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January 28, 2025

Our Reference
Project No. 60735871

Agnes Wittmann
Director
Manitoba Environment and Climate Change
Environmental Approvals Branch
14 Fultz Boulevard
Winnipeg MB R3Y 0L6

RE: Rural Municipality (RM) of Stanley – Environment Act Proposal (EAP) Application

Dear Ms. Wittmann,

On behalf of the RM of Stanley enclosed is an Environment Act Proposal (EAP) application including an EAP report for the proposed development of a regional wastewater collection system within the RM of Stanley.

The RM of Stanley is planning to install new low pressure sewer collection systems (LPS) to service the communities of Schanzenfeld and Reinfeld, as well as installing two lift stations and two forcemains, to convey collected wastewater to the City of Winkler wastewater treatment facility lagoon.

If you have any questions regarding the proposed Project, please contact me at your earliest convenience.

Yours sincerely,

Marlene Gifford, M.Sc.
Biologist, Environmental Assessor
AECOM Canada ULC
T: 204-928-9210
E: marlene.gifford@aecom.com

cc: Colin Conrad, GIS and Engineering Manager, RM of Stanley
Bryce Wood, Environment Officer, Manitoba Environmental Approvals Branch

Environment Act Proposal Form

Manitoba

Name of the development:

RM of Stanley Regional Wastewater Collection System

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

Class 2 development "Pipe lines" under "Transportation and Transmission"

Legal name of the applicant:

Rural Municipality of Stanley

Mailing address of the applicant: 1-23111 PTH 14

Contact Person: Colin Conrad (GIS and Engineering Manager)

City: Stanley Province: Manitoba Postal Code: N/A

Phone Number: (204) 325-4101 Fax: email: cconrad@rmofstanley.ca

Location of the development: Rural Municipality of Stanley

Contact Person: Colin Conrad (GIS and Engineering Manager)

Street Address: N/A

Legal Description: As described in Environment Act Proposal Sec. 1.3

City/Town: N/A Province: Manitoba Postal Code: N/A

Phone Number: (204) 325-4101 Fax: email: cconrad@rmofstanley.ca

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

Marlene Gifford, M.Sc., P.Biol., R.P.Bio. AECOM Canada Ltd.

Phone: (204) 430-5633

Fax:

Mailing address: 99 Commerce Dr.
Winnipeg, MB
R3P 0Y9

Email address: marlene.gifford@aecom.com

Webpage address:

Date: 28 Jan 2025

Signature of proponent, or corporate principal of corporate proponent:

[redacted]

Printed name: Colin Conrad, C.E.T.

PRINT RESET

A complete **Environment Act Proposal (EAP)** consists of the following components:

- [X] **Cover letter**
- [X] **Environment Act Proposal Form**
- [X] **Reports/plans supporting the EAP** (see "Information Bulletin - Environment Act Proposal Report Guidelines" for required information)
- [X] **Application fee** (Cheque, payable to Minister of Finance, for the appropriate fee)

Per Environment Act Fees Regulation (Manitoba Regulation 168/96):

Class 1 Developments	$1,000
Class 2 Developments	$7,500
Class 3 Developments:	
Transportation and Transmission Lines	$10,000
Water Developments	$60,000
Energy and Mining	$120,000

Submit the complete EAP to:
Director
Environmental Approvals Branch
Environment and Climate Change
Box 35, 14 Fultz Boulevard
Winnipeg MB R3Y 0L6
EABDirector@gov.mb.ca

For more information:
Toll-Free: 1-800-282-8069
Phone: 204-945-8321
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Rural Municipality of Stanley

Regional Wastewater Conveyance System

Environment Act Proposal

FINAL

Prepared by:

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Prepared for:

Rural Municipality of Stanley
1-23111 PTH 14
Stanley MB R6P 0B1

Date: January 28, 2025

Project #: 60735871

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Nathan Wittmeier, P. Eng., M.T.S
Chief Engineer
Manitoba Water Services Board
2010 Currie Blvd.
Brandon, MB R7A 6Y9

January 28, 2025

Project #
60735871

Dear Mr. Wittmeier:

Subject: Rural Municipality of Stanley - Regional Wastewater Conveyance System Environment Act Proposal – Final

Please find enclosed the Environment Act Proposal and supporting information for the proposed regional wastewater conveyance system for the Rural Municipality (RM) of Stanley, Manitoba for consideration by the Manitoba Environmental Approvals Branch.

Should you have any questions regarding the in this report, please do not hesitate to contact Paul Barsalou at 204-781-2897.

Sincerely,
AECOM Canada ULC

[redacted]

Paul Barsalou, M.Sc., P.Eng.
Senior Project Manager
Water/Wastewater
MG/PB/LC/pab
Encl.

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Executive Summary

The population of the Rural Municipality (RM) of Stanley consists of several communities, including Schanzenfeld and Reinfeld. The existing wastewater collection system in both communities is comprised of sewage holding tanks which are regularly pumped out. Collected wastewater is currently hauled by truck to the City of Winkler wastewater treatment facility (WWTF) for treatment.

The RM of Stanley is planning to install new low pressure sewer (LPS) conveyance systems to service the communities of Schanzenfeld and Reinfeld, as well as installing two (2) lift stations and two (2) force mains, to convey collected wastewater to the City of Winkler WWTF lagoon. The components and works associated with this development are collectively referred to as the "Project" within this Environment Act Proposal (EAP). The Project is located primarily on previously disturbed land, within maintained (mowed) existing road RoWs, and adjacent to agricultural fields.

This Project will be reviewed by Manitoba Environmental Approvals Branch under *The Environment Act* as a "pipe line" greater than 10 km in length which is a Class 2 development in section 3 of the Classes of Development Regulation under group 7 "Transportation and Transmission". An Environment Act Licence (EAL) will be required for the Project under *The Environment Act*.

The proposed Project schedule is as follows:

- **Construction Phase**: Approximately 18 months from Q2 2025 – Q4 2026
- **Operation and Maintenance Phase**: Beginning Q4 2026

LPSs and force mains will be installed by a combination of directional drilling and surface open cut trenching installation methods. Two (2) new lift stations will be constructed: the Schanzenfeld Lift Station and the Reinfeld Lift Station. The pumps for both lift stations will be located approximately seven (7) metres underground. Both lift stations will be designed to mitigate odour, noise and vibration. Chain link fences will be installed around each lift station. Operation of the pumps for the two (2) new lift stations will be powered by connection to the existing local Manitoba Hydro power lines. Each lift station will have backup diesel-powered generators installed which will be triggered to operate by an auto-transfer switch and alert to the RM of Stanley via fiber optic communication in the event of a power failure.

Traffic control and safety signage, such as reduced speed limits in construction zones, will be implemented during Project construction and maintenance activities in accordance with MWSB and AECOM traffic-related specifications, and in accordance with *The Highway Traffic Act* and its amendments (*The Highway Traffic Amendment Act*).

Approximately three (3) separate contractors will be required to construct the Project. Local and/or other contractors retained for Project construction may require additional staff during the approximate 18-month Project construction phase.

An additional employment position may be required by the RM of Stanley for ongoing maintenance duties during the Project operation and maintenance phase. The employment position may include an operator for lift station operation or general force main/low pressure sewer maintenance position.

While measurable disturbances will be imposed on natural geologic and topographic features, disturbances will be limited to the Project Site. Mitigation measures applied will include using directional drilling in specified locations (e.g., under road/rail crossings and waterways) and Project construction in accordance with recommendations within geotechnical investigation reports for the Project Site and relevant MWSB Standard Construction Specifications. With the application of the above mitigation measures, impacts on topography have been assessed as being minor because disturbed land will be leveled, graded and rehabilitated. The extracted subsurface material that will be

removed to accommodate placement of Project components will not be replaced; therefore, minor impacts to the geology will be irreversible/permanent.

To mitigate the potential for soil erosion and contamination, the following measures will be incorporated:

- Erosion and sediment control mitigation measures as outlined in MWSB and AECOM specifications for the construction contractor will be implemented for all phases of the Project.
- Surplus excavated soil (if any) will be transported to a stockpile area approved by the RM of Stanley (bedrock or big boulders were not found in the proposed development area).
- The landscape will be leveled and graded, and disturbed areas will be revegetated with a seed mix as quickly as feasible to stabilize the soil and minimize soil erosion.
- Installation of Project components (e.g., wastewater conveyance piping) will be constructed in accordance with relevant MWSB Standard Construction Specifications.
- Measures to avoid spills and leaks will be implemented.
- For the open cut method of pipe installation, sloped trench walls will be specified to mitigate risks of wall collapsing. Trenchless methods of pipe installation will be used where open cut method is not feasible.

With the application of the above mitigation measures, the potential for soil erosion, soil contamination and associated adverse impacts to the surrounding environment are anticipated to be minor and restricted to the Project Site.

To mitigate the effects of the Project on groundwater, the following measures will be incorporated:

- Installation of Project components (e.g., wastewater conveyance piping) will be constructed in accordance with relevant MWSB Standard Construction Specifications.
- The installation of Project components will be done as per recommendations within geotechnical investigation reports for the Project Site and in accordance with a dewatering system plan.
- Measures to avoid spills and leaks will be implemented.

With the application of the above mitigation measures, the potential for adverse impacts to groundwater, and associated adverse impacts to the surrounding environment, are anticipated to be minor.

Measures that will be applied to minimize potential Project effects to air quality include the following:

- Idling of motorized equipment will be minimized to the extent feasible.
- Equipment and vehicles will be properly maintained.
- The two (2) new lift stations will include odour control units.

With the application of the above measures, impacts on air quality are expected minor to negligible, and sufficiently mitigated.

Greenhouse gases (GHGs) emitted by Project construction and maintenance/repair machinery will be minor and intermittent during construction and operation/maintenance phases. The pumps for the two (2) Project lift stations will be powered by electricity supplied by connection to the existing local Manitoba Hydro electrical grid and will not emit GHGs.

The following measures will be implemented to reduce noise generated from Project construction, maintenance/repair and operation activities:

- Pumps for both lift stations will be located approximately seven (7) meters underground which will mitigate the potential for nuisance noise from the two (2) lift stations.
- Vibration controls pads to mitigate vibration and associated noise are incorporated into the design of the lift stations.

- Project construction, maintenance and repair activities will be done in accordance with MWSB Standard Construction Specifications which include compliance with applicable noise laws and regulations (e.g., RM of Stanley By-Law No. 8-19; City of Winkler By-Law No. 2139-15 providing for Public Safety, Health, Wellbeing and Regulating of Noises).
- Construction equipment and vehicles will be kept well maintained and will be fitted with mufflers, and other noise mitigation equipment as required.
- Unnecessary idling and revving of engines will be avoided.

In consideration of the above measures to minimize noise levels due to Project construction, maintenance/repair and operations, noise generated by the Project is assessed as minor and the potential noise levels at the nearest residences is expected to be adequately attenuated.

There is a very low potential for naturally vegetated areas to be affected by Project activities considering most of the Project Site is within maintained road RoWs and within developed residential areas. Additionally, the two (2) lift stations will be constructed on agricultural land within a very small total footprint area of approximately 0.4 ha. The following mitigation measures will be implemented to avoid or minimize potential effects on vegetation and potential for noxious weeds and clubroot spread:

- Directional drilling method rather than open cut trenching method for piping installation will occur at naturally vegetated areas adjacent to waterways; therefore, clearing of natural vegetation adjacent to waterways will not occur.
- Areas temporarily disturbed during Project construction and maintenance/repair, will be re-seeded in accordance with MWSB Standard Construction Specifications for seeding.
- Construction machinery travel will be limited to existing road RoWs and previously developed areas, and will not traverse across agricultural land.

With the application of the above mitigation measures, the overall Project impacts to vegetation are assessed as minor within the Project Site and Regional Study Area. Disturbance of naturally vegetated areas, where plant species of conservation concern are most likely to occur, will be avoided by Project activities. Therefore, the probability of plant Species at Risk and species of conservation concern being adversely affected by Project activities is negligible.

Naturally vegetated landcover, which provides quality wildlife habitat, is very minimal in the Regional Study Area. The limited amount of vegetation clearing needed within the Project Site for Project construction is associated with open cut trenching installation of the Project piping components within road RoWs, and construction of the two (2) lift stations on agricultural land. To mitigate potential adverse effects on wildlife, measures to mitigate noise and impacts to vegetation will be implemented. Vegetation clearing and open cut trenching within grassy road RoWs that do not undergo weekly mowing will be done outside of the breeding bird season (i.e., April 30 to August 18). With the application of the above mitigation measures, Project impacts to wildlife populations in the Regional Study Area and the Lake Manitoba Plain Ecoregion are assessed as negligible. Additionally, the risk of contravening wildlife protection legislation (e.g., *Migratory Birds Convention Act, 1994*) is considered sufficiently mitigated.

Project activities are expected to have a very low risk of affecting terrestrial Species at Risk due to the:

- Lack of natural vegetation/habitat cover types that maybe used by Species at Risk that may be affected by Project construction and operation/maintenance activities; and
- The application of measures to mitigate adverse effects of the Project on vegetation and wildlife in general.

Therefore, Project impacts to regional populations of Species at Risk and species of conservation concern at the Project Site and adjacent areas are assessed as negligible

Project construction and operation/maintenance activities will not directly affect surface water because no existing waterbody will be directly disturbed (e.g., by excavation) to accommodate the Project due to the use of directional drilling method to install Project components under the three (3) waterways that occur within the Project Site.

The potential for adverse effects of the Project on surface water quality is assessed as negligible due to the implementation of measures to avoid soil erosion and sedimentation, and contamination due to spills/leaks from Project construction and maintenance machinery.

The potential for adverse effects on fish and fish habitat are assessed as negligible because:

- Project construction and operation/maintenance activities will not directly affect surface water, i.e., no existing waterbody will be directly disturbed (e.g., by excavation) to accommodate the Project; and
- Measures to avoid introduction of deleterious substance into surface water will be applied.

To avoid the damaging existing underground infrastructure, the construction contractor will contact local utility and communications service providers to confirm the locations of existing underground infrastructure prior to proceeding with trenching activities. Directional drilling will be used to install Project piping under existing roads and the CP Rail track to avoid disruption to road and rail traffic. Therefore, the potential for damage to exiting infrastructure and associated services disruption is assessed as negligible.

Installation of the new wastewater conveyance system (i.e., the Project) will replace the need for truck transport of wastewater to the City of Winkler WWTF for the communities of Reinfeld and Schanzenfeld which together make up approximately 35% of the population of the RM of Stanley. This new infrastructure will result in an overall minor benefit to the environment due to:

- Reduced greenhouse gas (GHG) emissions from wastewater transport trucks; and
- Reduced potential for wastewater spills / leakage from holding tanks, septic fields, connectors and potential for spills/leakage from wastewater transport trucks.

Therefore, installation of the new wastewater conveyance system is expected to result in a minor, positive long-term effect on air quality by reducing emissions from water transport trucks, and will also mitigate the potential for wastewater spills / leakage.

A negligible change in land use will occur with the construction of the two (2) lift stations on a very small total area (0.4 ha) of agricultural land under agreement from the current landowners. Other Project components will be installed underground with the temporarily disturbed areas returned to pre-construction condition. Construction and future maintenance of the Project may result in temporary, minor disruptions in traffic movements. Traffic control and safety signage will be implemented. In summary, the Project will have a negligible effect on land and resource use.

Mitigation measures that will avoid or minimize potential adverse effects on human health are the following:

- Measures to avoid or minimize adverse effects on air quality and effects on climate will be applied.
- Measures to control noise will be applied.
- Directional drilling method will be used to install piping underground in front of residences and other buildings/businesses within the communities of Reinfeld and Schanzenfeld to maintain continuous vehicle access (e.g., ambulances and fire trucks).
- Traffic control and safety signage, such as reduce speed limits in construction zones, will be implemented in accordance with MWSB and AECOM traffic-related specifications, and in accordance with *The Highway Traffic Act* and its amendments (*The Highway Traffic Amendment Act*).
- Construction and maintenance contractors and employees will abide by the standards, procedures and training required under *The Workplace Safety and Health Act.*

- Development of the Project will comply with CP's Geotechnical Protocol for Pipeline and Utility Crossing(s) Under Railway Tracks (CP 2022) and other CP standards, safety measures and compliance during Project construction.
- Measures to avoid accidents and malfunctions will be implemented.

Through the implementation of the measures referenced above, the risk of adverse impacts to human health is assessed as being sufficiently mitigated.

The Project is not expected to adversely impact the exercise of Indigenous or Treaty rights because:

- Effects on fish or fish habitat are assessed as negligible;
- The Project is primarily located on previously disturbed public land with limited potential for Indigenous resource use (e.g., trapping, gathering) and no known use for cultural or traditional activities;
- The residual environmental impact of the Project on vegetation within the Project Site and Regional Study Area is assessed to be minor; and
- The residual environmental impact of the Project on regional wildlife populations is assessed to be negligible.

Manitoba Historic Resources Branch (HRB) has indicated that based on current data, the potential for the Project to impact heritage resources is low. A Heritage Resources Protection Plan (HRPP) will be prepared for the Project for reference during Project planning, development and operations in the event that heritage resources are accidentally encountered.

The construction contractor will have an environmental monitor on-site as part of the construction contractor staff to monitor and report on the adequacy of compliance with environmental mitigation measures required to be applied as per the construction contract, in accordance with conditions stipulated in an Environment Act Licence for this Project.

Following construction, the Project operations will undergo regular maintenance and monitoring by the RM of Stanley for wastewater leaks and to maintain proper function of the two (2) new lift stations. Additionally, the Project will be operated in accordance with conditions stipulated in an Environment Act Licence for this Project.

In summary, based on the proposed environmental mitigation measures, construction specifications that will be applied, and environmental monitoring and follow-up measures that will be implemented, adverse residual environmental effects resulting from the Project are expected to be sufficiently mitigated and are not likely to cause significant adverse environmental impacts.

List of Abbreviations

CO	Carbon monoxide, which is a component of mobile equipment exhaust emissions
CP	Canadian Pacific Railway
EAL	Environment Act Licence
EAP	Environment Act Proposal
EC	Environmental Component
GHG	Greenhouse Gas(es)
ha	Hectares
HRB	Historic Resources Branch
HRPP	Heritage Resources Protection Plan
km	Kilometre
LPS	Low pressure sewer
LSA	Local Study Area
m	Metre
mm	Millimetre
masl	Metres above sea level
mbgs	Metres below ground surface
MBESEA	*The Endangered Species and Ecosystems Act* (Manitoba)
MSTW	Morden, Stanley, Thompson and Winkler, in reference to the MSTW District
MWSB	Manitoba Water Services Board
NO_2	Nitrogen dioxide: produced in combustion processes (e.g., from nitrogen compounds in the fuel)
PTH	Provincial Trunk Highway
Q2	QX = year quarter (e.g., **Q2** = April through June timeframe)
RM	Rural Municipality
RoW	Right of way
RSA	Regional Study Area
SAGR	Submerged Attached Growth Reactor
SARA	*Species at Risk Act* (federal)
SC	Social Component
SO_2	Sulfur dioxide: which is a component of mobile equipment exhaust emissions
WWTF	Wastewater treatment facility

Terms / Glossary

Directional Drilling	Directional drilling, also known as horizontal directional drilling (HDD), is a trenchless method used to install underground piping with minimal surface disruption.
Force Main (FM)	Pressurized pipeline for the purpose of conveying sewage.
Greenhouse Gasses	Greenhouse gasses (GHGs) are gases in the earth's atmosphere that trap heat. They absorb infrared radiation emitted from the earth's surface and radiate it back, contributing to the greenhouse effect. Carbon dioxide is the most common GHG emitted by the combustion of fossil fuels such as gasoline, diesel and natural gas.
Lift Station (LS)	A lift station, is designed to move wastewater from one (1) location to another along a force main.
Low Pressure Sewer Line (LPS)	Pressurized pipeline for the purpose of collecting and conveying raw sewage generally within a town or village.
Right of Way / Rights of Way	A right of way (RoW) or rights of way is a legal right that allows a person or entity to pass through or use someone else's property. For example, Manitoba Transportation and Infrastructure rights of way are used to accommodate provincial highways/roads and adjacent ditches, shoulders and cleared areas for signage, utility corridors and traffic viewing clearance.
Submerged Attached Growth Reactor (SAGR®)	A Submerged Attached Growth Reactor is a technology that uses a stone bed with aeration and insulation to achieve full nitrification of lagoon effluent in cold water.

Table of Contents

page

1. General Information 1

1.1 Project Overview 1
1.2 Proponent Contact Information 1
1.3 Project Location, Land Ownership and Property Rights 1
1.4 Existing Land Use 1
1.5 Project Need and Future Planning 2
1.6 Project Alternatives 2
1.7 Project Connection to City of Winkler WWTF 4
1.8 Regulatory Framework 4
1.8.1 The Environment Act 4
1.8.2 Other Regulatory Approvals 4
1.9 Engagement 5
1.10 Funding 5
1.11 Project Schedule 5

2. Project Description 6

2.1 LPS and Force Mains 6
2.1.1 Directional Drilling Method 6
2.1.2 Open Cut Trenching Method 7
2.2 Lift Stations 7
2.2.1 Schanzenfeld Lift Station 7
2.2.2 Reinfeld Lift Station 7
2.3 Traffic Management 8
2.4 Employment 8
2.4.1 Construction Phase 8
2.4.2 Operation and Maintenance Phase 8

3. Scope of the Assessment 9

3.1 Temporal Boundaries 9
3.2 Spatial Boundaries 9
3.3 Biophysical and Socioeconomic Components 9

4. Existing Environment 10

4.1 Physical Environment 10
4.1.1 Geology/Topography 10
4.1.2 Soils 10

4.1.3 Groundwater 11
4.2 Atmospheric Environment 14
4.2.1 Air Quality 14
4.2.2 Noise 14
4.3 Terrestrial Environment 14
4.3.1 Vegetation 14
4.3.2 Wildlife 16
4.3.3 Species of Conservation Concern 16
4.3.4 Parks and Protected Areas 16
4.4 Aquatic Environment 16
4.4.1 Surface Water 16
4.4.2 Fish and Fish Habitat 16
4.5 Socioeconomic Environment 17
4.5.1 Infrastructure and Services 17
4.5.2 Land Zoning and Resource Use 17
4.5.3 Indigenous Communities 17
4.5.4 Heritage Resources 17

5. Environmental Assessment and Mitigation Measures 19

5.1 Effects Assessment Methods 19
5.2 Physical Environment 22
5.2.1 Geology/Topography 22
5.2.2 Soils 22
5.2.3 Groundwater 23
5.3 Atmospheric Environment 24
5.3.1 Air Quality 24
5.3.2 Climate/Greenhouse Gasses 24
5.3.3 Noise 25
5.4 Terrestrial Environment 26
5.4.1 Vegetation 26
5.4.2 Wildlife 26
5.4.3 Species of Conservation Concern 28
5.5 Aquatic Environment 28
5.5.1 Surface Water 28
5.5.2 Fish and Fish Habitat 29
5.6 Socioeconomic Environment 29
5.6.1 Infrastructure and Services 29
5.6.2 Land and Resource Use 30
5.6.3 Human Health 30
5.6.4 Indigenous Communities 31

5.6.5 Heritage Resources....31
5.7 Accidents and Malfunctions....32
5.7.1 Worker Health and Safety....32
5.7.2 Spills and Leaks....32
5.7.3 Power Failure....32

6. Follow-up and Monitoring....33

7. Conclusion....34

8. References....35

List of Tables

Table 1-1: Proponent Contact Information....1
Table 5-1: Environmental Component Potential Interaction with the Project....20
Table 5-2: Environmental Effects Assessment Criteria....21

List of Figures

Figure 1-1: Project Location....3
Figure 4-1: Topography....12
Figure 4-2: Soils....13
Figure 4-3: Cover Types in the Regional Study Area....15
Figure 4-4: Development Plan Designations....18

Appendices

Appendix A Status of Title Documents
Appendix B Private Land Easements Agreements
Appendix C Photographs – Existing Environment
Appendix D Pre-Design Study Report
Appendix E Draft Project Design Drawings
Appendix F Geotechnical Investigation Report
Appendix G Historical Resources Branch Communication
Appendix H Heritage Resources Protection Plan (Draft)

1. General Information

1.1 Project Overview

The population of the Rural Municipality (RM) of Stanley consists of several communities, including Schanzenfeld and Reinfeld. The existing wastewater collection system in both communities is comprised of sewage holding tanks which are regularly pumped out. Collected wastewater is currently hauled by truck to the City of Winkler wastewater treatment facility (WWTF) for treatment.

The RM of Stanley is planning to install new low pressure sewer (LPS) conveyance systems to service the communities of Schanzenfeld and Reinfeld, as well as installing two (2) lift stations and two (2) force mains, to convey collected wastewater to the City of Winkler WWTF lagoon. The components and works associated with this development are collectively referred to as the "Project" within this Environment Act Proposal (EAP). A map figure showing the locations of Project components is provided in **Figure 1-1**. Additional information regarding the Project is provided in **Section 2**.

1.2 Proponent Contact Information

Table 1-1: Proponent Contact Information

Name of Proponent	RM of Stanley
Address of Proponent	1-23111 PTH 14 Stanley, MB R6P 0B1
Principal Contact Person for the EAP	**Colin Conrad, GIS and Engineering Manager** Ph: 204-325-4101 Email: cconrad@rmofstanley.ca

1.3 Project Location, Land Ownership and Property Rights

The Project is located in southern Manitoba approximately 116 km south-west of Winnipeg as illustrated in **Figure 1-1**.

The two (2) proposed lift stations will be located on the RM of Stanley land. Status of Title documents for the RM of Stanly land parcels required for the lift stations are provided in **Appendix A**. Easement agreements, which include land title numbers and legal land descriptions, are provided in **Appendix B**.

The force main piping will be located primarily on Crown land in existing road rights of way[1] (RoWs) within the legal land descriptions as shown in **Figure 1-1**.

The LPS will be located on private residential land in the communities of Reinfeld and Schanzenfeld within the RM of Stanley.

1.4 Existing Land Use

The Project is located primarily on previously disturbed land, within maintained (mowed) existing road RoWs, and adjacent to agricultural fields as shown in **Figure 1-1**.

[1] *Road RoW width is 30 m wide, 15 m offset from road centre on each side.*

With the exception of the LPS component that will connect building wastewater conveyance systems in the communities of Schanzenfeld and Reinfeld with the new force main piping, the locations of the nearest residences from the other Project components are as follows:

- Approximately 318 metres (m) southeast from the Schanzenfeld Lift Station
- Approximately 99 m southwest from the Reinfeld Lift Station
- Approximately 26 m north from the force main (where open cut trench installation method is used)

Representative photographs of the existing environment and land uses at the Project site are provided in **Appendix C**.

1.5 Project Need and Future Planning

Wastewater from the RM of Stanley communities of Schanzenfeld and Reinfeld is currently treated in a combination of septic fields and trucked wastewater with holding tanks. The communities are growing and cannot necessarily support septic fields in a high density community. With the lot sizes, houses may not be able to replace failed septic fields or new houses may not be allowed septic systems to begin with. The area needs to migrate to the use of a centralized wastewater treatment plant to minimize the potential for septic field failures, groundwater contamination and ultimately to reduce overall costs. This should reduce long term costs and reduce overall greenhouse gas (GHG) emissions. The RM of Stanley plans on upgrading the wastewater system with a new low pressure sewer conveyance system (LPS) with lift stations and force mains as described in **Section 2**.

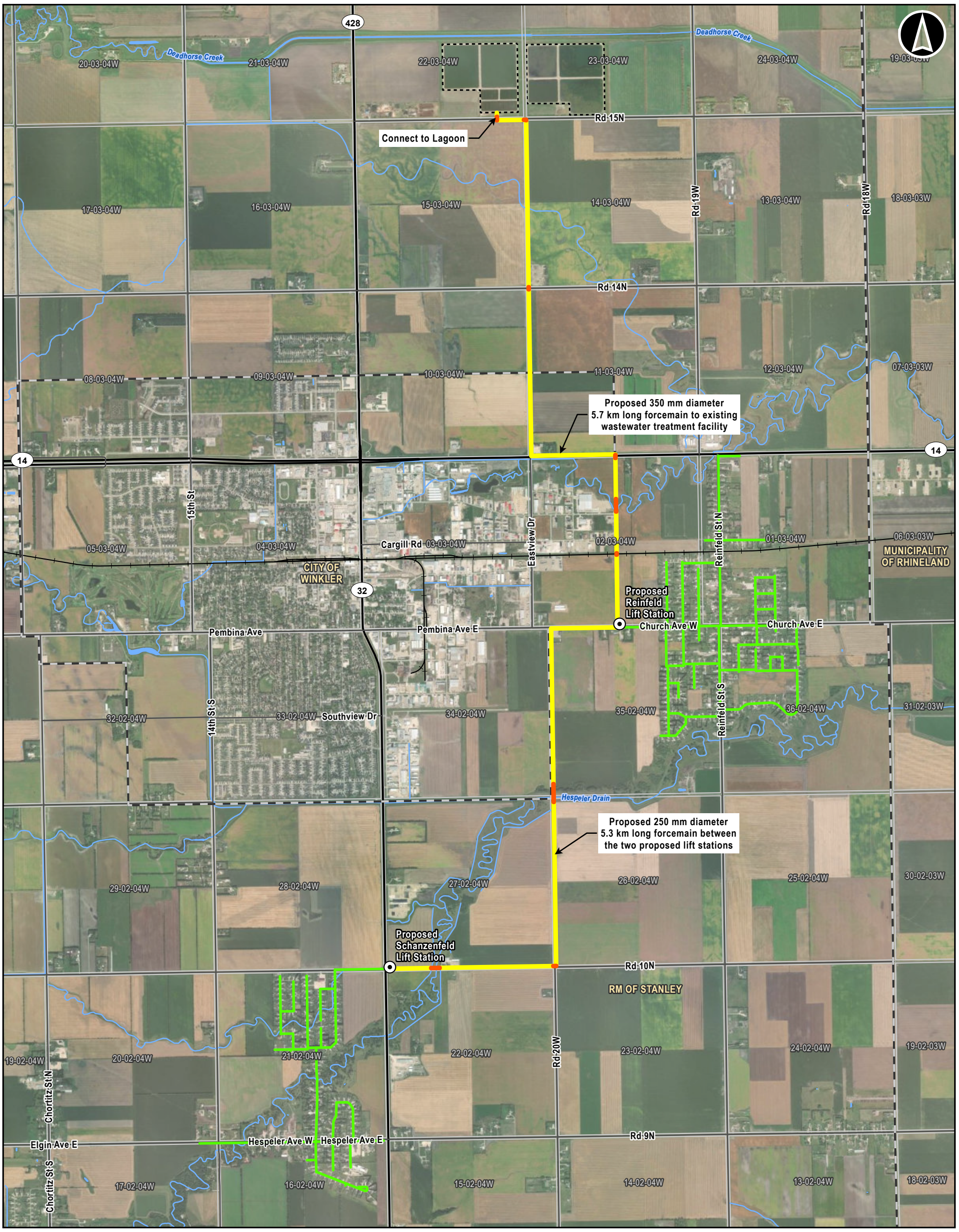
The RM of Stanley is also planning to install a new corridor with 90 lots for future dwellings along municipal roads 23W and 15N. All lots will be connected to a new sewer collection system dedicated to these lots, including a new lift station and force main flowing to the City of Winkler WWTF. Connection of this force main to the lagoon was included in the upgraded lagoon design parameters. Detailed design of this new corridor is by Stantec Consulting Ltd. Installation of the new force main will be within road rights-of-way.

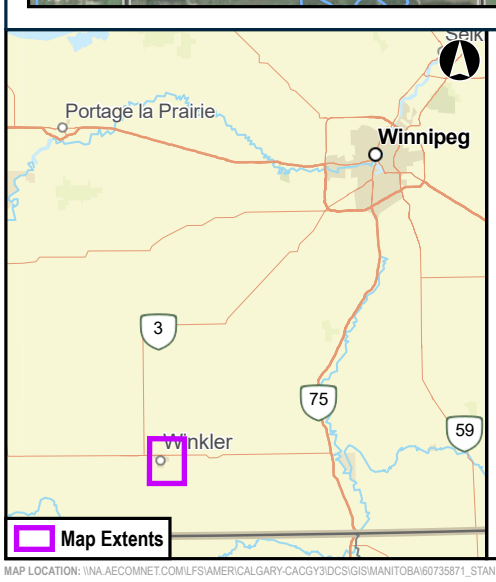
In the future, the RM is planning to install new piped sewer systems in other communities located south / south-west of Schanzenfeld. Force mains from these communities will be installed along municipal road rights-of-way. The proposed Schanzenfeld and Reinfeld Lift Stations were designed to accommodate some additional flow rates. At the time of this report, there is no information on potential flow rates from these communities and these new sewer collection systems are not part of the current detailed design.

1.6 Project Alternatives

To install the new LPS system, lift stations and force mains, land must be selected for development. The route shown in **Figure 1-1** was selected as it minimizes disturbance to natural vegetation and viable farmland. The low pressure component could be replaced with gravity flow systems, but these would be significantly more costly (need to be installed much deeper than LPS) and they would have disturbed substantially more land area during construction. For this reason the LPS was selected. The Pre-Design Study in **Appendix D** looks at the option of gravity and LPS, and recommends LPS for the communities.

Other options such as holding tanks and hauled waste systems may still be used for outlying systems, but they generally are more expensive to operate and they have a much higher greenhouse gas output.





Legend

City of Winkler Wastewater Treatment Facility Lagoons

Project Site

- Proposed Lift Station Location *
- Proposed Forcemain Pipeline (Installed by Open Cut Trench Excavation Method)
- Proposed Forcemain Pipeline (Installed by Directional Drilling)
- Proposed Low Pressure Sewer

General Features

- Highway
- Road
- Railway
- Watercourse
- Municipal Boundary

Note:
* The Schanzenfeld Lift Station Footprint will be 30 m x 66 m; and the Reinfeld Lift Station Footprint will be 45 m x 45 m

REGIONAL WASTEWATER CONVEYANCE SYSTEM
ENVIRONMENT ACT PROPOSAL
RM OF STANLEY

PROJECT LOCATION

0 0.3 0.6 0.9 1.2
Kilometres
Datum: NAD 1983 UTM Zone 14N

September 2024 | 1:35,000 * when printed 11"x17"

PN#: 60735871

Figure 1-1

AECOM

Data Sources: NRCan - Canvec, Manitoba Land Initiative
Esri Canada, Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NRCan, Parks Canada, Maxar

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1.7 Project Connection to City of Winkler WWTF

As indicated in **Section 1.1**, the Project force main will connect with the existing City of Winkler WWTF. A Notice of Alteration previously submitted to the Manitoba Environmental Approvals Branch describes the alterations to the City of Winkler WWTF that will accommodate the Project (Stantec Consulting Ltd. 2023).

The existing City of Winkler Aerated Lagoon is currently undergoing upgrading and expansion under Environment Act Licence (EAL) No. 2525RR. Installation of a new storage cell as well as a new multi-cell Submerged Attached Growth Reactor (SAGR®) system will be constructed to increase the City of Winkler WWTF capacity. Substantial completion of the upgrades to this system is currently scheduled for September 2026. Based on the "*City of Winkler Wastewater Treatment System Upgrade/Expansion – Notice of Alteration"* prepared and submitted to Manitoba Environment, Climate and Parks by Stantec Consulting Ltd. (2023), flows from both low-pressure sewer systems (i.e., the Project) were included in the design parameters of the upgraded City of Winkler Aerated Lagoon.

1.8 Regulatory Framework

1.8.1 The Environment Act

This Project will be reviewed by Manitoba Environmental Approvals Branch under *The Environment Act* as a "pipe line" greater than 10 km in length which is a Class 2 development in section 3 of the Classes of Development Regulation under group 7 "Transportation and Transmission". An Environment Act Licence (EAL) will be required for the Project under *The Environment Act*.

1.8.2 Other Regulatory Approvals

The RM of Stanley and Manitoba Water Services Board has been working with the City of Winkler regarding the proposed Project. The latest approved alteration to the City of Winkler's WWTF (EAL No. 2525 RR) provides for the alternations to the WWTF to accommodate the Project (**Section 1.7**).

The Project will be constructed under two (2) crossings of the Hespeler Drain, which is a designated Provincial Waterway under *The Water Resources Administration Act*. A permit under Section 15.2(1) of this legislation may be required prior to Project construction.

Project information will be provided to Canadian Pacific Railway (CP) for the purpose of entering into an agreement with CP's Public Works-Utilities department and provide CP with required information such Project compliance with CP's Geotechnical Protocol for Pipeline and Utility Crossing(s) Under Railway Tracks (CP 2022) and other CP standards, safety measures and compliance during Project construction.

Project information will be provided to Manitoba Transportation and Infrastructure to obtain required permitting and agreement to construct the Project within the RoW of Manitoba highways and to install the piping under Manitoba highways.

Project information will be provided to Manitoba Hydro to obtain required permitting and agreement to construct the Project near or under Manitoba Hydro utilities infrastructure. Confirmation of existence and location of all other existing services will be obtained from the individual utilities before proceeding with construction.

Project components will be installed in accordance with AECOM specifications and the Manitoba Water Services Board (MWSB) Standard Construction Specifications (Section 02 70 70) for highway, railway and utility crossings.[2]

[2] *MWSB construction specifications for highway, railway and utility crossings:* http://www.mbwaterservicesboard.ca/pubs/specs/2022/027070-highway-railway-utility-crossing-2022.pdf

No federal permit or approval is required for any aspect of the Project[3].

1.9 Engagement

Early public engagement regarding the potential for Reinfeld and Schanzenfeld to be part of a larger RM of Stanley new regional wastewater project was previously communicated in June 2021 on the RM of Stanley website[4].

The RM of Stanley is holding two (2) public Open House events on January 27 and 28, 2025 at the RM of Stanley office. The purpose of the Open House events is to communicate Project information, including Project cost, and obtain public feedback regarding the Project.

1.10 Funding

Funding for the Project is provided by Manitoba Water Services Board.

1.11 Project Schedule

The proposed Project schedule is as follows:

- **Construction Phase**: Approximately 18 months from Q2 2025 – Q4 2026
- **Operation and Maintenance Phase**: Beginning Q4 2026

[3] *The Project will not require work in fish-bearing waterbodies and Fisheries and Oceans Canada (DFO) methods to protect fish and fish habitat will be applied as needed; therefore, Project review and approval by DFO is not required.*

[4] *RM of Stanley website providing information on a "Possible Reinfeld/Schanzenfeld Extension" regarding wastewater conveyance is accessible at: https://www.rmofstanley.ca/p/possible-reinfeld-schanzenfeld-extension*

2. Project Description

The RM of Stanley is planning to install new LPS in the communities of Schanzenfeld and Reinfeld, as well as two (2) lift stations and two (2) force mains, to convey collected wastewater to the City of Winkler WWTF lagoon (**Figure 1-1**). Wastewater from the new Schanzenfeld Lift Station will be pumped to the new Reinfeld Lift Station via a new 250 mm, 5.3 km long force main. The Reinfeld Lift Station will pump wastewater collected from both communities to the City of Winkler WWTF lagoon via a new 350 mm, 5.7 km long force main. The force main piping from both communities will be installed along the existing municipal roads, within road rights-of-way.

A 20-year design projection was used to evaluate Project design populations and corresponding wastewater flow rates from the Schanzenfeld and Reinfeld communities as indicated in a pre-design report regarding the Project (AECOM 2016; **Appendix D**). The estimated 20-year design population in Reinfeld is 2,722 people[5], and the estimated design peak day wastewater flow is 30.7 L/s. The estimated 20-year design population in Schanzenfeld is 2,295 people, and the estimated design peak day wastewater flow is 27.2 L/s. To allow for additional future flow rates and population growth beyond the 20-year design period, the community of Schanzenfeld Lift Station and Force Main were designed for a design population of 3,443 people and a peak day flow of 46.06 L/s; the Reinfeld Lift Station and Force Main were designed for a population of 4,083 people and a combined peak day flow of 86.83 L/s. The Schanzenfeld Lift Station will require two (2) pumps (one (1) duty / one (1) stand-by) with a flow rate of 46.06 L/s at 23 m TDH each (excluding internal pump loses). The power requirement for this lift station is 600V / 3 phase. The Reinfeld Lift Station will have three (3) pumps (two (2) duty / one (1) stand-by), with design flow rate of 87 L/s at 42 m TDH (excluding internal pump loses) for two (2) pumps running together. The power requirement for this location is 230 V / 3 phase. The estimated velocities in the new 250 mm and 350 mm force main lines are 1.03 m/s and 1.14 m/s respectively.

Draft Project design drawings are provided in **Appendix E**. The Project will be constructed in accordance with relevant MWSB Standard Construction Specifications such as specifications for “Sewage Pumping Stations”, “Sewers” and “Pressure Pipelines” (MWSB 2022). Additional information regarding Project components and activities is provided below.

2.1 LPS and Force Mains

LPSs and force mains will be installed by a combination of directional drilling and surface open cut trenching installation methods. Temporarily disturbed areas will be restored to the existing condition and seeded with a standard seed mix as advised by Manitoba Transportation and Infrastructure standard construction specifications (MWSB 2022).

2.1.1 Directional Drilling Method

Directional drilling, also known as horizontal directional drilling, is a trenchless method used to install underground piping with minimal surface disruption. Directional drilling method will be used to install piping underground in the following locations:

- In front of residences and other buildings/businesses within the communities of Reinfeld and Schanzenfeld to maintain continuous vehicle access
- Existing roads
- CP Rail tracks
- Waterways

[5] *Population estimates used in the Project design for Reinfeld and Schanzenfeld were provided to AECOM by the RM of Stanley.*

2.1.2 Open Cut Trenching Method

Where open cut trenching method is used, a temporarily disturbed surface width of up to approximately 7 m will be required to accommodate piping installation activities. Piping will be installed to a minimum depth of 2.7 m, with no heat tracing required to prevent freezing. An example of the open cut trenching method is provided in **Photograph 2-1**.

Open Cut Trenching Method Example

Excavated material from the LPS and force main installation locations using the open cut trenching method will be temporarily stockpiled adjacent to the excavated trench for use as backfill within the trenched areas. Excavation works to install piping will be in accordance with the requirements of *The Workplace Safety and Health Act*, and all parts of the workplace safety and health regulation that apply to the excavation site. Adequate protection will be provided for pedestrian traffic that may come near the edge of the excavation.

2.2 Lift Stations

Two (2) new lift stations will be constructed: the Schanzenfeld Lift Station and the Reinfeld Lift Station (**Figure 1-1**). Both lift stations will be designed to mitigate odour, noise and vibration. Chain link fences will be installed around each lift station. The pumps for both lift stations will be located approximately 7 m underground and not in proximity to residences. Each lift station will have an odour control unit, including blowers, installed within a building to house electrical equipment for the lift stations. Blowers are required to supply air to the odour control units and will have noise canceling enclosures and vibration control pads.

Chain link fences will be installed around each lift station in accordance with MWSB construction specifications for “Fencing” (MWSB 2022). Construction of the lift stations will consider the construction recommendations provided by AECOM based on results of a geotechnical investigation conducted on October 23, 2017 (AECOM 2018). Operation of the pumps for the two (2) new lift stations will be powered by connection to the existing local Manitoba Hydro power lines. Each lift station will have backup diesel-powered generators installed which will be triggered to operate by an auto-transfer switch and alert to the RM of Stanley via fiber optic communication in the event of a power failure.

2.2.1 Schanzenfeld Lift Station

The new Schanzenfeld Lift Station will be located at the intersection of Provincial Trunk Hwy 32 and Road 10N, which is currently agricultural land (**Figure 1-1**). The footprint area of the Schanzenfeld Lift Station will be 30 m x 66 m and will consist of an underground, 2.7 m diameter precast concrete structure with duplex pumps. A new odour control unit and a building to house electrical equipment will be installed next to the station. Wastewater from the community will be collected by the new LPS and discharged into the Schanzenfeld Lift Station. A new 250 mm force main line will be connected to this lift station and flow to the new Reinfeld Lift Station.

2.2.2 Reinfeld Lift Station

The new Reinfeld Lift Station will be located west of Reinfeld, adjacent to Pembina Avenue E, which is currently agricultural land (**Figure 1-1**). The footprint area of the Reinfeld Lift Station will be 45 m x 45 m. This lift station will have a 4.0 m x 6.97 m rectangular concrete wet well, a new building to contain electrical equipment, and a new odour control unit. Wastewater produced within the community will be collected by the new LPS and discharged into the Reinfeld Lift Station. The combined sewage flow from both Schanzenfeld and Reinfeld will be pumped into the City of Winkler’s WWTF Lagoon via 350 mm force main.

2.3 Traffic Management

Traffic control and safety signage, such as reduced speed limits in construction zones, will be implemented during Project construction and maintenance activities in accordance with MWSB and AECOM traffic-related specifications, and in accordance with *The Highway Traffic Act* and its amendments (*The Highway Traffic Amendment Act*).

2.4 Employment

2.4.1 Construction Phase

Approximately three (3) separate contractors will be required to construct the Project. Local and/or other contractors retained for Project construction may require additional staff during the approximate 18-month Project construction phase (**Section 1.11**).

2.4.2 Operation and Maintenance Phase

An additional employment position may be required by the RM of Stanley for ongoing maintenance duties during the Project operation and maintenance phase. The employment position may include an operator for lift station operation or general force main/low pressure sewer maintenance position.

3. Scope of the Assessment

To assess the potential environmental impact of the proposed Project, spatial and temporal boundaries were defined as follows:

3.1 Temporal Boundaries

The temporal boundaries of the assessment are based on the timeframe during with Project effects may occur and area divided as follows:

- **Construction Phase**: Includes clearing for, and construction / installation of, components required for Project operations.
  - Period of approximately 18 months from Q2 2025 – Q4 2026
- **Operation and Maintenance Phase** – Duration of the functional use / operation of the Project including maintenance / repair as needed.
  - Beginning Q4 2026
- **Decommissioning Phase**
  - At this time, there are no plans to decommission the Project.

3.2 Spatial Boundaries

Spatial boundaries used for the assessment are described below. However, where specifically noted, the boundaries may be adjusted to suit the Environmental Component (EC), or Social Component (SC) affected.

Spatial Boundary Type	Description	Boundary
Project Site	Area subject to direct disturbance from the Project	The footprint of the Project (**Figure 1-1**).
Local Study Area (LSA)	Area where direct Project effects may occur	The footprint of the Project plus a 50 m radius
Regional Study Area (RSA)	Area where indirect Project effects may occur	A 500 m radius from the Project Site

3.3 Biophysical and Socioeconomic Components

In accordance with the “Information Bulletin – Environment Act Proposal Report Guidelines” (Manitoba Environment and Climate, 2023), the scope of the environmental assessment includes potential Project effects on the:

- Biophysical environment:
  - Including wildlife, fisheries, surface water, groundwater, and forestry resources
- Impact of such effects on the socioeconomic environment including:
  - Human health and safety
  - Heritage resources
  - Potential impacts on Indigenous communities such as resource use and cultural or traditional activities

Environmental assessment methods, including a specific list of the environmental components included within this assessment due to the potential for interactions with the Project, are described in **Section 5**.

4. Existing Environment

4.1 Physical Environment

4.1.1 Geology/Topography

Topography within the Regional Study Area is generally flat, ranging in elevation from 261 masl in the east to 280 masl in the south (**Figure 4-1**). Slope class of the land in the Regional Study Area is typically 0% to 2% (Manitoba Land Resource Unit 1998).

Within the Project Site and adjacent Local Study Area, elevations range from approximately 262 masl in the east to 278 masl in the south (**Figure 4-1**).

4.1.2 Soils

Surface soil textures within the Regional Study Area ranges from sandy to clayey (**Figure 4-2**; Manitoba Land Resource Unit 1998). Soil drainage ranges from imperfect to well-drained (Manitoba Land Resource Unit 1998). Water erosion risk ranges from moderate to negligible (Manitoba Land Resource Unit 1998).

Information regarding sub-surface soil stratigraphy within the Project Local and Regional Study Area is available from previous geotechnical investigations (**Appendix F**) and is summarized below.

Information regarding sub-surface soil stratigraphy in vacant farmland within the Regional Study Area is available from a geotechnical investigation for planned residential developments in the areas surrounding Reinfeld, Manitoba, including a location near Schanzenfeld, 1.5 km north of the City of Winkler where a total of 24 test holes were completed (TREK Geotechnical Inc. 2023; **Appendix F**). Sub-surface soil stratigraphy consisted of varying near-surface layers topsoil, clay, sand and silt, silt, or sand, over silty clay to the depth of exploration of test holes (up to 13.1 m depth; TREK Geotechnical Inc. 2023; **Appendix F**). The topsoil layer ranged from 0.075 to 0.9 m thick (TREK Geotechnical Inc. 2023; **Appendix F**). Underlying mix of silt and clay generally extended to depths ranging from 0.5 to 15.2 m. (TREK Geotechnical Inc. 2023; **Appendix F**).

Information regarding sub-surface soil stratigraphy at the proposed two (2) lift station locations is available from a Geotechnical Report by AECOM in 2018 and is provided within a Geotechnical Report by AECOM in **Appendix F**. The soil profile of the Schanzenfeld Lift Station site (TH17-01 and TH17-02) consisted of the following:

- Topsoil
    - 125 mm - 230 mm thickness
- Upper Complex (2.9 m and 3.9 m thickness)
    - Generally characterized by interlayered silts, sands and clays near ground surface that are comprised of a mixture of lacustrine and alluvial sediments with a description of generally brown, soft to firm, dry to wet and non-plastic to intermediately plastic.
- Glacio-lacustrine clay (extended to test hole termination depths of 10.7 m and 11. 2 m)
    - Generally silty clay with trance sand, with a description of generally brown, soft to firm, moist and highly plastic.

The soil profile of the Reinfeld Lift Station site (TH17-03; AECOM 2018) consisted of the following:

- Topsoil
    - 760 mm thickness
- Upper Complex (3.8 m thickness)

  - Generally characterized as sand and silt, containing some clay, light brown in colour, soft, moist to wet and of low plasticity.
- Glacio-lacustrine clay (extended to depth of test hole: 14.2 m)
  - Generally silty clay, dark brown, soft to firm, moist and highly plastic.

Information regarding sub-surface soil stratigraphy at the proposed two (2) CP Rail crossings is provided within a Geotechnical Report by AECOM in **Appendix F**. The soil encountered consisted of topsoil, clay fill, silt, sandy silt, clayey sand, lean clay, lean clay with sand, fat clay with sand and fat clay, respectively. The thickness of the topsoil was approximately 0.15 m in all test holes. The thickness of the clay fill ranged from 0.30 m to 1.22 m. Fat clay (CH) with sand was observed below the fat clay (CH) fill and with a thickness of approximately 2.29 m.

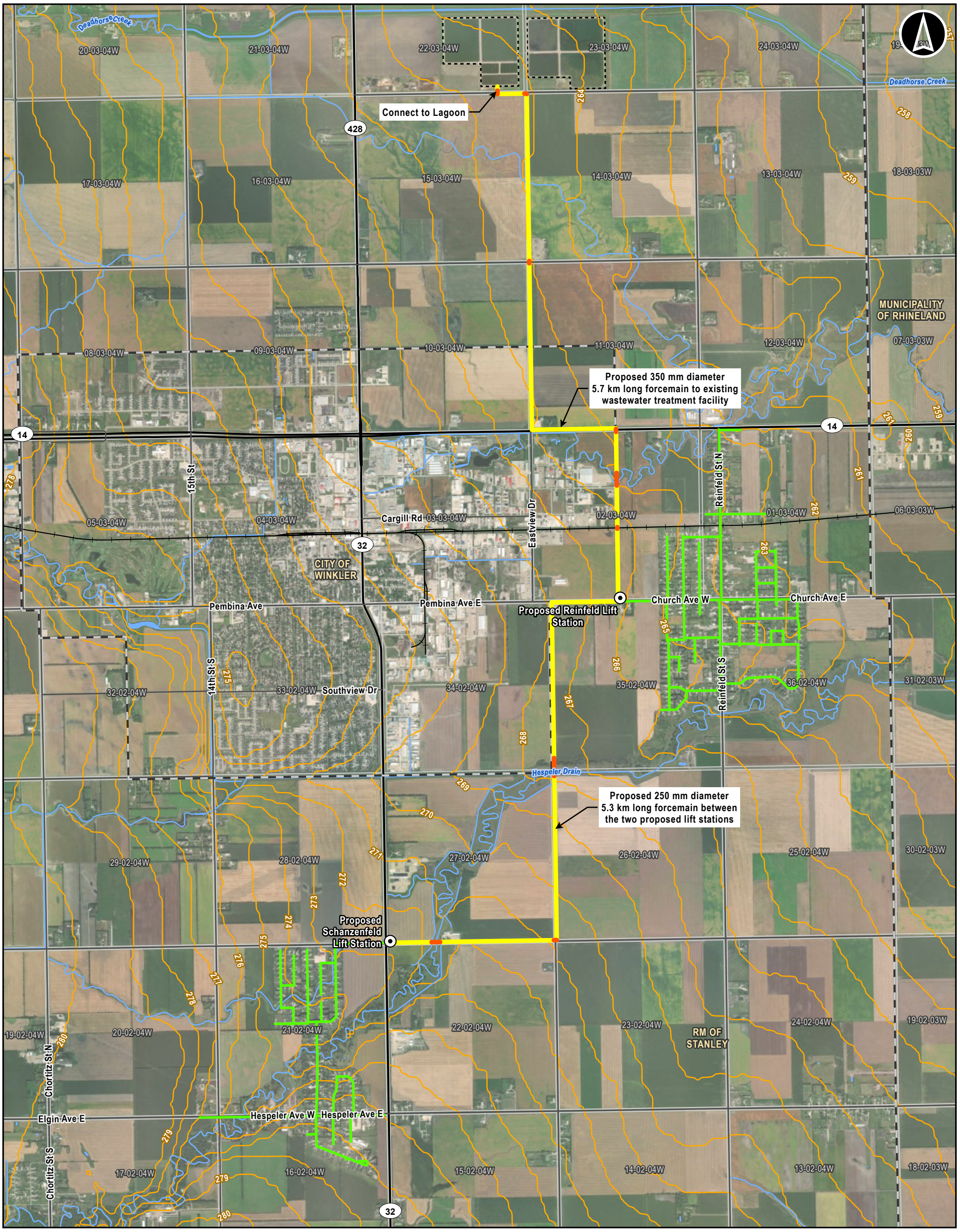
4.1.3 Groundwater

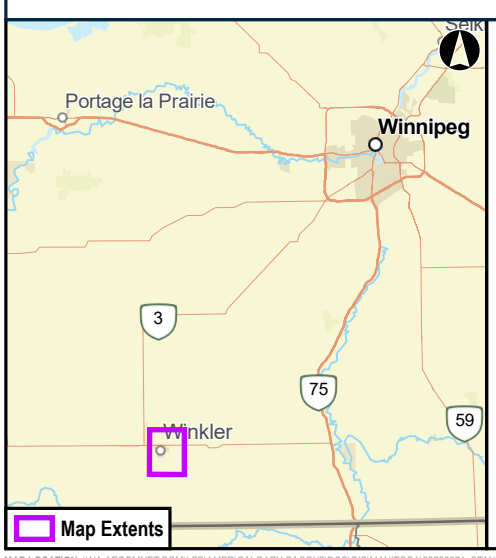
Information regarding groundwater conditions within the Regional Study Area is available in a geotechnical investigation report for planned residential developments in the areas surrounding Reinfeld, including a location near Schanzenfeld, 1.5 km north of the City of Winkler (TREK Geotechnical Inc. 2023; **Appendix F**). Depth to groundwater level ranged from 0.2 to 3.1 mbgs[6] during short-term test drilling during April, June and December 2022 (from Table 1 in TREK Geotechnical Inc. 2023; **Appendix F**), although determination of static groundwater levels would require monitoring for a year in duration. Sloughing and squeezing of sub-soil stratigraphy and seepage due to groundwater conditions occurred in 20 of 24 test drill holes, and was observed within silt and sand layers to depths of up to 4.9 m (**Appendix F**). The TREK Geotechnical Inc. report (**Appendix F**) indicated that available provincial groundwater information described similar groundwater conditions to those observed by these short-term drilling investigations within the Regional Study Area.

Information regarding groundwater on October 23, 2017, at the proposed two (2) lift station locations is available from a Geotechnical Memorandum by AECOM (2018) which is provided as an appendix in the Project Geotechnical Report in **Appendix F**. At the Schanzenfeld Lift Station location, groundwater seepage in two (2) test holes was observed at depths below 1.5 m and 2.1 m. Sloughing as influenced by groundwater conditions during testing at the Schanzenfeld Lift Station location was observed at depths below 3.0 and 4.6 m in the two (2) test holes. At the Reinfeld Lift Station location (one (1) test hole; AECOM 2018), groundwater seepage was observed at a depth below 2.1 m, with sloughing observed at a depth below 4.6 m.

Information regarding groundwater during Fall 2024, at the proposed two (2) CP Rail crossing locations, is available in the Project Geotechnical Report in **Appendix F**. Only short-term seepage and sloughing conditions were observed in the test holes (**Appendix F**).

[6] *mbgs = meters below ground surface*





Legend

City of Winkler Wastewater Treatment Facility Lagoons

Project Site

- Proposed Lift Station Location *
- Proposed Forcemain Pipeline (Installed by Open Cut Trench Excavation Method)
- Proposed Forcemain Pipeline (Installed by Directional Drilling)
- Proposed Low Pressure Sewer

General Features

- Highway
- Road
- Railway
- Watercourse
- Contours (1 m Interval)
- Municipal Boundary

Note:
* The Schanzenfeld Lift Station Footprint will be 30 m x 66 m; and the Reinfeld Lift Station Footprint will be 45 m x 45 m

REGIONAL WASTEWATER CONVEYANCE SYSTEM
ENVIRONMENT ACT PROPOSAL
RM OF STANLEY

TOPOGRAPHY

0 0.3 0.6 0.9 1.2
Kilometres
Datum: NAD 1983 UTM Zone 14N

September 2024 | 1:35,000 * when printed 11"x17"

PN#: 60735871

Figure 4-1

AECOM

Data Sources: NRCan - Canvec, Manitoba Land Initiative
Esri Canada, Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NRCan, Parks Canada, Maxar

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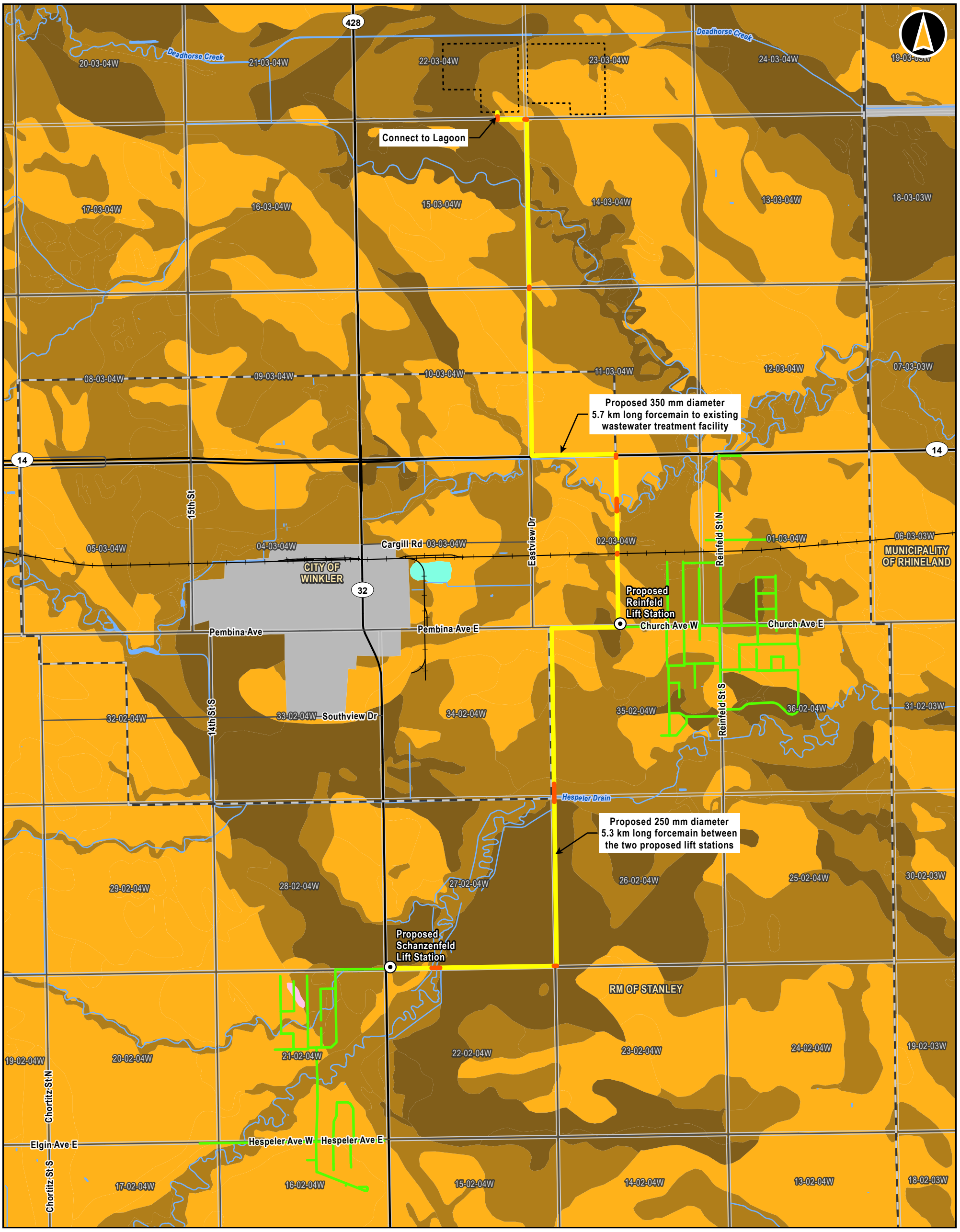

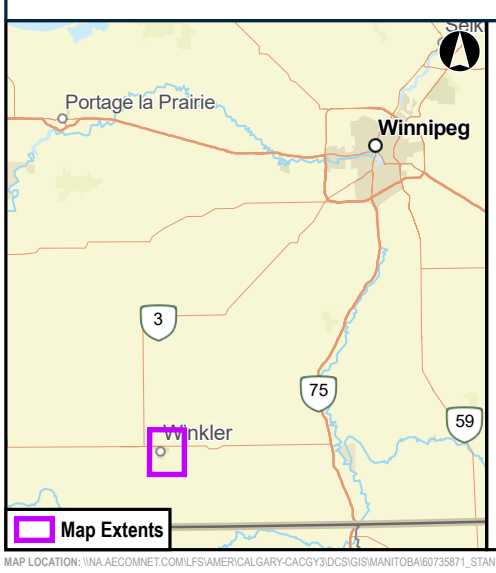

Legend

- City of Winkler Wastewater Treatment Facility Lagoons

Project Site

- Proposed Lift Station Location *
- Proposed Forcemain Pipeline (Installed by Open Cut Trench Excavation Method)
- Proposed Forcemain Pipeline (Installed by Directional Drilling)
- Proposed Low Pressure Sewer

General Features

- Highway
- Road
- Railway
- Watercourse
- Municipal Boundary

Surface Texture

- Sands
- Coarse Loamy
- Loamy
- Clayer
- Water
- Unclassified

Note:
* The Schanzenfeld Lift Station Footprint will be 30 m x 66 m; and the Reinfeld Lift Station Footprint will be 45 m x 45 m

REGIONAL WASTEWATER CONVEYANCE SYSTEM ENVIRONMENT ACT PROPOSAL RM OF STANLEY

SOILS

0 0.3 0.6 0.9 1.2
Kilometres
Datum: NAD 1983 UTM Zone 14N

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PN#: 60735871

Figure 4-2

AECOM

Data Sources: NRCan - Canvec, Manitoba Land Initiative; Soil Survey Manitoba
Esri Canada, Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NRCan, Parks Canada

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4.2 Atmospheric Environment

4.2.1 Air Quality

Influences on air quality at the Project Site and Regional Study Area are primarily associated with adjacent agriculture activities and traffic along roads adjacent to the Project Site (e.g., vehicle emissions, dust, seasonal smoke from controlled burns and regional wildfires).

4.2.2 Noise

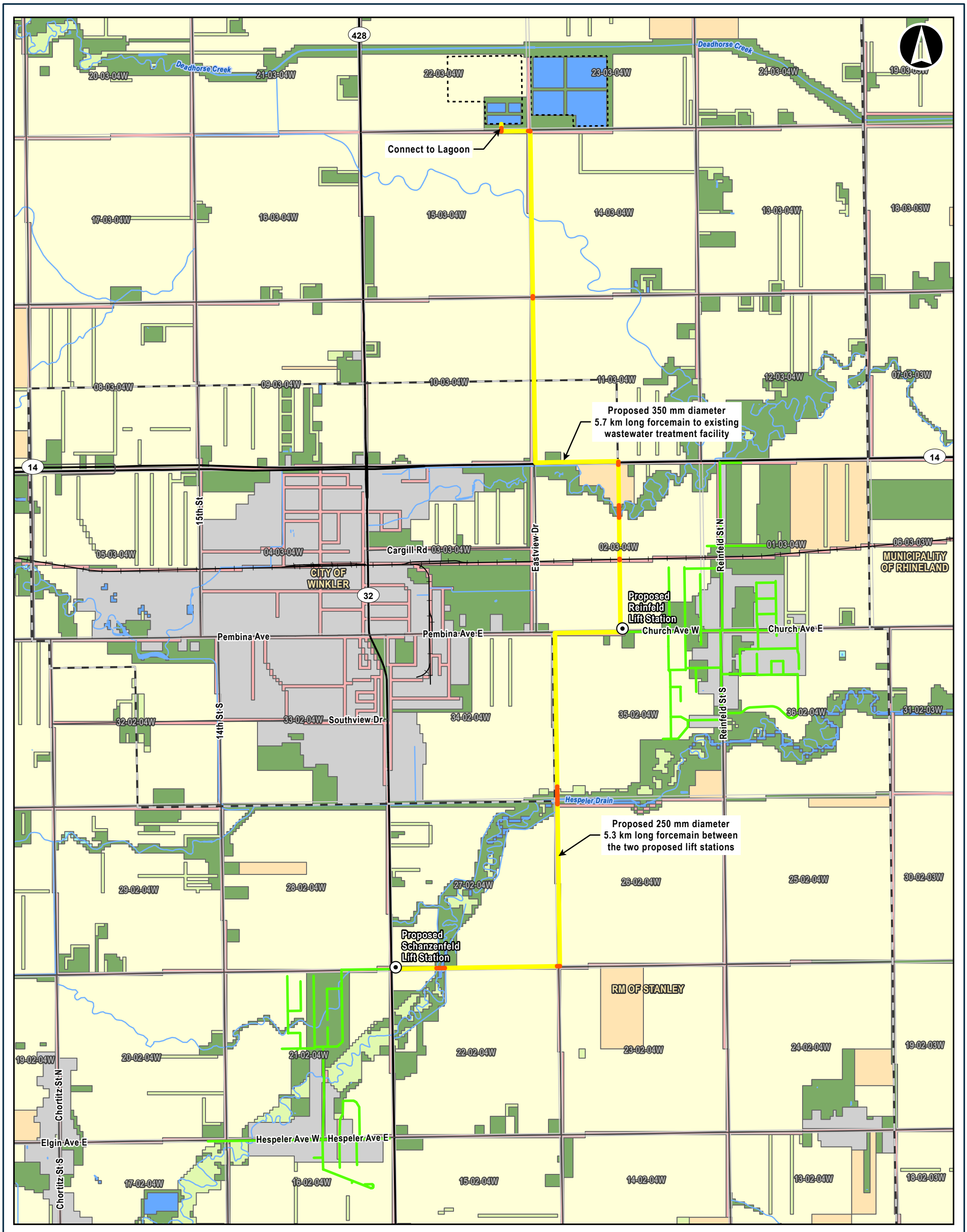
The above-described influences on air quality within the Project Site and Regional Study Area (**Section 4.2.1**), would also contribute to noise levels at the Project Site in addition to natural sounds such as ambient weather (e.g., wind). Noise has limited distance influence depending on the nature of the noise source (e.g., size, weight and type of facility machinery) and landscape features surrounding the sources of noise that may act to attenuate noise (e.g., tree cover; Yip et al. 2017; Albert 2004; and surrounding topography, e.g., Pijanowski et al. 2011).

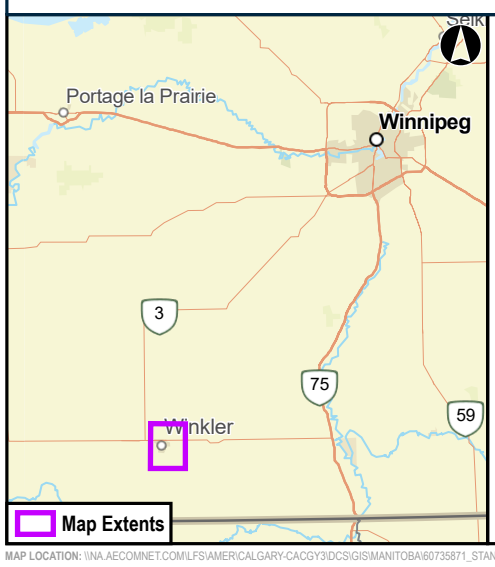
4.3 Terrestrial Environment

4.3.1 Vegetation

Landcover within the Project Site consists primarily of developed residential areas and grasses planted within the existing road RoWs within which the majority of the Project will be located. Adjacent landcover within the Local and Regional Study Areas is primarily agricultural fields with some limited areas of natural grassland vegetation adjacent to waterways (**Figure 4-3**).

It is expected that a variety of invasive, introduced plant species designated as noxious weeds under the Noxious Weeds Regulation of *The Noxious Weeds Act* occur within the Project Site due to the surrounding land uses within the Regional Study Area (e.g., agricultural land use; **Figure 4-3**). For example, clubroot (*Plamodiophora brassicae*) is a serious disease of cruciferous crops including canola, mustard, cabbage, cauliflower, broccoli, and rutabaga which is known to occur within the RM of Stanley at low to intermediate levels (Manitoba Agriculture 2022).





Legend

City of Winkler Wastewater Treatment Facility Lagoons

Project Site

- Proposed Lift Station Location *
- Proposed Forcemain Pipeline (Installed by Open Cut Trench Excavation Method)
- Proposed Forcemain Pipeline (Installed by Directional Drilling)
- Proposed Low Pressure Sewer

General Features

- Highway
- Road
- Railway
- Watercourse
- Municipal Boundary

Land Cover Class

- Agri - Forage Field
- Agricultural Field
- Cultural Features/Developed
- Decidious Forest
- Range and Grassland **
- Roads, Trails and Rail Lines
- Waterbody
- Wetland

Notes:

* The Schanzenfeld Lift Station Footprint will be 30 m x 66 m; and the Reinfeld Lift Station Footprint will be 45 m x 45

** Where "Range and Grassland" landcover is adjacent to the proposed low pressure sewer, those areas have been converted to residential developed areas

REGIONAL WASTEWATER CONVEYANCE SYSTEM ENVIRONMENT ACT PROPOSAL RM OF STANLEY

LANDCOVER

0 0.3 0.6 0.9 1.2

Kilometres

Datum: NAD 1983 UTM Zone 14N

September 2024 | 1:35,000 * when printed 11"x17"

PN#: 60735871

Figure 4-3

AECOM

Data Sources: NRCan - Canvec, Manitoba Land Initiative
Esri Canada, Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NRCan, Parks Canada

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4.3.2 Wildlife

Considering that the majority of the Project Site will be located primarily within developed residential areas and within the existing road RoWs, there is little naturally vegetated landcover within the Project Site that would provide optimal wildlife habitat (**Section 4.3.1**). Overall, the Regional Study Area consists of highly fragmented and minimal natural wildlife habitat. Migratory birds protected under provincial and federal legislation (e.g., *Migratory Birds Convention Act, 1994*) will nest in grasses within road RoWs that do not undergo weekly mowing during the breeding bird season (e.g., Clay-coloured Sparrow; Savannah Sparrow; Sutter et al. 2000). The breeding bird season for the Project Site is from April 30 to August 18 (i.e. Zone B4) as determined by Environment and Climate Change Canada 2024.

4.3.3 Species of Conservation Concern

As indicated in **Section 4.3.1** (Vegetation) and **Section 4.3.2** (Wildlife), the Project Site and Regional Study Area are located primarily within disturbed landcover (e.g., maintained road RoWs; developed residential areas) which would have a low probability of supporting Species at Risk[7] or other species of conservation concern. Therefore, no pre-construction surveys for the presence of species of conservation concern have been conducted within the Project Site and adjacent potentially affected areas. Further, mitigation measures proposed to avoid or minimized adverse effects on vegetation and wildlife (**Sections 5.4.1** and **5.4.2**) are expected to be sufficient to mitigate adverse Project effects on Species at Risk and species of conservation concern should they occur in the Project Site and Regional Study Area.

4.3.4 Parks and Protected Areas

There are no designated parks, protected areas or wildlife management areas within the Regional Project Area.

4.4 Aquatic Environment

4.4.1 Surface Water

Three (3) waterways occur within the Project Site: a tributary of the Deadhorse Creek, and two (2) crossings of the Hespeler Channel which is a designated Provincial Waterway (**Figure 1-1**). Although **Figure 1-1** also indicates a waterway crossing south of the existing City of Winkler WWTF lagoons (approximately 800 m south of Road 15 N at Road 20 W), historical satellite imagery (GoogleEarth™) indicates that the waterway is cultivated through during non-winter months and does not represent an ecologically functioning waterway.

The tributary that connects with Deadhorse Creek in the area of Hamburg, Manitoba flows generally east-northeast, with Deadhorse Creek flowing east into the Red River (Natural Resources Canada 2021). Similarly, the Hespeler Drain flows generally flows east-northeast to connect with the Deadhorse Creek which ultimately drains to the Red River (Natural Resources Canada 2021).

4.4.2 Fish and Fish Habitat

Within the Project Site and Local Study Area, the tributary of the Deadhorse Creek and two (2) crossings of the Hespeler Channel have the potential to support fish and fish habitat due to the seasonal connections of these waterways to the known fish-bearing waterbodies of Deadhorse Creek and the Red River (**Section 4.4.1**).

[7] *Species at Risk' are defined for the purpose of this report as those species listed in The Endangered Species and Ecosystems Act of Manitoba (MBESEA) and/or those listed as 'Endangered' or 'Threatened' in Schedule 1 of the federal Species at Risk Act (SARA).*

A previous fish community and fish habitat inventory study throughout agricultural areas of Manitoba (Milani 2013) included a sampling site within the Hespeler Drain approximately 188 m west of Road 20 W within 27-02-04W (**Figure 1-1**). Results of a fish and fish habitat assessment at that site, which occurred June 3, 2019, confirmed the presence of fish and indicated a “marginal habitat” assessment evaluation.

4.5 Socioeconomic Environment

4.5.1 Infrastructure and Services

As indicated in **Section 1.5**, wastewater in the RM of Stanley communities of Schanzenfeld and Reinfeld is currently transported by truck to the City of Winkler WWTF for treatment.

Potable water for these communities is supplied by the Pembina Valley Co-Op which draws water from the Red River at the Letellier Treatment Facility in Letellier, Manitoba. Treated potable water is pumped along Pembina Valey Water Cooperative Inc. main lines up to the Reinfeld reservoir and then to the Winkler south booster station where it is pumped into the Schanzenfeld reservoir. Within the Regional Study Area, potable water is then distributed through a network of underground pipes to end consumers (RM of Stanley 2022).

Other infrastructure and services within the Project Site include Manitoba Hydro natural gas and electrical services, communication lines (Bell MTS; Shaw Communications; Valley Fiber), existing RM roads and provincial highways, and a CP Railway crossing (**Section 2**; **Figure 1-1**)

4.5.2 Land Zoning and Resource Use

The Project is located primarily within land zoned as “AL-Agriculture Limited”, “RC-Community Residential” and “GD-General Development” according to the RM of Stanley Zoning By-Law #8-18[8].

The RM of Stanley is part of the MSTW Planning District which is comprised of the municipalities of The Town of Morden, The RM of Stanley, The RM of Thompson, and The City of Winkler. The MSTW Development Plan[9] is a guide to provide direction for future land use and development in the Planning District. As indicated in **Figure 4-4**, the Project is located within areas designated by the MSTW Planning District as “Agricultural Policy Area”, “Urban Employment Area” and “Emerging Communities Area”.

4.5.3 Indigenous Communities

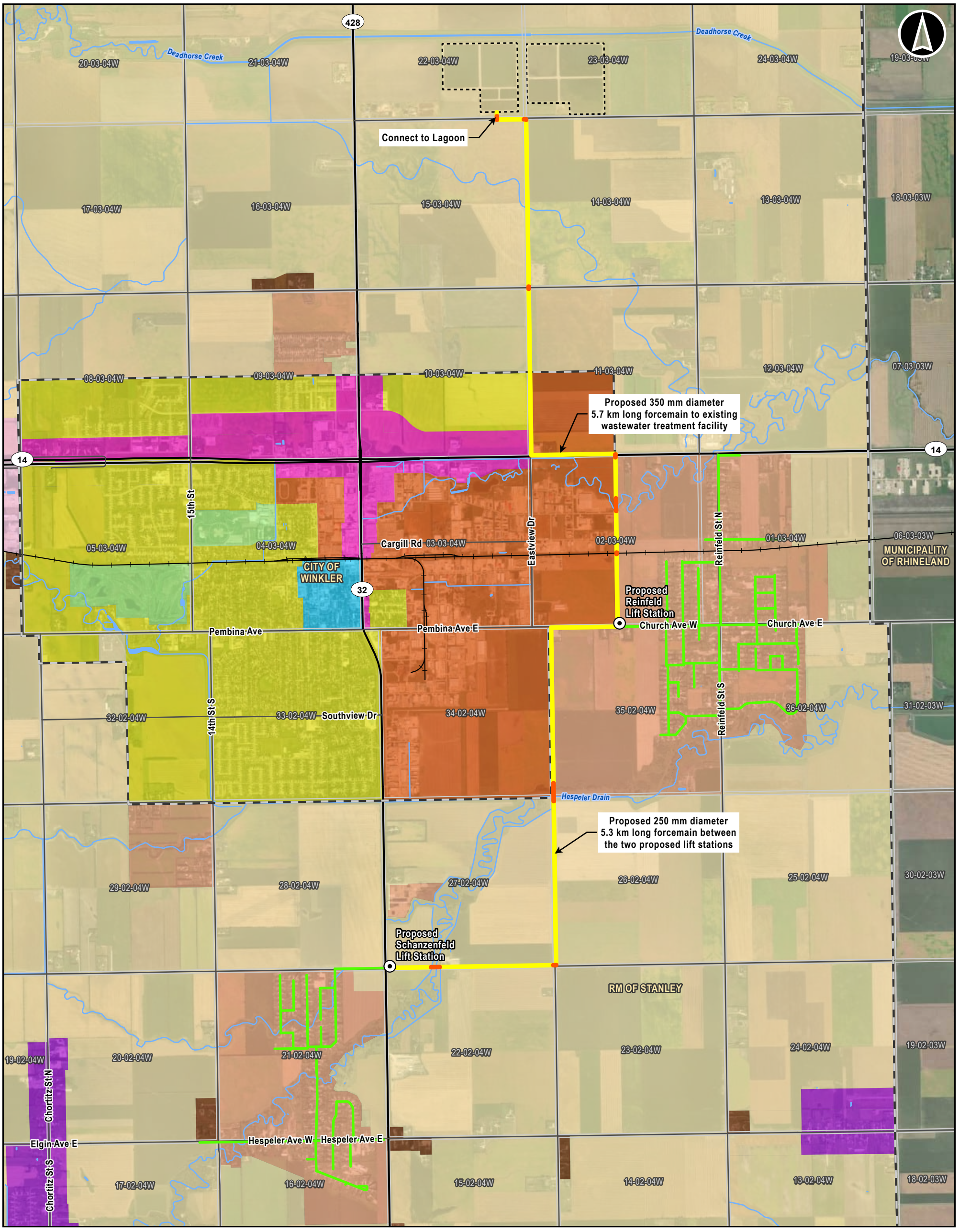
In the 2021 Census, 165 people in the RM of Stanley identified as either First Nations, Métis or Inuit, which is approximately 1.8% of the RM of Stanley population (Statistics Canada 2021). The Project Site falls under Treaty One Territory.

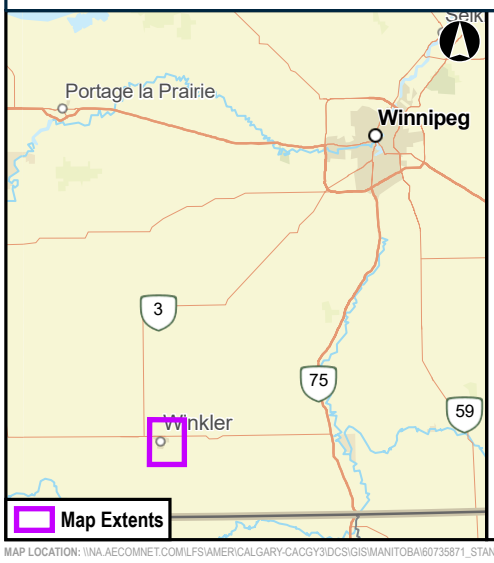
The closest reserve land designation is Roseau River 2, which is approximately 59 km driving distance east of the Project site.

4.5.4 Heritage Resources

A response from Manitoba Historic Resources Branch (HRB) on October 1, 2024 to a heritage resources screening request for the Project submitted to HRB on September 25, 2024 indicated that based on current data, the potential for the Project to impact heritage resources is low (**Appendix G**).

[8] *RM of Stanley Zoning By-Law #8-18 accessed at: https://rmofstanley.ca/Home/DownloadDocument?docId=46fa13ec-cfb9-4d2a-b5a9-829dac696d00*
[9] *MSTW Planning District development plan available at: https://rmofstanley.ca/p/mstw-planning-district-1*





Legend

City of Winkler Wastewater Treatment Facility Lagoons

Project Site

- Proposed Lift Station Location *
- Proposed Forcemain Pipeline (Installed by Open Cut Trench Excavation Method)
- Proposed Forcemain Pipeline (Installed by Directional Drilling)
- Proposed Low Pressure Sewer
- Municipal Boundary

General Features

- Highway
- Road
- Railway
- Watercourse

Development Plan Designation

- Agricultural Policy Area
- Emerging Communities Area
- Rural Clusters
- Stanley Corridor
- Urban Activity Corridor
- Urban Downtown Area
- Urban Employment Area
- Urban Neighbourhood
- Urban Parks and Open Space Area
- Village Area

Note:
* The Schanzenfeld Lift Station Footprint will be 30 m x 66 m; and the Reinfeld Lift Station Footprint will be 45 m x 45 m

REGIONAL WASTEWATER CONVEYANCE SYSTEM
ENVIRONMENT ACT PROPOSAL
RM OF STANLEY

DEVELOPMENT PLAN DESIGNATIONS

0 0.3 0.6 0.9 1.2
Kilometres
Datum: NAD 1983 UTM Zone 14N

September 2024 | 1:35,000 * when printed 11"x17"

PN#: 60735871

Figure 4-4

AECOM

Data Sources: NRCan - Canvec, Manitoba Land Initiative, Manitoba Government (DataMB)
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5. Environmental Assessment and Mitigation Measures

This section identifies the potential Project effects on the biophysical and socioeconomic environmental components, describes mitigation measures included in the design of the Project to avoid or minimize potential Project effects and determines the residual adverse impacts remaining, if any, after the application of mitigation measures.

The scope of this environmental assessment regarding spatial and temporal boundaries and the environmental components to be assessed has been described in **Section 3**.

5.1 Effects Assessment Methods

Table 5-1 identifies the biophysical and socioeconomic components that may be potentially affected by the Project due to the potential for interactions with the Project activities and components. Potential interactions were identified based on:

- Professional judgement;
- An understanding of Project components, construction methods, operation processes and the assumption that standard environmentally responsible construction techniques and operating procedures that will be applied during Project construction, operation and decommissioning; and
- Existing environment information (**Section 4**).

