Dauphin Consumers Co-operative Ltd.

18 Third Avenue NE
Dauphin, MB
R7N 0Y6

Phone (204) 638-6003
Fax (204) 638-6353
Email gm@dauphincoop.com

LOCALLY INVESTED
COMMUNITY MINDED
LIFETIME MEMBERSHIP BENEFITS

13 December 2023

Director
Environmental Approvals Branch Manitoba
Manitoba Environment and Climate Change
Environmental Approvals
14 Fultz Boulevard
Winnipeg, MB R3H 0W4

RE: **Dauphin Anhydrous Ammonia Tank Farm, Rural Municipality of Dauphin, MB**
Environment Act Proposal

Dear Ms. Ross:

Dauphin Cooperative Limited (Dauphin Co-op) is making an application under *The Environment Act* for the construction and operation of an Anhydrous Ammonia Tank Tarm within the Rural Municipality of Dauphin, along Township Road 112 W to the north of Manitoba Provincial Trunk Highway 5, approximately 1 km northwest of the City of Dauphin, Manitoba. The Anhydrous Ammonia Tank Farm would be constructed and operated on land located in legal land location Part of NW ¼ Section 16, Township 25, Range 19 WPM legal land location in the RM of Dauphin, Manitoba (the Site). As the anhydrous ammonia tank farm will consist of a bulk handling facility for the storage and distribution of ammonia, it is considered a Class 1 Development per the *Classes of Development Regulation of the Environment Act, M.R 39/2016* (the Regulation) and requires an *Environment Act* licence for its construction and operation.

Please find enclosed with this cover letter, a filled-out *Environment Act* Proposal Form, a copy of the Environmental Assessment Report, and a cheque of $1,000 (application fee for Class 1 development).

Should you have any questions, please do not hesitate to contact the undersigned or Christa Deblaere at WSP E&I Canada Limited (**christa.deblaere@wsp.com**) (204) 488-2997 who is coordinating our EA submission.

Sincerely,

[redacted]

Lorne Eiffert, General Manager

Dauphin Consumers Cooperative Limited

Environment Act Proposal Form

Manitoba

Name of the development:
Anhydrous Ammonia Tank Farm

Type of development per Classes of Development Regulation (Manitoba Regulation 164/88):
Class 1 - Agricultural

Legal name of the applicant:
Dauphin Consumers Cooperative Limited

Mailing address of the applicant: 18 Third Avenue NE

Contact Person: Lorne Eiffert

City: Dauphin Province: Manitoba Postal Code: R7N 0Y6

Phone Number: (204) 638-6003 Fax: email: gm@dauphincoop.com

Location of the development: Part of NW 1/4 16-25-19 WPM, RM of Dauphin

Contact Person: Lorne Eiffert

Street Address: 146131 112 W

Legal Description: NW 16-25-19 WPM

City/Town: RM of Dauphin Province: Manitoba Postal Code: R7N 0Y6

Phone Number: (204) 638-6003 Fax: (204) 638-6353 email: gm@dauphincoop.com

Name of proponent contact person for purposes of the environmental assessment:
Christa Deblaere

Phone: (204) 488-2997
Fax:

Mailing address: 6 High Level Road
Oak Bluff
R4G 0E2

Email address:christa.deblaere@wsp.com

Webpage address:

Date: December 4, 2023

Signature of proponent, or corporate principal of corporate proponent:
[redacted]

Printed name: Lorne Eiffert

PRINT RESET

DAUPHIN COOPERATIVE LTD

ANHYDROUS AMMONIA TANK FARM, RM OF DAUPHIN, MB

ENVIRONMENT ACT PROPOSAL REPORT

6 DECEMBER 2023

ANHYDROUS AMMONIA TANK FARM

ENVIRONMENT ACT PROPOSAL REPORT

DAUPHIN CONSUMERS COOPERATIVE LTD.

FCL SITE NUMBER (FSN): 2129
PROJECT NO.: WX19850
DATE: 6 DECEMBER 2023

WSP E&I Canada Limited
6 High Level Road
Oak Bluff (Winnipeg), MB R4G 0E2

T: +1 204-488-2997
WSP.com

"Effective September 21, 2022, Wood Environment & Infrastructure Solutions Canada Limited is now operating as WSP E&I Canada Limited. No other aspects of our legal entity, contractual terms or capabilities have changed in relation to this report submission."

E&I Canada Limited
6 High Level Road, Oak Bluff, Manitoba, Canada R4G 0E2
Phone: (204) 488-2997
www.wsp.com

ENVIRONMENT ACT PROPOSAL REPORT

ANHYDROUS AMMONIA TANK FARM, RURAL MUNICIPALITY OF DAUPHIN, MANITOBA

WSP Project Number – WX19850

Prepared for:	Dauphin Consumers Cooperative Ltd 18 Third Avenue NE Dauphin, MB, R7N 0Y6		
Contact:	Lorne Eiffert, General Manager		
Report Distribution:			
Dauphin Consumers Cooperative Ltd:	Electronic		
WSP:	Electronic		
Report Classification:	Confidential		
	Name	**Job Title**	**Signature**
Prepared by:	Jamie Ziegler, B.Sc.	Environmental Scientist	[redacted]
Reviewed by:	Fiona Scurrah, M.Sc., P. Biol., R.P. Bio.	Senior Principal Environmental Scientist	[redacted]
Project Manager:	Fiona Scurrah, M.Sc., P. Biol., R.P. Bio.	Senior Principal Environmental Scientist	[redacted]
Other Technical Contributors	Christa DeBlaere, B.A., C.E.T.	Environmental Professional	[redacted]

Rev.	**Date**	**Revision Notes**
0	**30 Oct 2023**	**Draft report for review**
1	**6 Dec 2023**	**Final**

WSP E&I Canada Limited
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EXECUTIVE SUMMARY

WSP E&I Canada Ltd. has prepared this Environmental Assessment Report (EA) on behalf of Dauphin Consumers Cooperative (Co-op) as supporting documentation for Dauphin Co-op's EAP for an existing anhydrous ammonia development and the proposed installation and operation of three (3) new anhydrous ammonia tanks. The Development is in the RM of Dauphin approximately 1 km northwest of Dauphin, Manitoba, by Township Road 112 W in an area zoned for industrial use. The proposed development will consist of the construction and operation of an anhydrous ammonia tank farm and an office building, collectively referred to as the Anhydrous Ammonia Tank Farm (the Project).

The Project will rely on water drawn from an on-Site cistern filled on an as needed basis for its water needs. The current septic tank will be replaced with a new tank, which will be cleaned out as needed by a contracted septic tank services provider. Office waste generated at the Project Site will be disposed of at the City of Dauphin's waste disposal ground (WDG).

It is anticipated that there will be a slight increase in the number of vehicles using both Rural Road 147 N and Rural Road 112 W during Project construction. However, the vehicles travelling to and from the Project Site (employees, delivery semi-trucks and consumer vehicles) are not expected to exceed current service capacity levels of either Rural Road 147 N and Rural Road 112 W. It is not anticipated that there will be an increase in noise levels or dust generation from both the construction and operation of the Facility to the surrounding area.

The potential for adverse effects from accidents and malfunctions at the Project Site would primarily be related to accidents or malfunctions (e.g., fires, spills, and transportation accidents). The Project's operational procedures, emergency response plan, mitigation measures, and safe work practices will reduce the potential likelihood/severity of these events. In addition, Dauphin Co-op adheres to the Anhydrous Ammonia Code of Practice for its operations.

Based on the desktop studies undertaken, site observations and information available to date as presented in this report, the construction and operation of the proposed Anhydrous Ammonia Tank Farm is not expected to create significant adverse effects to the biophysical and socio-economic environment and is expected to provide economic benefits to the region.

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TABLES

APPENDICES

1 INTRODUCTION

This Environmental Assessment Report (EA) has been prepared by WSP E&I Canada Ltd. (WSP E&I) on behalf of Dauphin Consumer's Co-operative Limited (Dauphin Co-op) in accordance with Manitoba Environment and Climate Change's (MECC) *Information Bulletin – Environment Act Proposal Report Guidelines and Information Bulletin - Environment Act Proposals for Bulk Material Handling Facilities (Pesticide, Fertilizer and Seed Treatment Handling Facilities) dated 2017.* This EA forms part of Dauphin Co-op's *Environment Act* Proposal application and filing in pursuit of an *Environment Act* licence for the operation and expansion of an Anhydrous Ammonia Tank Farm. This Facility and the proposed expansion is considered a Class 1 Development, under the Classes of Development Regulation.

Accompanying this EA are the Cover Letter, the completed EAP Form, and the Application Fee of $1,000 in fulfilment of MECC's EAP submission requirements for licensing of a Class 1 Development.

1.1 PROJECT OVERVIEW

Dauphin Co-op currently operates an Anhydrous Ammonia Tank Farm on land located within Part of NW 1/4 Section 16, Township 25, Range 19 WPM in the RM of Dauphin, near the City of Dauphin, Manitoba. The Facility has been operating since the late 1970s and it was recently discovered that the Facility does not hold a current *Environment Act* Licence as required under Manitoba's Environment Act Classes of Development Regulations. In addition to the current operations, Dauphin Co-op is proposing to expand the Facility to include the following:

- A new shop building with an area of 745 m^2
- Installation of three (3) 300 metric tons (149,1000 USG) aboveground anhydrous ammonia tanks
- Expanded gravel yard and storage area.

The main purpose of the EA is for the submission of application under the *Environment Act* to have the Facility licensed as per regulatory requirements.

Appendix A provides an overview of the Site and the drawings related to the associated components for the Project.

1.2 THE PROPONENT

The proponent information for the proposed Project is shown in the Table 1-1 below.

Table 1-1 Project Proponent Information

Name of Project	Dauphin Co-op Anhydrous Ammonia Tank Farm
Name of Proponent	Dauphin Consumers Co-operative Limited
Address of Proponent	18 Third Avenue NE, Dauphin, MB, R7N 0Y6
Proponent Contact Person(s) for the EAPF	Lorne Eiffert General Manager P: +1 (204) 638-6003 ext. 218 Email: gm@dauphincoop.com

Principal Contact Person(s) for the EAPF (i.e., Consultant)	Christa DeBlaere, B.A., C.E.T. Senior Environmental Professional WSP E&I Canada Ltd 6 High Level Road, Oak Bluff (Winnipeg), Manitoba, CA. R4G 0E2 Office: +1 (204) 488-2997 Email: christa.deblaere@wsp.com

1.2.1 COMPANY PROFILE

Dauphin Co-op is a member owned entity which services Dauphin and Ste. Rose du Lac, with various products and services through its retail operations. The retail operations focus on petroleum products, fertilizers, crop protection products, as well as food stores and gas bars.

Dauphin Co-op's agricultural operations will be run by four full-time employees, and up to four more employees during the busy season (spring and fall).

1.3 LAND OWNERSHIP AND PROPERTY RIGHTS

Dauphin Co-op is the current owner of the Site. The most recent certificate of title is included in **Appendix B.**

The Site is located in the RM of Dauphin located on a parcel of land approximately 1 km northwest of Dauphin, Manitoba along Township Road 112 W to the north of Manitoba Provincial Trunk Highway 5, adjacent to the CN rail line. The site location is presented on Figure 1.

The Project Site is surrounded by the following neighbouring properties within the RM of Dauphin:

North	Perennial forage field, followed by agricultural land and Road 147 N beyond.
South	CN Rail line and Dauphin Rail Yard, followed by agricultural crop land.
East	Undeveloped municipal industrial park, currently a perennial forage field.
West	Road 112 W followed by Salt Creek, a farmstead to the southwest, and agricultural crop land beyond.

Photos of the existing Site are found in **Appendix C**.

1.4 PURPOSE OF THE PROJECT

The purpose of the project is to operate and expand the existing anhydrous ammonia tank farm. Dauphin Co-op is required to licence its current operations and is proposing to expand the Site to increase its storage and retail capacity for anhydrous ammonia, to serve its customers within the RM of Dauphin and surrounding areas.

1.5 REGULATORY FRAMEWORK

As the development consists of a bulk material handling facility for the storage and distribution of ammonia, it is a Class 1 Development per the Classes of Development Regulation of the *Environment Act*. As required by Section 10

of the *Environment Act,* construction and operation of the proposed development requires submission of an EAP with MECC and issuance of an *Environment Act* licence (EAL) will be determined from the regulatory review of the EAP and associated documents.

The activities proposed as a part of the Project are not listed under the Physical Activities Regulations, SOR 2019/285 under the federal *Impact Assessment Act* and as such, it does not require any federal assessment.

While there is not a trigger for an environmental assessment under the IAA, there maybe additional federal Acts or regulations that may be applicable to the Facility's operations. Dauphin Co-op will obtain required additional federal permitting requirements related to anhydrous ammonia.

1.6 FUNDING

The construction and operation of the Project will be funded by Dauphin Co-op.

2 PROPOSED DEVELOPMENT

2.1 EXISTING SITE CONDITIONS

WSP E&I completed a reconnaissance of the Project Site on 10 July 2023 as part of the Phase I Environmental Site Assessment (ESA). According to the Site representative, the Site was initially developed in the late 1970's solely as an anhydrous ammonia storage and distribution facility. Dauphin Consumers Co-operative Ltd. purchased the Site and the Facility infrastructure in 2000. It has been operating as an anhydrous ammonia handling and storage Facility since that time. The total volume of anhydrous ammonia contained at the Site is 60 metric tons (30,000 USG).

The Facility's anhydrous ammonia handling and storage operations are implemented according to the Anhydrous Ammonia Code (Ammonia Code) of Practice (Canadian Fertilizer Institute (CFI)'s Fertilizer Safety & Security Council [FSSC] 2022). The Ammonia Code of Practice (the Ammonia Code) was created to provide uniform safety and security practices for the handling and storage of anhydrous ammonia at agricultural product retail (ag retail) facilities in Canada. As the Facility is an ag retail that receives ammonia by transport into a storage vessel, there is a requirement for the Facility to complete and pass the Ammonia Code of Practice Audit (FSSC 2012). As of January 1, 2011, only facilities certified as compliant with the Ammonia Code are eligible to receive shipments of anhydrous ammonia. Certified facilities under the Ammonia Code are required to maintain their operations in compliance with the Ammonia Code. This Facility has a current certification, and the certificate is found in Appendix D. The Facility's ammonia handling and storage operations are and have been compliant with the Ammonia Code since 28 December 2022. The Facility was last audited in 2022 and anticipates being next audited in 2024.

The Facility's existing anhydrous ammonia tank has a capacity of sixty (60) metric tons (equivalent to 30,000 US gallons) and the supports for the tank are constructed of non-combustible materials. Approximately forty-five (45) nurse tanks, ranging in size from 2.5 metric tons to 12 metric tons (1200 USG to 5800 USG), are stored at the Site. Nurse tanks are typically used to transport anhydrous ammonia from the Facility to the receiving field. The Site has two load-out stations and one load-in station for anhydrous ammonia.

The Site consisted of a slab-on-grade building. The southern portion of the building was utilized as office space. The northern portion of the building was utilized as a garage and small mechanical maintenance area for the facility. A 3,785 L cistern is stored within the southeast corner of the Site building and is the Site's water source. A septic tank is located adjacent to the west of the Site building. The interior walls and ceilings were observed to consist of painted plywood. Flooring in the building consisted of concrete. Lighting was provided by a mixture of fluorescent tube lighting and incandescent bulbs. Cooling was provided via a wall-mounted air conditioning unit. Heating was provided via electric baseboard heaters. Exterior building materials and roofing were observed to consist of corrugated metal.

An approximate 10 m x 10 m utility/electrical shed was observed near the center of the southern Site boundary. WSP E&I did not observe the interior of the shed, and it was reported that no chemicals were stored within the shed. Exterior building materials consisted of vinyl siding and double wood doors and roofing was observed to consist of shingles.

The Site is gravel-surfaced and enclosed by a six-foot high chain link fence. The northern and western portions of the Site, outside of the chain-linked fenced area, were observed to consist of grasses, shrubs, and other low-lying flora. A small area of distressed vegetation was observed in the north center of the Site.

2.2 PROPOSED PROJECT

2.2.1 CONSTRUCTION

The proposed additional anhydrous vessels that will be installed will consist of three (3) 300 metric tons (149,100 USG) anhydrous ammonia vessels, for an additional total storage of approximate 900 metric tons or 447,300 USG at the Site. The total volume of anhydrous ammonia capacity at the Site, considering the existing operations and the addition of the three new tanks will be approximately 960 metric tons (477,300 USG). The anhydrous ammonia vessels will be installed as per the Ammonia Code with an accredited contractor for the installation. A 30.5 m x 24.5 m (approximately 100 ft x 80 ft) office building will be constructed on Site in 2024. This building will include a meeting room, Co-op personnel offices, a washroom, and a lunchroom. Gravelled parking areas will be located on the north, east, and west sides of the building. A new septic tank, designed to be comparable in size and layout to the existing one, will be installed following the removal of the current septic tank.

WSP E&I conducted a geotechnical investigation at the Site in August and September 2023, to evaluate the soil and groundwater conditions at the Site. The geotechnical investigations will provide geotechnical recommendations for the design and construction of the type of foundation that will be required for the anhydrous ammonia tank as well as the traffic areas within the Facility.

A drawing of the office structure and its associated components is found in **Appendix A.**

2.2.2 TRAFFIC VOLUME CHANGES

CONSTRUCTION

It is anticipated that there will be a slight increase in the number of vehicles using Rural Road 112 W and Rural Road 147 N during the construction and operation of the Anhydrous Ammonia Site.

During construction, about 35 to 40 construction-related vehicles are expected to arrive at the Site. The increase in traffic will be temporary in nature.

OPERATION

The number of Dauphin Co-op employees at the facility is not anticipated to change due to the Project. Traffic volumes to and from the Site will remain unchanged during the off-season. However, an increase is anticipated to occur during the spring and fall due to increase delivery of anhydrous ammonia as well as the associated increase in consumer traffic. For this Report, it is anticipated that the increase in traffic due to the operation of the anhydrous ammonia tank farm will be approximately 10% of current traffic levels.

	Approximate Traffic – Full Year
Current	Incoming – 280 trucks at 28 MT
	Outgoing – 500 trucks at 15 MT
Future (anticipated)	Incoming – 300 trucks at 33 MT
	Outgoing – 500 trucks at 30 MT

Traffic to and from the Anhydrous Ammonia Tank Farm will consist of delivery trucks, and customer and staff vehicles. The use of rail transportation for product delivery is not anticipated.

Signage for the Facility is not expected to be erected for this stage of the overall Site development. Dauphin Co-op is aware that there may be a requirement for submission of a permit under the *Transportation Infrastructure Act* with Manitoba Transportation and Infrastructure (MTI), if the location of the Facility and any associated signage falls within the MTI controlled zone. WSP E&I has requested additional information regarding existing load bearing and traffic counts for the Dauphin area from Manitoba Infrastructure and Transportation, however, as of the issuance of this report, data has not been received.

2.2.3 WATER AND ENERGY

No appreciable changes to water consumption are anticipated of the Project and there are no plans for the installation of a water well. Water will be hauled to Site and held in the cistern and piped into the office building and other water hookups (i.e. bathroom).

Electrical and heating is supplied through the current tie into the Manitoba Hydro distribution line.

2.2.4 WASTE GENERATION AND DISPOSAL

As part of the first stage of Site development, bathroom facilities will be supplied through the installation of a porta potty (i.e., job john). A third party contracted service provider will ensure the supplied porta potty is properly serviced and wastes disposed of as per regulatory requirements. The Project's anticipated air emission sources are considered minor and would include fugitive dust from on-site roadways, exhaust from transport trucks and staff and customer vehicles on site.

The City of Dauphin has a Class I Waste Disposal Ground (WDG) that is located approximately 940 m northwest of the Site. Waste materials generated at the Site would be disposed in accordance with the WDG's listed accepted materials.

2.2.5 EMERGENCY RESPONSE PLAN

In accordance with the Ammonia Code, Site emergency response plan will consist of the following:

- Written emergency response plan consisting of an index, roles and responsibilities, appropriate telephone numbers, a location map showing nearby occupancies; a site plan, list that outlines the trigger for the plan, annual risk assessment, emergency shut off locations, and a management plan for any contaminated run-off water.
- Documentation showing the communication of the emergency plan with emergency responders.

- An up-to-date risk assessment of operations at the site.
- An annual review of the plan.
- A list of the emergency contacts.
- An annual emergency drill.
- The plan includes a plan for contaminated run-off water that includes the site topography, potential at risk water sources, mitigation measures prior to and post incident.
- An incident reporting system.

The Table of Contents for the ERP is found in Appendix D and the full version is available for review, if required. The ERP is tested yearly. Once the facility is updated to reflect the change, the ERP will be updated, as in accordance with the Ammonia Code.

2.2.5.1 SITE SECURITY

In accordance with the Ammonia Code, Site security will consist of the following:

For security purposes, a 24-hour monitored burglar and fire alarm system will be installed in the facility along with CCTV equipment, lighting, and ventilation to ensure a safe working environment. The entrance to the property will be secured with a gate and signage.

Accidents or malfunctions that could arise at the Project Site include fire, serious injury or fatality, spill and burglary. Dauphin Co-op understands the safety and health hazards associated with the Anhydrous Ammonia Tank Farm from their knowledge with the construction and operation of several such facilities in Manitoba.

Staff at the Anhydrous Ammonia Tank Farm will be trained on operational, safety and emergency response procedures. Emergency contact information would be made readily available on-site.

2.3 PROJECT SCHEDULE

The Project will be constructed by an independent contractor that will be retained by Dauphin Co-op. The contractor would provide construction materials and complete the needed construction and installations on site.

Construction of the Project is anticipated to be begin late Fall of 2023 (i.e., November 2023) with site preparation for the construction and installation of the concrete pads. The placement and installation of the anhydrous tanks would then follow. It is anticipated that the tank farm would be fully operational by the fall of 2024.

Project Phases and Associated Activities	**Timeframe**
Construction	Fall 2023 – Summer 2024
Transportation of construction-related materials and equipment to construction site	November 2023 February – March 2024 June – July 2024
Construction of anhydrous ammonia tank farm and associated facilities and structures	November 2023 – August 2024
Installation of equipment and upgrading support infrastructure at the Facility	January – August 2024

Operation	Fall 2024 - 2054

2.4 DECOMMISSIONING

The design life of the proposed Project is 30 years. A decommissioning plan, which will include the removal of constructed building, equipment, and ancillary infrastructure along with reclamation of the Project Site, will be compiled and submitted to the appropriate regulatory authority for approval prior to any decommissioning being undertaken. The decommissioning plan will be developed in accordance with the applicable legislation at that time.

3 SCOPE OF THE ASSESSMENT

To assess the potential environmental impact of the construction and operation of the Project, the following spatial and temporal boundaries were considered appropriate.

3.1 SPATIAL BOUNDARIES

Spatial boundaries used for the assessment are described below and the figures for the Project Site, the Local and Regional Assessment Areas are found in **Appendix A**.

PROJECT SITE

The Project Site refers to the land on which the Anhydrous Ammonia Tank Farm is located (i.e., the municipal address of 146131 112 W in the Rural Municipality of Dauphin and the legal description NW ¼ 16-25-19 W).

LOCAL ASSESSMENT AREA

The Local Assessment Area (LAA) refers to the area within which most direct potential Project residual effects are likely to occur. The LAA for the Project is defined as a 1.5-km radius around the Project Site.

REGIONAL ASSESSMENT AREA

The Regional Assessment Area (RAA) represents the area within which direct residual effects are assessed to provide a context for the Project in terms of significance of potential project residual effects.

- The RAA for biophysical components was defined as a 10 km (6.2 mile) radius beyond the Project Site boundaries, intended to account for the maximum spatial extent of potential impacts of the Anhydrous Ammonia Site.
- The Municipality was used as the RAA for socioeconomic valued components. Because it is not practical to assess the effects of greenhouse gas emissions over a 10-km radius, the province is considered the RAA for greenhouse gas effects.

3.2 TEMPORAL BOUNDARIES

The temporal boundaries of the assessment are:

- Construction Phase – The period over which the Anhydrous Ammonia Tank Farm will be constructed or installed is anticipated to span October 2023 to end of August 2024.
- Operation Phase – The period over which the Anhydrous Ammonia Tank Farm will be operational is at least 30 years (i.e., from summer 2024 to 2053).
- Decommissioning Phase – When the Anhydrous Ammonia Tank Farm needs to be decommissioned at some point in the future, a site decommissioning plan will be filed, and decommissioning conducted according to License conditions and regulatory requirements at the time.

4 EXISTING BIOPHYSICAL ENVIRONMENT IN PROJECT AREA

4.1 PHYSIOLOGY, DRAINAGE AND CLIMATE

The Project Site occurs in the Dauphin Ecodistrict (the Ecodistrict) of the Lake Manitoba Plain Ecoregion within the Prairie Ecozone (Smith et al., 1998). The Ecodistrict lies along the foot of the Manitoba Escarpment and has a mean elevation of approximately 290 meters above sea level (masl). The Ecodistrict is part of the Dauphin River drainage division, which is part of the Nelson River drainage system. Soils in the area are imperfectly drained Gleyed Rego Black Chernozems that have developed on shallow, very strongly calcareous, loamy-sand to clayey sediments. The natural vegetation has been altered by agricultural development, which formerly consisted of a mixture of tree bluffs and grasslands. This Ecodistrict lies within the most humid subdivision of the Grassland Transition Ecoclimatic Region. The climate is characterized by short, warm summers and long, cold winters. The mean annual precipitation is approximately 500 mm. Precipitation varies greatly from year to year and is highest from late spring through summer (Smith et al., 1998).

Climate data for the closest station to the Site is from Dauphin, MB and is shown in the table below.

Table 4-1 Climate Normals for Dauphin A, Manitoba (1981 – 2010)

	MONTH											
	JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
TEMPERATURE												
DAILY AVERAGE	-15.4	-12.6	-6.1	3.6	10.5	15.7	18.7	17.7	11.7	4.4	-5.3	-13.1
DAILY MAXIMUM	-10.0	-7.1	-0.5	10.1	17.6	22.1	25.2	24.6	18.1	10.1	-0.6	-8.0
DAILY MINIMUM	-20.7	-18.0	-11.6	-2.9	3.4	9.2	12.1	10.6	5.2	-1.4	-10.0	-18.1
PRECIPITATION												
RAINFALL (mm)	0.4	0.3	5.5	17.1	52.9	81.7	73.1	61.3	57.2	29.4	4.5	0.6
SNOWFALL (cm)	16.6	14.3	20.2	12.9	3.3	0.3	0.0	0.0	1.0	6.0	17.9	21.3

https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=3780&autofwd=1

4.2 AMBIENT AIR QUALITY

Manitoba collects ambient air quality data, fine particulate matter ($PM_{2.5}$) and ozone (O_3) from stations located in Winnipeg, Brandon, Flin Flon and Thompson, Manitoba. The closest air quality monitoring station to the Project Site is the Brandon monitoring station. Data from these stations is compiled and reported on by the Province of Manitoba over three-year intervals. The latest report observed was published in October 2020 and represented

the air quality data over the period of 2013 - 2015. The report shows that the results were below the Canadian Ambient Air Quality Standards (CAAQS) for this period.

Air quality concerns due to pollutants tend to be of a localized nature, with sources of pollutants including industrial operations, vehicle emissions, man-made substances, and other specific activities (Manitoba Sustainable Development 2015). Given the Project Site's siting in proximity to active agricultural areas, the Project Site's air quality could be affected by agricultural operations, with short term increases in particulate due to harvesting at certain times of the year.

4.3 GREENHOUSE GAS EMISSIONS

Greenhouse gas (GHG) emission sources in Manitoba, in order of decreasing magnitude, are transportation, agriculture, stationary combustion, waste, industrial process and product use, and fugitive emissions (Environment and Climate Change Canada 2018b). At a national level, Canada's GHG emission sources, in order of decreasing magnitude, are transportation, buildings, electricity, heavy industry, agriculture, and waste and others (Environment and Climate Change Canada 2018b). According to the National Inventory Report for the period spanning 2005 to 2016, during this period, Manitoba's GHG emissions have increased by 3.5% (Environment and Climate Change Canada 2018b). In 2016, Manitoba contributed 20.9 million tonnes (Mt) of carbon dioxide equivalent (CO2 eq) GHG emissions to Canada's total GHG emissions of 704 Mt CO2 eq and ranked 6th among the provinces and territories (Environment and Climate Change Canada 2018b).

