (Fe)			98.6		%		70-130	30-DEC-14
Lead (Pb)			98.4		%		70-130	30-DEC-14
Magnesium (Mg)			102.2		%		70-130	30-DEC-14
Manganese (Mn)			108.9		%		70-130	30-DEC-14
Molybdenum (Mo)			98.0		%		70-130	30-DEC-14
Nickel (Ni)			103.9		%		70-130	30-DEC-14
Phosphorus (P)			94.2		%		70-130	30-DEC-14
Potassium (K)			93.4		%		70-130	30-DEC-14
Selenium (Se)			95.6		%		70-130	30-DEC-14
Silver (Ag)			102.3		%		70-130	30-DEC-14
Sodium (Na)			96.5		%		70-130	30-DEC-14
Strontium (Sr)			107.3		%		70-130	30-DEC-14
Thallium (Tl)			78.2		%		70-130	30-DEC-14
Tin (Sn)			98.0		%		70-130	30-DEC-14
Titanium (Ti)			96.5		%		70-130	30-DEC-14
Uranium (U)			104.8		%		70-130	30-DEC-14
Vanadium (V)			105.1		%		70-130	30-DEC-14
Zinc (Zn)			101.2		%		70-130	30-DEC-14
WG2020889-3 CRM		**OGGEO08**						
Aluminum (Al)			99.2		%		70-130	30-DEC-14
Antimony (Sb)			102.1		%		70-130	30-DEC-14
Arsenic (As)			105.2		%		70-130	30-DEC-14
Beryllium (Be)			110.2		%		70-130	30-DEC-14
Bismuth (Bi)			102.5		%		70-130	30-DEC-14
Cadmium (Cd)			95.1		%		70-130	30-DEC-14
Calcium (Ca)			99.7		%		70-130	30-DEC-14
Chromium (Cr)			95.9		%		70-130	30-DEC-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-MS-WP	**Soil**							
Batch R3126586								
WG2020889-3 CRM		**OGGEO08**						
Cobalt (Co)			99.5		%		70-130	30-DEC-14
Iron (Fe)			98.0		%		70-130	30-DEC-14
Magnesium (Mg)			100.0		%		70-130	30-DEC-14
Manganese (Mn)			102.6		%		70-130	30-DEC-14
Molybdenum (Mo)			106.9		%		70-130	30-DEC-14
Phosphorus (P)			91.1		%		70-130	30-DEC-14
Potassium (K)			97.5		%		70-130	30-DEC-14
Selenium (Se)			91.0		%		70-130	30-DEC-14
Silver (Ag)			101.0		%		70-130	30-DEC-14
Sodium (Na)			98.8		%		70-130	30-DEC-14
Strontium (Sr)			103.1		%		70-130	30-DEC-14
Tin (Sn)			102.3		%		70-130	30-DEC-14
Uranium (U)			94.5		%		70-130	30-DEC-14
Vanadium (V)			97.0		%		70-130	30-DEC-14
WG2020889-4 IRM		**ALS MET IRM2**						
Aluminum (Al)			103.6		%		70-130	30-DEC-14
Antimony (Sb)			103.2		%		70-130	30-DEC-14
Arsenic (As)			102.6		%		70-130	30-DEC-14
Barium (Ba)			101.0		%		70-130	30-DEC-14
Beryllium (Be)			102.9		%		70-130	30-DEC-14
Bismuth (Bi)			100.8		%		70-130	30-DEC-14
Boron (B)			14		mg/kg		5-25	30-DEC-14
Cadmium (Cd)			102.9		%		70-130	30-DEC-14
Calcium (Ca)			109.4		%		70-130	30-DEC-14
Chromium (Cr)			99.8		%		70-130	30-DEC-14
Cobalt (Co)			102.1		%		70-130	30-DEC-14
Copper (Cu)			101.9		%		70-130	30-DEC-14
Iron (Fe)			100.0		%		70-130	30-DEC-14
Lead (Pb)			99.0		%		70-130	30-DEC-14
Magnesium (Mg)			106.0		%		70-130	30-DEC-14
Manganese (Mn)			110.2		%		70-130	30-DEC-14
Molybdenum (Mo)			109.4		%		70-130	30-DEC-14
Nickel (Ni)			102.0		%		70-130	30-DEC-14
Phosphorus (P)			94.4		%		70-130	30-DEC-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-MS-WP	**Soil**							
Batch R3126586								
WG2020889-4 IRM		**ALS MET IRM2**						
Potassium (K)			89.2		%		70-130	30-DEC-14