Table 5-1: Environmental Component Potential Interaction with the Project

ACTIVITY	BIOPHYSICAL COMPONENTS										SOCIO-ECONOMIC COMPONENTS				
	Physical			Atmospheric		Terrestrial			Aquatic						
	Geology/ Topography	Soil	Groundwater	Air Quality (Odour, emissions, dust, noise)	Climate / Greenhouse Gases	Vegetation	Wildlife	Species of Conservation Concern	Surface Water Quality	Fish and Fish Habitat	Infrastructure and Services	Land and Resource Use	Human Health	Indigenous Communities*	Heritage Resources
CONSTRUCTION															
Mobilizing construction equipment, materials and crew to and from Project Site		X		X	X	X	X	X	X	X		X	X		
Vegetation clearing, grubbing, excavation and leveling as needed	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Stockpiling cleared organics/soil	X	X		X	X	X	X	X	X	X		X	X		
Installation of LPS, force main and lift stations	X	X	X	X	X	X	X	X	X		X	X	X		X
Disposing and recycling of miscellaneous construction wastes (e.g. hazardous wastes [e.g. used oil); parts packaging)		X	X	X	X		X	X					X		
OPERATION and MAINTENANCE / REPAIR															
Operation of lift stations				X									X		
Mobilizing operations and maintenance equipment and crew to and from Project Site		X		X	X	X	X	X	X	X		X	X		
All other activities related to Project maintenance and repair.	X	X	X	X	X	X	X	X	X	X	X	X	X		
Disposing and recycling of miscellaneous operations-related wastes (e.g. hazardous wastes [e.g. used oil]; parts packaging)		X		X	X		X	X					X		

* Project activities are not anticipated to adversely impact Indigenous and Treaty Rights (**Section 5.6.4**).

The framework for determining environmental impacts of the Project on environmental components includes the following:

- Determine potential adverse effects of the Project on environmental components;
- Apply mitigation measures to avoid or minimize potential adverse effects;
- Determine the residual environmental impacts, which are those adverse environmental effects that remain after the application of mitigation measures; and
- Evaluate the residual environmental impacts based on defined effects evaluation criteria.

The criteria used to evaluate residual environmental impacts are defined in **Table 5-2**, noting that the defined criteria are used as a general guide and may be modified to more appropriately evaluate impacts to specific environmental components.

Table 5-2: Environmental Effects Assessment Criteria

Criteria Term	Definition			
Magnitude of Effect:	Refers to the estimated percentage of population or resource that may be affected by activities associated with the construction, operation and decommissioning of the Project. Where possible and practical, the population or resource base has been defined in quantitative or ordinal terms (e.g. hectares of soil types, units of habitat). Magnitude of effect has been classified as less than (<) 1%, 1% to 10%, or greater than (>) 10% of the population or resource base. Where the magnitude of an effect was determined as virtually immeasurable or represented a potential change that was within the natural variation of population or resource levels, the effect was considered Negligible. An exception to this is regarding human health effects where, for example adverse health issues due to the Project and affecting 1% of the population would still be considered major.			
	Negligible (immeasurable)	Minor (<1%)	Moderate (1 to 10%)	Major (>10%)
Direction of Effect:	Refers to whether an effect on a population or a resource is considered to have a positive, adverse or neutral effect			
	Positive	Adverse	Neutral	
Duration of Effect:	Refers to the time it takes a population or resource to recover from the effect. If quantitative information was lacking, duration was identified as short term (<1 year), Moderate term (1 to 10 years) and long term (>10 years)			
	Short term (<1 year)	Moderate (1 to 10 years)	Long term (>10 years)	
Frequency:	Refers to the number of times an activity occurs over the Project phase and is identified as once, rare, intermittent or continuous			
	Once	Rare	Intermittent	Continuous
Scope of Effect:	Refers to the spatial area potentially affected by the effect and categorized as Project Site, Local Study Area or Regional Study Area as defined in **Section 3.2**. Where possible, quantitative estimates of the resource affected are provided			
	Project Site	Local Study Area	Regional Study Area	
Reversibility:	Refers to if an adverse effect is likely to be reversed after completion of the activity or Project decommissioning/closure			
	Reversible	Irreversible		

The significance of residual environmental impacts is commented on where applicable regulatory criteria exist such as a regulatory threshold (e.g., air quality guidelines are exceeded due to Project activities). In the absence of such regulatory thresholds, an overall characterization of the impact is provided, taking into consideration the assessment criteria as described above in **Table 5-2**.

Measures that will be applied to avoid or minimize environmental effects that may be caused as a result of accidents and malfunctions are discussed separately in **Section 5.7**.

5.2 Physical Environment

5.2.1 Geology/Topography

Magnitude of Effect: Minor (Topography and Geology)
Direction of Effect: Adverse
Duration of Effect: Long term
Frequency: Intermittent
Scope of Effect: Project Site
Reversibility: Reversible (Topography); Irreversible (Geology)

The geology and topography of the Project Site will be affected by Project activities including:

- Open cut trenching to install LPS and force main piping in most areas of the Project Site;
- Directional drilling to install LPS and force main piping at other locations (as described in **Section 2.1.1** (e.g., under road/rail crossings and waterways); and
- Ground excavation and leveling for installation of lift stations.

The following measures will be implemented to avoid or minimize Project adverse effects on geology and topography, including potential for surface subsidence / ground slumping due to the open cut trenching activities:

- Directional drilling method will be used to install the piping components underground at locations as described in **Section 2.1.1** (e.g., under road/rail crossings and waterways).
- The installation of Project components will be done as per recommendations within geotechnical investigation reports for the Project Site (TREK Geotechnical Inc. 2023; AECOM 2018; **Appendix F**) as relevant and required based on site conditions during construction.
- Installation of Project components (e.g., wastewater conveyance piping; lift stations) will be constructed in accordance with relevant MWSB Standard Construction Specifications (e.g., Pipe Excavation, Bedding and Backfill; MWSB 2022).

While measurable disturbances will be imposed on natural geologic and topographic features, disturbances will be limited to the Project Site. With the application of the above described mitigation measures, impacts on topography have been assessed as being minor because disturbed land will be leveled, graded and rehabilitated. The extracted subsurface material that will be removed to accommodate placement of Project components will not be replaced; therefore, minor impacts to the geology will be irreversible/permanent.

5.2.2 Soils

Magnitude of Effect: Minor
Direction of Effect: Adverse
Duration of Effect: Long term
Frequency: Intermittent
Scope of Effect: Project Site
Reversibility: Reversible

Construction of the Project has the potential to result in soil erosion, where piping infrastructure is installed due to soil stratigraphy types and groundwater conditions in the Regional Study Area (**Sections 4.1.2** and **4.1.3**). Similar potential effects on soil may occur during Project repair activities (e.g., piping repairs as needed). Soil erosion, soil

disturbances and the potential for soil contamination due to spills and leaks may affect other environmental components, such as air quality (e.g. dust from soil disturbance), water quality and vegetation.

Removal of sub-surface material/soil to accommodate placement of Project components has been assessed under the 'Geology' biophysical component in **Section 5.2.1**.

To mitigate the potential for soil erosion and contamination, the following measures will be incorporated:

- Erosion and sediment control mitigation measures as outlined in MWSB and AECOM specifications for the construction contractor will be implemented for all phases of the Project.
- Surplus excavated soil (if any) will be transported to a stockpile area approved by the RM of Stanley (bedrock or big boulders were not found in the proposed development area).
- The landscape will be leveled and graded, and disturbed areas will be revegetated with a seed mix as specified by MWSB (2022) as quickly as feasible to stabilize the soil and minimize soil erosion.
- Installation of Project components (e.g., wastewater conveyance piping) will be constructed in accordance with relevant MWSB Standard Construction Specifications (e.g., Pipe Excavation, Bedding and Backfill; MWSB 2022).
- Measures to avoid spills and leaks will be implemented (**Section 5.7.2** and **Section 5.7.3**).
- For the open cut method of pipe installation, sloped trench walls will be specified to mitigate risks of wall collapsing. Trenchless methods of pipe installation will be used where open cut method is not feasible.

With the application of the above mitigation measures, the potential for soil erosion, soil contamination and associated adverse impacts to the surrounding environment are anticipated to be minor and restricted to the Project Site.

5.2.3 Groundwater

Magnitude of Effect: Minor (both quantity and quality)
Direction of Effect: Adverse
Duration of Effect: Long term
Frequency: Intermittent
Scope of Effect: Local Study Area
Reversibility: Reversible

Installation of underground Project components has the potential for interaction with the groundwater table which maybe encountered within the area of the proposed development as described in a geotechnical investigation report for locations within the Local and Regional Project Area (**Section 4.1.3**; **Appendix F**). Additionally, groundwater has the potential to be contaminated due to spills and leaks from Project construction and maintenance machinery and Project components (e.g., wastewater conveyance piping).

To mitigate the effects of the Project on groundwater, the following measures will be incorporated:

- Installation of Project components (e.g., wastewater conveyance piping) will be constructed in accordance with relevant MWSB Standard Construction Specifications (e.g., Pipe Excavation, Bedding and Backfill; MWSB 2022).
- The installation of Project components will be done as per recommendations within geotechnical investigation reports for the Project Site (**Appendix F**; TREK Geotechnical Inc. 2023; AECOM 2018) as relevant and required based on site conditions during construction.
- The construction contractor will submit a detailed proposed dewatering system plan, bearing the seal of a qualified professional engineer registered in the Province of Manitoba, to the Project engineer at least four (4) weeks prior to commencing work. The contractor will advise the Project engineer of any changes to proposed method of dewatering at least two (2) weeks before enacting change. Upon completion of dewatering

installations, the contractor will submit a detailed plan of the dewatering system as constructed including test data and computations demonstrating that the system is capable of achieving the desired result.
    - The dewatering system plan will contain the following:
        - Plan layout showing the arrangement and location of wells/well points, methods of installation, location of headers and discharge lines and points of discharge disposal.
        - Back-up system including contingency measures if part or all of the dewatering system fails.
        - Temporary drainage and pumping facilities.
        - Dewatering construction staging.
        - Details of well/well point installation including depth, screen dimension, screen slot size backfill filter gradation, riser dimensions, pump type and capacity, and header dimensions.
        - Locations of piezometers and details of installation including depth, backfill, tip type and dimensions, riser pipe.
        - Estimate of flow rate and duration of dewatering.
        - Details of plugging method for any piezometers installed within structure footprint.
- Measures to avoid spills and leaks will be implemented (**Section 5.7.2**).

With the application of the above mitigation measures, the potential for adverse impacts to groundwater, and associated adverse impacts to the surrounding environment, are anticipated to be minor.

5.3 Atmospheric Environment

5.3.1 Air Quality

Magnitude of Effect: Minor to Negligible
Direction of Effect: Adverse
Duration of Effect: Long term
Frequency: Intermittent
Scope of Effect: Local and Regional Study Area
Reversibility: Reversible

Project construction and maintenance activities are expected to affect air quality due to dust generated by movement of construction vehicles (e.g., excavators) and other mobile equipment, and due to exhaust emissions including nitrogen dioxide (NO_2), carbon monoxide (CO) and sulfur dioxide (SO_2). The exhaust emissions and dust generated from mobile equipment can have adverse effects on human health, wildlife and vegetation.

Wastewater conveyance piping will be installed underground (**Section 2**); however, lift stations have the potential to generate odour.

Measures that will be applied to minimize potential Project effects to air quality include the following:

- Idling of motorized equipment will be minimized to the extent feasible.
- Equipment and vehicles will be properly maintained.
- The two (2) new lift stations will include odour control units (**Section 2.2**).

With the application of the above measures, impacts on air quality are expected minor to negligible, and sufficiently mitigated.

5.3.2 Climate/Greenhouse Gasses

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Long term

Frequency: Intermittent
Scope of Effect: Beyond the Regional Study Area
Reversibility: Irreversible

Greenhouse gases (GHGs) emitted by Project construction and maintenance/repair machinery will be minor and intermittent during construction and operation/maintenance phases. As indicated in **Section 2.2**, the pumps for the two (2) Project lift stations will be powered by electricity supplied by connection to the existing local Manitoba Hydro electrical grid and will not emit GHGs. Therefore, generation of GHGs by the Project and associated activities are expected to have a negligible effect on climate and would not be substantial enough to warrant a formal greenhouse gas inventory calculation estimate in accordance with Environment Canada and United Nations Guidelines (Manitoba Environment and Climate 2023).

5.3.3 Noise

Magnitude of Effect: Minor
Direction of Effect: Adverse
Duration of Effect: Long term
Frequency: Intermittent (construction and repair/maintenance) and Continuous (lift stations operation)
Scope of Effect: Regional Study Area
Reversibility: Reversible

There is the potential for nuisance noise to be generated by Project construction and maintenance activities. Wastewater lift station pumps may also generate various levels of noise, depending on factors such as the type of pump, speed of the pump and design of the lift station.

The following measures will be implemented to reduce noise generated from Project construction, maintenance/repair and operation activities:

- Pumps for both lift stations will be located approximately seven (7) meters underground (**Section 2.2**) which will mitigate the potential for nuisance noise from the two (2) lift stations.
- Vibration controls pads to mitigate vibration and associated noise are incorporated into the design of the lift stations (**Section 2.2**).
- Project construction, maintenance and repair activities will be done in accordance with MWSB Standard Construction Specifications (MWSB 2022) which include compliance with applicable noise laws and regulations (e.g., RM of Stanley By-Law No. 8-19; City of Winkler By-Law No. 2139-15 providing for Public Safety, Health, Wellbeing and Regulating of Noises).
- Construction equipment and vehicles will be kept well maintained and will be fitted with mufflers, and other noise mitigation equipment as required.
- Unnecessary idling and revving of engines will be avoided.

As indicated in **Section 1.4**, the nearest residence to the Schanzenfeld Lift Station is approximately 313 m to the southeast, and nearest residence to the Reinfeld Lift Station is approximately 99 m to the southwest. Odor control units and equipment installed above ground at lift stations (**Sections 2.2.1** and **2.2.2**) will produce minimal to no noise. The designs of the Project lift stations (i.e., pumps located seven (7) metres underground and not in proximity to residential houses; **Section 2.2**) are expected to sufficiently mitigate the potential for nuisance noise at nearest residences.

In consideration of the above measures to minimize noise levels due to Project construction, maintenance/repair and operations, noise generated by the Project is assessed as minor and the potential noise levels at the nearest residences is expected to be adequately attenuated.

5.4 Terrestrial Environment

5.4.1 Vegetation

Magnitude of Effect: Minor
Direction of Effect: Adverse
Duration of Effect: Long term
Frequency: Intermittent
Scope of Effect: Project Site (vegetation clearing) to Regional Study Area (noxious weeds)
Reversibility: Reversible

Potential effects of the Project on vegetation are associated with temporary vegetation removal to accommodate construction of Project components and the potential for vehicles and machinery to spread noxious weeds and clubroot spores within the regional area.

As shown in **Figure 4-3**, there is a very low potential for naturally vegetated areas to be affected by Project activities considering most of the Project Site is within maintained road RoWs and within developed residential areas. Additionally, the two (2) lift station will be constructed on agricultural land within a very small total footprint area of approximately 0.4 ha (**Section 2**).

The following mitigation measures will be implemented to avoid or minimize potential effects on vegetation and potential for noxious weeds and clubroot spread:

- Directional drilling method rather than open cut trenching method for piping installation will occur at naturally vegetated areas adjacent to waterways; therefore, clearing of natural vegetation adjacent to waterways will not occur.
- Areas temporarily disturbed during Project construction and maintenance/repair, will be re-seeded in accordance with MWSB Standard Construction Specifications for seeding (MWSB 2022).
- Construction machinery travel will be limited to existing road RoWs and previously developed areas, and will not traverse across agricultural land.

With the application of the above mitigation measures, the overall Project impacts to vegetation are assessed as minor within the Project Site and Regional Study Area.

5.4.2 Wildlife

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Long term
Frequency: Intermittent
Scope of Effect: Regional Study Area
Reversibility: Reversible

Project activities that disrupt the natural environment (e.g., site clearing; noise) are the primary contributors to potential adverse effects on wildlife. Wildlife management focuses on regional wildlife populations because wildlife populations (e.g., deer) are typically not measurably affected if only an individual or small number of individuals are affected within a relatively small spatial area (e.g., the home range of a deer). Therefore, the spatial scope of the assessment of the Project impacts on wildlife has been conducted in consideration of the Regional Study Area and the Lake Manitoba Plain Ecoregion within which the Regional Study Area is located. The availability of nearby alternative habitat for wildlife is also taken into consideration when assessing the potential effects of a development on wildlife.

Naturally vegetated landcover, which provides quality wildlife habitat, is very minimal in the Regional Study Area (**Figure 4-3**). The limited amount of vegetation clearing needed within the Project Site for Project construction is associated with open cut trenching installation of the Project piping components within road RoWs, and construction of the two (2) lift stations on agricultural land. Those Project components will require temporary removal of existing vegetation (primarily grasses) within road RoWs and minimal clearing of vegetation adjacent to road RoWs and in agricultural fields to accommodate construction of the two (2) lift stations.

As indicated in **Section 4.3.2**, migratory birds protected under provincial and federal legislation (e.g., *Migratory Birds Convention Act, 1994*) will nest in grasses within road RoWs that do not undergo weekly mowing during the breeding bird season (e.g., Clay-coloured Sparrow; Savannah Sparrow; Sutter et al. 2000). Open cut trenching construction activities within grassy road RoWs have a very high risk of disturbing and destroying active bird nests during the breeding bird season within the footprint area to be trenched, and adjacent vegetated areas considering road RoWs are typically not mowed on a weekly basis which would deter bird from nesting in the road RoWs. In most cases, Environment and Climate Change Canada does not recommend conducting pre-construction nest searches for construction activities scheduled during the breeding bird season due to the high risk of causing harm to bird nests, eggs and/or young and contravening the *Migratory Birds Convention Act, 1994* (Environment and Climate Change Canada 2023). The potentially affected vegetated area for open cut trenching activities is larger than what Environment and Climate Change Canada recommends as appropriate within which to conduct pre-construction bird nest searches (Environment and Climate Change Canada 2023).

Project construction, and repair/maintenance activities during Project operation, are unlikely to have a measurable effect on wildlife populations within the Regional Study Area, and are not expected to contravene wildlife protection legislation, because:

- The Project Site and adjacent Regional Study Area currently provides minimal and sub-optimal wildlife habitat due to existing disturbances from residential development, existing roads and railway, and agriculture activities (**Figure 4-3**), and the following mitigation measures will be implemented:
    - Directional drilling method rather that open cut trenching method for piping installation will occur at naturally vegetated areas adjacent to waterways; thereby minimizing adverse effects on the highest quality wildlife habitat in the Regional Study Area.
    - Vegetation clearing and open cut trenching within grassy road RoWs that do not undergo weekly mowing will be done outside of the breeding bird season (‘Zone B4’, i.e., April 30 to August 18; Environment and Climate Change Canada 2024).
    - Measures to mitigate impacts to vegetation will be implemented (**Section 5.4.1**).

Noise generated during Project construction, and operation (e.g., maintenance and repair), is expected to influence wildlife behaviour (e.g., area avoidance) to a limited degree within the Regional Study Area due to the limited extent and quality of wildlife habitat in the Regional Study Area, and depending on the type of wildlife (U.S. National Parks Service, 2018). Noise generated at the Project Site is not expected to be of a magnitude that would substantially affect wildlife populations within the Regional Study Area because:

- Project-generated noise during construction and maintenance activities will be temporary and will not occur simultaneously throughout the Project Site;
- Existing wildlife habitat at the Project Site and Regional Study Area is minimal and sub-optimal;
- Wildlife species present in the vicinity of the Project are anticipated to be accustomed (habituated) to some level of noise (U.S. National Parks Service, 2018) due to the presence of existing developments (e.g., roads; railway; surrounding agricultural, and residential developed areas); and
- Measures listed in **Section 5.3.3** to mitigate noise will be applied.

With the application of the above mitigation measures, Project impacts to wildlife populations in the Regional Study Area and the Lake Manitoba Plain Ecoregion are assessed as negligible. Additionally, the risk of contravening wildlife protection legislation (e.g., *Migratory Birds Convention Act, 1994*) is considered sufficiently mitigated.

5.4.3 Species of Conservation Concern

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Long term
Frequency: Intermittent
Scope of Effect: Regional Study Area
Reversibility: Reversible

As described in **Section 5.4.1**, disturbance of naturally vegetated areas, where plant species of conservation concern are most likely to occur, will be avoided by Project activities. Therefore, the probability of plant Species at Risk and species of conservation concern being adversely affected by Project activities is negligible. As described in **Section 5.4.2**, the Project is unlikely to have a measurable effect on wildlife populations within the Regional Study Area considering the limited availability of suitable wildlife habitat that would also be required to support terrestrial wildlife Species at Risk and species of conservation concern. In summary, Project activities are expected to have a very low risk of affecting terrestrial Species at Risk due to the:

- Lack of natural vegetation/habitat cover types that maybe used by Species at Risk that may be affected by Project construction and operation/maintenance activities; and
- The application of measures indicated in **Sections 5.4.1** and **5.4.2** to mitigate adverse effects of the Project on vegetation and wildlife in general.

Therefore, Project impacts to regional populations of Species at Risk and species of conservation concern at the Project Site and adjacent areas are assessed as negligible.

5.5 Aquatic Environment

5.5.1 Surface Water

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Long term
Frequency: Intermittent
Scope of Effect: Local and Regional Study Area
Reversibility: Reversible

As indicated in **Section 2.1.1**, directional drilling method will be used to install Project components under the three (3) waterways that occur within the Project Site (**Section 4.4.1**). Therefore, Project construction and operation/maintenance activities will not directly affect surface water because no existing waterbody will be directly disturbed (e.g., by excavation) to accommodate the Project.

There is the potential for waterways within the Project Site and adjacent areas to be affected by soil erosion and sedimentation, and contamination due to spills/leaks from Project construction and maintenance machinery. To avoid or minimize the potential for soil erosion and sedimentation, and spills/leaks, mitigation measures to protect soil as indicated in **Section 5.2.2** will be applied. Therefore, the potential for adverse effects of the Project on surface water quality is assessed as negligible.

5.5.2 Fish and Fish Habitat

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Long term
Frequency: Intermittent
Scope of Effect: Local and Regional Study Area
Reversibility: Reversible

As indicated in **Section 4.4.2**, within the Project Site and Local Study Area the tributary of the Deadhorse Creek and two (2) crossings of the Hespeler Channel have the potential to support fish and fish habitat due to the seasonal connections of these waterways to the known fish-bearing waterbodies of Deadhorse Creek and the Red River. The potential for adverse effects on fish and fish habitat are assessed as negligible because:

- Project construction and operation/maintenance activities will not directly affect surface water, i.e., no existing waterbody will be directly disturbed (e.g., by excavation) to accommodate the Project; and
- Measures to avoid introduction of deleterious substance into surface water as indicated in **Section 5.5.1** will be applied.

5.6 Socioeconomic Environment

5.6.1 Infrastructure and Services

Magnitude of Effect: Negligible (services disruption) to Minor (regarding reduced impacts to emissions and potential for spills)
Direction of Effect: Adverse (regarding temporary services disruption) to Positive (regarding reduced impacts to emissions and potential for spills)
Duration of Effect: Long Term
Frequency: Rare (regarding temporary services disruption) to Continuous (regarding reduced impacts to emissions and potential for spills)
Scope of Effect: Regional Study Area
Reversibility: Reversible

During Project construction and maintenance activities, there is the potential for service disruptions to some locations within the RM of Stanley if existing infrastructure (e.g., potable water piping) are accidentally damaged during open cut trenching installation of Project piping. To avoid the damaging existing underground infrastructure, the construction contractor will contact local utility and communications service providers to confirm the locations of existing underground infrastructure prior to proceeding with trenching activities. Directional drilling will be used to install Project piping under existing roads and the CP Rail track to avoid disruption to road and rail traffic. Therefore, the potential for damage to exiting infrastructure and associated services disruption is assessed as negligible.

Installation of the new wastewater conveyance system (i.e., the Project) will replace the need for truck transport of wastewater to the City of Winkler WWTF for the communities of Reinfeld and Schanzenfeld which together make up approximately 35% of the population of the RM of Stanley (AECOM 2016; Statistics Canada 2021). This new infrastructure will result in an overall minor benefit to the environment due to:

- Reduced greenhouse gas (GHG) emissions from wastewater transport trucks; and
- Reduced potential for wastewater spills / leakage from holding tanks, septic fields, connectors and potential for spills/leakage from wastewater transport trucks.

Therefore, installation of the new wastewater conveyance system is expected to result in a minor, positive long-term effect on air quality by reducing emissions from water transport trucks, and will also mitigate the potential for wastewater spills / leakage.

5.6.2 Land and Resource Use

Magnitude of Effect: Negligible
Direction of Effect: Negative to neutral
Duration of Effect: Long term
Frequency: Intermittent (construction and maintenance) to Continuous (operations)
Scope of Effect: Project Site to Local Study Area
Reversibility: Reversible

A negligible change in land use will occur with the construction of the two (2) lift stations on a very small total area (0.4 ha) of agricultural land under agreement from the current landowners (**Appendix B**). Other Project components will be installed underground with the temporarily disturbed areas returned to pre-construction condition. Construction and future maintenance of the Project may result in temporary, minor disruptions in traffic movements. As indicated in **Section 2.3**, traffic control and safety signage will be implemented. In summary, the Project will have a negligible effect on land and resource use.

5.6.3 Human Health

Magnitude of Effect: Minor (regarding nuisance noise) to Negligible
Direction of Effect: Adverse
Duration of Effect: Long Term
Frequency: Intermittent
Scope of Effect: Local and Regional Study Areas
Reversibility: Reversible

Project activities have the potential to adversely affect human health through:

- Traffic and construction equipment/machinery during Project construction and future maintenance resulting in:
    - Emissions from construction vehicles and machinery affecting air quality.
    - Noise generated by construction vehicles and machinery and from the pumps in the two (2) new lift stations.
- Potential odour from the two (2) new lift stations.
- Accidents and malfunctions.

Mitigation measures that will avoid or minimize potential adverse effects on human health are the following:

- Measures to avoid or minimize adverse effects on air quality (Section **5.3.1**) and effects on climate (**Section 5.3.2**) will be applied.
- Measures to control noise will be applied (**Section 5.3.3**).
- Directional drilling method will be used to install piping underground in front of residences and other buildings/businesses within the communities of Reinfeld and Schanzenfeld to maintain continuous vehicle access (e.g., ambulances and fire trucks) (**Section 2.1.1**).
- Traffic control and safety signage, such as reduce speed limits in construction zones, will be implemented in accordance with MWSB and AECOM traffic-related specifications, and in accordance with *The Highway Traffic Act* and its amendments (*The Highway Traffic Amendment Act*) (**Section 2.3**).

- Construction and maintenance contractors and employees will abide by the standards, procedures and training required under *The Workplace Safety and Health Act.*
- Development of the Project will comply with CP's Geotechnical Protocol for Pipeline and Utility Crossing(s) Under Railway Tracks (CP 2022) and other CP standards, safety measures and compliance during Project construction (**Section 1.8.2**).
- Measures to avoid accidents and malfunctions as indicated in **Section 5.7** will be implemented.

Through the implementation of the measures referenced above, the risk of adverse impacts to human health is assessed as being sufficiently mitigated.

5.6.4 Indigenous Communities

Magnitude of Effect: Negligible (regarding Human Health) to Minor (regarding Employment)
Direction of Effect: Adverse (regarding Human Health) to Positive (regarding Employment)
Duration of Effect: Long Term
Frequency: Continuous
Scope of Effect: Regional Study Area, and beyond for employment
Reversibility: Reversible

The Project is expected to be an overall benefit to nearby Indigenous communities within commuting distance to the Project Site as there will be the potential for increased employment opportunities associated with Project construction and maintenance/repair. Human health effects as assessed in **Section 5.6.3**, would be potentially applicable to the nearest Indigenous peoples residing in the RM of Stanley (**Section 4.5.3**).

The Project is not expected to adversely impact the exercise of Indigenous or Treaty rights because:

- Effects on fish or fish habitat are assessed as negligible (**Section 0**);
- The Project is primarily located on previously disturbed public land with limited potential for Indigenous resource use (e.g., trapping, gathering) and no known use for cultural or traditional activities;
- The residual environmental impact of the Project on vegetation within the Project Site and Regional Study Area is assessed to be minor (**Section 5.4.1**); and
- The residual environmental impact of the Project on regional wildlife populations is assessed to be negligible (**Section 5.4.2**).

5.6.5 Heritage Resources

Magnitude of Effect: Negligible
Direction of Effect: Adverse
Duration of Effect: Long Term
Frequency: Intermittent
Scope of Effect: Project Site
Reversibility: Irreversible

As indicated in **Section 4.5.4**, response from Manitoba Historic Resources Branch (HRB) on October 1, 2024, to a heritage resources screening request for the Project submitted to HRB on September 25, 2024, indicated that based on current data, the potential for the Project to impact heritage resources is low (**Appendix G**).

To avoid or minimize potential adverse effects on potentially undiscovered heritage resources, and as required by HRB (**Appendix G**), a Heritage Resources Protection Plan (HRPP) will be prepared for the Project for reference during Project planning, development and operations in the event that heritage resources are accidentally encountered. A draft HRPP is provided in **Appendix H**. The final HRPP will be provided to the construction contractor(s) prior to the initiation of Project construction.

5.7 Accidents and Malfunctions

5.7.1 Worker Health and Safety

Worker protection in Manitoba is regulated through standards, procedures and training under *The Workplace Safety and Health Act,* Workplace Safety and Health Regulation M.R. 217/2006. Construction and operational maintenance workers will have, and use, safety equipment and personal protective equipment commensurate with the duties and potential hazards each worker may encounter for each task.

Contractors will be subject to site specific environmental health and safety orientation for all phases of the Project as needed.

5.7.2 Spills and Leaks

The Project works will be constructed, operated and maintained in accordance with provisions within a future Environment Act Licence and in accordance with applicable environmental legislation. To minimize the potential for spills and leaks related to the Project works, the contractor will be required to complete all Project related work in accordance with MWSB Standard Construction Specifications (MWSB 2022).

5.7.3 Power Failure

As indicated in **Section 2.2**, operation of two (2) new lift station pumps will be powered by connection to the existing local Manitoba Hydro power lines. Each lift station will have backup diesel-powered generators installed which will be triggered to operate by an auto-transfer switch and alert to the RM of Stanley via fiber optic communication in the event of a power failure.

6. Follow-up and Monitoring

The construction contractor will have an environmental monitor on-site as part of the construction contractor staff to monitor and report on the adequacy of compliance with environmental mitigation measures required to be applied as per the construction contract, in accordance with conditions stipulated in an Environment Act Licence for this Project.

Following construction, the Project operations will undergo regular maintenance and monitoring by the RM of Stanley for wastewater leaks and to maintain proper function of the two (2) new lift stations. Additionally, the Project will be operated in accordance with conditions stipulated in an Environment Act Licence for this Project.

7. Conclusion

Based on the proposed environmental mitigation measures, construction specifications that will be applied, and environmental monitoring and follow-up measures that will be implemented, adverse residual environmental effects resulting from the Project are expected to be sufficiently mitigated and are not likely to cause significant adverse environmental impacts.

8. References

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AECOM

Appendix A

Status of Title Documents

STATUS OF TITLE

Title Number **3262778/4**
Title Status **Accepted**
Client File

Manitoba Land Titles Registry

1. REGISTERED OWNERS, TENANCY AND LAND DESCRIPTION

RURAL MUNICIPALITY OF STANLEY

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

PARCEL "A" WORKS PLAN 71980 MLTO
IN SE 1/4 2-3-4 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

No active instruments

3. ADDRESSES FOR SERVICE

RM of Stanley
2 - 23111 PTH 14
Stanley MB
R6P 0B1

4. TITLE NOTES

No title notes

5. LAND TITLES DISTRICT

Morden

6. DUPLICATE TITLE INFORMATION

Duplicate not produced

7. FROM TITLE NUMBERS

3257567/4 All

8. REAL PROPERTY APPLICATION / CROWN GRANT NUMBERS

No real property application or grant information

9. ORIGINATING INSTRUMENTS

Instrument Type:	**Request To Issue Title - Internal**
Registration Number:	**1286848/4**
Registration Date:	2023-09-19
From/By:	District Registrar
To:	
Amount:	

10. LAND INDEX

Lot A Plan 71980

SE 2-3-4W
WORKS PLAN 71980

CERTIFIED TRUE EXTRACT PRODUCED FROM THE LAND TITLES DATA STORAGE SYSTEM OF TITLE NUMBER 3262778/4

STATUS OF TITLE

Title Number **3217772/4**
Title Status **Accepted**
Client File

Manitoba Land Titles Registry

1. REGISTERED OWNERS, TENANCY AND LAND DESCRIPTION

RURAL MUNICIPALITY OF STANLEY

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

PARCEL "A" WORKS PLAN 70741 MLTO
IN SW 1/4 27-2-4 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:	**Easement**
Registration Number:	**1199097/4**
Instrument Status:	**Accepted**
Registration Date:	2014-12-08
From/By:	MTS INC.
To:	
Amount:	
Notes:	No notes
Description:	STATUTORY EASEMENT

Instrument Type:	**Easement**
Registration Number:	**1232808/4**
Instrument Status:	**Accepted**
Registration Date:	2018-04-06
From/By:	FROESE ENTERPRISES INC.
To:	THE MANITOBA HYDRO-ELECTRIC BOARD
Amount:	
Notes:	No notes
Description:	STATUTORY EASEMENT

3. ADDRESSES FOR SERVICE

RURAL MUNICIPALITY OF STANLEY
2 - 23111 PTH 14
STANLEY MB
R6P 0B1

4. TITLE NOTES

No title notes

5. LAND TITLES DISTRICT

Morden

6. DUPLICATE TITLE INFORMATION

Duplicate not produced

7. FROM TITLE NUMBERS

2946598/4 Part

8. REAL PROPERTY APPLICATION / CROWN GRANT NUMBERS

No real property application or grant information

9. ORIGINATING INSTRUMENTS

Instrument Type:	**Request To Issue Title**
Registration Number:	**1279136/4**
Registration Date:	2022-11-02
From/By:	Rural Municipality of Stanley
To:	
Amount:	

10. LAND INDEX

Lot A Plan 70741
WORKS PLAN

SW 27-2-4W
WORKS PLAN 70741

CERTIFIED TRUE EXTRACT PRODUCED FROM THE LAND TITLES DATA STORAGE SYSTEM OF TITLE NUMBER 3217772/4

Appendix B

Private Land Easements Agreements

EASEMENT AGREEMENT

(s. 111, *The Real Property Act*)

DATED this 3rd day of May, 2019.

BETWEEN:

TRUSTEES OF NEW HOPE MENNONITE CHURCH,
A RELIGIOUS SOCIETY IN THE RURAL MUNICIPALITY OF STANLEY,
IN THE PROVINCE OF MANITOBA
("New Hope")

- and -

RURAL MUNICIPALITY OF STANLEY
("Stanley")

WHEREAS New Hope is the registered owner of certain lands and premises more particularly described below;

AND WHEREAS Stanley owns and operates a wastewater treatment facility and intends to install a force main sewer line on New Hope's property;

AND WHEREAS Stanley requires access to New Hope's property for the purpose of installing, maintaining, and repairing the force main sewer line to be located thereon;

AND WHEREAS New Hope has agreed to grant Stanley an easement and right-of-way for persons and vehicles over and across its lands and premises under Section 111 of *The Real Property Act* (Manitoba) for the purpose of installing, maintaining, and repairing the force main sewer line to be located thereon;

NOW THEREFORE the parties hereto, in consideration of the mutual covenants set forth herein and the benefits to be derived by each from the fulfillment of this agreement, do hereby covenant and agree as follows:

1. In this agreement the following definitions apply:

    a. "New Hope Property" means:

    THE WLY 508.75 FEET OF THE NE ¼ OF SECTION 2-3-4 WPM
    EXC FIRSTLY: THE ELY 210 FEET OF THE NLY 1200 FEET
    AND SECONDLY: ROAD PLAN 1480 MLTO;
    (Title No. 2384917/4).

b. "Easement Property" means:

THE WLY 20 FEET PERP OF
THE WLY 508.75 FEET OF THE NE ¼ OF SECTION 2-3-4 WPM
EXC FIRSTLY: THE ELY 210 FEET OF THE NLY 1200 FEET
AND SECONDLY: ROAD PLAN 1480 MLTO.

2. New Hope grants unto Stanley an easement and right-of-way over and across the Easement Property:

a. to construct, maintain, inspect, replace, alter, and repair the force main sewer line;

b. to construct, maintain, inspect, replace, alter, and repair such ancillary works as may be necessary for the operation of the force main sewer line; and

c. for the servants, agents, contractors, and employees of Stanley to enter the Easement Property with such machinery, material, vehicles, and equipment as may be necessary for the use of the easement.

3. New Hope may fully use and enjoy the Easement Property, subject always to and so as not to interfere with the rights, licenses, and easements hereby granted to Stanley, provided that New Hope may not, without the consent in writing of Stanley first had and obtained, excavate, drill, place, install, or permit to be excavated, drilled, installed, or erected on, over, or under the Easement Property, any pit, well, foundation, pavement, material, fence, or structure.

4. Stanley agrees to use the right-of-way and allow its use by others in such a manner so as to cause:

a. as little disturbance as possible to the use and enjoyment of the Easement Property by New Hope;

b. as little damage as possible to the surface of the Easement Property and any plants, bushes, or trees which may be growing thereon, provided always that Stanley is not bound to complete any repairs to the Easement Property beyond restoring the level of the surface prior to its being disturbed; and

c. as little damage as possible to the crops being grown by New Hope on the Easement Property;

and to this end, agrees, so much as is reasonably practical, reasonably practical to be determined at the sole discretion of Stanley, acting in good faith, to complete any work on the Easement Property during the agricultural off-season.

5. Stanley covenants and agrees to stockpile all topsoil removed from the Easement Property and to fill in all excavations and replace the topsoil so that as far as practicable the surface of the Easement Property will be restored to the same condition as prior to the commencement of construction or of any subsequent work thereto.

6. New Hope agrees that the rights, licenses, and easements hereby granted are exercisable forthwith and at any and all times hereafter by Stanley and by its servants, agents, and employees, in any manner, free of charge.

7. Subject to Stanley performing and observing the covenants and conditions on its part to be performed and observed hereunder, Stanley will hold the rights, licenses, and easements hereby granted without hindrance, molestation, or interruption on the part of New Hope or of any person claiming by, through, under, or in trust for, New Hope.

8. Stanley agrees to indemnify and save harmless New Hope from and against all public liability and property damage claims and personal injury claims arising from the exercise by Stanley, at any time during the term of this agreement, of the rights, licenses, and easements hereby granted, together with all costs, charges, and expenses arising by reason of or in connection with any such claims, provided that nothing in this clause extends the indemnity to any act, matter, or thing done, or omitted to be done by New Hope, its agents, servants, employees, or invitees.

9. It is understood and agreed that all of the covenants and agreements herein made by Stanley, and all of the acts and undertakings herein agreed to be done by Stanley will be performed, done, and undertaken within the limits of all applicable laws, rules, and regulations of legislative bodies superior to Stanley and notwithstanding anything herein before contained, Stanley will be under no higher obligation or duty than to exercise its best efforts to perform, do, and undertake those covenants, agreements, acts, or undertakings herein before referred to, and Stanley will be under no liability to New Hope or any other person, firm, or corporation for its failure to perform, do, and undertake any of the covenants, agreements, acts, or undertakings if such failure is beyond the control of Stanley or caused by operation of law.

10. Stanley must keep an accurate record of the location of its underground installations and must provide New Hope, upon request, with such records.

11. The force main sewer line and all ancillary works will remain the property of Stanley, notwithstanding that they are attached to the New Hope Property.

12. Nothing will be construed as rendering New Hope or any agent, employee or servant of New Hope, an agent, servant, employee or invitee of Stanley, and vice-versa.

13. The term of this agreement will be for so long as Stanley requires the force main sewer

line to remain in place and the terms and provisions of this agreement will constitute a covenant running with the New Hope Property until removed by Stanley.

14. The preamble forms part of this agreement.

15. New Hope's address for service is:

Box 2, Altona, Manitoba, R0G 0B0

16. Stanley's address for service is:

Box 1600, Winkler, Manitoba, R6W 4B5

17. This agreement may be registered in the appropriate Land Titles Office as a statutory easement under Section 111 of *The Real Property Act* (Manitoba) by any means Stanley sees fit.

18. Stanley may at any time request the District Registrar of the appropriate Land Titles Office to issue a Statutory Easement Title under *The Real Property Act* (Manitoba).

SIGNED, SEALED, AND DELIVERED in the presence of:

[redacted]

Witness Name:

) TRUSTEES OF NEW HOPE MENNONITE
) CHURCH, A RELIGIOUS SOCIETY IN
) THE RURAL MUNICIPALITY OF
) STANLY, IN THE PROVINCE OF MANITOBA
)
)
) per: [redacted]
) N
) O

SIGNED, SEALED, AND DELIVERED in the presence of:

[redacted]

Witness Name:

) RURAL MUNICIPALITY OF STANLEY
)
)
)
) per: [redacted]
) Name:
) Office: Trustee

AFFIDAVIT OF LAND OWNER

CANADA
PROVINCE OF MANITOBA
TO WIT:

) I, JERROLD Stoesz (name),
) Trustee (office), of
) Trustees of New Hope Mennonite Church, a Religious
) Society in the Rural Municipality of Stanly,
) in the Province of Manitoba

MAKE OATH AND SAY THAT:

1. Trustees of New Hope Mennonite Church, a Religious Society in the Rural Municipality of Stanly, in the Province of Manitoba is the registered owner of the New Hope Property.

2. I am of the full age of eighteen years and have the authority to bind the corporation.

3. The New Hope Property is not Homestead Property.

SWORN before me at the City of Winkler, in Manitoba, this 3rd day of May, 2019.

[redacted]

A Commissioner for Oaths
In and for the Province of Manitoba
My Commission Expires: Sept 19/19

[redacted]

AFFIDAVIT OF LAND OWNER

CANADA
PROVINCE OF MANITOBA
TO WIT:

) I, PETER REMPEL (name),
) Trustee (office), of
) Trustees of New Hope Mennonite Church, a Religious
) Society in the Rural Municipality of Stanly,
) in the Province of Manitoba

MAKE OATH AND SAY THAT:

1. Trustees of New Hope Mennonite Church, a Religious Society in the Rural Municipality of Stanly, in the Province of Manitoba is the registered owner of the New Hope Property.

2. I am of the full age of eighteen years and have the authority to bind the corporation.

3. The New Hope Property is not Homestead Property.

SWORN before me at the City of Winkler, in Manitoba, this 3rd day of May, 2019.

[redacted]

A Commissioner for Oaths
In and for the Province of Manitoba
My Commission Expires: Sept 19/19

[redacted]

AFFIDAVIT OF EXECUTION

CANADA)
PROVINCE OF MANITOBA)
)
TO WIT:)

I, Melanie Walker, of the City of Morden, in Manitoba,

MAKE OATH AND SAY:

1. THAT I was personally present and did see the attached Easement Agreement executed by Jerrold Stoesz (name) as Peter Rempel (office) of Trustees of New Hope Mennonite Church, a Religious Society in the Rural Municipality of Stanly, in the Province of Manitoba.

2. **THAT** I know Jerrold Stoesz + Peter Rempel (name) and am satisfied that they are the full age of eighteen years.

3. **THAT** the Easement Agreement was executed at the City of Winkler in Manitoba.

4. **THAT** I am a subscribing witness thereto.

DECLARED before me at the City of Winkler, in Manitoba, this 3rd day of May, 2019.

[redacted]

[redacted]

A Commissioner for Oaths
in and for the Province of Manitoba.
My Commission expires: Sept 19/19

STATUTORY DECLARATION

CANADA	) In the matter of:
PROVINCE OF MANITOBA	) Easement Agreement
TO WIT:	) Rural Municipality of Stanley
	) and Trustees of New Hope Mennonite Church,
	) a Religious Society in the Rural Municipality of Stanly,
	) in the Province of Manitoba

I, DALE TOEWS, of the City of Winkler, in Manitoba, solemnly declare:

1. THAT I am the Chief Executive Officer of the Rural Municipality of Stanley and as such have personal knowledge of the matters hereinafter deposed to by me.

2. THAT the Rural Municipality of Stanley is an eligible Grantee within the meaning of Section 111(1) of *The Real Property Act* (Manitoba).

3. THAT I make this declaration pursuant to Section 111.1(3) of *The Real Property Act* (Manitoba).

AND I make this declaration conscientiously believing it to be true and knowing that it is of the same force and effect as if made under oath and by virtue of the *Canada Evidence Act*.

DECLARED before me at the City of Winkler, in Manitoba, this 3rd day of May, 2019.

[redacted]

[redacted]

A Commissioner for Oaths
in and for the Province of Manitoba.
My Commission expires: Sept 19/19

EASEMENT AGREEMENT

(s. 111, *The Real Property Act*)

DATED this 10th day of April, 2019.

BETWEEN:

MARY AGNES WIENS
("Wiens")

- and -

RURAL MUNICIPALITY OF STANLEY
("Stanley")

WHEREAS Wiens is the registered owner of certain lands and premises more particularly described below;

AND WHEREAS Stanley owns and operates a wastewater treatment facility and intends to install a force main sewer line on Wiens's property;

AND WHEREAS Stanley requires access to Wiens's property for the purpose of installing, maintaining, and repairing the force main sewer line to be located thereon;

AND WHEREAS Wiens has agreed to grant Stanley an easement and right-of-way for persons and vehicles over and across its lands and premises under Section 111 of *The Real Property Act* (Manitoba) for the purpose of installing, maintaining, and repairing the force main sewer line to be located thereon;

NOW THEREFORE the parties hereto, in consideration of the mutual covenants set forth herein and the benefits to be derived by each from the fulfillment of this agreement, do hereby covenant and agree as follows:

1. In this agreement the following definitions apply:

    a. "Wiens Property" means:

    ALL THAT PORTION OF SE ¼ 2-3-4 WPM LYING TO THE NORTH OF RAILWAY RIGHT-OF-WAY PLAN 76 MLTO;
    (Title No. 2135682/4).

    b. "Easement Property" means:

THE WLY 50 FEET PERP OF
ALL THAT PORTION OF SE ¼ 2-3-4 WPM LYING TO THE NORTH OF RAILWAY RIGHT-OF-WAY PLAN 76 MLTO.

2. Wiens grants unto Stanley an easement and right-of-way over and across the Easement Property:

   a. to construct, maintain, inspect, replace, alter, and repair the force main sewer line;

   b. to construct, maintain, inspect, replace, alter, and repair such ancillary works as may be necessary for the operation of the force main sewer line; and

   c. for the servants, agents, contractors, and employees of Stanley to enter the Easement Property with such machinery, material, vehicles, and equipment as may be necessary for the use of the easement.

3. Wiens may fully use and enjoy the Easement Property, subject always to and so as not to interfere with the rights, licenses, and easements hereby granted to Stanley, provided that Wiens may not, without the consent in writing of Stanley first had and obtained, excavate, drill, place, install, or permit to be excavated, drilled, installed, or erected on, over, or under the Easement Property, any pit, well, foundation, pavement, material, fence, or structure.

4. Stanley agrees to use the right-of-way and allow its use by others in such a manner so as to cause:

   a. as little disturbance as possible to the use and enjoyment of the Easement Property by Wiens;

   b. as little damage as possible to the surface of the Easement Property and any plants, bushes, or trees which may be growing thereon, provided always that Stanley is not bound to complete any repairs to the Easement Property beyond restoring the level of the surface prior to its being disturbed; and

   c. as little damage as possible to the crops being grown by Wiens on the Easement Property;

   and to this end, agrees, so much as is reasonably practical, reasonably practical to be determined at the sole discretion of Stanley, acting in good faith, to complete any work on the Easement Property during the agricultural off-season.

5. Stanley covenants and agrees to stockpile all topsoil removed from the Easement Property and to fill in all excavations and replace the topsoil so that as far as practicable the surface of the Easement Property will be restored to the same condition as prior to the commencement of construction or of any subsequent work thereto.

6. Wiens agrees that the rights, licenses, and easements hereby granted are exercisable forthwith and at any and all times hereafter by Stanley and by its servants, agents, and employees, in any manner, free of charge.

7. Subject to Stanley performing and observing the covenants and conditions on its part to be performed and observed hereunder, Stanley will hold the rights, licenses, and easements hereby granted without hindrance, molestation, or interruption on the part of Wiens or of any person claiming by, through, under, or in trust for, Wiens.

8. Stanley agrees to indemnify and save harmless Wiens from and against all public liability and property damage claims and personal injury claims arising from the exercise by Stanley, at any time during the term of this agreement, of the rights, licenses, and easements hereby granted, together with all costs, charges, and expenses arising by reason of or in connection with any such claims, provided that nothing in this clause extends the indemnity to any act, matter, or thing done, or omitted to be done by Wiens, its agents, servants, employees, or invitees.

9. It is understood and agreed that all of the covenants and agreements herein made by Stanley, and all of the acts and undertakings herein agreed to be done by Stanley will be performed, done, and undertaken within the limits of all applicable laws, rules, and regulations of legislative bodies superior to Stanley and notwithstanding anything herein before contained, Stanley will be under no higher obligation or duty than to exercise its best efforts to perform, do, and undertake those covenants, agreements, acts, or undertakings herein before referred to, and Stanley will be under no liability to Wiens or any other person, firm, or corporation for its failure to perform, do, and undertake any of the covenants, agreements, acts, or undertakings if such failure is beyond the control of Stanley or caused by operation of law.

10. Stanley must keep an accurate record of the location of its underground installations and must provide Wiens, upon request, with such records.

11. The force main sewer line and all ancillary works will remain the property of Stanley, notwithstanding that they are attached to the Wiens Property.

12. Nothing will be construed as rendering Wiens or any agent, employee or servant of Wiens, an agent, servant, employee or invitee of Stanley, and vice-versa.

13. The term of this agreement will be for so long as Stanley requires the force main sewer line to remain in place and the terms and provisions of this agreement will constitute a covenant running with the Wiens Property until removed by Stanley.

14. The preamble forms part of this agreement.

15. Wiens's address for service is:

306 – 310 7th Street, Winkler, Manitoba, R6W 1H2

16. Stanley's address for service is:

Box 1600, Winkler, Manitoba, R6W 4B5

17. This agreement may be registered in the appropriate Land Titles Office as a statutory easement under Section 111 of *The Real Property Act* (Manitoba) by any means Stanley sees fit.

18. Stanley may at any time request the District Registrar of the appropriate Land Titles Office to issue a Statutory Easement Title under *The Real Property Act* (Manitoba).

SIGNED, SEALED, AND DELIVERED)
in the presence of:)
[redacted])
[redacted])
Witness Name:) Mary Agnes Wiens

SIGNED, SEALED, AND DELIVERED) RURAL MUNICIPALITY OF STANLEY
in the presence of:)
[redacted])
[redacted])
Witness Name:) per [redacted]
) Name: Dale Toews
) Office: Chief Administrative Officer

AFFIDAVIT OF LAND OWNER

CANADA) I, Mary Agnes Wiens,
PROVINCE OF MANITOBA) of the City of Winkler, Manitoba
TO WIT:)

MAKE OATH AND SAY THAT:

1. I am the registered owner of the Wiens Property.

2. I am of the full age of eighteen years.

3. The Wiens Property is not Homestead Property.

SWORN before me at the City of Winkler,)
in Manitoba, this 10th day)
of April , 2019.)
[redacted])
[redacted])
)

A Commissioner for Oaths
in and for the Province of Manitoba
My Commission Expires:
Sept. 19/19

AFFIDAVIT OF EXECUTION

CANADA)
PROVINCE OF MANITOBA)
)
TO WIT:)

I, John C. Froese, of the City of Winkler, in Manitoba,

MAKE OATH AND SAY:

1. **THAT** I was personally present and did see the attached Easement Agreement executed by Mary Agnes Wiens.

2. **THAT** I know Mary Agnes Wiens and am satisfied that she is the full age of eighteen years.

3. **THAT** the Easement Agreement was executed at the City of Winkler in Manitoba.

4. **THAT** I am a subscribing witness thereto.

DECLARED before me at the City of Winkler, in Manitoba, this 10th day of April, 2019.

[redacted]

A Commissioner for Oaths
in and for the Province of Manitoba.
My Commission expires:
Sept. 19/19

[redacted]

STATUTORY DECLARATION

CANADA	) In the matter of:
PROVINCE OF MANITOBA	) Easement Agreement
TO WIT:	) Rural Municipality of Stanley
	) and Mary Agnes Wiens

I, DALE TOEWS, of the City of Winkler, in Manitoba, solemnly declare:

1. THAT I am the Chief Executive Officer of the Rural Municipality of Stanley and as such have personal knowledge of the matters hereinafter deposed to by me.

2. THAT the Rural Municipality of Stanley is an eligible Grantee within the meaning of Section 111(1) of *The Real Property Act* (Manitoba).

3. THAT I make this declaration pursuant to Section 111.1(3) of *The Real Property Act* (Manitoba).

AND I make this declaration conscientiously believing it to be true and knowing that it is of the same force and effect as if made under oath and by virtue of the *Canada Evidence Act*.

DECLARED before me at the City of Winkler, in Manitoba, this 10th day of April, 2019.

[redacted]

A Commissioner for Oaths
in and for the Province of Manitoba.
My Commission expires:
Sept. 19/19

[redacted]

EASEMENT AGREEMENT

(s. 111, *The Real Property Act*)

DATED this 18th day of April, 2019.

BETWEEN:

TWIN ELEVEN INVESTORS LIMITED
("Twin")

- and -

RURAL MUNICIPALITY OF STANLEY
("Stanley")

WHEREAS Twin is the registered owner of certain lands and premises more particularly described below;

AND WHEREAS Stanley owns and operates a wastewater treatment facility and intends to install a force main sewer line on Twin's property;

AND WHEREAS Stanley requires access to Twin's property for the purpose of installing, maintaining, and repairing the force main sewer line to be located thereon;

AND WHEREAS Twin has agreed to grant Stanley an easement and right-of-way for persons and vehicles over and across its lands and premises under Section 111 of *The Real Property Act* (Manitoba) for the purpose of installing, maintaining, and repairing the force main sewer line to be located thereon;

NOW THEREFORE the parties hereto, in consideration of the mutual covenants set forth herein and the benefits to be derived by each from the fulfillment of this agreement, do hereby covenant and agree as follows:

1. In this agreement the following definitions apply:

    a. "Twin Property" means:

        THE WLY 412.5 FEET OF THE SE ¼ OF SECTION 2-3-4 WPM WHICH LIES TO THE SOUTH OF THE SOUTHERN LIMIT OF CANADIAN PACIFIC RAILWAY RIGHT-OF-WAY PLAN 76 MLTO; (Title No. 2919588/4).

b. "Easement Property" means:

THE ELY 50 FEET PERP OF
THE WLY 412.5 FEET OF THE SE ¼ OF SECTION 2-3-4 WPM
WHICH LIES TO THE SOUTH OF THE SOUTHERN LIMIT OF
CANADIAN PACIFIC RAILWAY RIGHT-OF-WAY PLAN 76 MLTO.

2. Twin grants unto Stanley an easement and right-of-way over and across the Easement Property:

a. to construct, maintain, inspect, replace, alter, and repair the force main sewer line;

b. to construct, maintain, inspect, replace, alter, and repair such ancillary works as may be necessary for the operation of the force main sewer line; and

c. for the servants, agents, contractors, and employees of Stanley to enter the Easement Property with such machinery, material, vehicles, and equipment as may be necessary for the use of the easement.

3. Twin may fully use and enjoy the Easement Property, subject always to and so as not to interfere with the rights, licenses, and easements hereby granted to Stanley, provided that Twin may not, without the consent in writing of Stanley first had and obtained, excavate, drill, place, install, or permit to be excavated, drilled, installed, or erected on, over, or under the Easement Property, any pit, well, foundation, pavement, material, fence, or structure.

4. Stanley agrees to use the right-of-way and allow its use by others in such a manner so as to cause:

a. as little disturbance as possible to the use and enjoyment of the Easement Property by Twin;

b. as little damage as possible to the surface of the Easement Property and any plants, bushes, or trees which may be growing thereon, provided always that Stanley is not bound to complete any repairs to the Easement Property beyond restoring the level of the surface prior to its being disturbed; and

c. as little damage as possible to the crops being grown by Twin on the Easement Property;

and to this end, agrees, so much as is reasonably practical, reasonably practical to be determined at the sole discretion of Stanley, acting in good faith, to complete any work on the Easement Property during the agricultural off-season.

5. Stanley covenants and agrees to stockpile all topsoil removed from the Easement Property and to fill in all excavations and replace the topsoil so that as far as practicable the surface of the Easement Property will be restored to the same condition as prior to the commencement of construction or of any subsequent work thereto.

6. Stanley covenants and agrees to reimburse Twin for any crop loss caused as a result of the use the right-of-way and easement by Stanley by paying Twin an amount per unit of measurement (be it by the bushel or the ton or any other unit of measurement normally used for the crop in question) equal to the price obtained by Twin for a similar unit of the same crop grown on the unaffected portions of the Twin Property, multiplied by the average return in units of measurement per acre for the crop grown on the unaffected portions of the Twin Property with the per acre return then multiplied by the number of acres of the Twin Property affected by the crop loss.

7. Twin agrees that the rights, licenses, and easements hereby granted are exercisable forthwith and at any and all times hereafter by Stanley and by its servants, agents, and employees, in any manner, free of charge.

8. Subject to Stanley performing and observing the covenants and conditions on its part to be performed and observed hereunder, Stanley will hold the rights, licenses, and easements hereby granted without hindrance, molestation, or interruption on the part of Twin or of any person claiming by, through, under, or in trust for, Twin.

9. Stanley agrees to indemnify and save harmless Twin from and against all public liability and property damage claims and personal injury claims arising from the exercise by Stanley, at any time during the term of this agreement, of the rights, licenses, and easements hereby granted, together with all costs, charges, and expenses arising by reason of or in connection with any such claims, provided that nothing in this clause extends the indemnity to any act, matter, or thing done, or omitted to be done by Twin, its agents, servants, employees, or invitees.

10. It is understood and agreed that all of the covenants and agreements herein made by Stanley, and all of the acts and undertakings herein agreed to be done by Stanley will be performed, done, and undertaken within the limits of all applicable laws, rules, and regulations of legislative bodies superior to Stanley and notwithstanding anything herein before contained, Stanley will be under no higher obligation or duty than to exercise its best efforts to perform, do, and undertake those covenants, agreements, acts, or

undertakings herein before referred to, and Stanley will be under no liability to Twin or any other person, firm, or corporation for its failure to perform, do, and undertake any of the covenants, agreements, acts, or undertakings if such failure is beyond the control of Stanley or caused by operation of law.

11. Stanley must keep an accurate record of the location of its underground installations and must provide Twin, upon request, with such records.

12. The force main sewer line and all ancillary works will remain the property of Stanley, notwithstanding that they are attached to the Twin Property.

13. Nothing will be construed as rendering Twin or any agent, employee or servant of Twin, an agent, servant, employee or invitee of Stanley, and vice-versa.

14. The term of this agreement will be for so long as Stanley requires the force main sewer line to remain in place and the terms and provisions of this agreement will constitute a covenant running with the Twin Property until removed by Stanley.

15. The preamble forms part of this agreement.

16. Twin's address for service is:

Box 1869, Winkler, Manitoba, R6W 4B7

17. Stanley's address for service is:

Box 1600, Winkler, Manitoba, R6W 4B5

18. This agreement may be registered in the appropriate Land Titles Office as a statutory easement under Section 111 of *The Real Property Act* (Manitoba) by any means Stanley sees fit.

19. Stanley may at any time request the District Registrar of the appropriate Land Titles Office to issue a Statutory Easement Title under *The Real Property Act* (Manitoba).

Signature Page to Follow

SIGNED, SEALED, AND DELIVERED in the presence of:

[redacted]

Witness Name:

) TWIN ELEVEN INVESTORS LIMITED
)
)
)
) per: [redacted]
) Name: KELLY MCDONALD
) Office: President

SIGNED, SEALED, AND DELIVERED in the presence of:

[redacted]

Witness Name:

) RURAL MUNICIPALITY OF STANLEY
)
)
)
) per [redacted]
) Name: DALE TOEWS
) Office: CAO

AFFIDAVIT OF LAND OWNER

CANADA) I, KELLY MCDONALD (name),
PROVINCE OF ALBERTA) President (office),
TO WIT:) of Twin Eleven Investors Limited

MAKE OATH AND SAY THAT:

1. Twin Eleven Investors Limited is the registered owner of the Twin Property.

2. I am of the full age of eighteen years and have the authority to bind the corporation.

3. The Twin Property is not Homestead Property.

SWORN before me at the City of Winkler,)
in Manitoba, this 18th day)
of April , 2019.)
[redacted])
[redacted])
)
)

A Commissioner for Oaths
In and for the Province of Manitoba
My Commission Expires:
Sept. 19/19

AFFIDAVIT OF EXECUTION

CANADA)
PROVINCE OF MANITOBA)
)
TO WIT:)

I, Mike Wiebe, of the City of Morden, in Manitoba,

MAKE OATH AND SAY:

1. **THAT** I was personally present and did see the attached Easement Agreement executed by Kelly McDonald (name) as President (office) of Twin Eleven Investors Limited.

2. **THAT** I know Kelly McDonald (name) and am satisfied that they are the full age of eighteen years.

3. **THAT** the Easement Agreement was executed at the City of Winkler in Manitoba.

4. **THAT** I am a subscribing witness thereto.

DECLARED before me at the City of Winkler, in Manitoba, this 18th day of April 2019.

[redacted]

A Commissioner for Oaths
in and for the Province of Manitoba.
My Commission expires:
Sept. 19/19

STATUTORY DECLARATION

CANADA	) In the matter of:
PROVINCE OF MANITOBA	) Easement Agreement
TO WIT:	) Rural Municipality of Stanley
	) and Twin Eleven Investors Limited

I, DALE TOEWS, of the City of Winkler, in Manitoba, solemnly declare:

1. THAT I am the Chief Executive Officer of the Rural Municipality of Stanley and as such have personal knowledge of the matters hereinafter deposed to by me.

2. THAT the Rural Municipality of Stanley is an eligible Grantee within the meaning of Section 111(1) of *The Real Property Act* (Manitoba).

3. THAT I make this declaration pursuant to Section 111.1(3) of *The Real Property Act* (Manitoba).

AND I make this declaration conscientiously believing it to be true and knowing that it is of the same force and effect as if made under oath and by virtue of the *Canada Evidence Act.*

DECLARED before me at the City of Winkler, in Manitoba, this 18th day of [redacted]

[redacted]

A Commissioner for Oaths
in and for the Province of Manitoba.
My Commission expires:
Sept. 19/19

AECOM

Appendix C

Photographs – Existing Environment

AECOM Imagine it. Delivered.

PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
RM of Stanley	RM of Stanley – Regional Wastewater Conveyance System Project	60735871

Photo No.	Date
1	8/20/2024

Direction

North

Coordinates

49° 8'53.67"N; 97°55'50.38"W

Description

Proposed Schanzenfeld lift station site.

Photo No.	Date
2	8/20/2024

Direction

N/A

Coordinates

N/A

Description

Typical street view, Schanzenfeld.

AECOM Imagine it. Delivered.

PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
RM of Stanley	RM of Stanley – Regional Wastewater Conveyance System Project	60735871

Photo No.	Date
3	8/20/2024

Direction

N/A

Coordinates

N/A

Description

Typical street view, Schanzenfeld.

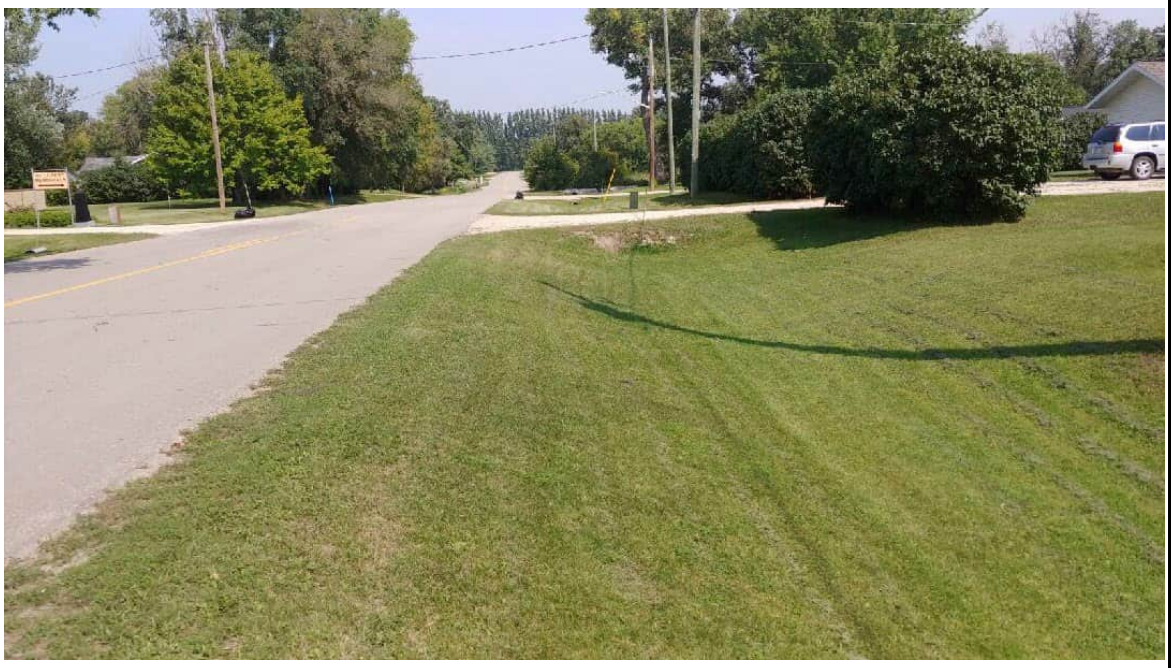

Photo No.	Date
4	8/20/2024

Direction

N/A

Coordinates

49° 8'19.76"N; 97°56'25.53"W

Description

Creek crossing within Schanzenfeld.

AECOM Imagine it. Delivered.

PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
RM of Stanley	RM of Stanley – Regional Wastewater Conveyance System Project	60735871

Photo No.	Date
5	8/20/2024

Direction

N/A

Coordinates

49° 8'35.52"N; 97°56'41.85"W

Description

Drain crossing within Schanzenfeld.

Photo No.	Date
6	8/20/2024

Direction

N/A

Coordinates

49° 9'46.85"N; 97°54'31.19"W

Description

Creek crossing east of Schanzenfeld proposed lift station location, across road 10N.

AECOM Imagine it. Delivered.

PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
RM of Stanley	RM of Stanley – Regional Wastewater Conveyance System Project	60735871

Photo No.	Date
7	8/20/2024

Direction

East

Coordinates

N/A

Description

Force main route from proposed Schanzenfeld lift station to proposed Reinfeld lift station, along road 10N, looking east (typical view).

Photo No.	Date
8	8/20/2024

Direction

N/A

Coordinates

49° 9'46.62"N; 97°54'31.21"W

Description

Creek crossing, north-east of proposed Schanzenfeld lift station, along road 20W.

AECOM Imagine it. Delivered.

PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
RM of Stanley	RM of Stanley – Regional Wastewater Conveyance System Project	60735871

Photo No.	Date
9	8/20/2024

Direction

North

Coordinates

49° 8'53.07"N; 97°54'30.45"W

Description

Force main route from proposed Schanzenfeld lift station to the proposed Reinfeld lift station, turning point from road 10N to road 20W, looking north (typical view)

Photo No.	Date
10	8/20/2024

Direction

N/A

Coordinates

49°10'40.41"N; 97°53'58.88"W

Description

Proposed Reinfeld lift station site.

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PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
RM of Stanley	RM of Stanley – Regional Wastewater Conveyance System Project	60735871

Photo No.	Date
11	8/20/2024

Direction

N/A

Coordinates

49°10'40.41"N; 97°53'58.88"W

Description

Proposed Reinfeld lift station site.

Photo No.	Date
12	8/20/2024

Direction

N/A

Coordinates

49°10'40.41"N; 97°53'58.88"W

Description

Groundwater monitoring well at proposed Reinfeld lift station site.

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PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
RM of Stanley	RM of Stanley – Regional Wastewater Conveyance System Project	60735871

Photo No.	Date
13	8/20/2024

Direction

N/A

Coordinates

N/A

Description

Typical street views, Reinfeld.

Photo No.	Date
14	8/20/2024

Direction

N/A

Coordinates

N/A

Description

Typical street views, Reinfeld.

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PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
RM of Stanley	RM of Stanley – Regional Wastewater Conveyance System Project	60735871

Photo No.	Date
15	8/20/2024

Direction

N/A

Coordinates

49°11'2.84"N; 97°53'9.88"W

Description

Rail crossing along proposed force main route.

Photo No.	Date
16	8/20/2024

Direction

N/A

Coordinates

49°11'16.17"N; 97°53'58.60"W

Description

Creek crossing east of Winkler along proposed force main route.

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PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
RM of Stanley	RM of Stanley – Regional Wastewater Conveyance System Project	60735871

Photo No.	Date
17	8/20/2024

Direction

N/A

Coordinates

N/A

Description

Force main route along road 20W, north of road 14 (typical view).

Photo No.	Date
18	8/20/2024

Direction

N/A

Coordinates

N/A

Description

FM route along road 15N, west of road 20W (typical view) – proposed connection to lagoon area.

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PHOTOGRAPHIC LOG

Client Name:	Site Location	Project No.
RM of Stanley	RM of Stanley – Regional Wastewater Conveyance System Project	60735871

Photo No.	Date
19	8/20/2024

Direction

N/A

Coordinates

N/A

Description

Force main route along road 15N, west of road 20W (typical view) – proposed connection to lagoon area.

AECOM

Appendix D

Pre-Design Study Report

Rural Municipality of Stanley

Low Pressure Sewer System Pre-design Report for Schanzenfeld and Reinfeld Revised Final

Prepared by:

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November 2016

Project Number: 60428376 (500)

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	X	Mr. D. Toews, RM of Stanley

Revision History

Revision #	Date	Revised By:	Revision Description
0	July 2015	Z. Pan	Draft
1	June 2016	Z. Pan	Final
2	November 2016	Z. Pan	Revised Final

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November 23, 2016

Mr. Dale Toews
Chief Administrative Officer
Rural Municipality of Stanley
100 – 379 Stephen Street
Morden, MB R6M 1V1

Dear Mr. Toews:

Project No: **60428376 (500)**

Regarding: **Low Pressure Sewer System Pre-design Report for Schanzenfeld and Reinfeld**
Revised Final

We are pleased to submit our revised final report entitled Low Pressure Sewer Pre-design for Schanzenfeld and Reinfeld. This report provides low pressure sewer preliminary design, including pipeline layout and sizing, for both communities, reviews lift stations and forcemains system capacity, and updates the cost estimates.

If you have any questions, please do not hesitate to contact Keith Fitchett at 204-928-8445.

Sincerely,
AECOM Canada Ltd.

[redacted]

Andy Nagy, P. Eng.
Conveyance Area Market Sector Leader
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Senior Manager

Table of Contents

page

1. Executive Summary 1

2. Introduction 2

3. Low Pressure Sewer 2

3.1 Grinder Pump System 2
3.2 Step Systems 2

4. Design Parameters and Flows 3

4.1 20 Year Development Scenarios 4
4.2 Ultimate Future Development 5
4.3 20 Year Sewage Flow WWTP Impact 5

5. Low Pressure Sewer Design and Cost Estimates 13

5.1 Village of Schanzenfeld 13
5.2 Village of Reinfeld 14
5.3 Lift Station and Forcemain 15
5.3.1 Schanzenfeld 15
5.3.2 Reinfeld 16

6. Conclusion and Recommendation 19

List of Figures

Figure 1 – Schanzenfeld Low Pressure Sewer System – Preliminary Design 20 Year Development 7
Figure 2 - Schanzenfeld Low Pressure Sewer System – Preliminary Design Future Option 1 8
Figure 3 - Schanzenfeld Low Pressure Sewer System – Preliminary Design Future Option 2 9
Figure 4 - Reinfeld Low Pressure Sewer System – Preliminary Design 20 Year Development 10
Figure 5 - Reinfeld Low Pressure Sewer System – Preliminary Design Future Option 1 11
Figure 6 - Reinfeld Low Pressure Sewer System – Preliminary Design Future Option 1 12
Figure 7 – RM of Stanley – Low Pressure Sewer System Preliminary Design – Forcemain Pipeline Layout and Lift Stations 18

List of Tables

Table 1 - Existing and Future Lots 3
Table 2 - Low Pressure Sewer Design Flows for Reinfeld 4
Table 3 - Low Pressure Sewer Design Flows for Schanzenfeld 4
Table 4 - Average Sewage Flow Calculations for WWTP Capacity Impact Review 6
Table 5 - Low Pressure Sewer Diameters and Lengths for the Village of Schanzenfeld 13
Table 6 - Estimated Low Pressure Sewer Costs for the Village of Schanzenfeld 14

Table 7 - Low Pressure Sewer Diameters and Lengths for the Village of Reinfeld 14
Table 8 - Estimated Low Pressure Sewer Costs for the Village of Reinfeld 14
Table 9 - Estimated Cost for Schanzenfeld Lift Station and Separate Forcemain 16
Table 10 - Estimated Cost for Reinfeld Lift Station and Separate Forcemain 16
Table 11 - Total Estimated Costs for Schanzenfeld 19
Table 12 - Total Estimated Costs for Reinfeld 20

Appendices

Appendix A Preliminary Design Drawings
Appendix B Breakdown Cost Analyses
Appendix C Low Pressure Sewer Operation and Maintenance Information

1. Executive Summary

In February 2011, AECOM submitted the Wastewater Feasibility Study for Schanzenfeld and Reinfeld to the RM of Stanley. The feasibility study provided analysis of a low pressure system design for both Schanzenfeld and Reinfeld based on the population projection development scenarios.

This pre-design report updates the information from previous studies, and provides further analysis for the low pressure sewer system design, sewage pump stations design, and forcemain system design for both communities based on the 20 Year development scenario and the ultimate future development scenario, as well as updates the cost estimates for two scenarios.

Reinfeld community currently has the estimated population of 1702, a projected 20 Year population of 2722, and an ultimate future population of 8418. The estimated 20 Year design peak sewage flow is Reinfeld is 30.7 L/s, and the ultimate future peak sewage flow is about 94.9 L/s.

Schanzenfeld community currently has the estimated population of 1435, a projected 20 Year population of 2295, and an ultimate future population of 3711. The estimated 20 Year design sewage flow is Reinfeld is 27.2 L/s, and the ultimate future sewage flow is about 44.0 L/s.

Three development scenarios were included in the hydraulic analysis: 20 Year Development, ultimate future Option 1, and ultimate future Option 2. The ultimate future Option1 assumes that all sewage flow from future areas is collected by the internal LPS and discharge directly into the proposed pump station wetwell. The ultimate future Option 2 assumes that portion of sewage flow from future areas are discharged into the LPS within the community. The proposed LPS main sizes based on three scenarios are presented in Figure 1, 2, &3 for Schanzenfeld, and Figure 4, 5, &6 for Reinfeld. And the estimated costs of LPS are outlined in Table 5 and Table 7.

A sewage lift station is proposed for Schanzenfeld at the intersection of Eastview Dr and Church Ave. The Schanzenfeld Lift Station will be a submergible underground precast concrete structure with duplex pumping system. The sewage flow collected by the LPS will discharge into the Schanzenfeld Lift Station and pump into the proposed Reinfeld List Station by an approximately 5.3 km forcemain system. A sewage lift station is proposed for Reinfeld near the intersection of Road 10N and Moline Drive. The Reinfeld Main Lift Station will be a separate dry-well/wet-well lift station with above ground structure. The sewage flow produced within community will be collected by the LPS and discharged into the Reinfeld Lift Station. The combined sewage flow from both Schanzenfeld and Reinfeld will be pumped into the City of Winkler's WWTP via an approximately 5.7 km forcemain system. The lift station and forcemain design were evaluated on both the 20 Year Development scenario and the ultimate future development scenario. The estimated costs for both scenarios are outlined in Table 8 and Table 9. The forcemain alignment and pump station location is shown in Figure 7.

At this report, we recommend that the LPS system design for Schanzenfeld community is based on the ultimate future development Option 2 scenario. And for Reinfeld community, the LPS system design is based on the ultimate future development Option 1 scenario. The lift station design and forcemain sizing should consider the 20 Year flow condition, and provide additional space and capacity to accommodate the ultimate future sewage flow. The total estimated cost for Schanzenfeld, including low pressure sewer system servicing the community, the proposed Schanzenfeld Lift Station, and approximately 5.3 km forcemain pipeline is **$3,969,063.** The total estimated cost for Reinfeld, including low pressure sewer system servicing the community, the proposed Reinfeld Main Lift Station, and approximately 5.7 km of 350mm diameter forcemain pipeline is **$7,757,063.**

2. Introduction

AECOM previously conducted the wastewater feasibility study for Schanzenfeld and Reinfeld and submitted the feasibility study report to the RM of Stanley in August 2010. The study provided both the low pressure sewer (LPS) and the gravity sewer system options for each community and concluded that the low pressure sewer system would be more cost effective for both Schanzenfeld and Reinfeld. The final feasibility study was submitted in February, 2011. The final report provided analysis of only a low pressure system for both Schanzenfeld and Reinfeld under revised population projection development scenarios.

This report updates the information in the previous feasibility study to the pre design stage. Pre design work includes updating development parameters, updating population projections, developing a 20 year design scenario, calculating revised sewage flows for the low pressure option only, completing the hydraulic analysis of the pipe networks based on the updated sewage flows, confirming pipe sizing, developing preliminary alignments, preparing preliminary piping and lift station details, and providing the cost estimates to reflect projected 2016 pricing.

3. Low Pressure Sewer

As discussed in the previous report (AECOM 2010), low pressure sewer systems require pumping facilities at each building connection. Sewage is pumped from each house into a mainline sewer system, so the sewer system is pressurized by the combined effects of the various building pumps connected to the sewer system. This pressure forces the sewage towards an outlet point, which can be a sewage treatment plant, a lift station or a gravity sewer system. Since the low pressure sewer mains are pressurized, the sewer mains can follow the topography of an area, keeping excavation depths to a minimum. Therefore, the initial capital cost of pressure sewers is typically less than gravity systems. However, since the system relies on pumping at every building connection, it has a greater annual operation and maintenance cost than a gravity sewer system.

There are two options for low pressure sewers, Grinder Pump (GP) Systems and Septic Tank Effluent Pump (STEP) systems. The systems are described as follows:

3.1 Grinder Pump System

In a Grinder Pump system, sewage flows by gravity from the house service to a pumping chamber / holding tank at each home. As the name suggests, grinder pumps are equipped with cutting blades to chop the solid matter in sewage into a small size that can easily be transported along a pipeline without clogging. Grinder pumps are typically placed in the basement for easy access. Usually mainlines are small in order to keep velocities above 0.6 m/s, the rate required to mitigate the potential for solids separation and to provide self-cleaning.

3.2 Step Systems

These systems operate similarly to a septic tank. The sewage flows by gravity into a two chamber septic tank. The solids settle out in the first chamber and the liquid portion overflows into the second chamber. A float switch activates the pump when the liquid reaches a specific level in the second chamber. The pump draws down the level in the chamber and forces the liquid into the sewage collection system. Pressure and velocities are lower in a STEP system compared to a GP system. The solids are retained in the tank and require removal on an as-required basis, typically once per year. A STEP system can use a submersible pump within the tank, or a dry pump arrangement

where the pump is installed in a building basement, heated crawl space or in a closet or mechanical room. A submersible pump is a simpler arrangement, but a dry pump is easier to service and maintain. Check valves on the sewer service lines are required to ensure the sewage from the mainline cannot backup into the tank when the home owner's pump is not operating. A shut-off valve is also installed on the service line to allow pump and check valves to be disconnected for servicing.

Typically, a policy is defined by the municipality or government authority outlining responsibilities for maintenance and operation of the pressure sewer system. The policy typically states that the home owners are responsible for maintaining their own sewer pump and tank, including the cleaning of the tank and the de-clogging of their service lines. The collector lines and treatment facilities are maintained by the municipality.

The STEP system is viewed to be a simpler installation and have lower operations and maintenance cost than a Grinder Pump system. A STEP system would be the preferable low pressure sewer system for the following reasons:

- The majority of existing septic or holding tanks are likely two chamber tanks and could be retrofitted for use with a STEP system.
- Low pressure sewers would be less susceptible to clogging than if fed by Grinder Pumps, given the fairly long lengths and branching of sewer mains required to service the community.
- The large capacity of STEP system holding tanks provides storage capacity during power outages.

Grinder pumps are more expensive than the pumps on STEP systems and typically require more maintenance.

AECOM recommends that STEP system low pressure sewer is designed for both Schanzenfeld and Reinfeld communities.

4. Design Parameters and Flows

Table 1 identifies the number of existing and current subdivided lots as well as proposed undeveloped lots for each community.

Table 1 - Existing and Future Lots

Lot Type	Schanzenfeld	Reinfeld
Within Village Boundary		
Existing Lots	294	452
Subdivided Lots	13	35
Undeveloped Land Lots	95	389
Subtotal	**402**	**876**
Outside of Village Boundary		
Future Development Lots	461	1255
Total	**863**	**2131**

'Existing Lots' include developed existing lots with or without existing homes or buildings. 'Subdivided Lots' is the number of homes that can be developed from subdividing larger lots. It was assumed that each future lot would be approximately 0.4 acre in area. 'Undeveloped Land Lots' refers to potential future development within the village boundary, while 'Future Development Lots' refers to potential future development outside the village boundary. For all future development areas including both undeveloped land lots with the current Village boundary and future development lots outside the current village boundary, thirty percent (30%) of the entire land development was

considered to be used as right-of-way and/or green space, and the remaining seventy percent (70%) of the lands would be used to estimate numbers of the future residential property lots.

In order to determine potential wastewater loads and pipe sizing for the low pressure systems, the following parameters were used, as outlined in Section 3.3 of the 'Wastewater Feasibility Study for Schanzenfeld and Reinfeld':

- 4.0 people per residence as recommended by the RM of Stanley;
- 270 L/c/d average wastewater production;
- Infiltration allowance of 15% of peak flow;
- Hazen-Williams C-factor of 130 (plastic pipe, i.e. HDPE);
- Minimum velocity of 0.6 m/s; and
- Maximum operating pressure of 17 psi.

Average flows were estimated based on a wastewater generation rate of 270 L/c/d and 4.0 persons per residence or lot. A peak to average flow ratio was then determined based on a variation of the Harmon's Peaking Factor. Peak flows were calculated based on this peak to average flow ratio. The peak to average flow ratio varied throughout the communities depending the cumulative number of homes contributing at any given location. Modeling analysis consists of three scenarios based on the RM's development strategy and servicing populations. The estimated low pressure sewer design flows for both communities under three scenarios, existing condition, including 20 Year Development, and ultimate development, are indicated in Table 2 and Table 3.

Table 2 - Low Pressure Sewer Design Flows for Reinfeld

Scenario	Lots	Population	Peak Flow (L/s)
Existing condition	452	1702	19.2
20 Year Development	255	1020	11.5
Ultimate Future Development	1424	5696	64.2
Total	2131	8418	94.9

Table 3 - Low Pressure Sewer Design Flows for Schanzenfeld

Scenario	Lots	Population	Peak Flow (L/s)
Existing condition	294	1435	17.0
20 Year Development	215	860	10.2
Ultimate Future Development	354	1416	16.8
Total	863	3711	44.0

The existing residential property lots as indicated in Table 2 and Table 3 include all occupied houses, unoccupied houses, and subdivided large property lots within the village boundary. Total 452 existing lots were counted in Reinfeld, and the estimated sewage flow is about 19.2 L/s. Total 294 existing lots were counted in Schanzenfeld, which is equivalent to about 17.0 L/s sewage flow.

The RM of Stanley projects a 2.5% population increase rate in both Reinfeld and Schanzenfeld for the 20 year design period. Reinfeld currently has an estimated population of 1702 and a projected 20 year population of 2721, which requires an additional 255 homes. Schanzenfeld currently has a population of 1435, and a projected 20 year population of 2294, which requires an additional 215 homes.

4.1 20 Year Development Scenarios

As per Section 4 above to accommodate the year 20 population Schanzenfeld would require an additional of 215 developed lots. Therefore the Schanzenfeld 20 Year Development would include approximately 8.3 ha (20.5 acre)

of the two undeveloped subdivision lands (S1 & S2), 22.1 ha (54.5 acre) of undeveloped land (B1) within the village boundary, and 23.1 ha (57.0 acre) future land (F3) south of the village or a similar combination. See Figure 1 for locations of development areas for Schanzenfeld. The estimated sewage flow from 20 Year Development Area is 10.2 L/s. Overall sewage flow in year 20 would be 10.2 L/s plus 17.0 L/s for a total of 27.2 L/s.