The proposed Project is anticipated to contribute to GHG emissions through mobile combustion (diesel and gasoline in vehicles and equipment). As the Facility will rely on electricity for its energy needs, it will not contribute to GHG emission due to stationary combustion (e.g., natural gas combustion for heating). Relative to the Province of Manitoba's total GHG emissions, the proposed Project's GHG emissions are considered to be negligible.

4.4 GEOLOGY

4.4.1 LOCAL GEOLOGY AND GROUNDWATER

Based on available geological maps, the surficial stratigraphy in this area of Dauphin is represented by offshore glaciolacustrine sediments and normally consists of clay, silt, and sand to a depth of 1 to 20 m, with laminated and massive deposits originating from deep glacial lakes, such as Lake Agassiz, and features defined by iceberg activity (Matile and Keller 2007). The underlying till is classified as "diamicton; 1-75 m thick; low-relief, commonly streamlined deposits; subglacial deposits; largely derived from shale above the Manitoba Escarpment, carbonate rocks in the central lowlands, and crystalline rocks in areas of Precambrian terrane. Thicker sequences consist of multiple units of varying texture; commonly scoured by icebergs and covered discontinuously by thin veneers (<1 m) of glaciolacustrine and glaciofluvial sediments" (Matile and Keller, 2007).

Based on aquifer maps of southern Manitoba, sand and gravel aquifers occur in the till and surficial deposits that range in depth from a few metres to over 100 m and range in size from less than 100 m^2 to several km^2. In some areas, the surficial aquifers are common and in other areas, they are scarce. Bedrock aquifers consist of sandstone and sand of the Cretaceous Swan River Foundation. These sand and sandstone beds are interbedded with shale, silt, and clay. Groundwater in the Dauphin area is salty with high total dissolved solids (Water Resources Branch 1987).

4.4.1.1 ON-SITE GEOTECHNICAL INVESTIGATION

WSP E&I conducted a geotechnical investigation at the Project Site in August and September 2023 (**Appendix E**). The purpose of the geotechnical investigation was to evaluate the soil and groundwater conditions at the Project Site, in order to provide geotechnical recommendations for the design and construction of foundations for the building structures, pavement structures for traffic areas and general site development recommendations.

The geotechnical investigation involved the drilling of eighteen test holes. Test holes TH23-01 to TH23-05, TH23-13 and TH23-14 were advanced to auger refusal, which occurred at depths between 3.2 m and 9.3 m below grade. TH23-06 to TH23-12 and TH23-15 to TH23-18 were advanced to a termination depth of 3.0 m except for TH23-07, and TH23-11 which encountered auger refusal at 2.8 m and 0.6 m respectively. A companion test hole was advanced at TH23-02 to obtain a soil sample from the upper clay, and at TH23-11, TH23-13 and TH23-14 to confirm the depth of refusal. Slotted standpipe piezometers were installed in TH23-02 and TH23-04 to measure long-term groundwater levels. The test holes were laid out using a survey grade GPS. The test hole depths are summarized in Table 4-2. Sloughing or seepage was observed upon drilling. The table below provides a summary of the drilling program.

Table 4-2 Summary of Sloughing and Groundwater Observations

Test Hole ID	Drill Depth (m)	During Drilling		Upon Completion	
		Sloughing Zone	Seepage Zone	Depth Open (m)	Depth to Groundwater (m)
TH23-01	*4.3	Below 1.5 m	Below 1.5 m	2.0	2.0
TH23-02	*3.2	Below 2.4 m	Below 2.4 m	2.4	2.0
TH23-03	*7.1	Below 2.4 m	Below 0.3 m	2.4	1.2
TH23-04	*3.2	Below 1.8 m	Below 2.1 m	1.8	1.8
TH23-05	*4.6	None Observed	Below 2.2 m	4.6	4.0
TH23-06	3.0	Below 1.7 m	Below 0.3 m	1.7	1.5
TH23-07	*2.8	Below 1.5 m	Below 1.2 m	1.8	1.5
TH23-08	3.0	Below 1.4 m	Below 1.2 m	1.4	0.5
TH23-09	3.0	None Observed	Below 1.2 m	3.0	2.7
TH23-10	3.0	Below 2.1 m	Below 0.6 m	2.1	1.8

Test Hole ID	Drill Depth (m)	During Drilling		Upon Completion	
		Sloughing Zone	Seepage Zone	Depth Open (m)	Depth to Groundwater (m)
TH23-11	*0.6	None Observed	None Observed	0.6	None Observed
TH23-12	3.0	Below 2.3 m	Below 2.1 m	2.3	2.1
TH23-13A	*4.7	Below 1.8m	Below 1.8m	1.8	1.2
TH23-13B (Companion hole)	*5.2	None Observed	Below 1.8m	5.2	5.0
TH23-14A	*2.7	None Observed	None Observed	3.7	None Observed
TH23-14B (Companion hole)	9.3	Below 2.9m	Below 1.2m	2.9	None Observed
TH23-15	3.5	Below 1.2m	Below 1.2m	2.3	2.2
TH23-16	3.5	Below 1.2m	Below 1.2m	2.4	2.3
TH23-17	3.0	Below 1.4m	Below 1.4m	1.4	None Observed
TH23-18	3.0	Below 1.5m	None Observed	1.5	None Observed

*Test hole terminated by auger refusal.

The general stratigraphy at the Project Site consisted of gravel fill, organic clay, clay, silt, and glacial till (WSP E&I 2023). The individual layers are discussed in further detail below.

GRAVEL FILL

Gravel fill was present at the ground surface of test holes TH23-01, 04, 05, 06, 11, and 12. The thickness of the gravel ranged between 300 and 600 mm below grade. The gravel fill was generally described as poorly graded, silty, moist, and tan-brown. The moisture contents of the gravel fill ranged from 7% to 22%. In TH23-11, gravel fill was encountered to the depth of auger refusal at 600 mm below existing grade. WSP attempted additional companion holes adjacent to the test hole location but could not advance past a depth of 600 mm.

ORGANIC CLAY

Organic clay was present at the ground surface in TH23-02, TH23-03, and from TH23-13 to TH23-18. The thickness of the organic clay ranged between 150 mm and 600 mm below grade. The organic clay was classified as silty, high plastic, moist, firm to stiff, dark grey, and contained occasional to abundant rootlets. The moisture contents in the organic clay ranged from 33% to 49% respectively.

CLAY

Clay was encountered at the ground surface in TH23-07, 08, and 10, below the gravel fill layer in TH23-04 and 05, and below the organic clay in TH23-02, TH23-03, and from TH23-13 to TH23-18. The clay layer extended to depths of 0.6 m to 1.4 m below grade. The clay was generally described as silty, moist, medium to high plastic, firm, grey, and contained occasional to frequent silt till inclusions. Moisture contents in the clay ranged from 36 to 51%.

SILT

Silt was present below the clay at TH23-05, 16, 17, and beneath the gravel fill at TH23-06 and TH23-12. The silt extended to depths ranging from 0.6 to 2.2 m below grade. In TH23-05, 06, and 12, the silt was clayey, low to medium plastic, moist, firm to stiff, and tan-brown. In TH23, 16, and 17, the silt was low plastic, very moist to wet, soft, and dark grey. Moisture contents in the silt ranged from 8 to 28%.

GLACIAL TILL

Sand till was present in TH23-01 below the silt layer and in TH23-14 below the clay till. The sand till layer extended to a depth of 2.9 m below grade in TH23-01, and to auger refusal at 9.3 m in TH23-14. The sand till in TH23-01 was described as silty, with traces of gravel, poorly graded, fine grained, wet, inferred to be compact and brown. The sand till in TH23-14 was described as silty, with traces of gravel, poorly graded, fine to medium grained, very moist, dense and grey. The moisture content of the sand till ranged from 19% to 25%. SPT 'N' values in the sand till ranged from 47 to greater than 50.

Clay till was encountered below the gravel fill at TH23-01, below the clay at TH23-08 and TH23-18, at ground surface at TH23-09, below the silt till at TH23-13, 14, and 17, and below the sand at TH23-15. The clay till was generally described as silty, trace to some sand, trace gravel, loose to compact, and brown to brownish grey. Moisture contents of the clay till ranged from 10 to 40%. SPT 'N' values in the clay till ranged from 7 to greater than 50. Additional laboratory testing conducted on the clay till consisted of Atterberg limits and grain size analysis at TH23-01. Results of the testing are shown on the test hole logs and are summarized in Table 4-3 below.

Table 4-3: Summary of Laboratory Testing

Test Hole Id	Depth (m)	Atterberg Limit Results			Grain Size Analysis Results			
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% Gravel	% Sand	% Silt	% Clay
TH23-01	0.6	88.3	30.3	58.0	2.2	11.4	30.9	55.5

Below the clay at TH23-13 and below the silt layer at TH23-14, silt till was present and extended to depths of 3.1 m and 3.8 m below grade. Silt till was also present below the clay till at TH23-09 and extended to the termination depth at 3.0 m below grade. The silt till was generally described as clayey, with traces of sand, low plastic,

compact, and brown to brownish grey. Moisture contents of the silt till ranged from 15 to 25%. SPT 'N' values in the silt till ranged from 8 to greater than 50.

4.5 SOILS

The project is located within the Lake Manitoba Plain Eco-region of the Prairies eco-zone (Agriculture and Agri-Foods Canada). The soils in the region are mainly Gleysolic and Black Chernozems.

Agricultural capability for soils in the vicinity of the Project Site falls under Class 2, with crop productivity moderately limited by two or more cumulative effects which singly are not serious enough to affect the overall rating (Michalyna, 1984).

Based on the Geotechnical investigation, the soil deposits within the Site are consistent with the regional soil deposits, as discussed in Section 4.4.1.1. The Site is situated on developed, gravel-surfaced grounds, ensuring effective drainage. No signs of standing water or low-lying areas were detected during the site reconnaissance.

4.6 HYDROGEOLOGY AND GROUNDWATER

The RM of Dauphin is located in the Canadian Shield hydrogeological region. Early investigations of the hydrogeology of the area identified the aquifer types in the RM includes sandstone and sand and gravel deposits. The bedrock beneath the general area consists of shale and sandstone beds.

The Lake Manitoba Plain eco-region is typically underlain by limestone bedrock which is covered by extremely calcareous broadly rigid glacial tills in the northern half and by smooth level, lacustrine sand, silts, and clays in the southern half.

4.6.1 GROUNDWATER USE AT AND NEAR THE PROJECT SITE

There are no domestic groundwater wells at the Project Site.

According to the Government of Manitoba groundwater well database (2022), there are no known domestic groundwater well within the vicinity of the Project Site. However, there are production wells on the adjacent quarter sections to the east, southeast, and west. It is anticipated that the Project will not impact on these wells.

4.7 SURFACE WATER

Closest surface water is Salt Creek approximately 100 m west of the Site. Vermillion River runs approximately 2 km east of the Site through Dauphin.

The Site is well drained where overland stormwater typically follows a north/northeast path or permeates into the Site's granular base. During the Site reconnaissance, no signs of standing water or low-lying areas were noted. Anticipated surface water drainage issues at the Site are not expected.

4.8 VEGETATION

The Project Site is in the Dauphin Ecodistrict (the Ecodistrict) of the Lake Manitoba Plain Ecoregion within the Prairies Ecozone (Smith et al., 1998). With the larger Lake Manitoba Plain Ecoregion, this ecoregion is

predominantly dominated by trembling aspen and shrubs in moist areas with bur oak and grasslands in drier areas. Varieties of dominant grasses include fescues, wheat grasses, June grass and Kentucky bluegrass. Areas with poorly drained soils support slough grasses, marsh reed grass, sedges, cattails, and shrubby willows (Smith et al, 1998).

Within the Dauphin Ecodistrict, the natural vegetation has been strongly altered by agricultural development. Where forest cover remains, it is dominated by trembling aspen stands and bluffs.

4.9 WILDLIFE

The Site is located within the Lake Manitoba Plain Eco-region of the Prairies ecozone (Agriculture and Agri-Food Canada). Characteristic mammals in the eco-region include waterfowl, white-tailed deer, coyote, rabbit, and ground squirrel. Bird species in the prairies ecozone include ferruginous hawk, sage grouse, American avocet, burrowing owl, great blue heron, black-billed magpie, Baltimore oriole, veery and brown thrasher (Smith et al., 1998).

At the time of the Project Site visit no wildlife species were observed at the Project Site.

4.10 MIGRATORY BIRDS

Waterfowl, including various ducks and geese, meadowlarks, killdeer, and mourning doves are common in the ecoregion and are protected under Article I of the *Migratory Birds Convention Act, SC 1994, c 22*. Other common birds include black-billed magpie and various raptors, (Smith et al 1998).

According to the Bird Studies Canada (BSC) Breeding Bird Atlas (BBA) online database, 113 bird species were identified as having demonstrated breeding behaviour in the within 100 km^2 atlas square (14MB26) which encompasses the Project Region. A search of the Conservation Data Centre's (CDC) database indicates that provincially and federally listed species found in the general area of the proposed Project Region includes the Sprague's Pipet (SARA threatened), the Bobolink (SARA threatened), the Barn Swallow (SARA threatened), the Prairie Loggerhead Shrike (SARA endangered), the Chimney Swift (SARA threatened), and the Red-headed Woodpecker (SARA endangered).

At the time of the Project Site visit no bird species were observed at the Project Site.

4.11 REPTILES AND AMPHIBIANS

Red-sided and western plains garter snakes and various frogs are common in the area of the Project Site (Smith et al 1998). Other reptile and amphibians present in the ecozone include the western painted turtle, gray salamander, and various toads and frogs.

At the time of the Project Site visit no reptiles of amphibians were observed at the Project Site.

4.12 PROTECTED SPECIES

A variety of sources were consulted to identify species at risk that could potentially occur within the Project Region, including the Manitoba Conservation Data Centre (CDC) the BSC, BBA, and the MHA. The occurrence data from these sources were compared to Schedule 1 of the *Federal Species at Risk Act (SARA) SC 2002, C29* and The *Endangered Species and Ecosystems Act (Manitoba), CCSM c E111 to* determine which federally and/or provincially

listed rare or sensitive species have the potential to occur in the Project Region. Distribution maps were referenced, and habitat requirements were considered to determine the probability that listed species would occur in the Project Region.

Based on this search, there are 9 Provincially and Federally listed species that may occur in the Project RAA (Table 4-4). WSP submitted an information request to Manitoba Conservation Data Centre (MCDC) for records of rare species recorded at or near the Project Site. In their response MCDC indicated that at that time, there were no known occurrences recorded for the Project Site footprint.

Table 4-4: Potential Listed Species in the Project Area

SPECIES	SARA STATUS	MESA STATUS	HABITAT DESCRIPTION	POTENTIAL TO OCCUR IN THE PROJECT REGION
INVERTEBRATES				
Yellow-banded Bumble Bee *Bombus terricola*	Not Listed	Special Concern	Habitat generalist.[2]	Not known to occur within the area of the Project Site. Vegetation within the Project Site is now cultivated farmland.
VERTEBRATES				
Sprague's Pipit *Anthus Spragueii*	Threatened	Threatened	Native grasslands.[2]	Low: not known to breed in the Project Site. Possible within the Dauphin area.[3]
Bobolink *Dolichonyz Oryzivorus*	Threatened	Not Listed	Native grasslands and pastures.[2]	Not known to breed in the Project Site. Probably within the Dauphin area. [3]
Barn Swallow *Hirundo Rustica*	Threatened		Grasslands, agricultural fields, shorelines, woodland clearings, wetlands, sand dunes, tundra, and roads.[2]	Not known to occur within the area of the Project Site. Confirmed within the Dauphin area. [3]
Prairie Loggerhead Shrike *Lanius ludovicianus excubitorides*	Endangered	Threatened	Grasses and/or forbs.[2]	Not known to occur within the area of the Project Region.
Plains Spadefoot *Spea bombifrons*	Not Listed	Not Listed	Grasslands, prairies, and desert scrubs habitat.[2]	Not known to occur within the area of the Project Region.
Chimney Swift *Chaetura pelagica*	Threatened	Threatened	Variety of habitats. Adapted to urban and suburban environments.[2]	Not known to breed in the Project Site. Probably within the Dauphin area. [3]
Red-headed Woodpecker *Melanerpes erythrocephalus*	Endangered	Threatened	Treed habitats, including deciduous woodlands, open woodlots, parks, golf courses, treed agricultural, urban areas, riparian forests, wetlands.[2]	Not known to occur within the area of the Project Site. Confirmed within the Dauphin area. [3]

Sources:
[1] Species at Risk Public Registry (Province of Manitoba) https://www.gov.mb.ca/sd/environment_and_biodiversity/species_ecosystems/index.html
[2] Species at Risk Public Registry (Government of Canada 2019) https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html
[3] Artuso et al 2010 -2014.
[4] Manitoba Conservation Data Centre
[5] Manitoba Herps Atlas Database 2018

5 EXISTING AND SOCIO-ECONOMIC ENVIRONMENT IN PROJECT AREA

5.1 LAND USE, POPULATION AND WELL-BEING

The Rural Municipality of Dauphin is located in western Manitoba, near Duck Mountain Provincial Park and Riding Mountain National Park. Agriculture is the top type of employment followed by retail and health care and social assistance. The RM of Dauphin covers a land area of approximately 1,512 square kilometres (km^2) with a population of 2,136 (Statistics Canada Census Profile, 2023).

Table 5-1: Population Statistics for the RM of Dauphin

	RM OF DAUPHIN
Population in 2021	8,034
Population in 2016	8,233
% change in population between 2016 and 2021	-2.4%
Total private dwellings	3,877
Population density per km^2	1,010.4
Source: Statistics Canada Census Profile (2023)	

Emergency services in the Project Site's regional area, are carried out through 911 and are provided by the City of Dauphin fire department and the Royal Canadian Mounted Police (RCMP).

For healthcare, the Municipality is serviced by Prairie Mountain Health, with the Regional Health Centre providing transitional care (e.g., in-patient beds, palliative care), outpatient services including emergency services, and diagnostic services.

5.2 EMPLOYMENT, ECONOMY, INFRASTRUCTURE AND SERVICES

Most businesses within the RM of Dauphin lie in the primary sectors of Agriculture, retail, health care services (Statistics Canada Census Profile, 2021). Crop production related to crop insurance, within the RM of Dauphin, falls under Manitoba Agricultural Services Corporation (MASC) Risk Area 9. The land surrounding the proposed Project location consists of productive agricultural cropland and agricultural cropland is the predominant habitat type in the regional assessment area (Manitoba Land Use and Development).

Dauphin Co-op's proposed construction and operation of an Anhydrous Ammonia Tank Farm is as substantial economic investment in the RM of Dauphin with numerous benefits. These benefits include wages paid to employees; continued supply of NH_3 to local and surrounding area agricultural producers; work for local contractors; cash back and equity payments through annual patronage allocations; and contributions to municipal, provincial, and federal tax revenue.

The City of Dauphin is the nearest service centre to the Project. The Project Site can be accessed via PTH 5 to Provincial Road 362 to Rural Road 147N and Rural Road 112W.

5.3 PARKS AND PROTECTED AREAS

There are no immediate provincial parks located within the Project area, however Riding Mountain National Park is located 40 km south of the Project Site.

5.4 FIRST NATION COMMUNITIES

The proposed Project falls within the lands of Treaty 2. There are no First Nation communities within 50 km of the Project Site.

The proposed Project does not consist of leasing or obtaining any provincial crown land or impacting on any current designated Treaty Land Entitlements (TLE) that Co-op is aware of.

5.5 HERITAGE RESOURCES

WSP submitted a screening request to the Manitoba Historic Resources Branch (the Branch) for the proposed Anhydrous Ammonia Site. Given the already-developed nature of the Project Site, it is unlikely that heritage resources will be encountered at the Project Site during the construction of the Anhydrous Ammonia Tank Farm and the completion of a HRIA is not deemed to be required during construction. During construction, the following measures will be implemented:

- If artifacts or historical features of skeletal remains are encountered during construction activities, work activities will stop immediately around the affected area with the find reported to the Project Site supervisor. A qualified archaeologist would investigate and assess the find prior to continuation of work.
- If skeletal remains are encountered, the find would be immediately reported to the Project Site supervisor and the RCMP.

6 PUBLIC ENGAGEMENT

Dauphin Co-op has consulted with the Municipality regarding the planned Anhydrous Ammonia Site. The RM of Dauphin did not express concerns with the construction and operation of the proposed Project. Dauphin Co-op is in the process of obtaining the necessary RM approvals and permits related to the Project. The RM is responsive to Dauphin Co-op investing in the RM of Dauphin and providing anhydrous ammonia retail services to the producers in the rural municipality and surrounding area.

7 ASSESSMENT APPROACH

This assessment was completed to meet the requirements of an EAP and considers project-specific environmental effects. For this assessment, the term "environment" refers broadly to both biophysical and socio-economic elements of the environmental setting.

The assessment is focused on valued components (VCs) which are elements identified as having scientific, social, cultural, economic, historical, archaeological, or aesthetic importance. The selection of VCs is based on consideration of several factors, namely, input from regulators, the public, as well as professional judgement of the Dauphin Co-op and environmental assessment team, combined with the assumed implementation of industry standard, environmentally responsible construction techniques and operating procedures during project construction, operation, and closure. The MSD *Information Bulletin – Environment Act Proposal Report Guidelines and Information Bulletin - Environment Act Proposals for Bulk Material Handling Facilities (Pesticide, Fertilizer and Seed Treatment Handling Facilities)* dated 2018 was used as guidance in the determination of likely interactions between the Project and biophysical and socio-economic elements of the environment.

7.1 SELECTION OF PROJECT INTERACTIONS AND VALUED COMPONENTS

To concentrate the assessment on matters of the most importance, potential interactions of the Project with the surrounding biophysical and socio-economic environment are identified using a variety of sources, including:

- Applicable provincial regulatory requirements and guidance pertaining to the proposed Anhydrous Ammonia Tank Farm from regulators.
- Existing information on biophysical and socio-economic components within the local and regional areas of the Facility (e.g., air quality, surface water quality, and human and ecological health) and results of desktop studies.
- Professional judgment of the environmental assessment and Dauphin Co-op teams, based on knowledge with similar projects elsewhere and other projects and activities in the project area.
- Biophysical and socio-economic VCs that could be affected due to interactions between the Project and environment are identified to scope the assessment. The selected VCs embody one or more of the following:
    - represent a broad biophysical or socio-economic component that might be affected by the Project;
    - are a part of the heritage of First Nation communities or a part of their current use of lands for traditional purposes; and
    - are of scientific, historical, or archaeological importance.

For those VCs where a potential interaction is identified, but which based on past experience and professional judgement, will result in an environmental effect that can be reduced to acceptable levels through use of standard operating or industry best management practices, the VC was excluded from further assessment.

The designation of VCs is shown in Table 7-1. Project-related effects on the VCs and corresponding mitigation measures are assessed in Section 8. Residual effects are characterized using specific predetermined criteria (e.g., direction, magnitude, geographical extent, duration, frequency) as outlined in Table 7-2.

Table 7-1 Designation of Valued Components

COMPONENT NAME	POTENTIAL PROJECT INTERACTION	INCLUDED/ EXCLUDED	VALUE COMPONENT	RATIONAL FOR EXCLUSION OF INCLUSION AND PROJECT POTENTIAL EFFECT
Air Quality and Noise	✓	Included	Yes	The Anhydrous Ammonia Tank Farm will have a gravel surface outside of building footprints. On-site traffic including product delivery and customer vehicles will generate fugitive dust emissions. Construction activities for the proposed Anhydrous Ammonia Tank Farm will temporarily generate dust emission due to physical disturbance of soil, including topsoil stripping and stockpiling, and movement of construction-related vehicles. Noise level generation is deemed acceptable for an Anhydrous Ammonia Tank Farm along a Rural Road.
Greenhouse Gas Emissions	✓	Included	Yes	The Anhydrous Ammonia Tank Farm will contribute to GHG largely due to emissions from NH_3 delivery and customer vehicles.
Soil Quality	✓	Included	Yes	Construction activities within the Anhydrous Ammonia Tank Farm footprint will have the potential to affect soil quality. There would be potential for compaction and rutting, erosion and admixing which adversely affect soil quality. Such effects would be restricted to the construction phase.
Vegetation	x	Included	No	The Project Site is developed, and gravel covered. The northern and western portion of the Site consists of grasses, shrubs, and other low-lying flora. As a result, there will not be potential for interaction with natural vegetation.
Surface Water Quality	x	Included	No	Surface drainage at the Project Site is influenced by how the Site has been developed – ie compacted granular base that minimizes standing water at the Site. The closest surface water body that could support aquatic life is Salk Creek which is approximately 100 m west of the Project Site. The Project Site does not appear to have a direct link to this and other nearby water channels and thus the potential for surface water contamination by NH3 associated with the Facility is deemed negligible.
Groundwater Quality	✓	Included	No	For its water needs, the Anhydrous Ammonia Tank Farm will rely on water that is brough onto Site and pumped into a cistern.
Fish and Fish Habitat	x	Included	No	There is no fish habitat present within the Project Site and immediately surrounding areas and there is no direct discharge proposed to surface water bodies.
Wildlife and Wildlife Habitat	✓	Included	Yes	The Anhydrous Ammonia Tank Farm will be gated and surrounded by a security fence topped with barbed wire resulting in limited access to the Project Site. The Project Site is not expected to provide suitable nesting habitat for birds therefore the potential for effects to the migratory, and/or protected species is deemed low.
Land and Resource Use	X	Included	No	The Project Site is already zoned 'MR' for Industrial General Zone with the surrounding properties zoned for 'MR' and 'AG' for Agricultural General Zone. There will not be need for land use zone change to facilitate the construction and operation of the Anhydrous Ammonia Tank Farm.

COMPONENT NAME	POTENTIAL PROJECT INTERACTION	INCLUDED/ EXCLUDED	VALUE COMPONENT	RATIONAL FOR EXCLUSION OF INCLUSION AND PROJECT POTENTIAL EFFECT
Heritage Resources	✓	Included	No	Project activities during construction (e.g., clearing or trenching) can potentially affect heritage resources, particularly in previously non-disturbed areas. Given the developed nature of the Project Site, the potential for effects to heritage resources is deemed negligible.
Human Health and Aesthetics	X	Included	No	The Project Site is not in immediate proximity to private residences.
Infrastructure and Services	✓	Included	Yes	The additional traffic due to the Anhydrous Ammonia Tank Farm product deliveries and customers may increase traffic. Municipal services (energy, water, waste disposal ground) have sufficient capacity to accommodate the proposed Anhydrous Ammonia Tank Farm .
Employment and Economy	✓	Included	No	Positive effects attributable to the proposed Anhydrous Ammonia Tank Farm are expected and include benefits related to employment, increased and ready supply of NH_3 to local agricultural producers, and tax generation.

Table 7-2 Residual Effects Description Criteria

CHARACTERIZATION	DESCRIPTION	QUANTITATIVE MEASURE OR DEFINITION OF QUALITATIVE CATEGORIES
Direction	The long-term trend of the residual effect	**Positive**— an improvement in the valued component compared with existing conditions and trends. **Adverse**— a decline in the valued component compared with existing conditions and trends. **Neutral**— no change in the valued component from existing conditions and trends
Magnitude	The amount of change in the VC relative to existing conditions	**Negligible**—no measurable change **Low**— a change that falls within the level of natural variability. **Moderate**— a measurable change which is unlikely to affect the valued component. **High**— a measurable change which is likely to affect the valued component.
Geographic Extent	The geographic area in which an environmental effect occurs	**PS**– residual effects are restricted to the (Project Site, PS) **LAA** - residual effects extend into the LAA (i.e., 1.5 km radius of the Project Site boundary. **RAA** - residual effects extend to a 10-km radius of the Facility; for Socio-Economic VCs the applicable RAA is the RM of Dauphin; for greenhouse gases the applicable RAA is the province of Manitoba.
Frequency	Identifies when the residual effect occurs and how often during the Project or in a specific phase	**Single event** - residual effect occurs once throughout the life of the Project. **Multiple irregular event** - residual effect occurs sporadically and intermittently (no set schedule) throughout. **Multiple regular event** - residual effect occurs repeatedly and regularly throughout. **Continuous** - residual effect occurs continuously throughout the life of the Project.