Selenium (Se)			105.2		%		70-130	30-DEC-14
Silver (Ag)			101.3		%		70-130	30-DEC-14
Sodium (Na)			98.9		%		70-130	30-DEC-14
Strontium (Sr)			112.7		%		70-130	30-DEC-14
Thallium (Tl)			85.8		%		70-130	30-DEC-14
Tin (Sn)			10.0		mg/kg		4.6-14.6	30-DEC-14
Titanium (Ti)			90.5		%		70-130	30-DEC-14
Uranium (U)			95.3		%		70-130	30-DEC-14
Vanadium (V)			99.6		%		70-130	30-DEC-14
Zinc (Zn)			99.4		%		70-130	30-DEC-14
WG2020889-1 MB								
Aluminum (Al)			<5.0		mg/kg		5	30-DEC-14
Antimony (Sb)			<0.10		mg/kg		0.1	30-DEC-14
Arsenic (As)			<0.10		mg/kg		0.1	30-DEC-14
Barium (Ba)			<0.50		mg/kg		0.5	30-DEC-14
Beryllium (Be)			<0.10		mg/kg		0.1	30-DEC-14
Bismuth (Bi)			<0.020		mg/kg		0.02	30-DEC-14
Boron (B)			<10		mg/kg		10	30-DEC-14
Cadmium (Cd)			<0.020		mg/kg		0.02	30-DEC-14
Calcium (Ca)			<100		mg/kg		100	30-DEC-14
Chromium (Cr)			<1.0		mg/kg		1	30-DEC-14
Cobalt (Co)			<0.020		mg/kg		0.02	30-DEC-14
Copper (Cu)			<1.0		mg/kg		1	30-DEC-14
Iron (Fe)			<25		mg/kg		25	30-DEC-14
Lead (Pb)			<0.20		mg/kg		0.2	30-DEC-14
Magnesium (Mg)			<10		mg/kg		10	30-DEC-14
Manganese (Mn)			<0.50		mg/kg		0.5	30-DEC-14
Molybdenum (Mo)			<0.020		mg/kg		0.02	30-DEC-14
Nickel (Ni)			<0.50		mg/kg		0.5	30-DEC-14
Phosphorus (P)			<100		mg/kg		100	30-DEC-14
Potassium (K)			<25		mg/kg		25	30-DEC-14
Selenium (Se)			<0.50		mg/kg		0.5	30-DEC-14
Silver (Ag)			<0.10		mg/kg		0.1	30-DEC-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-MS-WP	**Soil**							
Batch R3126586								
WG2020889-1 MB								
Sodium (Na)			<10		mg/kg		10	30-DEC-14
Strontium (Sr)			<0.10		mg/kg		0.1	30-DEC-14
Thallium (Tl)			<0.10		mg/kg		0.1	30-DEC-14
Tin (Sn)			<5.0		mg/kg		5	30-DEC-14
Titanium (Ti)			<0.50		mg/kg		0.5	30-DEC-14
Uranium (U)			<0.020		mg/kg		0.02	30-DEC-14
Vanadium (V)			<0.50		mg/kg		0.5	30-DEC-14
Zinc (Zn)			<10		mg/kg		10	30-DEC-14
N-TOTKJ-COL-SK	**Soil**							
Batch R3126897								
WG2019276-3 IRM		**08-109_SOIL**						
Total Kjeldahl Nitrogen			108.2		%		80-120	31-DEC-14
WG2019276-4 MB								
Total Kjeldahl Nitrogen			<0.020		%		0.02	31-DEC-14
WG2019276-5 RB								
Total Kjeldahl Nitrogen			<0.020		%			31-DEC-14
N2/N3-AVAIL-SK	**Soil**							
Batch R3126904								
WG2020669-2 MB								
Nitrite-N			<0.40		mg/kg		0.4	31-DEC-14
Nitrate+Nitrite-N			<2.0		mg/kg		2	31-DEC-14
NH4-AVAIL-SK	**Soil**							
Batch R3126909								
WG2020655-3 IRM		**SAL814**						
Available Ammonium-N			105.5		%		70-130	31-DEC-14
WG2020655-2 MB								
Available Ammonium-N			<1.0		mg/kg		1	31-DEC-14
OM-LOI-SK	**Soil**							
Batch R3129523								
WG2023906-1 DUP		**L1561401-1**						
Organic Matter		21.7	21.7		%	0.2	20	09-JAN-15
Loss on Ignition @ 375 C		27.5	27.5		%	0.2	25	09-JAN-15
WG2023906-3 IRM		**FARM2009**						
Organic Matter			4.5		%		3-5	09-JAN-15
Loss on Ignition @ 375 C			5.4		%		4.2-6.2	09-JAN-15
WG2023906-2								