As per Section 4 above to accommodate the year 20 population Reinfeld would require an additional 255 developed lots. This equates to approximately about 60% of undeveloped lands and subdivided lands being developed in 20 years. Therefore, the Reinfeld 20 Year Development would include approximately 90 ha (222.4 acre) undeveloped lands (B1 – B4) and about 8 ha (19.8 acre) of subdivided lands (S1-S3) within the village boundary or a similar combination. See Figure 2 for available lands of Reinfeld 20 Year Development. A total available land within the village boundary is 98 ha (242.1 acres), which is equivalent to approximately 424 lots. The estimated peak sewage flow from 20 Year Development area is 11.5 L/s plus 19.2 L/s for a total of 30.7 L/s.

4.2 Ultimate Future Development

The ultimate future flow for Schanzenfeld was estimated based on sewage flows development areas F1 and F2. The total sewage inflow to the proposed lift station for Schanzenfeld is 44.0 L/s, including 17.0 L/s of the existing flow, 10.2 L/s of 20 Year Development flow, and 16.8 L/s of ultimate future flow. Two LPS design options were evaluated for the ultimate future development in Schanzenfeld. Option-1 assumes that all sewage flows from F1 and F2 (361 Units) will be collected by the internal LPS pipeline and directly discharge into the proposed Schanzenfeld lift station. Option-2 assumes that portion of sewage flow from F1 &F2 (approximately 130 units) will discharge into Schanzenfeld LPS at west end of Moline Drive. And remaining future flows (about 231 units) will be collected by the internal LPS and discharge directly into Schanzenfeld lift station.

The ultimate future flow for Reinfeld includes all flows from future development areas (F1 – F7), and about 40% of undeveloped area within village boundary. The total sewage inflow to the proposed lift station for Schanzenfeld is 94.9 L/s, including 19.2 L/s of the existing flow, 11.5 L/s of 20 Year Development flow, and 64.2 L/s of ultimate future flow. Two LPS design options were investigated. Option-1 assumes that all sewage flows from the future development will be discharged directly into the proposed lift station for Reinfeld. Option-2 assumes that portion of future sewage flows will be tied into the proposed low pressure sewer system within the village boundary. Sewage flows from future development F1 – F3 will be discharged into the LPS main along Reinfeld St N, and sewage flows from F5 will be discharged into the LPS main at the south end of the community. Sewage flows from future developments F4, F6, and F7 will be directly discharged into the proposed Reinfeld Main Lift Station. Although only 60% of undeveloped lands within the village boundary will be included for 20 Year Development, the LPS pipelines within the boundary should be designed to accommodate sewage flows from all undeveloped lands (B1-B4). That will provide more flexibility to the RM for choosing alternative lands for 20 Year Development.

Flows from the low pressure system for both Schanzenfeld and Reinfeld would be routed from each community to the City of Winkler's Wastewater Treatment Plant (WWTP) at southwest corner of the existing lagoon site.

4.3 20 Year Sewage Flow WWTP Impact

The 20 Year projecting sewage peak design inflows discussed above for two communities are for low pressure sewer system design purpose, and also for sizing forcemain and lift station pumping capacity calculation.

The required additional treatment capacity at the City of Winkler's WWTP to accommodate the 20 Year sewage flows from both Reinfeld and Schanzenfeld are computed based on the average day sewage flow. The WWTP designs typically include an equalization tank to accommodate the peak design inflow from the lift station and forcemain.

The average sewage flow was calculated based on the estimated wastewater generate rate of 270 L/c/d, plus 15% of inflow and infiltration rate, and multiply with 20 Year projecting servicing populations in both Schanzenfeld and Reinfeld. Calculated average day sewage flows for Reinfeld and Schanzenfeld are 9.8 L/s and 8.2 L/s, respectively. Detailed calculations are outlined in Table 4 below.

Table 4 - Average Sewage Flow Calculations for WWTP Capacity Impact Review

Items	Reinfeld	Schanzenfeld
Existing population	1702	1435
20 Year population	1020	860
Total population	2722	2295
Sewage generation rate (L/c/d)	270	270
15% of inflow & Infiltration (L/c/d)	40.5	40.5
Average day sewage flow (L/s)	9.8	8.2

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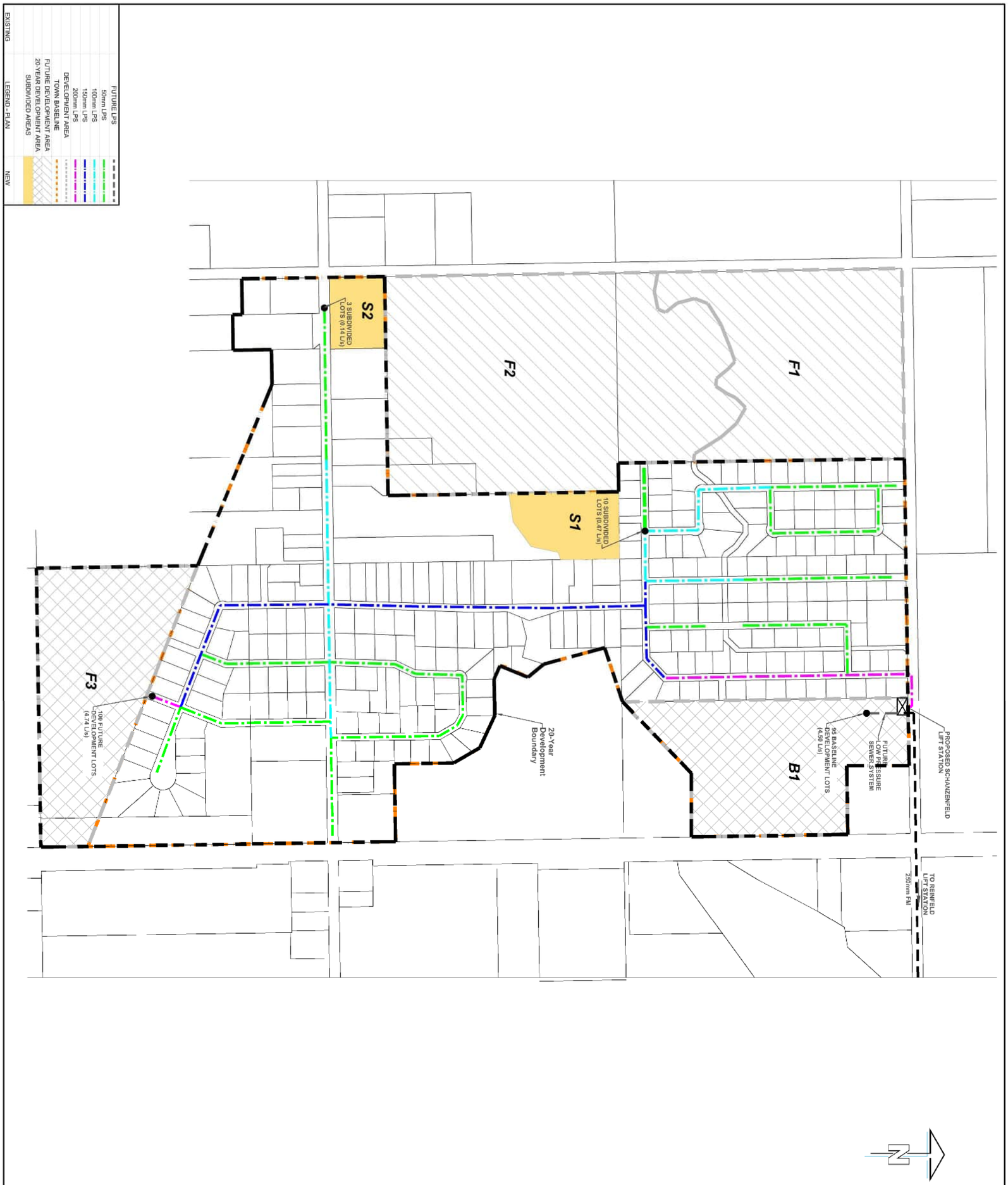

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WASTEWATER FEASIBILTY STUDY
FOR REINFELD/SCHANZENFELD
R.M. OF STANLEY
Project No.: 60428376 Date: 2015-07-02

SCHANZENFELD
LOW PRESSURE SEWER SYSTEM
PRELIMINARY DESIGN - 20 YEAR DEVELOPMENT

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Figure: 1

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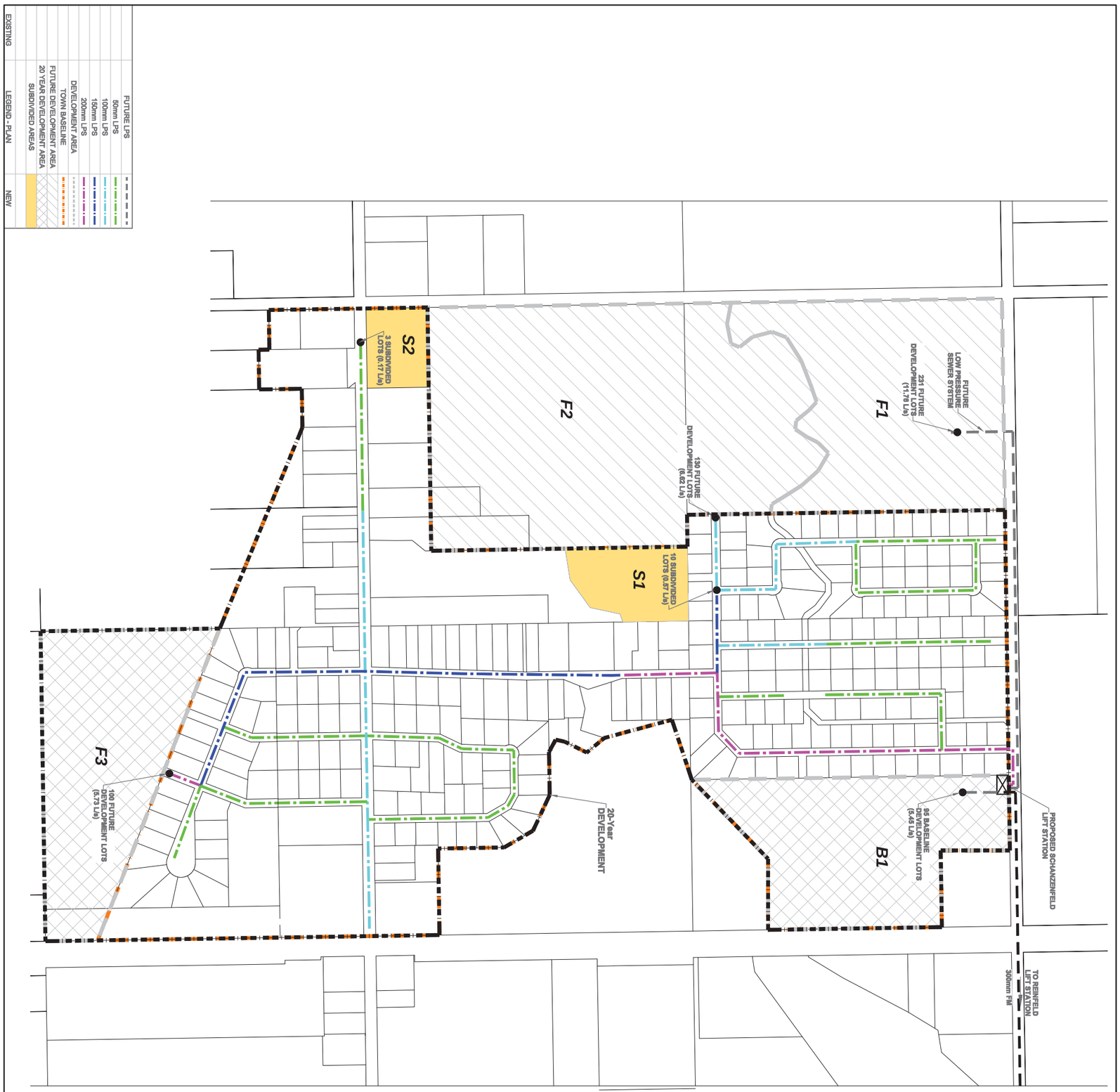

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WASTEWATER FEASIBILTY STUDY
FOR REINFELD/SCHANZENFELD
R.M. OF STANLEY
Project No.: 60428376 Date: 2015-07-02

SCHANZENFELD
LOW PRESSURE SEWER SYSTEM
PRELIMINARY DESIGN - FUTRUE OPTION2

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Figure: 3

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WASTEWATER FEASIBILTY STUDY
FOR REINFELD/SCHANZENFELD
R.M. OF STANLEY
Project No.: 60428376 Date: 2015-07-02

SCHANZENFELD
LOW PRESSURE SEWER SYSTEM
PRELIMINARY DESIGN - FUTRUE OPTION1

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Figure: 2

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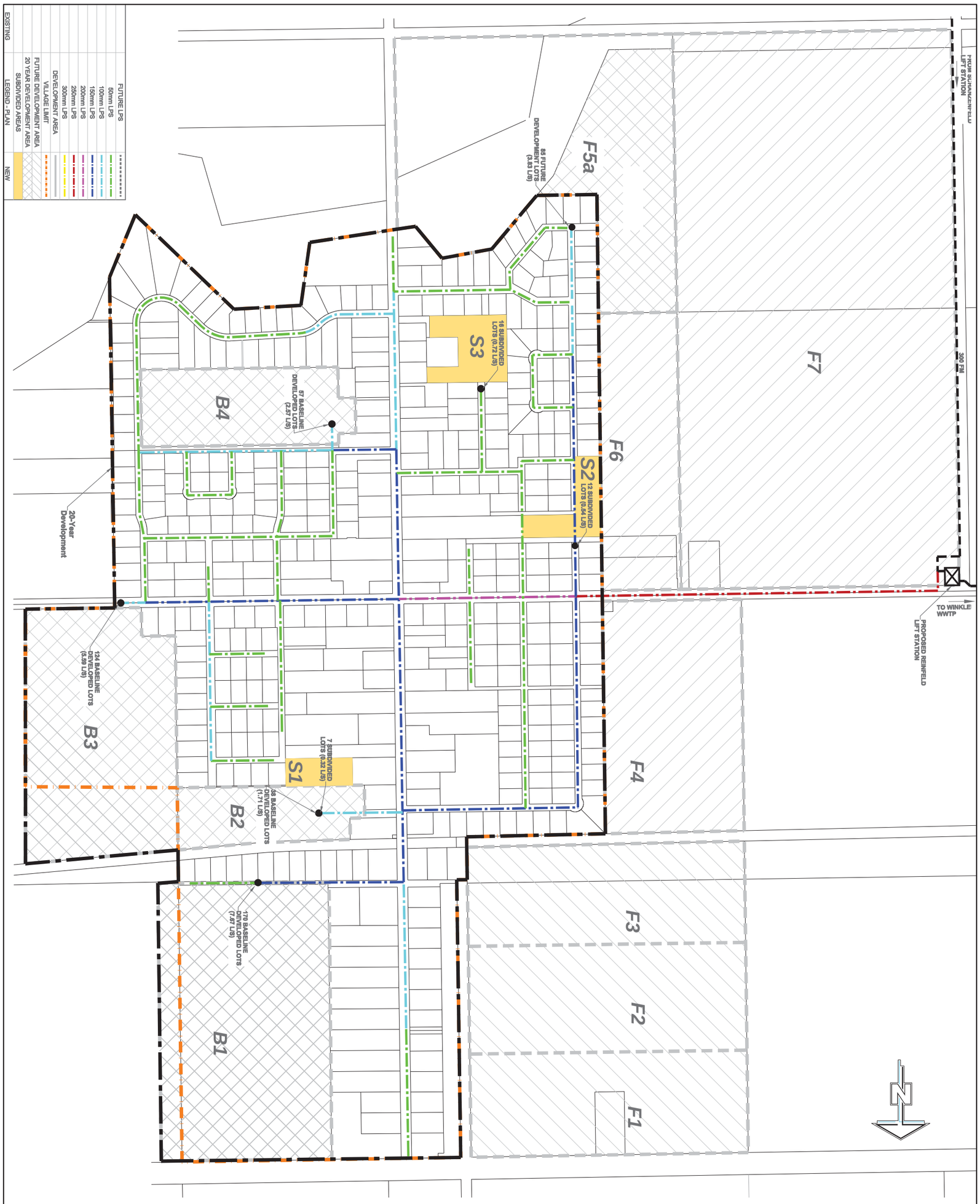

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WASTEWATER FEASIBILTY STUDY
FOR REINFELD/SCHANZENFELD
R.M. OF STANLEY
Project No.: 60428376 Date: 2015-07-02

REINFELD
LOW PRESSURE SEWER SYSTEM
PRELIMINARY DESIGN - 20 YEAR

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Figure: 4

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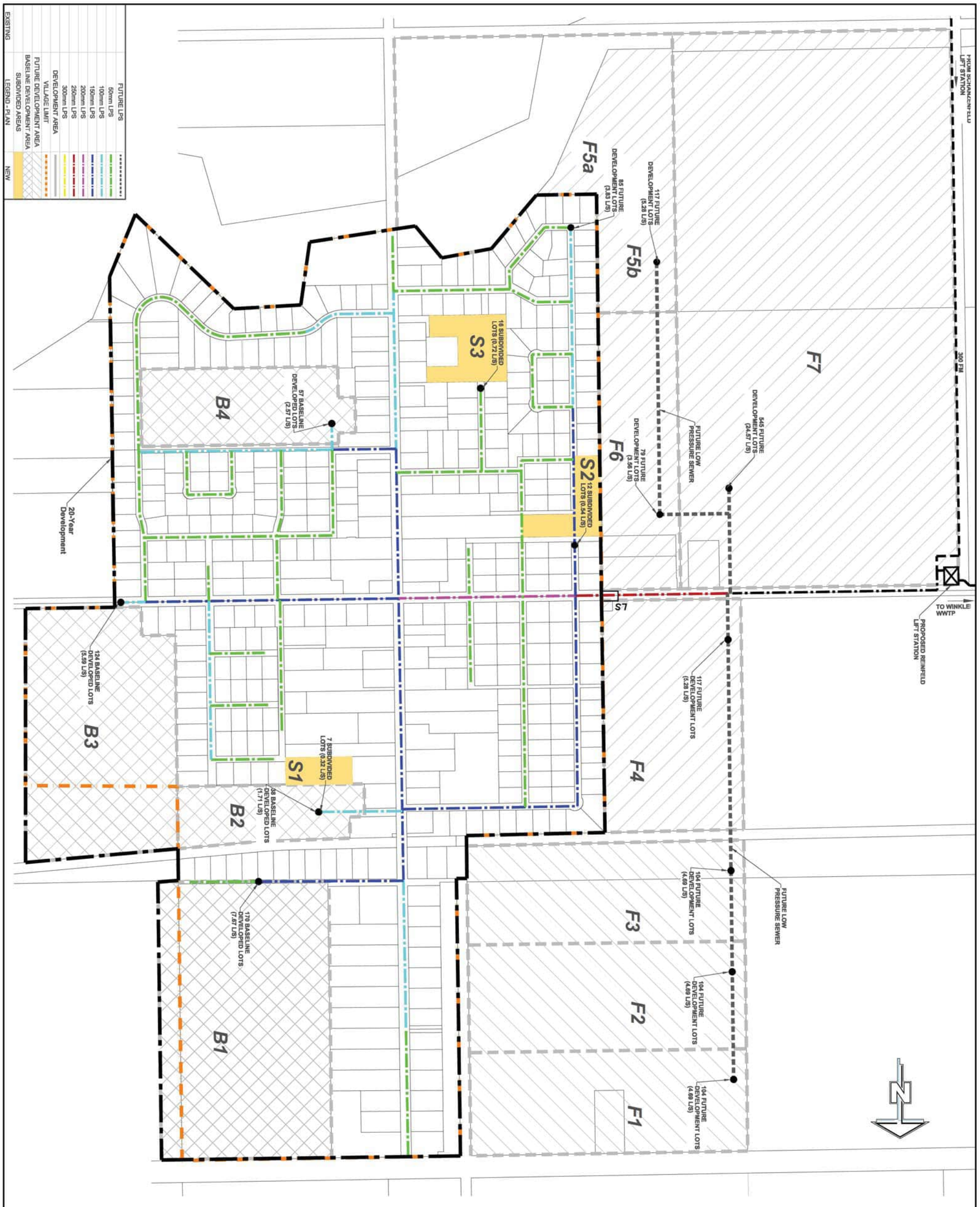

Issue Status: DRAFT

WASTEWATER FEASIBILTY STUDY
FOR REINFELD/SCHANZENFELD
R.M. OF STANLEY
Project No.: 60428376 Date: 2015-07-02

REINFELD
LOW PRESSURE SEWER SYSTEM
PRELIMINARY DESIGN - FUTRUE OPTION 1

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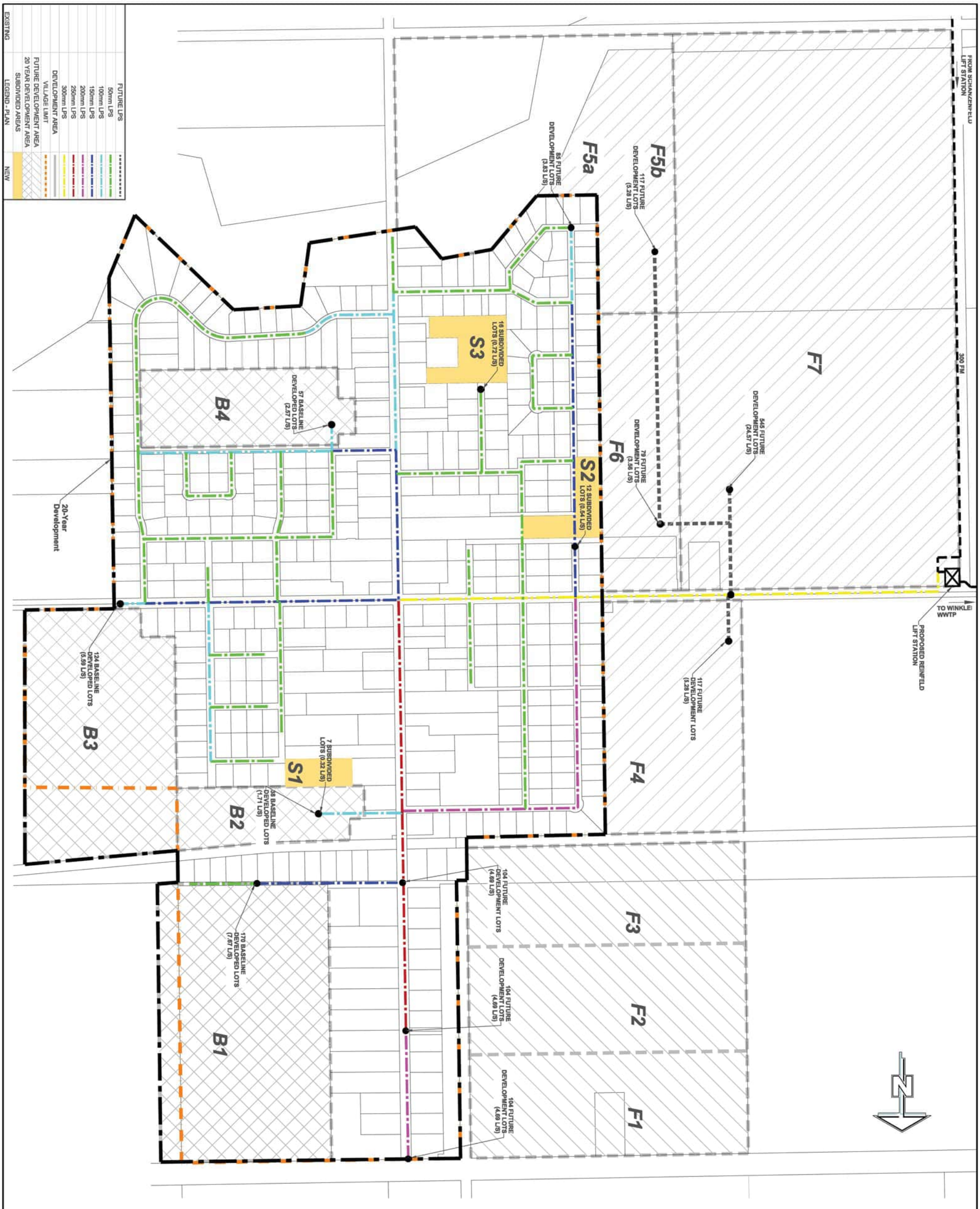

Issue Status: DRAFT

WASTEWATER FEASIBILTY STUDY
FOR REINFELD/SCHANZENFELD
R.M. OF STANLEY
Project No.: 60428376 Date: 2015-07-02

REINFELD
LOW PRESSURE SEWER SYSTEM
PRELIMINARY DESIGN - FUTRUE OPTION 2

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Figure: 6

5. Low Pressure Sewer Design and Cost Estimates

Models for both Schanzenfeld and Reinfeld were established in order to develop low pressure sewer systems for each. The modeling analysis was conducted by using Bentley WaterCAD V8i hydraulic software.

The preliminary cost estimates are provided for both Reinfeld and Schanzenfeld communities. The LPS pipeline sizes were calculated based on the 20 Year Development flow scenario. The LPS service for individual property lot covers service pipe and curb stop, but not septic tank. The piping within the future development, baseline development, and subdivided lands were not included as part of this cost estimate. The breakdown cost analyses are included in Appendix B.

5.1 Village of Schanzenfeld

The proposed low pressure sewer system for the Village of Schanzenfeld is shown in Figure 1, Figure 2 and Figure 3. Three development scenarios were included in the analysis, 20 Year Development, ultimate future Option 1, and ultimate future Option 2, as discussed in Section 2. A proposed lift station is located at the northern limit of the community which will direct flows to the wet-well of the proposed Reinfeld Main Lift Station. A brief summary of pressure sewer main sizes and lengths (within the village boundary) for all three scenarios are outlined in Table 5.

Table 5 - Low Pressure Sewer Diameters and Lengths for the Village of Schanzenfeld

Diameter (mm)	Pipeline Length (m)		
	20 Year	Ultimate Option-1	Ultimate Option-2
50	3800	3800	3650
100	2250	2250	2250
150	1800	1800	1450
200	800	800	1300
Total	**8650**	**8650**	**8650**

The proposed LPS main sizes and lengths are same for 20 Year Development scenario and ultimate future Option-1 scenario, because that all sewage flows from F1 and F2 will discharge into the Schanzenfeld Lift Station separately. For the ultimate future Option 2 scenario, portion of future sewage flow will discharge into the proposed LPS within the village boundary, the net results is that upsizing approximately 230m of LPS sewer mains along Moline Drive from 150mm to 200mm diameter, and approximately 270m of LPS sewer along Schantz St N from 150mm to 200mm diameter, are required.

The estimated costs associated for the Village of Schanzenfeld's Low Pressure Sewer are shown in Table 6. The cost estimates indicated that allowing portion of future development sewage flow discharged into the proposed LPS within the village boundary will increase approximately $32,000 of the capital cost, which is about 1.6% increasing of total construction cost.

Table 6 - Estimated Low Pressure Sewer Costs for the Village of Schanzenfeld

Item	Estimated Cost	
	20 Year	Future Option2
Low Pressure Sewers	$965,500	$991,000
Valves and Cleanouts	$83,750	$83,750
Services	$514,500	$514,500
Sub-total	**$1,563,750**	**$1,589,250**
Engineering & Contingency (25%)	**$390,938**	**$397,313**
Total Cost	**$1,954,688**	**$1,986,563**

Note: Engineering & Contingency at 25% is for budget costs only. Actual costs will vary depending on Scope of Work.

5.2 Village of Reinfeld

Similar to Schanzenfeld, three LPS design scenarios were evaluated for Reinfeld community: 20 Year Development, ultimate future Option 1, and ultimate future Option 2, as discussed in Section 2. For the 20 Year Development scenario, the portion of future development F5 (About 85 units) was included, in order to provide the more flexibility to the RM for 20 Year Development. The LPS pipeline layout and sizes are shown in Figure 4, Figure 5 and Figure 6. A lift station is proposed at the interception of Church Avenue and Government Road Allowance, and a forcemain will convey sewage flows from both Schanzenfeld and Reinfeld communities to the City of Winkler's new WWTP located at southwest corner of the existing lagoon site. A brief summary of pressure sewer main sizes and lengths for three scenarios are outlined in Table 7.

Table 7 - Low Pressure Sewer Diameters and Lengths for the Village of Reinfeld

Diameter (mm)	Length		
	20 Year	Future Option -1	Future Option -2
50	7750	7750	7350
100	3100	3100	2400
150	4350	4350	2700
200	500	500	1500
250	1300	450	1250
300	-	850	1800
Total	**17000**	**17000**	**17000**

The estimated costs associated for the Village of Reinfeld's low pressure sewer are shown in Table 8. The estimated cost for future development Option-2 is about $4,085,625, which is approximately 11% more than the estimated cost for 20 Year Development of $3,665,188.

Table 8 - Estimated Low Pressure Sewer Costs for the Village of Reinfeld

Item	Estimated Cost		
	20 Year	Future Option-1	Future Option-2
Low Pressure Sewers	$1,989,500	$2,032,000	$2,306,000
Valves and Cleanouts	$151,650	$167,650	$171,500
Services	$791,000	$791,000	$791,000
Sub-total	**$2,932,150**	**$2,990,650**	**$3,268,500**
Engineering & Contingency (25%)	**$733,038**	**$747,663**	**$817,125**
Total Cost	**$3,665,188**	**$3,738,313**	**$4,085,625**

Note: Engineering & Contingency at 25% is for budget costs only. Actual costs will vary depending on scope of work.

5.3 Lift Station and Forcemain

The sewage flows collected by the low pressure sewer system from each community will be discharged into the proposed lift stations for Reinfeld and Schanzenfeld, respectively. The sewage flows from the proposed Schanzenfeld Lift Station will be pumped into the wet-well of the proposed Reinfeld Main Lift Station via a 5.3 km forcemain pipeline. The sewage flow will be eventually pumped into the City of Winkler's new WWTP at southwest corner of the existing lagoon site via an approximately 5.7 km forcemain system. See Figure 7 for forcemain alignment and locations of lift stations.

Sewage lift stations are facilities designed to move wastewater from lower to higher elevation through forcemains. Key elements of lift stations include a sewage receiving well (wet-well), often equipped with a screen or grinding to remove coarse materials; a power supply system; an equipment control and alarm system; and an odour control system and ventilation system. The two most common types of lift stations are dry-well and submersible lift stations. In dry-well lift station, pumps and valves are housed in a pump room (dry-well) that is easily accessible. The wet-well is a separate chamber attached to the dry-well structure. Submersible lift stations do not have a separate pump room; the lift station header piping, associated valves, and flow meters are located in a separate dry vault at grade for easy access. A key advantage of dry-well lift stations is that they allow easy access for routine visual inspection and maintenance. An advantage of submersible lift stations is that they typically cost less than dry-well stations.

Forcemains are pipelines that convey sewage flows under pressure from the discharge side of pumps to a discharge point. Forcemains could be constructed from various materials based on the sewage flow rates, operation pressure, trench conditions, and wastewater quality. We recommend the forcemain pipelines will be High Density Polyethylene (HDPE) DR 17, the pressure rating is 695 kPa (100 psi). The HDPE pipe is light weight, with low hydraulic friction characteristics and high corrosion resistance. Most important, HDPE is suitable for trenchless installation and will reduce the construction cost comparing to other material, such ductile iron and PVC pipe. The typical velocity for the forcemain design ranges between 0.6 and 2.4 m/s. Such velocities are normally based on the most economical pipe diameters and typical available pump heads.

The capacity of the lift station and forcemain system was evaluated for both 20 Year scenario and future scenario. A common configuration is a duplex system, which has two identical pumps. The pumps are selected so that a single pump running along can keep up with the design sewage inflow. Larger stations may use three or more pumps, often with a smaller pump for use during periods when loads are small. A pump station should be designed so that, even if the largest unit is out of service, the remaining pumps can meet the design inflow. At this stage, it is recommended the pumping rate be oversize by a 50% as a safety factor.

5.3.1 Schanzenfeld

Design pumping rates of Schanzenfeld Lift Station are 40.8 L/s (27.2 L/s design inflow times150%) @ 16m TDH (6.2 kw) for the 20 Year Development scenario and 66 L/s (44 L/s design inflow times150%) @ 16m TDH (10.4 kw) for the ultimate future scenario. The proposed Schanzenfeld Lift Station will be a submersible lift station consists of simple subsurface concrete structure (precast manholes), with no building or superstructure overtop. The station will be equipped with the duplex pumping systems, with each pump capable of pumping the maximum sewage flow entering the station. The typical lift station design, including site plan, plan and section views, are included in Drawing C-0004 in Appendix A.

The forcemain is sized at 250mm diameter for the 20 Year scenario and 300mm for the future scenario. The cost estimate for Schanzenfeld Lift Station and separate forcemain system are listed in Table 9.

Table 9 - Estimated Cost for Schanzenfeld Lift Station and Separate Forcemain

Item	Estimated Cost	
	20 Year	**Future**
Lift Station	$400,000	$475,000
Odour control device	$20,000	$20,000
Forcemain (5.3km)	$1,166,000	$1,484,000
Sub-total	**$1,586,000**	**$1,979,000**
Engineering & Contingency (25%)	$396,500	$494,750
Total	**$1,982,500**	**$2,473,750**

The estimated cost of Schanzenfeld's Lift Station and Forcemain system is approximately $1,982,500 for the 20 Year sewage flow scenario. If the lift station and forcemain need to accommodate the ultimate future sewage flows, the estimated cost will be increased to $2,473,750.

5.3.2 Reinfeld

Design pumping rates of Reinfeld Main Lift Station are 86 L/s (includes 40.8 L/s pumping flow from Schanzenfeld lift station and 30.7 L/s design inflow from Reinfeld times 150%) @ 28m TDH (24 kw) for the 20 Year Development scenario and 208 L/s (includes 66 L/s pumping flow from Schanzenfeld lift station and 94.9 L/s design inflow from Reinfeld times 150%) @ 26m TDH (54 kw) for the ultimate future scenario. The pumping flow rate was estimated to include the design sewage inflow from Reinfeld community and the sewage flow from the proposed Schanzenfeld Lift Station. The location of building is approximately as shown on Figure 7. The exact location will be confirmed up with the RM of Stanley during the detailed design.

The Reinfeld Main Lift Station will be design as with a separate wet-well and dry-well to allow for easier maintenance and inspection. The pumps would be located in the lower level dry-well drawing from a wet-well. The wet-well would be isolated from the dry-well with access to the well through exterior hatches.

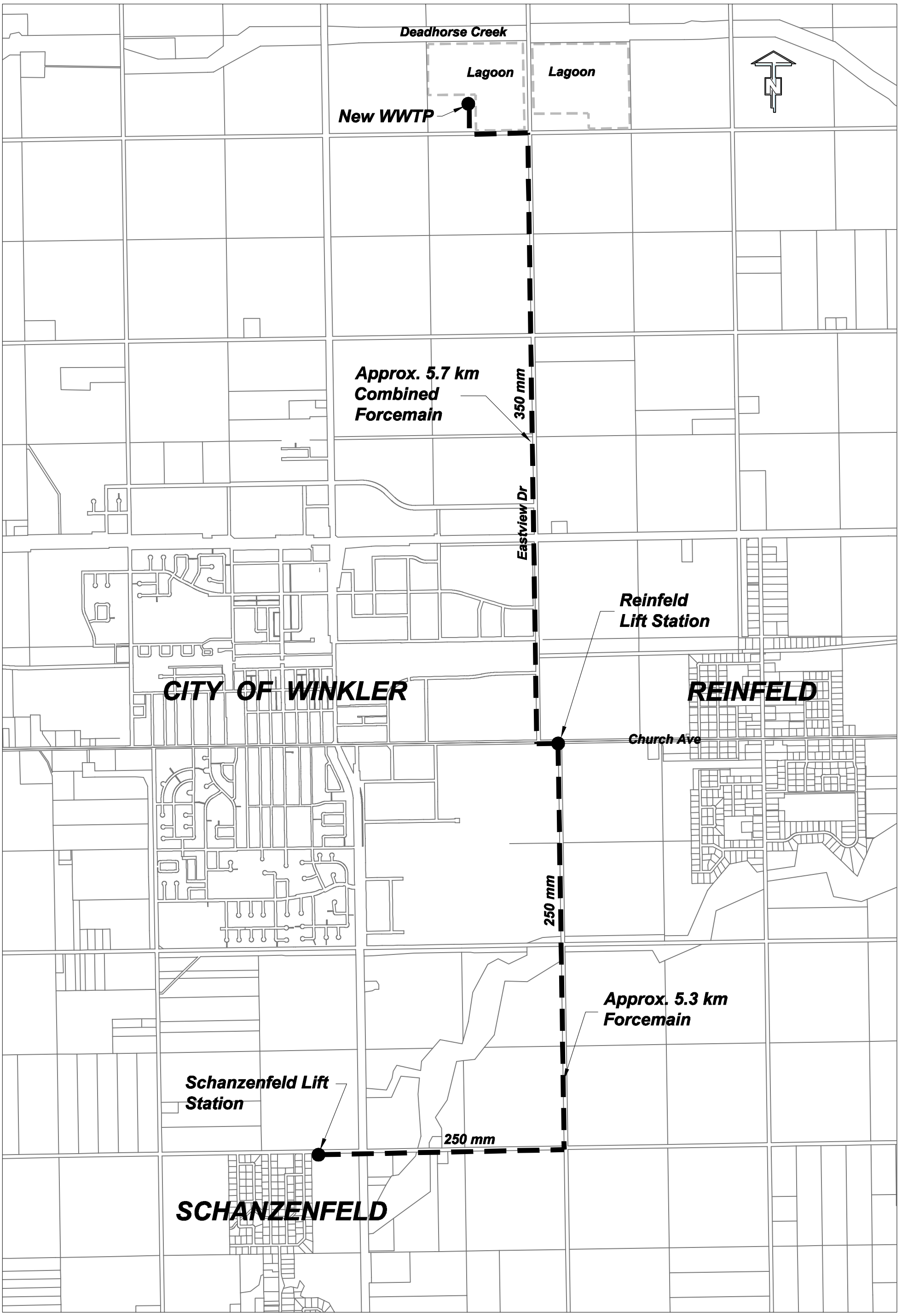
The above ground structure of the lift station will be split face concrete block exterior and metal roof. The wet-well will be sized to accommodate the existing and future design flows as described above. Two pump scenarios were analyzed for baseline flow condition and future flow condition. The design approach was to provide both scenarios in a duty/standby pump configuration. Each pump would be designed duty/standby which means they would be exercised regularly while also providing redundancy. The pumps will be installed with variable frequency drives (VFDs) as well as the projected future flow. The size and number of pumps should be selected so that the range of inflow rates can be met without starting and stopping pumps too frequently and without excessive wet-well storage.

The forcemain is sized at 350mm diameter for the baseline scenario and 450mm for the future scenario. The cost estimate for Reinfeld Lift Station and separate forcemain system are listed in Table 10.

Table 10 - Estimated Cost for Reinfeld Lift Station and Separate Forcemain

Item	Estimated Cost	
	20 Year	**Future**
Lift Station	$1,200,000	$1,500,000
Odour control device	$20,000	$20,000
Forcemain (5.7 km)	$1,995,000	$2,707,500
Sub-total	**$3,215,000**	**$4,227,500**
Engineering & Contingency (25%)	**$803,750**	**$1,056,875**
Total	**$4,018,750**	**$5,284,375**

The estimated cost of Reinfeld's Lift Station and Forcemain system is about $4,018,750 for the 20 Year sewage flow scenario. If the lift station and forcemain need to accommodate the future sewage flows, the estimated cost will be increased to $5,284,375.



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RM OF STANLEY LOW PRESSURE SEWER SYSTEM PRELIMINARY DESIGN

FIGURE 7. FORCEMAIN PIPELINE LAYOUT AND LIFT STATIONS

PROJECT NUMBER	DRAWING NUMBER	ISSUE DATE	ISSUE/REVISION
60428376	FIGURE 7	2016/05/27	DRAFT

6. Conclusion and Recommendation

The low pressure sewer pre-design for both Reinfeld and Schanzenfeld are based on the 20 Year flow scenario and the ultimate future development scenario as discussed in Section 2.

For Schanzenfeld, the 20 Year flow also includes the sewage flow from the future development south of the village (F3). The 20 Year peak sewage flow for Schanzenfeld is 27.2 L/s. The estimated construction cost for the LPS pipeline and services within the community boundary is approximately $1,954,688 under the 20 Year scenario. The estimated construction cost for the LPS pipelines and services under the ultimate future development Option 2 scenario is $1,986,563.

For Reinfeld, the LPS design was evaluated for both the 20 Year Development scenarios and the ultimate future development scenario. The total sewage flow from the 20 Year Development is about 30.6 L/s, and the estimated construction cost for the LPS pipeline and services within the village are approximately $3,665,188. The estimated sewage flow for the ultimate future development is 94.9L/s. The ultimate flow analysis includes two options. Option 1 excludes all sewage flows from the future development areas to the LPS main within the community boundary. Option 2 allows portion of future development tie into the LPS main within the community boundary. Comparing to the 20 Year Development scenario, Option 1 requires larger LPS main pipeline on Church Avenue E. the estimated cost for Option 1 is $3,743,125, which is about 2% increasing to the 20 Year Development. Option 2 requires larger LPS mains to be installed on Reinfeld Street N, Church Avenue W, and Prairie Street, in order to accommodate the sewage flows from the future development areas F1, F2, F3, & F5. The estimated construction cost for Option 2 is about $4,085,625, which is about 11% more than the 20 Year scenario.

For the lift station and forcemain system, the cost analyses were conducted based on both the 20 Year flow and ultimate future flow scenarios. At this stage, we recommend that the lift station design and forcemain sizing should consider the 20 Year flow condition, and provide additional space and capacity to accommodate the ultimate future sewage flow. The Schanzenfeld Lift Station will be a submergible underground precast concrete structure with duplex pumping system. The Reinfeld Main Lift Station will be a separate dry-well/wet-well lift station with above ground structure.

We recommend that the LPS pipeline design for Schanzenfeld community should be based on the ultimate future development Option 2 scenario. Total estimated cost for Schanzenfeld, including low pressure sewer system servicing the community, the proposed Schanzenfeld Lift Station, and approximately 5.3 km of 250mm diameter forcemain pipeline, is listed in Table 11.

Table 11 - Total Estimated Costs for Schanzenfeld

Items	Estimated Cost
Low Pressure Sewers (Ultimate Future Option 2)	$991,000
Valve & Cleanout Chambers (Ultimate Future Option 2)	$83,750
LPS Service (Ultimate Future Option 2)	$514,500
Lift Station (40 L/s @ 16 m TDH (10 kw) (20 Year)	$400,000
Odour control device (20 Year)	$20,000
Forcemain (5.3 km - 300mm diameter) (20 Year)	$1,166,000
Subtotal	**$3,175,250**
Engineering and Contingency (25%)	$793,813
Total	**$3,969,063**

We recommend that the LPS pipeline design for Reinfeld community should be based on the ultimate future development Option 1 scenario. Total estimated cost for Reinfeld, including low pressure sewer system servicing the community, the proposed Reinfeld Main Lift Station, and approximately 5.7 km of 350mm diameter forcemain pipeline, is listed in Table 12.

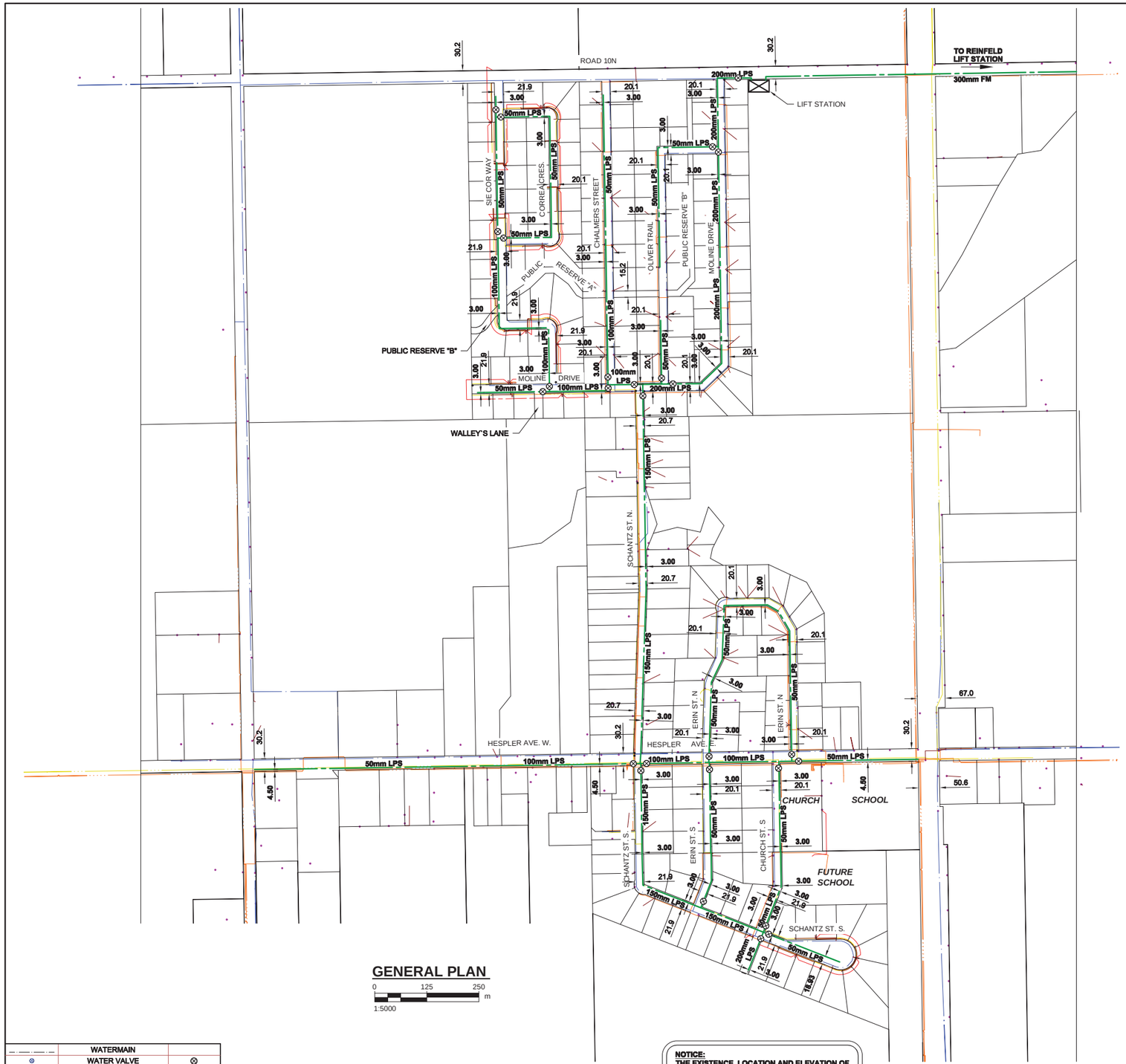
Table 12 - Total Estimated Costs for Reinfeld

Items	Estimated Cost
Low Pressure Sewers (Ultimate Future Option 1)	$2,032,000
Valve & Cleanout Chambers (Ultimate Future Option 1)	$167,650
LPS Service ((Ultimate Future Option 1)	$791,000
Lift Station (86 L/s @ 28 m TDH (24 kw) (20 Year)	$1,200,000
Odour control device (20 Year)	$20,000
Forcemain (5.7 km - 450mm diameter) (20 Year)	$1,995,000
Subtotal	**$6,205,650**
Engineering and Contingency (25%)	$1,551,413
Total	**$7,757,063**

At this report, we recommend that the LPS system design for Schanzenfeld community is based on the ultimate future development Option 2 scenario. And for Reinfeld community, the LPS system design is based on the ultimate future development Option 1 scenario. The lift station design and forcemain sizing should consider the 20 Year flow condition, and provide additional space and capacity to accommodate the ultimate future sewage flow. The total estimated cost for Schanzenfeld, including low pressure sewer system servicing the community, the proposed Schanzenfeld Lift Station, and approximately 5.3 km forcemain pipeline is $3,969,063. The total estimated cost for Reinfeld, including low pressure sewer system servicing the community, the proposed Reinfeld Main Lift Station; an approximately 5.7 km of 350mm diameter forcemain pipeline is $7,757,063.

Appendix A

Preliminary Design Drawings



GENERAL PLAN

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EXISTING	LEGEND - PLAN	NEW
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⊗	WATER VALVE	⊗
	LOW PRESSURE SEWER	
	GAS	
	MTS	
	CABLE	
	CONDUIT	
	PRIMARY POWER	

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ISSUE/REVISION

I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

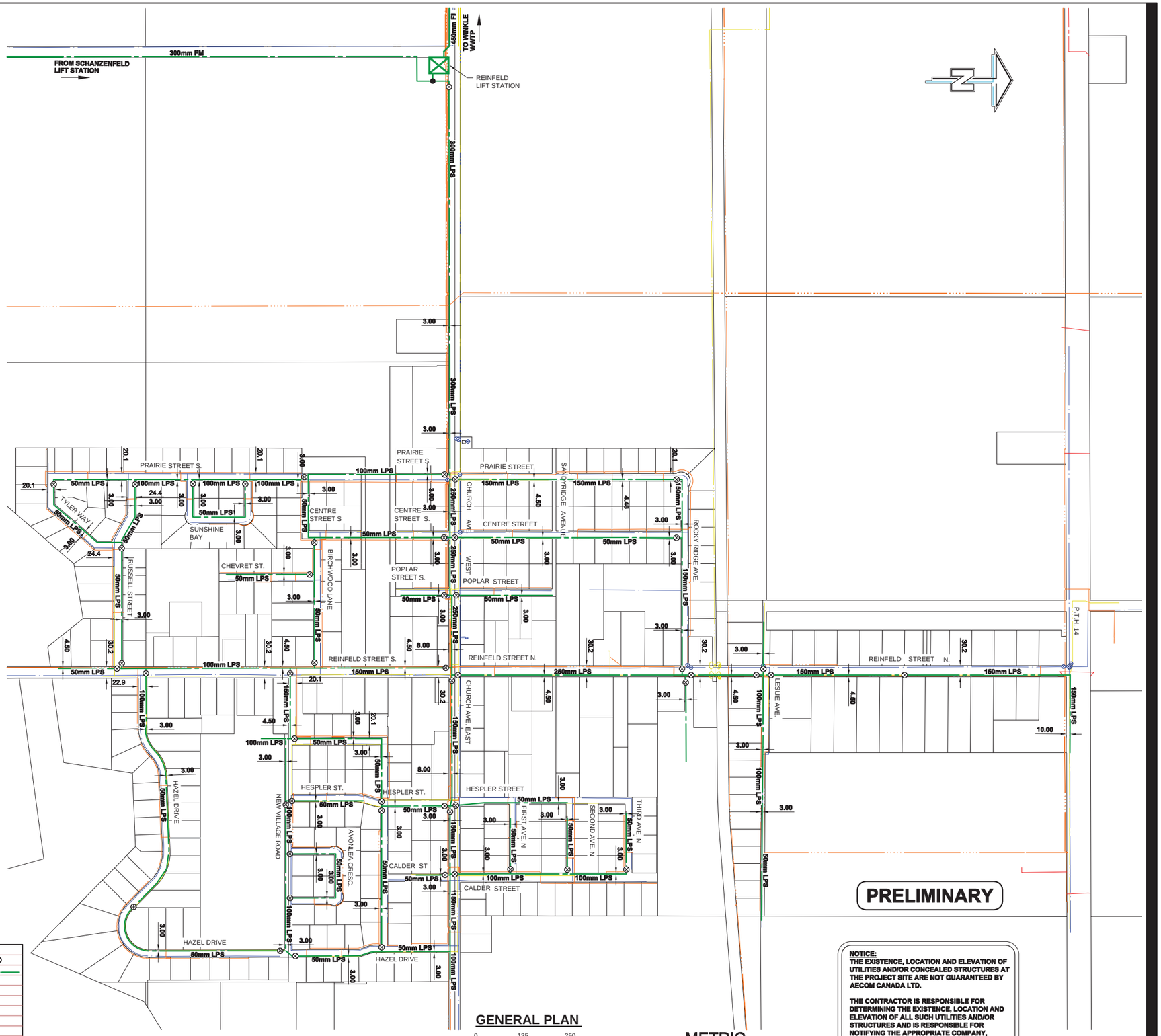
60428376

SHEET TITLE

SCHANZENFELD
LOW PRESSURE SEWER SYSTEM
PIPING LAYOUT

SHEET NUMBER

C-0001



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REINFELD
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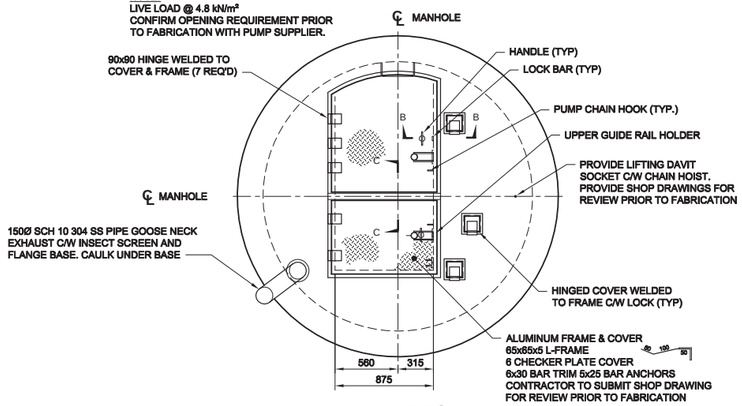

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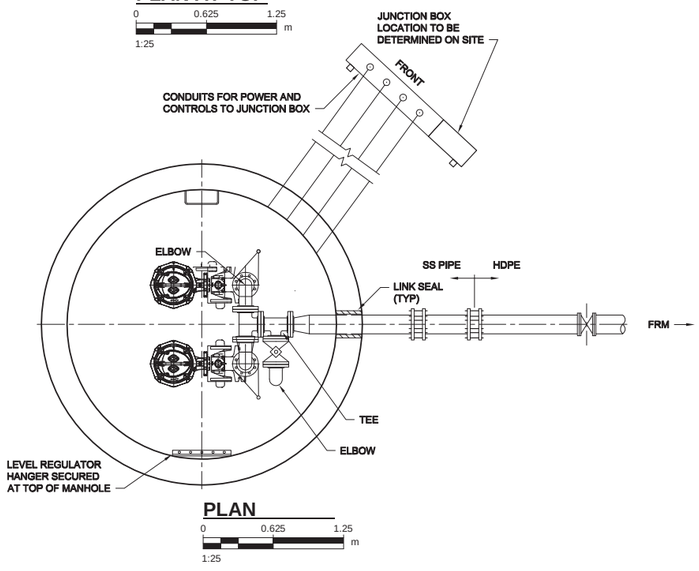

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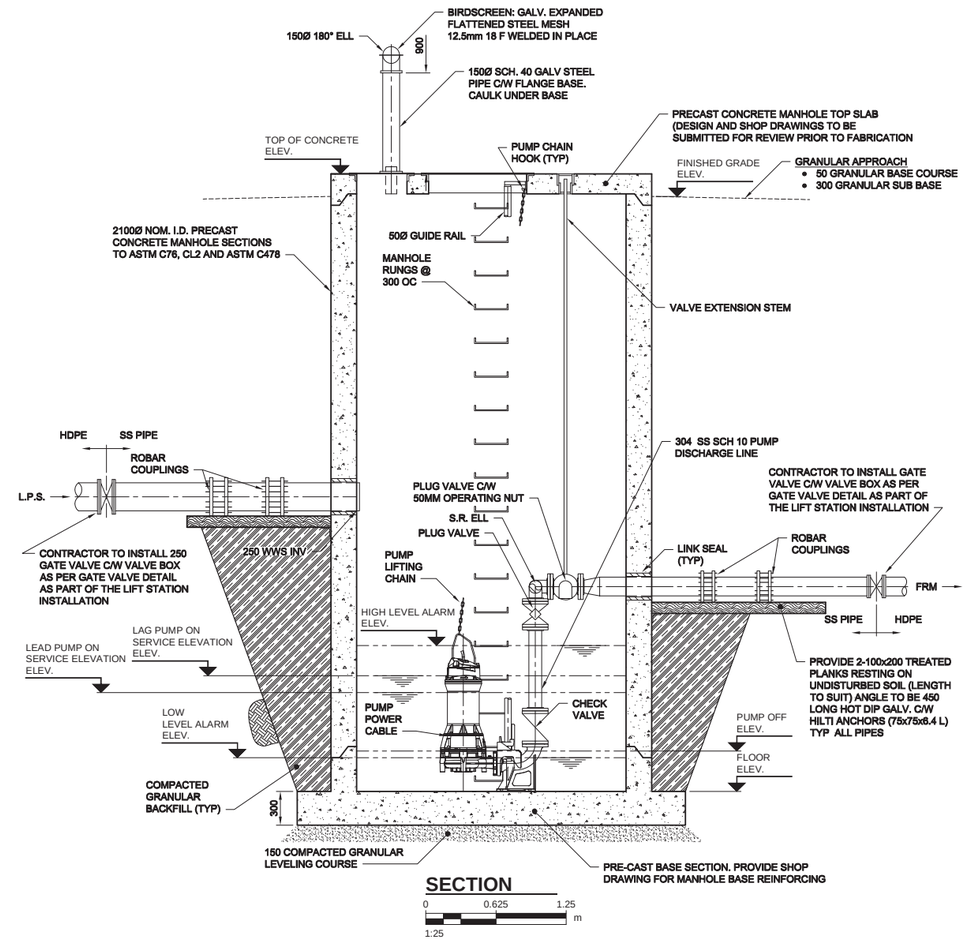

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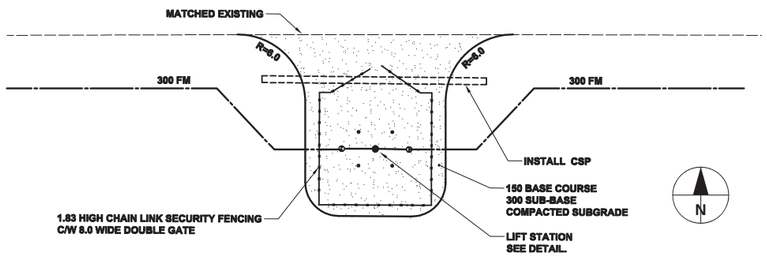

SCHANZENFELD LIFT STATION SITE PLAN

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SCHANZENFELD LIFT STATION TYPICAL DETAILS

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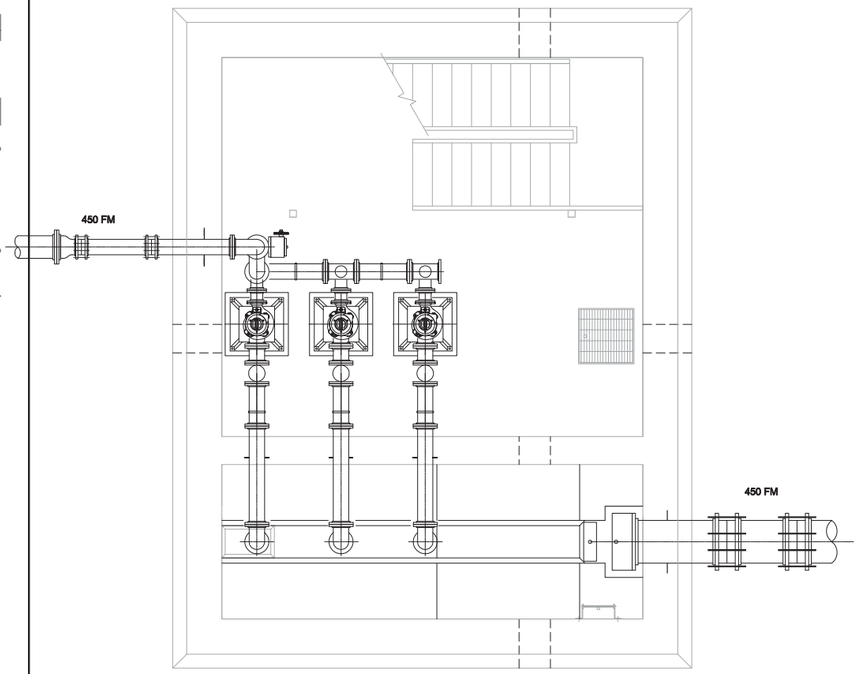

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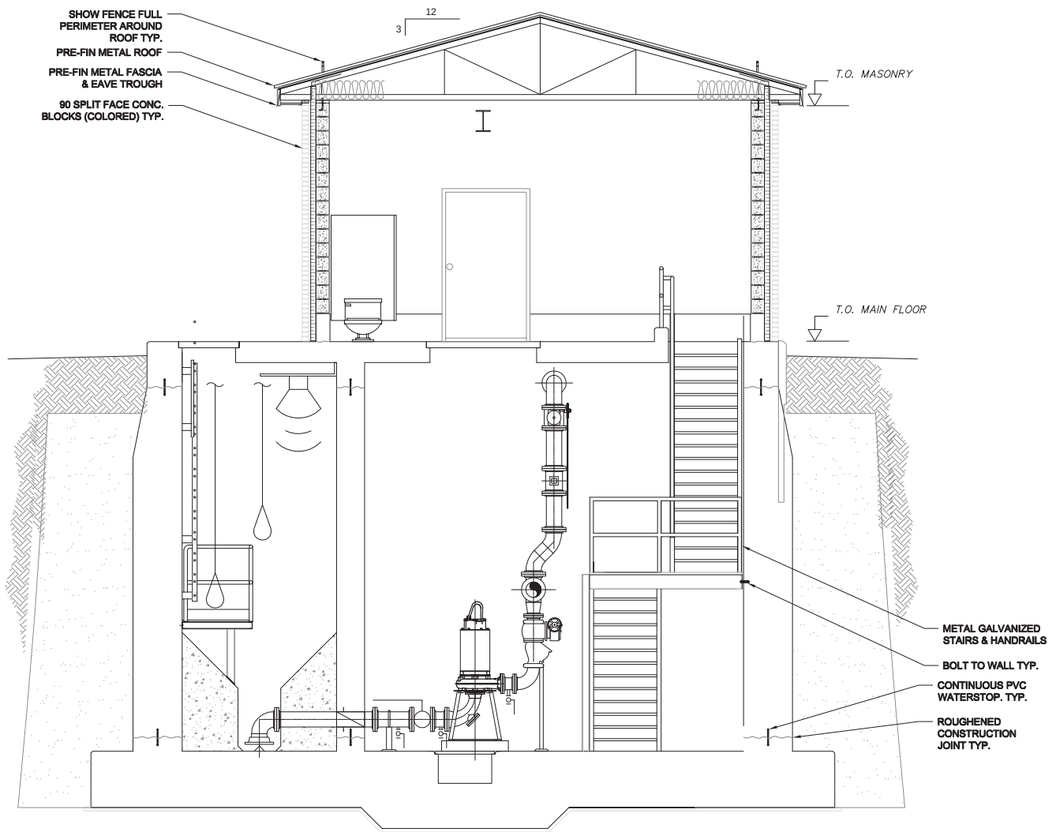

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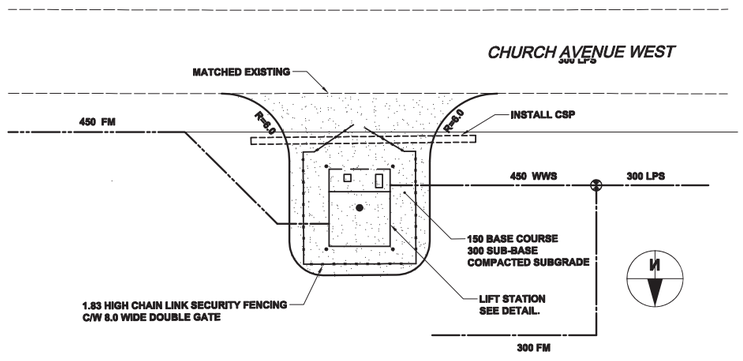

REINFELD LIFT STATION SITE PLAN
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CLIENT

R.M. of STANLEY

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REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

60428376

SHEET TITLE

REINFELD LIFT STATION
TYPICAL DETAILS

SHEET NUMBER

C-0004

Last saved by: LACOSTEG(2016-06-03) Last Plotted: 2016-06-03
Filename: P:\60428376\900-WORK\910-CAD\20-SHEETS\C\60428376-FIG-20-C-0003_C-0005.DWG

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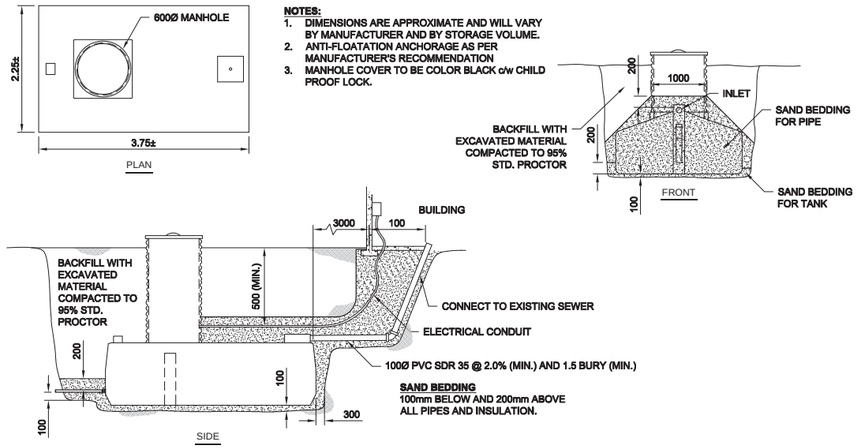
Project Management Initials: ____ Designer: ____ Checked: ____ Approved: ____ ISO A1 594mm x 841mm



STANDARD BEDDING AND BACKFILL FOR TANKS

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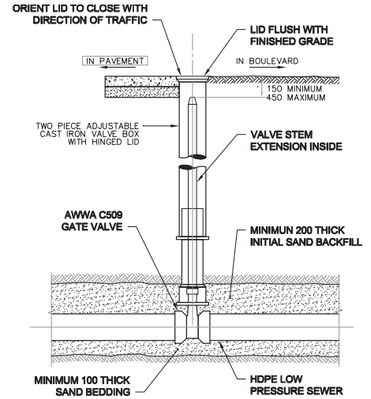
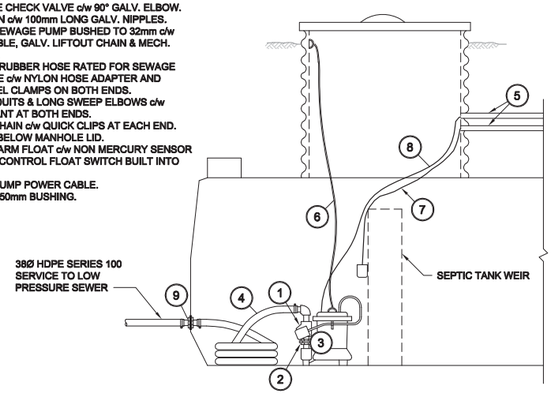


GATE VALVE INSTALLATION

SCALE: NTS

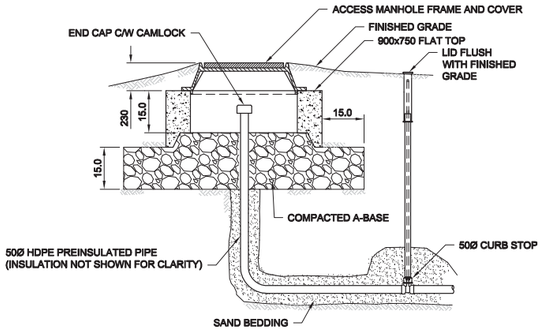
MATERIAL LIST:

1. 32mm BALL TYPE CHECK VALVE c/w 90° GALV. ELBOW.
2. 32mm PVC UNION c/w 100mm LONG GALV. NIPPLES.
3. SUBMERSIBLE SEWAGE PUMP BUSHED TO 32mm c/w ELECTRICAL CABLE, GALV. LIFTOUT CHAIN & MECH. FLOAT SWITCH .
4. 32mm FLEXIBLE RUBBER HOSE RATED FOR SEWAGE EFFLUENT. HOSE c/w NYLON HOSE ADAPTER AND STAINLESS STEEL CLAMPS ON BOTH ENDS.
5. 38mm PVC CONDUITS & LONG SWEEP ELBOWS c/w SILICONE SEALANT AT BOTH ENDS.
6. GALV. LIFTING CHAIN c/w QUICK CLIPS AT EACH END. FASTEN 300mm BELOW MANHOLE LID.
7. HIGH WATER ALARM FLOAT c/w NON MERCURY SENSOR SWITCH. (PUMP CONTROL FLOAT SWITCH BUILT INTO PUMP UNIT)
8. SUBMERSIBLE PUMP POWER CABLE.
9. 32x38mm OR 32x50mm BUSHING.



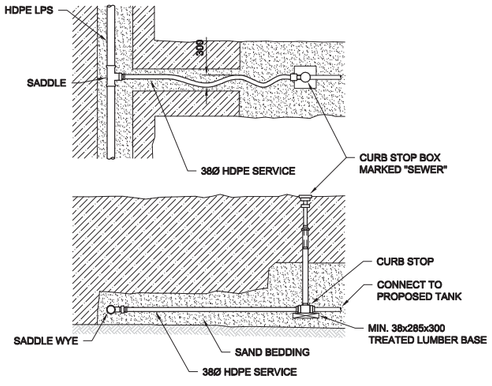
SUBMERSIBLE PUMP

SCALE: NTS



LOW PRESSURE SEWER FLUSHOUT ASSMEBLY

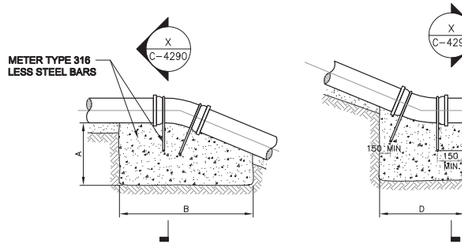
SCALE: NTS



LOW PRESSURE SEWER SERVICE

SCALE: NTS

INSULATION NOT SHOWN FOR CLARITY



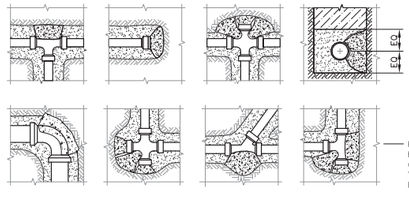
PIPE SIZE (D) (millimeters)	ANGLE OF BEND	VOLUME OF CONCRETE FOR VERTICAL BEND PIPE SIZE (millimeters)	DIMENSIONS FOR CONCRETE THRUST BLOCKS FOR VERTICAL BENDS (millimeters)				
			A	B	C	D	E
150	11 1/4° 22 1/2° 45°	0.21 0.41 0.75	265 385 715	750 1000 1000	265 385 715	750 750 750	1050 1050 1050
200	11 1/4° 22 1/2° 45°	0.36 0.70 1.29	340 665 1025	1000 1000 1200	340 665 1025	750 750 750	1050 1050 1050
250	11 1/4° 22 1/2° 45°	0.53 1.05 1.94	510 835 1230	1000 1200 1500	510 835 1230	1000 1000 1000	1050 1050 1050
300	11 1/4° 22 1/2° 45°	0.76 1.48 2.74	685 940 1450	1050 1500 1800	685 940 1450	1050 1050 1050	1050 1050 1050
350	11 1/4° 22 1/2° 45°	1.02 1.99 3.68	805 1055 1630	1200 1800 2150	805 1055 1630	1200 1200 1200	1050 1050 1050
400	11 1/4° 22 1/2° 45°	1.31 2.58 4.76	835 1140 1850	1500 2150 2450	835 1140 1850	1350 1350 1350	1050 1050 1050
450	11 1/4° 22 1/2° 45°	1.65 3.24 5.98	1045 1435 1965	1500 2150 2900	1050 1050 1350	1350 1350 1350	1050 1050 1050

* TEST PRESSURE 1.0 MPa, SOIL BEARING PRESSURE = 71.8 kPa

* IF DIMENSION FOR A PARTICULAR SIDE OF THE THRUST BLOCK VARIES FROM THAT SHOWN, ADJUST REMAINING DIMENSIONS TO OBTAIN REQUIRED VOLUME.

CONCRETE THRUST BLOCKS FOR VERTICAL BENDS

SCALE: NTS



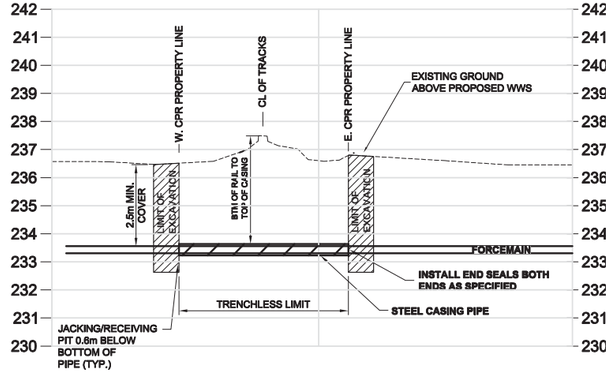
CONCRETE THRUST BLOCK BEARING AREA FOR HORIZONTAL FITTINGS
TEST PRESSURE 1.0 MPa, SOIL BEARING PRESSURE = 71.8 kPa

PIPE SIZE mm	TEE, PLUG OR CROSS m²	BENDS			
		11 1/4° m²	22 1/2° m²	45° m²	90° m²
150	0.27	0.11	0.21	0.39	0.55
200	0.47	0.18	0.36	0.67	0.95
250	0.71	0.28	0.54	1.01	1.42
300	1.00	0.39	0.77	1.42	2.01
350	1.35	0.53	1.03	1.91	2.70
400	1.75	0.68	1.34	2.48	3.51
450	2.18	0.85	1.67	3.09	4.37

MECHANICAL RESTRAINERS TO BE USED ON ALL PLUGS DIMENSIONS IN MILLIMETERS

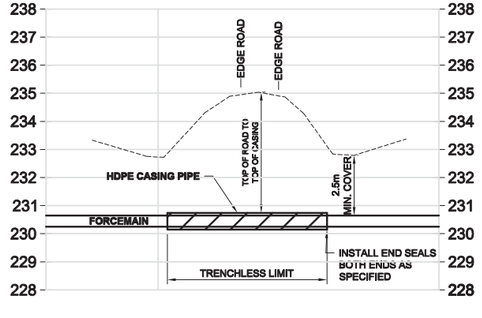
CONCRETE THRUST BLOCKS FOR HORIZONTAL BENDS

SCALE: NTS



TYPICAL RAIL CROSSING PROFILE

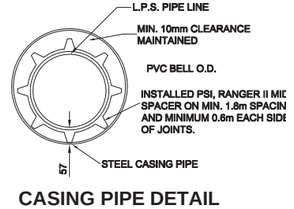
Scale NTS



TYPICAL HIGHWAY CROSSING PROFILE

Scale NTS

PRELIMINARY



CASING PIPE DETAIL

SCALE: NTS

AECOM

PROJECT

WASTEWATER FEASIBILITY STUDY FOR REINFELD / SCHANZENFELD

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60428376

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C-0005

Last saved by: LACOSTEG(2016-06-03) Last Plotted: 2016-06-03
Filename: P:\60428376\900-WORK\910-CAD\20-SHEETS\C\60428376-FIG-20-C-0003_C-0005.DWG

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Appendix B

Breakdown Cost Analyses

LPS Cost Estimate for Reinfeld - 20 Year

NO.	Items	Unit	Quantity	Unit Price	Amount
1	**Lower Pressure Sewers**				
a)	50mm	m	7,750	$80	$620,000
b)	100mm	m	3,100	$110	$341,000
c)	150mm	m	4,350	$150	$652,500
d)	200mm	m	500	$180	$90,000
e)	250mm	m	1,300	$220	$286,000
2	**Isolation Valve and Valve Box**				
a)	50 mm	each	32	$850	$27,200
b)	100 mm	each	10	$1,400	$14,000
c)	150 mm	each	9	$1,800	$16,200
d)	200 mm	each	3	$2,500	$7,500
e)	250mm	each	2	$3,000	$6,000
3	**Cleanout**				
a)	50 mm	each	20	$2,500	$50,000
b)	100 mm	each	5	$2,750	$13,750
c)	150 mm	each	2	$3,000	$6,000
d)	200 mm	each	2	$3,500	$7,000
e)	250mm	each	1	$4,000	$4,000
4	**Services**				
a)	Sewer Saddles and Curb Stops	each	452	$1,000	$452,000
b)	38mm Pressure Sewer Service	m	6,780	$50	$339,000
	Sub-Total				$2,932,150
	10% Contingency				$293,215
	15% Engineering				$439,823
	Total before Tax				$3,665,188

LPS Cost Estimate for Reinfeld - Ultimate Future Option 1

NO.	Items	Unit	Quantity	Unit Price	Amount
1	**Lower Pressure Sewers**				
a)	50mm	m	7,750	$80	$620,000
b)	100mm	m	3,100	$110	$341,000
c)	150mm	m	4,350	$150	$652,500
d)	200mm	m	500	$180	$90,000
e)	250mm	m	450	$220	$99,000
f)	300mm	m	850	$270	$229,500
2	**Isolation Valve and Valve Box**				
a)	50 mm	each	32	$850	$27,200
b)	100 mm	each	10	$1,400	$14,000
c)	150 mm	each	9	$1,800	$16,200
d)	200 mm	each	3	$2,500	$7,500
e)	250mm	each	2	$3,000	$6,000
f)	300mm	each	2	$3,500	$7,000
3	**Cleanout**				
a)	50 mm	each	20	$2,500	$50,000
b)	100 mm	each	5	$2,750	$13,750
c)	150 mm	each	2	$3,000	$6,000
d)	200 mm	each	2	$3,500	$7,000
e)	250mm	each	1	$4,000	$4,000
f)	300mm	each	2	$4,500	$9,000
4	**Services**				
a)	Sewer Saddles and Curb Stops	each	452	$1,000	$452,000
b)	38mm Pressure Sewer Service	m	6,780	$50	$339,000
	Sub-Total				$2,990,650
	10% Contingency				$299,065
	15% Engineering				$448,598
	Total before Tax				$3,738,313

LPS Cost Estimate for Reinfeld - Ultimate Future Option 2

NO.	Items	Unit	Quantity	Unit Price	Amount
1	**Lower Pressure Sewers**				
a)	50mm	m	7,350	$80	$588,000
b)	100mm	m	2,400	$110	$264,000
c)	150mm	m	2,700	$150	$405,000
d)	200mm	m	1,500	$180	$270,000
e)	250mm	m	1,250	$220	$275,000
f)	300mm	m	1,800	$280	$504,000
2	**Isolation Valve and Valve Box**				
a)	50 mm	each	24	$850	$20,400
b)	100 mm	each	10	$1,400	$14,000
c)	150 mm	each	12	$1,800	$21,600
d)	200 mm	each	5	$2,500	$12,500
e)	250mm	each	3	$3,000	$9,000
f)	300mm	each	2	$3,500	$7,000
3	**Cleanout**				
a)	50 mm	each	14	$2,500	$35,000
b)	100 mm	each	8	$2,750	$22,000
c)	150 mm	each	2	$3,000	$6,000
d)	200 mm	each	2	$3,500	$7,000
e)	250mm	each	2	$4,000	$8,000
f)	300mm	each	2	$4,500	$9,000
4	**Services**				
a)	Sewer Saddles and Curb Stops	each	452	$1,000	$452,000
b)	38mm Pressure Sewer Service	m	6,780	$50	$339,000
	Sub-Total				$3,268,500
	10% Contingency				$326,850
	15% Engineering				$490,275
	Total before Tax				$4,085,625

Reinfeld Lift Station and Forcemain System Cost Estimate

	Unit	Quantity	Unit Price	Amount
20-Year Scenario				
Lift Station - 86.8 L/s @ 28.7m (24.5 kw)	each	1	$1,200,000	$1,200,000
Odour Control Device	each	1	$20,000	$20,000
Forcemain 350mm	m	5700	350	$1,995,000
Sub-total				**$3,215,000**
Engineering and Contingency (30%)				$803,750
Total				**$4,018,750**
Future Scenario				
Lift Station - 208 L/s @ 26m (54 kw)	each	1	$1,500,000	$1,500,000
Odour Control Device	each	1	$20,000	$20,000
Forcemain 500mm	m	5700	475	$2,707,500
Sub-total				**$4,227,500**
Engineering and Contingency (30%)				$1,056,875
Total				**$5,284,375**

LPS Cost Estimate for Schanzenfeld (20 Year)

NO.	Items	Unit	Quantity	Unit Price	Amount
1	**Lower Pressure Sewers**				
a)	50mm	m	3,800	$80	$304,000
b)	100mm	m	2,250	$110	$247,500
c)	150mm	m	1,800	$150	$270,000
d)	200mm	m	800	$180	$144,000
2	**Isolation Valve and Valve Box**				
a)	50 mm	each	11	$850	$9,350
b)	100 mm	each	7	$1,400	$9,800
c)	150 mm	each	2	$1,800	$3,600
d)	200 mm	each	3	$2,500	$7,500
3	**Cleanout**				
a)	50 mm	each	14	$2,500	$35,000
c)	100 mm	each	2	$2,750	$5,500
d)	150 mm	each	2	$3,000	$6,000
e)	200 mm	each	2	$3,500	$7,000
4	**Services**				
a)	Sewer Saddles and Curb Stops	each	294	$1,000	$294,000
b)	38mm Pressure Sewer Service	m	4,410	$50	$220,500
	Sub-Total				$1,563,750
	10% Contingency				$156,375
	15% Engineering				$234,563
	Total before Tax				$1,954,688

LPS Cost Estimate for Schanzenfeld (Ultimate Future Option2)

NO.	Items	Unit	Quantity	Unit Price	Amount
1	**Lower Pressure Sewers**				
a)	50mm	m	3,650	$80	$292,000
b)	100mm	m	2,250	$110	$247,500
c)	150mm	m	1,450	$150	$217,500
d)	200mm	m	1,300	$180	$234,000
2	**Isolation Valve and Valve Box**				
a)	50 mm	each	11	$850	$9,350
b)	100 mm	each	7	$1,400	$9,800
c)	150 mm	each	2	$1,800	$3,600
d)	200 mm	each	3	$2,500	$7,500
3	**Cleanout**				
a)	50 mm	each	14	$2,500	$35,000
c)	100 mm	each	2	$2,750	$5,500
d)	150 mm	each	2	$3,000	$6,000
e)	200 mm	each	2	$3,500	$7,000
4	**Services**				
a)	Sewer Saddles and Curb Stops	each	294	$1,000	$294,000
b)	38mm Pressure Sewer Service	m	4,410	$50	$220,500
	Sub-Total				$1,589,250
	10% Contingency				$158,925
	15% Engineering				$238,388
	Total before Tax				$1,986,563

Schanzenfeld Lift Station and Forcemain System Cost Estimate

	Unit	Quantity	Unit Price	Amount
20-Year Scenario				
Lift Station - 40.8 L/s @ 16m (6.4 kw)	each	1	$400,000	$400,000
Odour control device	each	1	$20,000	$20,000
Forcemain 250mm	m	5300	220	$1,166,000
Sub-total				**$1,586,000**
Engineering and Contingency (25%)				$396,500
Total				**$1,982,500**
Future Scenario				
Lift Station - 66 L/s @ 16m (10.4 kw)	each	1	$475,000	$475,000
Odour control device	each	1	$20,000	$20,000
Forcemain 300mm	m	5300	280	$1,484,000
Sub-total				**$1,979,000**
Engineering and Contingency (25%)				$494,750
Total				**$2,473,750**

Appendix C

Low Pressure Sewer Operation and Maintenance Information

1. Connecting sanitary sewer forcemain to the low pressure sewer system:

Background

AECOM recently completed a Pre-Design report for the RM of Stanley, Low Pressure Sewer System Pre-design Report for Schanzenfeld and Reinfeld (AECOM June 2016), which recommended that the Low Pressure Sewer (LPS) system for Schanzenfeld be designed on the ultimate future development detailed in the Option 2 scenario. The recommended design for a LPS in Reinfeld was to be based on the ultimate future development detailed in the Option 1 scenario.

System Design and Characteristics

In both communities the selected design was based on a STEP type LPS wastewater collection system where the LPS network conveyed wastewater independently from individual tanks and low horsepower pumps at each residences to the lift station and conveyed by forcemain to the Winkler treatment facility.

Low Pressure Sewer System

It is preferred to maintain separate systems to collect (LPS) and transfer (lift station & forcemain) waste water as the needs and characteristics of these networks are quite different. Low pressure sewer networks, as the name implies, operate under low operating pressure and flows relying on smaller horsepower pumps in individual residential tanks to incrementally move liquid through the system over short distances.

The type of LPS system chosen for Schanzenfeld and Reinfeld are of a type where the liquid and solid portions of the wastewater are separated an only the decanted liquid is pumped into the piped network, with the solids being retained in the tank and pumped out annually by a sewage truck. This distinction allows the system to pump at lower velocities and using smaller pipes due in part to the lack of solids present in the wastewater.