CHARACTERIZATION	DESCRIPTION	QUANTITATIVE MEASURE OR DEFINITION OF QUALITATIVE CATEGORIES
Duration	The period of time required until the VC returns to its existing condition, or the effect can no longer be measured or otherwise perceived	**Short-term** - residual effect restricted to the duration of two years. **Medium-term** - residual effect extends up to 25 years. **Long-term** - residual effect extends for longer than 25 years.
Reversibility	Pertains to whether the VC can return to its existing condition after the project activity ceases	**Reversible** - the effect is likely to be reversed after activity completion and decommissioning/remediation. **Irreversible** - the effect is unlikely to be reversed even after decommissioning/remediation.
Ecological and Socio-Economic Context	Existing condition and trends in the area where environmental effects occur	**Undisturbed** - area is relatively undisturbed or not adversely affected by human activity. **Disturbed** - area has been previously disturbed by human development or human development is still present.

8 ENVIRONMENTAL EFFECTS ASSESSMENT AND MITIGATION

This section contains the results of the environmental assessment. Applying professional judgement and a thorough understanding of the components of the proposed Anhydrous Ammonia Tank Farm (outlined in Section 2 of this report); WSP determined the potential for physical, biological, and socio-economic components to interact with project components (presented in Table 7-1).

The assessment includes any effects on social components resulting from residual adverse environmental effects. The assessment also considers mitigation measures that Dauphin Co-op plans to incorporate as design aspects, as well as environmental protection practices and procedures included in the proponent's standard of operation. Environmental effects that may be caused as a result of accidents and malfunctions are discussed separately in Section 8.7. Definitions of the terms used to guide the effects assessment are provided in Table 7-2.

8.1 AIR QUALITY AND NOISE

8.1.1 DUST

The Project will involve construction activities that generate dust, namely vehicle movement, clearing, excavation, stockpiling of materials, and grading within the proposed Anhydrous Ammonia Tank Farm components' footprints. Air quality may be affected by dust and particulates with potential for subsequent effects on human health (including respiratory issues) and off-site vegetation (dust deposition).

During operation of the Anhydrous Ammonia Tank Farm , fugitive dust generation is anticipated from on-site traffic (delivery and customer vehicles).

To reduce dust emissions during construction of the Project, the following mitigation measures will be implemented:

- Minimizing soil disturbance at the Project Site.
- Limiting heights of stockpiled materials on site.
- Using soil stabilizers for soil stockpiles exposed for prolonged periods of time.
- Suppressing dust through use of water or other approved control agents, if needed.

8.1.2 NOISE EMISSIONS

An increase in noise levels at or near the Project Site could occur due to the anticipated traffic accessing the Project Site and potentially affect people and wildlife in the surrounding area. Sources of noise during construction would be typical of heavy equipment such as graders, excavators, and haulage trucks.

The entrance to the residence that is closest to the Facility is located along Rural Road 112 W, approximately 185 m south of the Site. This receptor residence is deemed too distant to be disturbed by everyday noise at the Project Site due to construction.

The effect of the Anhydrous Ammonia Tank Farm 's construction or operation activities on noise levels in the area is anticipated to be negligible.

During the operation phase, sources of noise at the Anhydrous Ammonia Tank Farm would primarily be movement of trucks delivering fertilizers and customers' vehicles. Given the Project Site's proximity to Rural Road 112 W and Rural Road 147 N, the delivery of NH_3 at the Anhydrous Ammonia Tank Farm is anticipated to result in negligible residual noise effects.

The implementation of the following measures will mitigate potential adverse effects.

- Limitation of construction hours as required to normal working hours.
- Provision of appropriate hearing protection to workers/employees and encouraging proper use of hearing protection among workers during construction.
- Regular maintenance of vehicles and equipment.

SUMMARY

With the implementation of the mitigation and prevention measures identified above, the potential adverse effects on air quality during construction and operation are expected to be negligible, limited to the Project Site, short-term in duration, irregular in frequency, and reversible upon decommissioning. The potential adverse effects of noise are expected to be low, limited to the immediate vicinity of the Project Site, short-term in duration, multiple regular in frequency, and reversible upon decommissioning.

8.2 GREENHOUSE GAS EMISSIONS

During construction, exhaust emissions containing greenhouse gases (GHGs) will be generated by vehicles and equipment during delivery of construction materials; preparing the footprint of the Anhydrous Ammonia Tank Farm ; construction of the Anhydrous Ammonia Tank Farm components and during reclamation or landscaping activities following construction. These emissions could also adversely affect air quality by increasing the local concentrations of carbon monoxide, carbon dioxide, particulate matter, and nitrogen oxides in the air with potential for subsequent effects on human health.

During construction, over the period of October 2023 to August 2024, up to 40 construction related vehicles (Section 2.2) are anticipated to access public roads near the Project Site. This traffic will be temporary and restricted to the construction phase of the Project.

During operation of the Anhydrous Ammonia Tank Farm , fertilizer and agrichemical delivery and customer vehicles will generate GHG emissions. This traffic would be restricted to the operational days and hours (typically Monday to Friday, 8:00 to 17:00 hours).

The following mitigation measures will be implemented to mitigate GHG emissions due to exhaust emissions:

- Vehicles and equipment will be properly maintained.
- Minimizing the number of vehicles or equipment in use as far as is practical.

SUMMARY

The construction and operation of the Anhydrous Ammonia Tank Farm will result in GHG emissions. However, relative to the provincial total emissions, the project related GHG emissions are expected be negligible and short-term in duration, of multiple irregular frequency, and irreversible upon decommissioning.

8.3 SOIL QUALITY

Changes to soil quality attributable to the Anhydrous Ammonia Tank Farm would be largely restricted to the construction phase. Following construction and during operation of the Anhydrous Ammonia Tank Farm , the Project footprint will be covered by gravel.

8.3.1 COMPACTION AND RUTTING RISK

Vehicles and heavy equipment traffic in the proposed Anhydrous Ammonia Tank Farm could cause compaction and rutting of topsoil and subsoil, adversely affecting soil quality. Soil compaction is largely influenced by soil texture so that finer-textured soils are more susceptible to compaction than coarser-textured soils. Rutting is primarily driven by moisture so that as soil moisture increases, the soil's susceptibility to rutting also increases. Given the reported predominant future use of gravel fill at the surface within the Project Site, there is low potential for soil compaction and rutting.

8.3.2 ADMIXING

Admixing refers to the dilution of topsoil with subsoil resulting in topsoil of reduced quality (Powter 2002). Admixing can cause soil quality deterioration due to changes in topsoil texture, soil aggregation and structure, organic matter content and consistence when topsoil is inadvertently mixed with subsoil. For the Project, the Site is a developed Site, and little to no toil soil will be stripped at this Site, therefor the potential for admixing is negligible.

8.3.3 WIND AND WATER EROSION RISK

Physical disturbance of soil during construction activities (e.g., topsoil stripping, excavation, backfilling, grading, and clean-up can reduce soil thickness, due to wind or water erosion. The exposure of soil makes it more vulnerable to the elements and can cause soil loss from exposed soils (e.g., in stockpiles). Such losses could be associated with a one-time weather event, like strong winds or high intensity rainfall and the associated reduction in soil thickness might be permanent.

Due to the proposed predominant gravel fill at the surface at the Project Site, water and wind erosion risk for soils is deemed to be low. Erosion of soil and material stockpiles due to wind has the potential to cause subsequent effects on air quality (dust and particulate matter).

To reduce potential effects to soil quality, the following mitigation measures will be implemented:

- Disturbed/exposed areas will be kept to a minimum with site restoration occurring as soon as practical where required.
- Construction equipment and vehicle movements will be limited to designated roads/pathways within and around work areas.

- During construction, in the event of adverse weather that could result in rutting or compaction (heavy rainfall), the contractor in consultation with Dauphin Co-op should implement contingency measures including use of matting for access through wet areas and limiting or suspension of activities until soil conditions are appropriate.
- Colour change should be used to guide stripping between topsoil (A horizon) and subsoil (B or C horizon) within the Anhydrous Ammonia Tank Farm components' footprints to prevent admixing.
- The contractor will be responsible for the appropriate repair of any areas where equipment has compacted soils with the repairs including appropriate grading and site restoration (if required).
- Traffic should be limited as much as possible during smoothing and levelling of soils to prevent further compaction. Smoothing and levelling should also be avoided if soils are near saturation.
- Areas with vehicle ruts should be decompacted and regraded.
- Soil stockpiles at the Project Site should be stabilized and adequately protected from erosion with good vegetation establishment or other protective measures.
- Appropriate erosion and sediment control measures should be implemented and maintained, as needed, until spreading of topsoil is complete.

SUMMARY

The mitigation measures outlined above are considered sufficient to mitigate potential adverse effects due to soil compaction, rutting, admixing, and erosion during construction, operation, and decommissioning phases. Residual effects on soils are therefore assessed to be adverse, of low magnitude, limited to the areas where soil will be disturbed within the Project Site, span medium to long-term duration, occur once, and irreversible.

8.4 WILDLIFE AND WILDLIFE HABITAT

The Project Site and immediately surrounding area occur the existing Ammonia Site and undeveloped grassland.

The Project Site is currently in operation of an existing Ammonia Site, and therefore the interactions with vegetation and wildlife are expected to be minimal.

In order to ensure that there are no impacts to migratory bird and to reduce the potential for harm to ground nests and other interactions with wildlife during construction at the Project Site, the following mitigation will be implemented:

- Prior to commencement of construction activities surveys for potential ground nests and occurrences of breeding birds will be conducted at the Project Site, and buffers established around nesting sites to protect breeding bird populations, if nests are found.
- During construction temporary fencing would also be used as required to keep wildlife from accessing the Project Site.

SUMMARY

The proposed Anhydrous Ammonia Tank Farm footprint is a previously disturbed area. The mitigation measures outlined above are deemed sufficient to mitigate potential adverse effects to wildlife due to construction activities. Residual effects on wildlife and wildlife habitat are assessed to be adverse, of low magnitude, limited to the Project Site, span short to medium-term duration, of single occurrence, and reversible.

8.5 INFRASTRUCTURE AND SERVICES

The Anhydrous Ammonia Tank Farm's use of municipal services (i.e., energy, waste disposal and recycling) is not anticipated to result in residual effects as the RM of Dauphin and Manitoba Hydro services will have sufficient capacity to accommodate the increase anticipated for the demands of the Anhydrous Ammonia Tank Farm .

Considering the forecasted additional traffic attributable to the Anhydrous Ammonia Tank Farm 's construction and operation as well as the reported traffic volumes near the Project Site along Rural Road 147N and Rural Road 112W W, which will be used to access the Anhydrous Ammonia Tank Farm, the Anhydrous Ammonia Tank Farm's potential impact on traffic is deemed adverse, low in the LAA/negligible in the RAA, multiple irregular, short-term and reversible.

SUMMARY

The potential adverse residual effects on infrastructure and services are expected to be negligible in the RAA, short-term in duration, multiple irregular in frequency, and reversible upon the Anhydrous Ammonia Tank Farm's decommissioning.

8.6 SUMMARY OF RESIDUAL EFFECTS CHARACTERIZATION

A summary of residual environmental effects characterization is found in Table 8-1. Positive effects are not addressed, only adverse effects are characterized.

Table 8-1 Summary of Residual Environmental Effects

PROJECT EFFECTS	RESIDUAL ENVIRONMENTAL EFFECTS CHARACTERIZATION						
	DIRECTION	MAGNITUDE	GEOGRAPHICAL EXTENT	DURATION	FRQUENCY	REVERSIBILITY	Ecological or Socio-Economic context
CONSTRUCTION							
Air Quality and Noise							
Fugitive dust generation	A	L	PS	S	MI	R	D
Outdoor noise generation	A	L	LAA	S	MI	R	D
GHG Emissions							
Emissions during construction of Anhydrous Ammonia Tank Farm	A	N	RAA	L	MI	IR	D
Soil Quality							
Soil compaction and rutting, admixing and erosion	A	L	PS	M-L	S	IR	D
Infrastructure and Services							
Construction-related traffic	A	N	RAA	S	MI	R	D
OPERATION							
Air Quality and Noise							

PROJECT EFFECTS	RESIDUAL ENVIRONMENTAL EFFECTS CHARACTERIZATION						
	DIRECTION	MAGNITUDE	GEOGRAPHICAL EXTENT	DURATION	FRQUENCY	REVERSIBILITY	Ecological or Socio-Economic context
Fugitive dust generation	A	N	LAA	S	MI	R	D
Outdoor noise generation	A	N	LAA	S	MI	R	D
GHG Emissions							
Increased GHG emissions associated with Anhydrous Ammonia Tank Farm operations	A	N	RAA	L	MI	IR	D
Infrastructure and Services							
Fertilizer and agrichemicals delivery and customer traffic	A	N	RAA	S	MI	R	D

KEY (see Table 7-2 for definitions)

Direction P Positive A Adverse N Neutral **Magnitude** N Negligible L Low M Moderate H High **Geographical Extent** PS Project Site LAA Local Assessment Area RAA Regional Assessment Area	**Duration** S Short-term M Medium-term L Long-term **Frequency** S Single event MI Multiple irregular MR Multiple regular C Continuous	**Reversibility** R Reversible IR Irreversible **Ecological/Socio-Economic Context** U Undisturbed D Disturbed N/A = Not applicable

8.7 ACCIDENTS AND MALFUNCTIONS

The effects of accidents and malfunctions for the proposed Anhydrous Ammonia Tank Farm largely pertain to the potential for mechanical equipment failure and NH_3 release during warehouse handling or customer pick-up, or catastrophic release of ammonia vapours due to transportation accidents or fire-caused tank explosions. Dauphin Co-op will develop and have an on-site emergency response plan and employees will be trained in the daily operations of the Anhydrous Ammonia Tank Farm . The presence of prevention measures and procedures for managing adverse effects associated with accidents and malfunctions will minimize the effects in the event of an emergency. With the implementation of safe work practices, the likelihood of such events occurring is reduced.

8.7.1 FIRES/EXPLOSIONS

During operation of the Anhydrous Ammonia Tank Farm, there will be potential for fires involving mechanical equipment and other combustible materials/substances. Effects due to fires include harm or injury to on-site personnel, damage to equipment, and the potential release of contaminants and hazardous materials.

Dauphin Co-op will take precautions necessary to prevent fire hazards at the Anhydrous Ammonia Tank Farm, including:

- Removal of flammable waste from the Project Site on a regular basis and disposal of such waste at an appropriate disposal site.
- Availability of and easy access to appropriate fire extinguisher(s) at the Anhydrous Ammonia Tank Farm. Such equipment will comply with and be maintained to, the manufacturers' standards.
- Fire prevention/response equipment will be checked on a regular basis, as required, in accordance with local fire safety regulations, to ensure the equipment is in proper working order.
- The emergency response plan will be provided to and reviewed with the municipal fire department to discuss response and containment in the event of a fire impacting the self-contained chemical shed.

With implementation of the above-mentioned mitigation measures and typical safe work practices, the risk of fires and explosions is deemed to be appropriately mitigated.

8.7.2 LEAKS AND SPILLS

Leaks (e.g., vehicle or equipment fuel and oils) and spills could occur during construction and/ or operation. Leak and spill-related effects on air quality, soil quality, birds or other wildlife, and human health and safety are possible.

To reduce the potential for leaks and spills at the Anhydrous Ammonia Tank Farm, the following measures will be implemented:

- During construction activities, refueling of heavy equipment will be conducted off-site or will adhere to proper procedures such as using a designated area defined by Dauphin Co-op with spill kits located at the refueling area.
- Storage (bins and chemical shed) infrastructure will be inspected periodically for continued compliance with requirements.
- On-site staff will be trained on how to deal with leaks and spills, including knowledge of how to properly deploy site spill kit materials.
- Appropriate type and size of spill kits will be available at the Anhydrous Ammonia Tank Farm.
- Service and minor repairs of equipment performed on-site will be performed by trained personnel.
- Vehicles and equipment will be maintained to reduce the potential for leaks. Regular inspections of hydraulic and fuel systems on machinery will be completed on a routine basis, when detected, leaks will be repaired immediately.

Adherence to standard environmental management practices will minimize the risks of accidental leaks and spills and adverse effects. In the event of an accidental spill, Dauphin Co-op will proceed as per the emergency response plan for the Project Site and file a regulatory report with MECC within required timelines. Following a spill, an

appropriate spill kit or other suitable alternative would be utilized to prevent migration of the spilled material. Recovery measures would be implemented as necessary in consultation with the appropriate provincial authorities. Following initial response, a remediation program will be undertaken if needed with contaminated material appropriately managed (in accordance with federal and provincial regulations).

With the implementation of the above mitigation measures as necessary and assuming the implementation of safe work practices, the risk of spills is considered appropriately mitigated.

8.7.3 SUBSTANTIAL AMMONIA VAPOUR RELEASE

During operation of the anhydrous ammonia tank farm, the release of large quantities of ammonia to the environment would likely be associated with major catastrophic events, e.g., widespread system or equipment failure or if tanks exploded due to a fire. To reduce the potential for effects from such catastrophic release of ammonia, the following procedures will be employed:

- Anhydrous ammonia storage infrastructure will be inspected periodically for continued compliance with manufacturer and regulatory requirements.
- On-site staff are trained in how to deal with ammonia vapour release, including knowledge of how to react to fire emergencies at the Site.
- Service and minor repairs of anhydrous ammonia equipment performed on-site will be performed by trained personnel.
- The anhydrous ammonia tanks and accessory equipment will be maintained as per manufacturer requirements. Regular inspections of hydraulic and fuel systems on machinery will be completed on a routine basis, when detected, ammonia vapour releases will be addressed immediately.

As per Section 2.2.6, should a substantive release of anhydrous ammonia occur at the Site, the staff on Site (first respondent) should immediately call the Dauphin Fire Department through calling 911 (staff should not attempt to contain it) and immediately evacuate the Site. Depending on the magnitude of the release, prevailing wind direction, and risk deemed to be presented by the release, there could be need for evacuation of rural residences within a 1.5 km radius of the Site.

With the implementation of the above mitigation measures as necessary, and assuming the implementation of safe work practices, the risk of ammonia vapour releases or escape is considered appropriately mitigated.

8.7.4 FLOODING

Overland flooding is a potential emergency scenario for the Project Site and surrounding areas. The Project is situated on well drained soils therefore the risk of flooding is considered low.

8.7.5 TRANSPPORTATION ACCIDENTS

Transportation accidents can result in the release of vehicle fluids (i.e., diesel, gasoline, oils, etc.) and the materials the vehicles were transporting (i.e., fertilizers, agrichemicals) to the environment. Effects related to such releases can include air, surface water, groundwater, and soil quality effects with potential for subsequent effects on the environment and human health.

The potential for transportation accidents at the Anhydrous Ammonia Tank Farm during construction and operational activities will be reduced by the following measures:

- Traffic at the Project Site (i.e., deliveries and pickups) will operate at a slow speed that will be posted near the entrance and within the Project Site.
- Dauphin Co-op will utilize qualified transportation companies and personnel to transport its retail products.

8.8 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

Potential effects of the environment that can affect the proposed Anhydrous Ammonia Tank Farm include damage from fires originating from adjacent properties and wildfires. Climate change will increase the risk over time of extreme weather events, such as tornados and strong winds, and grass fires.

9 SUMMARY AND CONCLUSION

WSP E&I Canada Ltd. has prepared this Environmental Assessment Report (EA) on behalf of Dauphin Consumers Cooperative (Co-op) as supporting documentation for Dauphin Co-op's EAP for an existing anhydrous ammonia development and the proposed installation and operation of three (3) new anhydrous ammonia tanks. The Development is in the RM of Dauphin approximately 1 km northwest of Dauphin, Manitoba, by Township Road 112 W in an area zoned for industrial use. The proposed development will consist of the construction and operation of an anhydrous ammonia tank farm and an office building, collectively referred to as the Anhydrous Ammonia Tank Farm (the Project).

The Project will rely on water drawn from an on-Site cistern filled on an as needed basis for its water needs. The current septic tank will be replaced with a new tank, which will be cleaned out as needed by a contracted septic tank services provider. Office waste generated at the Project Site will be disposed of at the City of Dauphin's waste disposal ground (WDG).

It is anticipated that there will be a slight increase in the number of vehicles using both Rural Road 147 N and Rural Road 112 W during Project construction. However, the vehicles travelling to and from the Project Site (employees, delivery semi-trucks and consumer vehicles) are not expected to exceed current service capacity levels of either Rural Road 147 N and Rural Road 112 W. It is not anticipated that there will be an increase in noise levels or dust generation from both the construction and operation of the Facility to the surrounding area.

The potential for adverse effects from accidents and malfunctions at the Project Site would primarily be related to accidents or malfunctions (e.g., fires, spills, and transportation accidents). The Project's operational procedures, emergency response plan, mitigation measures, and safe work practices will reduce the potential likelihood/severity of these events. In addition, Dauphin Co-op adheres to the Anhydrous Ammonia Code of Practice for its operations.

Based on the desktop studies undertaken, site observations and information available to date as presented in this report, the construction and operation of the proposed Anhydrous Ammonia Tank Farm is not expected to create significant adverse effects to the biophysical and socio-economic environment and is expected to provide economic benefits to the region.

10 REFERENCES

Anhydrous Ammonia Handling and Transport Regulation, M.R. 236/89;.

Artuso C, A. R. Couturier, K. D. De Smet, R. F. Koes, D. Lepage, J. McCracken, R. D. Mooi, and P. Taylor (editors.). The Atlas of the Breeding Birds of Manitoba, 2010-2014. Bird Studies Canada. Winnipeg, Manitoba < http://www.birdatlas.mb.ca/ e > .

Betcher R., G. Grove, C. Pupp. 1995. Groundwater in Manitoba: Hydrogeology, Quality Concerns, Management. NHRI Contribution No. CS-93017.

Das, S.R. 2011. Estimation of Greenhouse Gases Emissions from Biological Wastewater Treatment Plants at Windsor. Electronic thesis and Dissertations. Paper 77.

Environment Canada. 2018. Canadian Climate Normals 1981-2010 Station Data – Dauphin, Manitoba, Government of Canada Website: http://climate.weather.gc.ca/climate_normals/index_e.html (accessed August 2023).

Environment and Climate Change Canada 2018b. National Inventory Report 1990-2016 - Greenhouse Gas Sources and Sinks in Canada.

Fertilizer Canada. June 2008, revision January 2022. Anhydrous Ammonia Code of Practice.

Fertilizer Canada. January 2022. Anhydrous Ammonia Code of Practice User Guide.

Foster, C. 2008. Rare Plant Surveys and Stewardship Activities by the Manitoba Conservation Data Centre, 2007. MS Report 08-01. Manitoba Conservation Data Centre, Winnipeg, Manitoba. 35 pp.

Government of Canada. 2023. Species at Risk Public Registry - Schedule 1 -List of Wildlife Species at Risk. Available online at: http://www.sararegistry.gc.ca/species/schedules_e.cfm?id=1. (Accessed August 2023)

Manitoba Conservation Data Centre. 2023. Occurrence of Species by Ecoregion – Manitoba Plain. Accessed online at: https://www.gov.mb.ca/nrnd/fish-wildlife/cdc/index.html

Manitoba Environment and Climate. Manitoba Air Quality Data – 2016 Annual Pollutant Summary – Continuous Monitoring. Available online at: https://www.gov.mb.ca/sd/about/articles-and-publications/index.html?wg=air_quality&term=summary.

Manitoba Flood Information. No date. Manitoba Flood Facts. Available online at https://www.gov.mb.ca/flooding/history/index.html (accessed in August 2023).

Manitoba Environment and Climate. 2017. Waste Disposal Grounds Valid Permits as of 04 August 2017. Available online at: https://www.manitoba.ca/sd/envprograms/swm/pdf/facility_permit_listing.pdf (accessed in August 2023).

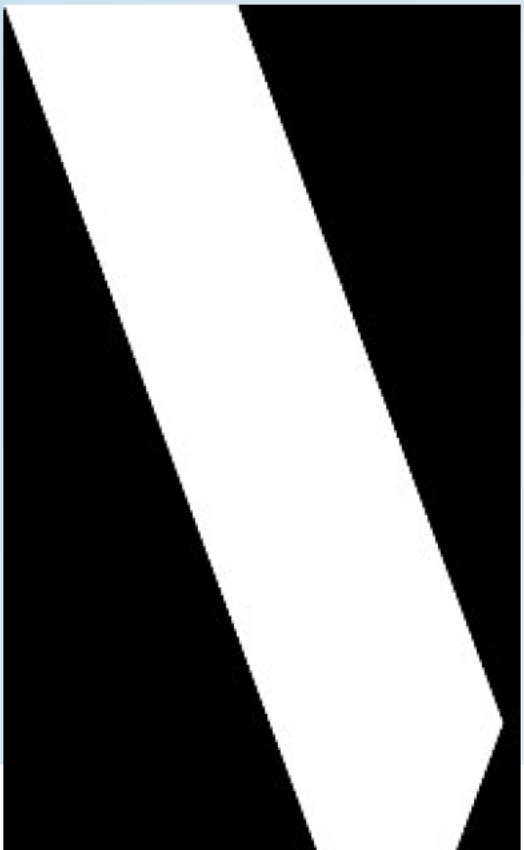
Matile G.L.D., G.R. Keller. 2004. Surficial Geology of the Dauphin Lake map sheet (NTS 621O, Manitoba. Manitoba Industry, Economic Development and Mines, Manitoba Geological Survey. Surficial Geology Compilation Map Series, SG-62O, scale 1:250 000.

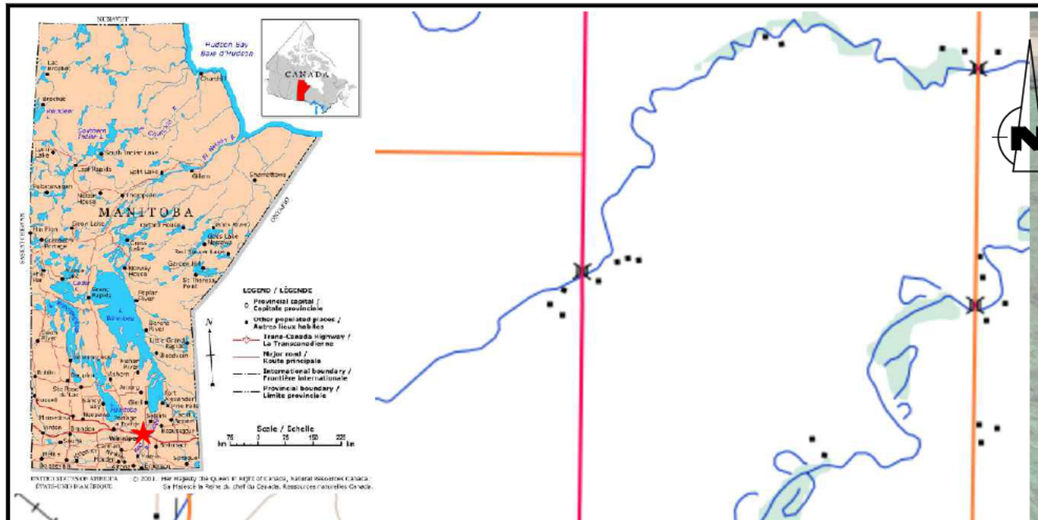
Smith R.E., H. Veldhuis, G.F. Mills, R.G. Eilers, W.R. Fraser, G.W. Lelyk. 1998. Terrestrial Ecozones, Ecoregions and Ecodistricts of Manitoba. An Ecological Stratification of Manitoba's Natural Landscapes. Land Resource Unit. Brandon Research Centre, Research Branch. Agriculture and Agri-Food Canada.