Quality Control Report

Workorder: L1561401 Report Date: 13-JAN-15

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
OM-LOI-SK	**Soil**							
Batch R3129523								
WG2023906-2 MB								
Organic Matter			<1.0		%		1	09-JAN-15
Loss on Ignition @ 375 C			<1.0		%		1	09-JAN-15
PH,EC-1:2-SK	**Soil**							
Batch R3126687								
WG2020652-3 IRM		**SAL814**						
Conductivity (1:2)			96.6		%		80-120	31-DEC-14
pH (1:2 soil:water)			7.97		pH		7.65-8.25	31-DEC-14
WG2020652-2 MB								
Conductivity (1:2)			<0.050		dS m-1		0.05	31-DEC-14
PO4-AVAIL-OLSEN-SK	**Soil**							
Batch R3126898								
WG2018164-3 IRM		**FARM2005**						
Available Phosphate-P			71.4		%		70-130	31-DEC-14
WG2018164-2 MB								
Available Phosphate-P			<1.0		mg/kg		1	31-DEC-14
SAT-PCNT-SK	**Soil**							
Batch R3126323								
WG2020393-2 IRM		**SAL814**						
% Saturation			46.6		%		37-47	30-DEC-14
SO4-AVAIL-SK	**Soil**							
Batch R3126805								
WG2020671-2 IRM		**SAL814**						
Available Sulfate-S			92.6		%		70-130	31-DEC-14
WG2020671-1 MB								
Available Sulfate-S			<3.0		mg/kg		3	31-DEC-14
SPECGRAV-CL	**Soil**							
Batch R3127643								
WG2022125-2 DUP		**L1561401-2**						
Specific Gravity		1.13	1.13		kg/L	0.0	20	05-JAN-15
CL-COL-SK	**Waste**							
Batch R3126357								
WG2020393-1 MB								
Chloride (Cl)			<1.0		mg/L		1	30-DEC-14

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH/EC-SK	**Waste**							
Batch R3126323								
WG2020393-1 MB								
Conductivity (EC)			0.012		dS m-1		0.2	30-DEC-14
SAR-CALC-SK	**Waste**							
Batch R3126302								
WG2020393-2 IRM		**SAL814**						
Sulfur (as SO4)			109.0		%		70-130	30-DEC-14
WG2020393-1 MB								
Calcium (Ca)			<2.0		mg/L		2	30-DEC-14
Potassium (K)			<1.0		mg/L		1	30-DEC-14
Magnesium (Mg)			<2.0		mg/L		2	30-DEC-14
Sodium (Na)			<4.0		mg/L		4	30-DEC-14
Sulfur (as SO4)			<5.0		mg/L		5	30-DEC-14
SOLIDS-TOT/TOTVOL-SK	**Manure**							
Batch R3126717								
WG2020198-1 DUP		**L1561401-1**						
Total Solids		35.9	35.8		%	0.2	25	31-DEC-14
Total Volatile Solids (dry basis)		12.3	12.7		%	3.4	25	31-DEC-14