Sewage Forcemain

Sewage forcemains, on the other hand, are intended to operate under higher pressures and flow rates and their purpose is to convey large volumes under higher pressures and flow rates over much larger distances. Sewage forcemains also do not separate solids from the waste water and must therefore pump at higher velocities to prevent sedimentation from occurring and affect capacity and efficiency.

Consequences of Mixed Systems

- Higher flow and pressure lift station pumps pushing smaller residential pumps off their curve.
- All pumps on the system working harder to overcome additional system pressures
- Accumulation of additional solids in piped systems originally designed as LPS systems
- Creating additional system complexity and a reduction in redundancy

Recommendations

Due to these differences in the intended operating characteristics of the two types of pressure sewers it is preferred not to combine the two. In cases where no other feasible options exist the hydraulic design of such combined systems must be carried out in greater detail with special consideration being given to designing a system where all pumps can be accommodated and won't be 'blocked' from pumping due to

high system pressures that may be present (i.e. residential tanks being blocked from pumping by the larger pumps in the lift station).

Wastewater Systems from Future Development

An allowance for expansion in the communities has been included in the design and sizing of the proposed sewer systems for both communities. Allowances for future development, in accordance with the development plans, have been made when the LPS network was sized. When new residential or commercial developments are constructed they should be limited to the number of additional development lots or equivalent flow that the design allowed for.

Should new developments be constructed in excess of the capacity of the allotment or be constructed using a combination of gravity sewers and an independent lift station, they must be connected directly to the main sewage lift station via a separate forcemain to avoid the potential consequences of mixing low pressure sewers with sewage forcemains for the reasons noted above.

In the case where a residential development is proposed which exceeds the allotted capacity, further detailed analysis would be required to determine the impacts of the higher flows on the networks as a whole, and to examine alternate configurations.

2. Maintenance Requirements

Maintenance activities can generally be broken down between RM and resident responsibilities. These responsibilities vary due to the differing nature of the infrastructure under the control of each party.

RM Maintenance Activities

The assets under the RM's control are the Lift Station, Forcemain, and LPS mains. Forcemains and LPS mains are generally low maintenance items with most municipalities reporting very little time commitment. Periodically flushing activities may be required to remove accumulated solids or air, however these should be considered to be isolated activities and done on an as needed basis.

Most municipalities carry out annual inspections and cleaning of the wetwell. These inspections will be carried out by municipal staff or contractors who will perform mechanical and electrical inspections of the pumps and other components in the lift station. At the same time the lift station wetwell is typically cleaned of accumulated debris by pressure washing and hydro-vacing out solids.

Resident Maintenance Activities

The two different types of low pressure sewer systems, STEP and grinder pumps, have similar components. These components and their typical maintenance activities are listed below.

- Tank
  - Annual pump out of accumulated solids. Typically by the Municipality as part of the sewage rates paid by the resident.
  - Pump out by the municipality also allows for a routine inspection of the tank for compliance with local by-laws (ie poorly fitting lid, damage, leaks, or poor site grading).
- Electrical, mechanical, and pump
  - Recommended annual inspection by qualified contractor.

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Appendix E

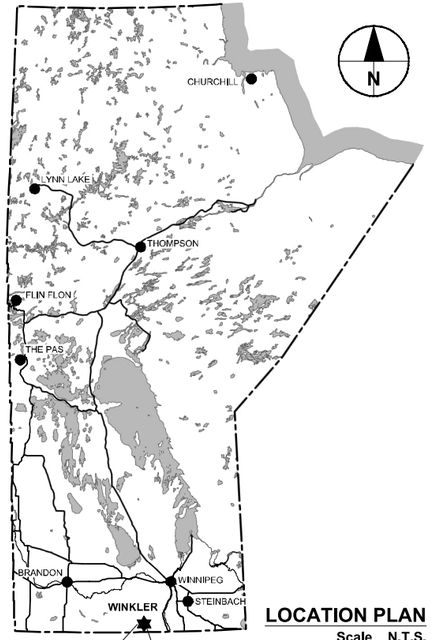
Draft Project Design Drawings

The Manitoba Water Services Board

PRELIMINARY

DRAWING INDEX

DRAWING No.	DISCIPLINE	AREA	DRAWING TITLE
G-0001	GENERAL	GENERAL	COVER SHEET
G-0002	GENERAL	WASTEWATER FORCEMAIN	FORCEMAIN SEWER AND GENERAL SITE PLAN
C-0001	CIVIL	WASTEWATER FORCEMAIN	SCHANZENFELD TO REINFELD - PIPING LAYOUT
C-0002	CIVIL	WASTEWATER FORCEMAIN	REINFELD TO WINKLER WWTP - PIPING LAYOUT
C-0003	CIVIL	WASTEWATER FORCEMAIN	MISCELLANEOUS CROSSING PROFILES 1 - PIPING LAYOUT
C-0004	CIVIL	WASTEWATER FORCEMAIN	MISCELLANEOUS CROSSING PROFILES 2 - PIPING LAYOUT
C-0005	CIVIL	CPR FORCEMAIN CROSSING	MISCELLANEOUS CROSSING PROFILES 3 - PIPING LAYOUT
C-0007	CIVIL	WASTEWATER FORCEMAIN	MISCELLANEOUS CROSSING PROFILES 4 - PIPING LAYOUT
C-4001	CIVIL	GENERAL	TYPICAL DETAILS 1
C-4002	CIVIL	GENERAL	TYPICAL DETAILS 2



LOCATION PLAN
Scale N.T.S.

AECOM

60539657

THE MANITOBA WATER SERVICES BOARD
RM OF STANLEY REGIONAL WASTEWATER SYSTEM
FORCEMAINS
MWSB No. 1769
REVIEW SET, 2025.01.08

Last saved by: LACOSTEG (2025-01-08) Last Plotted: 2025-01-08
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Project Management Initials: Designer: Checked: Approved: ISO A1 594mm x 841mm

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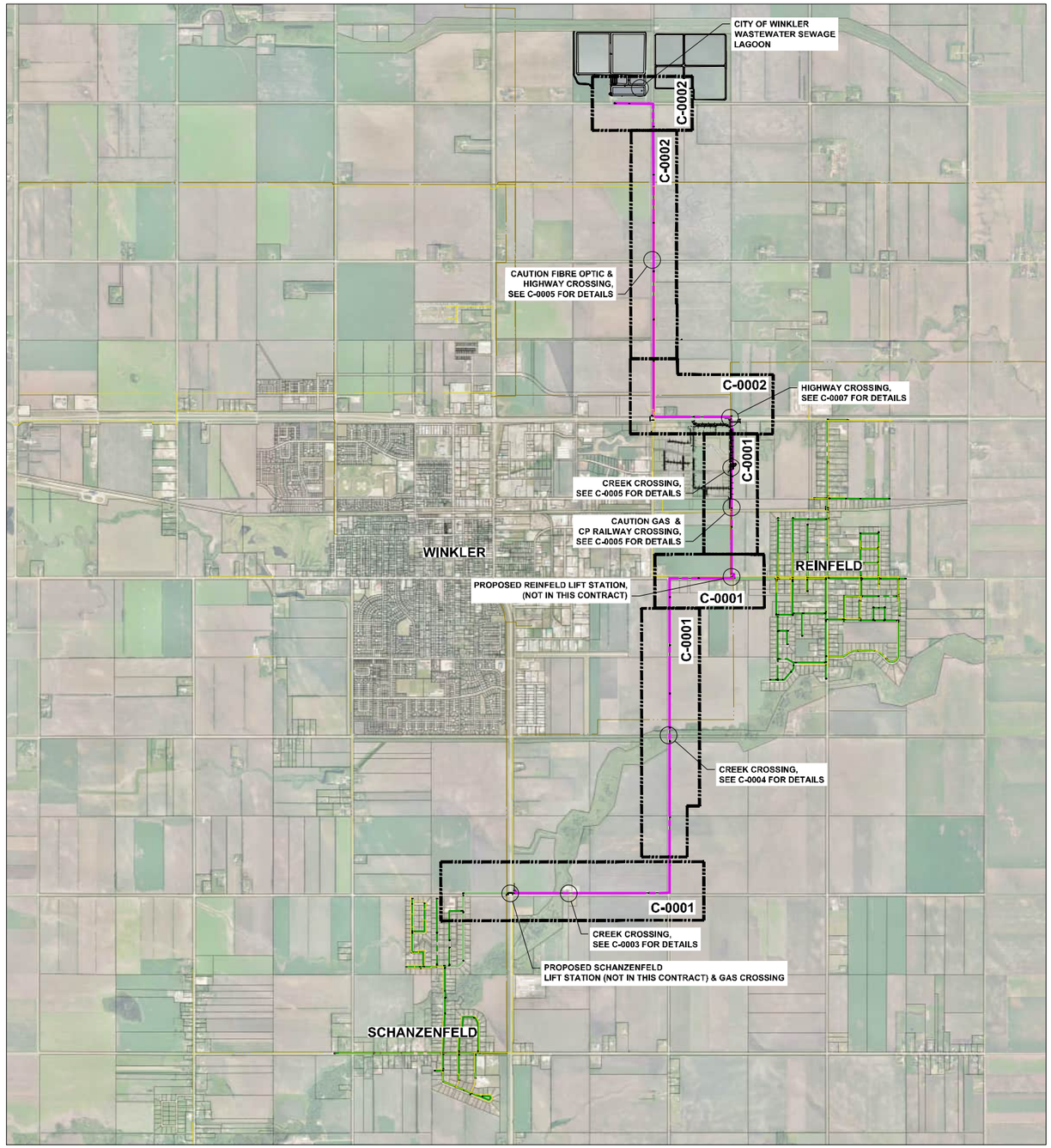
Project Management Initials: ____ Designer: ____ Checked: ____ Approved: ____ ISO A1 594mm x 841mm

CONSTRUCTION NOTES:

1. LOCATION OF UNDERGROUND STRUCTURES AS SHOWN IS BASED ON THE BEST INFORMATION AVAILABLE, BUT NO GUARANTEE IS GIVEN THAT ALL EXISTING UTILITIES ARE SHOWN OR THAT THE GIVEN LOCATIONS ARE EXACT. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION. THE CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY ERROR OR OMISSION IN THE LOCATION OF ALL EXISTING UTILITIES SHOWN ON THE DRAWING.
2. PRIOR TO CONSTRUCTION, DELETERIOUS SOILS COMPRISING VEGETATION, TOPSOIL, POND SEDIMENT, AND THE SOFT/VERY SOFT, LOOSE, WET, DISTURBED, PORTION OF NATIVE SOILS, IF ANY, SHOULD BE REMOVED FROM THE FOOTPRINT AREAS FOR STRUCTURES AND OTHER SETTLEMENT SENSITIVE FACILITIES.
3. CONTRACTOR TO EXPOSE AND CONFIRM LOCATION OF EXISTING UNDERGROUND UTILITIES AT CROSSING LOCATIONS PRIOR TO THE START OF CONSTRUCTION.
4. CHAINAGE IS ALONG CENTRELINE OF PROPOSED FORCEMAIN.
5. NEW FORCEMAIN PIPE IS HDPE DR17.
6. AL EXCAVATIONS SHALL BE UNDERTAKEN USING SAFE SLOPES IN ACCORDANCE WITH MANITOBA WORKPLACE SAFETY AND HEALTH.
7. WHEN CUT BACK SLOPES ARE TO BE USED IN LIEU OF CAGES AND SHORING, THESE SLOPES ARE TO MEET REQUIREMENTS OF LOCAL CODES.
8. CONTRACTOR TO VERIFY INSITU SOIL CONDITIONS PRIOR TO THE START OF CONSTRUCTION.
9. MINIMUM COVER ABOVE PIPE IS 2.7 m EXCEPT WHEN SHOWN OTHERWISE.
10. THE FINISHED SUBGRADE MUST BE FREE OF DEPRESSIONS AND SHOULD BE SLOPED TOWARD THE ROAD EMBANKMENT'S SIDE SLOPES, OR TOWARD THE SIDE DITCHES, IN ORDER TO PROVIDE EFFICIENT SURFACE WATER CONTROL (DRAINAGE).
11. THE CONTRACTOR SHALL ENSURE THAT LOCAL DRAINAGE PATTERNS ARE NOT ALTERED BY THE CONSTRUCTION.
12. SURFACE WATER SHOULD NOT BE ALLOWED TO POND ON THE FINISHED SUBGRADE OR ADJACENT TO THE OUTSIDE EDGES OF THE ROAD, THE SUBGRADE MUST BE SLOPED MIN 3% TOWARD THE ROAD EDGES OR SIDE DITCHES, IN ORDER TO PROMOTE FAST AND EFFICIENT SURFACE WATER DRAINAGE.
13. PROPOSED FORCEMAIN UNDER ALL ROADS, PRIVATE APPROACHES, DRIVEWAYS, WITHIN PTH 14 AND ROAD 20W RIGHT-OF-WAYS, UNDER WATER BODIES, RAILWAYS, AND ALL OTHER LOCATIONS SPECIFIED ON THE DRAWING TO BE INSTALLED BY DIRECTIONAL DRILLING OR OTHER TRENCHLESS METHOD OF INSTALLATION AS APPROVED BY THE ENGINEER.
14. IN AREAS WHERE TRENCHLESS METHOD OF INSTALLATION IS NOT FEASIBLE, APPROVAL OF THE ENGINEER IS REQUIRED FOR OPEN CUT TRENCH EXCAVATION. IF OPEN CUT TRENCH EXCAVATION IS USED FOR PIPE INSTALLATION UNDER THE EXISTING ROADS, BACKFILL WITH GRANULAR MATERIAL AND MATCH THE EXISTING ROAD PROFILE.
15. CONTRACTOR TO USE SOFT EXCAVATION METHODS (HYDROVAC OR HAND DIGGING) TO CONFIRM EXISTING WATER PIPELINE AT CONNECTION AND CROSSING LOCATIONS PRIOR TO THE START OF CONSTRUCTION.
16. DURING CONSTRUCTION OF PIPELINES, THE CONTRACTOR SHALL ENSURE THAT ALL NECESSARY MEASURES ARE IMPLEMENTED TO PREVENT THE EROSION OF EXPOSED SOIL INTO WATERBODIES.
17. CONSTRUCTION ADJACENT TO WATERBODIES SHALL NOT OCCUR DURING HIGH RAINFALL EVENTS.
18. PLACE SURPLUS EXCAVATED MATERIAL FROM UTILITY TRENCH OVER UTILITY TRENCH WHEREVER POSSIBLE, AS SHOWN ON THE DRAWINGS OR AS DIRECTED BY THE ENGINEER IN THE FIELD. DRAINAGE MAINTAINED, AND AREAS RESTORED.
19. ALL PIPE BEDDING TO BE CLASS "B" UNLESS NOTED OTHERWISE.
20. PROVIDE MIN. 300 SEPARATION BETWEEN SEWER LINES IN COMMON TRENCH.
21. ANY PIPE DEFLECTION MUST NOT EXCEED PIPE MANUFACTURES SPECIFICATIONS.
22. WHERE THE SEWERMAINS INTERSECTS OTHER UTILITIES, MAINTAIN A MINIMUM OF 450mm CLEARANCE BETWEEN SEWERMAIN AND SAID UTILITY.
23. CONTRACTOR TO RESTORE CONSTRUCTION AREA WITH TOPSOIL AND GRASS SEEDING MAINTAINING POSITIVE DRAINAGE TOWARDS DITCHES.
24. CONTRACTOR TO PROVIDE RM OF STANLEY WITH TWO VALVE KEYS FOR EACH SIZE OF STEM EXTENSIONS.



N

150 WM	WATERMAIN	150 WM		CURB STOP		150 WM	WATERMAIN	150 WM
	HYDRANT			REDUCER			HYDRANT	
	VALVE			GAS			VALVE	
300 LDS	LAND DRAINAGE SEWER	300 LDS		MTS		300 LDS	LAND DRAINAGE SEWER	300 LDS
250 WWS	WASTE WATER SEWER	250 WWS		CABLE		250 WWS	WASTE WATER SEWER	250 WWS
	MANHOLE			CONDUIT			PAVEMENT CROWN	
	CATCH BASIN			PRIMARY POWER			N/W PROPERTY LINE	
	RAILWAY TRACKS			FIBRE OPTIC			S/E PROPERTY LINE	
	CULVERT			TESTHOLE			N/W GUTTER	
	PIPE ABANDONMENTS			LAMP STANDARD			S/E GUTTER	
	SURVEY BAR		TH-	TREE			AIR RELEASE VALVE	
	TERMINAL CLEANOUT			VALVE (NORMALLY CLOSED)	NC			
	CLEANOUT							
EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PROFILE	NEW

GENERAL SITE PLAN

Scale: 1:25000

PRELIMINARY

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

NOTICE:
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PROJECT

RM OF STANLEY
REGIONAL WASTEWATER SYSTEM - FORCEMAINS
MWSB No. 1769

CLIENT

The Manitoba Water Services Board
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www.gov.mb.ca/ia/mwsb/mwsb.html

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www.aecom.com

REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
B	2018.08.01	ISSUED FOR 100% REVIEW
A	2018.03.14	ISSUED FOR REVIEW

PROJECT NUMBER

60539657

SHEET TITLE

WASTEWATER FORCEMAIN
GENERAL SITE PLAN

SHEET NUMBER

G-0002

Last saved by: LACOSTEG(2025-01-09) Last Plotted: 2025-01-09
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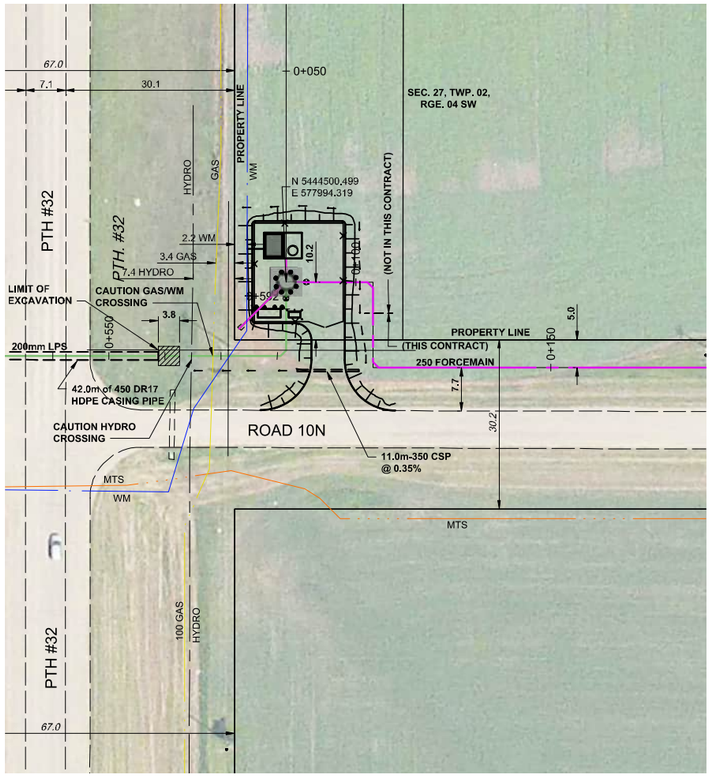
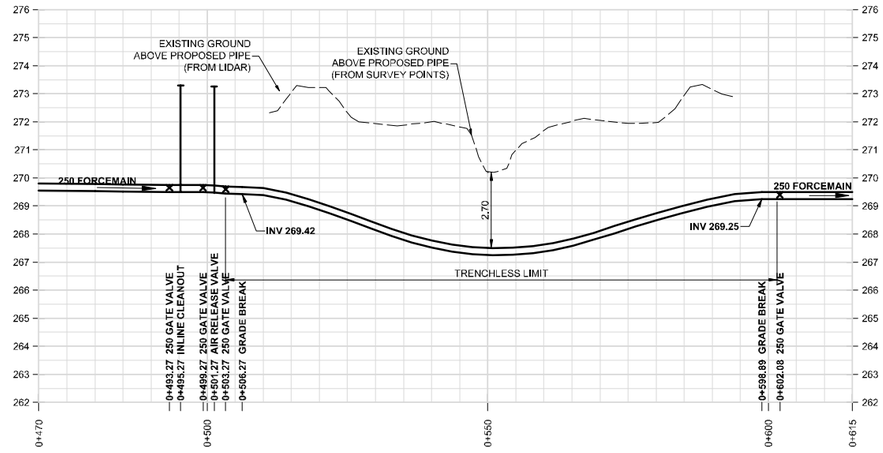
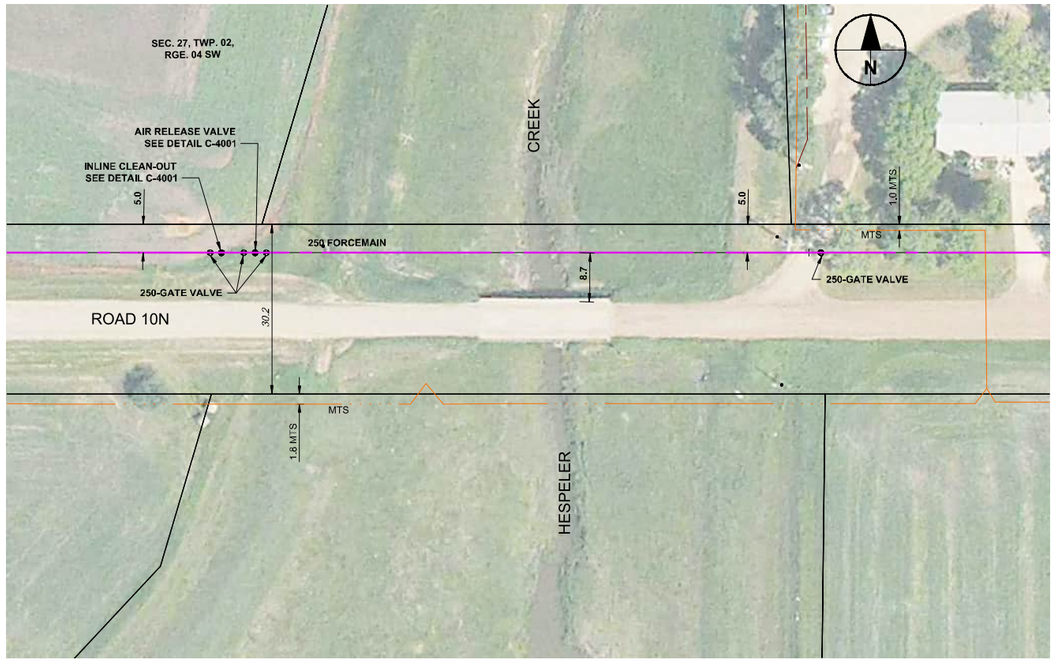


1 | PLAN
C-0003 | Scale Horz. 1:500





2 | PLAN
C-0003 | Scale Horz. 1:500

150 WM	WATERMAIN	150 WM		CURB STOP		150 WM	WATERMAIN	150 WM
	HYDRANT			REDUCER			HYDRANT	
	VALVE			GAS			VALVE	
300 LDS	LAND DRAINAGE SEWER	300 LDS		MTS		300 LDS	LAND DRAINAGE SEWER	300 LDS
250 WWS	WASTE WATER SEWER	250 WWS		CABLE		250 WWS	WASTE WATER SEWER	250 WWS
	MANHOLE			CONDUIT			PAVEMENT CROWN	
	CATCH BASIN			PRIMARY POWER			N/W PROPERTY LINE	
	RAILWAY TRACKS			FIBRE OPTIC			S/E PROPERTY LINE	
	CULVERT			TESTHOLE			N/W GUTTER	
	PIPE ABANDONMENTS			LAMP STANDARD			S/E GUTTER	
	SURVEY BAR		TH.	TREE			AIR RELEASE VALVE	
	TERMINAL CLEANOUT			VALVE (NORMALLY CLOSED)	NC			
	CLEANOUT							
EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PROFILE	NEW

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

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AECOM

PROJECT

RM OF STANLEY
REGIONAL WASTEWATER SYSTEM - FORCEMAINS
MWSB No. 1769

CLIENT

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2010 Currie Blvd.
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REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
B	2018.08.01	ISSUED FOR 100% REVIEW
A	2018.03.14	ISSUED FOR REVIEW
I/R	DATE	DESCRIPTION

PROJECT NUMBER

60539657

SHEET TITLE

WASTEWATER FORCEMAIN MISCELLANEOUS CROSSING PROFILES 1 - PIPING LAYOUT

SHEET NUMBER

C-0003

Project Management Initials: ____ Designer: ____ Checked: ____ Approved: ____ ISO A1 594mm x 841mm
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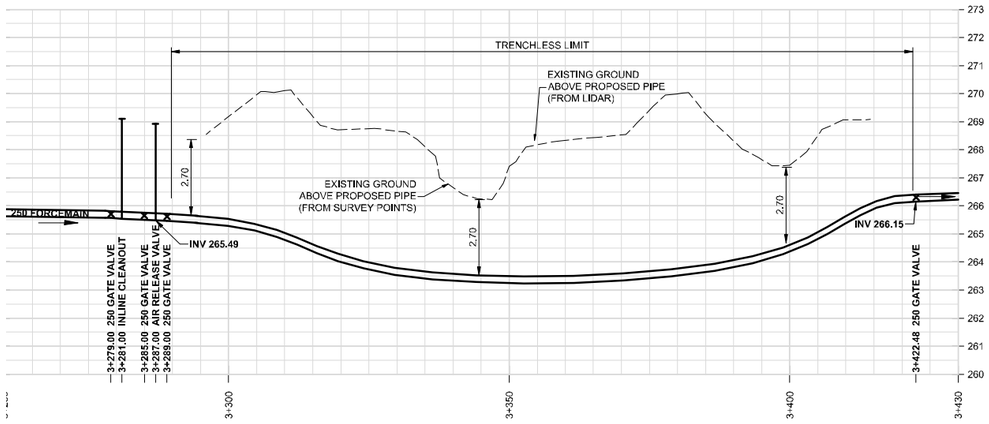
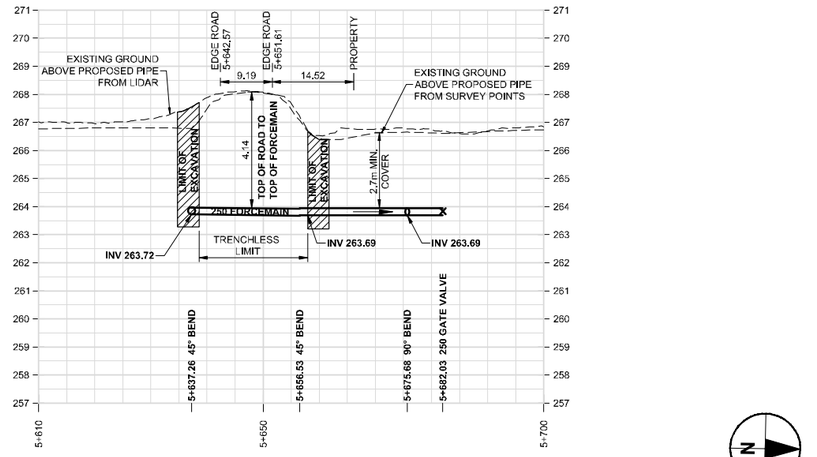
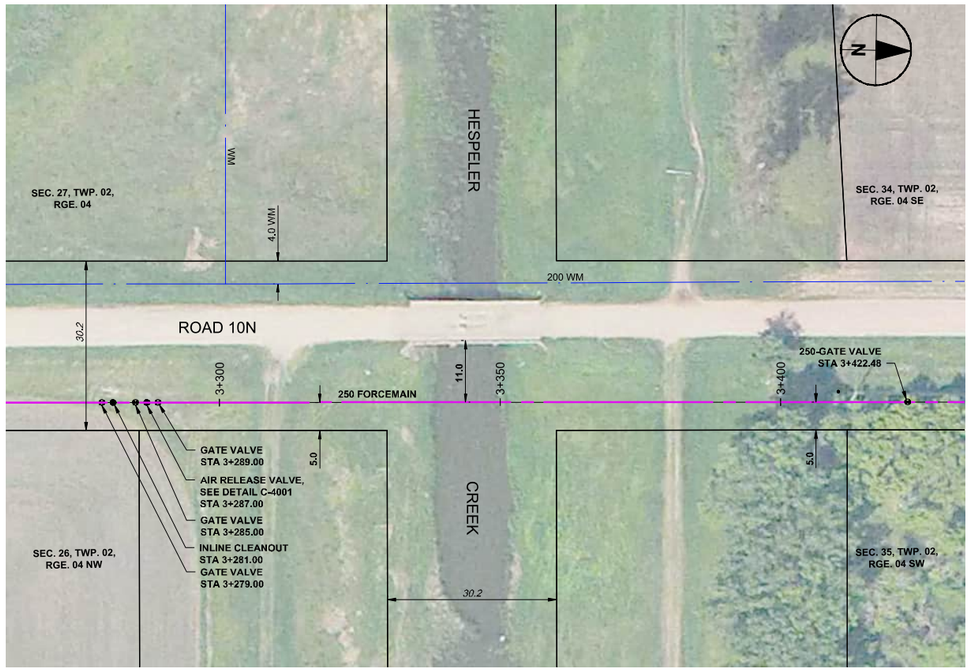
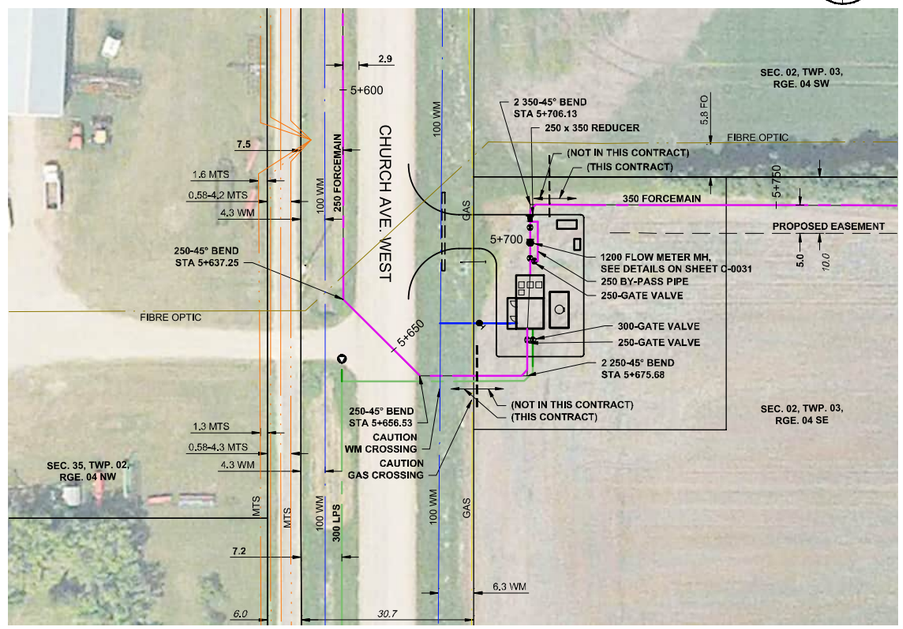






1 | PLAN
C-0001 | Scale Horz. 1:500



2 | PLAN
C-0001 | Scale Horz. 1:500

PRELIMINARY

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

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	HYDRANT			REDUCER			HYDRANT	
	VALVE			GAS			VALVE	
300 LDS	LAND DRAINAGE SEWER	300 LDS		MTS		300 LDS	LAND DRAINAGE SEWER	300 LDS
250 WWS	WASTE WATER SEWER	250 WWS		CABLE		250 WWS	WASTE WATER SEWER	250 WWS
	MANHOLE			CONDUIT			PAVEMENT CROWN	
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	CLEANOUT							
EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PROFILE	NEW

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PROJECT

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REGIONAL WASTEWATER SYSTEM - FORCEMAINS
MWSB No. 1769

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REGISTRATION

ISSUE/REVISION

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A	2018.03.14	ISSUED FOR REVIEW

PROJECT NUMBER

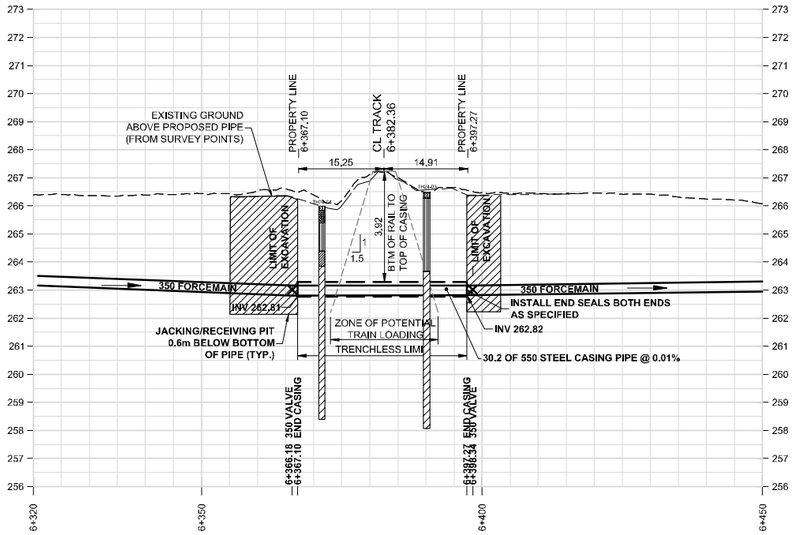
60539657

SHEET TITLE

WASTEWATER FORCEMAIN MISCELLANEOUS CROSSING PROFILES 2 - PIPING LAYOUT

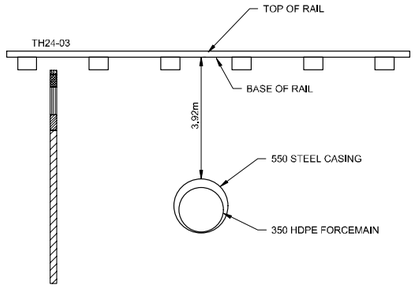
SHEET NUMBER

C-0004



BOREHOLE LEGEND:

- FILL
- SILT
- FAT CLAY



SECTION ON ℄ TRACK

Scale NTS

RAIL CROSSING NOTES:

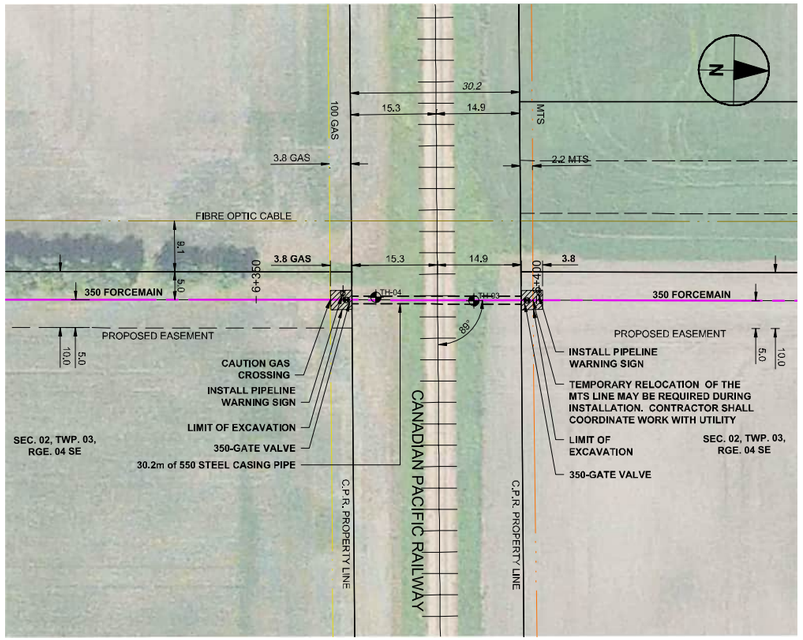
RAILWAY MILEAGE AND SUBDIVISION :	MILE 70.15 CP LA RIVIERE SUBDIVISION	
MUNICIPAL DESCRIPTION OF ADJACENT PROPERTIES:		
NAME OF PIPELINE OWNER:	RURAL MUNICIPALITY OF STANLEY	
CONTENTS TO BE HANDLED:	MUNICIPAL WASTEWATER	
MAXIMUM OPERATING PRESSURE:	520 KPa (75 psi)	
MAXIMUM TEST PRESSURE:	1000 KPa (145 psi)	
MAXIMUM OPERATING TEMPERATURE:	20°C	
MINIMUM OPERATING TEMPERATURE:	4°C	
PIPING MATERIALS:	CARRIER	CASING
NOMINAL DIAMETER:	350mm	550mm
OUTSIDE DIAMETER:	350mm	550mm
MATERIAL:	HDPE DR 17	STEEL
SPECIFICATION & GRADE:	PE 4710/CSA B137.1	ASTM 453 GRADE B WELDED STEEL MIN. YIELD STRENGTH 242 MPa
WALL THICKNESS:	20.9mm MIN.	15.8mm MIN.
TYPE OF JOINT:	BUTT FUSED	WELDED
COATING:	N/A	N/A
LOCATION OF SHUT OFF VALVES FOR 350 MUNICIPAL WASTEWATER PIPE LINE:	16.2 SOUTH OF TRACKS	
LOCATION OF SHUT OFF VALVES FOR 350 MUNICIPAL WASTEWATER PIPE LINE:	16.0 NORTH OF TRACKS	
METHOD OF INSTALLATION:	TRENCHLESS CONSTRUCTION	
VENTS: NUMBER: N/A	HEIGHT ABOVE GROUND: N/A	
SEALS: BOTH ENDS:	YES	
SEALS: TYPE:	PERMEABLE GEOTEXTILE FABRIC	
BURY: BASE OF RAIL TO TOP OF CASING:	3.92m	
BURY: NOT BENEATH TRACKS:	N/A	
BURY: ROADWAY DITCHES:	N/A	
BURY: BASE OF RAIL TO BOTTOM OF JACKING/RECIEVING PITS:	5.07m	

EXTENT OF CASING MEASURED PERPENDICULAR TO CENTERLINE OF TRACK: 15.2m SOUTH / 14.9m NORTH

CENTERLINE OF TRACK TO FACE OF JACKING/RECIEVING PITS: 15.3m /14.9m

TYPE, SIZE & SPACING OF INSULATORS OR SUPPORTS:	SEE DETAIL 1
CATHODIC PROTECTION:	NO
GEOTECHNICAL BOREHOLES:	YES, SEE SPECIFICATIONS
SOIL TYPE:	YES, SEE SPECIFICATIONS
BASE OF RAIL TO GROUND WATER:	N/A

TO BE CONSTRUCTED & MAINTAINED IN ACCORDANCE WITH TC-E10

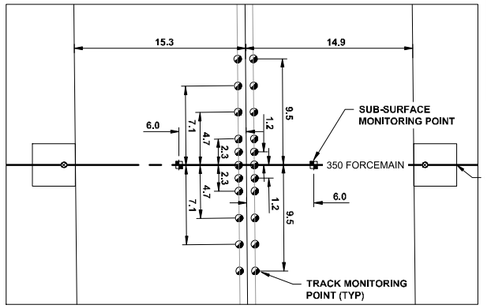


1 | FORCEMAIN RAIL CROSSING

C-0001

Scale Horz. 1:500

SUB-SURFACE MONITORING POINTS (2) TO BE INSTALLED TO 1m ABOVE CASING OBVERT IN ACCORDANCE WITH CP GEOTECHNICAL PROTOCAL FIGURE B



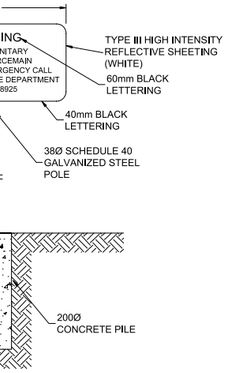
TRACK MONITORING PLAN

Scale 1:250

TRACK MONITORING

1. MONITOR RAIL TRACK IN ACCORDANCE WITH TRACK MONITORING PLAN.
2. REPORT MONITORING THRESHOLDS: CRITICAL / REVIEW THRESHOLD: >22mm; ALERT / WARNING THRESHOLD: >11mm
3. SETTLEMENT MONITORING OF THE RAIL TRACK SHALL COMMENCE A MINIMUM OF 2 DAYS PRIOR TO CONSTRUCTION/EXCAVATION IN ORDER TO ESTABLISH BASELINE COORDINATES AND ELEVATIONS.
4. MONITORING POINTS SHOULD BE SURVEYED AT LEAST TWICE PER DAY DURING THE DURATION OF CONSTRUCTION AND AT LEAST 3 DAYS AFTER THE COMPLETION OF CONSTRUCTION.

SURVEY RESULTS SHALL BE SUBMITTED DAILY TO GEOTECHNICAL ENGINEER FOR REVIEW.



2 | WARNING SIGN DETAIL

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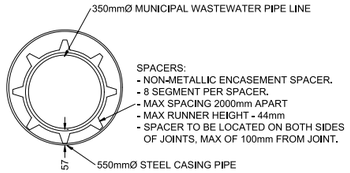
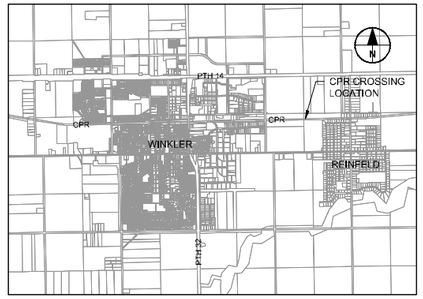
Scale N.T.S.



1 | CASING PIPE DETAIL

-

Scale 1:100



SITE PLAN

150 WM	WATERMAIN	150 WM		CURB STOP		150 WM	WATERMAIN	150 WM
	HYDRANT			REDUCER			HYDRANT	
	VALVE			GAS			VALVE	
300 LDS	LAND DRAINAGE SEWER	300 LDS		MTS		300 LDS	LAND DRAINAGE SEWER	300 LDS
250 WWS	WASTE WATER SEWER	250 WWS		CABLE		250 WWS	WASTE WATER SEWER	250 WWS
	MANHOLE			CONDUIT			PAVEMENT CROWN	
	CATCH BASIN			PRIMARY POWER			N/W PROPERTY LINE	
	RAILWAY TRACKS			FIBRE OPTIC			S/E PROPERTY LINE	
	CULVERT			TESTHOLE			N/W GUTTER	
	PIPE ABANDONMENTS			LAMP STANDARD			S/E GUTTER	
	SURVEY BAR		TH-	TREE			AIR RELEASE VALVE	
	TERMINAL CLEANOUT			VALVE (NORMALLY CLOSED)	NC			
	CLEANOUT							
EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PROFILE	NEW

NOTICE:
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THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE EXISTENCE, LOCATION AND ELEVATION OF ALL SUCH UTILITIES AND/OR STRUCTURES AND IS RESPONSIBLE FOR NOTIFYING THE APPROPRIATE COMPANY, DEPARTMENT OR PERSON(S) OF ITS INTENTION TO CARRY OUT ITS OPERATIONS.

PRELIMINARY

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

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AECOM

PROJECT

RM OF STANLEY
REGIONAL WASTEWATER SYSTEM - FORCEMAINS
MWSB No. 1769

CLIENT

The Manitoba Water Services Board
2010 Currie Blvd.
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REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
B	2018.08.01	ISSUED FOR 100% REVIEW
A	2018.03.14	ISSUED FOR REVIEW

PROJECT NUMBER

60539657

SHEET TITLE

WASTEWATER FORCEMAIN MISCELLANEOUS CROSSING PROFILES 3 - PIPING LAYOUT

SHEET NUMBER

C-0005

Project Management Initials: ____ Designer: ____ Checked: ____ Approved: ____ ISO A1 594mm x 841mm
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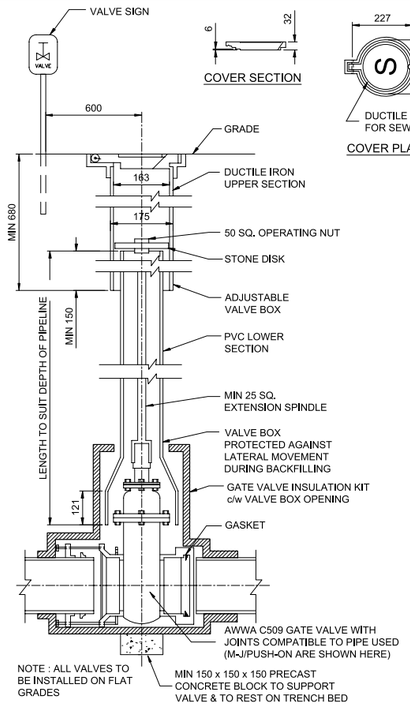
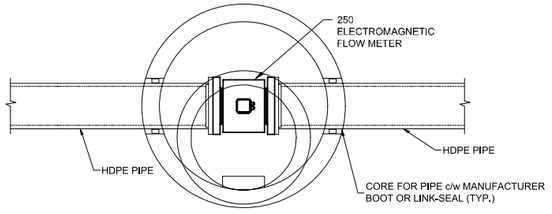
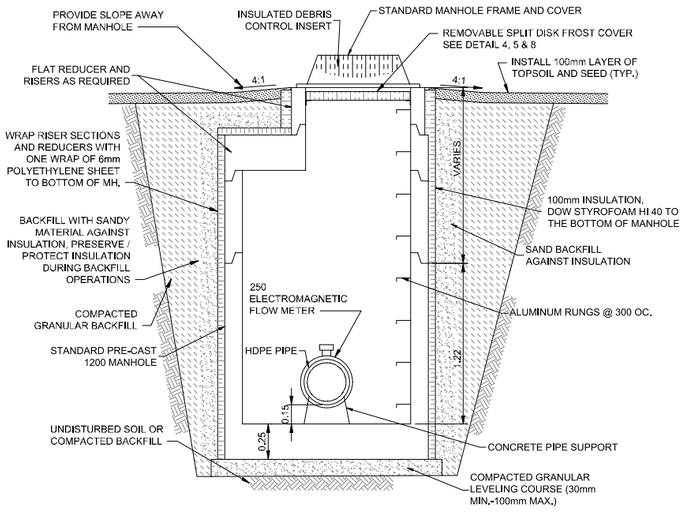


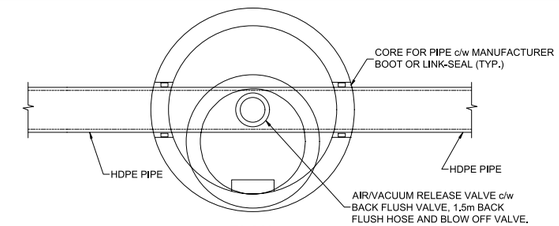
1 | GATE VALVE DETAIL
Scale NTS



PLAN



2 | 1200mm FLOW METER CHAMBER
Scale NTS



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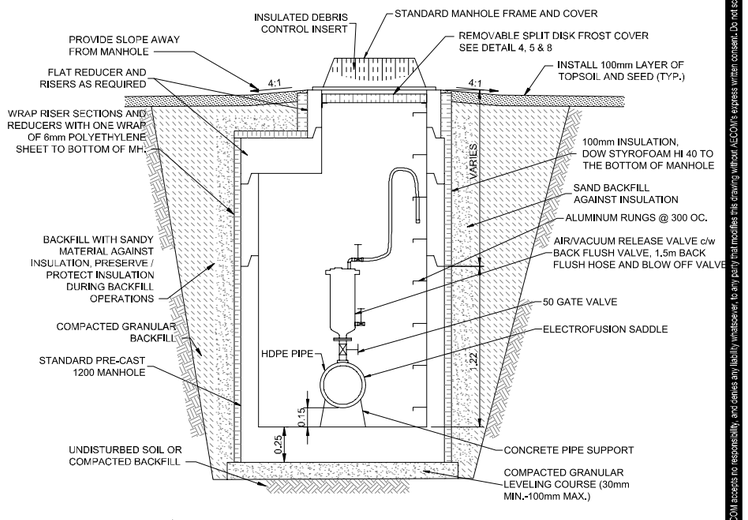
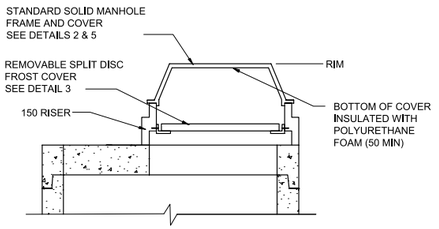
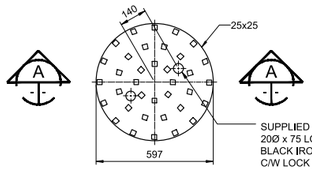
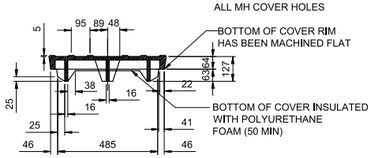


3 | 1200mm AIR RELEASE VALVE CHAMBER
Scale NTS

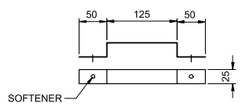


4 | MANHOLE FRAME AND COVER DETAIL
Scale NTS





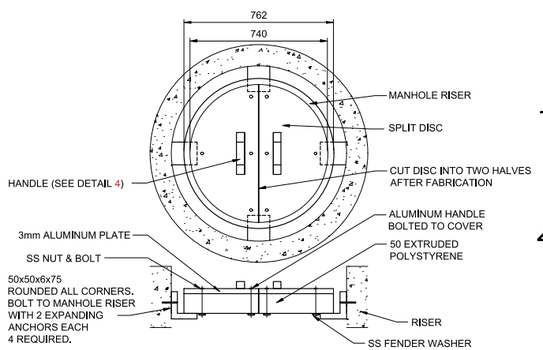
SECTION A-A



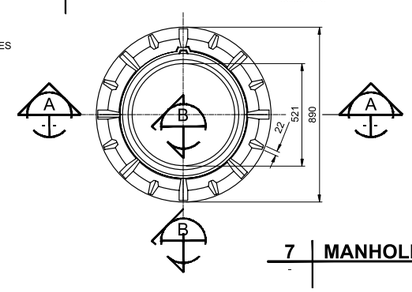
8 | FROST COVER HANDLE DETAIL
Scale NTS

MANHOLE NOTES:

1. CAST-IN-PLACE CONCRETE BASE MAY BE USED. CAST-IN-PLACE CONCRETE TO BE TYPE 50 25MPa IN 28 DAYS. CAST-IN-PLACE CONCRETE BASE TO BE MIN. 150mm THICK AND CONSTRUCTED ON UNDISTURBED SOIL.
2. PRECAST RINGS, CONES AND BARRELS TO MEET CURRENT ASTM C478 STANDARDS.
3. MH JOINTS TO BE SEALED WITH CEMENT MORTAR, OR CONFINED O-RING GASKET.
4. CONNECTION OF PIPES TO MH TO BE SEALED WITH CEMENT MORTAR.
5. SAFETY STEP SPACING TO BE EQUALLY SPACED AT A MAX. OF 410mm APART TO WITHIN 300mm BELOW COVER AND TO WITHIN 600mm OF THE BASE OR BENCHING.
6. COMPACT BACKFILL AROUND MH TO A MIN. OF 95% STANDARD PROCTOR DENSITY.
7. RIMS OF MANHOLES SHALL BE ABOVE GROUND ELEVATION BY MIN. 225mm, GROUND AROUND MANHOLES SHALL BE SLOPED AWAY FROM MANHOLES.
8. INSTALL 75 WIDE x 6 THICK x 900 LONG GALVANIZED STEEL FROST STRAPS c/w 19Ø 316 SS ANCHOR BOLTS ACROSS ALL JOINTS, PLACE AT 3 EQUIDISTANT CIRCUMFERENTIAL SPACING AROUND THE MANHOLE.
9. ALL MANHOLE EXTERIORS TO BE COATED WITH AN APPROVED WATERPROOFING MEMBRANE.

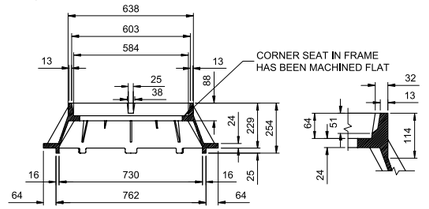


5 | SPLIT DISC FROST COVER DETAIL
Scale NTS



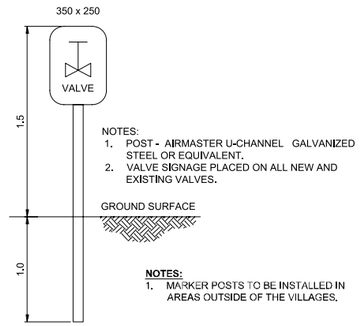
7 | MANHOLE FRAME DETAIL
Scale NTS

6 | MANHOLE COVER DETAIL
Scale NTS



SECTION A-A

SECTION B-B



NOTES:
1. POST - AIRMASTER U-CHANNEL GALVANIZED STEEL OR EQUIVALENT.
2. VALVE SIGNAGE PLACED ON ALL NEW AND EXISTING VALVES.

NOTES:
1. MARKER POSTS TO BE INSTALLED IN AREAS OUTSIDE OF THE VILLAGES.

9 | VALVE SIGNAGE DETAIL
Scale NTS

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PROJECT

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REGIONAL WASTEWATER SYSTEM - FORCEMAINS
MWSB No. 1769

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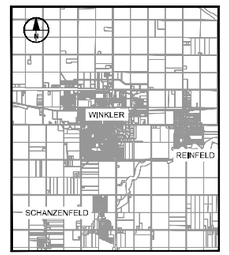
REGISTRATION



KEY PLAN

ISSUE/REVISION

I/R	DATE	DESCRIPTION

PROJECT NUMBER

60539657

SHEET TITLE

TYPICAL DETAILS 1

SHEET NUMBER

C-4001

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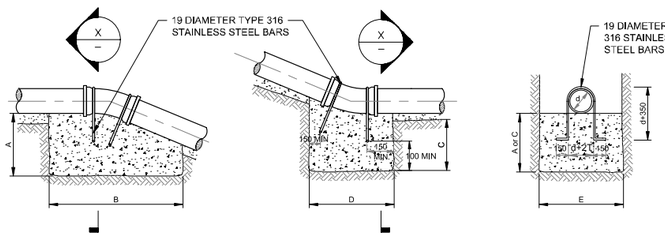
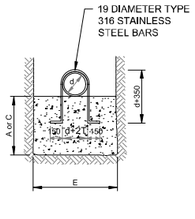


VERTICAL BEND UP | VERTICAL BEND DOWN

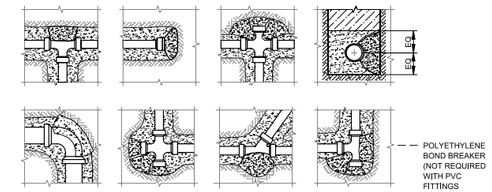


SECTION "X-X"

PIPE SIZE (D) (millimeters)	ANGLE OF BEND	VOLUME OF CONCRETE FOR VERTICAL BEND PIPE SIZE (millimeters)	DIMENSIONS FOR CONCRETE THRUST BLOCKS FOR VERTICAL BENDS (millimeters)				
			A	B	C	D	E
150	11 1/4°	0.21	265	750	265	750	1050
	22 1/2°	0.41	385	1000	385	750	1050
	45°	0.75	715	1000	715	750	1050
200	11 1/4°	0.36	340	1000	340	750	1050
	22 1/2°	0.70	665	1000	665	750	1050
	45°	1.29	1025	1200	1025	750	1050
250	11 1/4°	0.53	510	1000	510	1000	1050
	22 1/2°	1.05	835	1200	835	1000	1050
	45°	1.94	1230	1500	1230	1000	1050
300	11 1/4°	0.76	685	1050	685	1050	1050
	22 1/2°	1.48	940	1500	940	1050	1050
	45°	2.74	1450	1800	1450	1050	1050
350	11 1/4°	1.02	805	1200	805	1200	1050
	22 1/2°	1.99	1055	1800	1055	1200	1050
	45°	3.68	1630	2150	1630	1200	1050

* TEST PRESSURE 1.0 MPa, SOIL BEARING PRESSURE = 71.8 kPa
* IF DIMENSION FOR A PARTICULAR SIDE OF THE THRUST BLOCK VARIES FROM THAT SHOWN, ADJUST REMAINING DIMENSIONS TO OBTAIN REQUIRED VOLUME.

1 | VERTICAL THRUST BLOCK DETAILS
Scale NTS

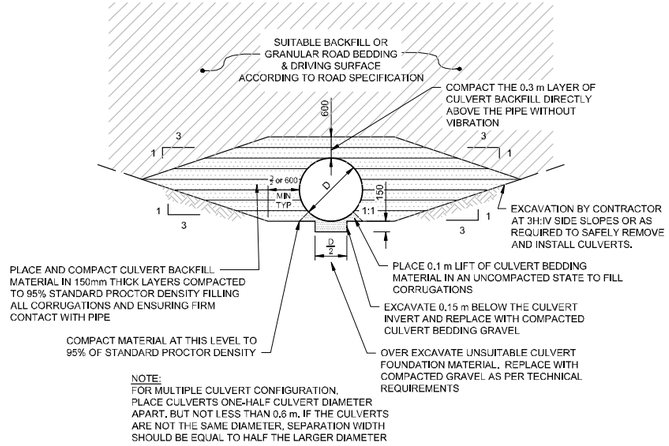


CONCRETE THRUST BLOCK BEARING AREA FOR HORIZONTAL FITTINGS
TEST PRESSURE 1.0 MPa, SOIL BEARING PRESSURE = 71.8 kPa

PIPE SIZE mm	TEE, PLUG OR CROSS m²	BENDS			
		11 1/4 ° m²	22 1/2 ° m²	45 ° m²	90 ° m²
150	0.27	0.11	0.21	0.39	0.55
200	0.47	0.18	0.36	0.67	0.95
250	0.71	0.28	0.54	1.01	1.42
300	1.00	0.39	0.77	1.42	2.01
350	1.35	0.53	1.03	1.91	2.76

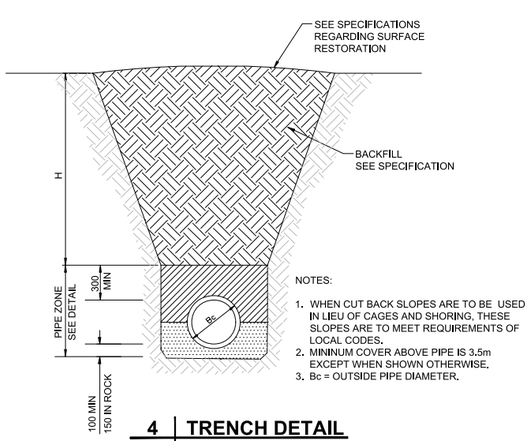
MECHANICAL RESTRAINERS TO BE USED ON ALL PLUGS DIMENSIONS IN MILLIMETERS

2 | THRUST BLOCK DETAILS
Scale NTS



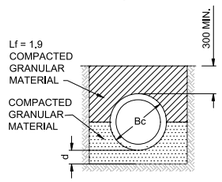
NOTE:
FOR MULTIPLE CULVERT CONFIGURATION, PLACE CULVERTS ONE-HALF CULVERT DIAMETER APART, BUT NOT LESS THAN 0.6 m. IF THE CULVERTS ARE NOT THE SAME DIAMETER, SEPARATION WIDTH SHOULD BE EQUAL TO HALF THE LARGER DIAMETER

3 | CULVERT BACKFILL DETAIL
Scale NTS



NOTES:
1. WHEN CUT BACK SLOPES ARE TO BE USED IN LIEU OF CAGES AND SHORING, THESE SLOPES ARE TO MEET REQUIREMENTS OF LOCAL CODES.
2. MININUM COVER ABOVE PIPE IS 3.5m EXCEPT WHEN SHOWN OTHERWISE.
3. Bc = OUTSIDE PIPE DIAMETER.

4 | TRENCH DETAIL
Scale NTS

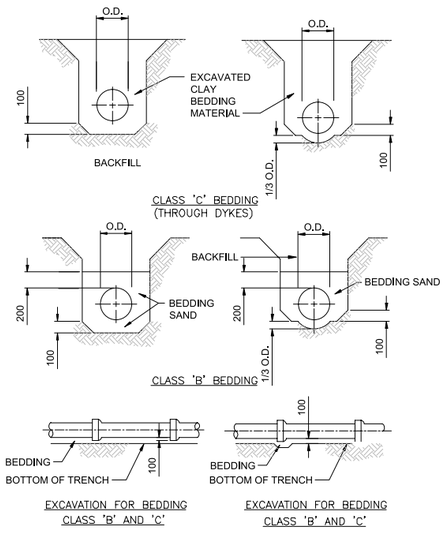


CLASS 'B'

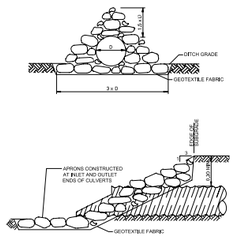
LEGEND:

H = TRENCH DEPTH ABOVE BEDDING ZONE
Bc = OUTSIDE PIPE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE (100mm MIN., 150mm IN ROCK
As = AREA OF TRANSVERSE STEEL IN THE CRADLE OR ARCH EXPRESSED AS A PERCENTAGE OF AREA OF CONCRETE AT INVERT OR CROWN.
Lf = LOAD FACTOR

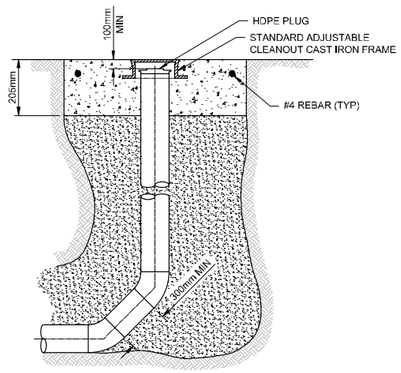
5 | PIPE ZONE
Scale NTS



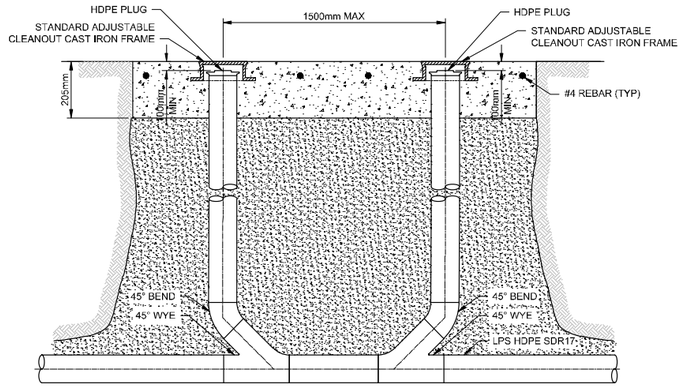
6 | PIPE BEDDING DETAILS
Scale NTS



7 | CULVERT RIP-RAP DETAIL
Scale NTS



8 | TERMINAL CLEANOUT DETAIL
Scale NTS



9 | INLINE CLEANOUT DETAIL
Scale NTS

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PROJECT

RM OF STANLEY
REGIONAL WASTEWATER
SYSTEM - FORCEMAINS
MWSB No. 1769

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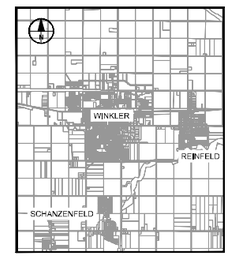
REGISTRATION



KEY PLAN

ISSUE/REVISION

I/R	DATE	DESCRIPTION

PROJECT NUMBER

60539657

SHEET TITLE

TYPICAL DETAILS 2

SHEET NUMBER

C-4001

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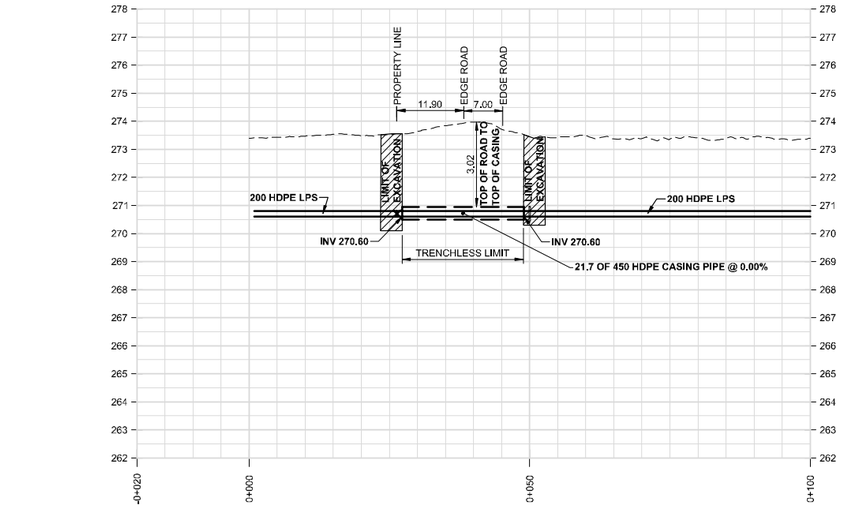

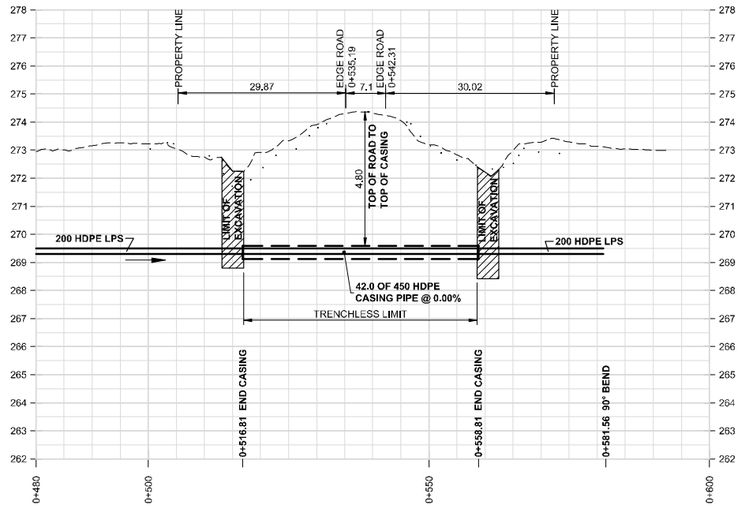

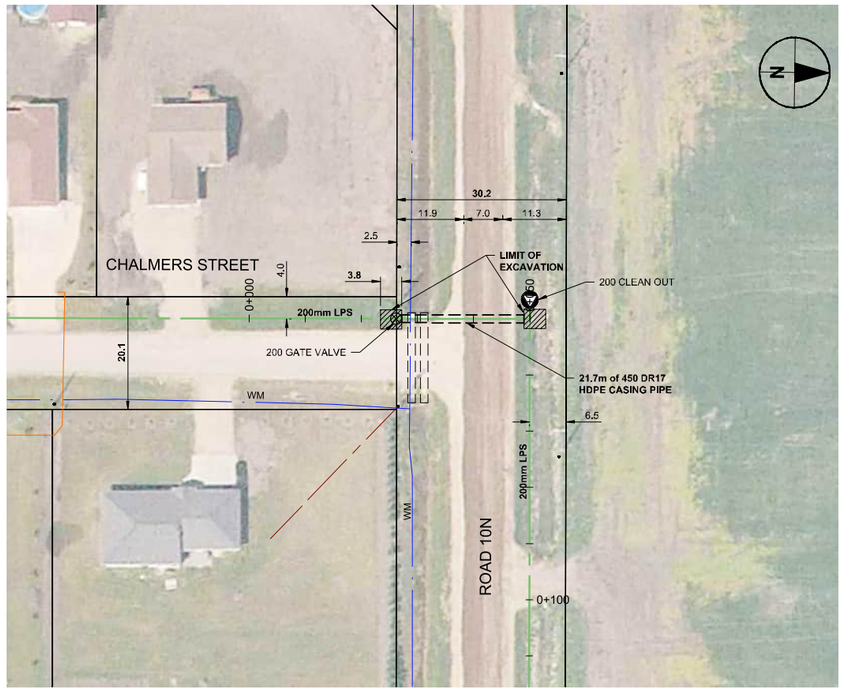

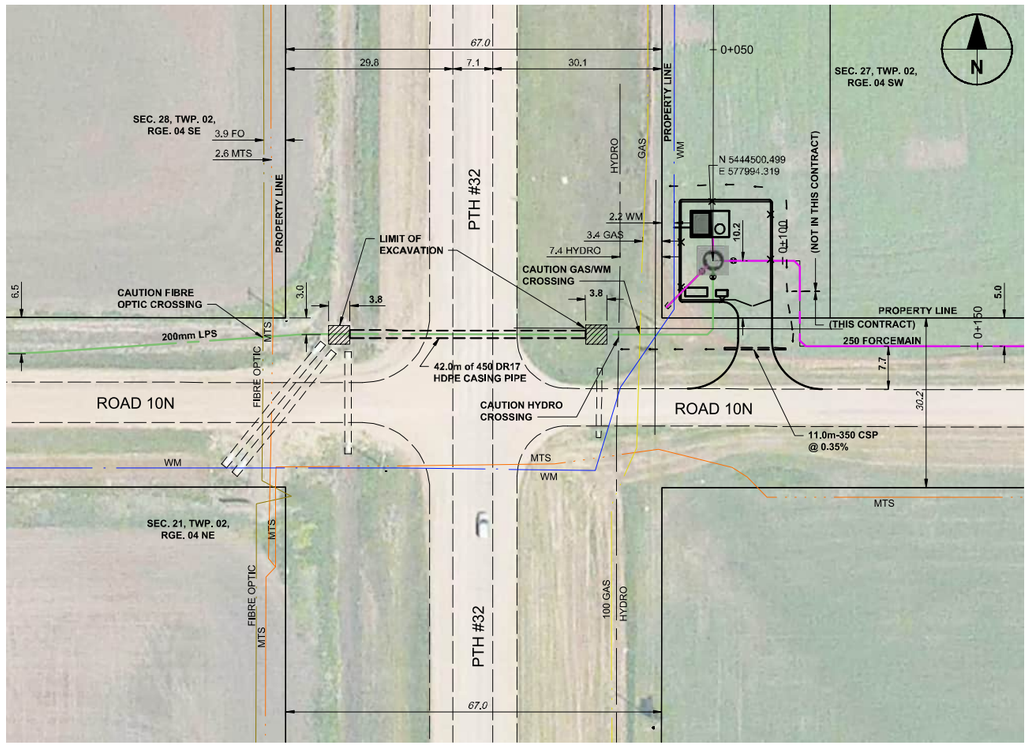

1 | PLAN
C-0001 | Scale Horz. 1:500 Vert. 1:100

2 | PLAN
C-0001 | Scale Horz. 1:500 Vert. 1:100

150 WM	WATERMAIN	150 WM		CURB STOP		150 WM	WATERMAIN	150 WM
	HYDRANT			REDUCER			HYDRANT	
	VALVE			GAS			VALVE	
300 LDS	LAND DRAINAGE SEWER	300 LDS		MTS		300 LDS	LAND DRAINAGE SEWER	300 LDS
250 WWS	WASTE WATER SEWER	250 WWS		CABLE		250 WWS	WASTE WATER SEWER	250 WWS
	MANHOLE			CONDUIT			PAVEMENT CROWN	
	CATCH BASIN			PRIMARY POWER			N/W PROPERTY LINE	
	RAILWAY TRACKS			FIBRE OPTIC			S/E PROPERTY LINE	
	CULVERT			TESTHOLE			N/W GUTTER	
	PIPE ABANDONMENTS			LAMP STANDARD			S/E GUTTER	
	SURVEY BAR			TREE			AIR RELEASE VALVE	
	TERMINAL CLEANOUT			VALVE (NORMALLY CLOSED)	NC			
	CLEANOUT							
EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PROFILE	NEW

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

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AECOM

PROJECT
RM OF STANLEY
REGIONAL WASTEWATER SYSTEM - LOW PRESSURE SEWER

CLIENT
The Manitoba Water Services Board
2010 Currie Blvd.
Brandon MB, R7A 6Y9
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Email: mwsb@gov.mb.ca
www.gov.mb.ca/ia/mwsb/mwsb.html

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AECOM Canada Ltd.
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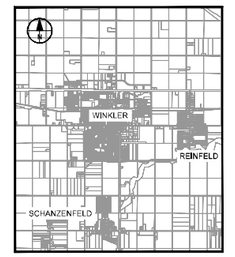
REGISTRATION



KEY PLAN

ISSUE/REVISION

I/R	DATE	DESCRIPTION
B	2018.08.01	ISSUED FOR 100% REVIEW
A	2018.03.14	ISSUED FOR REVIEW

PROJECT NUMBER
60539657

SHEET TITLE
SCHANZENFELD
LOW PRESSURE SEWER SYSTEM
PLAN PROFILES

SHEET NUMBER
C-0005

Project Management Initials: ____ Designer: ____ Checked: ____ Approved: ____ ISO A1 594mm x 841mm

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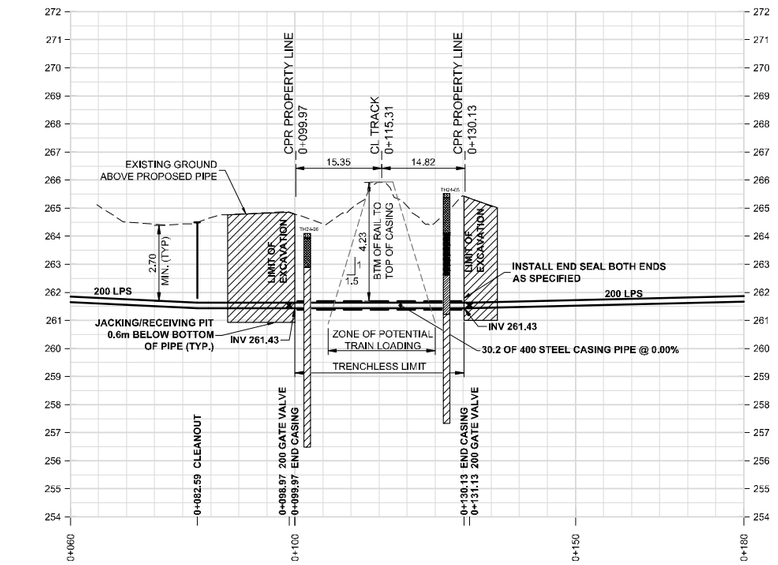
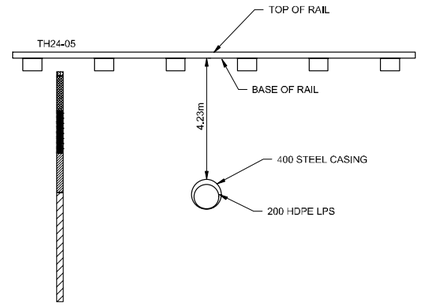


SECTION ON ℄ TRACK

Scale NTS

BOREHOLE LEGEND:

FILL
SILT
FAT CLAY



RAIL CROSSING NOTES:

RAILWAY MILEAGE AND SUBDIVISION :	MILE 69.54 CP LA RIVIERE SUBDIVISION	
MUNICIPAL DESCRIPTION OF ADJACENT PROPERTIES:		
NAME OF PIPELINE OWNER:	RURAL MUNICIPALITY OF STANLEY	
CONTENTS TO BE HANDLED:	MUNICIPAL WASTEWATER	
MAXIMUM OPERATING PRESSURE:	520 KPa (75 psi)	
MAXIMUM TEST PRESSURE:	1000 KPa (145 psi)	
MAXIMUM OPERATING TEMPERATURE:	20°C	
MINIMUM OPERATING TEMPERATURE:	4°C	
PIPING MATERIALS:	CARRIER	CASING
NOMINAL DIAMETER:	200mm	400mm
OUTSIDE DIAMETER:	219mm	400mm
MATERIAL:	HDPE DR 17	STEEL
SPECIFICATION & GRADE:	PE 4710/CSA B137.1	ASTM A53 GRADE B WELDED STEEL MIN. YIELD STRENGTH 242 MPa
WALL THICKNESS:	12.9mm MIN.	11.1mm MIN.
TYPE OF JOINT:	BUTT FUSED	WELDED
COATING:	N/A	N/A
LOCATION OF SHUT OFF VALVE FOR 200 MUNICIPAL WASTEWATER PIPE LINE:	15.5 SOUTH OF TRACKS	
LOCATION OF SHUT OFF VALVE FOR 200 MUNICIPAL WASTEWATER PIPE LINE:	15.2 NORTH OF TRACKS	
METHOD OF INSTALLATION:	TRENCHLESS	
VENTS: N/A	NUMBER:	N/A
HEIGHT ABOVE GROUND:		N/A
SEALS: BOTH ENDS:	YES	
TYPE:	PERMEABLE GEOTEXTILE FABRIC	
BURY: BASE OF RAIL TO TOP OF CASING:		4.23m
NOT BENEATH TRACKS:		N/A
ROADWAY DITCHES:		N/A
BASE OF RAIL TO BOTTOM OF JACKING/RECIEVING PITS:		5.23m

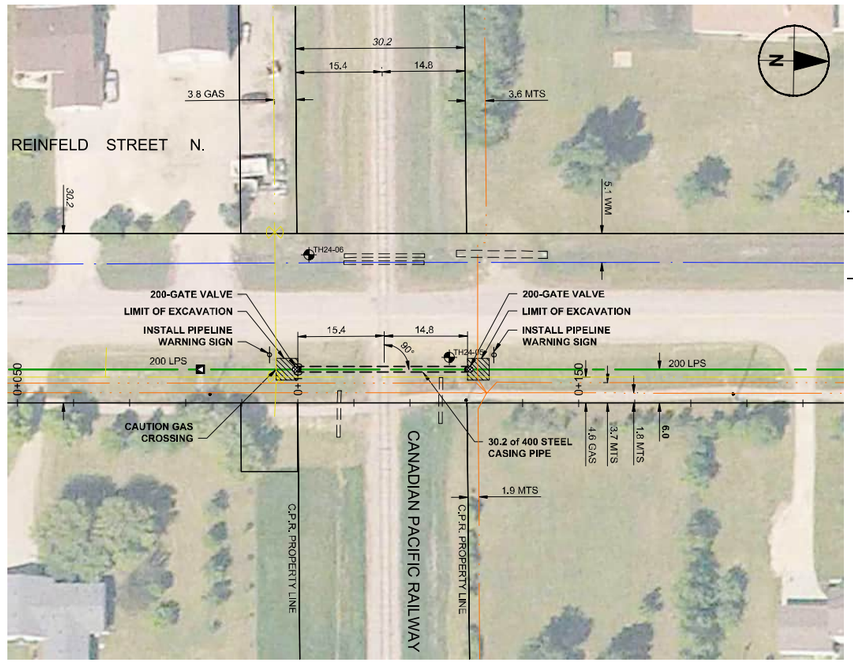
EXTENT OF CASING MEASURED PERPENDICULAR TO CENTERLINE OF TRACK: 15.35m SOUTH / 14.82m NORTH

CENTERLINE OF TRACK TO FACE OF JACKING/RECIEVING PITS: 15.35m /14.82m

TYPE, SIZE & SPACING OF INSULATORS OR SUPPORTS: SEE DETAIL 1

CATHODIC PROTECTION:	NO
GEOTECHNICAL BOREHOLES:	YES
SOIL TYPE:	SEE SPECIFICATIONS
BASE OF RAIL TO GROUND WATER:	SEE SPECIFICATIONS

TO BE CONSTRUCTED & MAINTAINED IN ACCORDANCE WITH TC-E10

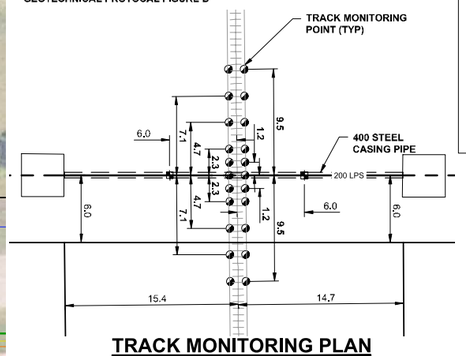


1 | REINFELD ST. RAIL CROSSING

C-0010

Scale Horz. 1:500

SUB-SURFACE MONITORING POINTS (2) TO BE INSTALLED TO 1m ABOVE CASING OBVERT IN ACCORDANCE WITH CP GEOTECHNICAL PROTOCAL FIGURE B



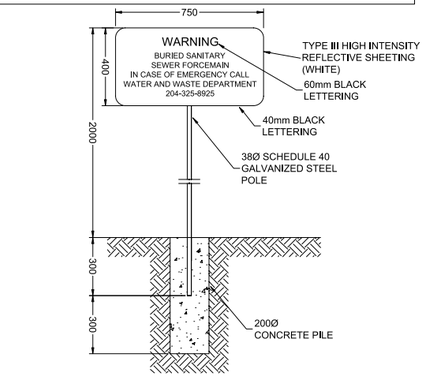
TRACK MONITORING PLAN

Scale 1:250

TRACK MONITORING

1. MONITOR RAIL TRACK IN ACCORDANCE WITH TRACK MONITORING PLAN.
2. REPORT MONITORING THRESHOLDS: CRITICAL / REVIEW THRESHOLD: >22mm; ALERT / WARNING THRESHOLD: >11mm
3. SETTLEMENT MONITORING OF THE RAIL TRACK SHALL COMMENCE A MINIMUM OF 2 DAYS PRIOR TO CONSTRUCTION/EXCAVATION IN ORDER TO ESTABLISH BASELINE COORDINATES AND ELEVATIONS.
4. MONITORING POINTS SHOULD BE SURVEYED AT LEAST TWICE PER DAY DURING THE DURATION OF CONSTRUCTION AND AT LEAST 3 DAYS AFTER THE COMPLETION OF CONSTRUCTION.

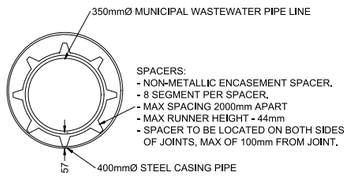
SURVEY RESULTS SHALL BE SUBMITTED DAILY TO GEOTECHNICAL ENGINEER FOR REVIEW.



2 | WARNING SIGN DETAIL

-

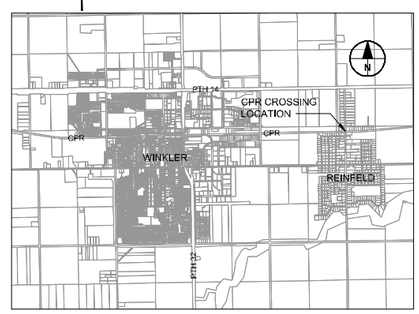
Scale N.T.S.