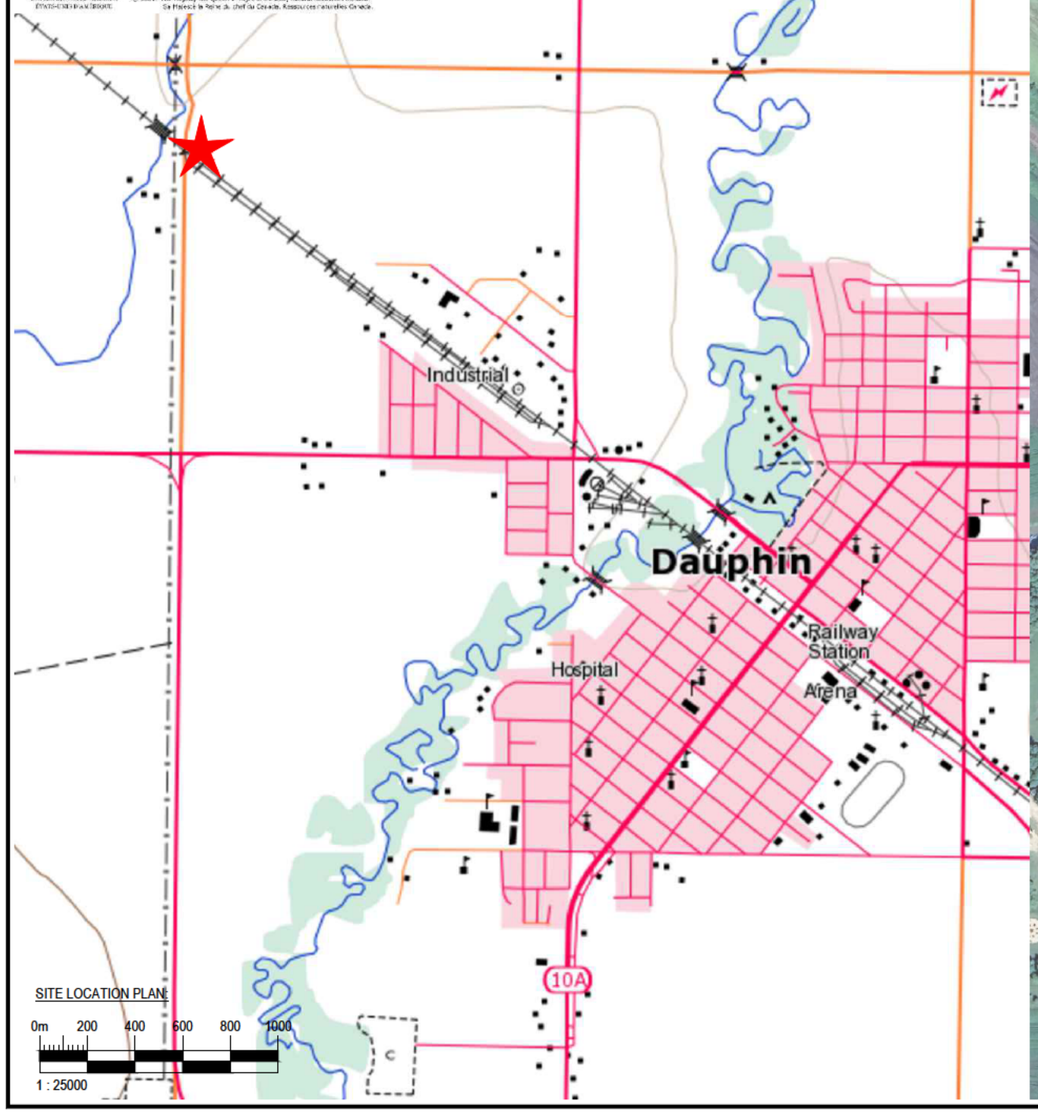
WSP E&I Canada Ltd. October 2023. Geotechnical Investigation Proposed Dauphin Co-op Development, Township Road 112W, RM of Dauphin, Manitoba.

Appendix A

Site Figures and Drawings







wsp
6 HIGH LEVEL ROAD
OAK BLUFF, MANITOBA R4G 0E2
TEL (204) 488-2997

CLIENT:

CO-OP

LEGEND:

SITE LOCATION

APPROXIMATE PROPERTY LINE

NOTE:
- SITE FEATURE LOCATIONS ARE APPROXIMATE.
- IMAGE FROM 2022 GOOGLE EARTH PRO.

ENVIRONMENT ACT PROPOSAL

146131 112 W
RURAL MUNICIPALITY OF DAUPHIN, MANITOBA

SITE AND SURROUNDING LAND USE PLAN

SCALE:	AS SHOWN
DATE:	SEPTEMBER 2023
DRAWN BY:	MD
PROJECT NO:	WX19850

FIGURE 1

P:\Jobs\19800's\19850's\19850 - Dauphin Coop PHI, EAP Submittals\Drawings\WX19850_EAP_2023.dwg - 1 - Oct. 24, 2023 8:21am - wds_matthews.dolores

wsp
6 HIGH LEVEL ROAD
OAK BLUFF, MANITOBA R4G 0E2
TEL (204) 488-2997

CLIENT:

CO-OP

LEGEND:

APPROXIMATE PROPERTY LINE

NOTE:
- SITE FEATURE LOCATIONS ARE APPROXIMATE.
- IMAGE FROM 2022 GOOGLE EARTH PRO.

ENVIRONMENT ACT PROPOSAL

146131 112 W
RURAL MUNICIPALITY OF DAUPHIN, MANITOBA

SITE PLAN

SCALE:	AS SHOWN
DATE:	SEPTEMBER 2023
DRAWN BY:	MD
PROJECT NO:	WX19850

FIGURE 2

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6 HIGH LEVEL ROAD
OAK BLUFF, MANITOBA R4G 0E2
TEL (204) 488-2997

CLIENT:

LEGEND:

APPROXIMATE PROPERTY LINE

NOTE:
- SITE FEATURE LOCATIONS ARE APPROXIMATE.
- IMAGE FROM 2022 GOOGLE EARTH PRO.

ENVIRONMENT ACT PROPOSAL

146131 112 W
RURAL MUNICIPALITY OF DAUPHIN, MANITOBA

SITE PLAN - PROPOSED EXPANSION

SCALE:	AS SHOWN
DATE:	SEPTEMBER 2023
DRAWN BY:	MD
PROJECT NO:	WX19850

FIGURE 3

P:\Jobs\19800's\19850's\19850 - Dauphin Coop PHI, EAP Submittals\Drawings\WX19850_EAP_2023.dwg - 3 - Oct. 24, 2023 8:21am - wds_matthews.dolores

6 HIGH LEVEL ROAD
OAK BLUFF, MANITOBA R4G 0E2
TEL (204) 488-2997

CLIENT:

CO-OP

LEGEND:

APPROXIMATE PROPERTY LINE

100m BUFFER

NOTE:
- SITE FEATURE LOCATIONS ARE APPROXIMATE.
- IMAGE FROM 2022 GOOGLE EARTH PRO.

ENVIRONMENT ACT PROPOSAL

146131 112 W
RURAL MUNICIPALITY OF DAUPHIN, MANITOBA

SET BACK DISTANCE

SCALE:	AS SHOWN
DATE:	SEPTEMBER 2023
DRAWN BY:	MD
PROJECT NO:	WX19850

FIGURE 4

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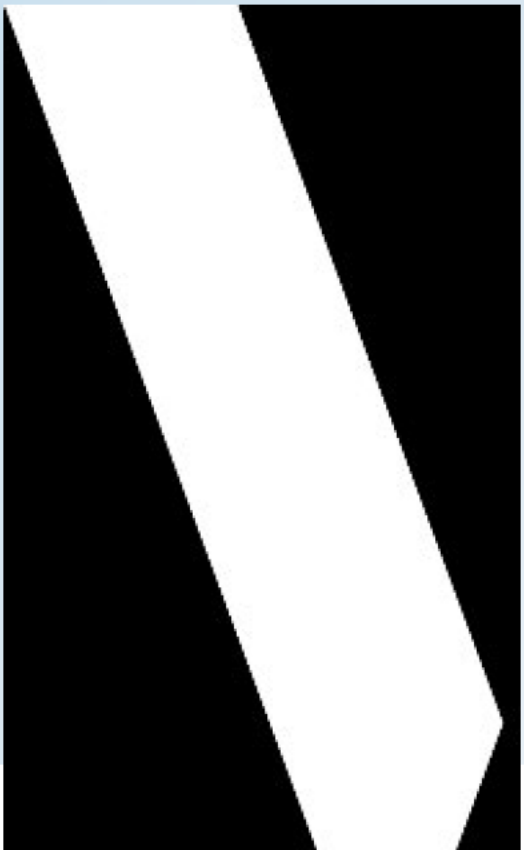
Appendix B

Certificate of Title



STATUS OF TITLE

Title Number **1753445/6**
Title Status **Accepted**
Client File

Manitoba Land Titles Registry

1. REGISTERED OWNERS, TENANCY AND LAND DESCRIPTION

DAUPHIN CONSUMERS CO-OPERATIVE LTD.

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

LOT 1 PLAN 38887 DLTO
SUBJECT TO THE RESERVATIONS AND PROVISOES
CONTAINED IN THE GRANT FROM THE CROWN
IN NW 1/4 16-25-19 WPM.

The land in this title is, unless the contrary is expressly declared, deemed to be subject to the reservations and restrictions set out in section 58 of *The Real Property Act.*

2. ACTIVE INSTRUMENTS

Instrument Type:	**Caveat**
Registration Number:	**92-6545/6**
Instrument Status:	**Accepted**
Registration Date:	1992-11-16
From/By:	MANITOBA TELEPHONE SYSTEM
To:	
Amount:	
Notes:	No notes
Description:	No description

Instrument Type:	**Caveat**
Registration Number:	**1008345/6**
Instrument Status:	**Accepted**
Registration Date:	1999-11-26
From/By:	MTS COMMUNICATIONS INC.
To:	DAUPHIN CONSUMERS CO-OPERATIVE LTD.
Amount:	$15.00
Notes:	No notes
Description:	ROW AGREEMENT ATTACHED

3. ADDRESSES FOR SERVICE

DAUPHIN CONSUMERS CO-OP. LTD.
18-3RD AVENUE N.E.
DAUPHIN MB
R7N 0Y6

4. TITLE NOTES

No title notes

5. LAND TITLES DISTRICT

Dauphin

6. DUPLICATE TITLE INFORMATION

Duplicate Produced for: HAWKINS & SANDERSON
20 - 2ND AVENUE N.W.
DAUPHIN MB
R7N 1H2

7. FROM TITLE NUMBERS

1753441/6 Part

8. REAL PROPERTY APPLICATION / CROWN GRANT NUMBERS

No real property application or grant information

9. ORIGINATING INSTRUMENTS

Instrument Type:	**Transfer Of Land**
Registration Number:	**1015012/6**
Registration Date:	2000-10-13
From/By:	DOREEN MARGUERITE LAMPARD
To:	DAUPHIN CONSUMERS CO-OPERATIVE LTD.
Consideration:	$1.00

10. LAND INDEX

Lot 1 Plan 38887
NW 1/4 16-25-19W EXC RES

CERTIFIED TRUE EXTRACT PRODUCED FROM THE LAND TITLES DATA STORAGE SYSTEM OF TITLE NUMBER 1753445/6

Appendix C

Site Photos

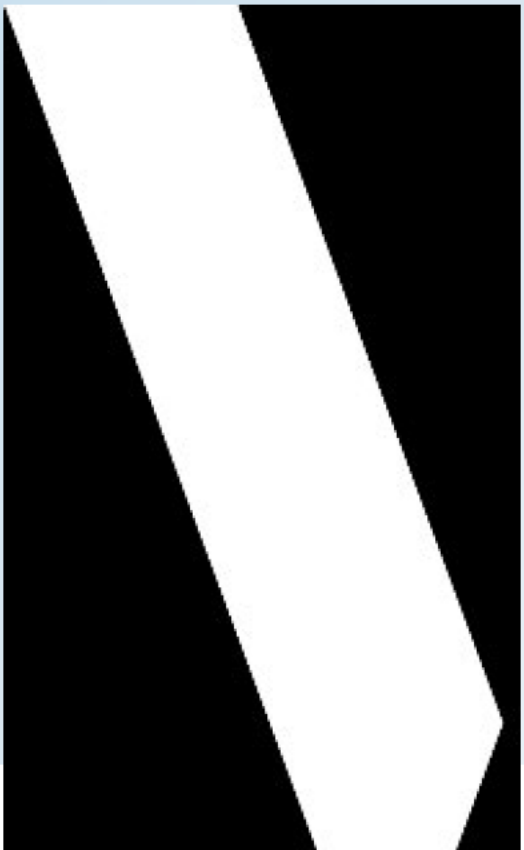


Photo 1 – Showing exterior of Site building, facing east.

Photo 2 – Showing exterior of Site building, facing west.

wsp	**ENVIRONMENT ACT PROPOSAL** **FSN 2129 DAUPHIN AG FACILITY** **146131 112W** **RURAL MUNICIPALITY OF DAUPHIN, MANITOBA**
DATE TAKEN: 11 July 2023	PROJECT NO.: WX19850 PLATE 1

Photo 3 – Interior of Site Building, garage portion.

Photo 4 – Interior building materials observed within Site Building, office area.

wsp	**ENVIRONMENT ACT PROPOSAL** **FSN 2129 DAUPHIN AG FACILITY** **146131 112W** **RURAL MUNICIPALITY OF DAUPHIN, MANITOBA**
DATE TAKEN: 11 July 2023	PROJECT NO.: WX19850 PLATE 2

Photo 5 – Water tank, located in the northwest corner of the Site building.

Photo 6 – Septic tank, located along the west side of the Site building.

wsp	**ENVIRONMENT ACT PROPOSAL** **FSN 2129 DAUPHIN AG FACILITY** **146131 112W** **RURAL MUNICIPALITY OF DAUPHIN, MANITOBA**
DATE TAKEN: 11 July 2023	PROJECT NO.: WX19850 PLATE 3

Photo 7 – Near the northeast corner of the Facility, facing south. Nurse tank storage.

Photo 8 - 60 metric tonne tank containing anhydrous ammonia.

wsp	**ENVIRONMENT ACT PROPOSAL** **FSN 2129 DAUPHIN AG FACILITY** **146131 112W** **RURAL MUNICIPALITY OF DAUPHIN, MANITOBA**
DATE TAKEN: 11 July 2023	PROJECT NO.: WX19850 PLATE 4

Photo 9 – Infrastructure associated with 60 metric tonne tank.

Photo 109 – Miscellaneous storage on north side of Site building. Totes were empty.

wsp	**ENVIRONMENT ACT PROPOSAL** **FSN 2129 DAUPHIN AG FACILITY** **146131 112W** **RURAL MUNICIPALITY OF DAUPHIN, MANITOBA**
DATE TAKEN: 11 July 2023	PROJECT NO.: WX19850 PLATE 5

Photo 11 – Near the northeast corner of Site, east of fenced facility, facing south.

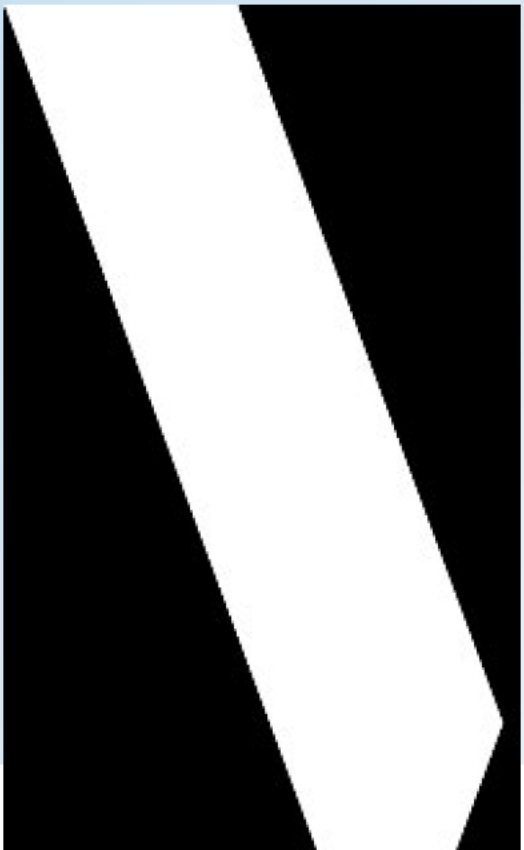
Photo 12 – Near center of northern boundary, north of fenced facility, facing north. Area of distressed vegetation.

wsp	**ENVIRONMENT ACT PROPOSAL** **FSN 2129 DAUPHIN AG FACILITY** **146131 112W** **RURAL MUNICIPALITY OF DAUPHIN, MANITOBA**
DATE TAKEN: 11 July 2023	PROJECT NO.: WX19850 PLATE 6

Appendix D

Client Provided Documents

-Emergency Response Plan
-Fertilizer Canada Certificate of Compliance



Federated Co-operatives Limited

AGRICHEMICAL/FERTILIZER AND CEPA REGULATION 200, 1999

ERAP# 2-1480

July 11, 2022

This Local Ag-Site Emergency Plan has been designed for use with Anhydrous Ammonia, Dry Fertilizer, Liquid Fertilizer and Agri-Chemical Storage Operations. Proper completion of this plan should satisfy compliance with Regulation 200 of the Environment Canada Emergency Legislation for Anhydrous Ammonia Storage.

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FERTILIZER CANADA

FERTILISANTS CANADA

Certificate of Compliance

In accordance with the terms of your application, this certificate confirms that

Dauphin Coop

for its facility located at **NW-16-25-19-W1 Dauphin MB R7N 0Y6**

has met, at the date of this certificate, the requirements of Fertilizer Canada's Anhydrous Ammonia Code of Practice based on the results of an independant audit conducted in respect to the above facility.

December 28th 2022

Audit Date

President & CEO, Fertilizer Canada

December 31st 2024

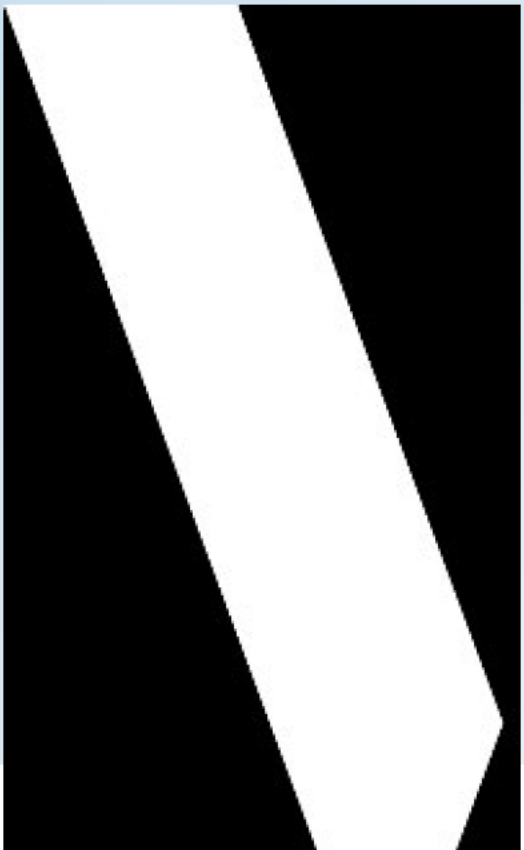
Expiry Date

Audited By: Agrichemical Warehousing Standards Association

No. 9433750

Appendix E

WSP Site Geotechnical Investigation Report



NO. WX19864
20 OCTOBER 2023

FINAL GEOTECHNICAL REPORT

PROPOSED CO-OP DEVELOPMENT
TOWNSHIP ROAD 112W, RM OF DAUPHIN, MANITOBA

REPORT INFORMATION:			
Report Name:	Final Geotechnical Report Proposed Co-op Development Township Road 112W, RM of Dauphin, Manitoba WSP Project Number – WX19864		
Prepared for:	Dauphin Consumers Co-operative 18-3rd Ave. N. E. - Dauphin, MB, R7N 0Y6		
Contact:	Lorne Eiffert General Manager, Dauphin Consumers Co-operative		
REPORT DISTRIBUTION:			
Federated Co-operatives Limited:	Lorne Eiffert		
Third Party:			
Report Classification:	Confidential		
	Name	Job Title	Signature
Prepared by:	Isaac Dennett, P. Eng.	Geotechnical Engineer	[redacted]
Reviewed by:	Brad Wiebe, M. Sc., P. Eng.	Sr. Principal Geotechnical Engineer	[redacted]
Project Manager:	Jason Plohman, P. Eng.	Geotechnical Engineer	
Other Technical Contributors	Christa Deblaere, CET	Senior Environmental Professional	[redacted]

Rev.	Date	Revision Notes
2	20 Oct 2023	Lateral resistance recommendations and additional subgrade preparation
1	13 Oct 2023	Final Geotechnical Report
0	05 Sept 2023	Preliminary Geotechnical Report

Permit Stamp	Engineer Seal
[redacted]	[redacted]

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Third Party Disclaimer

20 October 2023

Confidential

Dauphin Consumers Co-operative
18-3rd Ave. N. E. - Dauphin, MB, R7N 0Y6

Attention: Lorne Eiffert
Subject: Proposed Dauphin Co-op Development, Township Road 112W, Dauphin, MB

WSP is pleased to submit this revised geotechnical report for the proposed new Co-op Development on Township Road 112W in the RM of Dauphin, Manitoba. If you have any questions, please contact the undersigned directly at 204-226-4528 (c).

Yours sincerely,

[redacted]

Isaac Dennett
Geotechnical Engineer
Winnipeg Geotechnical Group

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LIST OF APPENDICES

1 INTRODUCTION

As authorized by Lorne Eiffert of Dauphin Consumers Co-operative Ltd. (Co-op), WSP E&I Canada Limited (WSP) conducted a geotechnical investigation for the proposed new Co-op Development to be located on Township Road 112W in the RM of Dauphin, Manitoba.

The scope of work for the geotechnical investigation was defined in WSP's proposal WPG2023.293, dated 22 June 2023. The purpose of the investigation was to determine the subsurface soil and groundwater conditions at the Site to provide geotechnical engineering recommendations for the design and construction of the proposed development. Additionally, a limited environmental screening program was conducted to assess potential petroleum hydrocarbon (PHC) and fertilizer (nitrates) impacts associated with the Site and provide environmental recommendations for soil disposal and handling.

A preliminary report titled “Preliminary Geotechnical Report Proposed Co-Op Development Township Road 112w, Rm of Dauphin, Manitoba” was submitted to Co-op by WSP on 5 September 2023 based on an initial geotechnical investigation conducted by on 10 and 11 August 2023. This investigation did not cover the entirety of the project site; therefore, WSP returned to site on 26 and 27 September to advance additional test holes within the footprint of the proposed development to confirm the geotechnical recommendations provided in the above-mentioned preliminary report. Subsequently, the recommendations provided in this report constitutes WSP’s final geotechnical investigation report for the proposed new Co-op Development to be located on Township Road 112W in the RM of Dauphin, Manitoba. This report revision also includes recommendations for laterally loaded piles and provides additional subgrade preparation recommendations.

2 PROJECT DESCRIPTION

2.1 SITE DESCRIPTION

The site is within the existing Co-op Dauphin Agro Ammonia site in the RM of Dauphin located on a parcel of land approximately 1 km northwest of Dauphin, Manitoba, east of Township Road 112W, to the north of Manitoba Provincial Trunk Highway 5, adjacent to the CN rail line. The site location is presented on Figure 1.

At the time of the investigation, the area of the proposed development consisted of the existing Co-op Dauphin Agro Ammonia site, undeveloped grasslands to the east, and agricultural fields to the north. Ground surface cover generally consisted of gravel within the existing facility, grass cover to the east and grass with areas of exposed soil to the north. The site was relatively flat lying with topographic relief visually estimated as less than 0.5 m. A portion of the site extended to the north, outside of the facility’s existing perimeter fence. Adjacent land use consisted of agricultural fields to the east and north, the CN rail line to the south, and Township Road 112W and the Salt Creek to the west.

2.2 PROJECT DESCRIPTION

Based on the information provided by Co-op, WSP understands the proposed development consists of:

- A new, single story shop building with no basement and a plan area of 745 m^2.
- A tank farm with four 90,000 USG aboveground NH_3 tanks.
- Expanded gravel yard and storage area.

Foundation loads were not provided to WSP at the time of this report.

3 GEOTECHNICAL INVESTIGATION

WSP conducted two separate geotechnical investigations in order to cover the scope of this project. The first was conducted on 10 and 11 August 2023, and the second was conducted on 26 and 27 September. Prior to initiating drilling, WSP contacted clickbeforeyoudig to notify the various public utility providers (i.e. Manitoba Hydro) of the intent to drill in order to clear public utilities. WSP also notified the RM of Dauphin of the intent to drill, and retained Structure Scan Inc., a private locator, to scan the work area for electronically detectable privately owned underground utilities, such as private gas and electric lines. All field activities were conducted without contact with underground utilities.

During the investigations mentioned above, WSP supervised the drilling of 18 test holes, TH23-01 to TH23-18, at the locations illustrated in Figure 1. Test holes TH23-01 to TH23-05, TH23-13 and TH23-14 were advanced to auger refusal, which occurred at depths between 3.2 m and 9.3 m below grade. TH23-06 to TH23-12 and TH23-15 to TH23-18 were advanced to a termination depth of 3.0 m except for TH23-07, and TH23-11 which encountered auger refusal at 2.8 m and 0.6 m respectively. A companion test hole was advanced at TH23-02 to obtain a soil sample from the upper clay, and at TH23-11, TH23-13 and TH23-14 to confirm the depth of refusal. Slotted standpipe piezometers were installed in TH23-02 and TH23-04 to measure long-term groundwater levels. The test holes were laid out using a survey grade GPS. The test hole depths are summarized in Table 4-2.

The test holes were drilled using a truck mounted Mobile B40 drill rig equipped with 125 mm solid stem augers, operated by Maple Leaf Drilling Ltd. of Winnipeg, Manitoba. During drilling, WSP field personnel visually classified the soil stratigraphy within the test holes in accordance with the Modified Unified Soil Classification System (MUSCS); and recorded observed seepage and sloughing conditions. Soil sampling consisted of disturbed grab samples off the auger cuttings, an undisturbed Shelby Tube sample of the overburden clay at test hole TH23-02, and split spoon samples of the silt till obtained in combination with Standard Penetration Tests (SPTs) at select locations.

Environmental screening for petroleum hydrocarbon vapour was conducted on all grab samples taken at or above 6.1 m in TH23-01 to TH23-12. Environmental screening for nitrates was conducted on the first four grab samples from each test hole. Pocket penetrometer tests were conducted on all cohesive samples. The pocket penetrometer readings are shown on the test hole logs in terms of compressive strength. All samples were retained in sealed plastic bags or Shelby Tubes and brought to WSP's Oak Bluff laboratory for review and selected testing.

The in-situ relative consistency of cohesive soil was evaluated during drilling using a pocket penetrometer. Standard Penetration Tests (SPT's) were conducted to characterize the density of clay till deposits. For each SPT, a

standard 63.5 kg hammer was repeatedly dropped 760 mm to drive a standard 50.8 mm diameter thick-walled sampling tube through the soil over up to three consecutive depth intervals of 150 mm each. The number of drops, or blows, required for the hammer to drive the sampler through each 150 mm interval was recorded. The recorded SPT results are shown on the test hole logs as the SPT 'N' value, which represents the number of blows to drive the sampler through the final two 150-mm intervals or partial increments in cases where 50 blows produced less than 150 mm penetration.