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Leachable Metals							
Available Boron, Hot Water							
	1	22-DEC-14 11:30	31-DEC-14	5	9	days	EHT
	2	22-DEC-14 14:00	31-DEC-14	5	8	days	EHT

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1561401 were received on 22-DEC-14 16:20.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Work Order	Sample	Client ID	Analyte	Result (Dry)	Result (Wet)	Qualifier	Units	LOR (dry)
L1561401	L1561401-1	CELL 1 WEST	Conductivity (1:2 soil:water)		1.52		dS m-1	0.050
L1561401	L1561401-1	CELL 1 WEST	Conductivity (Oversaturated)		2.60		dS m-1	0.010
L1561401	L1561401-1	CELL 1 WEST	% Moisture		65.5		%	0.10
L1561401	L1561401-1	CELL 1 WEST	pH (Oversaturated)		7.32		pH	0.10
L1561401	L1561401-1	CELL 1 WEST	pH (1:2 soil:water)		7.68		pH	0.10
L1561401	L1561401-1	CELL 1 WEST	Total Volatile Solids (dry basis)	12.3			%	0.10
L1561401	L1561401-1	CELL 1 WEST	Total Solids		35.1		%	0.10
L1561401	L1561401-1	CELL 1 WEST	Specific Gravity		1.18		kg/L	0.010
L1561401	L1561401-1	CELL 1 WEST	Total Kjeldahl Nitrogen	0.68	0.680		%	0.020
L1561401	L1561401-1	CELL 1 WEST	Total Available Nitrogen	111	111.000		mg/kg	4.3
L1561401	L1561401-1	CELL 1 WEST	Total Carbon by Combustion	7.4	7.400		%	0.1
L1561401	L1561401-1	CELL 1 WEST	Available Ammonium-N	111	111.000	DLM	mg/kg	1.6
L1561401	L1561401-1	CELL 1 WEST	Nitrate+Nitrite-N	<4.0	<1	DLM	mg/kg	4.0
L1561401	L1561401-1	CELL 1 WEST	Nitrate-N	<4.0	<1	DLM	mg/kg	4.0
L1561401	L1561401-1	CELL 1 WEST	Nitrite-N	1.28	1.280	DLM	mg/kg	0.80
L1561401	L1561401-1	CELL 1 WEST	Available Phosphate-P	49.2	49.2		mg/kg	1.0
L1561401	L1561401-1	CELL 1 WEST	Available Potassium	990	990		mg/kg	20
L1561401	L1561401-1	CELL 1 WEST	Available Sulfate-S	26.2	26.20		mg/kg	3.0
L1561401	L1561401-1	CELL 1 WEST	SAR	3.41	3.41		SAR	0.10
L1561401	L1561401-1	CELL 1 WEST	Calcium (Ca)	272	93.8		mg/kg	19
L1561401	L1561401-1	CELL 1 WEST	Chloride (Cl)	965	333		mg/kg	19
L1561401	L1561401-1	CELL 1 WEST	Magnesium (Mg)	209	72.1		mg/kg	19
L1561401	L1561401-1	CELL 1 WEST	Potassium (K)	54.2	18.7		mg/kg	9.5
L1561401	L1561401-1	CELL 1 WEST	Sodium (Na)	424	146		mg/kg	38
L1561401	L1561401-1	CELL 1 WEST	Sulfur (as SO4)	262	90		mg/kg	47
L1561401	L1561401-1	CELL 1 WEST	Aluminum (Al)	24500	24500	DLA	mg/kg	500
L1561401	L1561401-1	CELL 1 WEST	Antimony (Sb)	0.53	0.53		mg/kg	0.10
L1561401	L1561401-1	CELL 1 WEST	Arsenic (As)	9.41	9.41		mg/kg	0.10
L1561401	L1561401-1	CELL 1 WEST	Barium (Ba)	405	405		mg/kg	0.50
L1561401	L1561401-1	CELL 1 WEST	Beryllium (Be)	1.06	1.060		mg/kg	0.10
L1561401	L1561401-1	CELL 1 WEST	Bismuth (Bi)	0.297	0.297		mg/kg	0.020
L1561401	L1561401-1	CELL 1 WEST	Boron (B)	17	17.00		mg/kg	10
L1561401	L1561401-1	CELL 1 WEST	Cadmium (Cd)	0.512	0.512		mg/kg	0.020