1 | CASING PIPE DETAIL

-

Scale 1:100



SITE PLAN

150 WM	WATERMAIN	150 WM		CURB STOP		150 WM	WATERMAIN	150 WM
	HYDRANT			REDUCER			HYDRANT	
	VALVE			GAS			VALVE	
300 LDS	LAND DRAINAGE SEWER	300 LDS		MTS		300 LDS	LAND DRAINAGE SEWER	300 LDS
250 WWS	WASTE WATER SEWER	250 WWS		CABLE		250 WWS	WASTE WATER SEWER	250 WWS
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	CATCH BASIN			PRIMARY POWER			N/W PROPERTY LINE	
	RAILWAY TRACKS			FIBRE OPTIC			S/E PROPERTY LINE	
	CULVERT			TESTHOLE			N/W GUTTER	
	PIPE ABANDONMENTS			LAMP STANDARD			S/E GUTTER	
	SURVEY BAR			TREE			AIR RELEASE VALVE	
	TERMINAL CLEANOUT			VALVE (NORMALLY CLOSED)	NC			
	CLEANOUT							
EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PROFILE	NEW

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PROJECT

RM OF STANLEY
REGIONAL WASTEWATER SYSTEM - LOW PRESSURE SEWER

CLIENT

The Manitoba Water Services Board
2010 Currie Blvd.
Brandon MB, R7A 6Y9
204.726.6076 tel 204.726.7196 fax
Email: mwsb@gov.mb.ca
www.gov.mb.ca/ia/mwsb/mwsb.html

CONSULTANT

AECOM Canada Ltd.
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Winnipeg, MB R3P 0Y7
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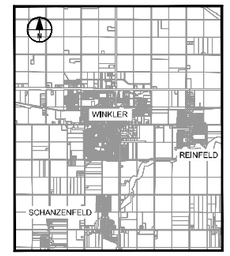

KEY PLAN

ISSUE/REVISION

B	2018.08.01	ISSUED FOR 100% REVIEW
A	2018.03.14	ISSUED FOR REVIEW
I/R	DATE	DESCRIPTION

PROJECT NUMBER

60539657

SHEET TITLE

REINFELD
LOW PRESSURE SEWER SYSTEM
PLAN PROFILE

SHEET NUMBER

C-0006

Project Management Initials: ____ Designer: ____ Checked: ____ Approved: ____ ISO A1 594mm x 841mm

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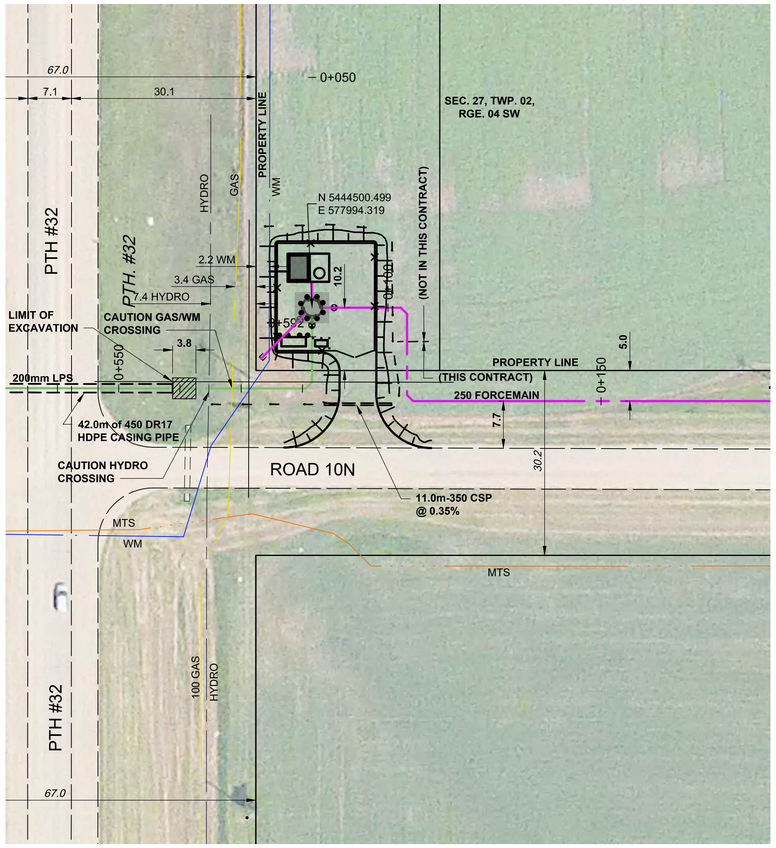

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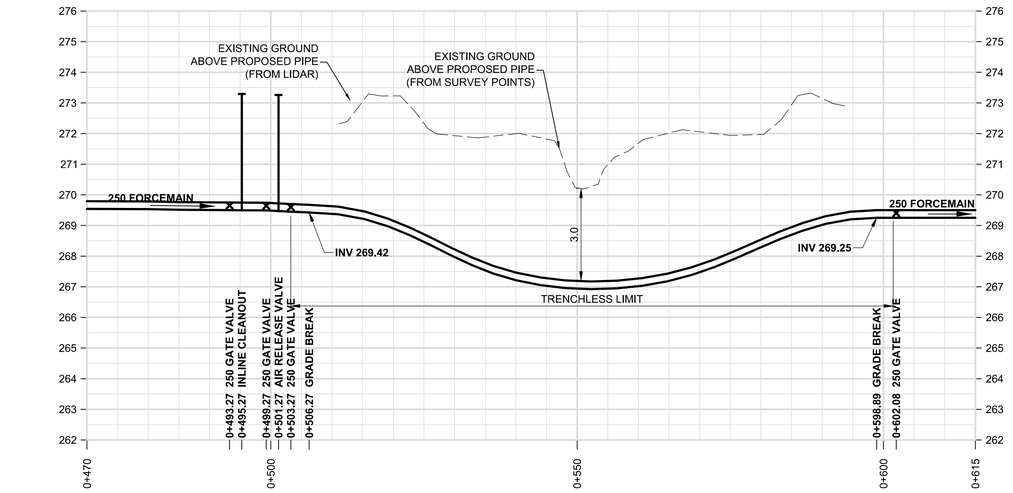
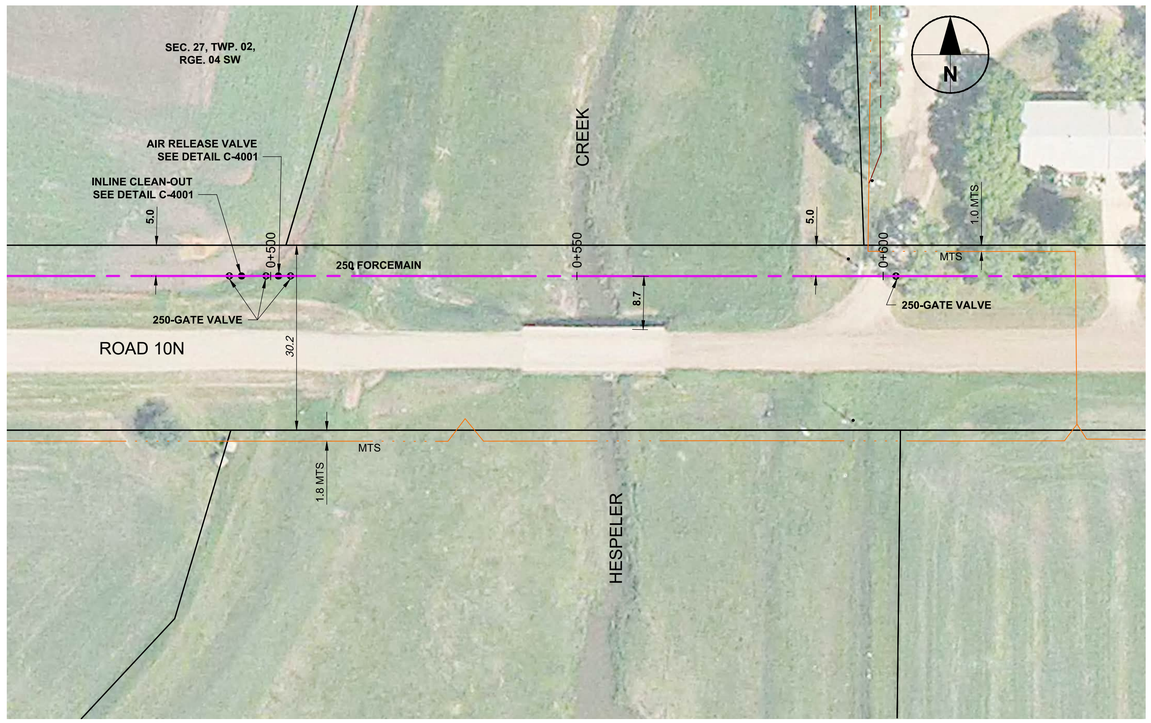
C-0003 | Scale Horz. 1:500





2 | PLAN
C-0003 | Scale Horz. 1:500

150 WM	WATERMAIN	150 WM		CURB STOP		150 WM	WATERMAIN	150 WM
	HYDRANT			REDUCER			HYDRANT	
	VALVE			GAS			VALVE	
300 LDS	LAND DRAINAGE SEWER	300 LDS		MTS		300 LDS	LAND DRAINAGE SEWER	300 LDS
250 WWS	WASTE WATER SEWER	250 WWS		CABLE		250 WWS	WASTE WATER SEWER	250 WWS
	MANHOLE			CONDUIT			PAVEMENT CROWN	
	CATCH BASIN			PRIMARY POWER			N/W PROPERTY LINE	
	RAILWAY TRACKS			FIBRE OPTIC			S/E PROPERTY LINE	
	CULVERT			TESTHOLE			N/W GUTTER	
	PIPE ABANDONMENTS			LAMP STANDARD			S/E GUTTER	
	SURVEY BAR		TH-	TREE			AIR RELEASE VALVE	
	TERMINAL CLEANOUT			VALVE (NORMALLY CLOSED)	NC			
	CLEANOUT							
EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PROFILE	NEW

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PROJECT

RM OF STANLEY
REGIONAL WASTEWATER
SYSTEM - FORCEMAINS
MWSB No. 1769

CLIENT

The Manitoba Water Services Board

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REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
B	2018.08.01	ISSUED FOR 100% REVIEW
A	2018.03.14	ISSUED FOR REVIEW

PROJECT NUMBER

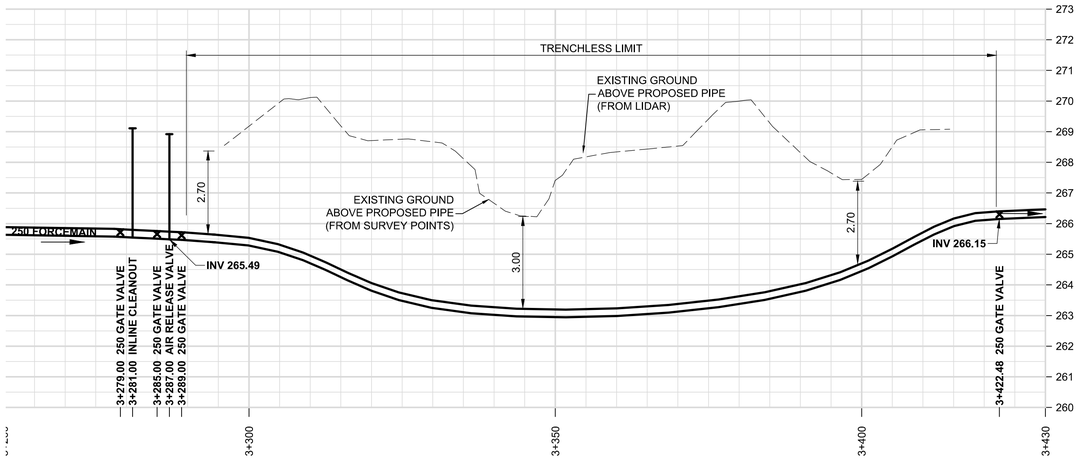
60539657

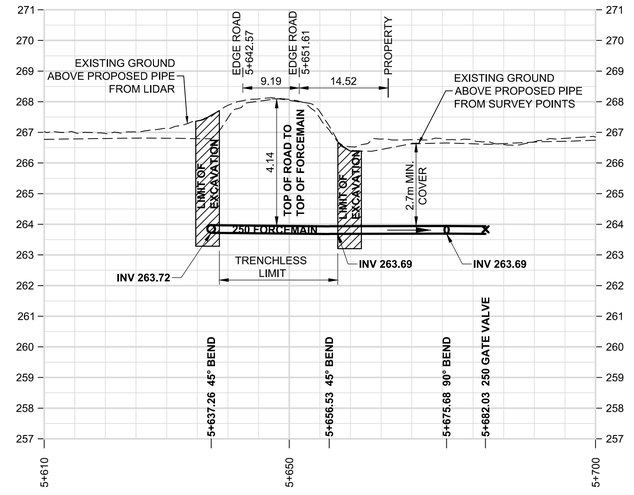
SHEET TITLE

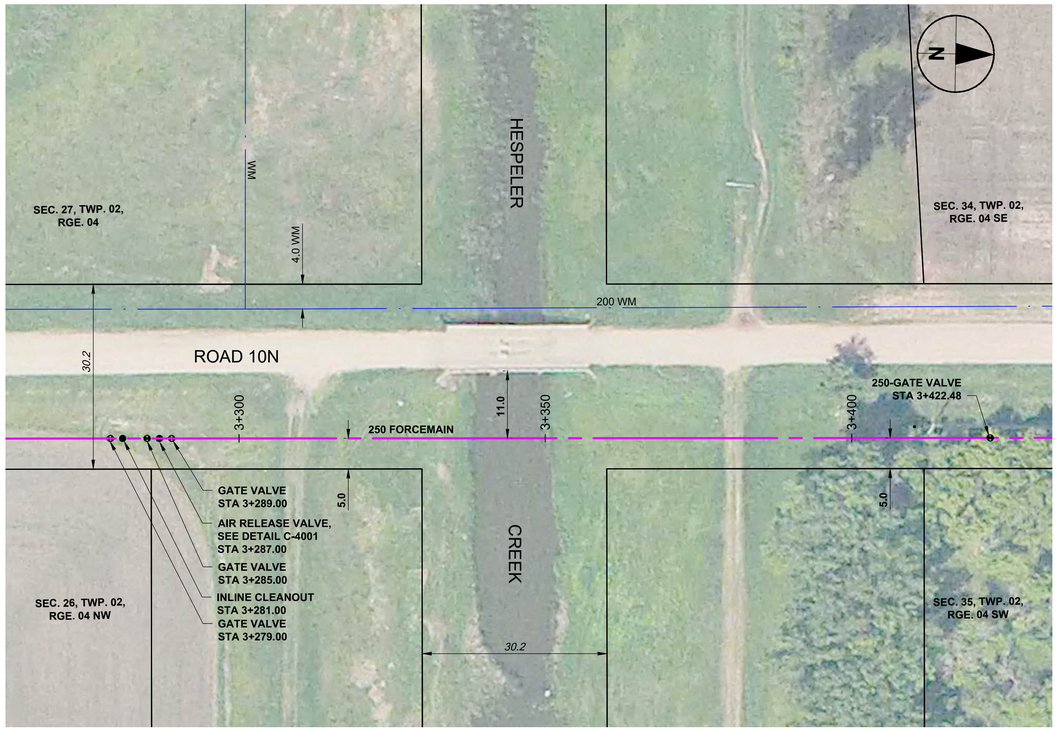
WASTEWATER FORCEMAIN
MISCELLANEOUS CROSSING
PROFILES 1 - PIPING LAYOUT

SHEET NUMBER

C-0003







1 | PLAN
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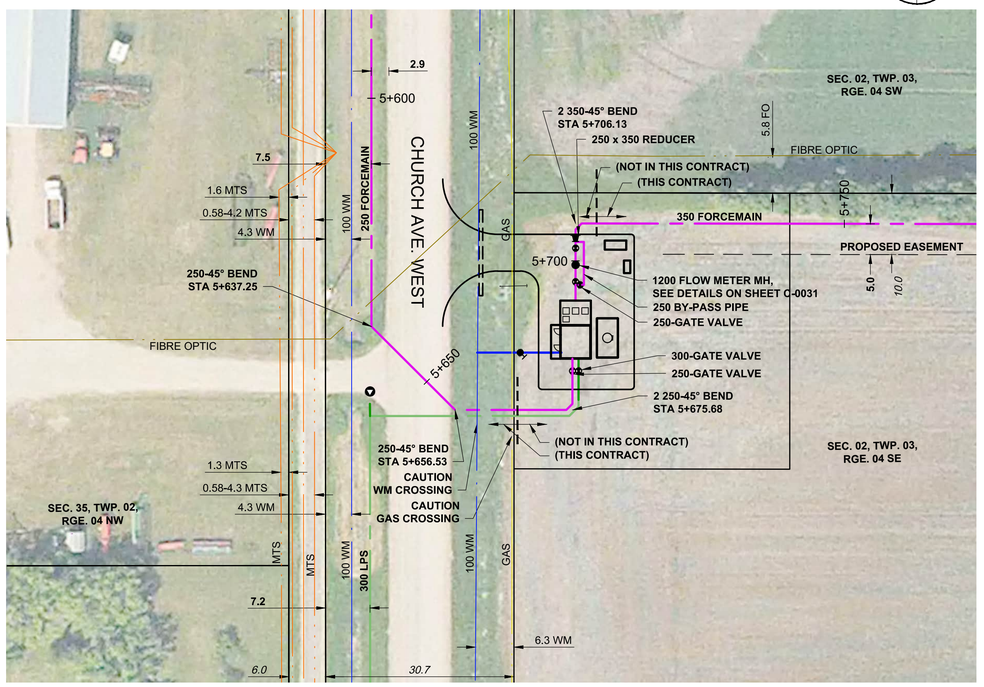

2 | PLAN
C-0001 | Scale Horz. 1:500

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	HYDRANT			REDUCER			HYDRANT	
	VALVE			GAS			VALVE	
300 LDS	LAND DRAINAGE SEWER	300 LDS		MTS		300 LDS	LAND DRAINAGE SEWER	300 LDS
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	MANHOLE			CONDUIT			PAVEMENT CROWN	
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Project Management Initials: ____ Designer: ____ Checked: ____ Approved: ____ ISO A1 594mm x 841mm

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PROJECT
RM OF STANLEY
REGIONAL WASTEWATER SYSTEM - FORCEMAINS
MWSB No. 1769

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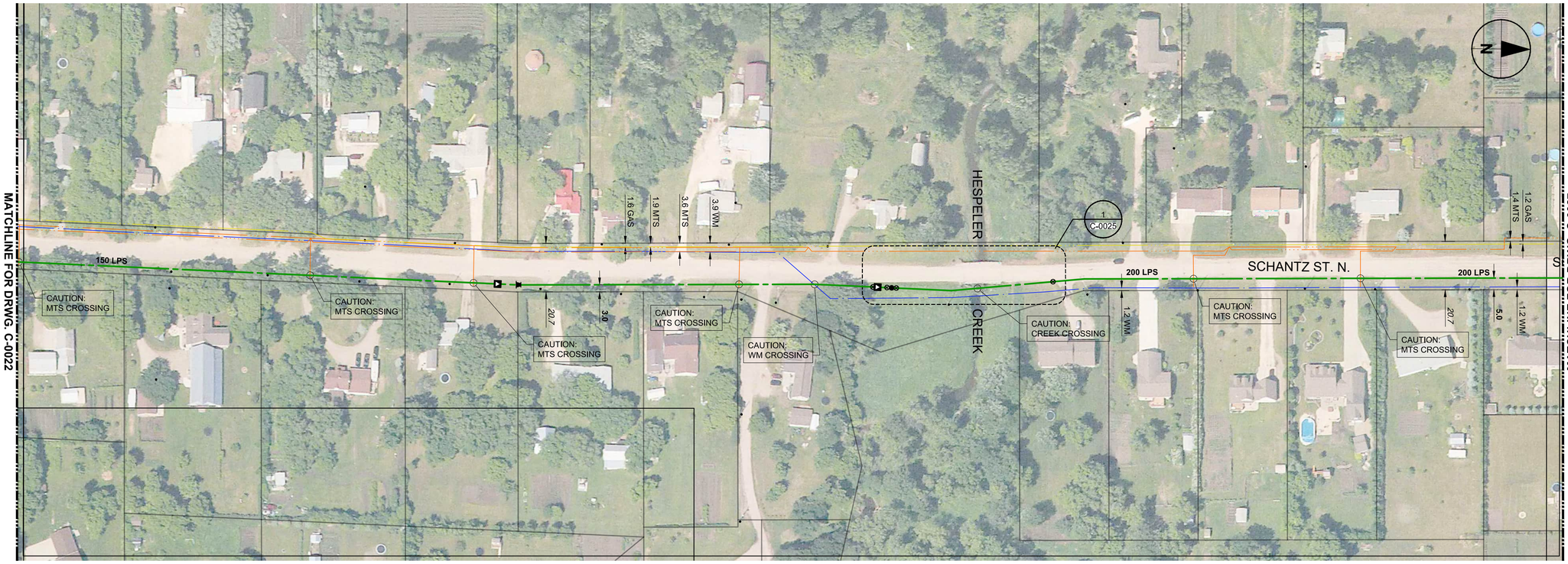
SHEET TITLE
WASTEWATER FORCEMAIN
MISCELLANEOUS CROSSING
PROFILES 2 - PIPING LAYOUT

SHEET NUMBER
C-0004



GENERAL PLAN

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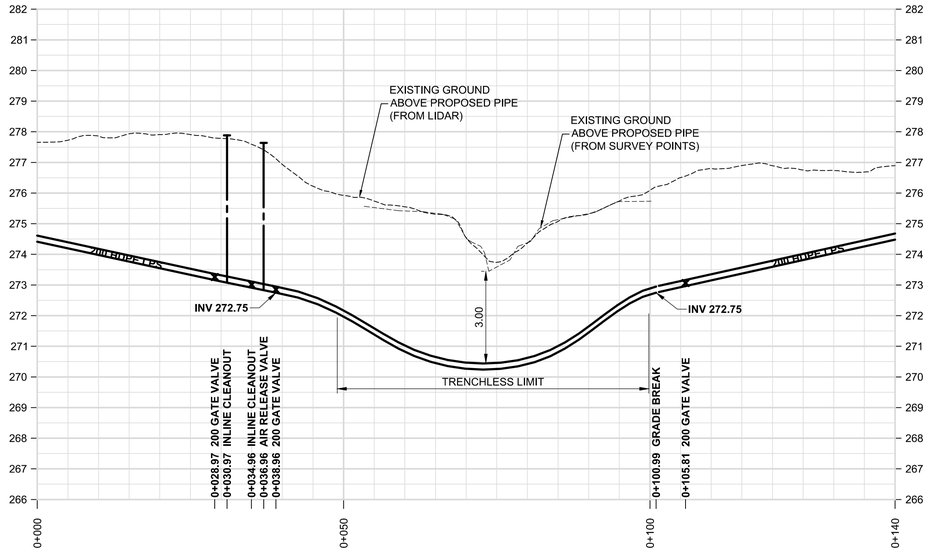

1 PROFILE - CREEK CROSSING

Scale Horz.1:500

150 WM	WATERMAIN	150 WM		CURB STOP		150 WM	WATERMAIN	150 WM
	HYDRANT			REDUCER			HYDRANT	
	VALVE			GAS			VALVE	
300 LDS	LAND DRAINAGE SEWER	300 LDS		MTS		300 LDS	LAND DRAINAGE SEWER	300 LDS
250 WWS	WASTE WATER SEWER	250 WWS		CABLE		250 WWS	WASTE WATER SEWER	250 WWS
	MANHOLE			CONDUIT			PAVEMENT CROWN	
	CATCH BASIN			PRIMARY POWER			N/W PROPERTY LINE	
	RAILWAY TRACKS			FIBRE OPTIC			S/E PROPERTY LINE	
	CULVERT			TESTHOLE			N/W GUTTER	
	PIPE ABANDONMENTS			LAMP STANDARD			S/E GUTTER	
	SURVEY BAR		TH.	TREE			AIR RELEASE VALVE	
	TERMINAL CLEANOUT			VALVE (NORMALLY CLOSED)	NC			
	CLEANOUT							
EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PROFILE	NEW

NOTE:

1. LOCATIONS OF SERVICE CONNECTIONS TO INDIVIDUAL LOTS ARE NOT SHOWN. EXACT LOCATIONS OF CURB STOPS ARE TO BE DETERMINED AT THE TIME OF CONSTRUCTION.

PRELIMINARY

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

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AECOM

PROJECT

RM OF STANLEY
REGIONAL WASTEWATER SYSTEM - LOW PRESSURE SEWER

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REGISTRATION

ISSUE/REVISION

B	2018.08.01	ISSUED FOR 100% REVIEW
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I/R	DATE	DESCRIPTION

PROJECT NUMBER

60539657

SHEET TITLE

SCHANZENFELD
LOW PRESSURE SEWER SYSTEM
PIPING LAYOUT 5

SHEET NUMBER

C-0025

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Appendix F

Geotechnical Investigation Report

RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Stations – Two Canadian Pacific Crossings Report

FINAL

The Manitoba Water Services Board

60735871

December 2024

Delivering a better world

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December 19, 2024

Project #
60735871

Subject: **RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Stations – Two Canadian Pacific Crossings Report – FINAL**

Dear Mr. Wittmeier:

AECOM Canada Ltd. is please to submit the Geotechnical Crossing Report for the two (2) proposed CP Crossings for the above referenced project.

Should you have any queries, please contact German Leal directly at 431-335-9734.

Sincerely,
AECOM Canada Ltd.

[redacted]

German Leal, M.Eng., P.Eng.
Discipline Lead, Geotechnical
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GL:ag
Encl.
cc:

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Table of Contents

1. Introduction 1
1.1 General 1
1.2 Project CP Rail Crossing Locations 1
1.3 Proposed Construction 1
1.3.1 550 mm FM Casing Crossing Details 1
1.3.2 400 mm LPS Casing Crossing Details 2
1.4 Background 2
1.4.1 Historical Geotechnical Information 2

2. Scope of Work 4

3. Geotechnical Investigation 5

4. Subsurface Conditions 6
4.1 Soil Stratigraphy 6
4.1.1 Topsoil 6
4.1.2 Clay Fill 6
4.1.3 Fat Clay (CH) with Sand 6
4.1.4 Sandy Silt (ML) 6
4.1.5 Clayey Sand (SC) 6
4.1.6 Lean Clay (CL) 6
4.1.7 Lean Clay (CL) with Sand 7
4.1.8 Fat Clay (CH) 7
4.1.9 Silt (ML) 7
4.1.10 Groundwater and Sloughing Conditions 7
4.2 Laboratory Test Results 9

5. CP Crossing Design Criteria 11
5.1 Design Requirements - Process 2 – Intermediate 11

6. Steel Pipe Casing Installation 13
6.1 Anticipated Stratigraphy 13
6.1.1 550 mm FM Casing 13
6.1.2 400 mm LPS Casing 13
6.1.3 Tunnelman's Ground Classification 14
6.2 Recommended Installation Options 16
6.2.1 Guided Auger Boring with Pipe Jacking Method 16
6.2.2 Guided Pipe Ramming 16
6.3 Trenchless Construction Risks 16
6.3.1 Ground Settlement and Heave 17
6.3.1.1 550 mm FM Casing 17
6.3.1.2 400 mm LPS Casing 17
6.3.2 Buried Obstructions 17
6.3.3 Groundwater 18
6.3.3.1 550 mm FM Casing 18

6.3.3.2 400 mm LPS Casing....18
6.3.4 Line and Grade Control for Trenchless Installation....18
6.3.5 Horizontal Stresses due to Pipe Jacking on the Casing Pipe....19
6.3.6 Pipe Ramming Dynamics....19
6.3.7 Face Stability....19
6.3.7.1 550 mm FM Casing....19
6.3.7.2 400 mm LPS Casing....19

7. Geotechnical Assessment....21

7.1 Jacking Pit and Receiving Pit....21
7.1.1 550 mm FM Casing Pit Excavations....21
7.1.2 400 mm LPS Casing Pit Excavations....21
7.1.3 Excavation....22
7.1.4 Temporary Shoring....22
7.1.5 Excavation Base Stability....23
7.1.5.1 550 mm FM....24
7.1.5.2 400 mm LPS....24
7.1.6 Heave Due to Artesian Pressure at Depth....24
7.2 Settlement Estimation....24
7.2.1 Empirical Method....25
7.2.1.1 550 mm FM Casing....25
7.2.1.2 400 mm LPS Casing....26

8. CP Monitoring Requirements....28

8.1 Monitoring Point Layout....28
8.2 Settlement Monitoring Frequency....28
8.3 Ground Movement Alarm Level....29
8.4 Settlement Monitoring Program....29
8.4.1 Pre-Construction Tasks....29
8.4.2 Construction Tasks....30
8.4.2.1 Level 1: “Warning Alert/Critical”....30
8.4.2.2 Level 2: “Critical/Review”....30
8.4.3 Post Construction Task....31

9. Conclusion....32

Figures

Figure 1: Graph of Groundwater Elevations Versus Time....8
Figure 2: Graph of SP24-05 Groundwater Elevations Versus Time....9
Figure 3: Ground Surface Settlement for 550 mm FM Casing Using Empirical Approach....26
Figure 4: Ground Surface Settlement for 400 mm LPS Casing Using Empirical Approach....27

Tables

Table 1: Observed Groundwater, Seepage, and Sloughing Conditions....7
Table 2: Groundwater Readings....8

Table 3: Particle Size Analysis (ASTM D422) 9
Table 4: Atterberg Limits (ASTM D4318) 10
Table 5: Unconfined Compressive Strength (Cohesive Soil) (ASTM 2166) 10
Table 6: CPR Protocol Requirements for Process 2 - Intermediate and AECOM Proposed Crossing Design 11
Table 7: Anticipated Stratigraphy for the 550 mm FM Casing Alignment 13
Table 8: Anticipated Stratigraphy for the 400 mm LPS Casing Alignment 14
Table 9: Tunnelman's Ground Classification and Probable Work Conditions 15
Table 10: Evaluation of Trenchless Construction Risks 17
Table 11: Lateral Earth Pressure Design Parameters 23

Appendices

Appendix A Testhole Location Plan
Appendix B Site Photographs
Appendix C Testhole Logs
Appendix D Laboratory Test Results
Appendix E AECOM 2018 Memorandum
Appendix F TREK 2023 Geotechnical Investigation Report
Appendix G Canadian Pacific (CP) Geotechnical Protocol for Pipeline and Utility Crossing(s) Under Railway Tracks
Appendix H AECOM – Crossing Profiles
Appendix I AECOM – Monitoring Drawing Sheets

1. Introduction

1.1 General

AECOM Canada Ltd. (AECOM) was retained to undertake a geotechnical investigation within the proposed low-pressure sewer (LPS) and forcemain (FM) project site within the RM of Stanley. AECOM conducted the geotechnical investigation from September 25 to 26, 2024 at the LPS and FM project site, where seven (7) testholes were drilled. The primary objective was to provide a geotechnical assessment for the proposed wastewater sewer network, specifically for two Canadian Pacific (CP) rail crossings. The first railway crossing is for the FM passing beneath the CP rail line at Mile 70.15 of the CP La Riviere Subdivision, and the second railway crossing is for the LPS passing beneath the CP rail line at Mile 69.54 of the CP La Riviere Subdivision.

This report presents the findings of the geotechnical investigation, including soil stratigraphy and the results of laboratory testing. It raises geotechnical concerns and provides recommendations related to proposed trenchless pipeline installation methods, settlement estimates for the two CP rail crossings, and proposed settlement monitoring details.

1.2 Project CP Rail Crossing Locations

The first CP rail crossing at Mile 70.15 of the CP La Riviere Subdivision is east of Winkler, MB approximately 800 m east of Rd 20 W, and approximately 900 m south of Provincial Trunk Highway (PTH) 14. The crossing is just outside of an industrial subdivision, situated within relatively flat agricultural land.

The second CP rail crossing at Mile 69.54 of the CP La Riviere Subdivision lies within the town of Reinfeld, MB. The crossing runs parallel to Reinfeld St. N approximately 900 m south of PTH 14. The site area is primarily residential with extensive land drainage, such as ditches running north to south and east to west. Due to conducting the geotechnical investigation shortly after a rain event, the ditches were relatively filled with rain runoff.

1.3 Proposed Construction

1.3.1 550 mm FM Casing Crossing Details

The first CP rail trenchless crossing is for installation of the proposed forcemain (FM), located at mile 70.15 of the CP La Riviere Subdivision. The proposed FM is a 350 mm diameter HDPE carrier pipe installed within a 550 mm diameter steel casing (from here on referred to as **550 mm FM Casing**). The proposed invert elevation is 262.81 m ASL at the south excavation pit and 262.82 m ASL at the north excavation pit of the CP rail crossing. The FM casing alignment extends 14.91 m north of the railway, and 15.25 m south of the railway.

The proposed 550 mm FM Casing has a crossing profile consisting of the following details:

- Base of rail (BOR) has an approximate elevation of 267.29 m ASL.
- The invert elevation of the 350 mm HDPE carrier pipe is approximately 262.88 m ASL. The invert depth from the BOR is 4.41 m (Elev. 262.88 m ASL).
- The invert elevation of the 550 mm FM Casing is approximately 262.82 m ASL. The invert depth from the BOR is 4.47 m (262.82 m ASL).
- Depth from the BOR to the top of the 550 mm FM Casing is approximately 3.92 m (i.e., obvert elev. 263.37 m ASL).

Detailed information is provided in the crossing detail drawing in **Appendix H**.

1.3.2 400 mm LPS Casing Crossing Details

The second required rail crossing is for the proposed LPS, located at mile 69.54 of the CP La Riviere Subdivision. The proposed LPS is a 200 mm diameter HDPE carrier pipe installed within a 400 mm steel casing (from here on referred to as **400 mm LPS Casing**). The proposed invert elevation of the LPS is 261.43 m ASL at both the north and south side of the CP rail line. The excavation limits for the proposed LPS is 14.82 m north of the railway, and 15.35 m south of the railway.

The proposed 400 mm LPS Casing has a crossing profile consisting of the following details:

- Base of rail (BOR) has an approximate elevation of 266.06 m ASL.
- The invert elevation of the 200 mm HDPE carrier pipe is approximately 261.49 m ASL. The invert depth from the BOR is 4.57 m (Elev. 261.49 m ASL).
- The invert elevation of the 400 mm LPS casing is approximately 261.43 m ASL. The invert depth from the BOR is 4.63 m (Elev. 261.43 m ASL).
- Depth from the BOR to the top of the LPS casing is approximately 4.23 m (i.e., obvert elev. 261.83 m ASL).

Detailed information is provided in on the crossing detail drawing in **Appendix H**.

1.4 Background

In 2018, the Rural Municipality of Stanley (RM of Stanley) planned to upgrade their regional wastewater collection and treatment systems to improve services to residents and to improve the quality of the effluent discharged into the environment. The upgrades were expected to consist of a new low-pressure sewer (LPS) collection system and lift stations within the communities of Schanzenfeld and Reinfeld, and an associated forcemain system to transmit the wastewater to the City of Winkler for Treatment.

AECOM completed the design for a regional wastewater conveyance system for the RM of Stanley that would convey wastewater from the villages of Reinfeld and Schanzenfeld to the proposed wastewater treatment plant at the City of Winkler. The project included the design for the following elements:

- A new low-pressure sewer (LPS) system for the villages of Schanzenfeld and Reinfeld.
- A new lift station and 250 mm forcemain to convey the wastewater from Schanzenfeld to the proposed lift station in Reinfeld.
- A new lift station and 350 mm forcemain to convey the wastewater from Reinfeld to the aerated wastewater treatment lagoon in Winkler.

AECOM was retained by the RM of Stanley to provide detailed design and contract administration services for the project which included a geotechnical assessment of the proposed construction sites. The scope of the geotechnical services included review of existing geotechnical information, completion of geotechnical investigation and laboratory testing program, and providing geotechnical recommendations in support of the design and construction of the project.

1.4.1 Historical Geotechnical Information

Two (2) testholes were drilled at the proposed Schanzenfeld lift station, and one (1) testhole was drilled at the proposed Reinfeld lift station. The subsurface ground conditions encountered during drilling were documented, and the geotechnical recommendations were provided in a Memorandum dated January 24, 2018. The 2018 AECOM Memorandum is provided in **Appendix E**.

In 2023, Trek Geotechnical completed a geotechnical investigation for the planned residential development areas surrounding the town of Reinfeld. The scope of work included a subsurface investigation and laboratory testing.

Geotechnical recommendations were provided for foundation systems, concrete slabs, pavement designs, site drainage, storm retention ponds, temporary excavations and buried infrastructure. The Trek 2023 Geotechnical Investigation Report is provided in **Appendix F**.

2. Scope of Work

AECOM's geotechnical exploration program was conducted based on the proposal submitted on July 17, 2024, which includes the following:

- A geotechnical drilling and soil sampling program at the proposed site to assess the existing subsurface and groundwater conditions;
- A laboratory testing program that included moisture contents on all collected grab samples, Atterberg limits, particle size analysis, and unconfined compressive strength tests on select soil samples;
- Completion of a geotechnical assessment; and,
- Provide geotechnical recommendations for the two CP rail crossings.

Those testhole logs not located near the CP rail crossings are provided to the AECOM project team for informational purposes. However, further geotechnical recommendations at these locations within the project site are not included within the scope of work described in the proposal submitted on July 17, 2024. These testhole logs are provided to AECOM's project team solely to provide the soil stratigraphy, groundwater and sloughing conditions for the proposed design and construction.

3. Geotechnical Investigation

AECOM completed a subsequent geotechnical investigation to support the design of the wastewater infrastructure at two CP rail crossings. The geotechnical program was developed in accordance with the proposal submitted to The Manitoba Water Service Board on July 17, 2024, titled “RM of Stanley Design Update/EAP Revision 1”. The subsurface and drilling program consisted of drilling seven (7) testholes to support the design of the new wastewater collection system. Originally AECOM considered drilling eight (8) testholes, however, during the geotechnical investigation ongoing construction with open excavations was observed at the proposed location near the City of Winkler Wastewater Treatment Plant (i.e., TH24-01). Due to the ongoing construction in the area, this testhole was not drilled and the soil conditions were not visually assessed. The following 7 testholes were drilled during the geotechnical investigation:

- TH24-02 (for soil stratigraphy at Provincial Trunk Highway 14)
- TH24-03 (for proposed 550 mm FM Casing Crossing at Mile 70.15 of the CP La Riviere Subdivision)
- TH24-04 (for proposed 550 mm FM Casing Crossing at Mile 70.15 of the CP La Riviere Subdivision)
- TH24-05 (for proposed 400 mm LPS Casing Crossing at Mile 69.54 of the CP La Riviere Subdivision)
- TH24-06 (for proposed 400 mm LPS Casing Crossing at Mile 69.54 of the CP La Riviere Subdivision)
- TH24-07 (for soil stratigraphy at creek crossing along Rd 20W)
- TH24-08 (for soil stratigraphy at creek crossing along Rd 10N)

The location of public utilities for the project site were provided by ClickBeforeYouDigMB.ca. Additionally, a private utility locator was subcontracted as an added safety measure, where they marked utilities and provided clearances for the testhole locations.

The testhole location plan is shown in **Appendix A**, with site photos taken during the geotechnical investigation shown in **Appendix B**. The testholes were drilled primarily along ditches. No testholes were drilled through asphalts or concrete pavements.

Drilling services were provided by Maple Leaf Drilling Ltd. Subsurface conditions observed during drilling were visually classified and documented by AECOM geotechnical personnel according to the Unified Soil Classification System (USCS) for soils. Representative soil samples were obtained directly from the auger at depth intervals ranging from 0.30 m to 1.52 m. Ten (10) relatively undisturbed samples were retrieved in Shelby tubes at select depth intervals in fat clay. The undrained shear strength of the cohesive soils (clay) were evaluated using a mini torvane, and the unconfined compressive strengths were estimated using a pocket penetrometer.

Testhole logs have been prepared for each testhole to record the descriptions and the relative positions of the soil strata, locations of samples obtained, laboratory test results and other pertinent information. The testhole logs are provided in **Appendix C**.

4. Subsurface Conditions

4.1 Soil Stratigraphy

The soil encountered during AECOM's investigation consisted of topsoil, clay fill, silt, sandy silt, clayey sand, lean clay, lean clay with sand, fat clay with sand and fat clay. Each of these soil layers are described further below.

4.1.1 Topsoil

Topsoil was encountered at the ground surface in all testholes. The topsoil was observed to be black in color with organic content. The thickness of the topsoil was approximately 0.15 m in all the testholes.

4.1.2 Clay Fill

Fat clay (CH) fill material was encountered below the topsoil in TH24-02, and TH24-04 to TH24-08. The thickness of the clay fill ranged from 0.30 m to 1.22 m. The clay fill was black to brown, very soft to firm in consistency, and had observed cobbles. The moisture content of the clay fill ranged from 15.6% to 40.1%, with an average of 25.8%.

4.1.3 Fat Clay (CH) with Sand

Fat clay (CH) with sand was observed below the fat clay (CH) fill in TH24-07. The thickness of the fat clay (CH) with sand was approximately 2.29 m. The fat clay (CH) with sand was observed at elevations ranging from 269.07 m ASL and extended to 266.79 m ASL. The fat clay (CH) with sand was soft, moist and brown in color. The moisture content of the fat clay (CH) with sand ranged from 26.1% to 31.1%, with an average of 28.6%.

4.1.4 Sandy Silt (ML)

Sandy silt (ML) was observed below the fat clay (CH) fill in TH24-02 and TH24-04, and the sandy silt (ML) layer was also observed below the topsoil in TH23-03. The thickness of the sandy silt (ML) layer ranged from 0.76 m to 3.05 m and was observed at elevations ranging from 265.37 m ASL 266.74 m ASL and extended to elevations ranging from 263.61 m ASL to 264.61 m ASL. The sandy silt (ML) was grey to tan in color, soft to very soft in consistency with depth, and moist to saturated with depth. The moisture content of the sandy silt (ML) ranged from 17.7% to 33.1% with an average of 25.2%.

4.1.5 Clayey Sand (SC)

Clayey sand (SC) was observed below the fat clay (CH) fill in TH24-05. The clayey sand (SC) had a thickness of 1.52 m and was observed at elevations ranging from 264.23 m ASL to 262.70 m ASL. The clayey sand (SC) was brown to tan in color, compact to loose in consistency, and appeared to be saturated. The moisture content of the clayey sand (SC) was 21.6%.

4.1.6 Lean Clay (CL)

Lean clay (CL) was observed in TH24-05 below the clayey sand (SC) layer. The lean clay (CL) layer had a thickness 1.37 m and was observed at elevations from 262.70 m ASL to 261.33 m ASL. The lean clay (CH) was observed to be grey in color, firm in consistency, and moist. The moisture content of the lean clay (CL) ranged from 38.0% to 43.5%, with an average of 40.8%.

4.1.7 Lean Clay (CL) with Sand

Lean clay (CL) with sand was observed in TH24-04 below the sandy silt (ML) layer. The lean clay (CL) with sand was observed to be approximately 0.76 m thick and ranged in elevation from 264.61 m ASL to 263.85 m ASL. The lean clay (CL) with sand was brown in color, stiff in consistency, and saturated. The moisture content of the lean clay (CL) was 28.1%.

4.1.8 Fat Clay (CH)

Fat clay (CH) was observed below the sandy silt (ML) layer in TH24-02 and TH24-03, the fat clay (CH) was observed below the lean clay (CL) with sand in TH24-04, the fat clay (CH) was observed below the lean clay (CL) in TH24-05, the fat clay (CH) was observed below the fat clay fill in TH24-06 and TH24-08, and the fat clay (CH) was observed below the silt (ML) in TH24-07. The fat clay (CH) ranged in thickness from 1.52 m to 6.40 m and was observed at elevations ranging from 261.33 m ASL to 272.92 m ASL and extended to elevations ranging from 265.76 ASL to 256.49 m ASL. It should be noted that the fat clay (CH) may extend to lower elevations, however, this can not be confirmed from the geotechnical investigation as the testholes were terminated within the fat clay (CH) layer. The fat clay (CH) was brown to tan to grey in color, stiff to very soft in consistency, and was moist to saturated. The moisture content of the fat clay (CH) ranged from 33.9% to 49.3%, with an average of 43.83%.

4.1.9 Silt (ML)

Silt (ML) was encountered below the fat clay (CH) with a sand layer in TH24-07 and was interbedded within the fat clay (CH) layer in TH24-08. The silt ranged in thickness from 1.22 m to 3.05 m and was observed at elevations ranging from 266.79 m ASL to 270.94 m ASL and extended to elevations ranging from 263.74 m ASL to 269.72 m ASL. The silt (ML) layer was observed to be tan in color, very soft in consistency, and saturated. The moisture content of the silt (ML) layer ranged from 28.9% to 33.9%, with an average of 32.1%.

4.1.10 Groundwater and Sloughing Conditions

Groundwater seepage and sloughing conditions were observed in each testhole upon completion of drilling. Details of the location and nature of sloughing, seepage, and groundwater encountered are provided on the testhole logs in **Appendix C** and presented in **Table 1**.

Table 1: Observed Groundwater, Seepage, and Sloughing Conditions

Testhole No.	Groundwater Seepage	Depth of Groundwater Seepage (m BGS)	Groundwater Depth Upon Completion of Drilling (m BGS)	Depth of Soil Sloughing (m BGS)
TH24-02	Minor	2.74	Unavailable (1)	2.44
TH24-03	Moderate	2.13	Unavailable (1)	1.22
TH24-04	Moderate	1.83	4.27	1.52
TH24-05	Moderate	2.47	2.16	2.44 and 3.05
TH24-06	Moderate	0.91	Unavailable (1)	0.15 and 0.91
TH24-07	Minor	4.27	2.74	3.66
TH24-08	Moderate	2.47	2.44	2.74

(1) Final groundwater readings were unavailable due to the amount of sloughing.

Groundwater readings were taken upon completion of the testhole drilling when possible. Two standpipe piezometers were installed during the geotechnical investigation, one in TH24-04 and one in TH24-05. Groundwater readings

were taken from the standpipes at the completion of drilling, and a second reading was taken approximately one (1) month later. The readings recorded are summarized in **Table 2**.

Table 2: Groundwater Readings

Standpipe No.	Stratum/Tip Elev. (m ASL)	Groundwater Elevation (m ASL)	
		September 26, 2024	October 25, 2024
SP24-04	Fat clay (CH)/260.67	261.68	265.06
SP24-05	Fat clay (CH)/257.37	263.44	263.63

The graphical summaries of these results are provided in **Figure 1** and **Figure 2**.

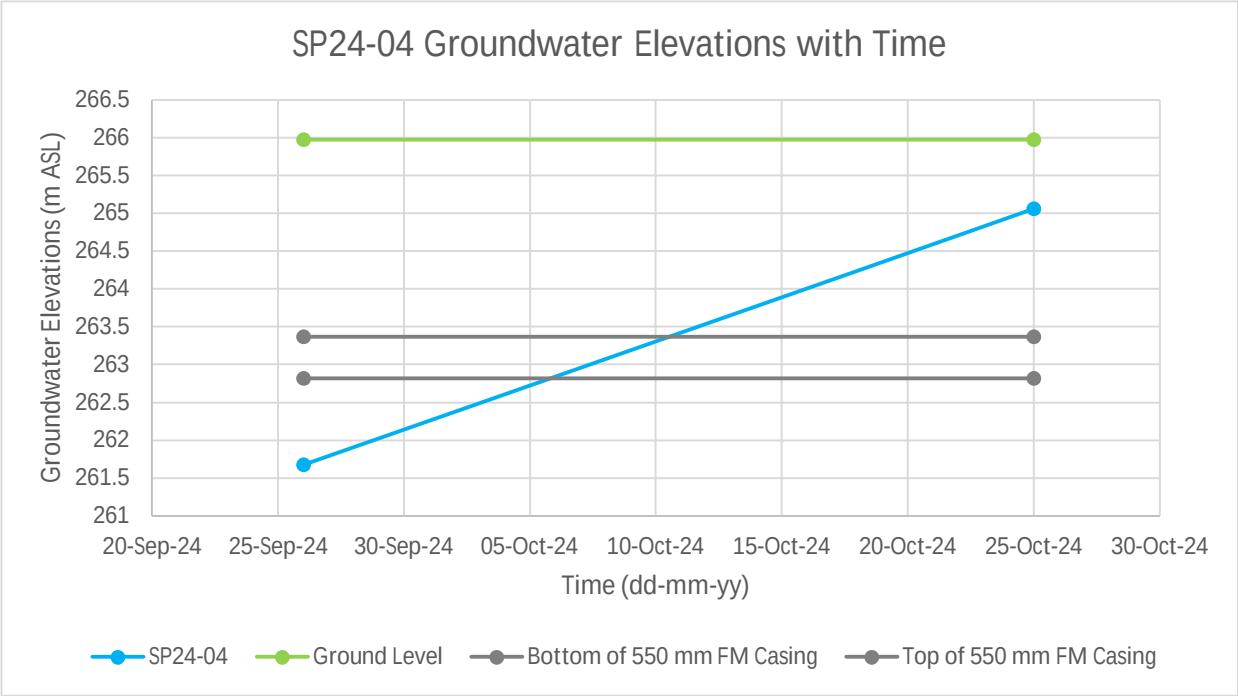


Figure 1: Graph of Groundwater Elevations Versus Time

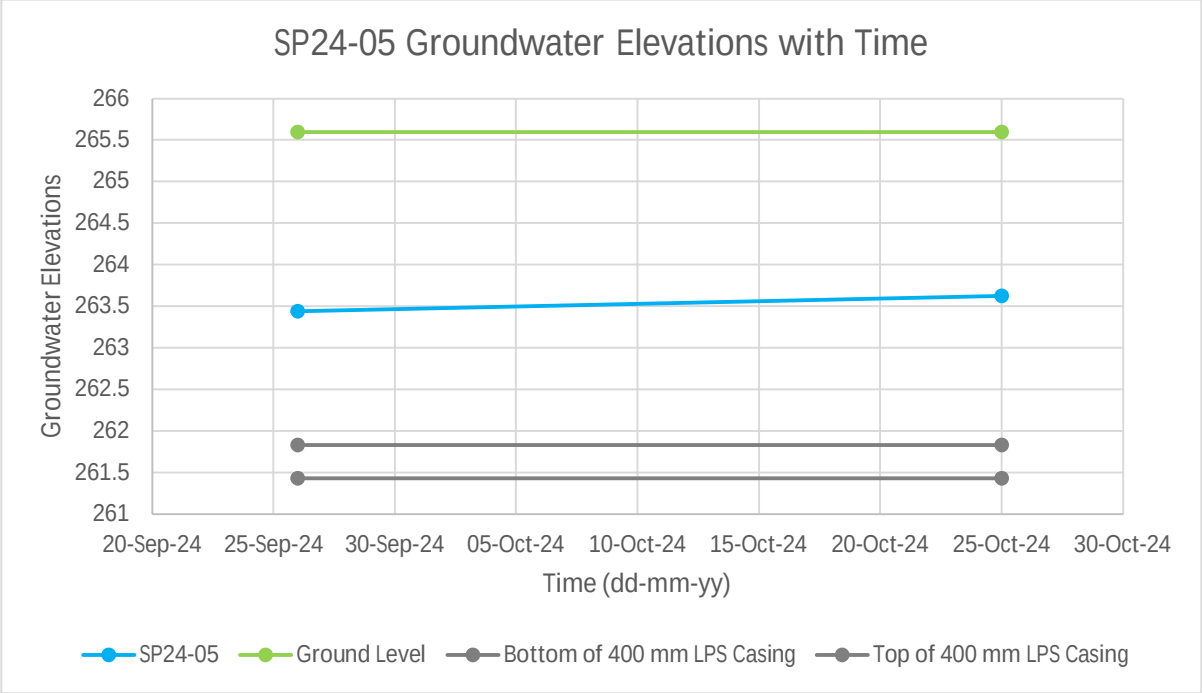


Figure 2: Graph of SP24-05 Groundwater Elevations Versus Time

Only short-term seepage and sloughing conditions were observed in the testholes. Groundwater levels will normally fluctuate during the year and depend on precipitation, surface drainage, and regional groundwater regimes. Groundwater seepage and soil sloughing should be expected from the silt (ML), sandy silt (ML), and clayey sand (SC) layers.

4.2 Laboratory Test Results

Various laboratory tests were performed on select samples collected from the field drilling program. Moisture contents were measured per ASTM D2216 on soil samples recovered from the testholes. The moisture contents are provided in the testhole records and the laboratory results in **Appendix C** and **Appendix D**, respectively.

Representative soil samples were selected and tested per particle size analysis (ASTM D422), Atterberg Limits (ASTM D4318) and unconfined compressive strength of cohesive soil (ASTM D2166). These results are provided in the testhole logs in **Appendix C** and laboratory test results in **Appendix D**.

Table 3: Particle Size Analysis (ASTM D422)

Testhole No.	Sample Depth (m BGS)	Group Symbol	Particle Size			
			Gravel 75 to 4.75 mm	Sand <4.75 to 0.075 mm	Silt <0.075 to 0.002 mm	Clay <0.002 mm
TH24-02	0.61 – 0.76	ML	0.0	42.0	44.2	13.8
TH24-04	1.37 – 1.52	CL	0.0	24.1	58.7	17.2
TH24-05	1.37 – 1.52	SM	8.9	50.8	27.4	12.9
TH24-05	2.90 – 3.05	CL	0.0	10.6	67.1	22.2
TH24-05	5.94 – 6.10	CH	0.0	2.9	54.0	43.1
TH24-08	4.42 – 4.57	CH	0.0	11.2	41.2	47.6

Table 4: Atterberg Limits (ASTM D4318)

Testhole No.	Sample Depth (m BGS)	Group Symbol	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Activity
TH24-02	0.61 – 0.76	ML	22	19	3	0.22
TH24-04	1.37 – 1.52	CL	26	17	9	0.52
TH24-05	1.37 – 1.52	SM	25	17	8	0.62
TH24-05	2.90 – 3.05	CL	32	15	17	0.77
TH24-05	5.94 – 6.10	CH	60	19	41	0.95
TH24-08	4.42 – 4.57	CH	52	15	37	0.78

Table 5: Unconfined Compressive Strength (Cohesive Soil) (ASTM 2166)

Testhole No.	Sample Depth (m BGS)	Group Symbol	Moisture Content (%)	Undrained Shear Strength (kPa)	Unconfined Compressive Strength (kPa)
TH24-03	1.52 – 2.13	ML	30.4	-	-
TH24-03	4.57 – 5.18	CH	41.5	51.6	103.2
TH24-03	7.62 – 8.23	CH	42.8	53.8	107.5
TH24-04	3.05 – 3.66	CH	45.6	46.5	93.0
TH24-04	6.10 – 6.71	CH	48.5	27.0	53.9
TH24-05	1.52 – 2.13	SM	22.4	-	-
TH24-05	3.05 – 3.66	CL	43.5	51.5	103.0
TH24-05	6.10 – 6.71	CH	43.9	51.3	102.6
TH24-05	7.62 – 8.23	CH	46.4	36.2	72.3
TH24-06	3.05 – 3.66	CH	43.7	23.2	46.4

5. CP Crossing Design Criteria

This report aims to ensure adequate subsurface information for crossing design, including geotechnical and groundwater information, to support the CP crossing application. CP's geotechnical group or a CP approved service provider will asses the geotechnical information prior to receiving CP's approval for each crossing application.

5.1 Design Requirements - Process 2 – Intermediate

Based on the CP Protocol Requirements for pipeline crossing under railway tracks with an outside diameter of 300 mm to 1500 mm. The proposed 550 mm FM Casing and 400 mm LPS Casing railway crossings are categorized as "Process 2 – Intermediate". AECOM proposed pipeline crossing design details and CP protocol for "Process 2 – Intermediate" are provided in **Table 6**.

Table 6: CPR Protocol Requirements for Process 2 - Intermediate and AECOM Proposed Crossing Design

Criteria	CPR Protocol Requirement (1)	Proposed Pipeline Crossing Design
Dimension Criteria		
Outside Pipe Diameter	300 mm to 1500 mm	550 mm Casing 400 mm Casing
Cover Between BOR and Top of Pipe	Greater than 1.5 m or two (2) pipe diameters whichever is greater	550 mm FM Casing = 3.92 m (greater than 1.5 m and greater than 2 x 0.55 m) 400 mm LPS Casing = 4.23 m (greater than 1.5 m and greater than 2 x 0.40 m)
Adjacent Structures Including Switches and Signals	Within 2.5 times, cover between BOR and top of pipe	550 mm FM Casing = None 400 mm LPS Casing = None
Depth of Pipes Outside Zone of Potential Track Loading (ZPTL)	Less than 0.91 m burial within ZPTL	550 mm FM Casing= approximate min. depth of pipe outside ZPTL (north) = 3.13 m 550 mm FM Casing = approximate min. depth of pipe outside ZPTL (south) = 3.14 m 400 mm LPS Casing = approximate min. depth of pipe outside ZPTL (north) = 3.57 m 400 mm LPS Casing = approximate min. depth of pipe outside ZPTL (south) = 2.92 m
Excavation Criteria		
Excavation Close to CP Track(s)	Excavations or jacking/access pits within 10 m of the closest track centerline	550 mm FM Casing = Centreline of track to face of north excavation pit: 14.91 m 550 mm FM Casing = Centreline of track to face of south excavation pit: 15.25 m 400 mm LPS Casing = Centreline of track to face of north excavation pit: 14.82 m 400 mm LPS Casing = Centreline of track to face of south excavation pit: 15.35 m
Crossing Angle	More than 45 degrees off perpendicular to the track	550 mm FM Casing = 89° (perpendicular) 400 mm LPS Casing = 90° (perpendicular)
Construction Method Criteria		
	Trenchless Method (2) – Auger Boring, Pipe Jacking, Pipe Ramming	Guided Auger Boring with Pipe Jacking or Guided Pipe Ramming
Other Criteria		
Settlement for Class 3 Track	Level 1 Warning/Alert: >10 mm Level 2 Critical/Review: >19 mm	Provided in Section 7.2

(1) CP Geotechnical Protocol for Pipeline and Utility Crossing(s) under Railway Tracks Criteria for Process 2 – Intermediate (Protocol provided in **Appendix G**).
(2) Trenchless methods include Auger Boring (AB), Pipe Jacking, Pipe Ramming (PR), Horizontal Direction Drilling (HDD) except high pressure fluid jetting method, Microtunneling (MT) but exclude any type of mining techniques where any stand-up time is required before the tunnel support is placed.

6. Steel Pipe Casing Installation

As mentioned in Section 1, there are two CP rail crossings that require geotechnical assessment. The first crossing evaluates a 550 mm FM Casing, and the second crossing evaluates a 400 mm LPS Casing. Further details are provided in the subsequent sections.

6.1 Anticipated Stratigraphy

6.1.1 550 mm FM Casing

The proposed 550 mm FM Casing invert has an approximate elevation of 262.82 m ASL at both the north and south extent of the rail line. The sandy silt (ML) layer was encountered in TH24-03 (north of rail line) at elevations ranging from 266.21 m ASL to 263.62 m ASL, the fat clay (CH) layer was encountered in TH24-03 at elevations ranging from 263.62 m ASL to 258.13 m ASL. The lean clay (CL) with sand layer was encountered in TH24-04 (south of rail line) at elevations ranging from 264.61 m ASL to 263.85 m ASL, the fat clay (CH) layer was encountered in TH24-04 at elevations ranging from 263.85 m ASL to 258.36 m ASL. **Table 7** further provides an indication of the strata anticipated to be present at the installation depth of the proposed 550 mm FM Casing.

Table 7: Anticipated Stratigraphy for the 550 mm FM Casing Alignment

Proposed FM	Approximate Elevation of the Proposed FM at BOR (m)	USCS Soil Type Anticipated at the Proposed FM Installation Level	USCS Soil Elevation (m ASL)
Top of Casing	263.37	Fat clay (CH)	263.62>TH24-03 CH >258.13 263.85>TH24-04 CH > 258.36
Bottom of Casing	262.82	Fat clay (CH)	TH24-03 CH <263.62 TH24-04 CH <263.85

As shown in **Table 7**, it is anticipated that the proposed 550 mm FM Casing will be installed within the fat clay (CH) layer. However, the sandy silt (ML) in TH24-03 extends to approximate elevations of 263.62 m ASL and lean clay (CL) with sand in TH24-04 extends to approximate elevations of 263.85 m ASL. Installing pipe within or near silt layers by trenchless methods is challenging due to construction risks and safety concerns. More details of these construction risks and safety concerns are provided in subsequent sections.

The approximate elevations at the bottom of the north and south excavation pits are 262.21 m ASL. Based on the bottom elevations of the pits, it is anticipated that topsoil, fat clay (CH) fill, sandy silt (ML), lean clay (CL) with sand, and fat clay (CH) layers will all be observed during excavation of the jacking and receiving pits.

6.1.2 400 mm LPS Casing

The proposed 400 mm LPS Casing invert has an approximate elevation of 261.43 m ASL. The lean clay (CL) layer was encountered in TH24-05 at an elevation ranging from 262.70 m ASL to 261.33 m ASL, the fat clay (CH) layer was encountered in TH24-05 at an elevation ranging from 261.33 m ASL to 257.37 m ASL, and in TH24-06 at an elevation ranging from 262.89 m ASL to 256.49 m ASL. **Table 8** further provides an indication of the strata anticipated to be present at the installation depth of the proposed LPS.

Table 8: Anticipated Stratigraphy for the 400 mm LPS Casing Alignment

Proposed LPS	Approximate Elevation of the Proposed LPS at BOR (m)	USCS Soil Type Anticipated at the Proposed LPS Installation Level	USCS Soil Elevation (m ASL)
Top of Casing	261.83	Lean clay (CL) Fat clay (CH)	262.70 >TH24-05 CL >261.33 262.89 >TH24-06 CH >256.49
Bottom of Casing	261.43	Lean clay (CL) Fat clay (CH)	262.70 >TH24-05 CL >261.33 262.89 >TH24-06 CH >256.49

As shown in **Table 8**, it is anticipated that the proposed LPS will be installed primarily within the fat clay (CH) and lean clay (CL) layers. The lean clay contained high percentages of silt content, silt can present risks when installing the 400 mm LPS Casing by trenchless methods, resulting in greater settlements.

The elevations at the bottom of the north and south excavation pits are 260.83 m ASL. Based on the bottom elevations of the pits, it is anticipated that topsoil, fat clay (CH) fill, clayey sand (SC), lean clay (CL), and fat clay (CH) layers will all be observed during excavation of the jacking and receiving pits during construction of the 400 mm LPS Casing crossing.

6.1.3 Tunnelman's Ground Classification

Table 9 is provided for completeness and as general information for the anticipated ground conditions along the 550 mm FM Casing and 400 mm LPS Casing crossing. This table provides the framework for Tunnelman's Ground Classification and indicates the respective tunnel working conditions for reference outlined by Heuer and Virgins (1987) and Brandt (1970) and others.

Table 9: Tunnelman's Ground Classification and Probable Work Conditions

Classification		Representative Soil Types	Tunnel Work Conditions
Hard		Very hard calcareous clay; cemented sand and gravel	Tunnel heading may be advanced without roof support.
Firm		Loess above water table; hard clay, marl, cement sand and gravel when not highly overstressed.	Tunnel heading can be advanced without initial support, and final lining can be constructed before ground starts to move.
Raveling	Slow Raveling Fast Raveling	Residual soils or sand with small amounts of binder may be fast raveling below the water table, slow raveling above. Stiff fissured clays may be slow or fast raveling depending upon degree of overstress.	Chunks or flakes of material begin to drop out of the arch or walls sometime after the ground has been exposed, due to loosening or to overstress and “brittle” fracture (ground separates or breaks along distinct surfaces, opposed to squeezing ground). In fast raveling ground, the process starts within a few minutes, otherwise the ground is slow raveling.
Squeezing		Soft or medium-soft clay.	Ground slowly advances into tunnel without fracturing and without perceptible increase of water content in ground surrounding the tunnel (may not be noticed in tunnel but cause surface subsidence).
Swelling		Heavily pre-compressed clays with a plasticity index more than about 30; sedimentary formations containing anhydrite.	Like squeezing ground, moves slowly into tunnel, but movement is associated with a very considerable volume increase in the ground surrounding tunnel.
Running	Cohesive Running Running	Cohesive running occurs in clean, fine moist sand. Running occurs in clean, coarse or medium sand above the GWT.	The removal of the lateral support of any surface rising at an angle of more than about 34° to the horizontal is followed by a “run” whereby the material flows like granulated sugar until the slope angle becomes equal to about 34°. If the “run” is preceded by a brief period of raveling of raveling, the ground is called cohesive raveling.
Very Soft Squeezing		Clay and silts with high plasticity index.	Ground advances rapidly into the tunnel is plastic flow.
Flowing		Below the water table in silt, sand, or gravel without enough clay content to give significant cohesion and plasticity. May also occur in highly sensitive clay when such material is disturbed.	Flowing ground moves like a viscous liquid. It can invade the tunnel not only through the roof and the sides but also through the bottom. If the flow is not stopped, it continues until the tunnel is filled.
Bouldery		Boulder glacial till; rip-rap fill; some landslide deposits; some residual soils. The matrix between boulders may be gravel, sand, clay or combination thereof.	Problems occurred in advancing shield or in forepoling; blasting or hard mining ahead of machine possibly necessary.

For reference, soft to firm fat clay (CH) below the groundwater level is anticipated to exhibit a ‘squeezing’ behavior. While silt below the groundwater level is anticipated to exhibit a ‘flowing’ behavior.

6.2 Recommended Installation Options

The methods of casing installation that are considered are:

- Guided Auger Boring with Pipe Jacking (with soil plug) (also called Pilot Tube Guided Auger Bore)
- Guided Pipe Ramming (also called Pilot Tube Guided Pipe Ramming)

All methods offer similar face support at the lead end of the casing. The casing should be installed with a guided pilot tube when auger boring or pipe ramming methods are used. The pilot tube method should utilize a guided pilot tube as a technique for accurately installing a pipe to line and grade. The pilot tube installation technique serves as the initial step in guided boring technology. Although it is recommended, it is the responsibility of the Contractor to determine the need for guided pilot tubes.

These methods have been considered based upon the known availability of resources, equipment, and expertise within the Manitoba market. Other factors for consideration including the geotechnical/geological constraints are discussed in Section 7 of this report.

6.2.1 Guided Auger Boring with Pipe Jacking Method

The guided auger boring with pipe jacking method involves several key steps. First, excavate the trench or pit to create the launching/jacking area. Next, pilot tubes are installed to control line and grade. The steel casing is connected to the installed pilot tubes and jacked into place while a soil plug is maintained to provide face stability. The auger is used inside the casing to bore through the soil, with soil cuttings removed towards the launching/jacking pit. Throughout this process, the soil plug is maintained to ensure continuous face stability and reduce the potential for ground subsidence. This method provides accurate control of line and grade and helps identify and mitigate potential obstructions before advancing the casing.

6.2.2 Guided Pipe Ramming

Pipe ramming is a trenchless construction method whereby a pneumatic hammer is used to drive the casing through the ground, and spoils are removed from the inside of the casing. With the guidance of a pilot tube (Guided Pipe Ramming), this method combines the line and grade accuracy of the pilot tube installation with the power of compressed air pneumatic pipe rammer affixed to the rear of the casing. Benefits of this method are that the casing can be advanced through poor soils with minimal surface effects, by maintaining a soil plug within the pipe to control caving or flowing soils. Overcut is minimal (typically less than 25 mm) and can be used to reduce friction of the drive when used in conjunction with lubricants and a correctly specified hammer.

6.3 Trenchless Construction Risks

Each trenchless option for the CP rail crossing has been evaluated against the following risks:

Table 10: Evaluation of Trenchless Construction Risks

Trenchless Method	Perceived Risks
Guided Auger Boring with Pipe Jacking	Ground Settlement and Heave
	Buried Obstructions
	Groundwater
	Pipe Alignment/Grade Control
	Dense/Very Stiff Soil Conditions
Guided Pipe Ramming	Ground Settlement and Heave
	Buried Obstructions
	Groundwater
	Pipe Alignment/Grade Control
	Noise and Vibrations

6.3.1 Ground Settlement and Heave

The major advantage of guided auger boring and guided pipe ramming methods is the reduced ground disturbance during installation. However, ground settlement and heave can still occur during installation of the steel casing.

6.3.1.1 550 mm FM Casing

For the 550 mm FM Casing, moderate groundwater seepage was observed at a depth of 2.13 m (Elev. 264.23 m ASL) in TH24-03, and moderate groundwater seepage was observed at a depth of 1.83 m (Elev. 264.15 m ASL) in TH24-04. Soil sloughing was observed in the sandy silt (ML) at a depth of 1.22 m (Elev. 265.14 m ASL) in TH24-03 and was observed in the sandy silt (ML) at a depth of 1.52 m (Elev. 264.46 m ASL) in TH24-04.

At the installation elevation for the 550 mm FM Casing, fat clay (CH) beneath the groundwater table is expected. As discussed in Section 6.1.3, fat clay (CH) below the groundwater table can experience squeezing. Although the 550 mm FM Casing is expected to be installed within the fat clay (CH) layer, the sandy silt (ML) layer was observed to be only 0.25 m above the top casing. Soil layers can change elevations between testholes, if the sandy silt (ML) below the groundwater table is observed during tunnelling, it can experience cohesive running or flowing. Cohesive running and flowing of soils is a risk during tunneling, as a soil plug can't be developed; allowing the soil to flow through the casing and into the excavation pit. The potential for observed flowing can result in larger quantities of observed settlement.

6.3.1.2 400 mm LPS Casing

For the 400 mm LPS Casing, moderate groundwater seepage was observed at a depth of 2.47 m (Elev. 263.13) in TH24-05, and moderate groundwater seepage was observed at a depth of 0.91 m (Elev. 263.20 m ASL) in TH24-06. Soil sloughing was observed in the clayey sand (SC) at a depth of 2.44 m (Elev. 263.16 m ASL) and in the lean clay (CL) at a depth of 3.05 m (Elev. 262.55 m ASL) in TH24-05 and was observed in the fat clay (CH) fill at depths of 0.15 m (Elev. 263.96 m ASL) and 0.91 m (Elev. 263.2 m ASL) in TH24-06.

Surface heave can occur during installation using pipe jacking by auger boring if the casing is advanced through the clay soil too quickly without allowing time for the auger to remove the displaced soils. For auger boring, the management and control of support pressures at the leading face of the tunnel is largely dependent upon the plug of soil forming inside the auger casing. Based in Section 6.1.3, swelling or squeezing may be observed when tunneling in clay layers.

6.3.2 Buried Obstructions

Buried obstructions were not encountered during AECOM's geotechnical investigation in September 2024, although utilities were present in the area during ClickBeforeYouDigMB requests. Buried obstructions such as abandoned rail

ties, abandoned pipe, or cobbles and boulders may be encountered during trenchless tunneling (pipe jacking or pipe ramming). Encountering buried obstructions can prevent or slow down the progress of a trenchless method. Particularly, auger boring with pipe jacking method can have difficulty cutting and moving obstructions beyond the auger flights, potentially creating misalignment to the pipe jacking. An installation technique should be selected that can accommodate removal of potential obstructions without having to remove or expose the leading edge of the encasement pipe.

6.3.3 Groundwater

6.3.3.1 550 mm FM Casing

As mentioned in Section 6.3.1, moderate groundwater seepage was observed in TH24-03 in the sandy silt (ML) layer at a depth of 2.13 m (Elev. 264.23 m ASL), and in TH24-04 in the lean clay (CL) with sand layer at a depth of 1.83 m (Elev. 264.15 m ASL) for the 550 mm FM Casing. Groundwater levels were measured upon completion of drilling, and upon installation of the standpipes (SP's) installed in TH24-04. These groundwater readings are mentioned in detail in Section 4.1.10. The installation of the 550 mm FM Casing (top of casing Elev. 263.37 m ASL) is below the highest groundwater elevation (recorded by the SP installed in TH24-04 (Elev. 265.06 m ASL). During construction of the jacking and receiving pit and the installation of the casing, the expected water head is approximately 2.85 m, the contractor should be prepared to deal with groundwater originating from the above-mentioned soil layers. The contractor should have adequate pumping to maintain safe excavations.

6.3.3.2 400 mm LPS Casing

Moderate groundwater seepage was also observed in TH24-05 in the clayey sand (SC) layer at a depth of 2.47 m (Elev. 263.13 m ASL), and in TH24-06 in the fat clay (CH) fill layer at a depth of 0.91 m (263.20 m ASL) for the 400 mm LPS Casing. Groundwater levels were measured upon completion of drilling, and upon installation of the standpipe (SP) installed in TH24-05. These groundwater readings are mentioned in detail in Section 4.1.10. The installation of the 400 LPS (top of casing Elev. 261.83 m ASL) is below the highest groundwater elevation recorded by the SP installed in TH24-05 (Elev. 263.63 m ASL). During construction of the jacking and receiving pit, and the installation of the casing, the expected water head is approximately 2.80 m, the contractor should be prepared to deal with groundwater originating from the above-mentioned soil layers. The contractor should have adequate pumping to maintain safe excavations.

Given the potential for seasonal fluctuation of the groundwater table, it is recommended that the groundwater level in the SP's be measured again prior to construction to confirm any change arising from seasonal variation or changed conditions since the time of the previous monitoring event.

Groundwater will require careful management and control throughout the casing installation process regardless of which trenchless method is adopted. Groundwater can promote instability at the face of the casing and may result in higher ground deformations (settlement/heave) at ground surface unless adequate solutions are implemented. The contractor will have to develop a method to mitigate this risk especially if auger boring with pipe jacking and pipe ramming techniques are employed.

6.3.4 Line and Grade Control for Trenchless Installation

Pipe alignment and grade control are critical during the initial stages of installation and require careful management to achieve adequate design inverts along the drive length. In difficult ground conditions where potential obstructions may be present (i.e., abandoned rail ties, abandoned pipes, or cobbles and boulders), encountering an obstruction may result in the reduction of alignment and grade control accuracy. The casing should be installed with a guided pilot tube when auger boring or pipe ramming methods are used. The use of guided pilot tube provides an accuracy of ±25 mm (1 inch) from the design grade and ±76 mm (3 inches) from the design alignment at any location; however,

it is at the discretion of the Contractor whether to utilize the use of guided pilot tubes as they are responsible for the work described.

In the case of pipe ramming without guided pilot tube, alignment and grade control is not readily steerable and can be significantly affected by ground conditions. Typical accuracies are in the order of 1% of the drive length, although with good initial alignment and control of the lead section, accuracies can be increased from 0.1% to 0.5%.

6.3.5 Horizontal Stresses due to Pipe Jacking on the Casing Pipe

In general, the jacking force required to propel the pipe sections forward must overcome forces associated with face pressures on the cutting head, plus friction on the shield and pipeline. The frictional forces develop between the surrounding soil and the exposed outer surface of the shield and installed pipe sections. The face pressure component relates to the depth of burial and can be estimated based on the soil and groundwater conditions at the site. The face pressure component of the jacking force remains theoretically constant if the depth of soil cover over the pipeline is constant. However, the frictional force increases as the drive length increases. As a result, longer drives require greater jacking forces. Other construction issues such as pipe misalignment due to obstructions and jacking stoppage can also affect the required jacking force.

6.3.6 Pipe Ramming Dynamics

To drive the casing pipe horizontally along the proposed alignment, the pipe ramming force must overcome soil resistance forces (as discussed in Section 6.3.5). Wave equation analysis should be performed to optimize the hammer energy required to install the pipe without damage. The maximum energy transfer from the hammer to the pipe is dependent upon hammer selection, hammer alignment, and degree of tension on restraining chains. Total soil resistance generally increases with pipe length, depth of soil cover and increasing soil strength.

The Contractor is responsible for conducting Wave Equation Analysis upon selection of an appropriate hammer type prior to construction.

6.3.7 Face Stability

6.3.7.1 550 mm FM Casing

Based on the results of the 2024 geotechnical investigation and the proposed 550 mm FM Casing, the FM will be installed within the fat clay (CH) layer. Although the casing is installed within the fat clay (CH) layer, the sandy silt (ML) layer is only approximately 0.25 m above the top of casing. Pipes installed within the sandy silt (ML) layer will have extreme difficulty developing face stability. When tunneling within a silt layer below the water table, there is insufficient clay content to give significant cohesion. There is an increased likelihood that the soil and water mixture flows into the tunnel like a viscous fluid. The material can enter the tunnel from the invert as well as from the face, crown and walls. The soil water mixture can flow for great distances, completely filling the tunnel in some cases. With the entire casing encompassed within the fat clay (CH) layer, the required face stability may develop. Face stability may be developed with the utilization of the soil plug with a length of 3x the casing diameter (i.e., 3 x 0.55 m = 1.65 m). The recommended soil plug length is dependent upon the installation method selected.

6.3.7.2 400 mm LPS Casing

While the 400 mm LPS Casing will be installed primarily within the fat clay (CH) and lean clay (CL) layers, however, the installation will take place below the groundwater table. Augering past the soil plug will result in the loss of face stability. As discussed in Section 6.3.1 of this report, mitigation measures should be put in place to limit the loss of ground at the face of the casing. The installation of the casing will take place below the groundwater table; therefore, reduced face instability is considered likely along the 400 mm LPS Casing drive length. Utilization of a soil plug 3x

the pipe diameter (i.e., 3 x 0.40 m = 1.20 m) is recommended to improve face stability, but is dependent upon the installation method selected.

7. Geotechnical Assessment

7.1 Jacking Pit and Receiving Pit

In accordance with CPR Geotechnical Protocol for Pipeline and Utility Installations within Railway Right of Way, the location of the jacking or receiving pits shall not extend into the "Zone of Potential Track Loading" (ZPTL). The ZPTL is conserved to the area under the track and within a 1V:1.5H soil zone extending down from a point at the level of the BOR and 2.0 m from the centreline of the tracks. According to the CPR Geotechnical requirement criteria for excavation close to CP track(s), when the excavation of jacking/receiving pits is within 10 m of the closest track centerline, the excavation criteria fall under Process 2 – Intermediate.

The dimensions and depths of the jacking and receiving pit are indicated in the drawing set provided in **Appendix H**.

7.1.1 550 mm FM Casing Pit Excavations

As mentioned in the previous sections, the faces of the excavation pits are 15.25 m and 14.91 m from the track centerline, and the depth from the BOR to the bottom of the pit excavations is 5.07 m. Typical CP Right-of-Way is 15.2 m from the track centre; for work within the right-of-way, CP must be advised, and work must be authorized prior to work within this zone. Entry and exit pits are typically outside the right-of-way. The soils encountered in TH24-03 and TH24-04 consisted of topsoil, fat clay (CH) fill, sandy silt (ML), lean clay (CL) with sand, and fat clay (CH).

The groundwater level observed in TH24-04 saw an elevation of up to 265.06 m ASL. During construction of the jacking and receiving pit and the installation of the casing, the expected water head is approximately 2.85 m; the contractor should be prepared to deal with groundwater originating from the above-mentioned soil layers. Moreover, the contractor should have adequate pumping to maintain safe excavations.

7.1.2 400 mm LPS Casing Pit Excavations

As mentioned in the previous sections, the faces of the excavation pits are 15.35 m and 14.82 m from the track centerline. Typical CP Right-of-Way is 15.2 m from the track centre; for work within the right-of-way, CP must be advised, and work must be authorized prior to work within this zone. Entry and exit pits are typically outside the right-of-way. The depth from the BOR to the bottom of the pit excavations is 5.23 m. The soils encountered in TH24-05 and TH24-06 consisted of topsoil, fat clay (CH) fill, clayey sand (SC), lean clay (CL), and fat clay (CH).

The groundwater level observed in TH24-05 saw an elevation of up to 263.63 m ASL. During construction of the jacking and receiving pit, and the installation of the casing, the expected water head is approximately 2.80 m, the contractor should be prepared to deal with groundwater originating from the above-mentioned soil layers. The contractor should have adequate pumping to maintain safe excavations.

With the above-mentioned excavated pit depths and the encompassing soil stratigraphy, the use of large excavating equipment should be considered to facilitate excavation to the intended depths. Based on the depths of the jacking and receiving pits, it is anticipated that temporary shoring will be required for the pits. Details on the temporary shoring can be found in Section 7.1.4. The pits need to be appropriately shored (in accordance with applicable regulations) because the side walls are normally cut vertically into the soil to conserve space. It is highly likely that sloughing will occur during excavation of the jacking and receiving pits if temporary shoring is not provided. Also, the excavated pit depths are well below the water table, increasing the risks, if proper dewatering is not implemented.

During the geotechnical investigation, public utility locates were obtained. Upon review of the locate clearance maps, it can be confirmed that these crossing areas are heavily congested with utility lines. To conduct a safe excavation,

careful exposure of these lines may be required. Cobbles and boulders were observed during the geotechnical investigation, which may increase the difficulty of the excavations.

The pits should be large enough to accommodate the backstop, jacking equipment, spacer, muck removal equipment, lubricant pumps, lines, pneumatic hammers, and augers, etc. All equipment is normally centered along the centerline of the casing pipe.

7.1.3 Excavation

Pipe jacking operations require the excavation of a suitable jacking and receiving pit. AECOM should be contacted to observe the materials excavated from the jacking and receiving pits and confirm soil conditions match to those encountered during the field drilling program. The method of excavation and support of the excavation sidewalls are the responsibility of the Contractor and must comply with the appropriate regulations under the Manitoba Workplace Safety and Health act. The information provided below is for use by the owner and engineer and should not be interpreted to mean AECOM is assuming responsibility for the Contractor's actions or site safety.

Contractors should acknowledge these concerns and develop a Safe Excavation Plan accordingly. Side slopes for temporary open-cut excavation must conform to the Manitoba Guide for Excavation Work. According to Manitoba's Guide for Excavation Work, the minimum side slope excavation is 1H:1V from the base of the excavation; however, for this type of work, sloped excavation is not commonly used due to available workspace. The services of a professional engineer are required to design support structures where workers are required to enter any open excavation that exceeds 1.5 m depth.

As mentioned, in previous sections, groundwater seepage was observed in the sandy silt (ML), clayey sand (SC), lean clay (CL) and fat clay (CH) fill layers during AECOM's drilling program. Groundwater seepage should be anticipated from the fill, silt, and sand layers during excavation. The stability of the excavated slopes should be monitored regularly by knowledgeable geotechnical personnel. Shoring related to temporary work is the responsibility of the Contractor, and all necessary measures should be undertaken to protect against adverse detrimental impacts.

7.1.4 Temporary Shoring

As mentioned in Section 7.1, it is anticipated that temporary shoring will be used to facilitate excavation of the jacking and receiving pits. Comments regarding the design and temporary shoring system are therefore provided as follows.

The design of the temporary shoring system should be carried out by a professional engineer specialized in shoring design. The shoring system should also be designed in accordance with the methods described in the Canadian Foundation Engineering Manual.

In consideration of the information provided in the preceding sections, it is anticipated that the maximum depth of the jacking and receiving pits will be in the order of 5.07 m (Elev. 262.21 m ASL) for the 550 mm FM Casing below the BOR, and 5.23 m (Elev. 260.83 m ASL) for the 400 mm LPS Casing below the BOR. In consideration of the conditions encountered in the testholes, it is recommended that the design of a shoring system consider the parameters provided in **Table 11**. **Table 11** provides the recommended earth pressure coefficients, and angle of internal friction and bulk unit weight of the fill, silt, sand, lean clay (CL), and fat clay (CH) for use in the calculation of lateral earth pressures. The bulk unit weight of the fat clay (CH) was taken from the average bulk unit weight obtained from AECOM's lab test results. The friction angles provided in the table have been assumed based on the soil conditions encountered in the testholes and consideration of literature references for similar soils.

Table 11: Lateral Earth Pressure Design Parameters

USCS Soil Type	Soil Unit Weight (kN/m³)	Angle of Internal Friction (°)	At Rest Lateral Earth Pressure Coefficient (K_o)	Active Lateral Earth Pressure Coefficient (K_a)	Passive Lateral Earth Pressure Coefficient (K_p)
Fill (Fat Clay)	17	25	0.58	0.41	2.46
Silt	16	28	0.53	0.36	2.77
Sand	19	32	0.47	0.31	3.25
Lean Clay	18	25	0.58	0.41	2.46
Fat Clay	17	25	0.58	0.41	2.46

For the purposes of design of shoring systems, it is recommended that the groundwater elevation be taken as 265.06 m ASL for the 550 mm FM Casing as being the highest elevation of the groundwater level recorded in the SP installed in TH24-04. For the 400 mm LPS Casing, it is recommended that the groundwater elevation be taken as 263.63 m ASL as being the highest elevation of the groundwater level recorded in the SP installed in TH24-05.

A perimeter ditch and associated pumping and an appropriate dewatering system should be provided to intercept surface runoff and groundwater from entering the excavation. To avoid the possibility of piping within the excavation, dewatering should be performed. The Contractor should submit a safe excavation plan, including dewatering measures, for Engineer review.

Monitoring must be carried out during installation/construction process and following installation/construction to confirm that movements of the temporary shoring system are within a pre-determined acceptable range.

7.1.5 Excavation Base Stability

The analysis in this section is based on a braced excavation. In this project braced excavations are expected for a pipe installation that is at an approximate launch and retrieval pit depth of approximately 4.3 m BGS for the 550 mm FM, and 3.9 m BGS and 4.4 m BGS, respectively, for the 400 mm LPS. Per the Canadian Foundation Engineering Manual (CFEM 5e), if the soil below the base of excavation is a soft, normally consolidated soil, it is possible that heaving can occur. In this project, there is firm to stiff, normally consolidated soil below the base of the excavation. Heaving may still be a concern, if the excavation pits were to reach a soft clay layer. The soil above the base acts as a surcharge on the soil below it. This surcharge load may exceed the bearing capacity on the soil, resulting in heaving. The following equation can be used to calculate the factor of safety for base heave:

$$(FS)_b = N_b\left(\frac{s_u}{\sigma_z + q}\right)$$

Where:

- $(FS)_b$ = factor of safety against base heave associated with shear failure
- N_b is a stability factor dependant upon geometry of the excavation and using Fig. 20.21 of CFEM 5e.
- s_u is undrained shear strength of soil below the base, corrected for plasticity, test method, and anisotropy as appropriate (kPa).
- σ_z is the total overburden pressures at the bottom of the excavation (kPa).
- q is surcharge pressure (kPa).

For $(FS)_b$ less than 2, substantial deformations of the excavation support, base and surrounding ground may occur. If $(FS)_b$ is less than 1.5, the sheeting should be extended below the base of the excavation for stability. Wall movements, strut loads, and wall moments are sensitive to $(FS)_b$.

The base of the excavations for the RM of Stanley are expected to be firm to stiff fat clay (CH). Base heave is deemed satisfactory if the factor of safety $(FS)_b$ is greater than 1.50. Groundwater seepage is expected to impact the $(FS)_b$

for these excavations and the factor of safety can be difficult to predict. Therefore, the design of the temporary shoring system should be carried out by a professional engineer specialized in shoring design.