Upon completion of drilling at each test hole, the depths to accumulated slough and groundwater were measured prior to backfilling. The test holes were then backfilled to grade with bentonite and auger cuttings. In test holes TH23-02 and TH23-04 where standpipes were installed, backfilling around the installed standpipes consisted of soil cuttings, sand, and bentonite. Excess soil cuttings were spread out to non-intrusive areas on the site.

Following completion of the field drilling program, a laboratory testing program was conducted on selected soil samples obtained from the test holes. The laboratory testing program consisted of moisture content determinations, Atterberg limit testing combined with hydrometer grain size analyses, Unconfined Compressive Strength test, soluble sulphate tests and soil corrosivity tests.

Detailed test hole logs summarizing the sampling, field testing, laboratory test results, and subsurface conditions encountered at the test hole locations are presented in Appendix A. Summaries of the terms and symbols used on the test hole logs and of the Modified Unified Soil Classification System are also presented in Appendix A.

4 SUBSURFACE CONDITIONS

4.1 STRATIGRAPHY

Consistent with regional soil deposits, the stratigraphy observed at the test holes consisted of the following, noted in descending order from grade level:

— Gravel Fill
— Organic Clay
— Clay
— Silt
— Glacial Till

A brief description of each of the soil layers listed above is presented in the following sub-sections. For detailed descriptions, the test hole logs in Appendix A should be consulted.

4.1.1 GRAVEL FILL

Gravel fill was present at the ground surface of test holes TH23-01, 04, 05, 06, 11, and 12. The thickness of the gravel ranged between 300 and 600 mm below grade. The gravel fill was generally described as poorly graded, silty, moist, and tan-brown. The moisture contents of the gravel fill ranged from 7% to 22%. In TH23-11, gravel fill was encountered to the depth of auger refusal at 600 mm below existing grade. WSP attempted additional companion holes adjacent to the test hole location but could not advance past a depth of 600 mm.

4.1.2 ORGANIC CLAY

Organic clay was present at the ground surface in TH23-02, TH23-03, and from TH23-13 to TH23-18. The thickness of the organic clay ranged between 150 mm and 600 mm below grade. The organic clay was classified as silty, high plastic, moist, firm to stiff, dark grey, and contained occasional to abundant rootlets. The moisture contents in the organic clay ranged from 33% to 49% respectively.

4.1.3 CLAY

Clay was encountered at the ground surface in TH23-07, 08, and 10, below the gravel fill layer in TH23-04 and 05, and below the organic clay in TH23-02, TH23-03, and from TH23-13 to TH23-18. The clay layer extended to depths of 0.6 m to 1.4 m below grade. The clay was generally described as silty, moist, medium to high plastic, firm, grey, and contained occasional to frequent silt till inclusions. Moisture contents in the clay ranged from 36 to 51%.

4.1.4 SILT

Silt was present below the clay at TH23-05, 16, 17, and beneath the gravel fill at TH23-06 and TH23-12. The silt extended to depths ranging from 0.6 to 2.2 m below grade. In TH23-05, 06, and 12, the silt was clayey, low to medium plastic, moist, firm to stiff, and tan-brown. In TH23, 16, and 17, the silt was low plastic, very moist to wet, soft, and dark grey. Moisture contents in the silt ranged from 8 to 28%.

4.1.5 GLACIAL TILL

Sand till was present in TH23-01 below the silt layer and in TH23-14 below the clay till. The sand till layer extended to a depth of 2.9 m below grade in TH23-01, and to auger refusal at 9.3 m in TH23-14. The sand till in TH23-01 was described as silty, with traces of gravel, poorly graded, fine grained, wet, inferred to be compact and brown. The sand till in TH23-14 was described as silty, with traces of gravel, poorly graded, fine to medium grained, very moist, dense and grey. The moisture content of the sand till ranged from 19% to 25%. SPT ‘N’ values in the sand till ranged from 47 to greater than 50.

Clay till was encountered below the gravel fill at TH23-01, below the clay at TH23-08 and TH23-18, at ground surface at TH23-09, below the silt till at TH23-13, 14, and 17, and below the sand at TH23-15. The clay till was generally described as silty, trace to some sand, trace gravel, loose to compact, and brown to brownish grey. Moisture contents of the clay till ranged from 10 to 40%. SPT ‘N’ values in the clay till ranged from 7 to greater than 50. Additional laboratory testing conducted on the clay till consisted of Atterberg limits and grain size analysis at TH23-01. Results of the testing are shown on the test hole logs and are summarized in Table 4-1 below.

Table 4-1: Summary of Laboratory Testing

Test Hole Id	Depth (m)	Atterberg Limit Results			Grain Size Analysis Results			
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% Gravel	% Sand	% Silt	% Clay
TH23-01	0.6	88	30	58	2.2	11.4	30.9	55.5

Below the clay at TH23-13 and below the silt layer at TH23-14, silt till was present and extended to depths of 3.1 m and 3.8 m below grade. Silt till was also present below the clay till at TH23-09 and extended to the termination depth at 3.0 m below grade. The silt till was generally described as clayey, with traces of sand, low plastic, compact, and brown to brownish grey. Moisture contents of the silt till ranged from 15 to 25%. SPT 'N' values in the silt till ranged from 8 to greater than 50.

4.2 Test Hole Termination

Test holes TH23-01 to TH23-05, TH23-07, TH23-11, TH23-13 and TH23-14 were advanced to auger refusal depths of at 4.3 m, 3.2 m, 7.1 m, 3.0 m, 4.6 m, 2.8 m, 0.6 m, 4.7 m, 5.2 m below grade, respectively. Based on the behaviour of the drill at the auger refusal depth, it is suspected that boulders or bedrock caused auger refusal. Coring to confirm the refusal condition (i.e. refusal in very dense till, on cobbles or boulders, or bedrock) was beyond the scope of work for this investigation. TH23-06, TH23-08 to TH23-10, TH23-12, TH23-17 and TH23-18 were terminated at 3.0 m below existing grade. TH23-15 and TH23-16 were terminated at 3.5 m below existing grade.

4.3 SHORT-TERM GROUNDWATER AND SLOUGHING CONDITIONS

Seepage and sloughing conditions were noted during drilling, and the depths to the accumulated slough and water levels after completion of each test hole were measured prior to backfilling. Recorded observations are summarized in Table 4-2.

Table 4-2: Summary of Sloughing and Groundwater Observations

Test Hole ID	Drill Depth (m)	During Drilling		Upon Completion	
		Sloughing Zone	Seepage Zone	Depth Open (m)	Depth to Groundwater (m)
TH23-01	*4.3	Below 1.5 m	Below 1.5 m	2.0	2.0

Test Hole ID	Drill Depth (m)	During Drilling		Upon Completion	
		Sloughing Zone	Seepage Zone	Depth Open (m)	Depth to Groundwater (m)
TH23-02	*3.2	Below 2.4 m	Below 2.4 m	2.4	2.0
TH23-03	*7.1	Below 2.4 m	Below 0.3 m	2.4	1.2
TH23-04	*3.2	Below 1.8 m	Below 2.1 m	1.8	1.8
TH23-05	*4.6	None Observed	Below 2.2 m	4.6	4.0
TH23-06	3.0	Below 1.7 m	Below 0.3 m	1.7	1.5
TH23-07	*2.8	Below 1.5 m	Below 1.2 m	1.8	1.5
TH23-08	3.0	Below 1.4 m	Below 1.2 m	1.4	0.5
TH23-09	3.0	None Observed	Below 1.2 m	3.0	2.7
TH23-10	3.0	Below 2.1 m	Below 0.6 m	2.1	1.8
TH23-11	*0.6	None Observed	None Observed	0.6	None Observed
TH23-12	3.0	Below 2.3 m	Below 2.1 m	2.3	2.1
TH23-13A	*4.7	Below 1.8m	Below 1.8m	1.8	1.2
TH23-13B (Companion hole)	*5.2	None Observed	Below 1.8m	5.2	5.0
TH23-14A	*2.7	None Observed	None Observed	3.7	None Observed
TH23-14B (Companion hole)	9.3	Below 2.9m	Below 1.2m	2.9	None Observed
TH23-15	3.5	Below 1.2m	Below 1.2m	2.3	2.2
TH23-16	3.5	Below 1.2m	Below 1.2m	2.4	2.3

Test Hole ID	Drill Depth (m)	During Drilling		Upon Completion	
		Sloughing Zone	Seepage Zone	Depth Open (m)	Depth to Groundwater (m)
TH23-17	3.0	Below 1.4m	Below 1.4m	1.4	None Observed
TH23-18	3.0	Below 1.5m	None Observed	1.5	None Observed

*Test hole terminated by auger refusal.

It should be noted that Table 4-2 only presents the short-term seepage and sloughing conditions that were observed during drilling and that groundwater levels can fluctuate annually, seasonally, or as a result of construction activity.

4.4 LONGER-TERM GROUNDWATER CONDITIONS

During the drilling program WSP installed a total of two standpipes at TH23-02 and TH23-04 to monitor longer-term groundwater levels. WSP returned to site on 25 August and 26 September 2023 to monitor the standpipes; the recorded groundwater levels are presented below in Table 4-3.

Table 4-3: Longer-Term Groundwater Levels

Test Hole Id	Depth to Groundwater (m)	
	25 August 2023	26 September 2023
TH23-02	1.6	1.3
TH23-04	2.9	2.3

5 FOUNDATIONS

5.1 GENERAL DISCUSSION

WSP understands that new foundations will be required for the proposed shop and tank farm. Deep test holes in the vicinity of the proposed shop and tank farm include TH23-03, TH23-13, and TH23-14. Based on the soil and groundwater conditions encountered, challenging construction conditions are anticipated for both deep and

shallow foundations. Foundation systems considered suitable include shallow footings and cast-in-place concrete piles.

Excavations for shallow footings bearing on compact silt or clay till at depths of around 2 to 3 m below grade are expected to encounter groundwater seepage as noted in Section 4.3 and Section 7. In this regard, dewatering using sumps and pumps, flatter slopes, and mud slabs may be required to maintain the stability of the excavation slopes and to maintain the bearing surface in an undisturbed condition.

In comparison to piled foundations, shallow foundations are generally at an increased risk of foundation movement associated with non-uniform subgrade support and seasonal impacts (ie wetting, drying, freeze thaw) of the shallow foundation soils. The impact of non-uniform bearing resistance on foundations may be mitigated with diligent bearing surface preparation, while the effect of seasonal conditions (ie precipitation, freeze thaw, etc) can be mitigated with site grading per the recommendations in Section 11 and optional insulation around the perimeter of the structure to reduce frost penetration beneath the footings.

Cast-in-place concrete piles are also considered suitable, however challenging drilling conditions will likely be encountered due to cobbles and boulders in the till and seepage and sloughing in the pile bore. The piling contractor should be equipped to install tight-fitting temporary steel casing to maintain sidewall stability and control seepage. In addition, the contractor should be equipped for the potential removal of water from the base of the pile bores and cobbles and boulders at variable depths within the pile bore.

WSP does not recommend the use of driven piles (steel or concrete) or helical piles at this site. Belled piles are also not recommended because seepage and sloughing may cause caving at the top of the bells. Belled piles will also likely encounter difficult belling conditions due to cobbles and boulders anticipated below a depth of around 3 m below grade.

5.2 CAST-IN-PLACE CONCRETE (CIPC) PILES

Straight shaft Cast-in-Place Concrete (CIPC) piles deriving their resistance from either friction and/or end bearing in the clay and silt till are considered a suitable pile foundation system; however, the potential to encounter seepage, sloughing, cobbles and boulders impacting sidewall stability and inhibiting drilling to the design pile embedment depth should be anticipated. The risk of encountering seepage, cobbles and boulders increases with the depth of penetration into the till, and the piling contractor should be equipped with means and methods to maintain sidewall stability and control seepage, and to remove seepage and obstructions.

5.2.1 GEOTECHNICAL AXIAL COMPRESSIVE RESISTANCE (ULS)

For straight shaft CIPC piles deriving their resistance primarily in shaft friction with mobilized end bearing, the geotechnical axial compressive resistance at the Ultimate Limit State (ULS) and Serviceability Limit State (SLS) conditions can be determined using the respective unit shaft friction and unit end bearing pressures presented in Table 6-1. The end bearing pressures have been provided based on a minimum embedment depth of 4 times the diameter of the pile toe below final grade. The inclusion of end bearing resistance in calculating the ULS & SLS resistance of a pile is contingent on providing a pile base cleaned of all loosened materials and seepage accumulations. Should loosened soil remain on the base of the pile after repeated attempts of mechanical

cleaning, then end bearing may need to be neglected and the pile extended at the time of construction, or shaft diameter increased, to carry the required design load in friction.

Table 6-1: Axial Compressive Resistance for Cast-in-Place Concrete Piles

Depth (m)	Assumed Soil Type	Ultimate Limit State (ULS)		Serviceability Limit State (SLS)[2]	
		Ultimate Unit Shaft Friction (kPa)	Mobilized End Bearing[3] (kPa)	SLS Unit Shaft Friction (kPa)	SLS Unit End Bearing[3] (kPa)
Above X[1]	All Soil Types	0	0	0	0
X[1] to 4.0	Loose to Compact Till	40	0	16	0
4.0 to 9.0	Compact to Dense Till	50	240	20	96

1. X = the deeper of 1.5 m below slab/grade in heated areas; or the depth of frost penetration of 2.4 m in unheated areas including perimeter piles, to account for possible movement of the soil away from the perimeter of the pile.
2. Assumes serviceability defined by a pile toe settlement of 0.4% or less of the diameter of the pile toe.
3. Use of end-bearing in calculating the ULS & SLS resistance of a pile is contingent on providing a pile base cleaned of all loosened materials and seepage accumulations. Assumes mobilized end bearing in the till from 4 to 9 m below existing grades.

Based on the National Building Code of Canada (NBCC), a geotechnical resistance Factor, Φ = 0.4, should be applied to the ultimate geotechnical compressive resistance of the pile to obtain the factored geotechnical resistance at the Ultimate Limit State (ULS) for compressive loading conditions. The following recommendations also apply to the design of bored CIPC piles.

- The weight of the embedded portion of the pile may be neglected in the design.
- To the extent practical, the depth of embedment into the till should be limited to that required for minimum embedment and protection from frost in order to reduce the risk of construction issues related to boulders, sloughing and groundwater conditions.
- The bases of the piles should be thoroughly cleaned of all loosened materials and seepage accumulations, if encountered. The methods of cleaning the pile bases, proposed by the selected piling contractor should be approved by a qualified geotechnical engineer. Should loosened soil and/or ponded water remain on the pile base after repeated attempts of mechanical cleaning with drilling tools, hand cleaning may be required.
- The pile embedment depth, pile diameter, steel reinforcement and concrete compressive strength should be determined by the structural engineer, as required, to provide sufficient resistance to the applied loads.
- Piles exposed to potential freezing ground conditions, including internal building piles that will be exposed to freezing ground conditions during construction prior to significant pile loading, should be designed for the frost design considerations are outlined in Section 6.
- While minimum shaft diameters of 400 mm may be considered, due to difficulties with cleaning of the pile base and with inspection of small diameter piles, and in the case where personnel will need to enter the pile, such as for hand cleaning, end bearing may only be considered for pile shafts 760 mm in diameter or larger.
- For conventionally bored straight shaft piles, the minimum pile spacing should be at least 2.5 pile diameters, center-to-center.
- Piles within small groups of two or three piles can be considered to act individually as single piles in vertical compression, provided that minimum pile spacing is followed. For closer spacing or for greater numbers of piles in a group, a group reduction factor may be required, and this office should be contacted to review the proposed layout.

— A void space (minimum of 150 mm thick) should be constructed, using a compressible and biodegradable material, below all piles caps and to accommodate movements of the underlying soil.

5.2.2 SERVICEABILITY AND SINGLE PILE SETTLEMENT

The settlement of a single pile depends on the applied load, strength-deformation properties of the foundation soils, load transfer mechanism, and load distribution over the pile embedment depth. A pile settlement limit value was not specified by the structural agent for use in developing geotechnical resistance limits for the serviceability limit state design criterion. Notwithstanding, assuming good workmanship, inclusive of good excavation, the predicted settlement of bored straight-shaft concrete piles deriving their resistance from shaft friction with mobilized end bearing and working loads equal to a maximum given by 40 percent of the ultimate resistance of the pile may be taken as 0.1 to 0.2 percent of the shaft diameter, plus elastic shortening due to the compressive load acting on the pile.

5.2.3 CONSTRUCTION RECOMMENDATIONS FOR BORED CIPC PILES

Construction recommendations for the installation of bored CIPC piles are as follows:

— Sloughing from the upper soils, as well as 'squeezing' and sloughing of the sidewalls of piles may occur during pile installation. Should either of these conditions be encountered during pile installation, tight-fitting temporary steel casing should be installed in the augered excavations to control caving and groundwater seepage so that piles are cast in clean, dry holes. The level of fresh concrete in the casing must be maintained above the caving or seepage zone as the casing is withdrawn and should be kept sufficiently high to equilibrate pressures inside and exterior of the casing to prevent collapse or squeezing of the sidewall into the pile bore.
— The excavation of adjacent piles within three (3) pile diameters should be deferred until the concrete in the constructed pile has set.
— All piles should be poured immediately after completion of drilling to reduce the potential for seepage into, and swelling or squeezing of the pile bore, and to mitigate soil stress relief which could negatively impact pile settlement performance. Concrete should be poured in accordance with the latest edition of Canadian Standards Association A23.1 (Concrete Materials and Methods of Concrete Construction). Where required, dewatering of pile bores should be managed using a bailing bucket or a pump, subject to actual field conditions.
— Qualified and experienced geotechnical personnel should be on site during the entire period of pile installation to confirm that soil conditions are consistent with those encountered in the geotechnical investigation, to confirm that construction procedures are in keeping with recommended practices and to keep complete and accurate records of the pile installations.

5.2.4 TENSILE (UPLIFT) RESISTANCE OF SINGLE PILES

The unfactored (ultimate) tensile (uplift) resistance of a single isolated straight shaft pile CIPC piles will be provided by the buoyant weight of the pile, any sustained downward (i.e. opposing) load acting on the pile, and the soil resistance provided over the embedment length of the pile. The unfactored soil resistance component to tensile loads for a straight shaft concrete pile may be determined as the ultimate shaft friction over the length of pile below the depth of frost penetration (for perimeter piles), as provided in Table 6-1.

Shaft friction should be neglected within the frost penetration zone (2.4 m) and below 1.5 m from final grade for heated interior piles. In the case of a straight shaft pile, the frictional component of the uplift resistance will be provided by shaft friction applied to the external circumference of the pile below the depth of frost (i.e. 2.4 m).

Based on the National Building Code of Canada (NBCC), a geotechnical resistance factor, Φ = 0.3 should be applied to the unfactored geotechnical tensile (uplift) resistance of the pile to obtain the factored geotechnical resistance at the Ultimate Limit State (ULS) for tensile loading conditions. Frost design considerations are discussed in Section 6.

5.3 LATERAL RESISTANCE, SINGLE PILES

Piles resist laterally applied loads by deflecting until the necessary resistance is mobilized in the adjacent soils. The lateral load is generally resisted within the upper 4 to 5 m of the soil profile (i.e., the typical point of inflection for the pile). The maximum bending moment typically occurs at 1.5 to 3.0 m below grade depending on the applied loading and soil resistance. The lateral capacity of the pile depends on properties of the soil and pile material, pile sizes, fixity of the top of the pile, depth of embedment, height of load application above ground, vertical load applied and tolerable deflections.

Analysis of piles for supporting lateral loads and moments considers strength-deformation characteristics of the adjacent soil by modelled soil response as springs, for which values of the modulus of horizontal subgrade reaction (K_h) are required. If only relatively small deflections of the foundations are tolerable (i.e., less than about 8 mm), the lateral resistance of a pile can be evaluated using the method of Broms, and the recommended values for K_h for cohesive soils given in Table 5-2.

Table 5-2: Modulus of Subgrade Reaction (k_h) for Lateral Pile Loads

Depth Range Below Final Grade	Horizontal Subgrade Reaction Coefficient, k_h (MPa/m		
	Sustained Loading	Cyclic Loading	Transient Loading
Existing grade to 1.0 m	0	0	0
1.0 m to 4.0 m	3.4/D	2.2/D	5.0/D
4.0 to 9.0 m	6.7/D	4.5/D	10.1/D
1. D = diameter. In order to maintain the lateral displacements within the elastic range of the soil, the above modulus values are recommended for lateral displacements not exceeding 8 mm at the ground line.			

The use of these parameters for determination of the lateral capacity of piles is based on a deflection criterion of 8 mm or less at the ground line. It should be noted that due to the influence of stress level, pile geometry and the empirical nature of the previously referenced coefficient of horizontal subgrade reaction, the *coefficients computed in this manner are subject to a high degree of uncertainty and must be used with caution*. Due to shrinkage effects resulting in reduced contact between the pile and soil near the ground line, it is recommended that the top 1.0 m of the soil profile not be considered as providing resistance to lateral loads and moments.

For pile spacings of less than 8 pile diameters in the direction of the lateral load, or less than 3 diameters perpendicular to the load direction, group action effects will need to be incorporated. Group effects can be evaluated once pile layout configurations and spacing are known.

Where the lateral load resistances or magnitude of movements of piles is critical, it is recommended that the lateral deflections and design capacities of piles or groups of piles be evaluated using Reese's method of p-y curves. This method models the strength-deformation characteristics using load-displacement curves for the various soil strata, and the non-linear behaviour of the soil. With the method of p-y curves, solutions may be obtained through an iterative procedure performed using *LPILE* Software for single piles, and extended to pile groups by using *GROUP* Software to analyze the behaviour of piles in a group subjected to both axial and lateral loadings. The analytical procedure provides lateral pile deflections, generated bending moments, shear forces, and the soil reaction computed at close intervals over the depth of the pile. This type of analysis with group action effects could be conducted by WSP on request. An *LPILE* analysis is recommended to determine the pile length required to achieve pile toe fixity.

Where either of the above procedures are used, a geotechnical resistance factor of 0.5 should be applied to the ultimate horizontal pile resistance, in accordance with the National Building Code.

5.4 SHALLOW FOOTINGS

5.4.1 BEARING RESISTANCE - ULTIMATE LIMIT STATE (ULS)

The bearing pressure available for use in determining the unfactored geotechnical resistance of a spread footing is a function of various factors, including footing geometry, embedment depth, and the amount of foundation movement that can be accommodated prior to development of an ultimate limit state condition within the supported structure/building. In this regard, variable bearing pressures can be used for specific footing configurations where required.

Conventional spread and strip footings of assumed width ranging from 0.6 m to 1.5 m may be designed using an ultimate bearing stress of 200 kPa for strip and square footings bearing on the compact clay/silt till soils. Test holes in the vicinity of the proposed new shop and tank farm indicate that compact to very dense or hard till may be encountered around 2.0 to 3.0 m below grade. Footings bearing above the depth of frost (i.e. 2.4 m) will require frost protection as noted in Section 0. It should also be strictly noted that the recommended design bearing pressure has been provided assuming an Ultimate Limit State defined by plastic soil deformation and geotechnical failure of the footing. In other words, no reduction has been applied to the bearing pressure value to maintain deformations with a zone of elastic or elastic-plastic deformation, nor to ensure a maximum level of tolerable deflection. Reduced bearing pressures may be required where the ultimate limit state (ULS) of the footing is to be defined by a specified deformation of foundation subgrade that could lead to the ULS state being induced in the superstructure.

A geotechnical resistance factor of $\Phi = 0.5$ should be applied to the ultimate bearing resistance to obtain the factored geotechnical resistance at the Ultimate Limit State (ULS).

5.4.2 AXIAL COMPRESSION – SERVICEABILITY LIMIT STATE (SLS)

The bearing pressure at the Serviceability Limit State (SLS) can only be determined from settlement analyses which in turn can only be evaluated once the final foundation configuration, including both depth and footing size, is known. However, the serviceability limit state may be assumed equivalent with traditional working stress design, and in this regard, the bearing pressure at the serviceability limit state, or SLS limit pressure, may be taken as equal to the factored ULS condition. Assuming good workmanship, clean bearing surfaces, settlement of new footings up to 1.5 m in width under SLS loads may be estimated 25 mm or less. Differential settlement between new footings can be expected to be 50% or less of the total settlement.

5.4.3 UPLIFT RESISTANCE

The factored ultimate vertical resistance (Rv) against an applied uplift factored force (Fv) may be determined by taking the sum of vertical forces, as shown in the following equation. Where the footings are based such that the top of the footings are provided with a minimum equivalent soil cover of 2.4 m below the finished grade, the effect of frost adfreeze (Ff) need not be taken into account in the summation of vertical forces. However, if sufficient cover is not provided, the additional effect of frost adfreeze should be considered. WSP can provide additional input in the event that sufficient frost protection is not provided.

The following equations are applicable for the summation of vertical forces. These equations should be checked for both buoyant and total unit weights of soil and concrete to determine proper footing sizing and depth requirements.

	Rv	> Fv
and:	Rv	= Φ x {(V x γ)footing + (V x γ)soil}

where:	Fv	= Applied uplift factored force (kN)
	$V_{footing}$	= volume of concrete footing (m3)
	$\gamma_{footing}$	= unit weight of concrete footing (use 24 kN/m3)
	$\gamma_{footing\ buoyant}$	= γ footing - 9.8 (kN/m3)
	V_{soil}	= soil volume projected above the footing (m3)
	γ_{soil}	= unit weight of soil above footing (use γ soil = 18 kN/m3)
	$\gamma_{soil\ buoyant}$	= γ soil - 9.8 (kN/m3)
	Φ	= Geotechnical Resistance Factor, use 0.3

It is recommended that the formula above be used with conservative input parameters, assuming that groundwater is at the surface. WSP can provide input to optimize this design on request.

5.4.4 LATERAL RESISTANCE

The factored ultimate horizontal resistance (R_h) against the applied lateral factored force (F_h) for a footing may be determined as the sum of horizontal forces, as shown in the following equations. For a footing bearing on the till such that the top of the footing is less than 2.4 m below grade, insulation will be required. If adequate insulation is not provided, the lateral resistance will be reduced and frost forces must be accounted for and in this case WSP should be contacted for further recommendations. The equation below should be checked for both buoyant and total unit weight soil conditions.

$$R_h \geq F_h$$

And:

$$R_h = \phi_E \left\{ (k_p - k_a) \frac{(D_1 + D_2)}{2} \gamma_{soil} \right\} (H \times W) + \phi_s \tan\delta \{ (\gamma_{footing} H + \gamma_{soil} D_1)(L \times W) + (F_{v*}) \}$$

Where:

F_h	=	applied lateral factored force (kN)
$(k_p - k_a)$	=	net earth pressure coefficient
	=	1.67 for compacted sand backfill, 0.87 for compacted clay backfill
γ_{soil}	=	unit weight of compacted backfill (use 18 kN/m^3)
$\gamma_{soil\ buoyant}$	=	γ_{soil} – 9.8 kN/m^3 (use 8.2 kN/m^3)
$\gamma_{footing}$	=	unit weight of concrete footing (use 24 kN/m^3)
$\gamma_{footing\ buoyant}$	=	$\gamma_{footing}$ - 9.8 kN/m^3 (use 14.2 kN/m^3)
D_1	=	depth of top of footing below soil surface (m)
D_2	=	depth of bottom of footing below soil surface (m)
H	=	height of footing (m)
L	=	length of footing (m), horizontal dimension of footing face parallel to the direction of the applied lateral force
W	=	width of footing (m), horizontal dimension of footing face normal to the direction of applied lateral force
δ	=	soil-to-concrete friction angle, use 16° for a cast-in-place concrete footing bearing on the undisturbed till.
Φ_E	=	Geotechnical Resistance Factor for net earth pressure, use 0.5
Φ_s	=	Geotechnical Resistance Factor for sliding resistance, use 0.8

F_{v*} = Vertical component of forces applied to the footing (i.e. positive acting downwards)

Side friction on the footing has been ignored to account for shrinkage of soil away from the sides of the footing.