L1561401	L1561401-1	CELL 1 WEST	Calcium (Ca)	44500	44500	mg/kg	100
L1561401	L1561401-1	CELL 1 WEST	Chromium (Cr)	39.4	39.4	mg/kg	1.0
L1561401	L1561401-1	CELL 1 WEST	Cobalt (Co)	13.3	13.30	mg/kg	0.020
L1561401	L1561401-1	CELL 1 WEST	Copper (Cu)	50.9	50.9	mg/kg	1.0
L1561401	L1561401-1	CELL 1 WEST	Iron (Fe)	29100	29100	mg/kg	25
L1561401	L1561401-1	CELL 1 WEST	Lead (Pb)	17.1	17.10	mg/kg	0.20
L1561401	L1561401-1	CELL 1 WEST	Magnesium (Mg)	17500	17500	mg/kg	10
L1561401	L1561401-1	CELL 1 WEST	Manganese (Mn)	527	527	mg/kg	0.50
L1561401	L1561401-1	CELL 1 WEST	Mercury (Hg)-Total	0.108	0.108	mg/kg	0.050
L1561401	L1561401-1	CELL 1 WEST	Molybdenum (Mo)	2.34	2.340	mg/kg	0.020
L1561401	L1561401-1	CELL 1 WEST	Nickel (Ni)	37.8	37.8	mg/kg	0.50
L1561401	L1561401-1	CELL 1 WEST	Phosphorus (P)	1680	1680	mg/kg	100
L1561401	L1561401-1	CELL 1 WEST	Potassium (K)	4410	4410	mg/kg	25
L1561401	L1561401-1	CELL 1 WEST	Selenium (Se)	0.71	0.71	mg/kg	0.50
L1561401	L1561401-1	CELL 1 WEST	Silver (Ag)	0.11	0.11	mg/kg	0.10
L1561401	L1561401-1	CELL 1 WEST	Sodium (Na)	793	793	mg/kg	10
L1561401	L1561401-1	CELL 1 WEST	Strontium (Sr)	129	129.0	mg/kg	0.10
L1561401	L1561401-1	CELL 1 WEST	Thallium (Tl)	0.25	0.250	mg/kg	0.10
L1561401	L1561401-1	CELL 1 WEST	Tin (Sn)	<5.0	<2	mg/kg	5.0
L1561401	L1561401-1	CELL 1 WEST	Titanium (Ti)	60.0	60.0	mg/kg	0.50
L1561401	L1561401-1	CELL 1 WEST	Uranium (U)	2.65	2.650	mg/kg	0.020
L1561401	L1561401-1	CELL 1 WEST	Vanadium (V)	73.6	73.6	mg/kg	0.50
L1561401	L1561401-1	CELL 1 WEST	Zinc (Zn)	148	148.0	mg/kg	10
L1561401	L1561401-1	CELL 1 WEST	Boron (B), Hot Water Ext.	1.73	1.73	mg/kg	0.20