7.1.5.1 550 mm FM

As previously mentioned, the base of the launch and retrieval shaft is within a firm to stiff fat clay (CH) layer. Base heave is deemed satisfactory if the factor of safety $(FS)_b$ is greater than 1.50. The calculated $(FS)_b$ for the excavation of the proposed launch shaft is 4.65, which is above the required safety factor of 1.50. The calculated $(FS)_b$ for the excavation of the proposed retrieval shaft is 3.08. Although heave of the excavated shafts provide satisfactory FS, the design of the temporary shoring system should be carried out by a professional engineer specialized in shoring design.

7.1.5.2 400 mm LPS

As previously mentioned, the base of the launch and retrieval shaft is within a firm to stiff fat clay (CH) layer. Base heave is deemed satisfactory if the factor of safety $(FS)_b$ is greater than 1.50. The calculated $(FS)_b$ for the excavation of the proposed launch shaft is 3.57, which is above the required safety factor of 1.50. The calculated $(FS)_b$ for the excavation of the proposed retrieval shaft is 4.05. Although heave of the excavated shafts provide satisfactory FS, the design of the temporary shoring system should be carried out by a professional engineer specialized in shoring design.

7.1.6 Heave Due to Artesian Pressure at Depth

According to the Canadian Foundation Engineering Manual (CFEM 5e), when an excavation is dug into a clay deposit underlain by a pervious stratum under artesian pressure, pressure and seepage may result, leading to instability of the excavation. An analysis has been prepared for the design of the temporary excavation, excavation depth and piezometric condition within the underlying fat clay.

The basal heave analysis is based on the ratio of total stresses and uplift pore water pressure.

For this approach, the FS is expressed using the equation:

$$FS = \frac{H_C \gamma_C}{H_w \gamma_w}$$

Where:

- γ_c = unit weight of fat clay = 17 kN/m^3
- H_c = thickness of the fat clay between the bottom of the excavation to the top of the glacial till = 0.93 m
- γ_w = unit weight of water = 9.81 kN/m^3
- H_w = the total head in the glacial till layer = 8.28 m

Heave due to artesian pressure at depth is deemed satisfactory if FS is greater than 1.25. Due to test holes not being drilled to refusal on till, the potential heave due to artesian pressure can not be predicted. Therefore, the Contractor should utilize a professional engineer that specializes in braced excavation design prior to beginning construction.

7.2 Settlement Estimation

Like other tunneling methods, pipe jacking/augering will result in a change in the state of stress in the ground with corresponding settlements. Ground subsidence can be caused by several factors such as ground loss at the tunnel face, behind the tail of the shield and through the tunnel support or linings. Based on cohesive soils tending toward a stable tunnelling face, the only significant contribution to ground loss is the closure of the over-cut. The overcut is the annular space between the tunnel boring walls and the installed pipe. Some degree of ground subsidence can

be expected from tunneling although in many instances its effects, from a practical perspective, are negligible with proper technique.

7.2.1 Empirical Method

A conventional method for prediction of settlement that may develop due to trenchless installation is the method outlined by Schmidt (1969) and later by Thomson (1993). A ground surface deformation induced by tunnel construction is estimated using a reverse Gaussian curve based on the anticipated ground loss.

The empirical method is characterized as a simplified method and an upper bound solution as the method does not consider the potential for arching effects in the overlying soil mass above the borehole obvert, nor does the method consider soil layering, groundwater conditions or the shape of the void. This method does not consider the use of a 'soil plug' either.

This method assumes that the total ground loss (V_t) (or over drill) that occurs over the pipe leads to settlement at the ground surface in the shape of a reverse Gaussian curve (normal probability distribution). The maximum settlement δ_{max} occurs at the ground surface above the tunnel centreline and is estimated from the following equation:

$$\delta_{max} = \frac{V_t}{2.5i}$$

Where "i" is the point of inflection for the normal distribution, and "V_t" represents the volume of ground loss during tunnel excavation multiplied by the cross-sectional area of the drilled shaft. The method suggests the following correlation between "i", depth of tunnel centreline (Z) and settlement trough parameter (K, function of soil type) for cohesive soil.

$$i = Kz$$

7.2.1.1 550 mm FM Casing

Based on the conditions encountered in the testhole soil stratigraphy (TH24-03 and TH24-04) at the proposed auger boring path, it is anticipated to consist of stiff to firm fat clay (CH). The track is likely comprised of subballast and ballast material; however, the empirical method does not address multi-layer systems. The method suggests K values ranging from 0.4 to 0.7 for very soft to stiff clay soils, 0.5 for normally consolidated soils, and a K value of 0.3 for cohesionless soils. The smaller the K value is taken the larger will be the settlement estimate. Given the conditions in the testholes, a K value of 0.4 is considered for this estimation.

It can be assumed that the difference in size of the auger cutter-head with a diameter up to 25 mm larger than the product pipe would create a space and that the space could potentially collapse. Due to the presence of clay within the path of the 550 mm FM Casing, a 10% to 25% annular space collapse has been assumed. In addition to the annular space collapse, we can consider a ground loss of approximately 1.0% to 2.5% of the borehole volume to occur at bore face for boring in soft to stiff clay soils (i.e., fat clay (CH)).

Figure 3 presents the results of the settlement estimation using the empirical method for various percentages of annular space collapse and ground loss for the proposed trenchless pipeline installation under railway tracks.

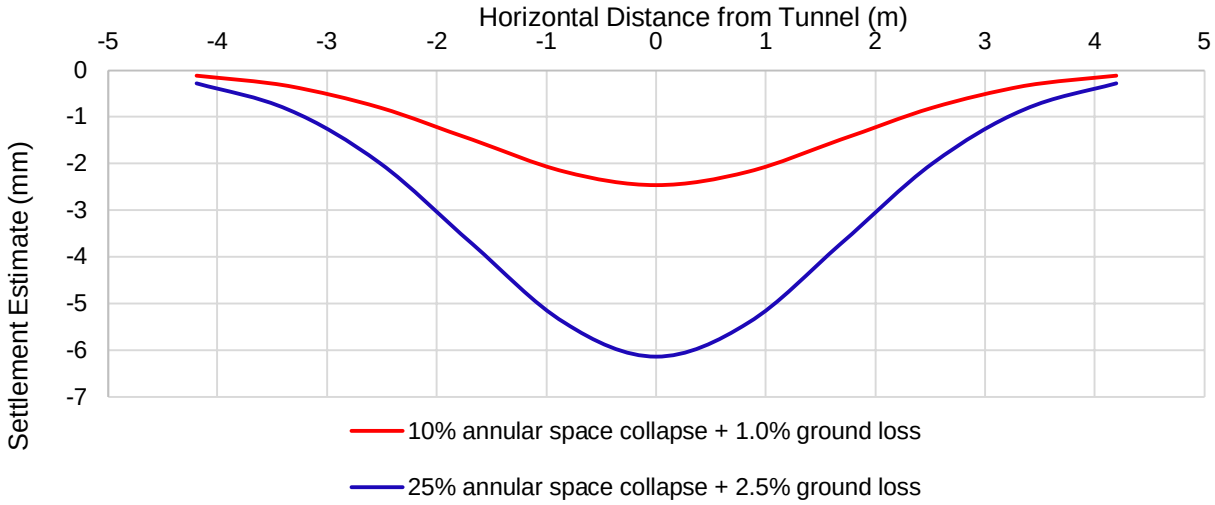


Figure 3: Ground Surface Settlement for 550 mm FM Casing Using Empirical Approach

As shown in the figure above, all the estimated settlement values are below the Level 1 “Warning/Alert” and Level 2 “Critical/Review” settlement limits for the CP Class 3 track (10 mm to 19 mm).

The above values should be considered approximate estimates. As discussed above, the potential for ground surface movement to occur is in part, dependent on the contractor’s work methods, equipment, and techniques (e.g., soil plug, guided auger, etc.). A settlement monitoring plan will need to be implemented to monitor settlement during the installation (pre- and post-construction) and adjust the methodology prior to reaching the crossing location as warranted. Section 8 further discusses the settlement monitoring program in accordance with CPR Geotechnical Protocol for Pipeline and Utility Crossing(s) Under Railway Tracks.

7.2.1.2 400 mm LPS Casing

Based on the conditions encountered in the testhole soil stratigraphy (TH24-05 and TH24-06) at the proposed auger boring path, it is anticipated to consist of firm lean to fat clay (CL to CH). Given the conditions in the testholes (firm lean to fat clay (CL to CH)), a K value of 0.3 is considered for this estimation due to the high percentage of silt content. It is typical to assume a contribution of 25% to 50% of the annular space collapse to the ground surface deformation given the potential benefit from ground arching effects and localized ground loosening (i.e., volume change). In addition to the annular space, we can consider a ground loss of approximately of 2.5% to 5.0% of the borehole volume to occur at bore face for boring in cohesionless (i.e., lean clay (CL)).

Figure 4 presents the results of the settlement estimation using the empirical method for various percentages of annular space collapse and ground loss for the proposed trenchless pipeline installation under railway tracks.

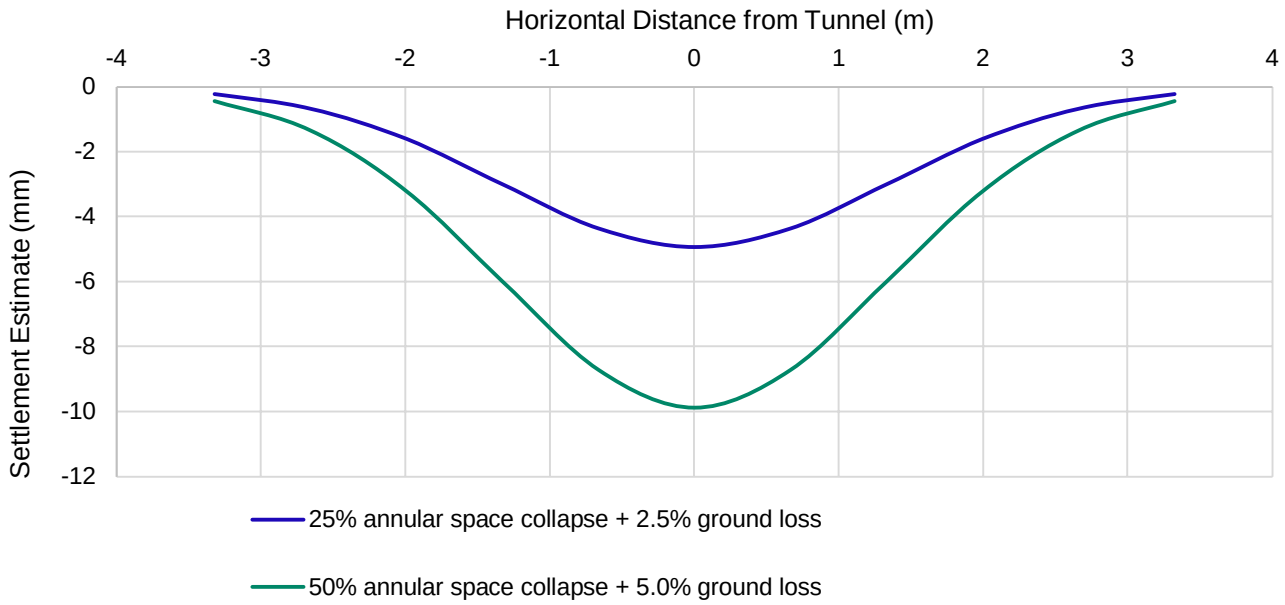


Figure 4: Ground Surface Settlement for 400 mm LPS Casing Using Empirical Approach

As shown in the figure above, all the estimated settlement values are below the Level 1 “Warning/Alert” and Level 2 “Critical/Review” settlement limits for the CP Class 3 track (10 mm to 19 mm). However, the settlement estimate with a 50% annular space collapse and 5.0% ground loss approaches near the Level 1 “Warning/Alert”. These values are approximate estimates, and it is the contractor’s responsibility to maintain a settlement values below the Level 1 “Warning/Alert” and Level 2 “Critical/Review” settlement limits for the CP Class 3 track.

The potential for ground surface movement depends on the contractor’s work methods, equipment and techniques (e.g., soil plug, guided auger). A settlement monitoring plan will be implemented to monitor settlement during installation (pre- and post-construction) and adjust the methodology as needed before reaching the crossing location. **Section 8** further discusses the settlement monitoring program in accordance with CPR Geotechnical Protocol for Pipeline and Utility Crossings Under Railway Tracks.

8. CP Monitoring Requirements

CP provides requirements for settlement monitoring in "Geotechnical Protocol for Pipeline and Utility Crossing(s) Under Railway Tracks" document dated May 16, 2022. A copy of this document is included in **Appendix G** for reference. This document includes the minimum monitoring frequency requirements for preconstruction, during construction and post-construction. It also identifies two alarm levels to be implemented during the settlement monitoring.

8.1 Monitoring Point Layout

The location of the settlement monitoring points are provided on drawings in **Appendix I**.

The installation of the monitoring points shall be as follows:

- Surface monitoring points along each of the BOR (north and south) for each crossing. Surface points installed directly along the base of both rails at a spacing of 9.45 m over the projected settlement trough should be used to monitor differential transversal elevations at each crossing. In total, AECOM recommends 22 surficial monitoring points centred on each encasement pipe alignment points at each crossing, to be installed by the Contractor.
- The subsurface settlement points will be installed 1 m above the crown of the casing profile. These points will be installed to a depth of 2.92 m (Elev. 264.36 m ASL) below the BOR for the 550 mm FM Casing, and to a depth of 3.23 m (Elev. 262.83 m ASL) below the BOR for the 400 LPS Casing. AECOM recommends two (2) subsurface monitoring points for each rail crossing, to be installed by the Contractor. The upper portion of the iron bar will be sleeved in PVC piping and backfilled with bentonite to prevent water infiltration, and the lower portion will be filled with sand. The installation will include a cover at the ground surface to protect against disturbance (typically a flush-mount or stick-up well casing).

The typical installation and decommissioning details for the surface and subsurface settlement monitoring points are shown on pages 36 and 37 of the CP Geotechnical Protocol for Pipeline and Utility Crossing(s) Under Railway Tracks as shown in **Appendix G**.

8.2 Settlement Monitoring Frequency

Track Movement Monitoring Guidelines for Trenchless Pipe Installation of CP's Geotechnical Protocol describes the minimum required frequency of the settlement monitoring points at various times. The subsurface settlement points will be monitored simultaneously with the surface settlement points which act as a precursor to potential surface movement during pipe installation. All monitoring points will be surveyed to the typical industry standard accuracy of ±2 mm. In accordance with CP's monitoring guidelines, a monitoring program of all points is to be conducted once the installation is complete. The instructions listed below are to be followed:

- **Pre-Construction:** Monitoring will start before the excavation of the pits and pipe installation begins, and readings should be taken at least twice per day for two days. This is required to establish a reliable methodology and demonstrate the accuracy to be achieved. The collection of the baseline readings will be done by the surveyors. AECOM surveyors will collect two (2) baseline readings daily on two (2) consecutive days. A memo will be prepared summarizing the baseline readings.
- **During Construction:** Monitoring will proceed through the construction period and readings should be taken every two (2) hours or after each train, whichever provides the greatest number of readings while the boring operation is within the ZPTL (for main lines and heavy traffic lines – Class 3-5 Track). This will be in coordination with the site surveyor. Daily reports will be prepared to include all settlement monitoring data, along with pertinent photos.

- **Post Construction:** Monitoring will continue three (3) days after completion of the construction. A memo will be prepared summarizing the monitoring points.
- If there is any loss of ground during pipe installation, any reason to believe settlement may be delayed or any settlement is identified during the installation of pipe or subsequent monitoring period, the monitoring will be continued until AECOM's Geotechnical Engineer of Record (GER) deems it is safe to discontinue such monitoring.

In accordance with CP Protocol, the GER, German Leal, M.Eng., P.Eng. will provide a sealed and stamped final report to CP's approved service provider with a copy to CP Public Works – Utilities supervisor confirming that the work has been completed in accordance with the approved plans and procedures.

8.3 Ground Movement Alarm Level

AECOM adopts the following criteria for the settlement monitoring. This criterion is applicable to both the surface and subsurface monitoring points required to be installed at the 550 mm FM Casing crossing and the 400 mm LPS Casing crossing and is based upon a Class 3 track. A Class 3 track is defined as a track that has freight train speeds up to 64 km/hr, based on Transport Canada's Rail Network and Crossings ArcGIS, rail speeds at these locations can reach up to 48 km/hr. According to the *Track Movement Monitoring Guidelines for Trenchless Pipe Installation* of the CP Geotechnical Protocol, there are two alarm levels for ground movement. The two alarm levels are as follows:

- Level 1: "Warning/Alert" – maximum value of 10 mm.
- Level 2: "Critical/Review" – a value ≥19 mm.

8.4 Settlement Monitoring Program

CP requires carrying out track settlement monitoring (i.e., surface and subsurface settlement points) before, during and after construction. The intent of subsurface settlement points is to measure soil settlement, if any, above the pipe during construction to predict the potential movement of the tracks above.

8.4.1 Pre-Construction Tasks

Prior to commencement of construction AECOM will complete the following tasks:

- Submit the scope of the proposed settlement monitoring program to the Manitoba Water Services Board (to include in the permit submission to CP).
- Review and incorporate any comments received from CP into the scope of the proposed settlement monitoring program.

On receipt of the CP permit from the Manitoba Water Services Board, AECOM will ensure:

- The Contractor prepares the monitoring point installations such as underground clearance and ClickBeforeYouDigMB. The utility locates program are as follows:
  - Public utility locates for the area of the proposed monitoring points;
  - Submit to CP to obtain utility locates specific to CP railway operations; and
  - Retain private utility locate company to identify and mark services and/or utilities.
  - Identify, if any, utilities/services that are within 3 m of the intended locations of the monitoring points and if so, said utilities/services will require positive identification (hand or hydro-vac exposure in the field). Where positive exposure is not practical, the locations of the proposed monitoring points will be adjusted accordingly.
  - Contact the railway operator to request a Protective Person (flag person) and coordinate access to enter the ROW for the described work.

- Develop an emergency contact list that identifies representatives from AECOM, the Manitoba Water Services Board, CP, the pipe installation contractor, and additional parties as may be identified at the time. The emergency contact list will be distributed to all parties to be used if the settlement Warning/Alert Limit range is exceeded.

On the completion of the preceding tasks, and receipt of approval from CP to proceed, AECOM will:

- Oversee the installation of the monitoring points as outlined in the proposed settlement monitoring program with adjustments as required for the presence of utilities/services. A drill rig will be used to install the subsurface monitoring points.
- AECOM surveyors will collect two (2) baseline readings daily on two (2) consecutive days.
  Collection of baseline readings on all monitoring points will be within 1-2 weeks of the commencement of construction. This timeline can be revised at the discretion of the geotechnical consultant subject to the prevailing subsurface conditions, activity in the area (construction or otherwise), and climate/weather conditions during the period prior to and leading up to the commencement of construction.
- Arrange a pre-construction meeting with all stakeholders to discuss project and construction details including work description, construction methods and schedule, restrictions, safety, work duration, daily reporting, and other CP requirements.

8.4.2 Construction Tasks

Monitoring will proceed through the construction period and readings will be completed every two (2) hours or after each train, whichever provides the greatest number of readings while the boring operation is within the ZPTL (for main lines and heavy traffic lines Class 3-5 Track). This will be in coordination with the project surveyor. Daily reports will be prepared to include all settlement monitoring data, along with pertinent photos.

If the result of the surveys are above the Level 1: “Warning/Alert Level” or Level 2: “Critical/Review”. The following will be implemented:

8.4.2.1 Level 1: “Warning Alert/Critical”

If the measured subsurface and/or surface settlement points are above the Warning/Alert Level (i.e., more than 10 mm):

- Notify all parties on the emergency contact list within 24 hours that the results of the monitoring are exceeding the Warning/Alert Level.
- A survey of the surface points will be carried out and work will be authorized to continue if no movement of the subsurface points have been measured from the previous readings. In this case, request that the Project Surveyor undertake an additional survey to confirm the results obtained and provide a verbal report of the results to the geotechnical consultant within 1-hour of completion of the survey and a written report of the results to the geotechnical consultant within 24 hours.
- Notify all parties on the emergency contact list within 24 hours of the results of the additional monitoring.

8.4.2.2 Level 2: “Critical/Review”

If the measured subsurface and/or surface settlement points are exceeding the Critical/Review Level (i.e., more than 19 mm):

- Mobilize geotechnical staff to the site within 12 hours to identify if there are any obvious visual indications of movement of the rail tracks, rail ballast, rail embankment or similar, and/or if there is any indication of the development of ground subsidence, sink holes or slope instability.
- Notify all parties on the emergency contact list, including CP, immediately that the monitoring results are above the Critical/Review Level.

- Communicate with project team, who shall advise the Contractor to cease the drilling operations immediately until an assessment of the observed settlement is conducted by a geotechnical engineer and a conference call/meeting is convened between CP, the Manitoba Water Service Board, the Contractor, and the Geotechnical Consultant to discuss the results of the assessment.
- A survey of the surface points will be carried out and work will be authorized to continue if no movement is measured for at least two (2) readings taken 12 hours apart. In this case, request that the project surveyor undertake an additional survey to confirm the results obtained and provide verbal report of the results to the Geotechnical Consultant immediately upon completion of the survey and a written report of the results to the Geotechnical Consultant within 24 hours.
- Notify all parties on the emergency contact list within 24 hours of the results of the additional monitoring and the results of the visual observations of the current conditions.

8.4.3 Post Construction Task

Decommissioning of the monitoring points will begin once post-construction monitoring has been completed (twice daily for three (3) consecutive days), and all parties have reviewed the monitoring data and are satisfied that, if any movement was detected during the monitoring period (if any) have stopped.

For the subsurface monitoring points, the protective covers and iron bars will be removed from CP ROW by the Contractor. The subsurface monitoring points will be backfilled with bentonite pellets. All backfill material from the installation of the monitoring points will be removed from CP ROW as well.

A final memo and as-built drawings will be submitted at the end of the project. The memo will summarize the settlement monitoring that shall be performed for the 550 mm FM Casing and 400 mm LPS Casing crossing installations and will confirm that the work is completed in general accordance with the submitted plans and procedures. The final memo and the as-built drawings will be sealed and stamped by the GER, German Leal, M.Eng., P.Eng.

9. Conclusion

In general, and based on the information available, it is AECOM's understanding that the proposed 550 mm FM Casing and 400 mm LPS Casing be installed under the CP railway using trenchless methodologies. From the geotechnical perspective, it is considered feasible to use a pipe jacking system utilizing either guided auger boring or guided pipe ramming. These trenchless installation methods are deemed appropriate given the required installation criteria based on the subsurface ground and groundwater conditions. It is thereafter the Contractor's means and methods to select the suitable trenchless method and mitigation measures based on their experience and equipment.

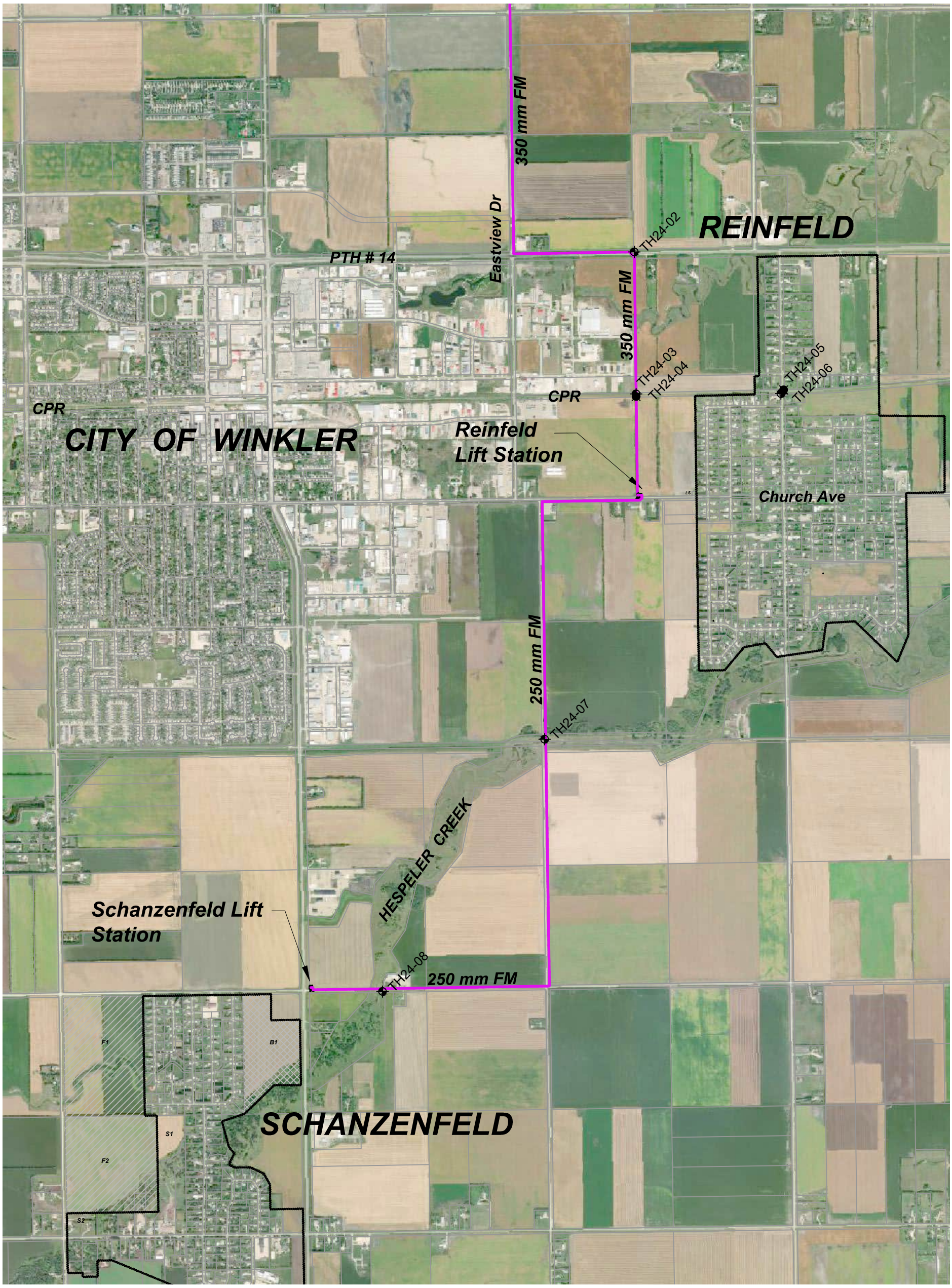
Characterization of groundwater conditions may be required to validate dewatering quantities, methodologies and techniques prior to the onset of construction.

Given that installation will occur within lean to fat clay (CH) layers under the groundwater table, the Contractor should be prepared to mitigate potential groundwater flow around the circumference of the casing. The Contractor should submit a construction methodology, including mitigation techniques for adverse track settlement, to the Engineer for approval prior to installation.

Throughout the pipe installation process, surface and subsurface ground movement monitoring shall be undertaken to evaluate the impact of pipe jacking/pipe ramming beneath the CP rail tracks. Should observed settlement and heave values exceed the maximum anticipated values, the Contractor shall implement the noted action plan to mitigate the tunneling/trenchless-induced heave/settlement.

Appendix A

Testhole Location Plan



AECOM

RM OF STANLEY LOW PRESSURE SEWER SYSTEM CONCEPTUAL DESIGN

FIGURE 1. FORCEMAIN PIPELINE LAYOUT

PROJECT NUMBER	DRAWING NUMBER	ISSUE DATE	ISSUE/REVISION
60735871			

Appendix B

Site Photographs

Figure 1: View of TH24-02 Location

Figure 2: TH24-04 SP Installed

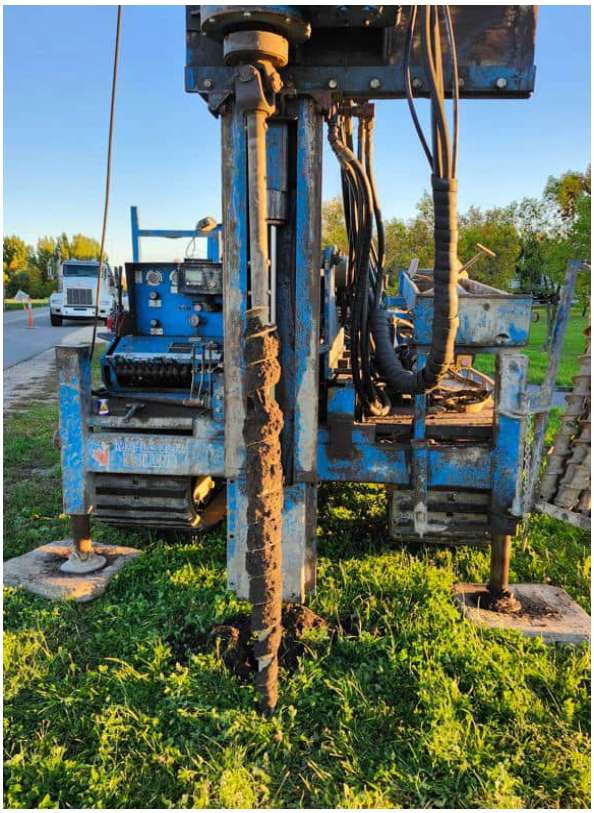


Figure 3: TH24-05 Drilling

Figure 4: TH24-05 SP Installed

Figure 5: TH24-06 Drilling

Figure 6: View of TH24-07 Location

Appendix C

Testhole Logs

EXPLANATION OF FIELD & LABORATORY TEST DATA

The field and laboratory test results, as shown for each hole, are described below.

1. EXPLANATION OF SOIL

Each soil stratum is classified and described noting any special conditions. The Modified Unified Classification System (MUCS) is used. The soil profile refers to the existing ground level at the time the hole was done. Where available, the ground elevation is shown. The soil symbols used are shown in detail on the soil classification chart.

1.1 Tests on Soil Samples

Laboratory and field tests are identified by the following and are on the logs:

γ_D - Dry Unit Weight. Usually expressed in kN/m^3.

γ_T - Total (moist, wet, or bulk) Unit Weight. Usually expressed in kN/m^3.

C_U - Undrained Shear Strength. Usually expressed in kPa. This value can be determined by a field vane shear test and may also be used in determining the allowable bearing capacity of the soil.

C_{PEN} - Pocket Penetrometer Reading. Usually expressed in kPa. Estimate of the undrained shear strength as determined by a pocket penetrometer.

N - Standard Penetration Test (SPT) Blow Count. The SPT is conducted in the field to assess the in-situ consistency of cohesive soils and the relative density of non-cohesive soils. The N value recorded is the number of blows from a 63.5 kg hammer free falling of 760 mm (30 in.) which is required to drive a 50 mm (2 in.) split spoon sampler 300 mm (12 in.) into the soil.

Q_U - Unconfined Compressive Strength. Usually expressed in kPa and may be used in determining allowable bearing capacity of the soil.

The following tests may also be performed on selected soil samples and the results are given on separate sheets enclosed with the logs:

- Grain Size Analysis
- Standard or Modified Proctor Compaction Test
- California Bearing Ratio Test
- Direct Shear Test
- Permeability Test
- Consolidation Test
- Triaxial Test

1.2 Natural Moisture Content

The relationship between the natural moisture content and depth is significant in determining the subsurface moisture conditions. The Atterberg Limits for a sample should be compared to its natural moisture content and plotted on the Plasticity Chart to determine the soil classification.

Descriptive Term	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually in coarse-grained soils below the water table

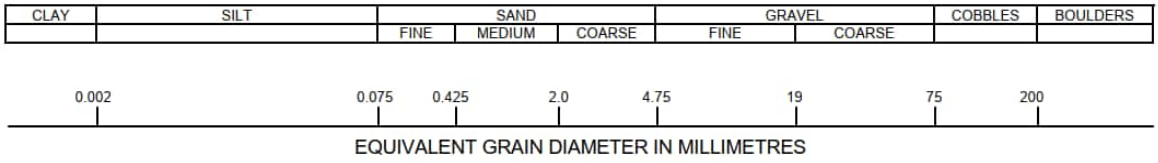
1.3 Grian Size Distrubtion

Laboratory grain size analyses provided by AECOM follow the following system. Note that, with the exception of those samples where a grain size distribution analysis has been completed, all samples have been classified by visual inspection. Visual inspection classification is not sufficient to provide exact gain sizing.

SOIL COMPONENTS

FRACTION		SIEVE SIZE (mm)		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
		PASSING	RETAINED	PERCENT	IDENTIFIER
GRAVEL	COARSE	75	19	50 – 35	AND
	FINE	19	4.75		
SAND	COARSE	4.75	2.00	35 – 20	ADJECTIVE
	MEDIUM	2.00	0.425		
	FINE	0.425	0.075	20 – 10	SOME
SILT (non-plastic) or CLAY (plastic)		0.075		10 – 1	TRACE
OVERSIZE MATERIALS					
ROUNDED OR SUB-ROUNDED COBBLES 75 mm TO 200 mm BOULDERS >200 mm			ANGULAR ROCK FRAGMENTS ROCKS > 0.75 m3 IN VOLUME		

ISSMFE / USCS SOIL CLASSIFICATION



1.4 Soil Compactness and Consistency

The standard terminology to describe cohesive soils includes consistency, which is based on undrained shear strength as measured by in-situ vane tests, penetrometer tests, unconfined compression tests, or similar field and laboratory analysis. Standard Penetration Test 'N' values can also be used to provide an approximate indication of the consistency and shear strength of fine-grained, cohesive soils.

The standard terminology to describe cohesionless soils includes the compactness condition as determined by the Standard Penetration Test 'N' value. These approximate relationships are summarized in the following tables:

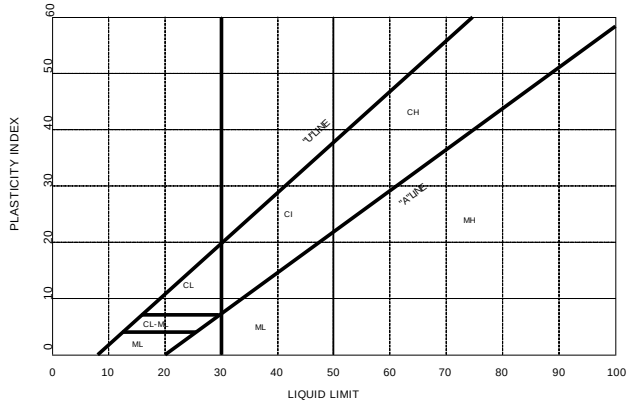
Table 1 Cohesive Soils

Consistency	SPT N (blows/0.3m)	C_u (kPa) approx.
Very Soft	<2	<12
Soft	2 - 4	12 - 25
Firm	4 - 8	25 - 50
Stiff	8 - 15	50 - 100
Very Stiff	15 - 30	100 - 200
Hard	>30	>200

Table 2 Cohesionless Soils

Compactness Condition	SPT N (blows/0.3m)
Very Loose	0 – 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very Dense	>50

MAJOR DIVISION			UCS	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS	GRAVELS (MORE THAN HALF COARSE GRAINS LARGER THAN 4.75 mm)	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			GP	POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		GRAVELS WITH FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE W_p LESS THAN 4
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE W_p MORE THAN 7
	SANDS (MORE THAN HALF COARSE GRAINS SMALLER THAN 4.75 mm)	CLEAN SANDS (LITTLE R NO FINES)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			SP	POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		SANDS WITH FINES	SM	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW 'A' LINE W_p LESS THAN 4
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE 'A' LINE W_p MORE THAN 7
FINE GRAINED SOILS	SILTS (BELOW 'A' LINE NEGLIGIBLE ORGANIC CONTENT)	$W_L < 50$	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)	
		$W_L > 50$	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS		
	CLAYS (ABOVE 'A' LINE NEGLIGIBLE ORGANIC CONTENT)	$W_L < 30$	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS	WHENEVER THE NATURE OF THE FINE CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER 'F'. E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY	
		$30 < W_L < 50$	CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50$	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS (BELOW 'A' LINE)	$W_L < 50$	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
		$W_L > 50$	OH	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE	
BEDROCK			BR	SEE REPORT DESCRIPTION		
FILL			FILL	SEE REPORT DESCRIPTION		



NOTE:
1. BOUNDARY CLASSIFICATION POSSESSING CHARACTERISTICS OF TWO GROUPS ARE GIVEN GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL MIXTURE WITH CLAY BINDER BETWEEN 5% AND 12%

SOIL COMPONENTS

FRACTION		SIEVE SIZE (mm)		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
		PASSING	RETAINED	PERCENT	IDENTIFIER
GRAVEL	COARSE	75	19	50 – 35	AND
	FINE	19	4.75		
SAND	COARSE	4.75	2.00	35 – 20	_____Y
	MEDIUM	2.00	0.425		
	FINE	0.425	0.075	20 – 10	SOME
SILT (non-plastic) or CLAY (plastic)		0.075		10 – 1	TRACE

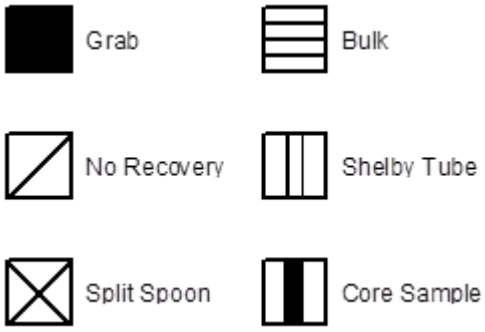
OVERSIZE MATERIALS	
ROUNDED OR SUB-ROUNDED COBBLES 75 mm TO 200 mm BOULDERS >200 mm	ANGULAR ROCK FRAGMENTS ROCKS > 0.75 m3 IN VOLUME

MODIFIED UNIFIED SOIL CLASSIFICATION SYSTEM

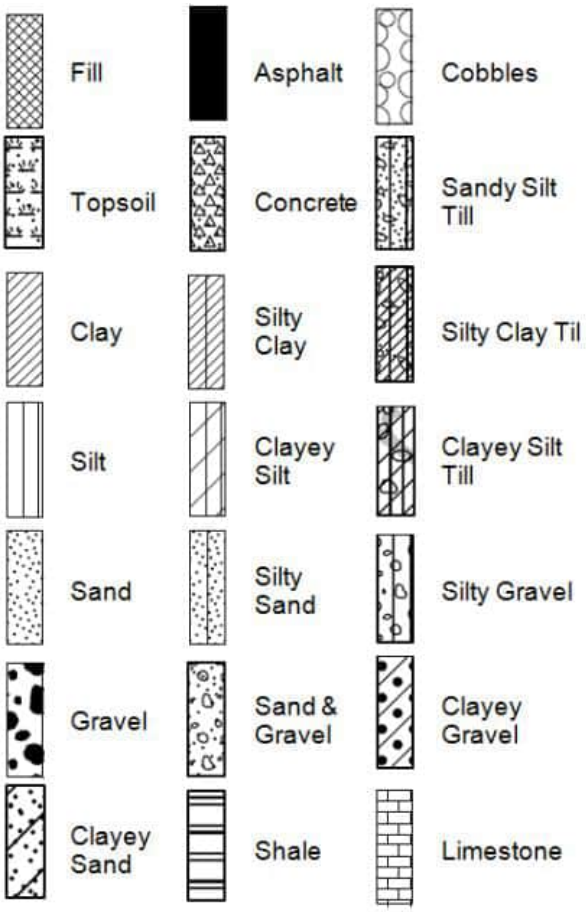
February 2022

1.5 Sample Type, Symbols and Abbreviations

The depth, type, and condition of samples are indicated on the logs by the following symbols or abbreviations:

Sample abbreviations:	Symbols:
GS: Grab Sample	
BK: Bulk Sample	
NR: No Recovery	
ST: Shelby Tube	
SS: Split Spoon	
Core: Core Samples	
FV: Field Vane	
PP: Pocket Penetrometer	
DCPT: Dynamic cone penetration test	

1.6 STRATA/Graphic Plot (Shall be Changed For Different Guidelines)



2. EXPLANATION OF ENVIROMENTAL SAMPLE

2.1 Contaminant Abbreviations

Contaminant Abbreviations	
BNAE	Base/neutral/acid extractables
BTEX	Benzene, toluene, ethylbenzene, xylenes
OCP	Organochlorine pesticides
MI	Metals and inorganics
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PHC	CCME petroleum hydrocarbons (fractions 1-4)
VOC	Volatile organic compounds (includes BTEX)
SO_4	Water Soluble Sulphate Content

2.2 Water Soluble Sulphate Concentration

The following table, from CSA Standard A23.1-14, indicates the requirements for concrete subjected to sulphate attack based upon the percentage of water-soluble sulphate as presented on the logs. CSA Standard A23.1-14 should be read in conjunction with the table.

Table 3 Requirements for Concrete Subjected to Sulphate Attack*

Class of exposure	Degree of exposure	Water-soluble sulphate (SO_4)† in soil sample, %	Sulphate (SO_4) in groundwater samples, mg/L‡	Water soluble sulphate (SO_4) in recycled aggregate sample, %	Cementing materials to be used§††	Performance requirements§,§§		
						Maximum expansion when tested using CSA A3004-C8 Procedure A at 23 °C, %		Maximum expansion when tested using CSA A3004-C8 Procedure B at 5 °C, % †††
						At 6 months	At 12 months††	At 18 months‡‡
S-1	Very severe	> 2.0	> 10 000	> 2.0	HS** ,HSb, HSLb*** or HSe	0.05	0.10	0.10
S-2	Severe	0.20–2.0	1500–10 000	0.60–2.0	HS**, HSb, HSLb*** or HSe	0.05	0.10	0.10
S-3	Moderate (including seawater exposure*)	0.10–0.20	150–1500	0.20–0.60	MS, MSb, MSe, MSLb***, LH, LHb, HS**, HSb, HSLb*** or HSe	0.10		0.10

*For sea water exposure, also see Clause 4.1.1.5.
†In accordance with CSA A23.2-3B.
‡In accordance with CSA A23.2-2B.
§Where combinations of supplementary cementing materials and portland or blended hydraulic cements are to be used in the concrete mix design instead of the cementing materials listed, and provided they meet the performance requirements demonstrating equivalent performance against sulphate exposure, they shall be designated as MS equivalent (MSe) or HS equivalent (HSe) in the relevant sulphate exposures (see Clauses 4.1.1.6.2, 4.2.1.1, and 4.2.1.3, and 4.2.1.4).
**Type HS cement shall not be used in reinforced concrete exposed to both chlorides and sulphates, including seawater. See Clause 4.1.1.6.3.
††The requirement for testing at 5 °C does not apply to MS, HS, MSb, HSb, and MSe and HSe combinations made without portland limestone cement.
‡‡ If the increase in expansion between 12 and 18 months exceeds 0.03%, the sulphate expansion at 24 months shall not exceed 0.10% in order for the cement to be deemed to have passed the sulphate resistance requirement.
§§For demonstrating equivalent performance, use the testing frequency in Table 1 of CSA A3004-A1 and see the applicable notes to Table A3 in A3001 with regard to re-establishing compliance if the composition of the cementing materials used to establish compliance changes.

***Where MSLb or HSLb cements are proposed for use, or where MSe or HSe combinations include Portland-limestone cement, they must also contain a minimum of 25% Type F fly ash or 40% slag or 15% metakaolin (meeting Type N pozzolan requirements) or a combination of 5% Type SF silica fume with 25% slag or a combination of 5% Type SF silica fume with 20% Type F fly ash. For some proposed MSLb, HSLb, and MSe or HSe combinations that include Portland-limestone cement, higher SCM replacement levels may be required to meet the A3004-C8 Procedure B expansion limits. Due to the 18-month test period, SCM replacements higher than the identified minimum levels should also be tested. In addition, sulphate resistance testing shall be run on MSLb and HSLb cement and MSe or HSe combinations that include Portland-limestone cement at both 23 °C and 5 °C as specified in the table.

†††If the expansion is greater than 0.05% at 6 months but less than 0.10% at 1 year, the cementing materials combination under test shall be considered to have passed.

2.3 Soil Corrosivity

The following table, from the Handbook of Corrosion Engineering (Roberge, 1999) indicates the corrosivity rating can be obtained from the soil resistivity, presented on the logs.

Table 4 Corrosivity Ratings Based on Soil Resistivity

Soil Resistivity (ohm-cm)	Corrosivity Rating
>20,000	Essentially non-corrosive
10,000 – 20,000	Mildly corrosive
5,000 – 10,000	Moderately corrosive
3,000 – 5,000	Corrosive
1,000 – 3,000	Highly corrosive
<1,000	Extremely corrosive

3. HYDROGEOLOGICAL

The groundwater table is indicated by the equilibrium level of water in a standpipe installed in a test hole or test pit. This level is generally taken at least 24 hours after installation of the standpipe. The groundwater level is subject to seasonal variations and is usually highest in the spring. The symbol on the logs indicating the groundwater level is an inverted solid triangle (▼).

4. EXPLANATION OF ROCK

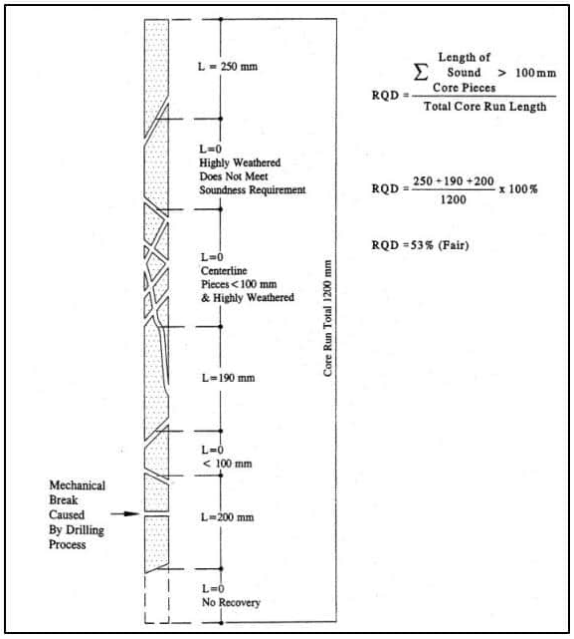
4.1 General Description and Terms

General Description of Geotechnical Unit including: Quantitative description including rock type (s), percentage of rock types, frequency and sizes of interbeds, colour, texture, weathering, strength and general joint spacing

Total Core Recovery (TCR): Total length of core recovered expressed as percentage of core run length.
Solid Core Recovery (SCR): Total length of solid full diameter core expressed as percentage of core run length.
Rock Quality Designation (RQD): Sum of lengths of solid core pieces longer than 100 mm expressed as percentage of core run length.
Fracture Index (FI): Number of fractures per meter of core.

4.2 Rock Quality Designation (RQD)

RQD(%)	RQD Classification
0 – 25	Very Poor Quality
25 – 50	Poor Quality
50 – 75	Fair Quality
75 – 90	Good Quality
90 – 100	Excellent Quality



4.3 Classification of Strength

Grade	Description	Field identification	Approximate range of Uniaxial compression strength (MPa)
R0	Extremely weak rock	Indented by thumbnail	0.25-1.0
R1	Very weak rock	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	1.0-5.0

R2	Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	5.0-25
R3	Medium strong rock	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	25-50
R4	Strong rock	Specimen requires more than one blow of geological hammer to fracture it	50-100
R5	Very strong rock	Specimen requires many blows of geological hammer to fracture it	100-250
R6	Extremely strong rock	Specimen can only be chipped with geological hammer	>250

4.4 Classification of Weathering

Grade	Description	Field identification
W1	Fresh	No visible sign of rock material weathering; perhaps slight discolouration on major discontinuity surface
W2	Slightly Weathered	Discolouration indicates weathering of rock material and discontinuity surface. All the rock material may be discoloured by weathering and may be somewhat weaker externally than in its fresh condition
W3	Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a continuous framework or as corestones.
W4	Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a continuous framework or as corestones.
W5	Completely Weathered	All rock material is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact. All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but soil has not been significantly transported.
W6	Residual Soil	Residual Soil

4.5 Type of discontinuity

Symbol	Description
F	Fault
J	Joint
Sh	Shear
Fo	Foliation
V	Vein
B	Bedding

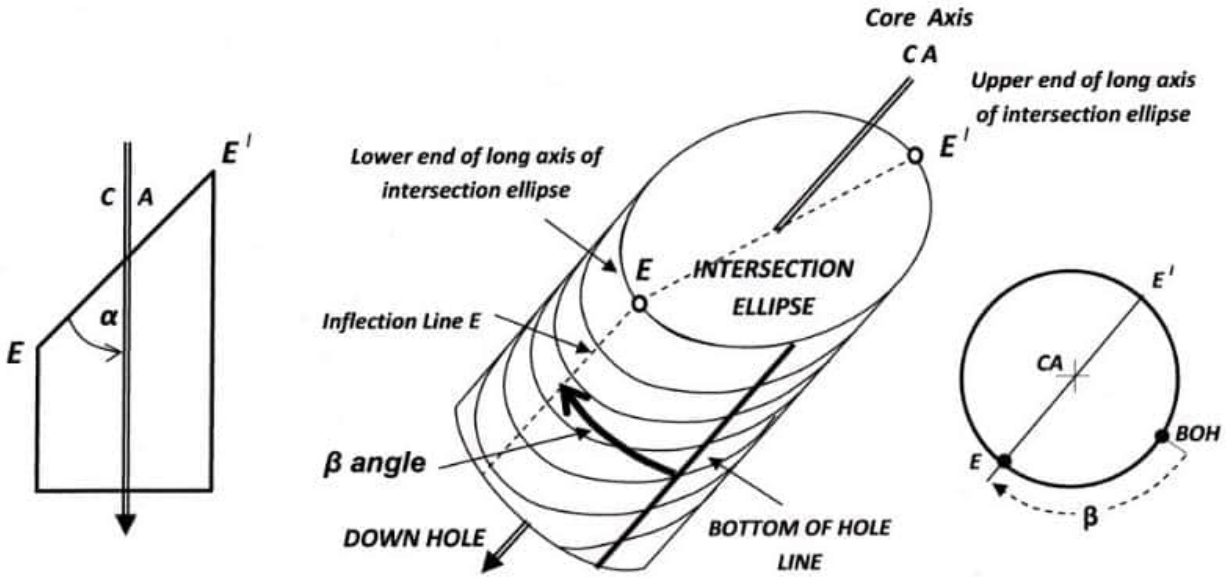
4.6 Spacing of discontinuity

Spacing Classification	Spacing width
Extremely close	<0.02m

Very close	0.02-0.06m
Close	0.06-0.2m
Moderately Close	0.2-0.6m
Wide	0.6-2.0m
Very Wide	2.0-6.0m
Extremely Wide	>6.0m

4.7 Joint Orientation

The orientation of a planar surface intersected by drill core can be defined by two angles called alpha (α) and beta (β). The definition of these angles is shown in the diagram below:



4.8 Inclination

Term	Inclination (degrees from the horizontal)
Sub-horizontal	0-5
Gently Inclined	6-15
Moderately Inclined	16-30
Steeply Inclined	31-60
Very Steeply Inclined	61-80
Sub-vertical	81-90

4.9 Stratification/foliation

Term	Spacing
Very Thickly Bedded	>2m
Thickly Bedded	600mm-2m
Medium Bedded	200mm-600mm
Thinly Bedded	60mm-200mm

Term	Spacing
Very Thinly Bedded	20mm-60mm
Laminated	6mm-20mm
Thinly Laminated	2mm-6mm
Fissile	<2mm

4.10 Grain Size

Term	Size
Very Coarse Grained	>60 mm
Coarse Grained	2mm-60mm
Medium Grained	60 microns – 2mm
Fine Grained	2 microns – 60 microns
Very Fine Grained	<2 microns

4.11 Aperture of open discontinuity

Symbol	Aperture Opening	Description	
VT	<0.1 mm	Very tight	Closed Features
T	0.1-0.25mm	Tight	
PO	0.25-0.5mm	Partly open	
O	0.5-2.5mm	Open	Gapped Features
MW	2.5-10mm	Moderately open	
W	>10mm	Wide	
VW	1-10cm	Very wide	Open Features
EW	10-100cm	Extremely wide	
C	>1m	Cavernous	

4.12 Width of filled discontinuity

Symbol	Width	Description
W	12.5-50mm	Wide
MW	2.5-12.5mm	Moderately Wide
N	1.25-2.5mm	Narrow
VN	<1.25mm	Very Narrow
T	0mm	Tight

4.13 Roughness of discontinuity

Symbol	Description
Slk	Slickenside (surface has smooth, glassy finish with visual evidence of striations)
S	Smooth (surface appears smooth and feels so to the touch)
SR	Slightly rough (asperities on the discontinuity surfaces are distinguishable and can be felt)
R	Rough (some ridges and side-angle steps are evident; asperities are clearly visible, and discontinuity surface feels very abrasive)

Symbol	Description
VR	Very rough (near-vertical steps and ridges occur on the discontinuity surface)

4.14 Shape of discontinuity

Symbol	Description
Pl	Planar
St	Stepped
Un	Undulating
Ir	Irregular

4.15 Filling amount

Symbol	Description
Su	Surface Stain
Sp	Spotty
Pa	Partially Filled
Fi	Filled
No	None

4.16 Filling Type

Symbol	Term	Hard/Soft
Ab	Albite	Hard
Ah	Anhydrite	Hard
Bt	Biotite	Soft
Bn	Bornite	Hard
Ca	Calcite	Hard
Cb	Carbonate	Hard
Ch	Chlorite	Soft
Cpy	Chalcopyrite	Hard
Cy	Clay	Soft
Do	Dolomite	Hard
Ep	Epidote	Hard
Fd	Feldspar	Hard
FeOx	Iron Oxide	Hard
Go	Gouge	Soft
Gr	Graphite	Soft
Gy	Gypsum	Soft
He	Hematite	Hard
Ka	Kaolinite	Soft
Kf	K-feldspar	Hard

Symbol	Term	Hard/Soft
Lm	Limonite/FeOx	Soft
Ms	Muscovite	Soft
Mt	Magnetite	Hard
Py	Pyrite	Hard
Qz	Quartz	Hard
Rb	Rubble	Hard
Sa	Sand	Hard
Se	Sericite/Illite	Soft
Si	Silt	Hard
Sm	Smectite	Soft
Su	Sulphide	Hard
Ta	Talc	Soft
UH	Unknown Hard	Hard
US	Unknown Soft	Soft
OTH - see comments		

PROJECT: RM of Stanley Regional Wastewater System	CLIENT: The Manitoba Water Service Board	TESTHOLE NO: TH24-02
LOCATION: UTM: 14 U, 580175.666 m E, 5449459.58 m N		PROJECT NO.: 60735871
CONTRACTOR: Maple Leaf Drilling	METHOD: Solid Stem Auger	ELEVATION (m): 267.35

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0	OR	TOPSOIL: loose black gravel with organic content - low plastic - dry		G1			267
	FILL	FILL: black to brown fat clay with gravel - firm - cobbles		G2		G2: LL =22, PL = 19; Gravel (%) = 0.0, Sand (%) = 42.0, Silt (%) = 44.2, Clay (%) = 13.8	
1		soft grey sandy SILT (ML) - some sand and clay, trace gravel - moist		G3			266
2	ML						265
		- tan - very soft below 2.44 m - saturated below 2.44 m		G4			
3							264
		stiff grey fat CLAY (CH) - trace sand - moist					
4				G5			263
		- firm below 4.57 m - silt inclusions					
5							262
	CH						
6				G6			261
7							260
				G7			
8		End of Testhole - Soil sloughing was observed in the SILT (ML) at a depth of 2.44 m - Minor groundwater seepage was observed at a depth of 2.74 m - Testhole terminated at a depth of 7.62 m in fat CLAY (CH) - Testhole backfilled with soil cuttings to ground surface					259
9							258
10							

PENETRATION TESTS: Becker | Dynamic Cone | SPT (Standard Pen Test) (Blows/300mm) 0 20 40 60 80 100; Total Unit Wt (kN/m³) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: Torvane | QU/2 | Lab Vane | Pocket Pen. | Field Vane (kPa) 50 100 150 200

AECOM

LOGGED BY: LC	COMPLETION DEPTH: 7.62 m
REVIEWED BY: GL	COMPLETION DATE: 24-9-26
PROJECT ENGINEER: German Leal	Page 1 of 1

LOG OF TEST HOLE 60735871 RM OF STANLEY - TESTHOLE LOGS (DRAFT) V1.GPJ UMA WINN.GDT 24-12-19

PROJECT: RM of Stanley Regional Wastewater System	CLIENT: The Manitoba Water Service Board	TESTHOLE NO: TH24-03
LOCATION: UTM: 14 U, 580187.876 m E, 5448502.596 m N		PROJECT NO.: 60735871
CONTRACTOR: Maple Leaf Drilling	METHOD: Solid Stem Auger	ELEVATION (m): 266.36

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0	OR	TOPSOIL: firm black gravel with organic content - intermediate plastic - moist	G1			266
		very soft grey sandy SILT (ML) - some sand and clay, trace gravel - moist	G2			
1						
	ML		G3			265
			T4		T4: Bulk Unit Weight (kN/m^3) = 15.6	
2						
						264
		firm grey fat CLAY (CH) - some silt - moist	G5			
3						263
4		- silt inclusions below 3.96 m				
		- stiff below 4.50 m	G6			262
			T7		T7: Bulk Unit Weight (kN/m^3) = 17.8	
5						
	CH					261
6			G8			
						260
7						
			G9			259
8			T10		T10: Bulk Unit Weight (kN/m^3) = 17.7	
		End of Testhole - Soil sloughing was observed in the SILT (ML) at a depth of 1.22 m - Moderate groundwater seepage was observed at a depth of 2.13 m - Testhole terminated at a depth of 7.62 m in fat CLAY (CH) - Testhole backfilled with soil cuttings to ground surface				258
9						
						257
10						

PENETRATION TESTS: Becker | Dynamic Cone | SPT (Standard Pen Test) (Blows/300mm) 0 20 40 60 80 100; Total Unit Wt (kN/m^3) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: Torvane | QU/2 | Lab Vane | Pocket Pen. | Field Vane (kPa) 50 100 150 200

LOG OF TEST HOLE 60735871 RM OF STANLEY - TESTHOLE LOGS (DRAFT) V1.GPJ UMA WINN.GDT 24-12-19

AECOM

LOGGED BY: LC	COMPLETION DEPTH: 8.23 m
REVIEWED BY: GL	COMPLETION DATE: 24-9-26
PROJECT ENGINEER: German Leal	Page 1 of 1

PROJECT: RM of Stanley Regional Wastewater System	CLIENT: The Manitoba Water Service Board	TESTHOLE NO: TH24-04
LOCATION: UTM: 14 U, 580187.531 m E, 5448485.111 m N		PROJECT NO.: 60735871
CONTRACTOR: Maple Leaf Drilling	METHOD: Solid Stem Auger	ELEVATION (m): 265.98

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0	OR	TOPSOIL: soft black sandy clay with organic content - low plastic - dry		G1			
	FILL	FILL: black fat clay - some gravel and cobbles - soft		G2			
1	ML	very soft tan sandy SILT (ML) - moist to saturated					265
		stiff brown lean CLAY (CL) with sand - saturated		G3		G3: LL =25, PL = 17; Gravel (%) = 0.0, Sand (%) = 24.1, Silt (%) = 58.7, Clay (%) = 17.2	
2	CL						264
		stiff brown fat CLAY (CH) - trace sand - saturated					
3				G4			263
				T5		T5: Bulk Unit Weight (kN/m^3) = 17.5	
4							262
		- grey below 4.27 m - moist below 4.27 m - silt inclusions		G6			
5	CH						261
6				G7			260
				T8		T8: Bulk Unit Weight (kN/m^3) = 17.7	
7							259
				G9			
8		End of Testhole - Soil sloughing was observed in the sandy SILT (ML) at a depth of 1.52 m - Moderate groundwater seepage was observed at a depth of 1.83 m - Groundwater level was observed at a depth of 4.27 m upon completion of drilling - Standpipe piezometer installed to a depth of 5.31 m, in fat CLAY (CH), slotted between a depth of 5.31 m and 0.70 m, stick up 0.82 m. - Testhole terminated at a depth of 7.62 m in fat CLAY (CH) - Testhole backfilled with bentonite to a depth of 5.61 m, then with filter sand to a depth of 0.40 m, then with bentonite to ground surface.					258
9							257
10							

PENETRATION TESTS: ✳ Becker ✳ | ◇ Dynamic Cone ◇ | ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100 | ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21 | Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + | × QU/2 × | □ Lab Vane □ | △ Pocket Pen. △ | ⬘ Field Vane ⬘ (kPa) 50 100 150 200

LOG OF TEST HOLE 60735871 RM OF STANLEY - TESTHOLE LOGS (DRAFT) V1.GPJ UMA WINN.GDT 24-12-19

AECOM

LOGGED BY: LC	COMPLETION DEPTH: 7.62 m
REVIEWED BY: GL	COMPLETION DATE: 24-9-26
PROJECT ENGINEER: German Leal	Page 1 of 1

PROJECT: RM of Stanley Regional Wastewater System	CLIENT: The Manitoba Water Service Board	TESTHOLE NO: TH24-05
LOCATION: UTM: 14 U, 581181.605 m E, 5448529.852 m N		PROJECT NO.: 60735871
CONTRACTOR: Maple Leaf Drilling	METHOD: Solid Stem Auger	ELEVATION (m): 265.60

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0	OR	TOPSOIL: loose black gravel with organic content - low plastic - dry to moist		G1			
	FILL	FILL: brown fat clay - trace gravel and cobbles - firm - moist		G2			265
1							
		loose to compact brown to tan clayey SAND (SC) - saturated		G3		G3: LL = 25, PL = 17; Gravel (%) = 8.9, Sand (%) = 50.8, Silt (%) = 27.4, Clay (%) = 12.9	264
2	SC			T4			
							263
3		firm grey lean CLAY (CL) - trace sand - moist		G5		G5: LL = 32, PL = 15; Gravel (%) = 0.0, Sand (%) = 10.6, Silt (%) = 67.1, Clay (%) = 22.2 T6: Bulk Unit Weight (kN/m^3) = 17.8	
	CL			T6			262
4							
		stiff grey fat CLAY (CH) - silt inclusions - moist		G7			261
5							
							260
6				G8		G8: LL = 60, PL = 19; Gravel (%) = 0.0, Sand (%) = 2.9, Silt (%) = 54.0, Clay (%) = 43.1 T9: Bulk Unit Weight (kN/m^3) = 17.4	
	CH			T9			259
7							
				G10			258
8				T11		T11: Bulk Unit Weight (kN/m^3) = 17.5	
		End of Testhole - Groundwater level was observed at a depth of 2.16 m upon completion of drilling - Soil sloughing was observed in the clayey SAND (SC) at a depth of 2.44 m and in the lean CLAY (CL) at 3.05 m - Moderate groundwater seepage was observed at a depth of 2.47 m - Standpipe piezometer installed to a depth of 8.23 m in fat CLAY (CH), slotted between a depth of 8.23 m and 1.52 m, flush mount. - Testhole terminated at a depth of 8.23 m in fat CLAY (CH) - Testhole backfilled with filter sand to a depth of 1.22 m, then with bentonite to ground surface.					257
9							
							256
10							
							255
11							

PENETRATION TESTS: Becker | Dynamic Cone | SPT (Standard Pen Test) (Blows/300mm) 0 20 40 60 80 100 | Total Unit Wt (kN/m^3) 16 17 18 19 20 21 | Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: Torvane | QU/2 | Lab Vane | Pocket Pen. | Field Vane (kPa) 50 100 150 200

AECOM

LOGGED BY: LC	COMPLETION DEPTH: 8.23 m
REVIEWED BY: GL	COMPLETION DATE: 24-9-25
PROJECT ENGINEER: German Leal	Page 1 of 1

LOG OF TEST HOLE 60735871 RM OF STANLEY - TESTHOLE LOGS (DRAFT) V1.GPJ UMA WINN.GDT 24-12-19

PROJECT: RM of Stanley Regional Wastewater System	CLIENT: The Manitoba Water Service Board	TESTHOLE NO: TH24-06
LOCATION: UTM: 14 U, 581163.689 m E, 5448504.629 m N		PROJECT NO.: 60735871
CONTRACTOR: Maple Leaf Drilling	METHOD: Solid Stem Auger	ELEVATION (m): 264.11

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
0	OR		TOPSOIL: compact black sand with organic content - low plastic - saturated		G1				264
	FILL		FILL: tan to brown fat clay - and silt, trace sand - very soft - moist		G2				
1									263
			firm tan fat CLAY (CH) - silty, trace sand - moist		G3				
2									262
			- grey - trace sand, silt inclusions						
3					G4				261
					T5			T5: Bulk Unit Weight (kN/m^3) = 18.0	
4									260
	CH				G6				
5									259
6					G7				258
7									257
					G9				
8			End of Testhole - Soil sloughing was observed in the FILL at a depth of 0.15 m and 0.91 m - Moderate groundwater seepage was observed at a depth of 0.91 m - Testhole terminated at a depth of 7.62 m in fat CLAY (CH) - Testhole backfilled with soil cuttings to ground surface						256
9									255
10									

PENETRATION TESTS: ✳ Becker ✳ | ◇ Dynamic Cone ◇ | ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100 | ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21 | Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + | × QU/2 × | ☐ Lab Vane ☐ | △ Pocket Pen. △ | ⬘ Field Vane ⬘ (kPa) 50 100 150 200

LOGGED BY: LC	COMPLETION DEPTH: 7.62 m
REVIEWED BY: GL	COMPLETION DATE: 24-9-25
PROJECT ENGINEER: German Leal	Page 1 of 1

AECOM

LOG OF TEST HOLE 60735871 RM OF STANLEY - TESTHOLE LOGS (DRAFT) V1.GPJ UMA WINN.GDT 24-12-19

PROJECT: RM of Stanley Regional Wastewater System	CLIENT: The Manitoba Water Service Board	TESTHOLE NO: TH24-07
LOCATION: UTM: 14 U, 579570.759 m E, 5446175.12 m N		PROJECT NO.: 60735871
CONTRACTOR: Maple Leaf Drilling	METHOD: Solid Stem Auger	ELEVATION (m): 269.83

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
0	OR		TOPSOIL: compact black gravel and sand with organic content - low plastic - dry		G1				
	FILL				G2				
1			FILL: black fat clay - silty, trace sand and gravel, cobbles - firm - moist						269
			soft brown fat CLAY (CH) with sand - moist		G3				
2	CH								268
3					G4				267
			very soft tan SILT (ML) - saturated						
4									266
	ML				G5				
5									265
6					G6				264
			very soft grey fat CLAY (CH) - saturated - stiff below 6.4 m - silt inclusions - trace sand						
7	CH								263
					G7				
8			End of Testhole - Groundwater level was observed at a depth of 2.74 m upon completion of drilling - Soil sloughing was observed in the SILT (ML) at a depth of 3.66 m - Minor groundwater seepage was observed at a depth of 4.27 m - Testhole terminated at a depth of 7.62 m in fat CLAY (CH) - Testhole backfilled with soil cuttings to ground surface						262
9									261
10									260

PENETRATION TESTS: Becker | Dynamic Cone | SPT (Standard Pen Test) (Blows/300mm) 0 20 40 60 80 100; Total Unit Wt (kN/m³) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: Torvane | QU/2 | Lab Vane | Pocket Pen. | Field Vane (kPa) 50 100 150 200

AECOM	LOGGED BY: LC	COMPLETION DEPTH: 7.62 m
	REVIEWED BY: GL	COMPLETION DATE: 24-9-26
	PROJECT ENGINEER: German Leal	Page 1 of 1

LOG OF TEST HOLE 60735871 RM OF STANLEY - TESTHOLE LOGS (DRAFT) V1.GPJ UMA WINN.GDT 24-12-19

PROJECT: RM of Stanley Regional Wastewater System	CLIENT: The Manitoba Water Service Board	TESTHOLE NO: TH24-08
LOCATION: UTM: 14 U, 578478.592 m E, 5444474.227 m N		PROJECT NO.: 60735871
CONTRACTOR: Maple Leaf Drilling	METHOD: Solid Stem Auger	ELEVATION (m): 273.38

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0	OR FILL		TOPSOIL: loose black with organic content - dry		G1			273
			FILL: brown fat clay - trace silt, cobbles - firm - dry		G2			
1	CH		stiff grey fat CLAY (CH) - trace gravel, trace sand - moist		G3			272
2			- silty					
	ML		very soft tan SILT (ML) - trace gravel - saturated		G4			271
3								
			stiff brown fat CLAY (CH) - silty, trace sand - moist					270
4			- grey below 4.27 m - silt inclusions below		G5		G5: LL = 52, PL = 15; Gravel (%) = 0.0, Sand (%) = 11.2, Silt (%) = 41.2, Clay (%) = 47.6	269
5								
	CH							268
6					G6			
								267
7								
					G7			266
8			End of Testhole - Groundwater level was observed at a depth of 2.44 m upon completion of drilling - Moderate groundwater seepage was observed at a depth of 2.47 m - Soil sloughing was observed in the SILT (ML) at a depth of 2.74 m - Testhole terminated at a depth of 7.62 m in fat CLAY (CH) - Testhole backfilled with soil cuttings to ground surface					265
9								
								264
10								

PENETRATION TESTS: Becker | Dynamic Cone | SPT (Standard Pen Test) (Blows/300mm) 0 20 40 60 80 100 | Total Unit Wt (kN/m³) 16 17 18 19 20 21 | Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: Torvane | QU/2 | Lab Vane | Pocket Pen. | Field Vane (kPa) 50 100 150 200

LOG OF TEST HOLE 60735871 RM OF STANLEY - TESTHOLE LOGS (DRAFT) V1.GPJ UMA WINN.GDT 24-12-19

AECOM

LOGGED BY: LC	COMPLETION DEPTH: 7.62 m
REVIEWED BY: GL	COMPLETION DATE: 24-9-26
PROJECT ENGINEER: German Leal	Page 1 of 1

Appendix D

Laboratory Test Results

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

204 477 5381 tel
204 284 2040 fax

Memorandum

To	Colton Wooster	Page	1
CC			
Subject	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station- Test Results		
From	German Leal		
Date	October 18, 2024	Project Number	60735871

Please find attached the following material test result(s) on sample(s) submitted to the Winnipeg Geotechnical Laboratory:

- Forty Nine (49) Moisture Content Determination Test.
- Six (6) Atterberg Limits (3 Points) Test.
- Six (6) Grain Size Distribution (Hydrometer method) Test.
- Ten (10) Unconfined Compressive Strength Tests.

If you have any questions, please contact the undersigned.

Prepared by:

Boughton, Lee [redacted]

Lee Boughton
Laboratory Manager

Reviewed by:

Leal, German [redacted]

German Leal, M.Eng., P.Eng.
Discipline Lead, Geotechnical

Att.

AECOM Canada Ltd.
Winnipeg Geotechnical Laboratory
99 Commerce Drive
Winnipeg, Manitoba
R3P 0Y7
Phone: 204 477 5381 Fax: 204 284 2040

Project Name:	RM of Stanley Regional Wastewater S	Supplier:	AECOM
Project Number:	60735871	Specification:	N/A
Client:	MWSB	Field Technician:	LCampodonico
Sample Location:	RM of Stanley	Sample Date:	September 27, 2024
Sample Depth:	Varies	Lab Technician:	LBoughton
Sample Number:	Varies	Date Tested:	October 1, 2024

Moisture Content (ASTM D2216-10)

Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

Location	Sample	Depth (m)	Moisture Content (%)
TH24-02	G1	0.15 - 0.30 m	**15.6%**
	G2	0.61 - 0.76 m	**18.5%**
	G3	1.37 - 1.52 m	**17.7%**
	G4	2.90 - 3.05 m	**24.7%**
	G5	4.42 - 4.57 m	**44.1%**
	G6	5.94 - 6.10 m	**48.1%**
	G7	7.47 - 7.62 m	**46.7%**
TH24-03	G1	0.15 - 0.30 m	**33.1%**
	G2	0.61 - 0.76 m	**28.0%**
	G3	1.37 - 1.52 m	**26.2%**
	T4	1.52 - 2.13 m	**-**
	G5	2.90 - 3.05 m	**43.7%**
	G6	4.42 - 4.57 m	**42.8%**
	T7	4.57 - 5.18 m	**-**
	G8	5.94 - 6.10 m	**41.5%**
	G9	7.47 - 7.62 m	**43.9%**
	T10	7.62 - 8.23 m	**-**
TH24-04	G1	0.15 - 0.30 m	**37.4%**
	G2	0.61 - 0.76 m	**22.7%**
	G3	1.37 - 1.52 m	**28.1%**
	G4	2.90 - 3.05 m	**46.0%**
	T5	3.05 - 3.66 m	**-**
	G6	4.42 - 4.57 m	**45.6%**
	G7	5.94 - 6.10 m	**48.6%**
	T8	6.10 - 6.71 m	**-**
	G9	7.47 - 7.62 m	**49.3%**
TH24-05	G1	0.15 - 0.30 m	**16.0%**
	G2	0.61 - 0.76 m	**16.7%**
	G3	1.37 - 1.52 m	**21.6%**
	G5	2.90 - 3.05 m	**38.0%**
	T6	3.05 - 3.66 m	
	G7	4.42 - 4.57 m	**43.4%**
	G8	5.94 - 6.10 m	**43.4%**
	T9	6.10 - 6.71 m	**-**
	G10	7.47 - 7.62 m	**48.4%**

Location	Sample	Depth (m)	Moisture Content (%)
	T11	7.62 - 8.23 m	**-**
TH24-06	G1	0.15 - 0.30 m	**31.1%**
	G2	0.61 - 0.76 m	**28.2%**
	G3	1.37 - 1.52 m	**33.9%**
	G4	2.90 - 3.05 m	**41.3%**
	T5	3.05 - 3.66 m	**-**
	G6	4.42 - 4.57 m	**46.1%**
	G7	5.94 - 6.10 m	**47.7%**
	T8	6.10 - 6.71 m	**-**
	G9	7.47 - 7.62 m	**48.9%**
TH24-07	G1	0.15 - 0.30 m	**40.1%**
	G2	0.61 - 0.76 m	**30.1%**
	G3	1.37 - 1.52 m	**31.1%**
	G4	2.90 - 3.05 m	**26.1%**
	G5	4.42 - 4.57 m	**33.5%**
	G6	5.94 - 6.10 m	**33.9%**
	G7	7.47 - 7.62 m	**43.6%**
TH24-08	G1	0.15 - 0.30 m	**28.2%**
	G2	0.61 - 0.76 m	**35.5%**
	G3	1.37 - 1.52 m	**35.2%**
	G4	2.90 - 3.05 m	**28.9%**
	G5	4.42 - 4.57 m	**40.4%**
	G6	5.94 - 6.10 m	**37.9%**
	G7	7.47 - 7.62 m	**44.3%**

AECOM Canada Ltd.
Winnipeg Geotechnical Laboratory
99 Commerce Drive, Winnipeg, MB R3P 0Y7
Phone: 204 477 5381

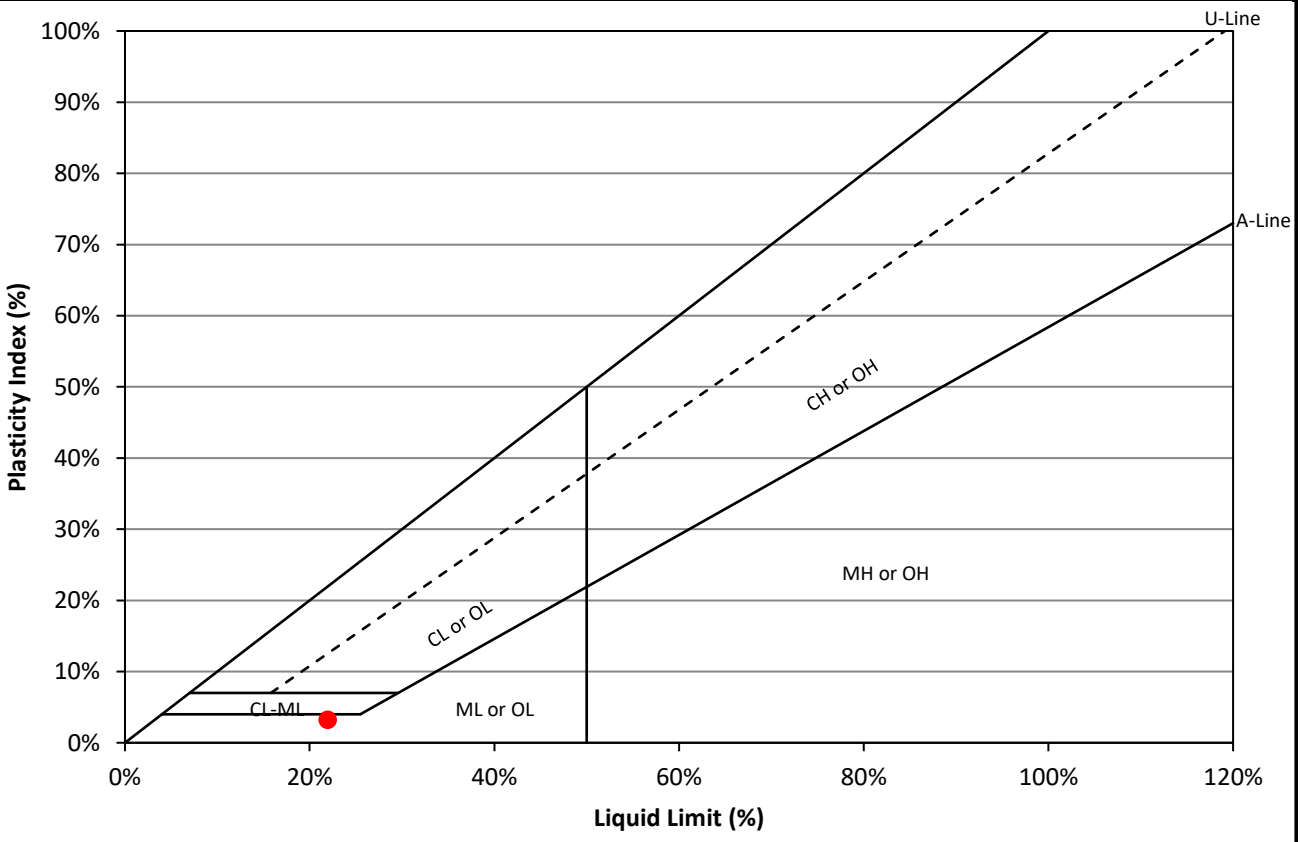
Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Supplier/Location:	AECOM
Client:	MWSB	Field Technician:	LCampodonico
Sample Location:	TH24-02	Sample Date:	September 27, 2024
Sample Depth:	0.61 - 0.76 m	Lab Technician:	LBoughton
Sample Number:	G2	Date Tested:	October 17, 2024

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	35	25	20
Wet Sample (g)	10.5	10.9	8.5
Dry Sample (g)	8.7	9.0	7.0
Water Content (%)	21.4%	21.8%	22.4%

Plastic Limit		
Trial	1	2
Wet Sample (g)	7.4	7.9
Dry Sample (g)	6.2	6.6
Water Content (%)	18.8%	18.6%



Liquid Limit:	22	Plastic Limit:	19	Plasticity Index:	3

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

AECOM Canada Ltd.
Winnipeg Geotechnical Laboratory
99 Commerce Drive, Winnipeg, MB R3P 0Y7
Phone: 204 477 5381

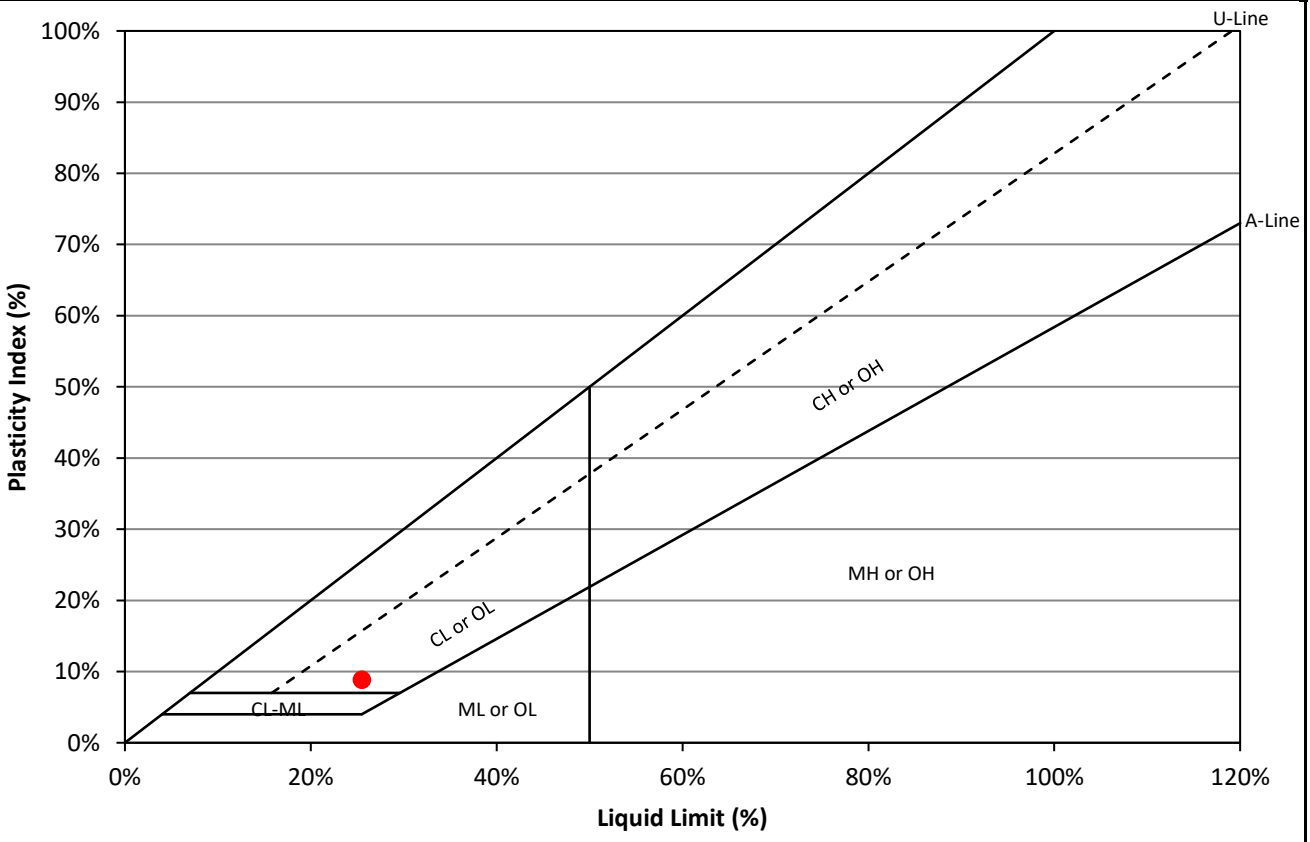
Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Supplier/Location:	AECOM
Client:	MWSB	Field Technician:	LCampodonico
Sample Location:	TH24-04	Sample Date:	September 27, 2024
Sample Depth:	1.37 - 1.52 m	Lab Technician:	LBoughton
Sample Number:	G3	Date Tested:	October 17, 2024

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	35	30	25
Wet Sample (g)	12.7	11.6	8.9
Dry Sample (g)	10.3	9.3	7.1
Water Content (%)	23.6%	24.2%	25.6%

Plastic Limit		
Trial	1	2
Wet Sample (g)	4.1	7.6
Dry Sample (g)	3.6	6.5
Water Content (%)	16.4%	16.9%



Liquid Limit:	26	Plastic Limit:	17	Plasticity Index:	9

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

AECOM Canada Ltd.
Winnipeg Geotechnical Laboratory
99 Commerce Drive, Winnipeg, MB R3P 0Y7
Phone: 204 477 5381