It should be noted that the vertical component of the load applied to the footing (F_{v*}) will affect the magnitude of the ultimate horizontal resistance. In the case of applied structural loads, the effect of an increased compressive (downwards-acting) load is to increase sliding resistance, whereas vertical tensile loads will reduce the horizontal sliding resistance. The sign of F_{v*} represents the directions of the expected forces, i.e. positive forces act downwards. The last term in the equation defining R_h (i.e. Φ_s*tan(δ) term) should be taken as zero if the resulting value is negative. When evaluating the design requirements for these cases, the structural engineer should carefully consider the sign of F_{v*}, and the need to apply a load factor to F_{v*}, and what load factor to use, if applicable.

It is recommended that the formula above be used with conservative input parameters, assuming that groundwater is at the surface. WSP can provide input to optimize this design on request.

5.4.5 DESIGN AND INSTALLATION

Further recommendations for the design and construction of shallow footings are as follows:

- Shallow foundations must not be founded on un-compacted fill, loosened or disturbed soil, or organic soils.
- To create a uniform base condition and limit total and differential settlements, excavation should continue to final design elevation, ensuring that the exposed soils consist of native, undisturbed compact till.
- Excavation should proceed with care using a smooth bladed bucket, operating from the edge of the excavation to reduce the potential for disturbance of the bearing surface. If seepage or inflow of surface water occurs, controls should be undertaken using trenches, sumps and pumps located outside the bearing surface area, and surface grading to prevent surface water from flowing into excavations. Localized seepage encountered on the slopes of the excavation should also be directed towards the sumps in trenches. All water pumped from the excavations should be discharged away from the site. Care should be taken to ensure that the bearing surface is not subject to frost, inundation, desiccation, or heavy equipment, or disturbed in any way prior to or after casting the footings. Section 7 provides additional recommendations related to excavations.
- Final preparation of the bearing surfaces should be done by hand, with the removal of all loosened soils, as well as any cobbles and boulders protruding from the surface.
- Once the bearing surface has been prepared, it should be inspected by qualified geotechnical personnel to verify the suitability of the proposed bearing soils and to confirm that the soils are uniform and consistent with the conditions noted in the test hole logs presented in the geotechnical report.
- As soon as possible following excavation and approval of the bearing surface by qualified geotechnical personnel, the steel re-bar should be laid and concrete poured. Bearing surfaces should be protected from environmental effects (i.e. precipitation and freezing temperatures) during the period between completion of excavation and casting of the footings. Water should not be allowed to pond on the bearing surface to reduce the potential for disturbance.
- Lean mix or mud slabs may be used to protect the bearing surface from being disturbed, particularly during placing of the rebar cages.
- The footing should be steel reinforced and suitably designed by a structural engineer to act as a rigid foundation. Regardless of bearing capacity considerations, all footings should have a minimum width of 0.6 m.

- Where grade beams or walls span between footings a minimum 150 mm thick void form will be required under the grade beams. The void material should be a low compressive strength, biodegradable cardboard material.
- Perimeter or unheated footings should be provided with sufficient insulation to resist seasonal frost penetration into the bearing material. Where the footings will bear at depths above 2.4 m from grade, insulation will be required. The insulation should extend outwardly in all directions a minimum of 2.4 m from the footing location.
- Clay backfill is preferred for backfilling the footing excavations. The fill should be placed in maximum 150 mm thick lifts and compacted to a minimum of 95% of standard Proctor maximum dry density (SPMDD). The fill should also be free draining and non-frost susceptible.

Construction activities, groundwater seepage, changes in groundwater elevations and precipitation during construction may expose the bearing surface to water. Drainage should be provided during construction to prevent inundation of the bearing surface. A water pump should be maintained on site and used to immediately remove any water accumulation. Any softened or disturbed materials should be removed as required. Foundation drainage systems should follow the recommendations provided in Section 11.

6 FROST DESIGN CONSIDERATIONS

6.1 FROST PENETRATION DEPTH

The upper stratigraphy at the Site is considered highly frost susceptible in the presence of a free supply of water. As such, frost effects should be considered for foundations or surface structures sensitive to movement. Based on historical temperature data for the area, a design frost penetration of 2.4 m below final grade is recommended in areas that will not have regular snow or vegetative ground cover. It should be noted that this recommended frost penetration depth extends both vertically and laterally behind final surfaces.

6.2 FROST FORCES

Foundation elements supporting unheated structures and perimeter foundation elements supporting heated structures should be designed to resist the frost forces discussed herein. Similarly, interior foundations for heated structures should be designed for the unheated condition if they will be exposed to freezing conditions at any time during construction. Potential frost forces acting on foundation elements include adfreeze pressures acting along the sides of foundation elements (i.e. grade beams, basement walls, piles and pile caps, etc.) extending through the frost zone, as well as frost heave forces acting on the undersides of such elements or connecting supports located above the anticipated depth of frost penetration.

Adfreeze forces acting on buried structures and foundation elements may be determined assuming an unfactored unit adfreeze stress of 65 kPa applied only to the exterior surface area of the portion of the structure or foundation element located within the zone of frost penetration. A load factor of 1.25 should be applied to obtain the factored adfreeze stress. The adfreeze stress could be reduced by affixing a 'bond-break' or 'friction reducer', such as greased poly-wrap or geosynthetic liner material, to portions of the structure or foundation element located within the zone of frost penetration.

With respect to frost heave, the potential for frost heave pressures to develop on the underside of foundation elements should be mitigated by one or more of the following optional measures:

- Foundation elements such as grade beams and pile caps may be designed to extend below the frost penetration depth. Alternatively, insulation may be used to establish a minimum equivalent depth of soil cover. WSP can provide a recommended insulation configuration upon request.
- Where the undersides of foundation elements are located above the depth of frost penetration, a void-forming product should be installed beneath the undersides of the grade beams, pile caps, and any other connecting elements located within the depth of frost penetration above the groundwater table. The recommended minimum thickness of the void is 150 mm. Alternatively, a compressible material may be used in lieu of a void forming material, and the uplift pressures may be taken as the crushing strength of the compressible medium. It is recommended that a frost heave potential of 150 mm be assumed in determining the required thickness for the void-filler and the associated uplift pressures associated with the thickness used.
- The finished grade adjacent to all structures and foundation elements should be capped with well compacted clay and sloped away from the structure so that the surface runoff is not allowed to infiltrate and collect in void spaces or saturate the compressible medium. Saturation of the void and/or compressible medium with water will negate the function of the void or compressible medium, if it becomes frozen, and therefore saturation should be avoided.

7 TEMPORARY EXCAVATIONS AND BACKFILL

7.1 SLOPED EXCAVATIONS

Conventional sloped excavations with cut slopes are considered appropriate for utility trenches and other shallow excavations up to about 3 m deep, however, depending on the depth of excavation challenging construction conditions due to groundwater infiltration should be anticipated. As shown in Table 4-2, groundwater seepage was observed during drilling below a depth of 1.2 m below grade and as shown in Table 4-3, groundwater levels at the standpipe piezometers varied from 1.3 m to 2.9 m below grade. The silt and sand till layers will pose risks for sloughing and seepage into the excavations, particularly if these layers are saturated or loose at the time of construction, or if the slopes are either too steep or not properly protected from surface water. Temporary excavation plans should be developed and should consider the duration of the excavation and potential instability or other risks to the project, including but not limited to worker safety, loss and replacement of completed construction, and impacts to adjacent building, infrastructure or properties.

For maximum excavation depths of about 3 m, WSP anticipates that the side walls of short-term temporary excavations will need to be cut no steeper than 2.5H:1V where entrance into the excavation is required. Side slopes up to 1H:1V may be possible in some areas depending on the conditions at the time of construction.

Regulations set forth by Manitoba Workplace Health & Safety must be followed for planning and execution of all excavations. Excavation works should be undertaken by an experienced contractor, and workers should not be allowed into open excavations without proper protection and appropriate training. Manitoba Workplace Safety and Health requires that the side walls of short-term temporary excavations should be cut no steeper than 1H:1V

where entrance into the excavation is required, however, that flatter side slopes (i.e. 2.5H:1V or flatter) or benching may be necessary if the fill, silt or sand is loose or saturated at the time of construction, or if the duration of excavation is beyond what may be referred to as 'short term'. 'Short term' is generally defined as excavations in clay with a duration of approximately one month or less; however, the specific duration is dependent on the soil and groundwater conditions encountered, as well as prevailing weather conditions. Therefore, it is important that all excavations be reviewed by competent geotechnical personnel periodically throughout construction to confirm that they are behaving as anticipated and to provide revised recommendations if required. If conditions are different than described herein or if the excavation duration is longer than anticipated, a detailed excavation plan prepared by a geotechnical engineer may be required. This should be confirmed at the time of construction.

Construction planning should be directed at minimizing the length of time an excavation is left open. If sloughing of the sidewalls is observed, the cut slope angle should be flattened until a stable angle of repose for the soil has been attained. Alternatively, if sloughing of the upper soils somewhere within the excavation depth is an issue, a benched excavation could be maintained at the interface of the unstable and stable soils to allow a collection area for sloughing of the upper soils. In the case of a combination of sloped sidewalls and a vertical trench (i.e. "Y"-excavation), the vertical faces shall not exceed 1 m in height. If space is insufficient to allow for a sloped excavation, appropriate structural support methods (i.e. trench boxes or shoring) should be used.

Surface drainage should be directed away from the crest of the excavations. All temporary surcharge loads, including stockpiles of materials and excavated soil, should be kept back from the excavated faces a distance equal to at least the depth of the excavation. Wheel loads should be kept back at least 1 m from the crest of the excavation. All open cuts should be examined and assessed by qualified geotechnical personnel and should be protected from erosion.

If seepage occurs during construction, it is expected that drainage can be managed by sloping the excavation to trenches directed to sumps and pumped out. The water should be pumped and discharged to a location sufficiently far away from the excavation such that it will not re-enter. The need for dewatering should be confirmed at the time of construction.

7.2 SHORED EXCAVATIONS

Based on the layout of the proposed development, it is expected that open excavations can be used and that shored excavations will not be required. If shoring recommendations are required, this office should be contacted for appropriate recommendations.

7.3 BACKFILL

Backfill material and quality requirements for excavations should be assessed during design from the standpoint of performance requirements, such as bedding and support requirements for underground utilities, drainage requirements along foundation walls, and long-term settlement limits of fill required to mitigate risks and impacts to grade supported structures (i.e. grade supported slabs, sidewalks, pavements, etc.) and/or surface grading and drainage.

Excavations at the perimeter of the structure (grade beams, pile caps, etc.) should be backfilled with moderately to well compacted fill, compacted to between 95% and 100% of Standard Proctor Maximum Dry Density (SPMDD). Backfill material selection and compaction specifications should consider the following:

- All backfill should be free of excessive organic content (i.e. greater than 6% by weight), and of any deleterious material such as tree roots, refuse, silt pockets, clumps of organic clay, etc. Excavated soils on site are expected to consist of gravel fill, medium to high plastic clay, and low plastic till and silt. Low plastic till and silt soils from excavations on site are considered not suitable for backfill.
- The upper 0.3 m of all backfilled excavations subject to runoff should consist of a moderately to well compacted clay or clay fill cap to reduce the potential for surface water infiltration into the underlying backfill.
- To mitigate potential settlement, trench backfill should be compacted to a minimum 95% of SPMDD within landscaped areas and to a minimum of 98% of SPMMD within the upper 1 m of areas requiring subgrade support, at soil moisture contents at or slightly above Optimum Moisture Content to achieve the desired compaction target. More stringent backfill criteria may be required for pipe support, and the pipe manufacturers specifications should be referenced in this regard.
- For clay or clay fill compacted to a minimum of 95% of the Standard Proctor maximum dry density, the self-weight settlement is expected to be in the order of 1 to 2% of the fill thickness. For clay fill compacted to a minimum of 98% of the Standard Proctor maximum dry density, the settlement is expected to be in the order of 1% of the fill thickness.
- For granular fill materials compacted to 98% or more of Standard Proctor maximum dry density, settlement due to self-weight is expected to be in the range of 0.5 to 1% of the fill thickness.

8 GRADE SUPPORTED SLABS

8.1 GENERAL DISCUSSION OF CONSTRUCTION AND PERFORMANCE RISKS

Grade supported slabs constructed over swell-susceptible highly plastic clays are generally subject to long term volumetric changes. These volumetric changes can result in movements that can be in the range of 25 to 50 mm; however, can be as high as 150 mm or more under extreme circumstances (such as a pipe break or extreme change in the evapotranspiration balance of the Site). Highly plastic clays were observed within the footprint of the proposed new shop at TH23-14, however in the vicinity of the new shop at test hole TH23-09 near surface soils consisted of medium to low plastic clay and silt till which are less susceptible to these types of volumetric change. Construction of buildings and pavements can lead to a change in natural evaporation routes, often leading to long-term increases in soil moisture content and consequently swelling, particularly within the upper desiccated soil zone. Pre-existing moisture conditions, which can be influenced by site drainage and recent climatic events, have one of the greatest effects on the swell potential. Design, site drainage, maintenance, and post construction climate, however, will also significantly influence the actual performance. To reduce the potential for movement across the floor slab, the top 150 mm of the clay subgrade should be scarified, moisture conditioned to its optimum moisture content (+/- 2%), and recompacted to 95 percent SPMDD.

At the time of the field investigation, the near-surface high plastic clay soils within the footprint of the proposed new shop (i.e. TH23-14) had a moisture content of around 42% where clay was present up to 1.1 m from grade, with lower moisture contents in the silt till below that depth. Based on site conditions, lab test data, and

correlations from WSP's experience with similar sites, the overall estimated swelling potential of the clay at the site is expected to be in the range of 25 mm. Greater movements can occur where poor drainage conditions exist, such as broken pipes. Due to variable soil conditions, the full expected heave magnitudes may occur differentially across the slab. The above heave movements are based on moisture content data and the Atterberg limits, combined with WSP's experience at this location and with similar sites.

Soft, weak shallow silt or silt till was present in all test holes and can cause construction complications if encountered near the design subgrade elevation. In general, the silt was encountered below a depth of 0.6 m below grade except for test hole TH23-06 where it was encountered at depth of 0.2 m below grade. Recommendations for management of soft subgrade are provided below.

8.2 FROST EFFECTS ON GRADE SUPPORTED SLABS

Grade supported slabs are also subject to heave where there is a potential for the subgrade to become frozen. The frost susceptibility of the upper silt and clay soils is high, particularly where the soils become wet. Frost-related slab performance risks are generally considered limited to exterior slabs and sidewalks. Frost heave is not a significant risk to interior slabs for heated structures unless the slabs will be subjected to freezing conditions during construction. If the subgrade is allowed to freeze after sub-base and base courses have been placed, some differential movements are expected to occur, potentially resulting in mid- to long-term movements of the slab up to (but not limited to) the heave amounts. Slabs for heated spaces should not be allowed to freeze, once the concrete has been placed.

Where the performance risks and potential slab movement discussed in this section are not tolerable, or where maintenance and/or repair is not feasible, WSP recommends a structural floor supported on shallow foundations designed using the foundation design recommendations presented in this report.

8.3 MINIMUM GRAVEL STRUCTURE AND SLAB THICKNESS DESIGN

Where the risks associated with a grade supported slab are tolerable to the owner and grade supported floor slabs are used, WSP recommends the main floor slabs should be underlain by a minimum 300 mm thick gravel structure consisting of 150 mm of 50 mm max. crushed limestone sub-base, overlain by 150 mm of crushed 20 mm max. limestone base course, uniformly compacted to a minimum of 98% and 100% of Standard Proctor Maximum Dry Density (SPMDD) for the sub-base and base course, respectively. All base and sub-base materials should meet the grading and durability specifications provided in Tables B-1 through B-4. Tables B-5 and B-6 provide specifications for crushed limestone rock such as for bridging layers where subgrade repairs are required.

For the purposes of concrete slab thicknesses and reinforcement design (i.e. rigidity), grade-supported concrete slabs designed on the minimum recommended gravel structure above, and constructed on an approved subgrade prepared as outlined in Section 8.4 below may be designed assuming a Westergaard subgrade reaction modulus (k) of 35 MPa/m. If additional subgrade stiffness is required, WSP can provide recommendations for additional gravel structure thickness on request.

To reduce the effects of slab movements on the building structure, the following provisions are recommended:

- Design equipment and partition walls bearing on the slab with a void space to minimize the potential for structural damage if the slab heaves.
- Provide control joints at regular intervals in the slab to reduce random cracking.
- Construct the floor independent of structural elements using isolation joints.
- Due to the potential for frost heaving of exterior slabs, all sidewalks and any apron slabs should be structurally separate from the structure and should not be dowelled into the grade beam or the interior slabs, except at doorway locations.
- Where it is proposed to dowel exterior slabs into structure components, or where frost related movement of the slab is undesirable, rigid insulation can be placed on the subgrade and below the slab concrete and granular structure, to reduce the effects of frost penetration beneath the slab. Placement of vertical insulation along the vertical sides of grade beams should be avoided at these areas to allow beneficial heat loss from the building and lessen frost effects.
- A polyethylene vapour barrier may be utilized directly below floor slabs to limit moisture migration through the slab. It should be noted that curing problems (delays before final finishing), curling of the slab at the edges and shrinkage cracking might be encountered where the concrete slab is cast directly on the poly. Where the concrete will not require a finished floor covering, a vapour barrier is not necessarily required.

8.4 SUBGRADE PREPARATION AND CONSTRUCTION RECOMMENDATIONS

The following recommendations for subgrade preparation and construction of grade supported interior slabs are provided on the assumption that the risks outlined above regarding potential slab movements are acceptable to the owner. Where the performance risks and potential slab movements discussed in Section 8.1 are not tolerable, or where maintenance and/or repair after their occurrence is not feasible, WSP recommends using a structural floor supported on piles designed using the foundation design recommendations presented in this report.

Recommendations for subgrade preparations and construction of grade-supported slabs are as follows:

- Excavate to design subgrade elevation, which should be taken as the top of the slab minus the thickness of the slab, base and sub-base provided in Section 8.3. Further remove any unsuitable / deleterious material such as organic soils, weak soils or silt if discovered during construction. Organic soil may be defined as any soil containing greater than 6% organic content by weight.
- The required depth of excavation to achieve the design subgrade elevation is expected to reach the bottom of the organic material within the surficial clay and silt soils, however where significant organic content remains, additional excavation may be required. Organic soil may be defined as any soil containing greater than 6% organic content by weight. Final excavation cuts to subgrade design elevation should be undertaken with an excavator equipped with a smooth bladed bucket and operating from the edge of the excavation. Construction traffic should not be allowed directly on the exposed subgrade.
- Once final subgrade is achieved, the subgrade should be evaluated by qualified personnel to detect soft or weak areas, and to verify that soils are as expected and that no unsuitable materials remain.
- Provided the subgrade can support heavy equipment without excessive disturbance, and where practical, the subgrade should be proofrolled using a fully loaded tandem dump truck to identify soft, weak or compressible areas. The suitability of the subgrade for proof rolling should be assessed by qualified personnel at the time of construction.

- Where weak zones are observed at or slightly below the subgrade during or prior to proof rolling, sub-excavating to a firm stratum or to a typical maximum depth of about 400 mm below design subgrade elevation is recommended. The sub-excavation should then be covered with a nonwoven geotextile separator meeting or exceeding the requirements outlined in Table 8-1 and backfilled with a single 400 mm thick lift of 100 mm to 150 mm nominal diameter crushed limestone rock meeting the requirements of Table B-5 or Table B-6. Actual procedures and sub-excavation depths should be determined by the geotechnical engineer at the time of construction according to the subgrade conditions encountered.
- To reduce the potential for movement across the floor slab as discussed in Section 8.1, the top 150 mm of the clay subgrade should be scarified after proof rolling, moisture conditioned to its optimum moisture content (+/- 2%), and recompacted to 95 percent SPMDD.

Table 8-1: Separation/Filtration Fabric Requirements

Physical Property	Statistical Reporting	Standard	Test Method
Grab Tensile Strength	MARV(1)	900 N minimum	ASTM D4632
Elongation	MARV	50% minimum	ASTM D4632
CBR Puncture	MARV(4)	2200 N minimum	ASTM D 6241
Trapezoid Tear	MARV(5)	350 N minimum	ASTM D4533
Apparent Opening Size	TV(2)	0.18 mm maximum	ASTM D4751
Permittivity	MV(3)	1.4 sec^{-1} minimum	ASTM D4491
Flow Rate	MV	4000 l/min/m^2 minimum	ASTM D4491
U.V. Resistance	MV	70% after 500 hrs minimum	ASTM D4355

Notes:
(1) MARV: Minimum Average Roll Value
(2) TV: Typical Value
(3) MV: Minimum Value
(4), (5): If CBR Puncture and Trapezoid Tear values are not available, Puncture Strength should be a minimum of 575 N per ASTM D4833, and Mullen Burst a minimum of 2000 kPa per ASTM D3786

- The geotextile should be placed, overlapped and secured in accordance with the manufacturer's specifications without any folds or wrinkles. Fabric joints should follow manufacturer specifications, with overlap of 1 m or as specified by the manufacturer, whichever is greater.
- The subgrade should be protected from frost, desiccation, inundation and excessive wheel loads at all times. Subgrade preparation and fill placement under freezing conditions should be avoided. The use of frozen soils for fill, placement/compaction of frozen soils, and placement/compaction of soils or concrete slab over frozen subgrade, should also be avoided. These practices carry a risk of differential slab movements upon thawing and could cause slab cracking potentially before the slab is put into service. Before the slab concrete is placed, and depending on the season of construction, the subgrade should be checked for the absence of freezing conditions such as with frost probes. The concrete slab granular design structure provided in this report is

intended for use under non-freezing conditions only. If any portion of the design slab structure is exposed to freezing conditions after the concrete has been placed, or if any portion remains frozen during concrete placement, damage to the slab may result. If the slab subgrade is frozen, it must be thawed and potentially repaired before placing fill, allowing time for thaw-settlements to occur. Rolling the subgrade to compact after thawing is complete may be suitable to mitigate thaw-related settlement potential.

— Fill materials required to raise grades to the underside of the granular section described above would ideally consist of additional 50 mm max. crushed limestone sub-base, placed in maximum 150 mm thick lifts and uniformly compacted to 98% of SPMDD. The use of clay fill could also be considered. Where clay fill is used to raise grades, the clay fill should be uniformly moisture conditioned to 0 to 5% above Proctor optimum moisture content depending on the specific characteristics of the clay, and uniformly compacted to 95% of SPMDD, in lifts a maximum 200 mm thick as measured uncompacted.

9 STRUCTURALLY SUPPORTED FLOOR SLABS

Where the potential for movements of a grade supported slab discussed in Section 8.1 is not acceptable to the owner, a structurally supported slab should be used, and should be adequately reinforced and supported on one of the foundations options discussed in Section 5. Any fibrous organics encountered in the subgrade within the proposed slab area (i.e. topsoil), should be removed to reduce the potential for methane accumulation to occur. The structural slab should be underlain by either a minimum 150 mm thick compressible and biodegradable cardboard void form material, or a vented and heated crawl space, to maintain separation of the slab and the underlying soil. If a crawlspace is implemented, the crawlspace should extend to a minimum of 150 mm below the bottom of the lowest floor beam or joist and should be rough graded such that a minimum gradient of 2%, and ideally 4%, is provided towards interior collection lines and sumps. The floor of the crawlspace should subsequently be covered with a vapour barrier and a 100 mm thick protective sand cover on top of the vapour barrier. The crawl space should also be drained with an interior drainage collection system as outlined in Section 11.

10 PAVEMENT

10.1 GENERAL DISCUSSION

The soils encountered have similar risks for pavement performance to those discussed in Section 8 for grade-supported floor slabs. Organic clay and silt soils such as those found near the surface within the development area can be of greater concern for pavements than for slabs, as they are typically prone to erosion, softening, rutting and pushing, and frost heave and as a result, silt is generally unsuitable for pavement subgrade material. Silt and other unsuitable subgrade materials, such as fibrous organics are typically managed by sub-excavation of up to 400 mm followed by replacement with a geotextile and crushed rock.

Where pavement distress such as cracking occurs, maintenance and/or repair of affected areas will be important to mitigating infiltration of water into the pavement structure and subgrade, which could exacerbate pavement deterioration. Notwithstanding the discussion above, subgrade conditions should be inspected and the

requirement for subgrade improvement should be reviewed by WSP at the time of construction once the subgrade is exposed.

10.2 PAVEMENT SECTIONS

10.2.1 ASPHALT TRAFFIC SURFACE

The following asphalt pavement sections are intended as minimums for a typical asphalt pavement service life. Design traffic loading information was not available at the time of this report, and in this regard, assumptions of anticipated traffic loads and design life were required for providing pavement recommendations. Recommended pavement sections outlined herein have been provided based on the use of the area by light passenger vehicles with some light truck traffic (i.e. 1-Ton trucks or lighter). Asphalt pavement recommendations for heavy truck traffic areas have also been provided based on these areas being used by fully loaded highway-legal tractor trailers at a frequency of less than 5 trucks per day (i.e. tractor-trailers and delivery and/or garbage trucks). The asphalt pavement sections should be reviewed during detailed design for actual design traffic loading.

Pavement sections have been established based on an assumed effective subgrade resilient modulus (M_r) of 20 MPa, or an approximately equivalent California Bearing Ratio of 2.0 percent. The subgrade resilient modulus is indicative of a relatively low level of subgrade support as is expected during spring thaw when the clay subgrade could be in a weakened condition. If softened areas are present in the subgrade during construction, it may be necessary to incorporate additional gravel as a working pad or haul road to establish a stable subgrade. Recommendations for additional gravel thickness should be made by WSP based on observations made in the field during site grading. Recommended asphalt pavement sections are provided in Table 10-1.

Table 10-1: Flexible Asphalt Pavement Design Sections

Material	Recommended Minimum Thickness (mm)		Compaction Required
	Passenger Vehicles	Truck Traffic	
Dense Hot Mix Asphalt - Type 1A	65	85	98% of Marshall Density (75 blows per face)
20 mm minus Crushed Limestone Base Course	150	150	100% of SPMDD
50 mm minus Crushed Limestone Sub-base	150	250	98% of SPMDD
Total Structure Depth	365	485	NA

The design pavement sections provided assume a properly compacted pavement structure constructed on a stable subgrade prepared in accordance with subgrade preparation recommendations outlined in Section 8.4. Additional measures recommended to improve long term pavement performance are as follows:

- Maximize drainage slopes;
- Minimize drainage path lengths;
- Maintain finished grades as high as possible; and
- Provide regular maintenance of the asphalt surface (crack sealing) to prevent water infiltration and subsequent softening of the subgrade.

Concrete pavement sections should be provided for any areas where heavy static wheel loads such as garbage trucks will be applied during unloading of dumpsters, and for any areas where trailer dollies or forklifts will bear on the pavement. Asphalt pavement used in such areas is prone to rutting.

With respect to maintenance, all pavements, no matter the pavement type, are subject to routine annual maintenance and upkeep essential to maintaining the pavement investment at a specified level of service, and to mitigate the rate of deterioration of the pavement. The annual maintenance is required to repair normal 'wear and tear' and environmental damages, and may include, but not be limited to, crack sealing or seal coating, patching, routing, or dowel joint repairs. In addition, un-maintained pavements are more susceptible to developing serious cracks or structural defects requiring earlier replacement than properly maintained pavements. By mitigating the deterioration of the pavement structure, particularly at depth, a properly maintained pavement could provide for an increased number of pavement rehabilitation alternatives when the design life of the pavement has been achieved.

A program of regularly scheduled maintenance should be undertaken to preserve the integrity of the pavement structure. During pavement service life, heavy vehicle traffic should be limited to heavy duty pavement areas. Cracks in pavement should be sealed as soon as possible to reduce the potential for moisture infiltration into the pavement subgrade. Drainage paths should be maintained to allow the free flow of surface water away from the structure and pavements, such as by regular cleanouts in catch basins and maintaining clear paths to nearby drainage ditches, if present.

10.2.2 GRAVEL SURFACED ROADWAYS

Shallow soils at the test holes generally consisted of clay or clay till with silt lenses. These soils would be expected at the roadway subgrade elevation.