Work Orde	Sample	Client ID	Analyte	Result (Dry)	Result (Wet)	Qualifier	Units	LOR (dry)
L1561401	L1561401-2	CELL 2 EAST	Conductivity (Oversaturated)		3.38		dS m-1	0.010
L1561401	L1561401-2	CELL 2 EAST	Conductivity (1:2 soil:water)		1.56		dS m-1	0.050
L1561401	L1561401-2	CELL 2 EAST	% Moisture		78.3		%	0.10
L1561401	L1561401-2	CELL 2 EAST	pH (Oversaturated)		7.00		pH	0.10
L1561401	L1561401-2	CELL 2 EAST	pH (1:2 soil:water)		8.47		pH	0.10
L1561401	L1561401-2	CELL 2 EAST	Total Volatile Solids (dry basis)	31.4			%	0.10
L1561401	L1561401-2	CELL 2 EAST	Total Solids		21.9		%	0.10
L1561401	L1561401-2	CELL 2 EAST	Specific Gravity		1.13		kg/L	0.010
L1561401	L1561401-2	CELL 2 EAST	Total Kjeldahl Nitrogen	2.27	2.270		%	0.020
L1561401	L1561401-2	CELL 2 EAST	Total Available Nitrogen	337	337.0		mg/kg	8.6
L1561401	L1561401-2	CELL 2 EAST	Total Carbon by Combustion	18.3	18.300		%	0.1
L1561401	L1561401-2	CELL 2 EAST	Available Ammonium-N	337	337.000	DLM	mg/kg	3.2
L1561401	L1561401-2	CELL 2 EAST	Nitrate+Nitrite-N	<8.0	<2.0	DLM	mg/kg	8.0
L1561401	L1561401-2	CELL 2 EAST	Nitrate-N	<8.0	<2.0	DLM	mg/kg	8.0
L1561401	L1561401-2	CELL 2 EAST	Nitrite-N	1.7	1.700	DLM	mg/kg	1.6
L1561401	L1561401-2	CELL 2 EAST	Available Phosphate-P	53.5	53.5		mg/kg	1.0
L1561401	L1561401-2	CELL 2 EAST	Available Potassium	843	843		mg/kg	20
L1561401	L1561401-2	CELL 2 EAST	Available Sulfate-S	40.6	40.60		mg/kg	3.0
L1561401	L1561401-2	CELL 2 EAST	SAR	3.89	3.89		SAR	0.10
L1561401	L1561401-2	CELL 2 EAST	Calcium (Ca)	795	173		mg/kg dwt	36
L1561401	L1561401-2	CELL 2 EAST	Chloride (Cl)	1440	313		mg/kg dwt	36
L1561401	L1561401-2	CELL 2 EAST	Magnesium (Mg)	461	100		mg/kg dwt	36
L1561401	L1561401-2	CELL 2 EAST	Potassium (K)	154	33.3		mg/kg dwt	18
L1561401	L1561401-2	CELL 2 EAST	Sodium (Na)	1060	230		mg/kg dwt	72
L1561401	L1561401-2	CELL 2 EAST	Sulfur (as SO4)	842	183		mg/kg dwt	90
L1561401	L1561401-2	CELL 2 EAST	Aluminum (Al)	21000	21000	DLA	mg/kg	500
L1561401	L1561401-2	CELL 2 EAST	Antimony (Sb)	0.60	0.60		mg/kg	0.10
L1561401	L1561401-2	CELL 2 EAST	Arsenic (As)	11.5	11.50		mg/kg	0.10
L1561401	L1561401-2	CELL 2 EAST	Barium (Ba)	248	248.0		mg/kg	0.50
L1561401	L1561401-2	CELL 2 EAST	Beryllium (Be)	0.91	0.91		mg/kg	0.10
L1561401	L1561401-2	CELL 2 EAST	Bismuth (Bi)	0.295	0.295		mg/kg	0.020
L1561401	L1561401-2	CELL 2 EAST	Boron (B)	24	24.00		mg/kg	10
L1561401	L1561401-2	CELL 2 EAST	Cadmium (Cd)	0.972	0.97		mg/kg	0.020