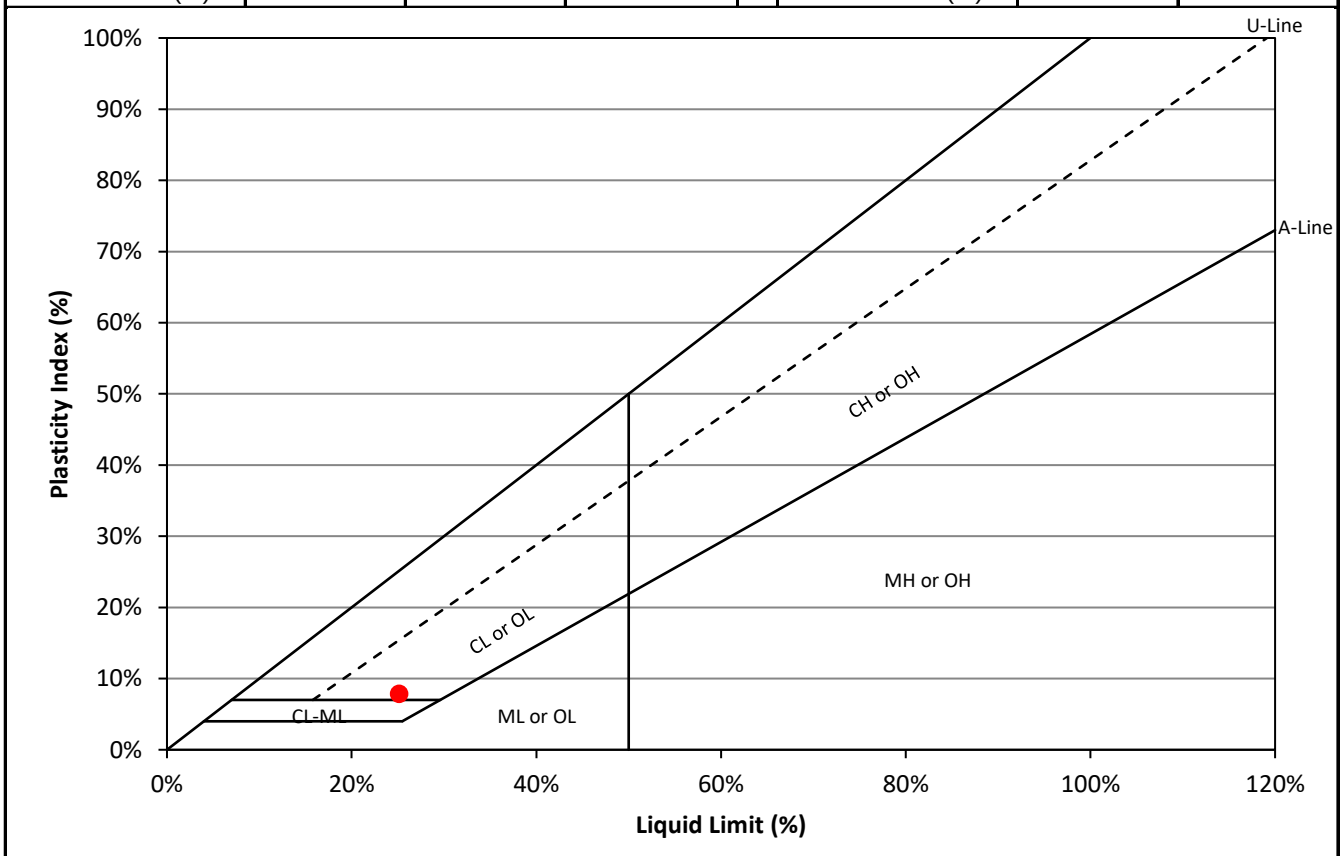
Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Supplier/Location:	AECOM
Client:	MWSB	Field Technician:	LCampodonico
Sample Location:	TH24-05	Sample Date:	September 27, 2024
Sample Depth:	1.37 - 1.52 m	Lab Technician:	LBoughton
Sample Number:	G3	Date Tested:	October 17, 2024

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	25	20	15
Wet Sample (g)	10.1	9.4	10.8
Dry Sample (g)	8.1	7.5	8.5
Water Content (%)	25.1%	25.8%	26.7%

Plastic Limit		
Trial	1	2
Wet Sample (g)	5.5	4.9
Dry Sample (g)	4.7	4.1
Water Content (%)	17.7%	17.0%



Liquid Limit:	25	Plastic Limit:	17	Plasticity Index:	8

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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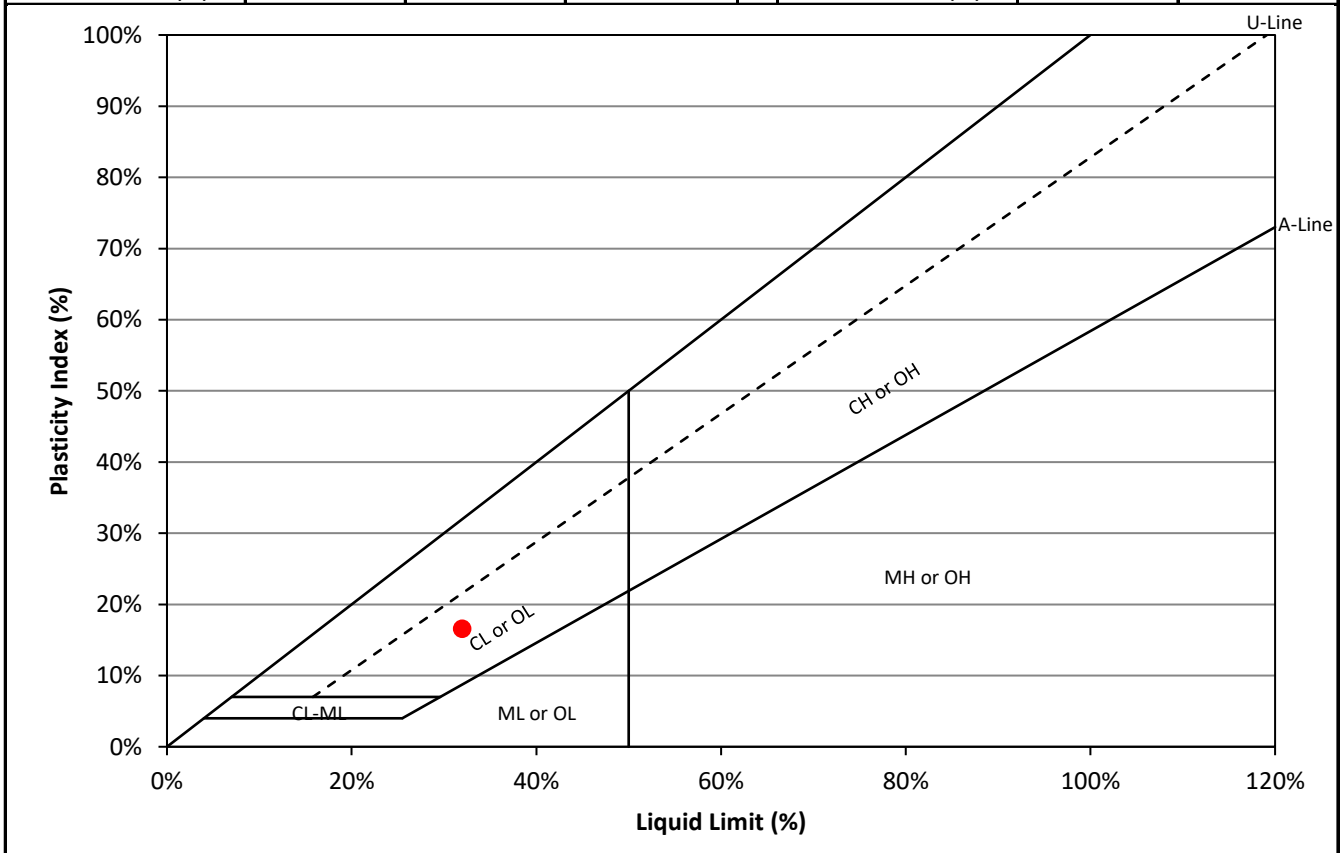
Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Supplier/Location:	AECOM
Client:	MWSB	Field Technician:	LCampodonico
Sample Location:	TH24-05	Sample Date:	September 27, 2024
Sample Depth:	2.90 - 3.05 m	Lab Technician:	LBoughton
Sample Number:	G5	Date Tested:	October 17, 2024

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	35	24	21
Wet Sample (g)	7.1	11.5	13.6
Dry Sample (g)	5.4	8.7	10.2
Water Content (%)	30.0%	32.3%	33.0%

Plastic Limit		
Trial	1	2
Wet Sample (g)	5.4	7.0
Dry Sample (g)	4.7	6.1
Water Content (%)	15.6%	15.2%



Liquid Limit:	32	Plastic Limit:	15	Plasticity Index:	17

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
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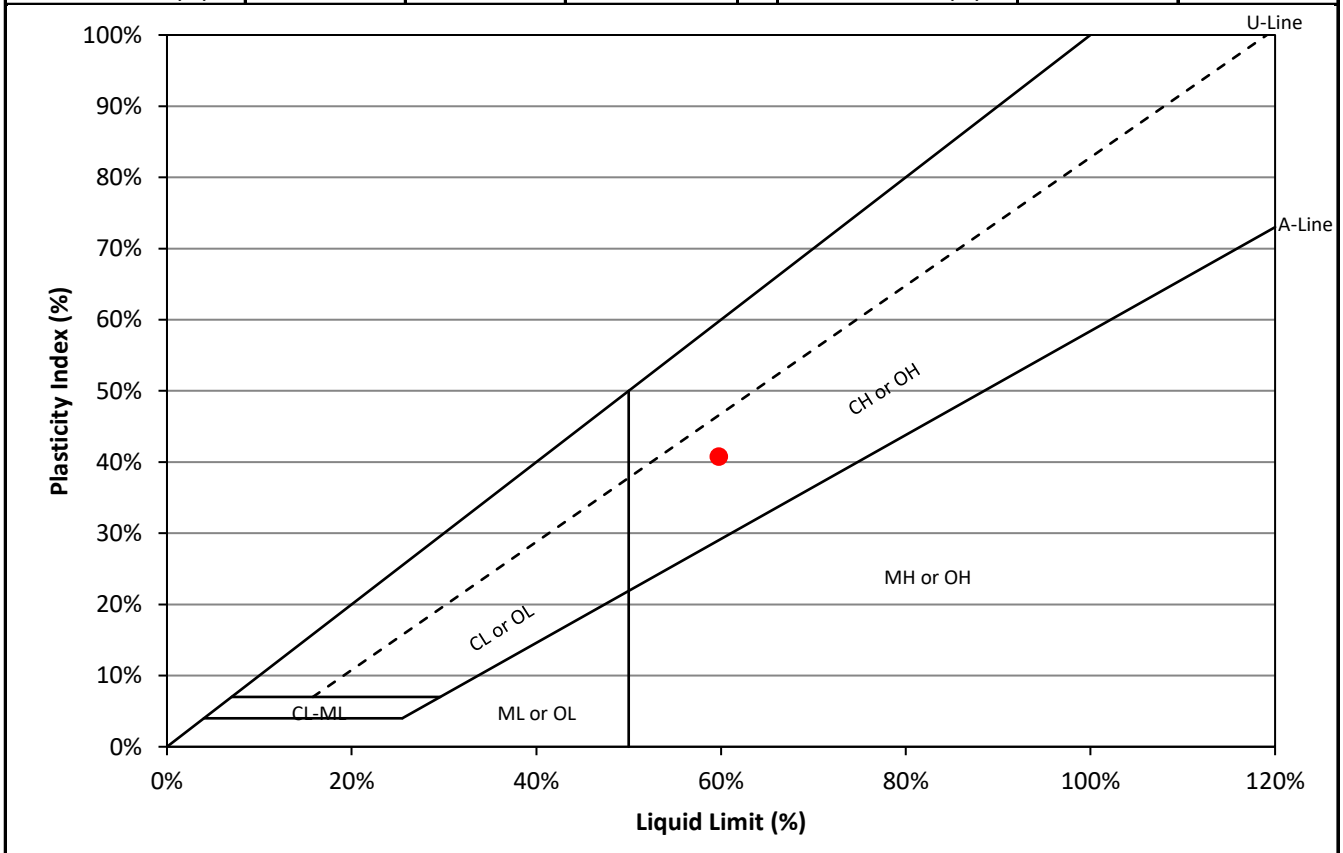
Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Supplier/Location:	AECOM
Client:	MWSB	Field Technician:	LCampodonico
Sample Location:	TH24-05	Sample Date:	September 27, 2024
Sample Depth:	5.94 - 6.10 m	Lab Technician:	LBoughton
Sample Number:	G8	Date Tested:	October 17, 2024

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	35	25	23
Wet Sample (g)	7.1	6.9	5.3
Dry Sample (g)	4.5	4.3	3.3
Water Content (%)	58.4%	59.6%	60.2%

Plastic Limit		
Trial	1	2
Wet Sample (g)	4.7	5.2
Dry Sample (g)	4.0	4.3
Water Content (%)	19.0%	19.0%



Liquid Limit:	60	Plastic Limit:	19	Plasticity Index:	41

Reviewed by: Lee Boughton
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Approved by: German Leal, M.Eng., P.Eng.
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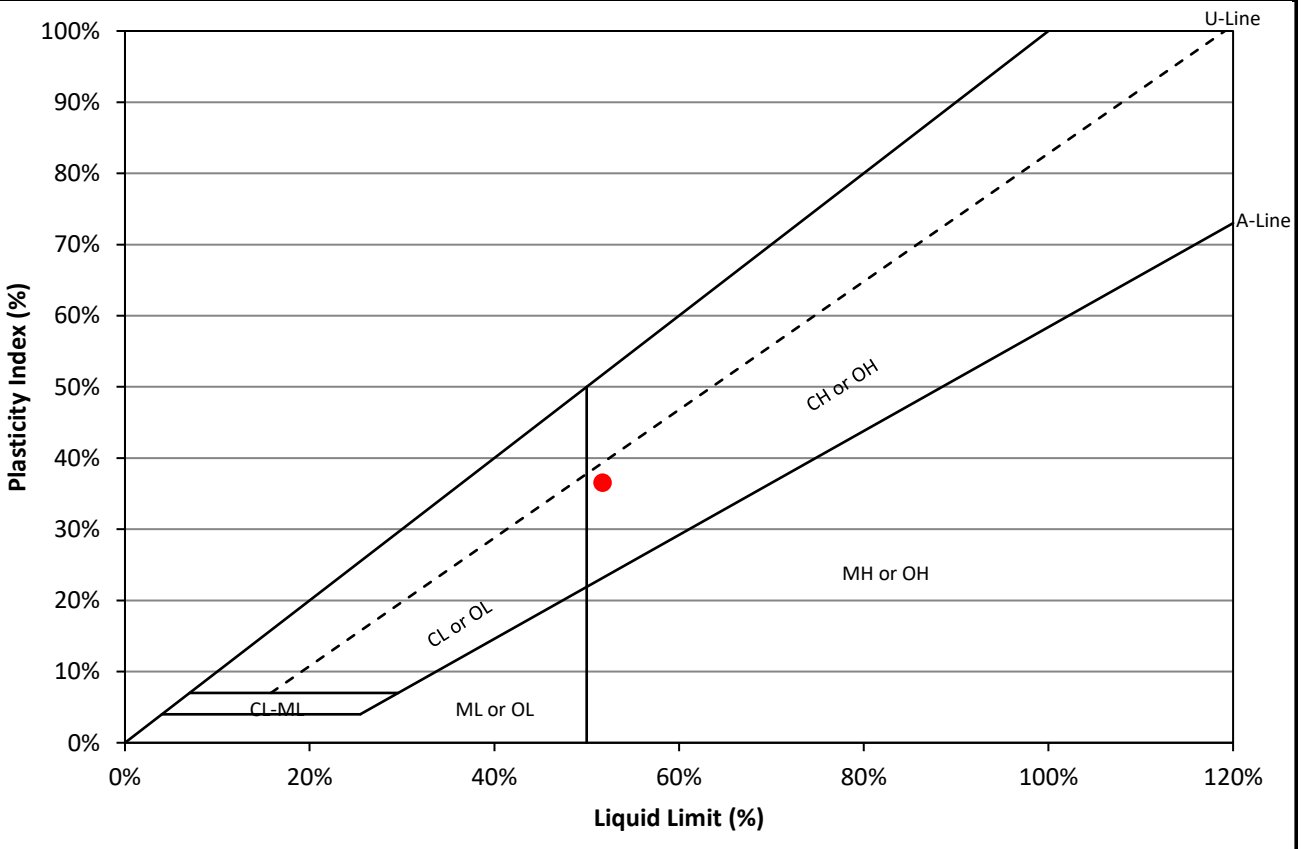
Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Supplier/Location:	AECOM
Client:	MWSB	Field Technician:	LCampodonico
Sample Location:	TH24-08	Sample Date:	September 27, 2024
Sample Depth:	4.42 - 4.57 m	Lab Technician:	LBoughton
Sample Number:	G5	Date Tested:	October 17, 2024

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	35	30	21
Wet Sample (g)	6.8	5.6	7.3
Dry Sample (g)	4.5	3.7	4.8
Water Content (%)	49.9%	50.7%	52.7%

Plastic Limit		
Trial	1	2
Wet Sample (g)	4.7	5.5
Dry Sample (g)	4.1	4.8
Water Content (%)	15.2%	15.2%



Liquid Limit:	52	Plastic Limit:	15	Plasticity Index:	37

Reviewed by: Lee Boughton
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Approved by: German Leal, M.Eng., P.Eng.
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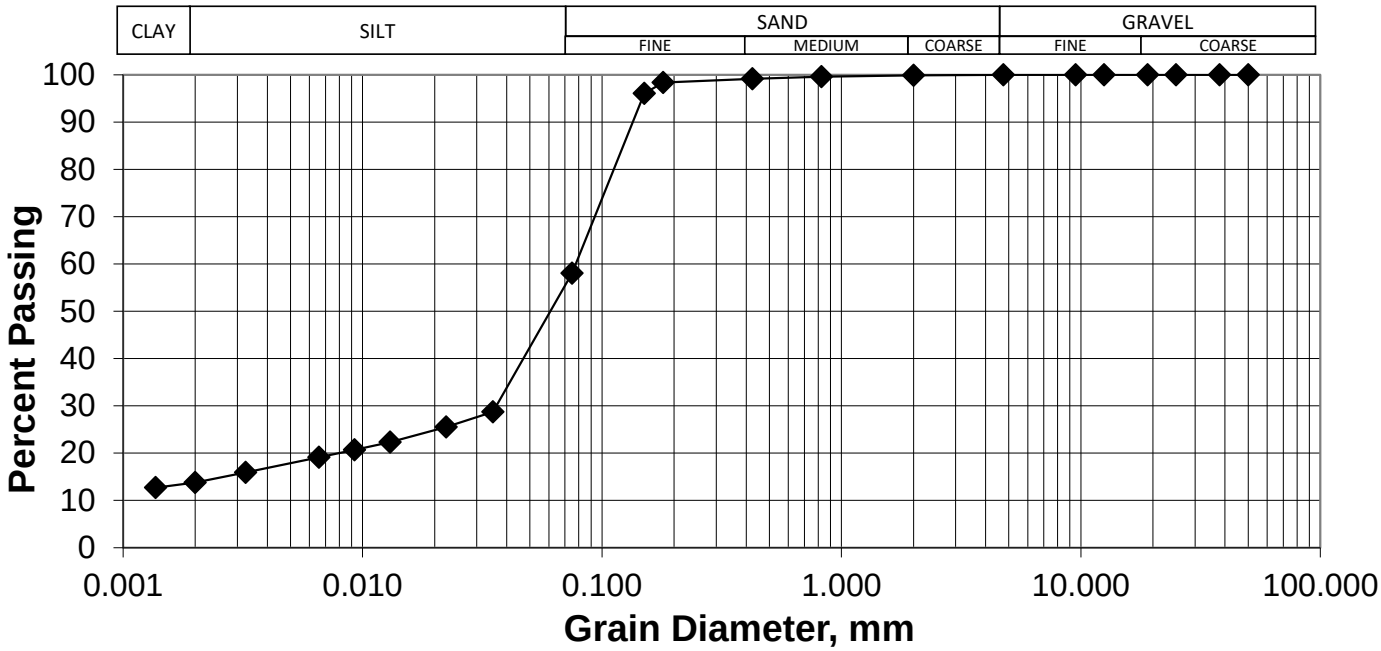
Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Supplier/Location:	AECOM
Client:	MWSB	Field Technician:	LCampodonico
Sample Location:	TH24-02	Sample Date:	27-Sep-24
Sample Depth :	0.61 - 0.76 m	Lab Technician:	LBoughton
Sample Number:	G2	Date Tested:	15-Oct-24

Hydrometer (AASHTO T88)

Standard Test Methods for Particle Size Analysis of Soils

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	100.0	0.0750	58.0
38.0	100.0	2.00	99.9	0.0350	28.8
25.0	100.0	0.825	99.6	0.0223	25.6
19.0	100.0	0.425	99.1	0.0130	22.4
12.5	100.0	0.18	98.4	0.0093	20.7
9.5	100.0	0.15	96.1	0.0066	19.1
4.75	100.0	0.075	58.0	0.0033	15.9
				0.0020	13.8
				0.0014	12.7

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**44.2%**
Sand	**42.0%**	**Clay**	**13.8%**

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
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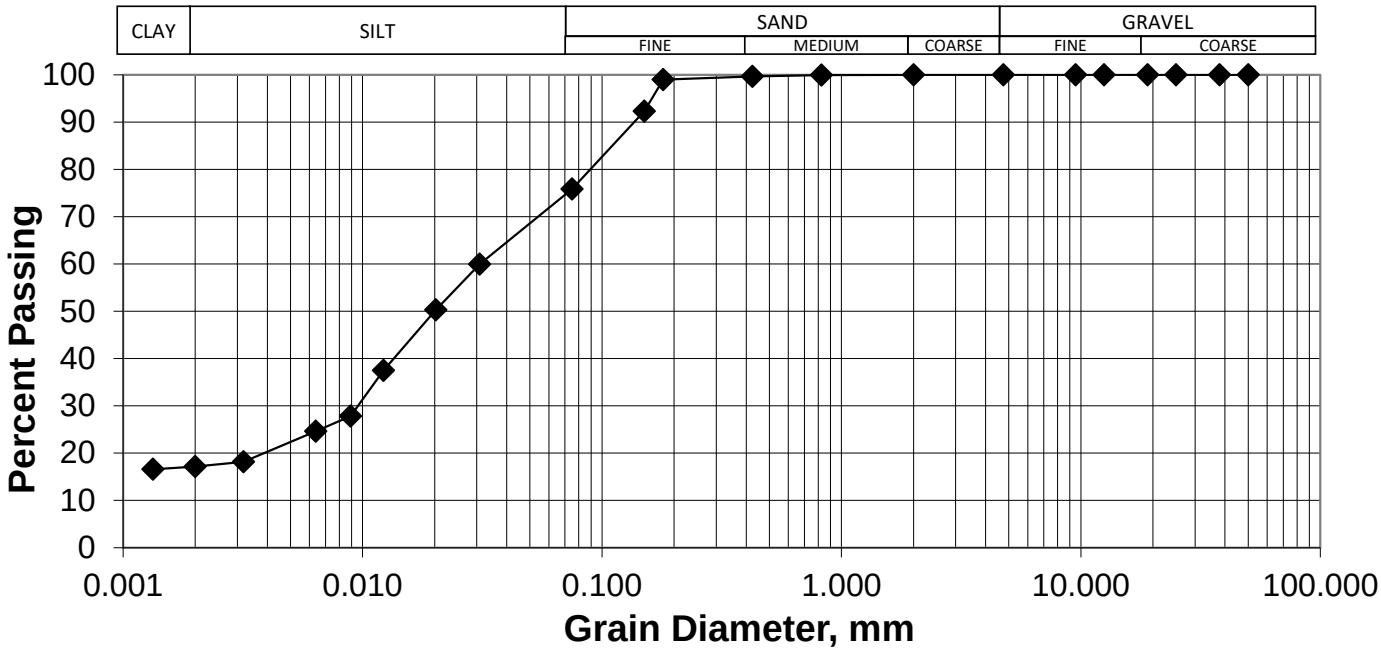
Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Supplier/Location:	AECOM
Client:	MWSB	Field Technician:	LCampodonico
Sample Location:	TH24-04	Sample Date:	27-Sep-24
Sample Depth :	1.37 - 1.52 m	Lab Technician:	LBoughton
Sample Number:	G3	Date Tested:	15-Oct-24

Hydrometer (AASHTO T88)

Standard Test Methods for Particle Size Analysis of Soils

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	100.0	0.0750	75.9
38.0	100.0	2.00	100.0	0.0309	59.9
25.0	100.0	0.825	99.9	0.0202	50.3
19.0	100.0	0.425	99.7	0.0122	37.5
12.5	100.0	0.18	99.0	0.0089	27.8
9.5	100.0	0.15	92.3	0.0064	24.6
4.75	100.0	0.075	75.9	0.0032	18.2
				0.0020	17.2
				0.0013	16.6

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**58.7%**
Sand	**24.1%**	**Clay**	**17.2%**

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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Phone: 204 477 5381

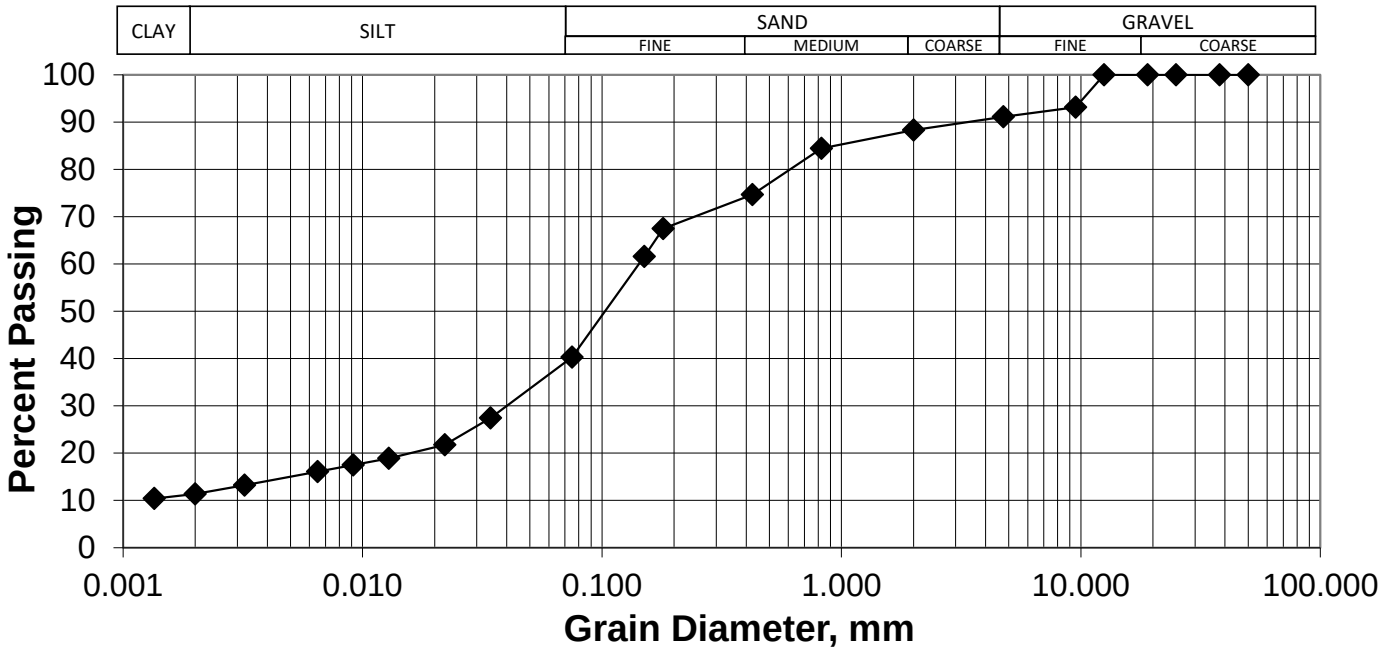
Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Supplier/Location:	AECOM
Client:	MWSB	Field Technician:	LCampodonico
Sample Location:	TH24-05	Sample Date:	27-Sep-24
Sample Depth :	1.37 - 1.52 m	Lab Technician:	LBoughton
Sample Number:	G3	Date Tested:	15-Oct-24

Hydrometer (AASHTO T88)

Standard Test Methods for Particle Size Analysis of Soils

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	91.1	0.0750	40.3
38.0	100.0	2.00	88.3	0.0342	31.0
25.0	100.0	0.825	84.4	0.0221	24.6
19.0	100.0	0.425	74.7	0.0129	21.4
12.5	100.0	0.18	67.5	0.0091	19.8
9.5	93.2	0.15	61.6	0.0065	18.2
4.75	91.1	0.075	40.3	0.0032	15.0
				0.0020	12.9
				0.0014	11.8

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**8.9%**	**Silt**	**27.4%**
Sand	**50.8%**	**Clay**	**12.9%**

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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Phone: 204 477 5381

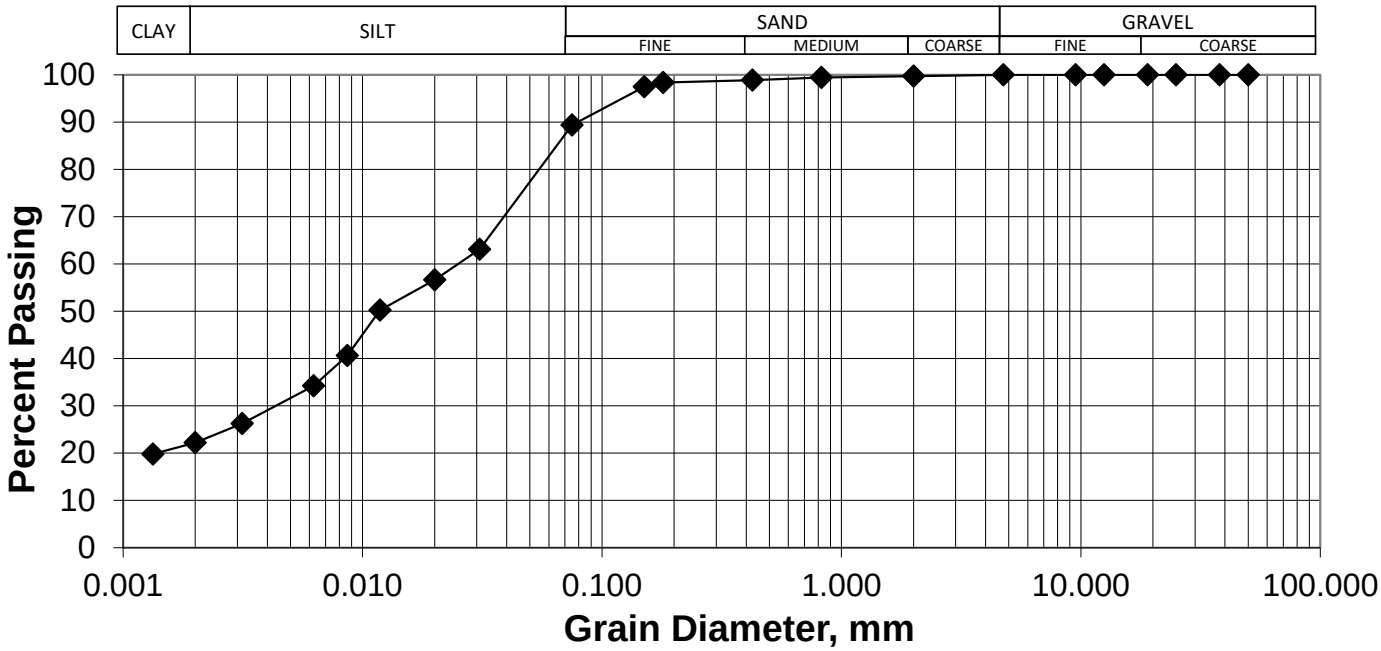
Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Supplier/Location:	AECOM
Client:	MWSB	Field Technician:	LCampodonico
Sample Location:	TH24-05	Sample Date:	27-Sep-24
Sample Depth :	2.90 - 3.05 m	Lab Technician:	LBoughton
Sample Number:	G5	Date Tested:	15-Oct-24

Hydrometer (AASHTO T88)

Standard Test Methods for Particle Size Analysis of Soils

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	100.0	0.0750	89.4
38.0	100.0	2.00	99.7	0.0308	63.2
25.0	100.0	0.825	99.4	0.0200	56.8
19.0	100.0	0.425	98.9	0.0118	50.4
12.5	100.0	0.18	98.4	0.0086	40.8
9.5	100.0	0.15	97.5	0.0062	34.3
4.75	100.0	0.075	89.4	0.0031	26.3
				0.0020	22.2
				0.0013	19.9

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**67.1%**
Sand	**10.6%**	**Clay**	**22.2%**

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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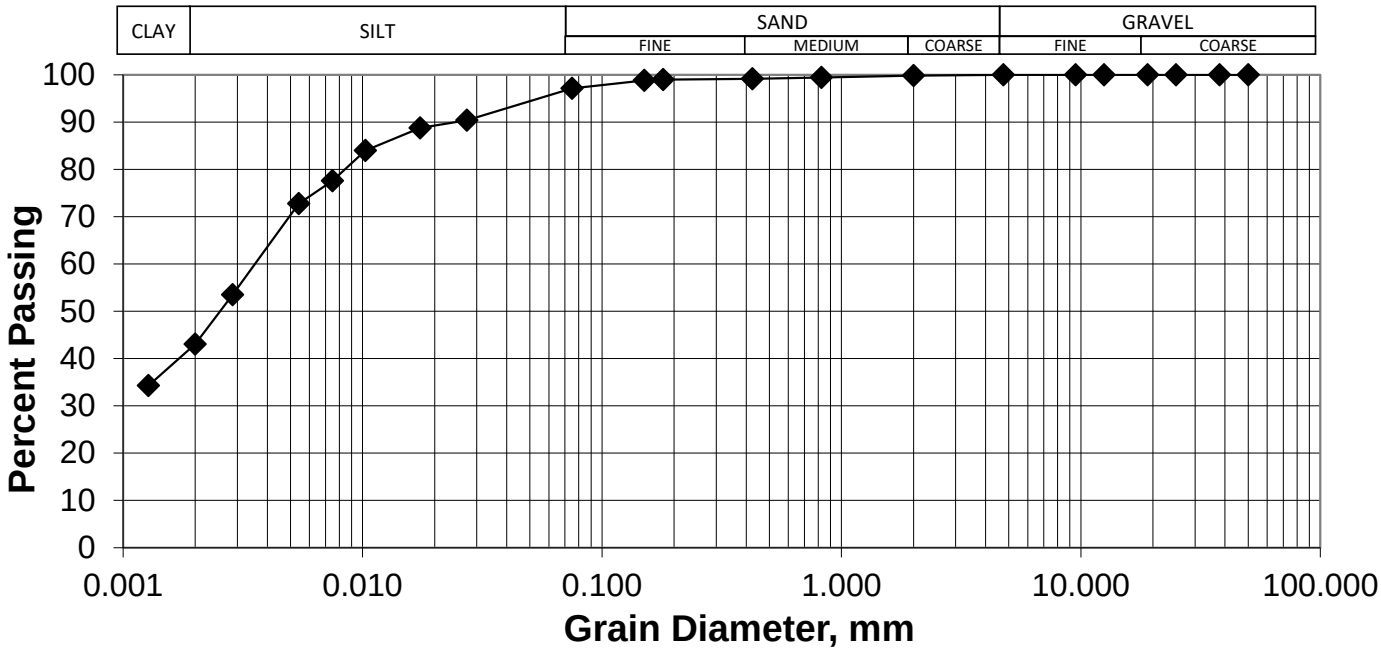
Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Supplier/Location:	AECOM
Client:	MWSB	Field Technician:	LCampodonico
Sample Location:	TH24-05	Sample Date:	27-Sep-24
Sample Depth :	5.94 - 6.10 m	Lab Technician:	LBoughton
Sample Number:	G8	Date Tested:	15-Oct-24

Hydrometer (AASHTO T88)

Standard Test Methods for Particle Size Analysis of Soils

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	100.0	0.0750	97.1
38.0	100.0	2.00	99.8	0.0273	90.5
25.0	100.0	0.825	99.4	0.0174	88.9
19.0	100.0	0.425	99.2	0.0103	84.1
12.5	100.0	0.18	99.0	0.0075	77.7
9.5	100.0	0.15	98.8	0.0054	72.9
4.75	100.0	0.075	97.1	0.0029	53.6
				0.0020	43.1
				0.0013	34.3

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**54.0%**
Sand	**2.9%**	**Clay**	**43.1%**

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
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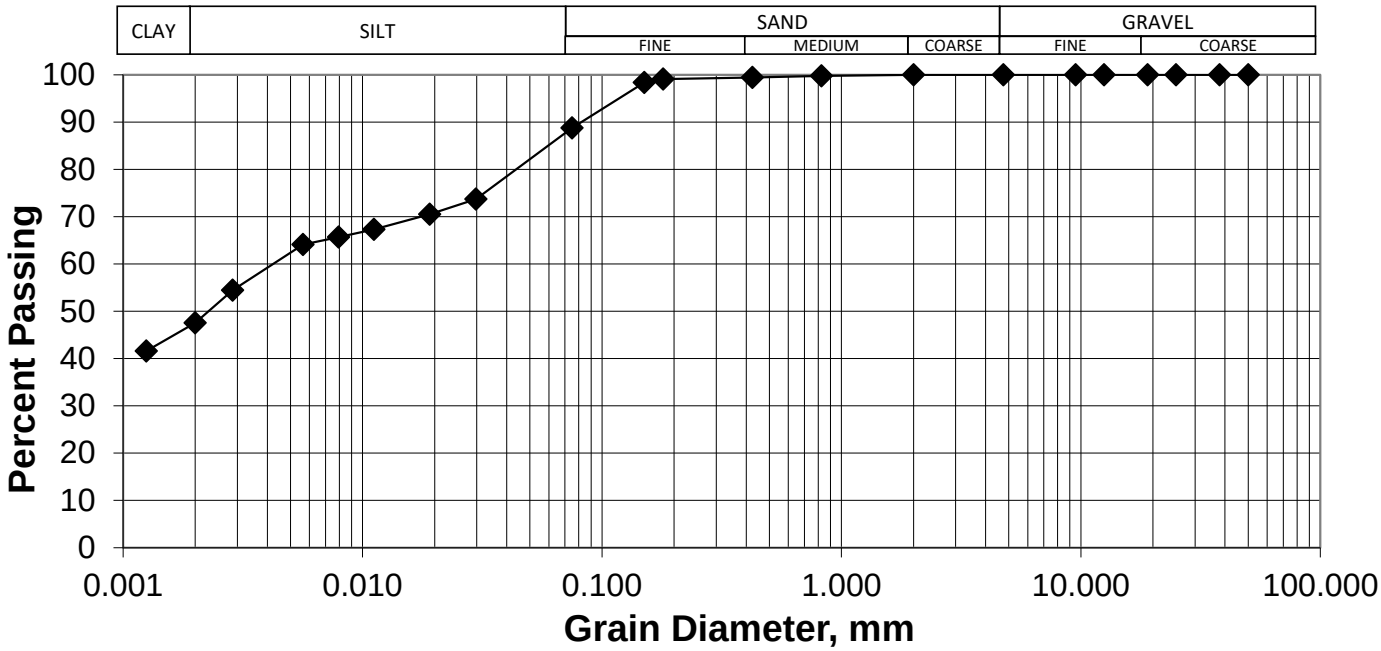
Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Supplier/Location:	AECOM
Client:	MWSB	Field Technician:	LCampodonico
Sample Location:	TH24-08	Sample Date:	27-Sep-24
Sample Depth :	4.42 - 4.57 m	Lab Technician:	LBoughton
Sample Number:	G5	Date Tested:	15-Oct-24

Hydrometer (AASHTO T88)

Standard Test Methods for Particle Size Analysis of Soils

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	4.75	100.0	0.0750	88.8
38.0	100.0	2.00	100.0	0.0297	73.7
25.0	100.0	0.825	99.7	0.0190	70.5
19.0	100.0	0.425	99.4	0.0111	67.3
12.5	100.0	0.18	99.1	0.0079	65.7
9.5	100.0	0.15	98.4	0.0056	64.1
4.75	100.0	0.075	88.8	0.0029	54.5
				0.0020	47.6
				0.0013	41.6

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.0%**	**Silt**	**41.2%**
Sand	**11.2%**	**Clay**	**47.6%**

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
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Phone: 204 477 5381

Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Date Sampled:	September 26, 2024
Client:	RM of Stanley	Sampled By:	LCampodonico
Supplier/Location:	Winnipeg, MB	Date Received:	September 26, 2024
Sample Depth (m):	1.52 - 2.13 m	Submitted By:	LCampodonico
Sample Location:	TH24-03	Date Tested:	October 17, 2024
Sample Number:	T4	Tested By:	LCampodonico

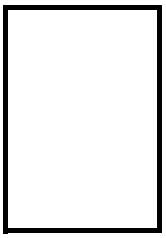
Unconfined Compressive Strength (ASTM D2166)

Standard Test Method for Unconfined Compressive Strenght of Cohesive Soil, using strain-controlled application of the axial load.

Soil Description:	SILT - tan, soft, moist, Sandy, Non Plastic, fissured

Average Diameter (cm):	7.12
Average Length (cm):	15.54
Length/Diameter Ratio:	2.18
Moisture content (%):	30.4
Bulk Density (g/cm³):	1.590
Bulk Unit Weight (kN/m³):	15.6
Bulk Unit Weight (pcf):	99.2
Dry Unit Weight (kN/m³):	11.96

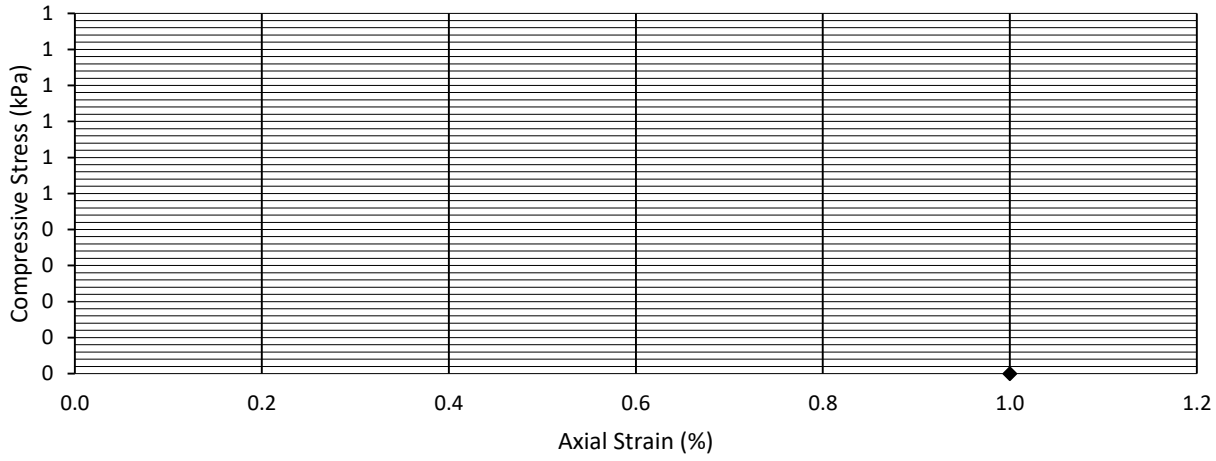
FAILURE SKETCH



Torvane	Undrained Shear Strength (kPa)	9.8
Pocket Pen.	Undrained Shear Strength (kPa)	31.9

UCS	Unconfined compressive strength (kPa)		Undrained Shear Strength (kPa)	
	Unconfined compressive strength (ksf)		Undrained Shear Strength (ksf)	
	Avg. Rate of Strain to Failure (%/min):		Strain at Failure (%):	

Unconfined Compressive Strength



Comments:
Sample too soft for unconfined compressive test

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

AECOM Canada Ltd.
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Phone: 204 477 5381

Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Date Sampled:	September 26, 2024
Client:	RM of Stanley	Sampled By:	Lcampodonico
Supplier/Location:	Winnipeg, MB	Date Received:	September 26, 2024
Sample Depth (m):	4.57 - 5.18 m	Submitted By:	Lcampodonico
Sample Location:	TH24-03	Date Tested:	October 16, 2024
Sample Number:	T7	Tested By:	Lcampodonico

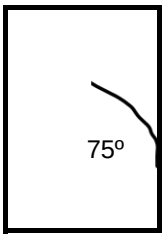
Unconfined Compressive Strength (ASTM D2166)

Standard Test Method for Unconfined Compressive Strenght of Cohesive Soil, using strain-controlled application of the axial load.

Soil Description:	CLAY - grey, stiff, moist, trace of silt inclusions, Low Plasticity, blocky

Average Diameter (cm):	7.10
Average Length (cm):	13.30
Length/Diameter Ratio:	1.87
Moisture content (%):	41.5
Bulk Density (g/cm³):	1.814
Bulk Unit Weight (kN/m³):	17.8
Bulk Unit Weight (pcf):	113.3
Dry Unit Weight (kN/m³):	12.58

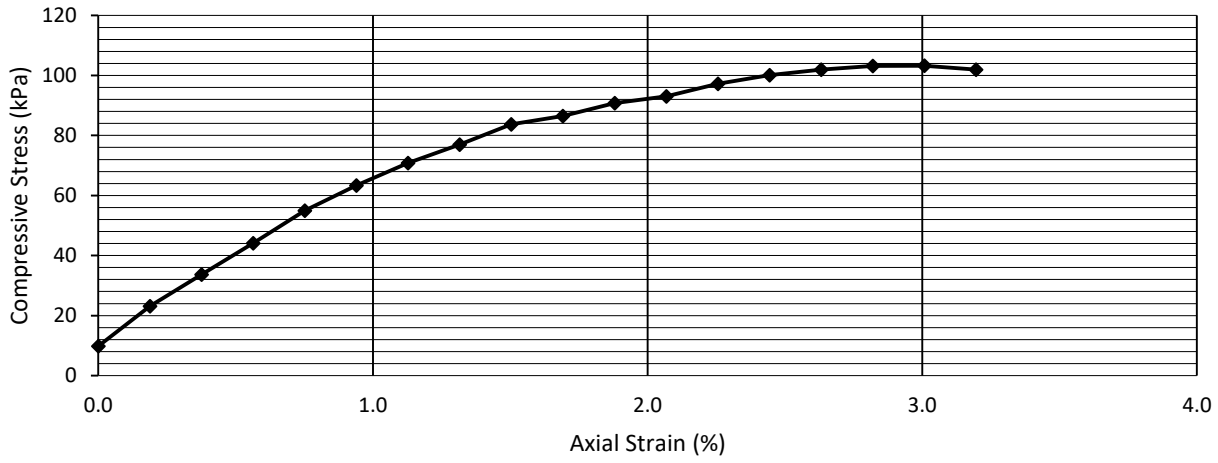
FAILURE SKETCH



Torvane	Undrained Shear Strength (kPa)	73.6
Pocket Pen.	Undrained Shear Strength (kPa)	87.8

UCS	Unconfined compressive strength (kPa)	103.22	Undrained Shear Strength (kPa)	51.61
	Unconfined compressive strength (ksf)	2.156	Undrained Shear Strength (ksf)	1.078
	Avg. Rate of Strain to Failure (%/min):	1.13	Strain at Failure (%):	3.01

Unconfined Compressive Strength



Comments:
Lower undrained shear strength (kPa) for unconfined compressive test due to the structure being blocky.

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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Phone: 204 477 5381

Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Date Sampled:	September 26, 2024
Client:	RM of Stanley	Sampled By:	LCampodonico
Supplier/Location:	Winnipeg, MB	Date Received:	September 26, 2024
Sample Depth (m):	7.62 - 8.23 m	Submitted By:	LCampodonico
Sample Location:	TH24-03	Date Tested:	October 17, 2024
Sample Number:	T10	Tested By:	LCampodonico

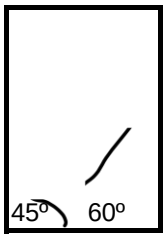
Unconfined Compressive Strength (ASTM D2166)

Standard Test Method for Unconfined Compressive Strenght of Cohesive Soil, using strain-controlled application of the axial load.

Soil Description:	CLAY - grey, firm, moist, trace of silt inclusions, High Plasticity, homogeneous

Average Diameter (cm):	7.16
Average Length (cm):	15.20
Length/Diameter Ratio:	2.12
Moisture content (%):	42.8
Bulk Density (g/cm³):	1.805
Bulk Unit Weight (kN/m³):	17.7
Bulk Unit Weight (pcf):	112.7
Dry Unit Weight (kN/m³):	12.39

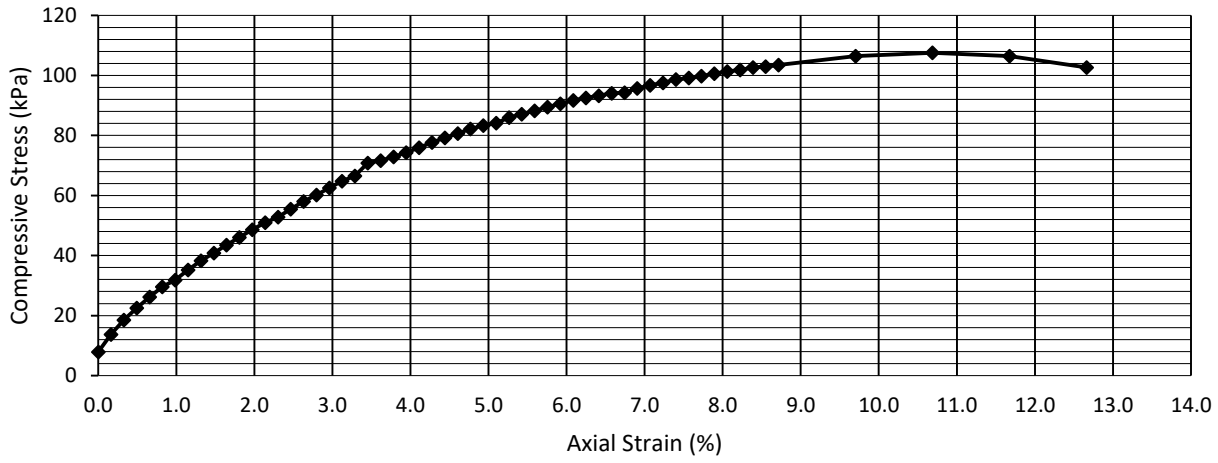
FAILURE SKETCH



Torvane	Undrained Shear Strength (kPa)	52.0
Pocket Pen.	Undrained Shear Strength (kPa)	59.1

UCS	Unconfined compressive strength (kPa)	107.53	Undrained Shear Strength (kPa)	53.76
	Unconfined compressive strength (ksf)	2.246	Undrained Shear Strength (ksf)	1.123
	Avg. Rate of Strain to Failure (%/min):	0.99	Strain at Failure (%):	10.69

Unconfined Compressive Strength



Comments:

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Date Sampled:	September 26, 2024
Client:	RM of Stanley	Sampled By:	LCampodonico
Supplier/Location:	Winnipeg, MB	Date Received:	September 26, 2024
Sample Depth (m):	3.05 - 3.66 m	Submitted By:	LCampodonico
Sample Location:	TH24-04	Date Tested:	October 15, 2024
Sample Number:	T5	Tested By:	LCampodonico

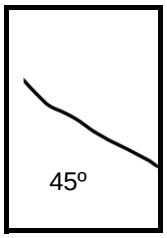
Unconfined Compressive Strength (ASTM D2166)

Standard Test Method for Unconfined Compressive Strenght of Cohesive Soil, using strain-controlled application of the axial load.

Soil Description:	CLAY - grey, firm, moist, trace of silt inclusions, some sand., High Plasticity, homogeneous

Average Diameter (cm):	7.13
Average Length (cm):	15.31
Length/Diameter Ratio:	2.15
Moisture content (%):	45.6
Bulk Density (g/cm³):	1.785
Bulk Unit Weight (kN/m³):	17.5
Bulk Unit Weight (pcf):	111.4
Dry Unit Weight (kN/m³):	12.02

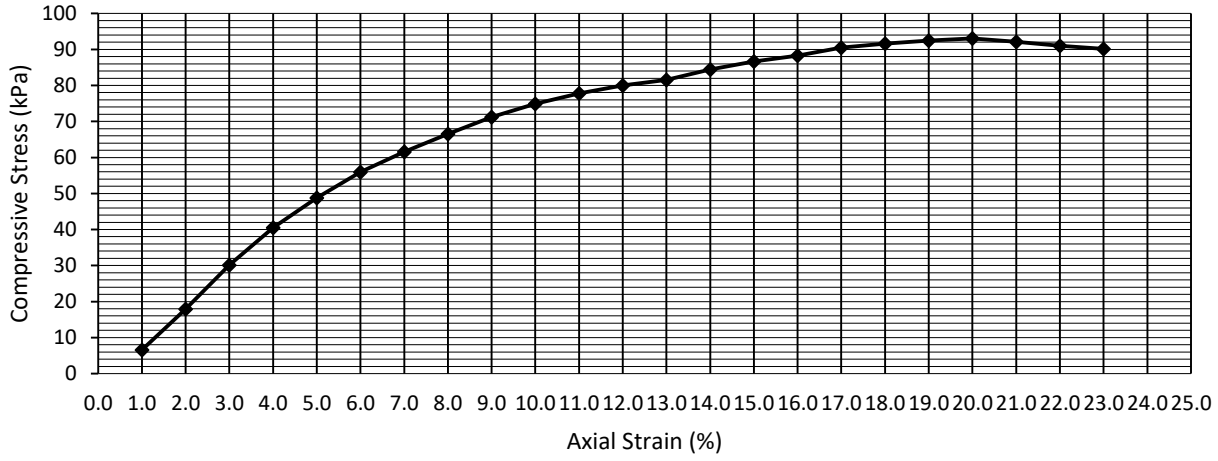
FAILURE SKETCH



Torvane	Undrained Shear Strength (kPa)	73.6	
Pocket Pen.	Undrained Shear Strength (kPa)	53.5	

UCS	Unconfined compressive strength (kPa)	93.04	Undrained Shear Strength (kPa)	46.52
	Unconfined compressive strength (ksf)	1.943	Undrained Shear Strength (ksf)	0.972
	Avg. Rate of Strain to Failure (%/min):	0.98	Strain at Failure (%):	3.10

Unconfined Compressive Strength



Comments:

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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Project Name:	THE MB WATER S. BOARD RM OF STANLEY RWS R & S LIFT STATIONS		
Project Number:	60735871	Date Sampled:	September 26, 2024
Client:	RM of Stanley	Sampled By:	LCampodonico
Supplier/Location:	Winnipeg, MB	Date Received:	September 26, 2024
Sample Depth (m):	6.10 - 6.71 m	Submitted By:	LCampodonico
Sample Location:	TH24-04	Date Tested:	October 15, 2024
Sample Number:	T8	Tested By:	LCampodonico

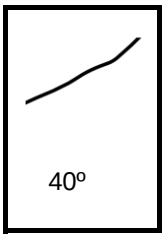
Unconfined Compressive Strength (ASTM D2166)

Standard Test Method for Unconfined Compressive Strenght of Cohesive Soil, using strain-controlled application of the axial load.

Soil Description:	CLAY - grey, soft, moist, trace of silt inclusions, some sand., High Plasticity, homogeneous

Average Diameter (cm):	7.08
Average Length (cm):	15.39
Length/Diameter Ratio:	2.17
Moisture content (%):	48.5
Bulk Density (g/cm³):	1.804
Bulk Unit Weight (kN/m³):	17.7
Bulk Unit Weight (pcf):	112.6
Dry Unit Weight (kN/m³):	11.91

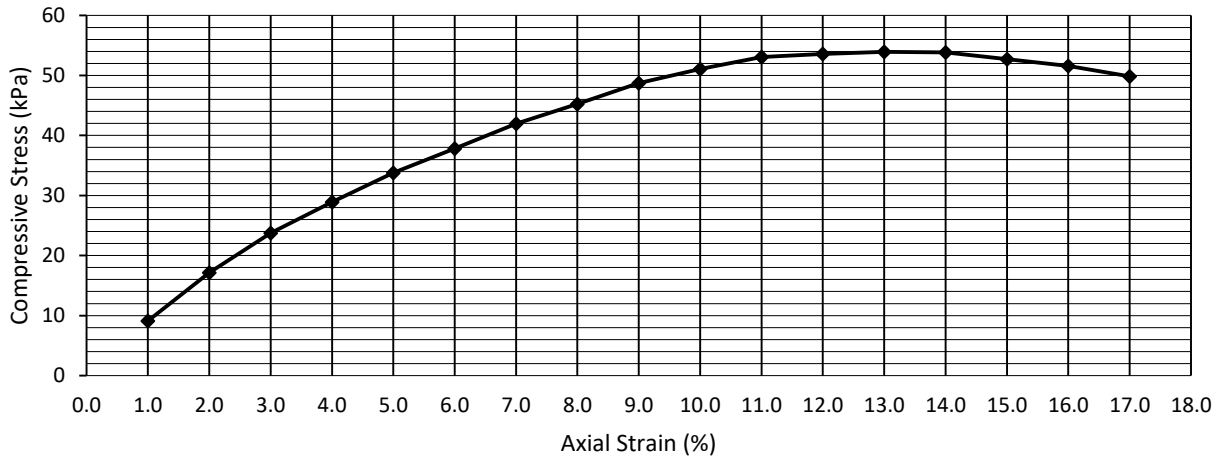
FAILURE SKETCH



Torvane	Undrained Shear Strength (kPa)	39.2
Pocket Pen.	Undrained Shear Strength (kPa)	11.2

UCS	Unconfined compressive strength (kPa)	53.93	Undrained Shear Strength (kPa)	26.96
	Unconfined compressive strength (ksf)	1.126	Undrained Shear Strength (ksf)	0.563
	Avg. Rate of Strain to Failure (%/min):	0.97	Strain at Failure (%):	1.95

Unconfined Compressive Strength



Comments:

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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Winnipeg Geotechnical Laboratory
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Phone: 204 477 5381

Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Date Sampled:	September 26, 2024
Client:	RM of Stanley	Sampled By:	LCampodonico
Supplier/Location:	Winnipeg, MB	Date Received:	September 26, 2024
Sample Depth (m):	1.52 - 2.13 m	Submitted By:	LCampodonico
Sample Location:	TH24-05	Date Tested:	October 17, 2024
Sample Number:	T4	Tested By:	LCampodonico

Unconfined Compressive Strength (ASTM D2166)

Standard Test Method for Unconfined Compressive Strenght of Cohesive Soil, using strain-controlled application of the axial load.

Soil Description:	CLAY - grey, firm, moist, silty, High Plasticity, homogeneous

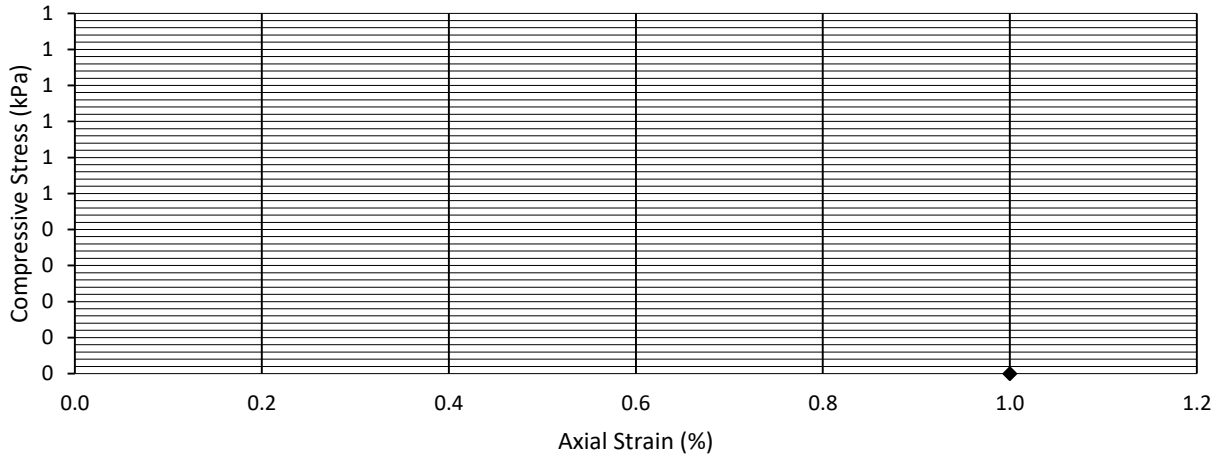
Average Diameter (cm):	
Average Length (cm):	
Length/Diameter Ratio:	
Moisture content (%):	22.4
Bulk Density (g/cm³):	
Bulk Unit Weight (kN/m³):	
Bulk Unit Weight (pcf):	
Dry Unit Weight (kN/m³):	

FAILURE SKETCH

Torvane	Undrained Shear Strength (kPa)	39.2
Pocket Pen.	Undrained Shear Strength (kPa)	67.8

UCS	Unconfined compressive strength (kPa)		Undrained Shear Strength (kPa)	
	Unconfined compressive strength (ksf)		Undrained Shear Strength (ksf)	
	Avg. Rate of Strain to Failure (%/min):		Strain at Failure (%):	

Unconfined Compressive Strength



Comments:
Not enough sample for unconfined compressive test.

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Date Sampled:	September 26, 2024
Client:	RM of Stanley	Sampled By:	LCampodonico
Supplier/Location:	Winnipeg, MB	Date Received:	September 26, 2024
Sample Depth (m):	3.05 - 3.66 m	Submitted By:	LCampodonico
Sample Location:	TH24-05	Date Tested:	October 17, 2024
Sample Number:	T6	Tested By:	LCampodonico

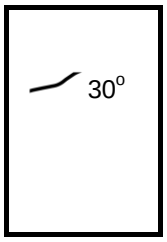
Unconfined Compressive Strength (ASTM D2166)

Standard Test Method for Unconfined Compressive Strenght of Cohesive Soil, using strain-controlled application of the axial load.

Soil Description:	CLAY - grey, firm, moist, silty, High Plasticity, homogeneous

Average Diameter (cm):	7.12
Average Length (cm):	14.92
Length/Diameter Ratio:	2.10
Moisture content (%):	43.5
Bulk Density (g/cm³):	1.814
Bulk Unit Weight (kN/m³):	17.8
Bulk Unit Weight (pcf):	113.3
Dry Unit Weight (kN/m³):	12.40

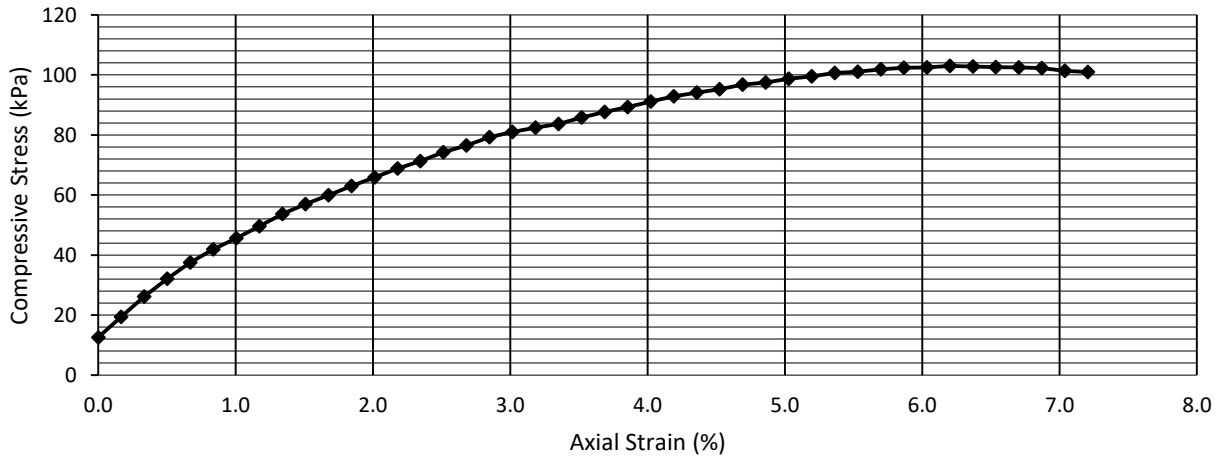
FAILURE SKETCH



Torvane	Undrained Shear Strength (kPa)	47.1	
Pocket Pen.	Undrained Shear Strength (kPa)	59.9	

UCS	Unconfined compressive strength (kPa)	103.00	Undrained Shear Strength (kPa)	51.50
	Unconfined compressive strength (ksf)	2.151	Undrained Shear Strength (ksf)	1.076
	Avg. Rate of Strain to Failure (%/min):	1.01	Strain at Failure (%):	6.20

Unconfined Compressive Strength



Comments:

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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Winnipeg Geotechnical Laboratory
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Phone: 204 477 5381

Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Date Sampled:	September 26, 2024
Client:	RM of Stanley	Sampled By:	LCampodonico
Supplier/Location:	Winnipeg, MB	Date Received:	September 26, 2024
Sample Depth (m):	6.10 - 6.71 m	Submitted By:	LCampodonico
Sample Location:	TH24-05	Date Tested:	October 16, 2024
Sample Number:	T9	Tested By:	LCampodonico

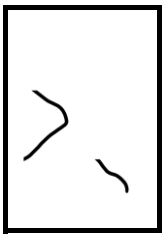
Unconfined Compressive Strength (ASTM D2166)

Standard Test Method for Unconfined Compressive Strenght of Cohesive Soil, using strain-controlled application of the axial load.

Soil Description:	CLAY - grey, firm, moist, silty, High Plasticity, homogeneous

Average Diameter (cm):	7.13
Average Length (cm):	15.25
Length/Diameter Ratio:	2.14
Moisture content (%):	43.9
Bulk Density (g/cm³):	1.776
Bulk Unit Weight (kN/m³):	17.4
Bulk Unit Weight (pcf):	110.9
Dry Unit Weight (kN/m³):	12.11

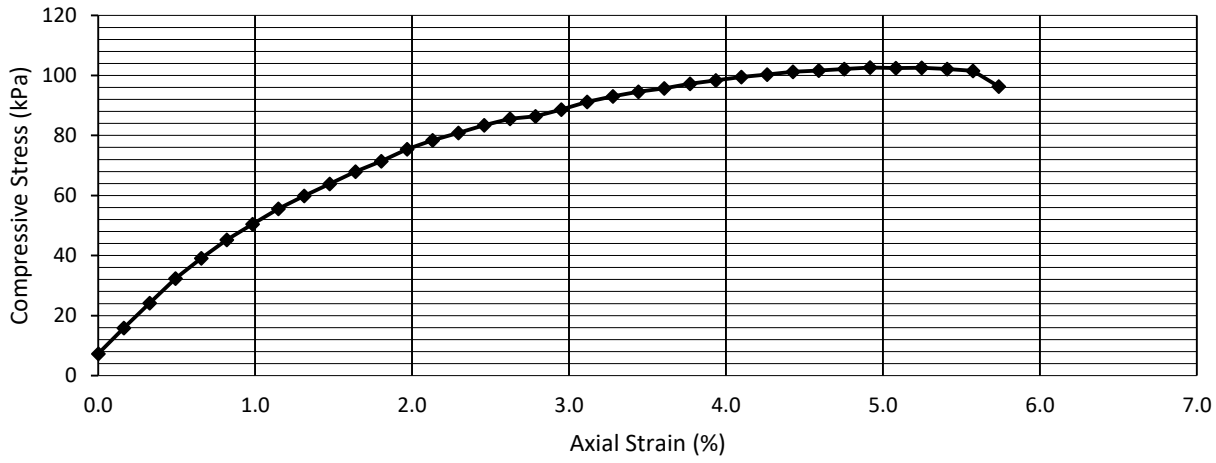
FAILURE SKETCH



Torvane	Undrained Shear Strength (kPa)	58.8	
Pocket Pen.	Undrained Shear Strength (kPa)	63.8	

UCS	Unconfined compressive strength (kPa)	102.63	Undrained Shear Strength (kPa)	51.32
	Unconfined compressive strength (ksf)	2.144	Undrained Shear Strength (ksf)	1.072
	Avg. Rate of Strain to Failure (%/min):	0.98	Strain at Failure (%):	4.92

Unconfined Compressive Strength



Comments:

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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Phone: 204 477 5381

Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Date Sampled:	September 26, 2024
Client:	RM of Stanley	Sampled By:	LCampodonico
Supplier/Location:	Winnipeg, MB	Date Received:	September 26, 2024
Sample Depth (m):	7.62 - 8.23 m	Submitted By:	LCampodonico
Sample Location:	TH24-05	Date Tested:	October 16, 2024
Sample Number:	T11	Tested By:	LCampodonico

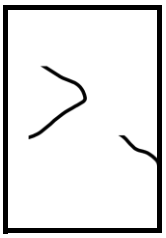
Unconfined Compressive Strength (ASTM D2166)

Standard Test Method for Unconfined Compressive Strenght of Cohesive Soil, using strain-controlled application of the axial load.

Soil Description:	CLAY - grey, firm, moist, silty, High Plasticity, homogeneous

Average Diameter (cm):	7.12
Average Length (cm):	14.46
Length/Diameter Ratio:	2.03
Moisture content (%):	46.4
Bulk Density (g/cm³):	1.786
Bulk Unit Weight (kN/m³):	17.5
Bulk Unit Weight (pcf):	111.5
Dry Unit Weight (kN/m³):	11.96

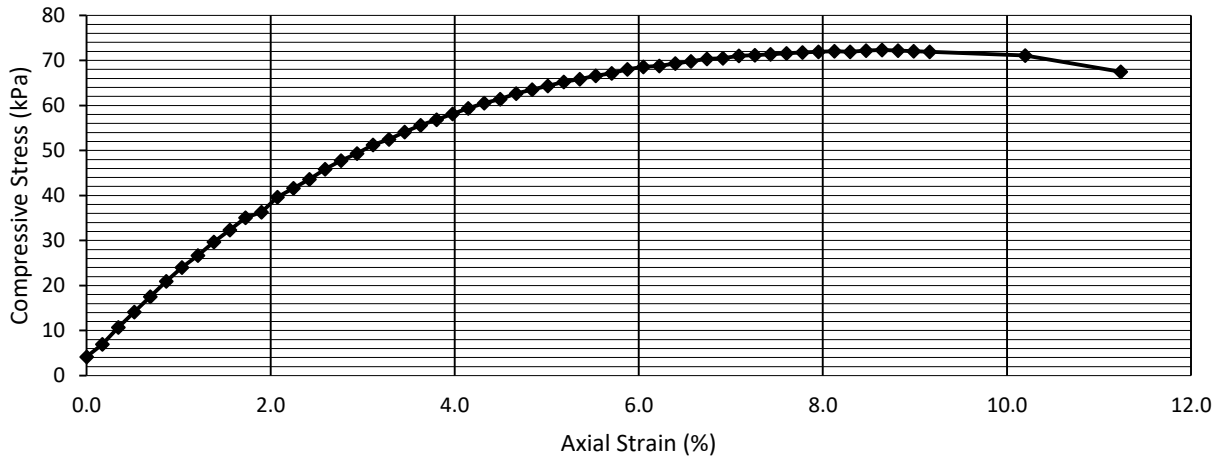
FAILURE SKETCH



Torvane	Undrained Shear Strength (kPa)	30.4
Pocket Pen.	Undrained Shear Strength (kPa)	23.9

UCS	Unconfined compressive strength (kPa)	72.33	Undrained Shear Strength (kPa)	36.16
	Unconfined compressive strength (ksf)	1.511	Undrained Shear Strength (ksf)	0.755
	Avg. Rate of Strain to Failure (%/min):	1.04	Strain at Failure (%):	8.64

Unconfined Compressive Strength



Comments:

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

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99 Commerce Drive, Winnipeg, MB R3P 0Y7
Phone: 204 477 5381

Project Name:	RM of Stanley Regional Wastewater System Reinfeld & Schanzenfeld Lift Station		
Project Number:	60735871	Date Sampled:	September 25, 2024
Client:	RM of Stanley	Sampled By:	LCampodonico
Supplier/Location:	Winnipeg, MB	Date Received:	September 25, 2024
Sample Depth (m):	3.05 - 3.66 m	Submitted By:	LCampodonico
Sample Location:	TH24-06	Date Tested:	October 15, 2024
Sample Number:	T5	Tested By:	LCampodonico

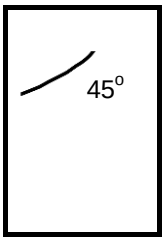
Unconfined Compressive Strength (ASTM D2166)

Standard Test Method for Unconfined Compressive Strenght of Cohesive Soil, using strain-controlled application of the axial load.

Soil Description:	CLAY - grey, firm, moist, silty, trace of silt inclusions, Int. Plasticity, fissured

Average Diameter (cm):	7.06
Average Length (cm):	14.54
Length/Diameter Ratio:	2.06
Moisture content (%):	43.7
Bulk Density (g/cm³):	1.840
Bulk Unit Weight (kN/m³):	18.0
Bulk Unit Weight (pcf):	114.9
Dry Unit Weight (kN/m³):	12.56

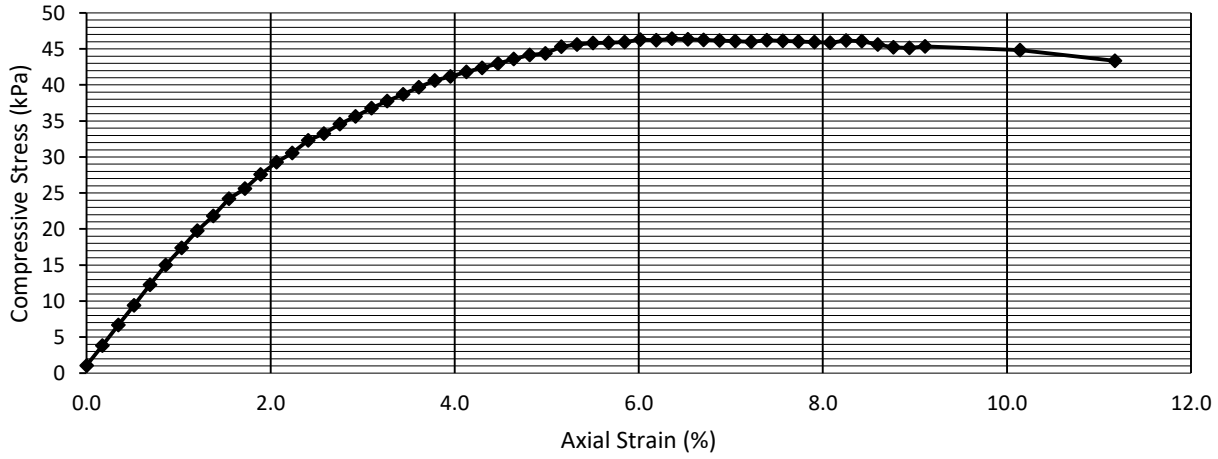
FAILURE SKETCH



Torvane	Undrained Shear Strength (kPa)	24.5
Pocket Pen.	Undrained Shear Strength (kPa)	19.2

UCS	Unconfined compressive strength (kPa)	46.41	Undrained Shear Strength (kPa)	23.21
	Unconfined compressive strength (ksf)	0.969	Undrained Shear Strength (ksf)	0.485
	Avg. Rate of Strain to Failure (%/min):	1.03	Strain at Failure (%):	6.36

Unconfined Compressive Strength



Comments:

Reviewed by: Lee Boughton
Laboratory Manager

Approved by: German Leal, M.Eng., P.Eng.
Geotechnical Discipline Lead

Appendix E

AECOM 2018 Memorandum

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www.aecom.com

204 477 5381 tel
204 284 2040 fax

Memorandum

To	Keith Fitchett	Page	1
CC	Eric Hutchison, Bill Burgess		
Subject	Rural Municipality of Stanley - Regional Wastewater System Geotechnical Investigation		
From	Ryan Harras, Elliott Drumright		
Date	January 24, 2018	Project Number	60539657 (470.9)

1. Introduction

The Rural Municipality of Stanley (RM of Stanley) is planning to upgrade their regional wastewater collection and treatment systems to improve services to local residents and to improve the quality of the effluent discharged into the environment. The upgrades are expected to consist of a new low pressure sewer (LPS) collection system and lift stations within the communities of Schanzenfeld and Reinfeld, and associated forcemain system to transmit the wastewater to the City of Winkler for treatment.

AECOM has been retained by the RM of Stanley to provide detailed design and contract administration services for this project which includes a geotechnical assessment of the proposed infrastructure. The scope of the geotechnical services include: review of existing information, completion of a geotechnical investigation, laboratory testing, and geotechnical recommendations in support of the design and construction of the project.

This memorandum summarizes the findings of the geotechnical investigation completed and provides geotechnical recommendations in support of the design and construction of the proposed infrastructure.

2. Field Investigation

On October 23, 2017, two (2) test holes (TH17-01 and TH17-02) were drilled at the proposed Schanzenfeld lift station, and one (1) test hole (TH17-03) was drilled at the proposed Reinfeld lift station. The approximate locations of these test holes are shown on the test hole location plan in Appendix A. A job hazard assessment was prepared prior to the field investigation, and utility clearance certificates were obtained by AECOM personnel from representatives of ClickBeforeYouDigMB.com and other local utility service providers.

Drilling was completed by Paddock Drilling using a track-mounted Acker SX drill rig equipped with 125 mm solid stem augers and 190 mm hollow stem augers, to depths ranging from 10.7 m to 14.2 m below ground surface. Subsurface conditions observed during drilling were documented by AECOM geotechnical personnel. Other pertinent information such as groundwater and drilling conditions were also recorded during drilling. Samples retrieved during the field investigation were tested in the AECOM Materials Testing Laboratory in Winnipeg, Manitoba and the ALS Environmental Laboratory in Winnipeg, Manitoba. Geotechnical samples collected during the investigation included relatively undisturbed Shelby Tube samples, and disturbed grab and split spoon samples.

Detailed test hole logs have been prepared for each hole and are attached as Appendix B. The test hole logs include descriptions and depths of the soil units encountered, sample types, sample locations, results of field and laboratory index testing, and other pertinent information such as seepage and sloughing related to groundwater conditions.

Laboratory testing was completed on select soil samples collected during the investigation. The laboratory soil testing program included determination of moisture contents, grain size distribution (hydrometer method), Atterberg Limits, undrained shear strength (unconfined compressive strength method), and bulk density. Electrochemical tests were also completed on select samples, and included determination of sulphate content, resistivity, and pH. The laboratory test results are presented in Appendix C.

3. Subsurface Conditions

The following subsections describe the subsurface conditions encountered at the Schanzenfeld and Reinfeld sites. Subsurface conditions can, however, vary across each site, and the information provided in this section is a summary of the findings from the field investigation and laboratory testing.

3.1 Schanzenfeld Site - Subsurface Profile

In descending order, the general soil profile at the Schanzenfeld site consists of:

- Topsoil
- Upper Complex
- Glacio-Lacustrine Clay

Each of these units is described below.

Topsoil

A layer of black topsoil was encountered at the ground surface in test holes TH17-01 and TH17-02 with thicknesses of 125 mm and 230 mm, respectively.

Upper Complex

The Upper Complex is a native stratum common to the local area and is generally characterized by interlayered silts, sands, and clays near ground surface that are comprised of a mixture of lacustrine and alluvial sediments. The Upper Complex was encountered immediately beneath the topsoil in test holes TH17-01 and TH17-02 with thicknesses of 2.9 m and 3.9 m, respectively. The Upper Complex was generally brown, soft to firm, dry to wet, and non-plastic to intermediately plastic. A summary of the index properties of the Upper Complex is presented in Table 3-1.

Table 3-1: Summary of Index Properties of Upper Complex (Schanzenfeld Site)

Test	Minimum Value	Maximum Value	Number of Tests
Moisture Content (%)	27	35	7
SPT 'N' Blow Count (uncorrected)	7	8	2

Glacio-Lacustrine Clay

A deposit of glacio-lacustrine clay was encountered beneath the Upper Complex in test holes TH17-01 and TH17-02 and extended to test hole termination depths of 10.7 m and 11.2 m, respectively. The glacio-lacustrine clay was generally silty, contained trace sand, and was generally brown, soft to firm, moist, and highly plastic. A summary of the index properties of the glacio-lacustrine clay is presented in Table 3-2.

Table 3-2: Summary of Index Properties of Glacio-Lacustrine Clay (Schanzenfeld Site)

Test	Minimum Value	Maximum Value	Number of Tests
Moisture Content (%)	38	51	6
SPT 'N' Blow Count (uncorrected)	3	8	5
Atterberg - Plastic Limit (%)	27		1
Atterberg - Liquid Limit (%)	88		1
Grain Size - Gravel (%)	0		1
Grain Size - Sand (%)	6		1
Grain Size - Silt (%)	23		1
Grain Size - Clay (%)	71		1

3.2 Schanzenfeld Site - Sloughing and Groundwater Conditions

Sloughing was observed during drilling in both test holes at depths below 3.0 m and 4.6 m in TH17-01 and TH17-02, respectively. Seepage was observed during drilling in both test holes at depths below 1.5 m and 2.1 m in TH17-01 and TH17-02, respectively. Information about the nature and location of the sloughing and/or seepage are provided in the test hole logs in Appendix B.

It should be noted that groundwater levels and subsequently the sloughing level in an open borehole may change seasonally, annually or as a result of construction activities.

3.3 Reinfeld Site - Subsurface Profile

In descending order, the general soil profile at the Reinfeld site consists of:

- Topsoil
- Upper Complex
- Glacio-Lacustrine Clay

Each of these units is described below.

Topsoil

A layer of black topsoil was encountered at the ground surface in test hole TH17-03 with a thickness of 760 mm.

Upper Complex

The Upper Complex was encountered immediately beneath the topsoil in test hole TH17-03 with a thickness of 3.8 m. The Upper Complex was characterized as sand and silt, contained some clay, and

was light brown, soft, moist to wet, and of low plasticity. A summary of the index properties of the Upper Complex is presented in Table 3-3.

Table 3-3: Summary of Index Properties of Upper Complex (Reinfeld Site)

Test	Minimum Value	Maximum Value	Number of Tests
Moisture Content (%)	19	28	3
Grain Size - Gravel (%)	0		1
Grain Size - Sand (%)	51		1
Grain Size - Silt (%)	35		1
Grain Size - Clay (%)	13		1

Glacio-Lacustrine Clay

A deposit of glacio-lacustrine clay was encountered beneath the Upper Complex in test hole TH17-03 and extended to test hole termination depth at 14.2 m. The glacio-lacustrine clay was silty, dark brown, soft to firm, moist, and highly plastic. A summary of the index properties of the glacio-lacustrine clay is presented in Table 3-4.

Table 3-4: Summary of Index Properties of Glacio-Lacustrine Clay (Reinfeld Site)

Test	Minimum Value	Maximum Value	Number of Tests
Moisture Content (%)	45	52	3
SPT 'N' Blow Count (uncorrected)	4	6	5
Atterberg - Plastic Limit (%)	25		1
Atterberg - Liquid Limit (%)	75		1
Undrained Shear Strength (kPa)	33		1
Bulk Density (kN/m^3)	17.4		1

3.4 Reinfeld Site - Sloughing and Groundwater Conditions

Sloughing was observed during drilling in test hole TH17-03 at a depth below 4.6 m. Seepage was observed during drilling in test hole TH17-03 at a depth below 2.1 m. Information about the nature and location of the sloughing and/or seepage are provided on the test hole log in Appendix B. A single standpipe piezometer was installed in test hole TH17-03 screened within the glacio-lacustrine clay, and was monitored on December 14, 2017. Details of the piezometer installation and groundwater level (GWL) measurements are provided in Table 3-5 and illustrated on the test hole log.

Table 3-5: Summary of Reinfeld Site GWL Measurements

Test Hole Number	TH17-03
Tip Depth [m]	10.7
Tip Strata	Glacio-Lacustrine Clay
Dates	**GWL Reading Below Ground Surface [m]**
December 14, 2017	2.2

Groundwater levels and subsequently the sloughing depth in an open borehole may change seasonally, annually or as a result of construction activities

4. Frost Concerns

4.1 Frost Susceptibility

Frost susceptibility of a soil can be assessed using guidelines developed by Casagrande (1932) on the basis of the percentage by weight of the soil finer than 0.02 mm, and the plasticity index. This classification system has been adapted by the U.S. Army Corps of Engineers and the Canadian Foundation Engineering Manual (2006). Soils are classed as F1 though F4 in order of increasing frost susceptibility.

The surficial soils encountered at the Schanzenfeld site primarily consist of silt with varying amounts of clay and sand. The site soils are generally classed as F4 based on the high silt content observed during the investigation. Based on this classification the native soils at this site are frost susceptible.

The surficial soils encountered at the Reinfeld site primarily consist of sand and silt. The percentage finer than 0.02 mm by weight in the sand and silt was measured to be approximately 36%. The site soils are generally classed as F4 based on the percentage finer than 0.02 mm by weight. Based on this classification the native soils at this site are also frost susceptible.

4.2 Seasonal Frost Penetration

The frost penetration depth was calculated for the encountered soils following the procedure outlined in the Canadian Foundation Engineering Manual (CFEM), 2006. The 50-year return period annual freezing index for the Schanzenfeld, Manitoba and Reinfeld, Manitoba areas is 1750° C-days. The seasonal frost penetration depth is therefore estimated to be approximately 2.6 m for a 50-year return period. The estimated frost penetration depth assumes that there is no snow cover, peat or vegetation on the surface. The presence of snow, vegetation, and peat may reduce the seasonal frost penetration depth. Infrastructure elements constructed below the finished grade should be protected from frost heave either by burial below the seasonal frost zone or by shallow burial combined with insulation and/or heat tracing. Assuming adequate bearing capacity where required, the minimum burial depth of un-insulated utility lines, water pipelines and foundations should not be less than seasonal frost penetration depth, unless insulation is provided.