The silt soils at this site are considered highly prone to frost heave and subsidence. These conditions are expected to affect pavement performance over the short and long terms. To promote improved pavement performance, in particular for gravel surfaced roads, drainage slopes should be at least 3%, drainage paths should be minimized, the traffic surface should be constructed as high as possible above surrounding grades, and a schedule of regular maintenance should be undertaken. Maintenance should include regular cleanouts of drainage paths re-grading of road surfaces, and prompt patching and sealing of potholes and cracks before underlying pavement subgrades become softened.

10.2.3 GRAVEL SURFACE DESIGN

Recommended gravel sections for truck traffic, loading areas and car parking, and constructed on a subgrade prepared as recommended in Section 8.4, are summarized in Table 10-2 below. WSP recommends adding a geotextile fabric between the subgrade and granular fill to help mitigate issues associated with rutting of the gravel surfaces.

Table 10-2: Gravel Surface Design Sections

Material	Standard Duty	Heavy Duty	Compaction Required
Base Course	300mm	350 mm	100% of Standard Proctor Maximum Dry Density (SPMDD)
Subbase	150mm	250 mm	98% of SPMDD
Total Thickness	**450 mm**	**600 mm**	**NA**

10.2.4 SUBGRADE PREPARATION AND PAVEMENT CONSTRUCTION RECOMMENDATIONS

Recommendations for subgrade preparations and pavement construction are as follows:

- Recommendations for subgrade preparation in pavement areas may be taken as outlined in Section 8.4, with subgrade design elevation taken as the top of pavement minus the total pavement structure selected from Section 10.2.1 or 10.2.3.
- The granular sub-base should be placed in maximum 150 mm thick lifts (or reduced lift thicknesses as governed by the compactive abilities of the compaction equipment) and uniformly compacted to a minimum of 98% of SPMDD to the bottom of the base course design elevation.
- The granular base course should be placed in maximum 150 mm thick lifts (or reduced lift thicknesses as governed by the compactive abilities of the compaction equipment) and uniformly compacted to a minimum 100% of SPMDD to the bottom of the asphalt design elevation.
- Qualified and knowledgeable geotechnical personnel should monitor the quality and placement of gravel and the compaction of the gravel should be monitored by field density testing at regular frequencies. The density of each lift should be tested to confirm that adequate compaction has been achieved before placing the next lift.
- Asphalt should be compacted to a minimum 98% of a 75 blow Marshall Density.
- All base course, sub-base and asphalt materials should meet the quality and gradation requirements provided in Table B-1 to Table B-4.

11 FINAL SITE GRADING AND SURFACE DRAINAGE

Sufficient gradients should be provided to promote surface drainage away from structure to reduce the potential for moisture percolation to the foundation elements. Site grading should provide positive drainage away from the structure at a minimum gradient of 4% for landscaped areas within 3 m of the perimeter of the building; and at a minimum gradient of 2% for all pavement areas as well as landscape areas outside of 3 m of the building perimeter. All downspouts from the roof of the structure should be discharged away from the building and proper measures (i.e. splashguards) should be provided where necessary to reduce the potential for erosion and ponding water at the perimeter of the structure.

Excavations at the perimeter of the structure (grade beams, pile caps, etc.) should be backfilled with moderately to well compacted fill and topped with a clay cap a minimum of 0.3 m thick to reduce the potential for surface water infiltration into the slab subgrade or backfill against grade beams. As a recommended minimum, the clay cap in landscape areas along the perimeter of the foundation should extend a minimum of 3.0 m from the foundation perimeter. Where pavement and/or concrete slabs meet the structure, these should be sealed against abutting structural components with a flexible seal, such as an asphaltic bead, to reduce the potential for surface water infiltration.

Perimeter drains should be surrounded by a clean, filter wrapped, granular drain material and should be directed to one or more positive outlets such as a central collection sump(s); or should be directed by gravity flow directly into an acceptable land drainage system. Drainage lines passing through perimeter walls, or connecting to outlets such as sump or sewer, should consist of solid pipe. Depending on final elevations and site configuration, grading of the crawlspace, or below the void space, may require installation of several interior filter wrapped drain lines and/or drainage outlets (i.e. sumps) to control slope lengths and drainage line lengths. To promote gravity drainage of seepage that has entered the crawlspace, grades within the crawlspace should be sloped towards collection lines at a minimum of 2%, and preferably, 4%.

12 FOUNDATION CONCRETE

Where concrete elements outlined in this report and all other concrete in contact with the local soil will be subjected in service to weathering, sulphate attack, a corrosive environment, or saturated conditions, the concrete should be designed, specified, and constructed in accordance with concrete exposure classifications outlined in the latest edition of CSA standard A23.1, Concrete Materials and Methods of Concrete Construction. In addition, all concrete must be supplied in accordance with current Manitoba and National Building Code requirements.

Based on our local experience gathered through previous work in the Dauphin area, the degree of sulphate exposure at the site should be considered as ‘severe’ in accordance with current CSA standards, and the use of sulphate resistance cement (Type HS or HSb) is recommended for concrete in contact with the local soil. Furthermore, air entrainment should be incorporated into any concrete elements that are exposed to freeze-thaw to enhance its durability.

It should be recognized that there may be structural and other considerations, which may necessitate additional requirements for subsurface concrete mix design.

13 SITE SEISMIC CLASSIFICATION

Section 4.1.8 of the 2015 National Building Code of Canada (NBCC) provides a method of determining the classification of a site for seismic activity, based on soil strength characteristics. A seismic classification has been calculated for the site based on information obtained from the test holes and laboratory tests.

Table 13-1, below, outlines the requirements for site classification of soils within the upper 30 m, specified in Section 4.1.8 of the NBCC.

Table 13-1: Site Classification for Seismic Site Response

Site Class	Ground Profile Name	Average Properties in Top 30 m		
		Average Shear Wave Velocity, V_s (m/s)	**Average Standard Penetration Resistance, N_{60}**	**Soil Undrained Shear Strength, s_u (kPa)**
A	Hard *Rock*	$\bar{V}_{s30} > 1500$	N/A	N/A
B	*Rock*	$760 < \bar{V}_{s30} \leq 1500$	N/A	N/A
C	Very Dense *Soil* and Soft *Rock*	$360 < \bar{V}_{s30} < 760$	$\bar{N}_{60} > 50$	$s_u > 100$
D	Stiff Soil	$180 < \bar{V}_{s30} < 360$	$15 \leq \bar{N}_{60} \leq 50$	$50 < s_u \leq 100$
E	Soft *Soil*	$\bar{V}_{s30} < 180$	$\bar{N}_{60} < 15$	$s_u < 50$
		Any profile with more than 3 m of soil with the following characteristics • Plasticity index: PI > 20 • Moisture content: w ≥ 40%, and • Undrained Shear Strength: s_u < 25 kPa		
F	Other *Soils*(1)	Site-specific evaluation required		

(1) Other *Soils* include

(a) Liquefiable *soils*, quick and highly sensitive clays, collapsible weakly cemented *soils*, and other *soils* susceptible to failure or collapse under seismic loading;
(b) Peat and / or highly organic clays greater than 3 m in thickness;
(c) Highly plastic clays (PI >75) more than 8 m thick; and
(d) Soft to medium stiff clays more than 30 m thick

Typically, shear wave velocities have not been directly measured at each site for foundation investigation purposes in Manitoba. In the absence of local shear wave velocity data, the pocket penetrometer strength and SPT results obtained from the geotechnical investigation were used, with SPTs extrapolated to a depth of 30 m below the pile cap depth based on local geologic data assumed.

Based on available mappings, the soil profile conservatively consists of compact to dense till. Given this interpretation of the layer thicknesses and strength characteristics, average parameters indicate that the site should be classified as a Class D.

14 ENVIRONMENTAL SCREENING

As the Site has been historically used as a fertilizer facility, there is a potential for impacts to soil and groundwater quality at the Site from historic spills, leaks or releases of fertilizer and ammonia. To screen for potential environmental impacts, the field investigation included environmental field screening of soil samples recovered as part of the geotechnical investigation. The field screening was conducted in each of the geotechnical investigation test holes and consisted of hydrocarbon vapour screening and nitrite and nitrate screening.

The vapour screening included testing samples from each test hole to a depth of 6 m or to the termination depth of the test hole, whichever was shallower. Soil samples were field screened for combustible organic vapours using ambient temperature headspace (ATH) techniques and an RKI™ Eagle combustible vapour analyzer set in the no methane response mode. The ATH method involved partially filling and sealing disposable soil sample bags with soil and allowing the vapours to accumulate prior to analyzing the headspace. Accumulated vapours were measured in parts per million total organic vapours (ppmv). While soil vapours were collected, the results (320 ppm in test hole TH23-11 to 4300 ppm in test hole TH23-07) with no odours or staining observed, indicate the readings are a result of equipment error and should be discounted.

Field screening of nitrite and nitrates was completed using strips placed into a distilled water and soil mixture and compared to a chart that referenced approximate nitrite and nitrate values. The first four samples within each test hole were field screened using the nitrite-nitrate strips. The readings for nitrite were non-detect in all the samples that were screened. Nitrate values ranged from non-detect to 500 ppm. The test holes with the 500 ppm nitrate readings were TH23-02 (0.15 m and 0.76 m) and TH23-12 (1.5 m).

Field screened nitrate samples with a reading of 250 ppm were observed in:

— TH23-03 at 0.3 m;
— TH23-04 at 1.5 m;
— TH23-09 at 2.3 m; and
— TH23-12 at 0.3 m and 0.76 m.

Field screened nitrate samples with a reading of 100 ppm were observed in:

— TH23-02 at 1.5 m;
— TH23-06 at 2.3 m;
— TH23-08 at 0.76 m;
— TH23-09 at 0.76 m and 1.5 m; and
— TH23-12 at 2.3 m.

The remainder of the samples field screened for nitrate were below 100 ppm.

15 CONSTRUCTION MONITORING AND TESTING

All engineering design recommendations presented in this report are based on the assumption that an adequate level of testing and monitoring will be provided during construction by either the designer or other suitably qualified personnel. Furthermore, it is assumed that all construction will be carried out by a suitably qualified contractor experienced in earthworks construction. An adequate level of testing and monitoring is considered to be:

- for earthworks:
  - full-time monitoring of fill quality and subgrade conditions and compaction testing.
- for deep foundations:
  - review of foundation design prior to construction;
  - full-time monitoring during construction.
- for concrete construction:
  - testing of plastic and hardened concrete in accordance with the latest editions of CSA A23.1 and A23.2; and
  - review of concrete supplier's mix designs for conformance with prescribed and/or performance concrete specifications.

On the basis of the above, and given WSP's familiarity with the subsurface conditions at this site as the Geotechnical Engineer of Record, WSP requests the opportunity to review the design drawings to confirm that the geotechnical recommendations have been correctly interpreted. WSP would be pleased to provide further information that may be needed during design and to advise on the geotechnical aspects of specifications for inclusion in contract documents. WSP can provide design modifications as required at the time of construction should subsurface conditions be found to vary from those described herein.

16 CLOSURE

The findings and recommendations presented in this report were based on geotechnical evaluation of the subsurface conditions and limited groundwater data observed during the site investigation described in this report. If conditions other than those reported in this report are noted during subsequent phases of the project, or if the assumptions stated herein are not in keeping with the current and/or future design stage, this office should be notified immediately in order that the recommendations can be verified and revised as required. Recommendations presented herein may not be valid if an adequate level of inspection is not provided during construction, or if relevant building code requirements are not met.

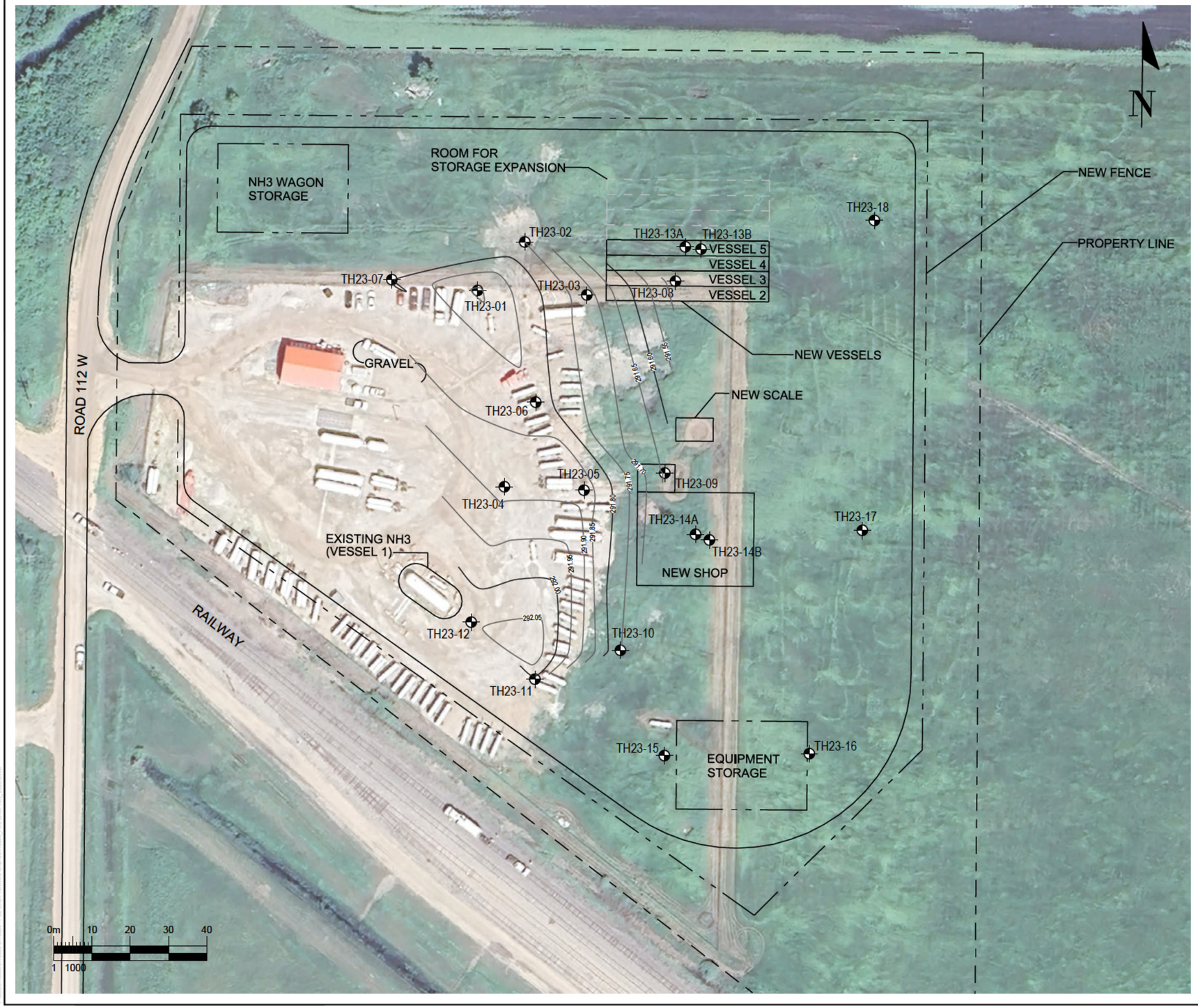
Soil conditions, by their nature, can be highly variable across a site. The placement of fill and prior construction activities on a site can contribute to the variability especially in near surface soil conditions. A contingency should always be included in any construction budget to allow for the possibility of variation in soil conditions, which may result in modification of the design and construction procedures.

This report has been prepared for the exclusive use of Federated Co-operatives Limited, and their agents, for specific application to the project described in this report. The data and recommendations provided herein should not be used for any other purpose, or by any other parties, without review and written advice from WSP. Any use that a third party makes of this report, or any reliance or decisions made based on this report, are the responsibility of those parties. WSP accepts no responsibility for damages suffered by a third party as a result of decisions made or actions based on this report.

This report has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, either expressed or implied, is made.

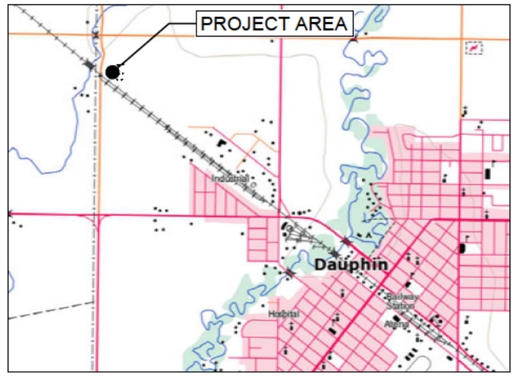
Respectfully submitted,

WSP E&I Canada Limited



LEGEND

TEST HOLE



NOTE
- SITE FEATURES ARE APPROXIMATE ONLY.
- IMAGE FROM 2022 GOOGLE EARTH.

CLIENT
FEDERATED CO-OPERATIVES LIMITED

PROJECT
GEOTECHNICAL INVESTIGATION
PROPOSED CO-OP DEVELOPMENT
ROAD 112 W, DAUPHIN, MANITOBA

TITLE
SITE PLAN

CONSULTANT

MM-YYYY	AUGUST 2023
PREPARED BY:	DP
DRAWN BY:	MD
REVIEWED BY:	KE
APPROVED BY:	ID

PROJECT No.	PHASE	Rev.	FIGURE
WX19864	---	0	1

20 mm

APPENDIX A: TEST HOLE LOGS

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Maple Leaf Drilling Ltd.	TEST HOLE ID: **TH23-01**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Mobile B40	PROJECT No: WX19864
LOCATION: N5568970 E424120	DRILL METHOD: 125 mm SSA	ELEVATION: 291.91 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		GW	GRAVEL (FILL) - poorly graded, silty, loose to compact (inferred), tan brown		1			291
		CH	CLAY (TILL) - silty, trace to some sand, trace gravel, high plastic, moist, firm to stiff, grey		2			
1							Particle Size Analysis - Sample 2 @ 0.6m: Gravel= 2.2% Sand= 11.4% Silt= 30.9% Clay= 55.5%	
		ML/CL	SILT - some clay to clayey, medium plastic, very moist, soft, dark grey		3			
2			- below 1.5m, very moist					290
		SM	SAND (TILL) - and silt, trace gravel, poorly graded, fine grained, wet, compact (inferred), brown		4			
3			CLAY (TILL) - silty, sandy, trace gravel, low plastic, moist, stiff, brown		5			289
		CL						
4			- below 4.1m, very stiff, frequent silt till inclusions		6	35-50 /75		288
			AUGER REFUSAL AT 4.3m BELOW EXISTING GRADE					
5			Notes: - Sloughing and seepage observed below 1.5 m during drilling - Test hole remained open to 2.0 m with water accumulated to 2.0 m prior to backfilling - Test hole backfilled with auger cuttings and bentonite					287
6								286
7								285
8								284
9								283
10								282

WX19864 - FCL DAUPHIN - REV.GPJ 23/09/08 01:23 PM (WPG - GEOTECH LOG 4)

WSP E&I Canada Limited

LOGGED BY: DP	COMPLETION DEPTH: 4.3 m
REVIEWED BY: KE	COMPLETION DATE: August 10, 2023
Figure No. A1	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Maple Leaf Drilling Ltd.	TEST HOLE ID: **TH23-02**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Mobile B40	PROJECT No: WX19864
LOCATION: N5668984 E424131.2	DRILL METHOD: 125 mm SSA	ELEVATION: 291.75 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	SLOTTED PIEZOMETER SP23-02	COMMENTS	ELEVATION (m)
0		OH	ORGANIC CLAY - silty, high plastic, moist, dark grey, occasional rootlets		1				291
			CLAY - silty, medium plastic, very moist, soft, grey		2				
1		CI			3				
			CLAY (TILL) - silty, medium plastic, moist, firm to stiff, dark grey, frequent silt lenses (~1mm thick)		4			- Groundwater Monitored on September 26, 2023 = 1.25 m below ground - Groundwater Monitored on August 25, 2023 = 1.56 m below ground	290
2			below 1.6m, trace to some clay, sandy, trace to some gravel, low plastic, moist, stiff, brown		5				
		CI							289
3					6				
			- below 3.1m, very dense, frequent silt till inclusions		7	43-50 /75			
			AUGER REFUSAL AT 3.2m BELOW EXISTING GRADE						288
4									
5									287
6									286
7									285
8									284
9									283
10									282

Notes:
- Sloughing observed below 2.4 m during drilling
- Seepage observed below 1.6 m during drilling
- Test hole remained open to 2.4 m with no water accumulation above slough prior to backfilling
- 25 mm diameter PVC standpipe piezometer with 300 mm slotted section installed to 3.0 m below exisitng grade
- Test hole sloughed to 1.2 m during installation of standpipe
- Test hole backfilled with sand from 1.2 m to 0.9 m and bentonite from 0.9 m to grade

WX19864 - FCL DAUPHIN - REV.GPJ 23/10/13 10:56 AM (WPG - GEOTECH LOG 4)

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LOGGED BY: DP	COMPLETION DEPTH: 3.2 m
REVIEWED BY: KE	COMPLETION DATE: August 11, 2023
Figure No. A2	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Maple Leaf Drilling Ltd.	TEST HOLE ID: **TH23-02A**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Mobile B40	PROJECT No: WX19864
LOCATION:	DRILL METHOD: 125 mm SSA	ELEVATION: 291.75 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		OH	ORGANIC CLAY - silty, high plastic, moist, dark grey, occasional rootlets					291
1		CI	CLAY - silty, medium plastic, very moist, soft, grey		1			290
2			TEST HOLE TERMINATED AT 1.2m BELOW EXISTING GRADE				Stratigraphy taken from TH23-02	289
3								288
4								287
5								286
6								285
7								284
8								283
9								282
10								

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LOGGED BY: DP	COMPLETION DEPTH: 3.2 m
REVIEWED BY: KE	COMPLETION DATE: August 11, 2023
Figure No. A3	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Maple Leaf Drilling Ltd.	TEST HOLE ID: **TH23-03**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Mobile B40	PROJECT No: WX19864
LOCATION: N5668970 E424148	DRILL METHOD: 125 mm SSA	ELEVATION: 291.72 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		OH	ORGANIC CLAY - silty, high plastic, moist, firm, dark grey		1			
		CI	CLAY - silty, medium plastic, moist, firm, grey		2			291
1			CLAY (TILL) - sandy, silty, trace gravel, low plastic, very moist, soft to firm, brownish grey		3			
2			- below 2.1m, greyish brown		4			290
3					5			
			- below 3.1m, compact		6	18		289
4		CL						
			- below 4.5m, damp, frequent silt till inclusions		7			288
5					8	20		
								287
6					9			
					10	29		286
7			AUGER REFUSAL AT 7.1 m BELOW EXISTING GRADE Notes: - Sloughing observed below 2.4 m during drilling - Seepage observed below 0.3 m during drilling - Test hole remained open to 2.4 m and water level measured at 1.2 m prior to backfilling - Test hole backfilled with auger cuttings and bentonite		11	10 /0	- SPT at 7.0m bouncing with no advance	285
8								284
9								283
10								282

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LOGGED BY: DP	COMPLETION DEPTH: 7 m
REVIEWED BY: KE	COMPLETION DATE: August 10, 2023
Figure No. A4	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Maple Leaf Drilling Ltd.	TEST HOLE ID: **TH23-04**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Mobile B40	PROJECT No: WX19864
LOCATION: N5668920 E424126	DRILL METHOD: 125 mm SSA	ELEVATION: 291.88 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		GP	GRAVEL (FILL) - poorly graded, damp, loose to compact (inferred), tan brown		1			291
1		CI	CLAY - silty, medium plastic, very moist, soft, grey		2			290
2			CLAY (TILL) - silty, trace sand, trace gravel, low plastic, moist, soft, brown		3		- Groundwater Monitored on September 26, 2023 = 2.25 m below ground	289
3		CL	below 2.2m, frequent silt till inclusions		4			288
					5		- Groundwater Monitored on August 25, 2023 = 2.87 m below ground	
			- below 3.0m, damp, very dense		6	42-50 /100		
4			TEST HOLE TERMINATED AT 3.2 m BELOW EXISTING GRADE					287
5			Notes: - Sloughing observed below 1.8 m during drilling - Seepage observed below 2.1 m during drilling - Test hole remained open to 1.8 m with water accumaulated to 1.8 m prior to backfilling - 25 mm diameter PVC standpipe piezometer with 300 mm slotted section installed to 3.0 m below existing grade - Test hole sloughed to 1.2 m during installation of standpipe - Test hole backfilled with sand from 1.2 m to 0.9 m and bentonite from 0.9 m to grade					286
6								285
7								284
8								283
9								282
10								

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LOGGED BY: DP	COMPLETION DEPTH: 3 m
REVIEWED BY: KE	COMPLETION DATE: August 11, 2023
Figure No. A5	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Maple Leaf Drilling Ltd.	TEST HOLE ID: **TH23-05**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Mobile B40	PROJECT No: WX19864
LOCATION: N5668920 E424146	DRILL METHOD: 125 mm SSA	ELEVATION: 291.88 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		GP	GRAVEL (FILL) - poorly graded, silty, loose to compact (inferred), tan brown		1			
			CLAY - silty, medium plastic, moist, firm, grey		2			
1		CI						291
			SILT - clayey, low plastic, very moist, soft (inferred), dark grey		3			
2		ML						290
			CLAY (TILL) - silty, trace sand, trace gravel, low plastic, very moist, firm to stiff, brown		4			
3		CL			5			289
4								288
					6			
			- below 4.5m, very dense		7	50 /125		
5			AUGER REFUSAL AT 4.6m BELOW EXISTING GRADE					287
			Notes:					
			- No sloughing observed suring drilling					
			- Seepage observed below 2.2 m during drilling					
			- Test hole remained open to 4.6 m with water accumulated to 4.0 m prior to backfilling					
			- Test hole backfilled with auger cuttings and bentonite					
6								286
7								285
8								284
9								283
10								282

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LOGGED BY: DP	COMPLETION DEPTH: 4.6 m
REVIEWED BY: KE	COMPLETION DATE: August 10, 2023
Figure No. A6	Sheet 1 of 1

WX19864 - FCL DAUPHIN - REV.GPJ 23/09/08 01:23 PM (WPG - GEOTECH LOG 4)

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Maple Leaf Drilling Ltd.	TEST HOLE ID: **TH23-06**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Mobile B40	PROJECT No: WX19864
LOCATION: N5668942 E424134	DRILL METHOD: 125 mm SSA	ELEVATION: 291.83 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		GP	GRAVEL (FILL) - poorly graded, silty, loose to compact (inferred), tan brown		6			
					1			
		ML	SILT - clayey, low plastic, moist, soft (inferred), dark brown					
1			CLAY (TILL) - silty, trace sand, some gravel, low plastic, wet, soft to firm, brown		2			291
					3			
2		CL						290
			- below 2.0m, brown		4			
3					5			289
			TEST HOLE TERMINATED AT 3.0 m BELOW GRADE					
4			Notes: - Sloughing observed below 1.7 m during drilling - Seepage observed below 0.3 m during drilling - Test hole remained open to 1.7 m with water accumulated to 1.5 m prior to backfilling - Test hole backfilled with auger cuttings and bentonite					288
5								287
6								286
7								285
8								284
9								283
10								282

WX19864 - FCL DAUPHIN - REV.GPJ 23/09/08 01:23 PM (WPG - GEOTECH LOG 4)

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LOGGED BY: DP	COMPLETION DEPTH: 3 m
REVIEWED BY: KE	COMPLETION DATE: August 10, 2023
Figure No. A7	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Maple Leaf Drilling Ltd.	TEST HOLE ID: **TH23-07**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Mobile B40	PROJECT No: WX19864
LOCATION: N5668974 E424096.4	DRILL METHOD: 125 mm SSA	ELEVATION: 291.8 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0			CLAY - silty, high plastic, moist, stiff, dark grey		1			
		CH	- below 0.6m, high plastic, firm		2			291
1								
			CLAY (TILL) - silty, trace sand, low plastic, wet, soft to firm, dark grey		3			
			- below 1.8m, sandy, trace gravel, moist, firm to stiff, brown					290
2		CL	- below 2.2m, damp		4			
			- below 2.5m, frequent silt till inclusions		5			
			AUGER REFUSAL AT 2.75 m BELOW EXISTING GRADE Notes: - Sloughing observed below 1.5 m during drilling - Seepage observed below 1.2 m during drilling - Test hole remained open to 1.8 m with water accumulated to 1.5 m prior to backfilling - Test hole backfilled with auger cuttings and bentonite					289
3								
4								288
5								287
6								286
7								285
8								284
9								283
10								282