L1561401	L1561401-2	CELL 2 EAST	Calcium (Ca)	24400	24400	mg/kg	100
L1561401	L1561401-2	CELL 2 EAST	Chromium (Cr)	38.3	38.30	mg/kg	1.0
L1561401	L1561401-2	CELL 2 EAST	Cobalt (Co)	12.4	12.40	mg/kg	0.020
L1561401	L1561401-2	CELL 2 EAST	Copper (Cu)	135	135.0	mg/kg	1.0
L1561401	L1561401-2	CELL 2 EAST	Iron (Fe)	26700	26700	mg/kg	25
L1561401	L1561401-2	CELL 2 EAST	Lead (Pb)	19.2	19.20	mg/kg	0.20
L1561401	L1561401-2	CELL 2 EAST	Magnesium (Mg)	12400	12400	mg/kg	10
L1561401	L1561401-2	CELL 2 EAST	Manganese (Mn)	245	245.0	mg/kg	0.50
L1561401	L1561401-2	CELL 2 EAST	Mercury (Hg)-Total	0.257	0.257	mg/kg	0.050
L1561401	L1561401-2	CELL 2 EAST	Molybdenum (Mo)	6.06	6.06	mg/kg	0.020
L1561401	L1561401-2	CELL 2 EAST	Nickel (Ni)	37.5	37.50	mg/kg	0.50
L1561401	L1561401-2	CELL 2 EAST	Phosphorus (P)	1480	1480	mg/kg	100
L1561401	L1561401-2	CELL 2 EAST	Potassium (K)	3760	3760	mg/kg	25
L1561401	L1561401-2	CELL 2 EAST	Selenium (Se)	1.77	1.77	mg/kg	0.50
L1561401	L1561401-2	CELL 2 EAST	Silver (Ag)	0.12	0.120	mg/kg	0.10
L1561401	L1561401-2	CELL 2 EAST	Sodium (Na)	1250	1250	mg/kg	10
L1561401	L1561401-2	CELL 2 EAST	Strontium (Sr)	95.5	95.5	mg/kg	0.10
L1561401	L1561401-2	CELL 2 EAST	Thallium (Tl)	0.26	0.260	mg/kg	0.10
L1561401	L1561401-2	CELL 2 EAST	Tin (Sn)	<5.0	<1.0	mg/kg	5.0
L1561401	L1561401-2	CELL 2 EAST	Titanium (Ti)	51.8	51.8	mg/kg	0.50
L1561401	L1561401-2	CELL 2 EAST	Uranium (U)	3.93	3.930	mg/kg	0.020
L1561401	L1561401-2	CELL 2 EAST	Vanadium (V)	69.1	69.1	mg/kg	0.50
L1561401	L1561401-2	CELL 2 EAST	Zinc (Zn)	323	323.0	mg/kg	10
L1561401	L1561401-2	CELL 2 EAST	Boron (B), Hot Water Ext.	2.19	2.190	mg/kg	0.20

ALS Environmental

L1561401-COFC

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COC # L1561401

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Report To		Report Distribution		Service Requested (Rush for routine analysis subject to availability)
Company:	Darren Keam	☑ Standard ☐ Other		◉ Regular (Standard Turnaround Times - Business Days)
Contact:	204-250-2020	☐ PDF ☑ Excel ☐ Digital ☐ Fax		○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address:	111 - 93 Lombard Ave., Wpg, MB	Email 1: keamd@mmm.ca		○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
		Email 2:		○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	204-250-4010 Fax: 204-943-4948	Email 3:		
Invoice To	Same as Report ? ☑ Yes ☐ No	Client / Project Information		Analysis Request
Hardcopy of Invoice with Report?	☐ Yes ☑ No	Job #: 3314347		Please indicate below Filtered, Preserved or both (F, P, F/P)
Company:		PO / AFE: 3314347		
Contact:		LSD:		
Address:				
Phone:	Fax:	Quote #: Q37455		
Lab Work Order # (lab use only)		ALS Contact: BM	Sampler:	

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	TKN	Nitrate-N	Nitrite-N	available ammonium-n	total available nitrogne	total phosphorous	total solids, total volatile soli	moisture	total carbon	available potassium	available sulfate	detailed salinity	Number of Containers
	Cell 1 West	22-Dec-14	11:30 am	Grab	X	X	X	X	X	X	X	X	X	X	X	X	3
	Cell 2 East	"	2:30 pm	Grab	X	X	X	X	X	X	X	X	X	X	X	X	3