WX19864 - FCL DAUPHIN - REV.GPJ 23/09/08 01:23 PM (WPG - GEOTECH LOG 4)

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LOGGED BY: DP	COMPLETION DEPTH: 2.7 m
REVIEWED BY: KE	COMPLETION DATE: August 11, 2023
Figure No. A8	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Maple Leaf Drilling Ltd.	TEST HOLE ID: **TH23-08**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Mobile B40	PROJECT No: WX19864
LOCATION: N5668974 E424170.5	DRILL METHOD: 125 mm SSA	ELEVATION: 291.47 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		CI/CH	CLAY - silty, trace sand, medium to high plastic, moist, firm to soft, dark grey, occasional silt till inclusions		1			291
1		CL	CLAY (TILL) - silty some sand, trace gravel, low plastic, very moist, soft to firm, dark brown		2			290
2		SP	SAND (TILL) - and silt, trace gravel, poorly graded, fine grained, wet, compact (nferred), brown		3			289
3		CI	CLAY (TILL) - silty, trace sand, trace gravel, medium plastic, moist, stiff, brown, frequent silt lenses (~5mm thick)		4			288
					5			287
			TEST HOLE TERMINATED AT 3.0 m BELOW EXISTING GRADE Notes: - Sloughing observed below 1.4 m during drilling - Seepage observed below 1.2 m during drilling - Test hole remained open to 1.4 m with water accumulated to 0.45 m prior to backfilling - Test hole backfilled with auger cuttings and bentonite					286
4								285
5								284
6								283
7								282
8								
9								
10								

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LOGGED BY: DP	COMPLETION DEPTH: 3 m
REVIEWED BY: KE	COMPLETION DATE: August 11, 2023
Figure No. A9	Sheet 1 of 1

WX19864 - FCL DAUPHIN - REV.GPJ 23/09/08 01:23 PM (WPG - GEOTECH LOG 4)

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Maple Leaf Drilling Ltd.	TEST HOLE ID: **TH23-09**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Mobile B40	PROJECT No: WX19864
LOCATION: N5668920 E424268	DRILL METHOD: 125 mm SSA	ELEVATION: 291.64 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0			CLAY (TILL) - silty, medium plastic, moist, firm to stiff, dark grey, frequent silt lenses (~1mm thick)		1			291
1		CI	- below 0.6m, and silt, trace sand, low plastic		2			
			SILT (TILL) - clayey, trace sand, trace gravel, low plastic, very moist, loose (inferred), brown, frequent clay lenses (~5mm thick)		3			290
2		ML	- below 2.1m, some sand, compact (inferred)		4			
3			TEST HOLE TERMINATED AT 3.0 m BELOW EXISTING GRADE Notes: - No sloughing observed - Seepage observed below 1.2 m during drilling - Test hole remained open to 3.0 m with water accumulated to 2.7 m prior to backfilling - Test hole backfilled with auger cuttings and bentonite		5			289
4								288
5								287
6								286
7								285
8								284
9								283
10								282

WX19864 - FCL DAUPHIN - REV.GPJ 23/09/08 01:23 PM (WPG - GEOTECH LOG 4)

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LOGGED BY: DP	COMPLETION DEPTH: 3 m
REVIEWED BY: KE	COMPLETION DATE: August 10, 2023
Figure No. A10	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Maple Leaf Drilling Ltd.	TEST HOLE ID: **TH23-10**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Mobile B40	PROJECT No: WX19864
LOCATION: N5668876 E424157	DRILL METHOD: 125 mm SSA	ELEVATION: 291.75 m

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		CI	CLAY - silty, medium plastic, moist, firm, dark grey		1			291
1			CLAY (TILL) - silty, some sand, trace gravel, low plastic, very moist, soft to firm, dark grey		2			
			- below 1.3m, sandy, wet, brown		3			290
2		CL			4			289
3					5			
			TEST HOLE TERMINATED AT 3.0 m BELOW GRADE Notes: - Sloughing observed below 2.1 m during drilling - Seepage observed below 0.6 m during drilling - Test hole remained open to 2.1 m with water accumulated to 1.8 m prior to backfilling - Test hole backfilled with auger cuttings and bentonite					288
4								287
5								286
6								285
7								284
8								283
9								282
10								

WX19864 - FCL DAUPHIN - REV.GPJ 23/09/08 01:23 PM (WPG - GEOTECH LOG 4)

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LOGGED BY: DP	COMPLETION DEPTH: 3 m
REVIEWED BY: KE	COMPLETION DATE: August 11, 2023
Figure No. A11	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Maple Leaf Drilling Ltd.	TEST HOLE ID: **TH23-11**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Mobile B40	PROJECT No: WX19864
LOCATION: N5668870 E424131.2	DRILL METHOD: 125 mm SSA	ELEVATION: 291.99 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		GP	GRAVEL (FILL) - poorly graded, silty, loose to compact (inferred), tan brown		1		- Auger encountered layer of compact 100 mm crushed limestone that it could not penetrate. - comapnion holes attempted at 3.0m intervals with same result	291
1			AUGER REFUSAL AT 0.6 m BELOW EXISTING GRADE Notes: - No sloughing or seepage observed during drilling - Test hole remained open to 0.6 m prior to backfilling - Test hole backfilled with auger cuttings					290
2								289
3								288
4								287
5								286
6								285
7								284
8								283
9								
10								

WX19864 - FCL DAUPHIN - REV.GPJ 23/09/08 01:23 PM (WPG - GEOTECH LOG 4)

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LOGGED BY: DP	COMPLETION DEPTH: 0.6 m
REVIEWED BY: KE	COMPLETION DATE: August 11, 2023
Figure No. A12	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Maple Leaf Drilling Ltd.	TEST HOLE ID: **TH23-12**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Mobile B40	PROJECT No: WX19864
LOCATION: N5668885 E424117.1	DRILL METHOD: 125 mm SSA	ELEVATION: 292.04 m

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		GP	GRAVEL (FILL) - poorly graded, silty, loose to compact (inferred), tan brown		1			
1		ML	SILT - clayey, low plastic, very moist, soft (inferred), brown		2			291
2		CL	CLAY (TILL) - silty, sandy, trace to some gravel, some gravel, low plastic, very moist, soft to firm, brown		3			290
3					4			289
					5			
4			TEST HOLE TERMINATED AT 3.0 m BELOW EXISTING GRADE Notes: - Sloughing observed below 2.3 m during drilling - Seepage observed below 2.1 m during drilling - Test hole remained open to 2.3 m with water accumulated to 2.1 m prior to backfilling - Test hole backfilled with auger cuttings and bentonite					288
5								287
6								286
7								285
8								284
9								283
10								

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LOGGED BY: DP	COMPLETION DEPTH: 3 m
REVIEWED BY: KE	COMPLETION DATE: August 11, 2023
Figure No. A13	Sheet 1 of 1

WX19864 - FCL DAUPHIN - REV.GPJ 23/09/08 01:23 PM (WPG - GEOTECH LOG 4)

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Paddock Drilling Ltd.	TEST HOLE ID: **TH23-13A**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Acker SS III	PROJECT No: WX19864
LOCATION: N5668983 E424173.1	DRILL METHOD: 125 mm SSA	ELEVATION: 291.57 m

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		OH	ORGANIC CLAY - silty, high plastic, moist, firm, dark grey, abudent roots		1			291
1		CH	CLAY - silty, high plastic, moist, firm to stiff, dark grey, occasional rootlets		2			
			SILT (TILL) - clayey, trace sand, low plastic, very moist, compact, brown, frequent clay lenses (~ 10mm thick)		3			290
2		ML			4	17		
			- below 2.3m, occasional clay lenses - below 2.4m, dark brown, occasional cobbles		5			289
3			CLAY (TILL) - silty, trace gravel, some sand, medium plastic, moist, hard, greyish brown, occasional silt pockets		6			
					7	44		288
4		CI			8			
					9	50		287
5			AUGER REFUSAL AT 4.7m BELOW EXISTING GRADE Notes: - Sloughing and seepage observed below 1.8m during drilling - Test hole remained open to 1.8m with water accumlated to 1.2m prior to backfilling - Test hole backfilled with auger cuttings and bentonite		10	/50		286
6								285
7								284
8								283
9								282
10								

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LOGGED BY: DP	COMPLETION DEPTH: 4.7 m
REVIEWED BY: ID	COMPLETION DATE: September 26, 2023
Figure No. A14	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Paddock Drilling Ltd.	TEST HOLE ID: **TH23-13B**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Acker SS III	PROJECT No: WX19864
LOCATION: N5668982 E424177.2	DRILL METHOD: 125 mm SSA	ELEVATION: 291.63 m

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		OH	ORGANIC CLAY - silty high plastic, moist, firm, dark grey, abudent roots					
1		CH	CLAY - silty, high plastic, moist, firm to stiff, dark grey, occasional rootlets				Companion test hole for TH23-13A. Soil Stratigraphy from grade to 4.7m assumed based on TH23-13A	291
2		ML	SILT (TILL) - clayey, trace sand, low plastic, very moist, compact (inferred), brown, frequent clay lenses (~ 10mm) - below 2.3m, occasional clay lenses - below 2.4m, dark brown, occasional cobbles					290
3		CI	CLAY (TILL) - silty, trace gravel, some sand, medium plastic, moist, hard, greyish brown, occasional silt pockets					289
4								288
5 ▼					11			287
6			AUGER REFUSAL AT 5.2m BELOW EXISTING GRADE Notes: - No sloughing observed during drilling - Seepage observed below 1.8m during dirlling - Test hole remained open to 5.2m with water accumulated to 5.0m prior to backfilling - Test hole backfilled with auger cuttings and bentonite					286
7								285
8								284
9								283
10								282

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LOGGED BY: DP	COMPLETION DEPTH: 5.2 m
REVIEWED BY: ID	COMPLETION DATE: September 26, 2023
Figure No. A15	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Paddock Drilling Ltd.	TEST HOLE ID: **TH23-14A**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Acker SS III	PROJECT No: WX19864
LOCATION: N5668907 E424175.8	DRILL METHOD: 125 mm SSA	ELEVATION: 291.67 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		OH	ORGANIC CLAY - silty, high plastic, moist, stiff, dark grey, occasional roots		1			291
		CH	CLAY - silty, high plastic, moist, very stiff, grey		2			
1			SILT (TILL) - sandy, trace clay, low plastic, wet, loose, dark grey		3			
			- below 1.2m, clayey, trace sand, very moist, brown, frequent clay lenses (~ 10mm thick)		4			
2					5	8		290
		ML			6			
3					7			289
			- below 3.2m, very dense		8	6-24-10 /0		
4			AUGER REFUSAL AT 3.7m BELOW EXISTING GRADE					288
			Notes:					
5			- No sloughing or seepage observed during drilling					287
			- Test hole remained open to 3.7m prior to backfilling					
6			- Test hole backfilled with auger cuttings and bentonite					286
7								285
8								284
9								283
10								282

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LOGGED BY: DP	COMPLETION DEPTH: 3.7 m
REVIEWED BY: ID	COMPLETION DATE: September 26, 2023
Figure No. A16	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Paddock Drilling Ltd.	TEST HOLE ID: **TH23-14B**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Acker SS III	PROJECT No: WX19864
LOCATION: N5668906 E424179.4	DRILL METHOD: 125 mm SSA	ELEVATION: 291.67 m

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		OH	ORGANIC CLAY - silty, high plastic, moist, stiff, dark grey, occasional roots				Companion test hole for TH23-14A. Soil Stratigraphy from grade to 3.7m assumed based on TH23-14A	291
1		CH	CLAY - silty, high plastic, moist, very stiff, grey					
2		ML	SILT (TILL) - sandy, trace clay, low plastic, wet, loose, dark grey - below 1.2m, clayey, trace sand, very moist, brown, frequent clay lenses (~ 10mm thick)					290
3			- below 3.2m, very dense					289
4		CL	CLAY (TILL) - silty, some sand, trace gravel low plastic, damp, very hard, dark brown, occasional cobbles		1			288
5					2	50 /125		287
6			- below 6.1m, brownish grey		3			286
7					4	40-30-50 /125		285
8		SM	SAND (TILL) - silty, trace gravel, poorly graded, fine to medium grained, very moist, dense, grey		5			284
9					6	47		283
10			- below 9.2m, very dense TEST HOLE TERMINATED AT 9.3m BELOW EXISTING GRADE Notes: - Sloughing observed below 2.9m during drilling - Seepage observed below 1.2m during drilling - Test hole remained open to 2.9m with no water accumulated above slough prior to backfilling - Test hole backfilled with auger cuttings and bentonite		7			282
11					8	29-21 /25		281
12								280

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LOGGED BY: DP	COMPLETION DEPTH: 9.3 m
REVIEWED BY: ID	COMPLETION DATE: September 26, 2023
Figure No. A17	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Paddock Drilling Ltd.	TEST HOLE ID: **TH23-15**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Acker SS III	PROJECT No: WX19864
LOCATION: N5668850 E424167.6	DRILL METHOD: 125 mm SSA	ELEVATION: 291.84 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		OH	ORGANIC CLAY - silty, high plastic, mosit, stiff, dark grey, occasional roots		1			
		CH	CLAY - silty, high plastic, moist, stiff, grey		2			291
1			CLAY (TILL) - sandy, silty, medium plastic, moist to very moist, firm, brown, abundant sand lenses		3			
					4	7		290
2					5			
		CI	- below 2.3m, silty to and silt - below 2.3m, trace sand, trace gravel, stiff, brown, occasional silt lenses					289
3					6			
					7	9		
			TEST HOLE TERMINATED AT 3.5m BELOW EXISTING GRADE Notes: - Sloughing and seepage observed below 1.2m - Test hole remained open to 2.3m with water accumulated to 2.2m prior to backfilling - Test hole backfilled with auger cuttings and bentonite					288
4								
5								287
6								286
7								285
8								284
9								283
10								282

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LOGGED BY: DP	COMPLETION DEPTH: 3.5 m
REVIEWED BY: ID	COMPLETION DATE: September 26, 2023
Figure No. A18	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Paddock Drilling Ltd.	TEST HOLE ID: **TH23-16**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Acker SS III	PROJECT No: WX19864
LOCATION: N5668850 E424205.5	DRILL METHOD: 125 mm SSA	ELEVATION: 291.68 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		OH	ORGANIC CLAY - silty, high plastic, moist, stiff, dark grey, occasional roots and sulphate inclusions		1			291
		CH	CLAY - silty, high plastic, firm, moist, mottled greyish brown		2			
1		ML	SILT - trace clay, low plastic, very moist, soft, dark grey		3			290
			CLAY (TILL) - silty, trace sand, high plastic, very moist, stiff, brown		4			
					5	14		
2			- below 1.8m, sandy, some gravel, occasional cobbles					289
			- below 2.1m, brown		6			
		CH						
3			- below 2.6m, frequent sand lenses		7			288
			- below 3.2m, damp, hard		8	18-36-50 /125		
			TEST HOLE TERMINATED AT 3.5m BELOW EXISTING GRADE Notes: - Sloughing and seepage observed below 1.2m during drilling - Test hole remained open to 2.4m with water accumulated to 2.3m prior to backfilling - Test hole backfilled with auger cuttings and bentonite					287
4								286
5								285
6								284
7								283
8								282
9								
10								

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LOGGED BY: DP	COMPLETION DEPTH: 3.5 m
REVIEWED BY: ID	COMPLETION DATE: September 26, 2023
Figure No. A19	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Paddock Drilling Ltd.	TEST HOLE ID: **TH23-17**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Acker SS III	PROJECT No: WX19864
LOCATION: N5668908 E424219.4	DRILL METHOD: 125 mm SSA	ELEVATION: 291.61 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

☒ POCKET PENETROMETER (kPa) ☒ 100 200 300 400

★ TORVANE (kPa) ★ 50 100 150 200

PLASTIC M.C. LIQUID 20 40 60 80

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		OH	ORGANIC CLAY - silty, trace sand, trace gravel, high plastic, moist, stiff, dark grey, occasional roots and cobbles		1			291
			CLAY - silty, high plastic, mosit, stiff, grey					
1		CH			2			
		MI	SILT - clayey, trace sand, medium plastic, very moist, dark grey		3			
		SP	SAND (TILL) - silty, poorly graded, fined grained, very moist, brown, frequent clay lenses (~ 10mm)		4			290
2			CLAY (TILL) - silty, some sand, medium plastic, very moist, soft, greyish brown		5			
		CI	- below 2.6m, and silt, trace gravel, low plastic, moist, compact, brown, occasional cobbles					289
3			TEST HOLE TERMINATED AT 3.0m BELOW EXISTING GRADE Notes: - Sloughing and seepage observed below 1.4m during drilling - Test hole remained open to 1.4m with no water accumulated above slough prior to backfilling - Test hole backfilled with auger cuttings and bentonite		6			288
4								
								287
5								
								286
6								
								285
7								
								284
8								
								283
9								
								282
10								

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LOGGED BY: DP	COMPLETION DEPTH: 3 m
REVIEWED BY: ID	COMPLETION DATE: September 27, 2023
Figure No. A20	Sheet 1 of 1

PROJECT: Proposed Dauphin Co-op Development	DRILLER: Paddock Drilling Ltd.	TEST HOLE ID: **TH23-18**
CLIENT: Federated Co-Operative Ltd.	DRILL RIG: Acker SS III	PROJECT No: WX19864
LOCATION: N5668989 E424222.5	DRILL METHOD: 125 mm SSA	ELEVATION: 291.43 m

SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

BACKFILL TYPE: Bentonite | Pea Gravel | Drill Cuttings | Grout | Slough | Sand

DEPTH (m)	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	ELEVATION (m)
0		OH	ORGANIC CLAY - silty, high plastic, moist, stiff, dark grey, occasional roots and sulphate inclusions		1			291
			CLAY - silty, high plastic, moist, stiff, grey					
1		CH			2			
			- below 1.1m, dark grey, soft					
			CLAY (TILL) - silty, some sand, trace gravel, low to medium plastic, very moist, firm, brown		3			290
2			- below 1.5m, some gravel, moist, brownish grey, occasional cobbles					
		CL-CI			4			289
			- below 2.3m, sandy					
3					5			288
			TEST HOLE TERMINATED AT 3.0m BELOW EXISTING GRADE Notes: - Sloughing observed below 1.5m during drilling - No seepage observed during drilling - Test hole remained open to 1.5m with no water accumulated above slough prior to backfilling - Test hole backfilled with auger cuttings and bentonite					
4								287
5								286
6								285
7								284
8								283
9								282
10								

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LOGGED BY: DP	COMPLETION DEPTH: 3 m
REVIEWED BY: ID	COMPLETION DATE: September 27, 2023
Figure No. A21	Sheet 1 of 1

APPENDIX B: GRANULAR FILL GRADATION AND DURABILITY SPECIFICATIONS

TABLE B-1: REQUIREMENTS FOR GRANULAR BASE COURSE

Gradation		**Aggregate Quality Requirements**
Sieve Size	Percent Passing (by dry mass)	The aggregate should have a minimum California Bearing Ratio (CBR) of 60 percent. The material passing the 0.425 mm sieve size should have a liquid limit of less than 25 and a plasticity index less than 6. The coarse fraction of the aggregate should have a maximum Los Angeles abrasion loss of 35%. The aggregate should consist of sound, durable particles of crushed rock, stone, gravel, sand and fine soil. It should not contain thin elongated particles, sods, topsoil, roots or plants. At least 35% of the material retained on the 4.75 mm sieve should consist of crushed particles, which are not shale or ironstone. A maximum of 12% of the material retained by weight on the 4.75 mm sieve may consist of shale and/or ironstone.
19 mm	100%	
16 mm	80 – 100%	
4.75 mm	40 – 70%	
2 mm	25 – 55%	
0.425 mm	15 – 30%	
0.075 mm	8 – 15%	

TABLE B-2: REQUIREMENTS FOR CRUSHED STONE BASE COURSE

Gradation		**Aggregate Quality Requirements**
Sieve Size	Percent Passing (by dry mass)	The aggregate should be crushed and have a minimum California Bearing Ratio (CBR) of 60 percent. The coarse fraction of the aggregate should have a maximum Los Angeles abrasion loss of 35%. The aggregate should consist of sound, durable crushed stone. It should not contain thin elongated particles, sods, topsoil, roots or plants. 100% of the material retained on the 4.75 mm sieve should consist of crushed stone.
19 mm	100%	
4.75 mm	35 – 70%	
0.425 mm	15 – 30%	
0.075 mm	6 – 17%	

TABLE B-3: REQUIREMENTS FOR GRANULAR SUB-BASE

Gradation		Aggregate Quality Requirements
Sieve Size	Percent Passing (by dry mass)	The aggregate should have a minimum California Bearing Ratio (CBR) of 30 percent. The material passing the 0.425 mm sieve size should have a liquid limit of less than 25 and a plasticity index less than 6. The coarse fraction of the aggregate should have a maximum Los Angeles abrasion loss of 40%. The aggregate should consist of sound, durable particles of crushed rock, stone, gravel, sand and fine soil. It should not contain thin elongated particles, sods, topsoil, roots or plants. At least 15% of the material retained on the 4.75 mm sieve should consist of crushed particles, which are not shale or ironstone. A maximum of 20% of the material retained by weight on the 4.75 mm sieve may consist of shale and/or ironstone.
38 mm	100%	
25 mm	85 – 100%	
4.75 mm	25 – 80%	
0.425 mm	15 – 40%	
0.075 mm	8 – 18%	

TABLE B-3: REQUIREMENTS FOR CRUSHED STONE SUB-BASE

Gradation		Aggregate Quality Requirements
Sieve Size	Percent Passing (by dry mass)	The aggregate should be crushed and have a minimum California Bearing Ratio (CBR) of 60 percent. The coarse fraction of the aggregate should have a maximum Los Angeles abrasion loss of 40%. The aggregate should consist of sound, durable crushed stone. It should not contain thin elongated particles, sods, topsoil, roots or plants. 100% of the material retained on the 4.75 mm sieve should consist of crushed stone.
50 mm	100%	
4.75 mm	25 - 80%	
0.075 mm	5 - 18%	

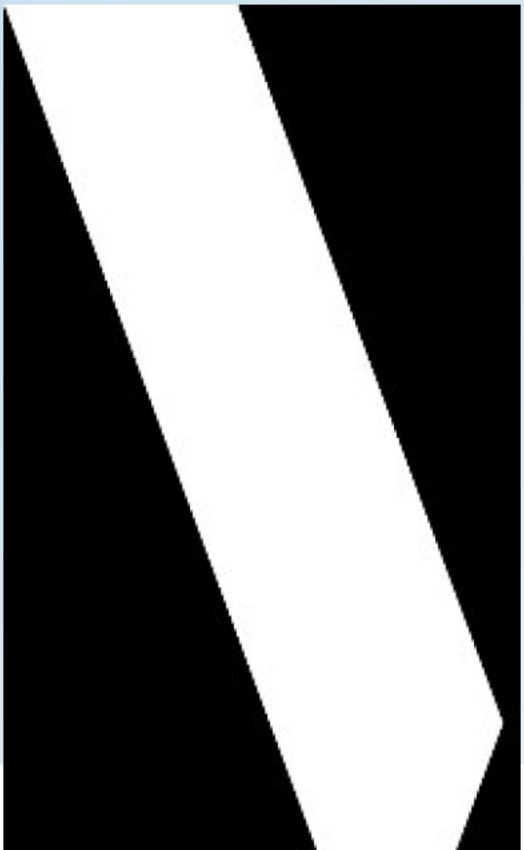
TABLE B-5: REQUIREMENTS FOR 100 MM CRUSHED ROCK BRIDGING MATERIAL

Gradation		**Aggregate Quality Requirements**
Sieve Size	Percent Passing (by dry mass)	The aggregate should be crushed and have a minimum California Bearing Ratio (CBR) of 60 percent. The coarse fraction of the aggregate should have a maximum Los Angeles abrasion loss of 40%. The aggregate should consist of sound, durable crushed stone. It should not contain thin elongated particles, sods, topsoil, roots or plants. 100% of the material retained on the 4.75 mm sieve should consist of crushed stone.
100 mm	97 - 100%	
25 mm	30 - 50%	
0.080 mm	8% max.	

TABLE B-6: REQUIREMENTS FOR 150 MM CRUSHED ROCK BRIDGING MATERIAL

Gradation		**Aggregate Quality Requirements**
Sieve Size	Percent Passing (by dry mass)	— The aggregate should be crushed and have a minimum California Bearing Ratio (CBR) of 60 percent. — The coarse fraction of the aggregate should have a maximum Los Angeles abrasion loss of 40%. — The aggregate should consist of sound, durable crushed stone. It should not contain thin elongated particles, sods, topsoil, roots or plants. 100% of the material retained on the 4.75 mm sieve should consist of crushed stone.
200 mm	100%	
150 mm	90 - 100%	
100 mm	65 - 85%	
25 mm	0 - 4%	

Appendix F
Limitations



Limitations

1. The work performed in the preparation of this report and the conclusions presented are subject to the following:
   a. The Standard Terms and Conditions which form a part of our Professional Services Contract;
   b. The Scope of Services;
   c. Time and Budgetary limitations as described in our Contract; and
   d. The Limitations stated herein.
2. No other warranties or representations, either expressed or implied, are made as to the professional services provided under the terms of our Contract, or the conclusions presented.
3. The conclusions presented in this report were based, in part, on visual observations of the Site and attendant structures. Our conclusions cannot and are not extended to include those portions of the Site or structures, which are not reasonably available, in WSP's opinion, for direct observation.
4. The environmental conditions at the Site were assessed, within the limitations set out above, having due regard for applicable environmental regulations as of the date of the inspection. A review of compliance by past owners or occupants of the Site with any applicable local, provincial, or federal bylaws, orders-in-council, legislative enactments, and regulations was not performed.
5. The Site history research included obtaining information from third parties and employees or agents of the owner. No attempt has been made to verify the accuracy of any information provided, unless specifically noted in our report.
6. Where testing was performed, it was carried out in accordance with the terms of our contract providing for testing. Other substances, or different quantities of substances testing for, may be present on-site and may be revealed by different or other testing not provided for in our contract.
7. Because of the limitations referred to above, different environmental conditions from those stated in our report may exist. Should such different conditions be encountered, WSP must be notified in order that it may determine if modifications to the conclusions in the report are necessary.
8. The utilization of WSP's services during the implementation of any remedial measures will allow WSP to observe compliance with the conclusions and recommendations contained in the report. WSP's involvement will also allow for changes to be made as necessary to suit field conditions as they are encountered.
9. This report is for the sole use of the party to whom it is addressed unless expressly stated otherwise in the report or contract. Any use which any third party makes of the report, in whole or the part, or any reliance thereon or decisions made based on any information or conclusions in the report is the sole responsibility of such third party. WSP accepts no responsibility whatsoever for damages or loss of any nature or kind suffered by any such third party as a result of actions taken or not taken or decisions made in reliance on the report, or anything set out therein.
10. This report is not to be given over to any third party for any purpose whatsoever without the written permission of WSP.
11. Provided that the report is still reliable, and less than 12 months old, WSP will issue a third-party reliance letter to parties that the client identifies in writing, upon payment of the then current fee for such letters. All third parties relying on WSP's report, by such reliance agree to be bound by our proposal and WSP's standard reliance letter. WSP's standard reliance letter indicates that in no event shall WSP be liable for any damages, howsoever arising, relating to third-party reliance on WSP's report. No reliance by any party is permitted without such agreement.