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Lagoon Sludge, CCME

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
				22 Dec 14	16:20	3 °C				

GENF 18.01 Front

ALS Environment

L1561401-COFC

Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # _____

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Report To		**Report Format / Distribution**	**Service Requested** (Rush for routine analysis subject to availability)
Company:	Darren Keam	☑ Standard ☐ Other	◉ Regular (Standard Turnaround Times - Business Days)
Contact:	204-250-2020	☐ PDF ☑ Excel ☐ Digital ☐ Fax	○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
Address:	111 - 93 Lombard Ave., Wpg, MB	Email 1: keamd@mmm.ca	○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
		Email 2:	○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT
Phone:	204-250-4010 Fax: 204-943-4948	Email 3:	**Analysis Request**
Invoice To	Same as Report ? ☑ Yes ☐ No	**Client / Project Information**	Please indicate below Filtered, Preserved or both (F, P, F/P)
Hardcopy of Invoice with Report?	☐ Yes ☑ No	Job #: 3314347	
Company:		PO / AFE: 3314347	
Contact:		LSD:	
Address:			
Phone:	Fax:	Quote #: Q37455	
Lab Work Order # (lab use only)		**ALS Contact:** BM	**Sampler:**

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Boron-hot water	mercury	CCME Metals	pH	specific gravity	total phosphorous	Sepcial Request 1						Number of Containers
	Cell 1 West	2-Dec-14	11:30am	Grab	X	X	X	X	X	X	X						3
	Cell 2 East	1	2:00pm	Grab	X	X	X	X	X	X	X						3

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Lagoon Sludge, CCME Tier 1 criteria, Special Request 1 - SK Analyze samples on as received basis. Report dry basis and as received results.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
				2 Dec 14	16:20	3 °C				

GENF 18.01 Front

APPENDIX E – Standard Limitations

STANDARD LIMITATIONS
ENVIRONMENTAL INVESTIGATIONS and CHARACTERIZATION PROGRAMS

These Standard Limitations form part of the Report to which they are appended and any use of the Report is subject to them.

1. EXCLUSIVE USE BY CLIENT

This Report was prepared for the exclusive use of the client identified as the intended recipient. Any use of the Report by any other party without the written consent of MMM Group Limited is the sole responsibility of such party. MMM Group Limited accepts no responsibility for damages that may be suffered by any third party as a result of decisions made or actions taken based on the Report.

2. SCOPE, TERMS AND CONDITIONS OF CONTRACT

The observations and investigations (hereinafter referred to as the "Work") upon which this Report is based were carried out in accordance with the scope, terms and conditions of the contract or the proposal pursuant to which the Work was commissioned. The conclusions presented in the Report are based solely upon the scope of services described in the contract or the proposal and governed by the time and budgetary constraints imposed by them.

3. STANDARD OF CARE

The principles, procedures and standards relevant to the nature of the services performed are not universally the same. The Work has been carried out in accordance with generally accepted environmental study and/or professional practices, industry standards and environmental regulations, where applicable. No other warranties are either expressed or implied with respect to the professional services provided under the terms of the contract or the proposal and represented in this Report.

4. SCOPE OF THE WORK

This Report may be based in part on information obtained at discrete sampling and/or monitoring locations. The conditions reported herein were those encountered at the subject property at the time the Work was performed and as present at the discrete sampling/monitoring locations, if any. Conditions between sampling/monitoring locations may be different than those encountered at the sampling/monitoring locations and MMM Group Limited is not responsible for such differences.

5. REASONABLE CONCLUSIONS

The conclusions contained in this Report are based on the Work and may also consider a review of information from other sources as identified in the Report. The accuracy of information from other sources was not verified unless specifically noted in the Report, nor was it determined if the reviewed information constituted all information that exists and pertains to the subject property.

The conclusions made are based on reasonable and professional interpretation of the information considered. If additional information concerning conditions of relevance to this Report is obtained during future work at the subject property, MMM Group Limited should be notified in order that we may determine if modifications to the conclusions presented in this Report are necessary.

6. REPORT AS A COMPLETE DOCUMENT

This Report must be read as a whole and sections taken out of context may be misleading. If discrepancies occur between the preliminary (draft) and final versions of the Report, the final version of the report shall take precedence.

7. LIMITS OF LIABILITY

MMM Group Limited's liability with respect to the Work is limited to re-performing, without cost, any part of the Work that is unacceptable solely as a result of failure to comply with industry standards. MMM Group Limited's maximum liability is limited in accordance with terms in the original contract, provided that notice of claim is made within regulated timelines as of the date of delivery of the Report.