5. Soil Electrical and Chemical Properties

Electrochemical tests were completed for four (4) soil samples collected from test holes TH17-01 to TH17-03 to determine water soluble sulphate concentration, resistivity, and pH. A summary of the test results, potential for sulphate attack and the estimated degree of corrosiveness are presented in Table 5-1. The potential for sulphate attack of buried concrete is taken from *CSA-A23.1-M2004 (Concrete Materials and Methods of Concrete Construction)*, while the corrosivity rating for buried steel is taken from the *Handbook of Corrosion Engineering.*

Table 5-1 – Summary of Electrochemical Tests

Site	Soil Unit	Sample ID	Sample Depth (m)	Water Soluble Sulphate (mg/kg)	Potential for Sulphate Attack	Resistivity (ohm*cm)	pH	Corrosivity Rating
Schanzenfeld Site	**Lacustr. Clay**	G5	3.8	11400	Severe	242	7.87	Extremely Corrosive
	Upper Complex	S15	3.3	1710	Positive	556	7.99	Extremely Corrosive
Reinfeld Site	**Upper Complex**	G25	2.3	102	Negligible	5610	7.83	Moderately Corrosive
	Lacustr. Clay	S27	4.8	1500	Positive	823	7.87	Extremely Corrosive

6. Lift Station Foundations

It is understood that new lift stations will be constructed in Schanzenfeld and Reinfeld, Manitoba. The following sections provide a geotechnical assessment of the proposed lift station structures.

6.1 Schanzenfeld Lift Station

The Schanzenfeld lift station is to consist of an underground, pre-cast concrete structure complete with a submersible duplex pumping system. It has been estimated by the civil designer that the lift station will be approximately 3.0 m in diameter, with its base located at a depth between 4.5 and 5.0 m below ground surface. Foundations placed at depths where the structure load is approximately equal to the weight of the excavated soil typically have adequate bearing capacity and only experience recompression settlement.

Bearing capacity analysis was completed assuming that the native soil at the lift station foundation level is not disturbed during excavation, and is maintained stable during construction. Recommendations for the bearing resistance at ultimate limit state (ULS) are provided in Table 6-1. These recommendations were estimated based on available site information and the structure dimensions provided by the civil designer. Settlement of the lift station is estimated to be 25 mm or less based on the configuration identified above. The estimated bearing capacity and settlement values presented should be reviewed if any changes to the location, dimensions, or depth of the structure are made.

Table 6-1: Recommended Bearing Resistance at Schanzenfeld Lift Station

Structure Location	Foundation Diameter (m)	Base of Foundation Depth (m)	Nominal Bearing Resistance at ULS (kPa)	Factored Bearing Resistance at ULS (kPa)
Schanzenfeld Site	3.0	4.5	175	85
		5.0	175	85

6.1.1 Construction Recommendations

The design information above indicates that the foundation will be located below the frost penetration depth. This depth can be reduced by placing rigid insulation to minimize frost penetration into the soil around and below the foundation, provided the foundation is bearing on competent soil.

Foundations should not be placed on uncontrolled fill, organic or other deleterious soils. The bearing surfaces should be excavated 0.3 to 0.5 m into the final bearing layer beneath the lift station foundation and backfilled with engineered, granular fill. The granular fill should be compacted to 98% or more of the associated Standard Proctor maximum dry density (SPMDD) and within +/- 2% of the optimum moisture content (OMC). A non-woven geotextile should be provided between the granular fill and the native soil. The bearing stratum should first be cleaned to remove all disturbed or otherwise affected soil, and should also be protected from frost, desiccation, and the ingress of free water. New concrete must not be cast on frozen soil.

Soil within the depth of frost penetration can freeze to the outside of the lift station, developing an uplift force. An adfreeze bond of 65 kPa for concrete can be used to estimate the uplift force. This force can be resisted by the sustained vertical loads on the foundation. A frost non-susceptible material or bond breaker/thermal insulation between the foundation and the adjacent soil within the adfreeze depth can be used to protect against adfreeze bond development.

Once the bearing surface has been suitably prepared, it should be evaluated by qualified geotechnical personnel to verify the suitability of the bearing soils, and to confirm that the soils are not affected by frost or disturbance and are consistent with the conditions noted in this memo.

The Upper Complex and glacio-lacustrine clays encountered during the investigation are considered poor to marginal when used as backfill for structures. These soils are susceptible to strength loss and swelling when wetted, typically have higher compressibility when compared to other soil types, and have been known to cause difficulty in achieving compaction density and moisture criteria. If this material is to be used as backfill, it should be free of deleterious material (debris, topsoil/organics, etc.) and should be placed in layers not exceeding 150 mm in compacted thickness. The fill should be compacted to at least 98% of SPMDD at +/- 2% of OMC.

6.2 Reinfeld Lift Station

The Reinfeld lift station is to consist of a cast-in-place concrete chamber with an above ground pre-engineered steel structure that will house odour control equipment. It has been estimated by the civil designer that the lift station will be approximately 3.0 m x 3.0 m, and with the base located at a depth between 4.5 and 5.0 m below ground surface. As stated above, foundations placed at depths where the structure load is approximately equal to the weight of the excavated soil typically have adequate bearing capacity and should experience only recompression settlement.

Bearing capacity analysis was completed assuming that the native soil at the lift station foundation level is not disturbed and is maintained stable during construction. Recommendations for the bearing resistance at ultimate limit state (ULS) are provided in Table 6-2. These recommendations were estimated based on available site information and the structure dimensions provided by the civil designer. Settlement of the lift station is estimated to be 25 mm or less based on the configuration identified above. The estimated bearing capacity and settlement values presented should be reviewed if any changes to the location, dimensions, or depth of the structure are made.

Table 6-2: Recommended Bearing Resistance at Reinfeld Lift Station

Structure Location	Foundation Dimensions (m)	Base of Foundation Depth (m)	Nominal Bearing Resistance at ULS (kPa)	Factored Bearing Resistance at ULS (kPa)
Reinfeld Site	3.0 x 3.0	4.5	160	80
		5.0	160	80

6.2.1 Construction Recommendations

Although indicated based on the depth of the structure, the base of the lift station should be located below the frost penetration depth. This depth can be reduced by placing rigid insulation to minimize frost penetration into the soil around and below the foundation, provided the foundation is bearing on competent soil.

The base of the lift station should not be placed on uncontrolled fill, organic or other deleterious soils. The bearing surfaces should be excavated 0.3 to 0.5 m into the final bearing layer beneath the base of the lift station and backfilled with engineered, granular fill. The granular fill should be compacted to 98% or more of the associated Standard Proctor maximum dry density (SPMDD) and within +/- 2% of the optimum moisture content (OMC). A non-woven geotextile should be provided between the granular fill and the native soil. The bearing stratum should first be cleaned to remove all disturbed or otherwise affected soil, and should also be protected from frost, desiccation, and the ingress of free water.

Soil within the depth of frost penetration can freeze to the outside of the structure, developing an uplift force. An adfreeze bond of 65 kPa for concrete can be used to estimate the uplift force. This force can be resisted by the sustained vertical loads of the foundation. A frost non-susceptible material or bond breaker/thermal insulation between the foundation and the adjacent soil within the adfreeze depth can be used to protect against adfreeze bond development.

Once the bearing surface has been suitably prepared, it should be evaluated by qualified geotechnical personnel to verify the suitability of the bearing soils, and to confirm that the soils are not affected by frost or disturbance, and are consistent with the conditions noted in this memo.

The Upper Complex and glacio-lacustrine clays encountered during the investigation are considered poor to marginal when used as backfill for structures. These soils are susceptible to strength loss and swelling when wetted, typically have higher compressibility when compare to other soil types, and have been known to cause difficulty in achieving compaction density and moisture criteria. If this material is to be used as backfill, it should be free of deleterious material (debris, organics, etc.) and should be placed in layers not exceeding 150 mm in compacted thickness. The fill should be compacted to at least 98% of SPMDD at +/- 2% of OMC.

7. Forcemain and Low Pressure Sewers

It is understood that the proposed new forcemain and LPS networks will be installed using open-cut methods where feasible, and trenchless installation methods at crossing locations where open-cut methods are not deemed feasible (i.e. railways, creeks, roadways).

7.1 Open-Cut Installation

Open-cut installation of pipe may be used where the available space allows and where trenchless pipe installation methods are not required. Recommendations related to temporary excavations required as part of the open-cut pipe installation are provided in Section 8.

The minimum burial depth of un-insulated pipelines should not be less than seasonal frost penetration depth. Insulation should be provided if the burial depth is less than the seasonal frost penetration depth. Pipes should not be placed on uncontrolled fill, organic, soft, or other deleterious soils. The subgrade elevation should be a minimum of 150 mm beneath the pipe design invert elevation to accommodate a layer of bedding sand. The exposed subgrade should first be cleaned to remove all disturbed or otherwise affected soil, and should also be protected from frost, desiccation, and the ingress of free water. Once the bearing surface has been suitably prepared, it should be evaluated by qualified geotechnical personnel to verify the suitability of the bearing soils, and to confirm that the soils are not affected by frost or disturbance and are consistent with the conditions noted in this memo.

The pipe zone backfill around the installed pipe should consist of a minimum 150 mm thick layer of bedding sand beneath the pipe and additional bedding sand placed and compacted around the pipe and to a minimum height of 200 mm above the top of the pipe. The minimum width of the pipe zone backfill should be equivalent to one pipe diameter on either side of the pipe to be installed. The bedding sand should be placed in lifts not exceeding 150 mm in compacted thickness, and compacted to 95% or more of the associated SPMDD and within +/- 2% of the optimum moisture content (OMC).

The Upper Complex and glacio-lacustrine clays encountered during the investigation are considered to be suitable backfill material above the pipe zone backfill, at locations where open-cut installation methods are considered feasible. Should open-cut installation methods be deemed feasible at any of the crossing locations, then the suitability of native soils as backfill material should be reassessed within the context of the crossing type and required loading and subgrade support characteristics. The backfill material should be free of deleterious material (debris, organics, etc.) and should be placed in layers not exceeding 150 mm in compacted thickness. The backfill should be compacted to at least 95% of SPMDD at +/- 2% of OMC.

Additional geotechnical test hole and/or test pit investigation along the proposed forcemain and LPS alignments is recommended to characterize the subsurface conditions along the pipe alignments. This investigation should provide information regarding the type and nature of the soil in which the pipes are to be installed, as well as information about the nature of sloughing and seepage observed along the alignment (the latter to plan trench dewatering requirements in the event those are needed).

7.2 Trenchless Pipe Installation

There are several methods of pipe jacking available to install the proposed forcemain and low pressure sewers at the crossing locations. Two trenchless installation methods are commonly utilized locally; the Atkins coring system, and the Akkerman system. In general, these two methods follow similar construction approaches and result in similar ground responses. However, the Akkerman system is suited for pipe with minimum diameter of 1050 mm, and is therefore not generally considered to be an appropriate method for this application. A third less commonly used method known as the Auger Boring system is also considered feasible. A brief description of each method is provided below.

7.2.1 Pipe Jacking by Atkins Method

The Atkins Method is a variation of the Atkins traditional coring method. This method requires a vertical shaft excavation on both ends of the pipe length to be installed. Three steel rods are driven through the soil from shaft to shaft along the centre of the proposed pipe alignment. A push-pull earth coring knife is attached to the center rod and a front cutting and shielding rim is attached to the two outer rods. The first pipe section is placed so that it abuts to the front cutting and shielding rim securely. A pulling and holding rim connected to the outer rods are pulled, or jacked, towards the opposite shaft to move the whole assembly through the soil. The spoil is removed from the coring knife as necessary by pushing the knife outward. Once a pipe section is installed, additional sections are added and the installation continues.

The drive length between shafts is limited to a maximum of 35 m for larger size pipes. At the crossing locations, the shafts should be located as far from the railways/roadways as possible to protect against potential impact from the excavation.

7.2.2 Pipe Jacking by Auger Boring Method

The Auger Boring Method uses a helical screw auger advanced through a steel casing. A cutting head is attached to the front of the auger. The soil cuttings are removed towards the launching/jacking shaft by the turning of the auger. The casing is jacked simultaneously as the soil cuttings are removed. Depending on the soil conditions, the auger can be advanced ahead of the casing leading edge or recessed a given distance within the casing. When unstable soil conditions are encountered, the casing is advanced ahead of the auger to allow for a soil plug to improve face stability and reduce the potential for ground subsidence. Common practice is to maintain a minimum soil plug length equal to two times the diameter of the casing, as the casing is advanced.

The major advantage of this method is the reduced ground disturbance (i.e. settlement/heave) during installation, as the casing can be jacked ahead of the face of the bore. Although the Auger Boring method has limited control over grade and alignment, considering the short drive length that would be required for some of the identified project crossings (less than 50 m in most cases), grade and alignment control should not be a concern for experienced contractors.

7.2.3 Trenchless Installation Recommendations

Unless the jacking method provides suitable casing, pipes should not be placed within uncontrolled fill, organic, soft, or other deleterious soils. Additional geotechnical test hole and/or test pit investigation at the proposed forcemain and LPS crossings is recommended to characterize the subsurface conditions along the pipe crossing alignments. This investigation should provide information regarding the type and nature of the soil in which the pipes are to be installed, as well as information about the nature of sloughing and seepage at the proposed jacking shaft locations. This information is required in order to provide an assessment of the face stability and an estimate of settlement for the proposed trenchless pipe installations. Assessment of the face stability and ground subsidence is outside the scope of this geotechnical memo, but can be provided should they be required to satisfy permit applications or otherwise upon request.

It is recommended that a construction monitoring program be implemented at the crossing locations to assess estimated ground subsidence resulting from trenchless installation. Generally, this monitoring program consists of establishing representative baseline survey readings at the crossing site prior to construction, and continued survey monitoring of the area throughout construction to identify any changes

resulting from the trenchless installation. A notification and action plan should be established with consultation from all associated parties (i.e. CP Rail, RM of Stanley, utility owners, etc.) at crossing locations prior to construction to identify acceptable displacement tolerance limits and to determine the course of action that is to be taken to repair the area should these limits be exceeded. Development of the construction monitoring program can be provided upon request.

8. Temporary Excavations

All temporary excavations and trenches are the responsibility of the Contractor and should be completed in accordance with Manitoba Workplace Health and Safety Regulations. All necessary measures should be undertaken to protect against adverse impact or undermining of the foundation bearing strata or stability of existing infrastructure. This includes (but is not limited to) protection of the slopes from erosion and softening due to precipitation. Based on field observations during the investigation, seepage was encountered at shallow depths at both sites. Additionally, a relatively high water table (approx. 2.0 m below ground surface) was measured from the piezometer installed at the Reinfeld site. The combination of a high water table and the near-surface Upper Complex layers will likely result in seepage during excavation for the lift stations and/or pipeline installations. Excavations should be monitored and controlled throughout the course of construction. Depending on the duration that they are open, dewatering may be required for the proposed excavation depths. The Contractor should submit a dewatering plan to AECOM for review and approval prior to any excavation work.

The vertical jacking shafts required for trenchless pipe installation are likely to be installed within the Upper Complex native stratum noted in the borings, which is often characterized by weak soils and groundwater seepage. Therefore, these shafts will most likely require shoring in the form of trench boxes or driven sheet piling, and/or dewatering of the excavation.

Geotechnical evaluations and concerns related to excavation, shoring, lateral forces, anticipated ground movement around excavations, heave and base stability can be provided once the design of the proposed infrastructure has been developed further.

9. Lateral Earth Pressures on Buried Structures

The lateral earth pressure on the below-grade walls of the lift stations due to soil pressure may be calculated on the basis of the following conventional relationship, which produces a triangular pressure distribution assuming horizontal ground next to the buried wall. If the ground surface slopes significantly away from the wall (more than required for surface runoff), the design pressure should be re-evaluated.

$$P = K(\gamma_b D + q)$$

Where:

P	lateral earth pressure at depth D (kPa)
K	coefficient of earth pressure from Table 11-1 below
γ_b	total unit weight of backfill soil (kN/m^3) – use buoyant unit weight below water table
q	surface surcharge pressure (kPa)

The equation above is based on the assumption that the backfill immediately behind the wall (and above the long-term water table) is properly drained so as not to allow excess water pressure to develop against the walls. Based on the test hole and piezometer results, the design water table should be taken as 2.0 m below current grade. Since the foundation of the proposed structures will be located more than 2.0 m

below grade, some portion of the walls must also be designed for hydrostatic pressure that is additive to the earth pressure listed in the equation above.

Based on the modest size of the pumping station vaults, the walls should behave as if they are braced and thus, the at-rest earth pressure coefficient is most relevant for structural design. For completeness, active, passive and at-rest earth pressure coefficients are listed for various backfill types in Table 9-1.

Table 9-1: Lateral Earth Pressure Parameters

Soil Type	γ_b (kN/m^3)	Angle of Internal Friction, Φ (degrees)	Active Earth Pressure Coefficient, K_a	Passive Earth Pressure Coefficient, K_p	At-rest Earth Pressure Coefficient, K_o	Coefficient of Friction with Concrete
Compacted Sand*	20.0	30	0.33	3.0	0.50	0.36
Compacted Crushed Gravel and Sand*	21.0	38	0.24	4.2	0.38	0.48

** Gradation tests should be conducted for compacted sand and for compacted crushed gravel and sand to confirm design parameters*

It is not recommended to use the native Upper Complex or glacio-lacustrine clay as backfill materials immediately behind the walls, as this material is not free-draining and could contribute to buildup of hydrostatic pressure behind the walls at levels above the natural water table.

Where traffic or other live loads may travel or operate near the wall, the horizontal pressure due to the live load should be added to the lateral earth pressure.

It is expected that the lift station vaults will be backfilled to fairly comparable depth on all sides and thus sliding is not generally a concern. In the event that a lift station is constructed below a sloping ground surface, the nominal unit resistance to sliding at ULS condition below the base of the concrete footings (for granular soil such as compacted sand and/or gravel) can be calculated by multiplying the total vertical load acting on the footing by a coefficient of friction between the concrete base and foundation soil, assuming that a minimum 300 mm thick layer of crushed granular material is placed below the foundation. The coefficients of friction between concrete and different granular foundation soils are provided in Table 9-1. A resistance factor of 0.8 should be used on ultimate sliding resistance to obtain factored sliding resistance.

If passive sliding resistance is used in the design, it should be carefully evaluated for the possibility of future removal of the soil from the front of the wall/structure and the associated displacement to mobilize the maximum passive soil resistance.

Wall backfill should not commence before the concrete walls have reached a minimum two-thirds of their 28-day compressive strength. Only hand-operated compaction equipment should be employed within 600 mm of the walls. Caution should be taken during compaction of backfill to reduce lateral loads caused by the compaction. To avoid differential lateral pressures against walls during construction, the backfill should be brought up evenly around the walls.

10. Buoyancy and Uplift

Structures located below the GWL should be designed to resist buoyant forces from hydrostatic pressures, or have an integrated pressure relief system. It is prudent to investigate buoyancy effect for the completed but empty structures, and for conditions during construction, assuming credible scenarios for groundwater conditions. In this regard, an input from a hydrogeologist may be required.

Structures resisting uplift forces will require restraining devices or uplift resistance measures. Forces that can be considered in providing the uplift resistance include the dead weight of the structure and the weight of the soil above projections of the foundation beyond the outside faces of the below-grade walls. The foundations can be extended symmetrically beyond the walls of the structure at least 1.0 m so that the weight of the soil above the footing can be accounted for in buoyancy resistance. A design factor of safety of 1.5 and 1.3 should be adopted against the buoyant uplift forces for long-term and short-term conditions, respectively. As noted above, it is recommended to assess resistance to buoyancy assuming a design GWL at approximately 2.0 m below ground surface. The total unit weights of soil and concrete should be used above the design GWL and buoyant unit weights should be used below the design GWL.

11. Closure

The findings and recommendations of this memorandum were based on the results of a field investigation combined with an interpretation of soil and ground water conditions at the test hole locations. If conditions are encountered that appear to be different from those shown by the test holes drilled at these sites and reflected in this memorandum, or if the assumptions stated herein are not in keeping with the design, this office should be notified in order that the recommendations can be reviewed and modified, if necessary.

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 of near surface soil conditions. A contingency should be included in the construction budget to allow for possibility in variation in soil conditions, which may result in modifications of the design and construction procedures.

Please do not hesitate to contact the undersigned for any questions or further information.

Respectfully Submitted,
AECOM Canada Ltd.

Prepared by:

Ryan Harras, B. Sc.
Geotechnical Engineer in Training

Reviewed by:

Elliott E. Drumright, Ph.D., P.E.
Geotechnical Engineer

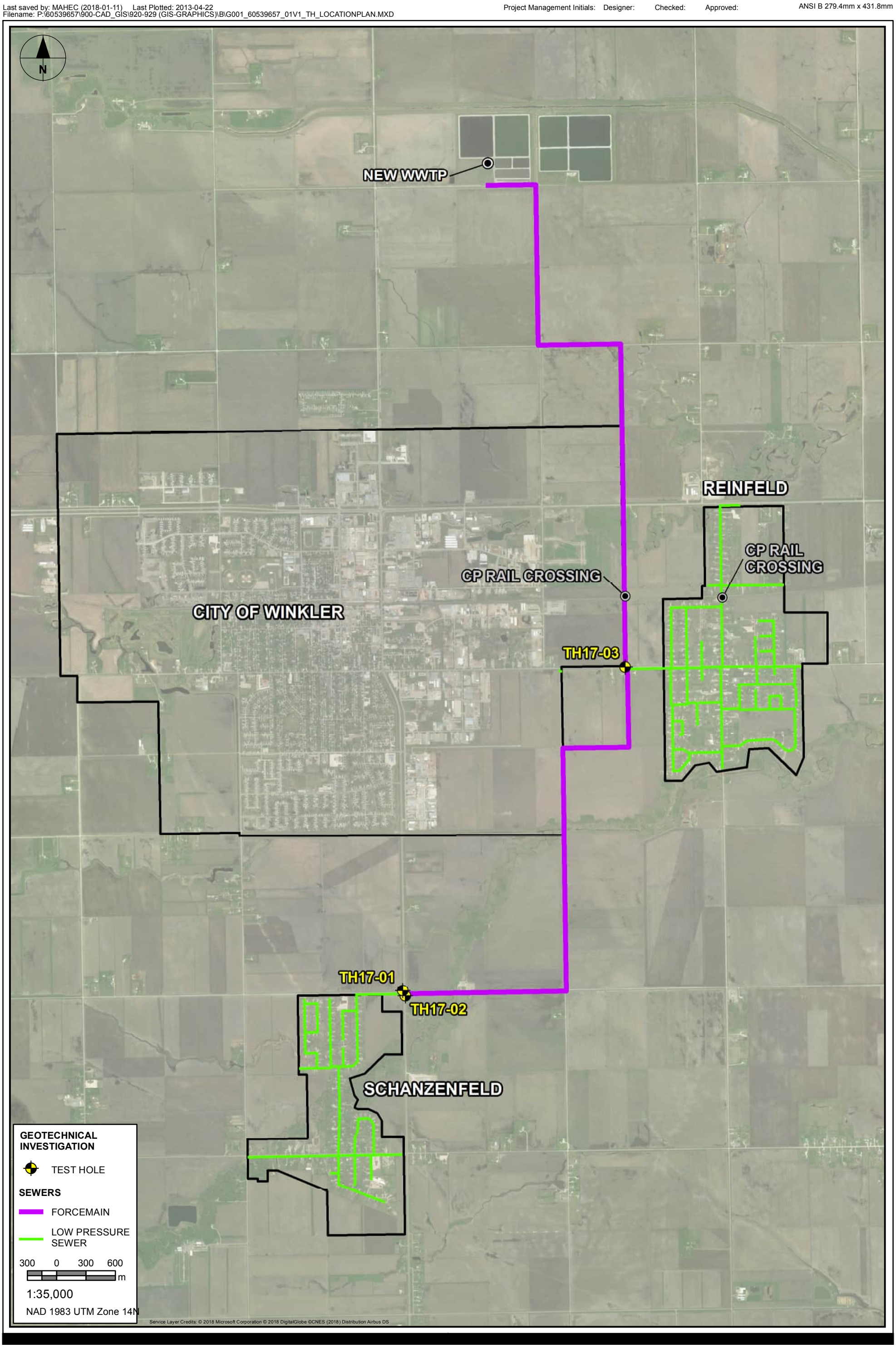
Appendix A

Test Hole Location Plan

Last saved by: MAHEC (2018-01-11) Last Plotted: 2013-04-22
Filename: P:\60539657\900-CAD_GIS\920-929 (GIS-GRAPHICS)\B\G001_60539657_01V1_TH_LOCATIONPLAN.MXD

Project Management Initials: Designer: Checked: Approved:

ANSI B 279.4mm x 431.8mm



Regional Wastewater Systems
Geotechnical Investigation
RM of Stanley - Reinfeld and Schanzenfeld, MB

Test Hole Location Plan

AECOM

Figure: 01

Appendix B
Test Hole Logs

AECOM Canada Ltd.

GENERAL STATEMENT

NORMAL VARIABILITY OF SUBSURFACE CONDITIONS

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

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

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

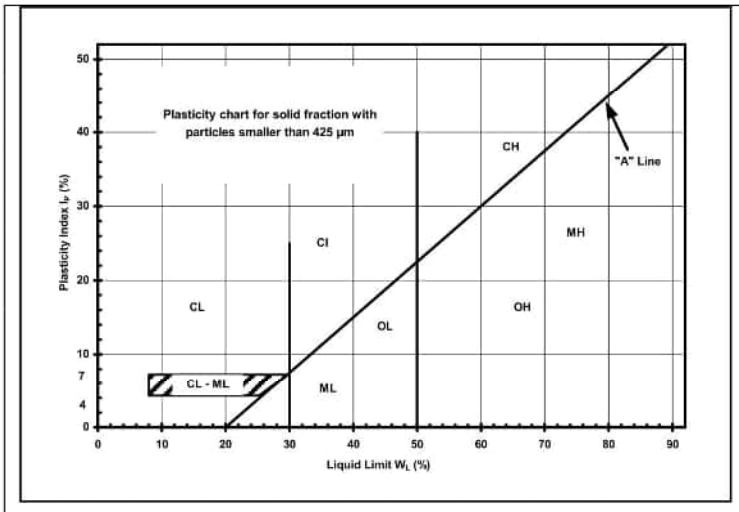
In order to observe compliance with the design concepts, specifications or recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated, we recommend that all construction operations dealing with earth work and the foundations be observed by an experienced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

EXPLANATION OF FIELD & LABORATORY TEST DATA

Description				UMA Log Symbols	USCS Classification	Laboratory Classification Criteria			
						Fines (%)	Grading	Plasticity	Notes
COARSE GRAINED SOILS	GRAVELS (More than 50% of coarse fraction of gravel size)	CLEAN GRAVELS (Little or no fines)	Well graded gravels, sandy gravels, with little or no fines		GW	0-5	$C_U > 4$ $1 < C_C < 3$		Dual symbols if 5-12% fines. Dual symbols if above "A" line and $4<W_P<7$ $C_U = \frac{D_{60}}{D_{10}}$ $C_C = \frac{(D_{30})^2}{D_{10} x D_{60}}$
			Poorly graded gravels, sandy gravels, with little or no fines		GP	0-5	Not satisfying GW requirements		
		DIRTY GRAVELS (With some fines)	Silty gravels, silty sandy gravels		GM	> 12		Atterberg limits below "A" line or $W_P<4$	
			Clayey gravels, clayey sandy gravels		GC	> 12		Atterberg limits above "A" line or $W_P<7$	
	SANDS (More than 50% of coarse fraction of sand size)	CLEAN SANDS (Little or no fines)	Well graded sands, gravelly sands, with little or no fines		SW	0-5	$C_U > 6$ $1 < C_C < 3$		
			Poorly graded sands, gravelly sands, with little or no fines		SP	0-5	Not satisfying SW requirements		
		DIRTY SANDS (With some fines)	Silty sands, sand-silt mixtures		SM	> 12		Atterberg limits below "A" line or $W_P<4$	
			Clayey sands, sand-clay mixtures		SC	> 12		Atterberg limits above "A" line or $W_P<7$	
FINE GRAINED SOILS	SILTS (Below 'A' line negligible organic content)	$W_L<50$	Inorganic silts, silty or clayey fine sands, with slight plasticity		ML			Classification is Based upon Plasticity Chart	
		$W_L>50$	Inorganic silts of high plasticity		MH				
	CLAYS (Above 'A' line negligible organic content)	$W_L<30$	Inorganic clays, silty clays, sandy clays of low plasticity, lean clays		CL				
		$30<W_L<50$	Inorganic clays and silty clays of medium plasticity		CI				
		$W_L>50$	Inorganic clays of high plasticity, fat clays		CH				
	ORGANIC SILTS & CLAYS (Below 'A' line)	$W_L<50$	Organic silts and organic silty clays of low plasticity		OL				
		$W_L>50$	Organic clays of high plasticity		OH				
HIGHLY ORGAINIC SOILS			Peat and other highly organic soils		Pt	Von Post Classification Limit		Strong colour or odour, and often fibrous texture	

	Asphalt		Till				AECOM
	Concrete		Bedrock (Undifferentiated)				
	Fill		Bedrock (Limestone)				

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



FRACTION		SEIVE SIZE (mm)		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
		Passing	Retained	Percent	Identifier
Gravel	Coarse	76	19	35-50	and
	Fine	19	4.75		
Sand	Coarse	4.75	2.00	20-35	"y" or "ey" *
	Medium	2.00	0.425		
	Fine	0.425	0.075	10-20	some
Silt (non-plastic) or Clay (plastic)		< 0.075 mm		1-10	trace

* for example: gravelly, sandy clayey, silty

Definition of Oversize Material

COBBLES: 76mm to 300mm diameter
BOULDERS: >300mm diameter

LEGEND OF SYMBOLS

Laboratory and field tests are identified as follows:

q_u - undrained shear strength (kPa) derived from unconfined compression testing.

T_v - undrained shear strength (kPa) measured using a torvane

pp - undrained shear strength (kPa) measured using a pocket penetrometer.

L_v - undrained shear strength (kPa) measured using a lab vane.

F_v - undrained shear strength (kPa) measured using a field vane.

γ - bulk unit weight (kN/m^3).

SPT - Standard Penetration Test. Recorded as number of blows (N) from a 63.5 kg hammer dropped 0.76 m (free fall) which is required to drive a 51 mm O.D. Raymond type sampler 0.30 m into the soil.

DPPT - Drive Point Pentrometer Test. Recorded as number of blows from a 63.5 kg hammer dropped 0.76 m (free fall) which is required to drive a 50 mm drive point 0.30 m into the soil.

w - moisture content (W_L, W_P)

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

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

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

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

PROJECT: RM of Stanley Regional Wastewater System	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH17-01**
LOCATION: UTM 14 - 5444497 m N, 577936 m E		PROJECT NO.: 60539657
CONTRACTOR: Paddock Drilling	METHOD: Ackers SX, 125 mm SSA	ELEVATION (m): NA

SAMPLE TYPE ■ GRAB ▯ SHELBY TUBE ☒ SPLIT SPOON ▬ BULK ⊘ NO RECOVERY ◧ CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS
0		TOPSOIL - black (125 mm)				
		SILT and CLAY - trace to some sand - dark brown, soft to firm, dry to moist - intermediate plasticity	■	G1		
1						
		SILT - sandy, clayey - brown, firm, moist - low plasticity	☒	S2	7	SPT Blows: [3/2/5], Spoon Recovery 25%
2			■	G3		
		- soft, wet below 2.3 m				
3			■	G4		
		CLAY - silty, trace sand - brown, firm, moist - high plasticity	■	G5		
4						
		- some silt to silty, trace silt inclusions below 4.6 m - (S6): LL = 88%, PL = 27%	☒	S6	7	(S6): Gravel: 0%, Sand: 6%, Silt: 23%, Clay: 71% SPT Blows: [3/2/5], Spoon Recovery 100%
5			■	G7		
6			■	G8		
		- brownish grey below 6.1 m				
7						
			☒	S9	8	SPT Blows: [3/3/5], Spoon Recovery 82%
8						
9			■	G10		
10						

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100; ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU/2 × ☐ Lab Vane ☐ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200

DEPTH

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 1/11/18

AECOM

LOGGED BY: Tessa Christi	COMPLETION DEPTH: 10.67 m
REVIEWED BY: Elliott Drumright	COMPLETION DATE: 10/23/17
PROJECT ENGINEER: Bill Burgess	Page 1 of 2

PROJECT: RM of Stanley Regional Wastewater System	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH17-01**
LOCATION: UTM 14 - 5444497 m N, 577936 m E		PROJECT NO.: 60539657
CONTRACTOR: Paddock Drilling	METHOD: Ackers SX, 125 mm SSA	ELEVATION (m): NA

SAMPLE TYPE ■ GRAB ▥ SHELBY TUBE ☒ SPLIT SPOON ▤ BULK ▨ NO RECOVERY ◧ CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100 ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21 Plastic MC Liquid 20 40 60 80 100	UNDRAINED SHEAR STRENGTH + Torvane + × QU/2 × □ Lab Vane □ △ Pocket Pen. △ ⚙ Field Vane ⚙ (kPa) 50 100 150 200	COMMENTS	DEPTH
10			■	G11					10
		END OF TEST HOLE AT 10.67 m IN CLAY							
11		Notes: 1. Light seepage observed from 1.5 m to 2.3 m. Heavy seepage observed below 2.3 m. 2. Test hole open to 3.0 m upon removal of auger. 3. Water to 2.9 m upon removal of auger. 4. Test hole backfilled with auger cuttings and bentonite upon completion.							11
12									12
13									13
14									14
15									15
16									16
17									17
18									18
19									19
20									

AECOM

LOGGED BY: Tessa Christi	COMPLETION DEPTH: 10.67 m
REVIEWED BY: Elliott Drumright	COMPLETION DATE: 10/23/17
PROJECT ENGINEER: Bill Burgess	Page 2 of 2

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 1/11/18

PROJECT: RM of Stanley Regional Wastewater System	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH17-02**
LOCATION: UTM 14 - 5444444 m N, 577963 m E		PROJECT NO.: 60539657
CONTRACTOR: Paddock Drilling	METHOD: Ackers SX, 125 mm SSA, 190 mm HSA	ELEVATION (m): NA

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	DEPTH
0		TOPSOIL - black (230 mm)					
		SAND - some silt to silty, trace clay, trace gravel - brown, dry					
		SILT and CLAY - dark brown, soft to firm, moist - intermediate plasticity		G12			
1				G13			1
2		SILT - sandy, some clay to clayey - light brown mottled dark brown, soft, wet - low plasticity		G14			2
3		- firm below 3.0 m		S15	8	SPT Blows: [3/3/5], Spoon Recovery 100%	3
				G16			
4		CLAY - some silt to silty - dark brown, firm, moist - high plasticity		G17			4
5				G18			5
6				G19			6
				S20	8	SPT Blows: [3/4/4], Spoon Recovery 100%	
7							7
8							8
9		- soft below 9.1 m		S21	4	SPT Blows: [2/1/3], Spoon Recovery 100%	9
10							

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100; ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU/2 × ☐ Lab Vane ☐ △ Pocket Pen. △ ✪ Field Vane ✪ (kPa) 50 100 150 200

LOGGED BY: Tessa Christi	COMPLETION DEPTH: 11.13 m
REVIEWED BY: Elliott Drumright	COMPLETION DATE: 10/23/17
PROJECT ENGINEER: Bill Burgess	Page 1 of 2

AECOM

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 1/11/18

PROJECT: RM of Stanley Regional Wastewater System	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH17-02**
LOCATION: UTM 14 - 5444444 m N, 577963 m E		PROJECT NO.: 60539657
CONTRACTOR: Paddock Drilling	METHOD: Ackers SX, 125 mm SSA, 190 mm HSA	ELEVATION (m): NA

SAMPLE TYPE ■ GRAB ▯ SHELBY TUBE ☒ SPLIT SPOON ☰ BULK ⊘ NO RECOVERY ◧ CORE

DEPTH (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100 ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21 Plastic MC Liquid 20 40 60 80 100	UNDRAINED SHEAR STRENGTH + Torvane + × QU/2 × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200	COMMENTS	DEPTH
10									10
11			☒	S22	3	◆		SPT Blows: [2/1/2], Spoon Recovery 100%	11
		END OF TEST HOLE AT 11.13 m IN CLAY							
12		Notes: 1. Seepage observed below 2.1 m. 2. Sloughing observed below 4.6 m. 3. Test hole open to 2.4 m upon removal of auger. 4. Water to 2.3 m upon removal of auger. 5. Test hole backfilled with auger cuttings and bentonite upon completion.							12
13									13
14									14
15									15
16									16
17									17
18									18
19									19
20									

AECOM

LOGGED BY: Tessa Christi	COMPLETION DEPTH: 11.13 m
REVIEWED BY: Elliott Drumright	COMPLETION DATE: 10/23/17
PROJECT ENGINEER: Bill Burgess	Page 2 of 2

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 1/11/18

PROJECT: RM of Stanley Regional Wastewater System	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH17-03**
LOCATION: UTM 14 - 5447802 m N, 580203 m E		PROJECT NO.: 60539657
CONTRACTOR: Paddock Drilling	METHOD: Ackers SX, 125 mm SSA, 190 mm HSA	ELEVATION (m): NA

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	SOIL SYMBOL	SLOTTED PIEZOMETER	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100; ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100	UNDRAINED SHEAR STRENGTH: + Torvane + × QU/2 × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200	COMMENTS	DEPTH
0			TOPSOIL - black (760 mm)						0
1			SAND and SILT - some clay - light brown, soft, moist to wet - low plasticity		G23		●		1
					G24		●		
2			- wet, some sand laminations (< 5 mm thick) below 2.1 m		G25				2
3					G26		●		(G26): Gravel: 0%, Sand: 51%, Silt: 36%, Clay: 13%	3
4										4
			CLAY - silty - dark brown, firm, moist - high plasticity - trace silt inclusions from 4.6 m to 10.7 m		S27	6	◆		SPT Blows: [2/3/3], Spoon Recovery 100%	
5										5
6					T28		■●	×△	Tube Recovery 80%	6
7										7
8					T29				Tube Recovery 80%	8
9										9
			- (S30): LL = 75%, PL = 25%		S30	5	◆—●		SPT Blows: [1/2/3], Spoon Recovery 100%	
10										

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 1/11/18

AECOM

LOGGED BY: Tessa Christi	COMPLETION DEPTH: 13.72 m
REVIEWED BY: Elliott Drumright	COMPLETION DATE: 10/23/17
PROJECT ENGINEER: Bill Burgess	Page 1 of 2

PROJECT: RM of Stanley Regional Wastewater System	CLIENT: Manitoba Water Services Board	TESTHOLE NO: **TH17-03**
LOCATION: UTM 14 - 5447802 m N, 580203 m E		PROJECT NO.: 60539657
CONTRACTOR: Paddock Drilling	METHOD: Ackers SX, 125 mm SSA, 190 mm HSA	ELEVATION (m): NA

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	SOIL SYMBOL	SLOTTED PIEZOMETER	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	DEPTH
10									10
			- soft below 10.7 m						
11					S31	4		SPT Blows: [2/2/2], Spoon Recovery 50%	11
12									12
					S32	4		SPT Blows: [1/2/2], Spoon Recovery 100%	
13									13
14					S33	4		SPT Blows: [1/2/2], Spoon Recovery 100%	14
			END OF TEST HOLE AT 14.2 m IN CLAY						
15									15
16									16
17									17
18									18
19									19
20									

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100 ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21 Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU/2 × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200

Notes:
1. Seepage observed below 2.1 m.
2. Sloughing observed below 4.6 m.
3. Test hole backfilled with bentonite to from 14.2 m to 11.0 m, sand from 11.0 m to 9.8 m, bentonite from 9.8 m to 9.1 m, auger cuttings from 9.1 m to 0.8 m, and bentonite from 0.8 m to original ground surface.
4. Ground water monitoring:
   - December 14, 2017 @ 2.21 m below ground surface

AECOM

LOGGED BY: Tessa Christi	COMPLETION DEPTH: 13.72 m
REVIEWED BY: Elliott Drumright	COMPLETION DATE: 10/23/17
PROJECT ENGINEER: Bill Burgess	Page 2 of 2

LOG OF TEST HOLE TEST HOLE LOGS.GPJ UMA WINN.GDT 1/11/18

Appendix C

Laboratory Testing Results

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

204 477 5381 tel
204 284 2040 fax

Memorandum

To	Tessa Christi	Page	1
CC			
Subject	RM Stanley - Regional WWS – Manitoba WSB – Test Results		
From	Elliott E. Drumright		
Date	November 27, 2017	Project Number	60539657.0300

Please find attached the following material test result(s) on sample(s) submitted to the Winnipeg Geotechnical Laboratory:

- Eighteen (18) Moisture Content Determination tests.
- Two (2) Atterberg Limits (3 Points) tests.
- Two (2) Grain Size Distribution (Hydrometer method) test.

If you have any questions, please contact the undersigned.

Sincerely,

Elliott E. Drumright, Ph.D., P.E.
Associate Geotechnical Engineer

Att.

AECOM Canada Ltd.
Winnipeg Geotechnical Laboratory
99 Commerce Drive
Winnipeg, Manitoba
R3P 0Y7
Phone: 204 477 5381 Fax: 204 284 2040

Project Name:	RM of Stanley - Regional WWS	Supplier:	AECOM
Project Number:	60539657	Specification:	N/A
Client:	Manitoba WSB	Field Technician:	TChristi
Sample Location:	RM of Stanley, MB	Sample Date:	October 23, 2017
Sample Depth:	Varies	Lab Technician:	TChristi
Sample Number:	Varies	Date Tested:	November 7, 2017

Moisture Content (ASTM D2216-10)

Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

Location	Sample	Depth (m)	**Moisture Content (%)**
TH17-01	G1	0.69 - 0.84 m	**32.0%**
	S2	1.37 - 1.52 m	**34.5%**
	G3	2.21 - 2.36 m	**27.9%**
	G4	2.90 - 3.05 m	**28.1%**
	G5	3.73 - 3.89 m	**-**
	S6	4.57 - 5.03 m	**47.3%**
	G7	5.26 - 5.41 m	**-**
	G8	6.10 - 6.55 m	**43.6%**
	S9	7.62 - 8.08 m	**-**
	G10	8.99 - 9.14 m	**48.9%**
	G11	10.52 - 10.67 m	**-**
TH17-02	G12	0.69 - 0.84 m	**27.2%**
	G13	1.37 - 1.52 m	**31.5%**
	G14	2.21 - 2.36 m	**33.1%**
	S15	3.05 - 3.51 m	**-**
	G16	3.73 - 3.89 m	**-**
	G17	4.57 - 5.03 m	**38.2%**
	G18	5.26 - 5.41 m	**-**
	G19	5.94 - 6.10 m	**42.7%**
	S20	6.10 - 6.55 m	**-**
	S21	9.14 - 9.60 m	**51.3%**
	S22	10.67 - 11.13 m	**-**
TH17--03	G23	0.61 - 0.76 m	**19.0%**
	G24	1.37 - 1.52 m	**24.1%**
	G25	2.21 - 2.36 m	**-**
	G26	2.90 - 3.05 m	**28.4%**
	S27	4.57 - 5.03 m	**-**
	T28	6.10 - 6.71 m	**-**
	T29	7.62 - 8.23 m	**-**
	S30	9.14 - 9.60 m	**52.4%**
	S31	10.67 - 11.13 m	**-**
	S32	12.19 - 12.65 m	**51.0%**

Location	Sample	Depth (m)	**Moisture Content (%)**

AECOM Canada Ltd.
Winnipeg Geotechnical Laboratory
99 Commerce Drive
Winnipeg, Manitoba
R3P 0Y7
Phone: 204 477 5381 Fax: 204 284 2040

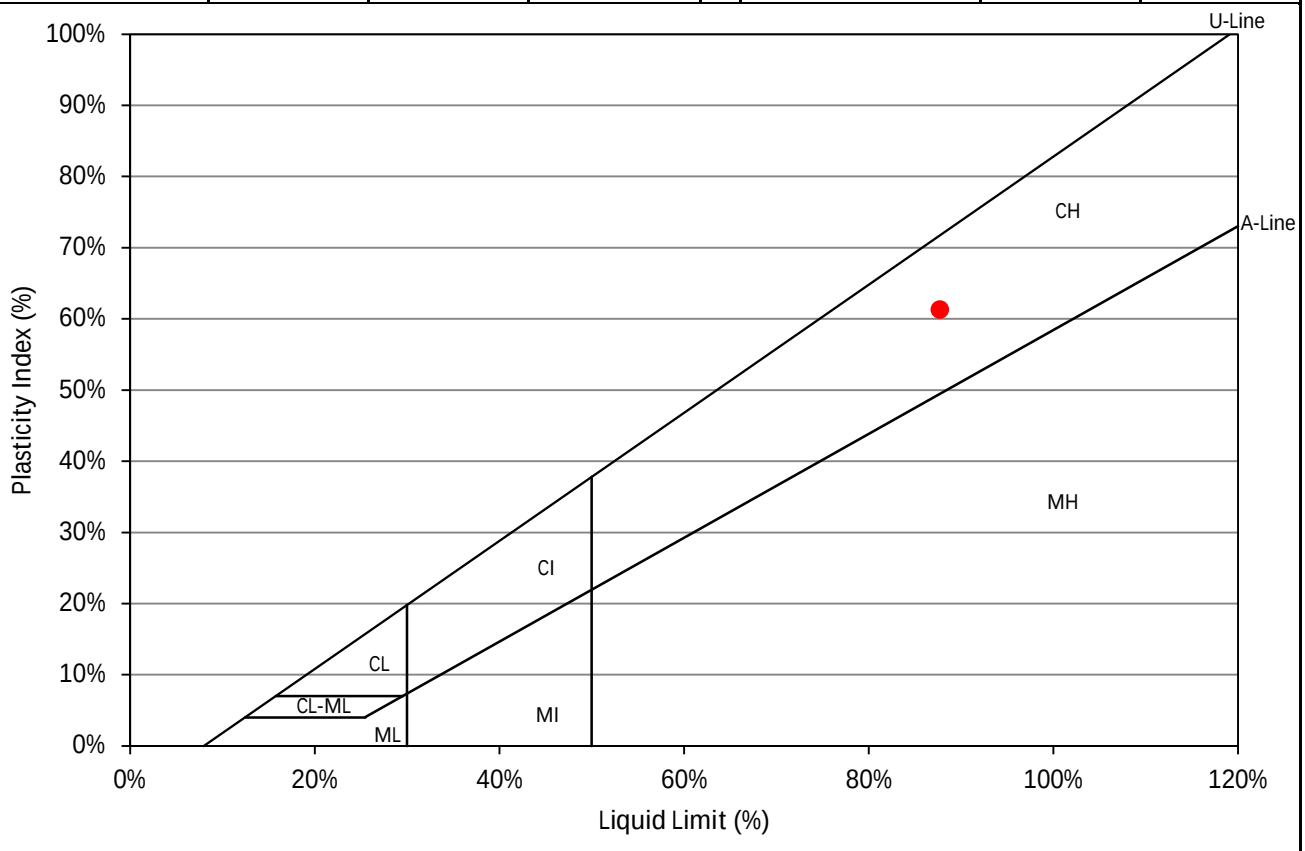
Project Name:	RM Stanley Regional WWS	Supplier:	AECOM
Project Number:	60539657	Specification:	N/A
Client:	Manitoba WSB	Field Technician:	TChristi
Sample Location:	TH17-01	Sample Date:	Varies
Sample Depth:	4.57 - 5.03 m	Lab Technician:	TChristi
Sample Number:	S6	Date Tested:	November 24, 2017

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	32	24	15
Wet Sample (g)	8.2	7.0	6.8
Dry Sample (g)	4.4	3.7	3.6
Water Content (%)	86.4%	88.1%	90.6%

Plastic Limit		
Trial	1	2
Wet Sample (g)	6.5	6.1
Dry Sample (g)	5.1	4.8
Water Content (%)	26.6%	26.3%



Liquid Limit (%): 87.7%	Plastic Limit (%): 26.5%	Plasticity Index (%): 61.3%

AECOM Canada Ltd.
Winnipeg Geotechnical Laboratory
99 Commerce Drive
Winnipeg, Manitoba
R3P 0Y7
Phone: 204 477 5381 Fax: 204 284 2040

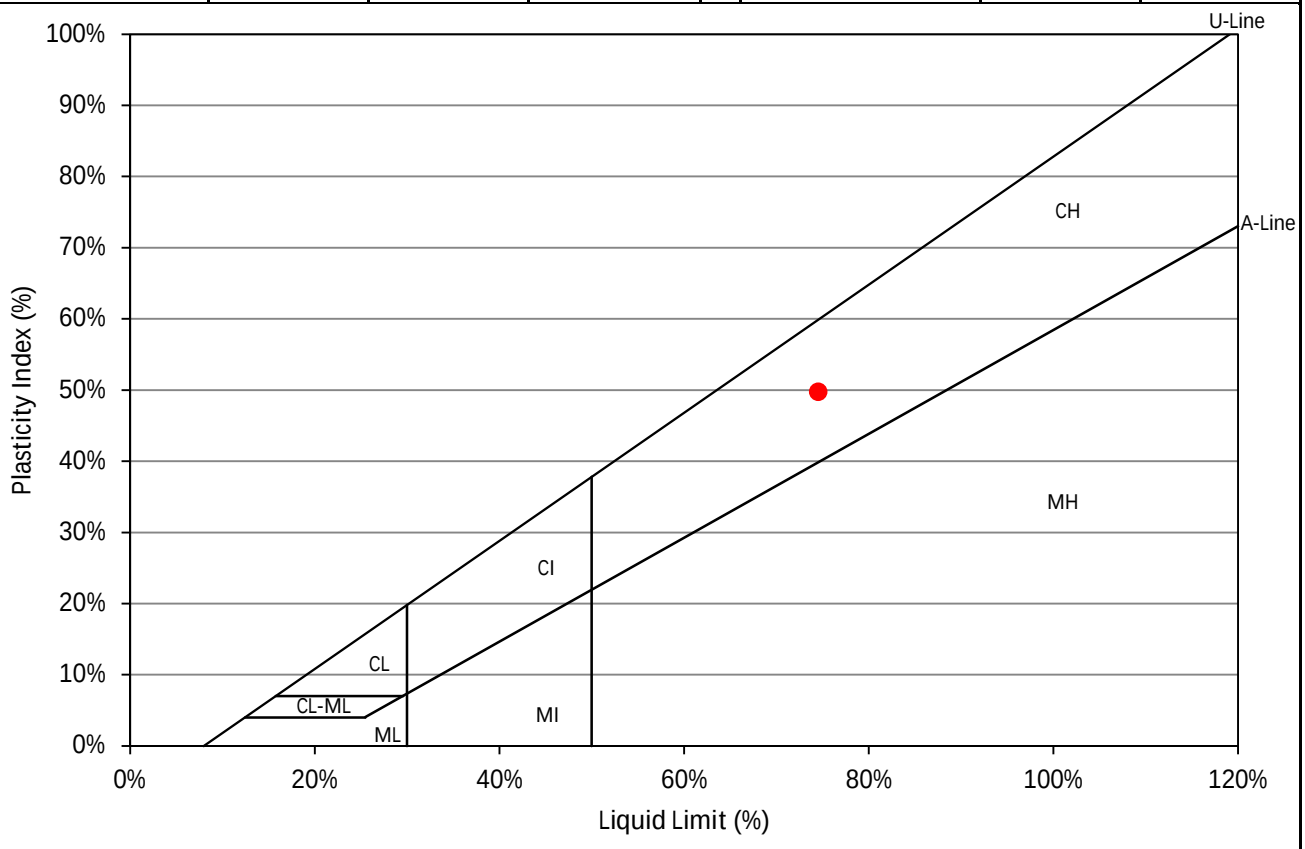
Project Name:	RM Stanley Regional WWS	Supplier:	AECOM
Project Number:	60539657	Specification:	N/A
Client:	Manitoba WSB	Field Technician:	TChristi
Sample Location:	TH17-03	Sample Date:	Varies
Sample Depth:	9.14 - 9.60 m	Lab Technician:	TChristi
Sample Number:	S30	Date Tested:	November 24, 2017

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	26	35	21
Wet Sample (g)	6.8	6.4	7.2
Dry Sample (g)	3.9	3.7	4.1
Water Content (%)	74.2%	73.3%	75.0%

Plastic Limit		
Trial	1	2
Wet Sample (g)	6.8	6.2
Dry Sample (g)	5.5	5.0
Water Content (%)	24.8%	24.8%



Liquid Limit (%): 74.5%	Plastic Limit (%): 24.8%	Plasticity Index (%): 49.7%

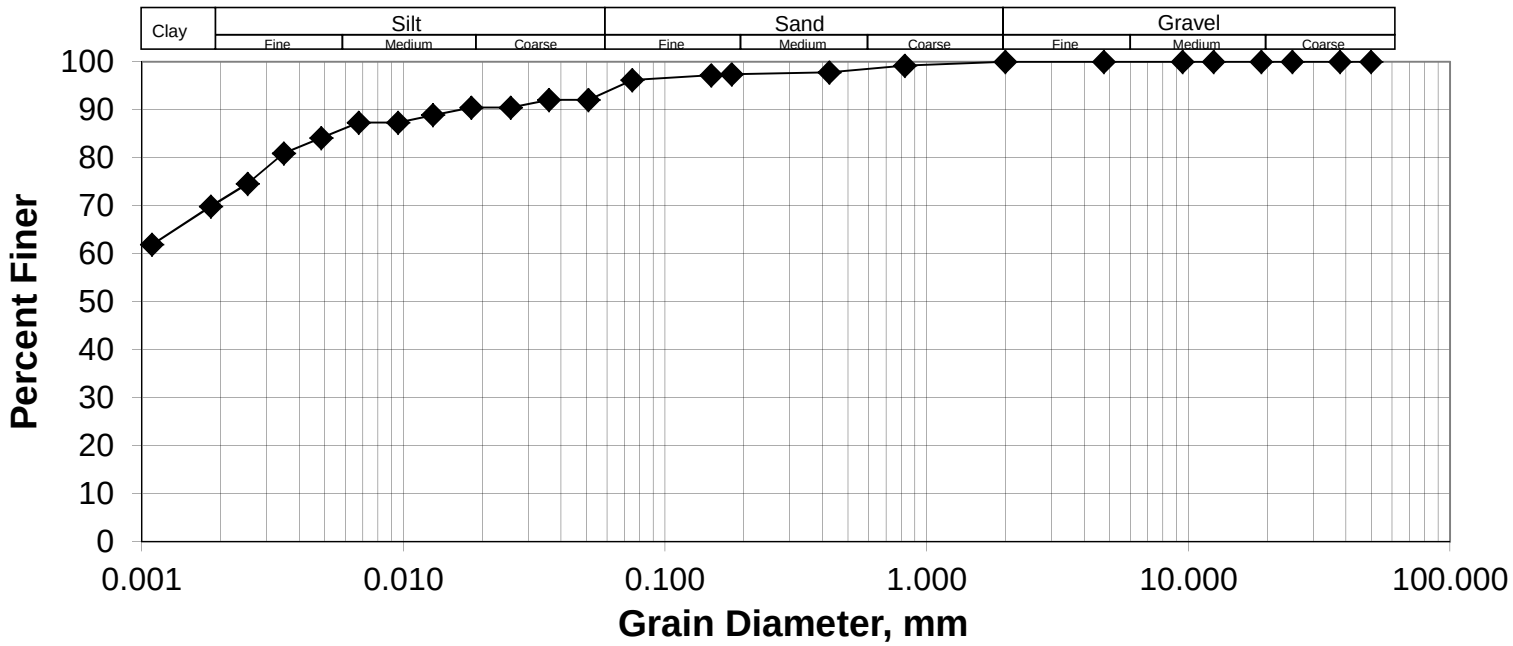
GRAIN SIZE DISTRIBUTION
(ASTM D422-63)

AECOM
MATERIALS LABORATORY
AECOM
99 Commerce Dr., Winnipeg, MB R3P 0Y7 Canada
tel (204) 477-5381 **fax** (204) 284-2040

Job No.:	60539657	Hole No.:	TH17-01
Client:	Manitoba WSB	Sample No.:	S6
Project :	RM Stanley - Regional WWS	Depth:	4.57 - 5.03 m
Date Tested:	21-Nov-17	Date Sampled:	Varies
Tested By:	EManimbao	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	100.0	0.0750	96.2
38.0	100.0	0.83	99.2	0.0510	92.1
25.0	100.0	0.43	97.8	0.0361	92.1
19.0	100.0	0.18	97.4	0.0257	90.5
12.5	100.0	0.15	97.2	0.0182	90.5
9.5	100.0	0.075	96.2	0.0130	88.9
4.75	100.0			0.0095	87.3
2.00	100.0			0.0068	87.3
				0.0049	84.1
				0.0035	80.9
				0.0025	74.6
				0.0018	69.8
				0.0011	61.9

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.00%**	**Silt**	**22.67%**
Sand	**6.39%**	**Clay**	**70.94%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

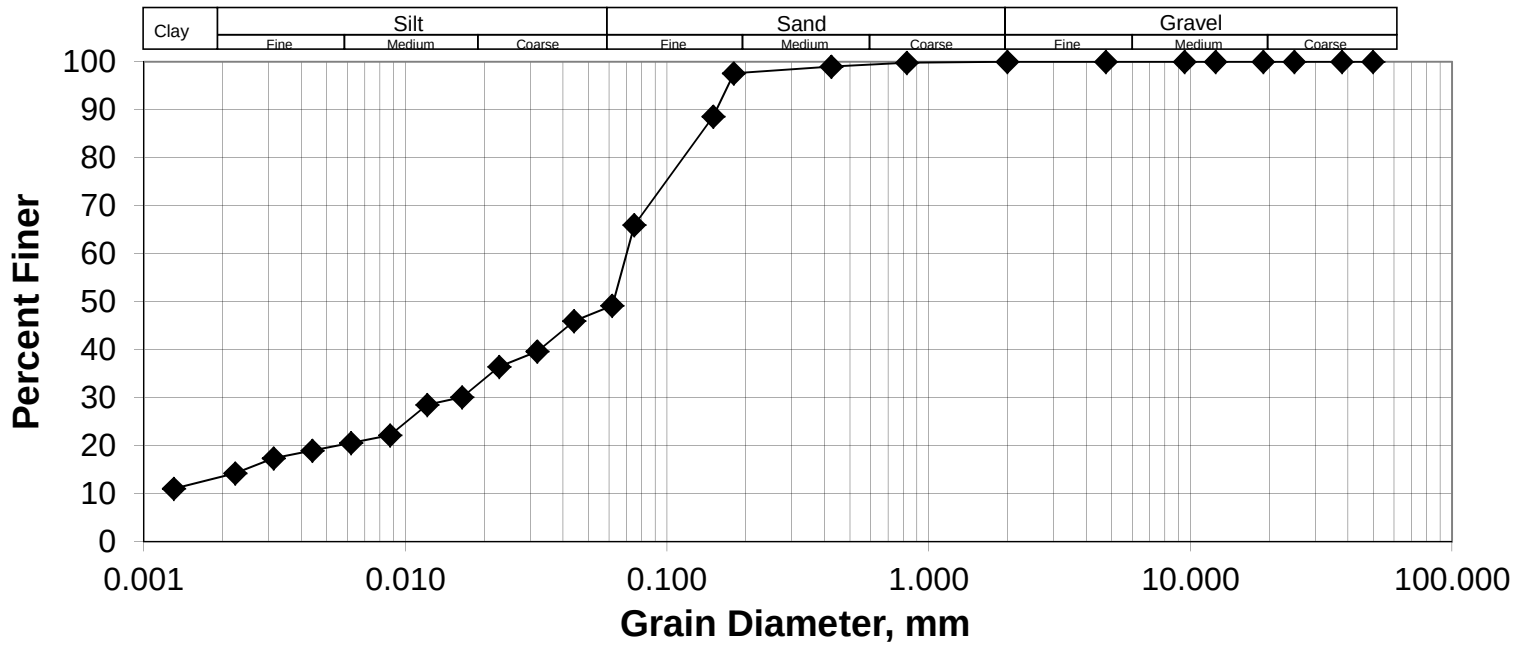
GRAIN SIZE DISTRIBUTION
(ASTM D422-63)

MATERIALS LABORATORY
AECOM
99 Commerce Dr., Winnipeg, MB R3P 0Y7 Canada
tel (204) 477-5381 **fax** (204) 284-2040

Job No.:	60539657	Hole No.:	TH17-02
Client:	Manitoba WSB	Sample No.:	G26
Project :	RM Stanley - Regional WWS	Depth:	2.90 - 3.05 m
Date Tested:	21-Nov-17	Date Sampled:	Varies
Tested By:	EManimbao	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	100.0	0.0750	66.0
38.0	100.0	0.83	99.8	0.0617	49.2
25.0	100.0	0.43	99.0	0.0442	46.0
19.0	100.0	0.18	97.6	0.0319	39.6
12.5	100.0	0.15	88.6	0.0228	36.5
9.5	100.0	0.075	66.0	0.0165	30.1
4.75	100.0			0.0121	28.5
2.00	100.0			0.0087	22.2
				0.0062	20.6
				0.0044	19.0
				0.0031	17.4
				0.0022	14.2
				0.0013	11.1

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.00%**	**Silt**	**35.43%**
Sand	**51.14%**	**Clay**	**13.43%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

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

204 477 5381 tel
204 284 2040 fax

Memorandum

To	Ryan Harras	Page	1
CC			
Subject	RM Stanley - Regional WWS – Manitoba WSB – Test Results		
From	Elliott E. Drumright		
Date	January 08, 2018	Project Number	60539657.0300

Please find attached the following material test result(s) on sample(s) submitted to the Winnipeg Geotechnical Laboratory:

- One (1) Torvane, Pocket Penetrometer, Moisture Content, Bulk Density and Visual Description with Unconfined Compressive Strength, on Shelby tube samples.

If you have any questions, please contact the undersigned.

Sincerely,

[redacted]

Elliott E. Drumright, Ph.D., P.E.
Associate Geotechnical Engineer

Att.

AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

CLIENT: Manitoba WSB
PROJECT: RM Stanley - Regional WWS
JOB NO.: 60539657

TEST HOLE NO.:	**TH17-03**
SAMPLE NO.:	**T28**
SAMPLE DEPTH:	6.10 - 6.71 m
DATE TESTED:	5-Jan-18
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.85
Vane Size (S, M, L)	M
Undrained Shear Strength (kPa)	**83.4**
Undrained Shear Strength (ksf)	1.74
POCKET PENETROMETER	
Reading - Qu (tsf)	1.00
Undrained Shear Strength (kPa)	**47.9**
Reading - Qu (tsf)	1.25
Undrained Shear Strength (kPa)	**59.9**
Reading - Qu (tsf)	0.75
Undrained Shear Strength (kPa)	**35.9**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**66.2**
Unconfined compressive strength (ksf)	**1.4**
Undrained Shear Strength (kPa)	**33.1**
Undrained Shear Strength (ksf)	**0.692**
MOISTURE CONTENT	
Tare Number	A37
Wt. Sample wet + tare (g)	389.7
Wt. Sample dry + tare (g)	271.0
Wt. Tare (g)	8.1
Moisture Content %	**45.2**
BULK DENSITY	
Sample Wt. (g)	1103.4
Diameter 1 (cm)	7.20
Diameter 2 (cm)	7.20
Diameter 3 (cm)	7.20
Avg. Diameter (cm)	**7.20**
Length 1 (cm)	15.30
Length 2 (cm)	15.30
Length 3 (cm)	15.30
Avg. Length (cm)	**15.30**
Volume (cm^3)	622.9
Moisture content (%)	45.2
Bulk Density (g/cm^3)	1.771
Bulk Density (kN/m^3)	**17.4**
Bulk Density (pcf)	**110.6**
Dry Density (kN/m^3)	**11.97**

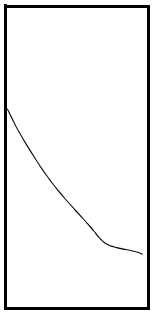
AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

AECOM

CLIENT:	Manitoba WSB
PROJECT:	RM Stanley - Regional WWS
JOB NO.:	60539657

TEST HOLE NO.:	TH17-03
SAMPLE NO.:	T28
SAMPLE DEPTH:	6.10 - 6.71 m
SAMPLE DATE:	
TEST DATE:	5-Jan-18

SOIL DESCRIPTION:	
CLAY - grey, moist, firm, high plasticity, homogeneous	
MOISTURE CONTENT:	45.2



FAILURE SKETCH

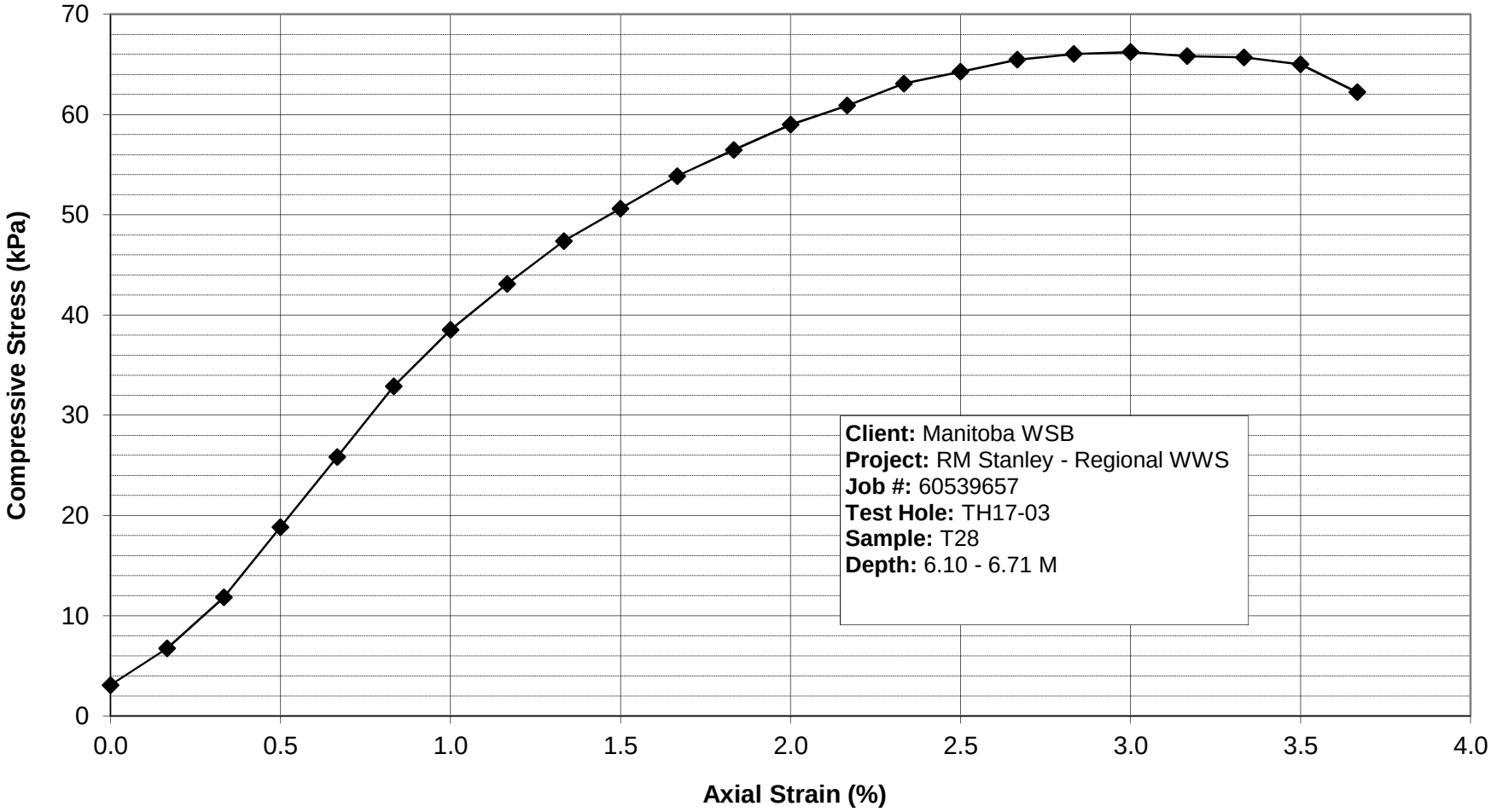
SAMPLE DIAM.(Do):	72.00	**(mm)**	**INITIAL AREA, Ao:**	4071.5	**(mm^2)**
SAMPLE LENGTH, (Lo):	153.00	**(mm)**	**PISTON RATE:**	0.0602	**(inches / minute)**
L / D RATIO:	2.13	**(2 < L/D < 2.5)**	**AXIAL STRAIN RATE, R:**	1.00	**(0.5<R<2 % / minute)**

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	**PROVING RING**	**TOTAL AXIAL STRAIN, ε_1**	**AVERAGE CROSS-SECTIONAL AREA, A**	**APPLIED AXIAL LOAD, P**	**COMPRESSIVE STRESS, σ_c**		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.01	0.0003	0.00	6.31	2.81	0.45	0.064	3.1
0.02	0.0007	0.17	6.32	6.18	0.98	0.141	6.7
0.03	0.0012	0.33	6.33	10.87	1.72	0.247	11.8
0.04	0.0019	0.50	6.34	17.33	2.73	0.394	18.8
0.05	0.0025	0.67	6.35	23.80	3.75	0.539	25.8
0.06	0.0032	0.83	6.36	30.36	4.77	0.687	32.9
0.07	0.0038	1.00	6.37	35.61	5.59	0.804	38.5
0.08	0.0043	1.17	6.39	39.92	6.25	0.900	43.1
0.09	0.0047	1.33	6.40	43.95	6.87	0.989	47.4
0.10	0.0050	1.50	6.41	47.04	7.34	1.057	50.6
0.11	0.0054	1.67	6.42	50.13	7.81	1.125	53.9
0.12	0.0056	1.83	6.43	52.66	8.19	1.180	56.5
0.13	0.0059	2.00	6.44	55.10	8.56	1.232	59.0
0.14	0.0061	2.17	6.45	56.97	8.83	1.272	60.9
0.15	0.0063	2.33	6.46	59.12	9.15	1.318	63.1
0.16	0.0064	2.50	6.47	60.34	9.32	1.342	64.3
0.17	0.0066	2.67	6.48	61.56	9.49	1.367	65.5
0.18	0.0066	2.83	6.49	62.22	9.58	1.379	66.0
0.19	0.0067	3.00	6.51	62.50	9.61	1.383	66.2
0.20	0.0066	3.17	6.52	62.22	9.55	1.375	65.8
0.21	0.0066	3.33	6.53	62.22	9.53	1.372	65.7
0.22	0.0066	3.50	6.54	61.65	9.43	1.358	65.0
0.23	0.0063	3.67	6.55	59.12	9.03	1.300	62.2

UNCONFINED COMPRESSIVE STRENGTH, q_u:	66.23	kPa
(based on maximum q_u value)	1.383	ksf
UNDRAINED SHEAR STRENGTH, S_u:	33.12	kPa
(based on maximum q_u value)	0.692	ksf

NOTES:

AECOM
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS
(ASTM D2166)



AECOM Canada Ltd.
ATTN: TESSA CHRISTI
99 Commerce Drive
Winnipeg MB R3P 0Y7

Date Received: 08-JAN-18
Report Date: 15-JAN-18 13:32 (MT)
Version: FINAL

Client Phone: 204-928-7493

Certificate of Analysis

Lab Work Order #: L2042196

Project P.O. #: NOT SUBMITTED
Job Reference: 60539657
C of C Numbers:
Legal Site Desc:

[redacted]

Hua Wo
Chemistry Laboratory Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2042196-1 TH17-01; G5 @ 12.5'							
Sampled By: CLIENT on 23-OCT-17 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
% Moisture	25.3		0.10	%	10-JAN-18	11-JAN-18	R3932822
Resistivity	242		1.0	ohm*cm		15-JAN-18	
Sulphate	11400		20	mg/kg	09-JAN-18	10-JAN-18	R3933074
Conductivity	4.14		0.0040	mS/cm		15-JAN-18	R3935291
pH	7.87		0.10	pH units		11-JAN-18	R3933209
L2042196-2 TH17-02; G15 @ 10'							
Sampled By: CLIENT on 23-OCT-17 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
% Moisture	18.4		0.10	%	10-JAN-18	11-JAN-18	R3932822
Resistivity	556		1.0	ohm*cm		15-JAN-18	
Sulphate	1710		20	mg/kg	09-JAN-18	10-JAN-18	R3933074
Conductivity	1.80		0.0040	mS/cm		15-JAN-18	R3935291
pH	7.99		0.10	pH units		11-JAN-18	R3933209
L2042196-3 TH17-03; G25 @ 7.5							
Sampled By: CLIENT on 23-OCT-17 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
% Moisture	22.1		0.10	%	09-JAN-18	10-JAN-18	R3932297
Resistivity	5610		1.0	ohm*cm		15-JAN-18	
Sulphate	102		20	mg/kg	09-JAN-18	10-JAN-18	R3933074
Conductivity	0.178		0.0040	mS/cm		15-JAN-18	R3935291
pH	7.83		0.10	pH units		11-JAN-18	R3933209
L2042196-4 TH17-04; S27 @ 15							
Sampled By: CLIENT on 23-OCT-17 @ 12:00							
Matrix: SOIL							
Miscellaneous Parameters							
% Moisture	31.4		0.10	%	10-JAN-18	11-JAN-18	R3932815
Resistivity	823		1.0	ohm*cm		15-JAN-18	
Sulphate	1500		20	mg/kg	09-JAN-18	10-JAN-18	R3933074
Conductivity	1.22		0.0040	mS/cm		15-JAN-18	R3935291
pH	7.87		0.10	pH units		11-JAN-18	R3933209

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

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
EC-WT	Soil	Conductivity (EC)	MOEE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

MOISTURE-WT	Soil	% Moisture	Gravimetric: Oven Dried
PH-WT	Soil	pH	MOEE E3137A

A minimum 10g portion of the sample is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	APHA 2510 B

Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	MOECC E3138

Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity.

SO4-WT	Soil	Sulphate	EPA 300.0

5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

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

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

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: AECOM Canada Ltd.
99 Commerce Drive
Winnipeg MB R3P 0Y7
Contact: TESSA CHRISTI

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-WT	**Soil**							
Batch R3935291								
WG2698641-1 LCS								
Conductivity			99.2		%		90-110	15-JAN-18
WG2698377-1 MB								
Conductivity			<0.0040		mS/cm		0.004	15-JAN-18
MOISTURE-WT	**Soil**							
Batch R3932297								
WG2696010-3 DUP		**L2042196-3**						
% Moisture		22.1	22.1		%	0.2	20	10-JAN-18
WG2696010-2 LCS								
% Moisture			99.7		%		90-110	10-JAN-18
WG2696010-1 MB								
% Moisture			<0.10		%		0.1	10-JAN-18
Batch R3932815								
WG2696098-2 LCS								
% Moisture			101.1		%		90-110	11-JAN-18
WG2696098-1 MB								
% Moisture			<0.10		%		0.1	11-JAN-18
Batch R3932822								
WG2696492-2 LCS								
% Moisture			99.5		%		90-110	11-JAN-18
WG2696492-1 MB								
% Moisture			<0.10		%		0.1	11-JAN-18
PH-WT	**Soil**							
Batch R3933209								
WG2696971-1 LCS								
pH			6.98		pH units		6.9-7.1	11-JAN-18
SO4-WT	**Soil**							
Batch R3933074								
WG2695869-3 CRM		**AN-CRM-WT**						
Sulphate			102.1		%		60-140	10-JAN-18
WG2695869-4 DUP		**L2042196-3**						
Sulphate		102	97		mg/kg	4.9	30	10-JAN-18
WG2695869-2 LCS								
Sulphate			101.7		%		80-120	10-JAN-18
WG2695869-1 MB								
Sulphate			<20		mg/kg		20	10-JAN-18

Quality Control Report

Legend:

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

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
% Moisture							
	1	23-OCT-17 12:00	11-JAN-18 15:55	14	80	days	EHTR
	2	23-OCT-17 12:00	11-JAN-18 15:56	14	80	days	EHTR
	3	23-OCT-17 12:00	10-JAN-18 19:52	14	79	days	EHTR
	4	23-OCT-17 12:00	11-JAN-18 09:36	14	80	days	EHTR
Conductivity (EC)							
	1	23-OCT-17 12:00	15-JAN-18 02:00	30	84	days	EHTR
	2	23-OCT-17 12:00	15-JAN-18 02:00	30	84	days	EHTR
	3	23-OCT-17 12:00	15-JAN-18 02:00	30	84	days	EHTR
	4	23-OCT-17 12:00	15-JAN-18 02:00	30	84	days	EHTR
pH							
	1	23-OCT-17 12:00	10-JAN-18 12:00	30	79	days	EHTR
	2	23-OCT-17 12:00	10-JAN-18 12:00	30	79	days	EHTR
	3	23-OCT-17 12:00	10-JAN-18 12:00	30	79	days	EHTR
	4	23-OCT-17 12:00	10-JAN-18 12:00	30	79	days	EHTR

Legend & Qualifier Definitions:

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

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2042196 were received on 08-JAN-18 09:30.

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

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

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

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2042196-COFC

COC Number: 15 - 550953

Page of

Report To	Contact and company name below will appear on the final report
Company:	AECOM
Contact:	Tessa Christi
Phone:	(204) -928- 7493
	Company address below will appear on the final report
Street:	99 Commerce Drive
City/Province:	Winnipeg, MB
Postal Code:	R3P 0Y7

Report Format / Distribution	
Select Report Format:	PDF ☑ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report	☑ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	tessa.christi@aecom.com
Email 2	enrico.manimbao@aecom.com
Email 3	ryan.harras@aecom.com

Invoice To		
	Same as Report To	☑ YES ☐ NO
	Copy of Invoice with Report	☑ YES ☐ NO
Company:		
Contact:		

Invoice Distribution	
Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	tessa.christi@aecom.com
Email 2	enrico.manimbao@aecom.com

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:	60539657	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		ALS Contact:	Sampler:

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	1 Business day [E1]	☐
3 day [P3]	☐	Same Day, Weekend or Statutory holiday [E0]	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	EC-WT	RESISTIVITY-CALC-WT	SO4-WT	PH-WT	Number of Containers
	TH17-01; G5 @ 12.5'			Soil	✓	✓	✓	✓	
	TH17-02; G15 @ 10'			Soil	✓	✓	✓	✓	
	TH17-03; G25 @ 7.5			Soil	✓	✓	✓	✓	
	TH17-03; S27 @ 15			Soil	✓	✓	✓	✓	

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? ☐ YES ☐ NO	
Are samples for human drinking water use? ☐ YES ☐ NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C		FINAL COOLER TEMPERATURES °C		
21.6 °C				

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
Tessa Christi	Jan 5 2017	14:00	AG	08-01-18	9:30			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

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RM of Stanley

Reinfeld Developments
Geotechnical Investigation Report

Prepared for:
Colin Conrad, CET
GIS and Engineering Manager
Rural Municipality of Stanley
1-23111 PTH 14, Stanley MB
R6P 0B1

Project Number: 0829 001 00

Date: December 13, 2023

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TREK GEOTECHNICAL Quality Engineering | Valued Relationships

December 13, 2023 Our File No. 0829 001 00

Colin Conrad, CET
GIS and Engineering Manager
Rural Municipality of Stanley
1-23111 PTH 14, Stanley MB
R6P 0B1

RE: Reinfeld Developments – Geotechnical Investigation Report

TREK Geotechnical Inc. is pleased to submit our Final Report for the geotechnical investigation for the above noted project.

Please contact the undersigned should you have any questions.

Sincerely,

TREK Geotechnical Inc.
Per:

[redacted]

Michael Van Helden Ph.D., P.Eng.
Senior Geotechnical Engineer

Encl.

Revision History

Revision No.	Author	Issue Date	Description
0	RJvR	December 13, 2023	Final Report

Authorization Signatures

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Table of Contents

Letter of Transmittal

Revision History and Authorization Signatures

1.0 Introduction 1

2.0 Background and Site Conditions 1

3.0 Field Program 1

3.1 Sub-surface Investigation 1

4.0 Foundation Recommendations 3

4.1 Limit States Design 4
4.2 Cast-in-Place Concrete Friction Piles 5
4.3 Helical Piles 6
4.4 Pile Caps and Grade Beams 7
4.5 Ad-freezing Effects 8
4.6 Foundation Concrete 8
4.7 Inspection Requirements 8

5.0 Concrete Slabs 9

5.1 Grade Supported Floor Slabs 9
5.2 Structural Slabs 10

6.0 Pavement Recommendations 10

7.0 Site Drainage 12

8.0 Basement Recommendations 13

9.0 Stormwater Retention Ponds 13

10.0 Temporary Excavations 13

11.0 Buried Infrastructure 14

11.1 Minimum Cover for Frost Penetration 14

12.0 Closure 15

Figures

Sub-Surface Logs

Appendices

List of Tables

Table 01 Groundwater Monitoring Summary 3
Table 02 ULS Resistance Factors for Foundations (NBCC, 2010) 4
Table 03 ULS Resistances for CIPC Friction Piles 5
Table 04 Recommended Pavement Structures 11

List of Figures

Figure 01 Location Plan
Figure 02 Test Hole Location Plan

List of Appendices

Appendix A Laboratory Testing Results
Appendix B Groundwater Monitoring Plots

1.0 Introduction

This report summarizes the results of a geotechnical investigation completed by TREK Geotechnical Inc. (TREK) for planned residential developments in areas surrounding the town of Reinfeld, Manitoba. The terms of reference for the investigation are included in our proposal to Colin Conrad of the RM of Stanley dated October 4, 2021. The scope of work includes a sub-surface investigation and laboratory testing to aid in preliminary design of roadways, stormwater ponds and buried infrastructure in addition to providing preliminary level recommendations for future building foundations.

2.0 Background and Site Conditions

Reinfeld is located approximately 3.5 km east of Winkler, MB on Rd 12N, within the Rural Municipality of Stanley. The RM of Stanley retained TREK to conduct a geotechnical investigation within potential development locations. The investigations were performed within vacant farmland in and around the Reinfeld area as shown on Figures 01 and 02.

An additional area, approximately 1.5 km north of Schanzenfeld (1 km south of Winkler), was added to the site investigation as shown in Figure 02 where a single test hole was drilled.

The purpose of the geotechnical investigation was to characterize the soil stratigraphy and groundwater conditions at the sites. Near surface silt layers may be present and will have an impact on the development costs due to the poor workability and frost susceptibility of these materials, which may pose problems to excavations, foundations, and structures. Groundwater conditions will influence the design of excavations, buried structures (e.g. basements), and stormwater retention ponds.

TREK understands that the preferred foundations consist of cast-in-place concrete friction piles.

3.0 Field Program

3.1 Sub-surface Investigation

Sub-surface investigations were completed under the supervision of TREK personnel to determine the soil stratigraphy and groundwater conditions at the site. The investigations were performed in three stages due to poor weather conditions and associated barriers to site access for the drill rig. The investigations were completed between April 5 and 7, 2022, June 27 and 29, 2022, and December 12 and 15, 2022; a total of 24 test holes were completed.

The test holes were drilled using a Mobile B57 or B48 track-mounted drill rig operated by Paddock Drilling Ltd. using either 125 mm diameter solid stem augers or 170 mm diameter hollow stem augers. Groundwater monitoring wells were installed in a select number of test holes using 50 mm diameter PVC pipe. Test holes were drilled, and piezometers were installed in 6 test holes.

Test holes with monitoring wells were backfilled with silica sand around the piezometer tip, and bentonite to ground surface. All other test holes were backfilled with auger cuttings and bentonite chips at surface.

Sub-surface soils observed during drilling were visually classified based on the Unified Soil Classification System (USCS). Samples retrieved during drilling included disturbed auger cutting and split spoon samples, as well as relatively undisturbed Shelby Tube samples. All samples retrieved during drilling were transported to TREK's testing laboratory in Winnipeg, Manitoba. Laboratory testing consisted of moisture content determination on all samples. Unconfined compressive strength, Atterberg limits and grain size (hydrometer) testing were performed on select samples. Laboratory testing results are included in Appendix A.

The test hole locations and elevations were recorded using an RTK-GPS device. TH22-06 (north of Schanzenfeld) was located using a hand-held GPS device and was referenced to depth below existing ground (elevation was not surveyed).

A brief description of the soil stratigraphy and groundwater conditions encountered during drilling is provided in the following sections. All interpretations of soil stratigraphy for the purposes of design should refer to the detailed information provided on the attached test hole logs.

3.1.1 Soil Stratigraphy

The subsurface stratigraphy at the site consists varying near-surface layers of clay (topsoil), clay, sand and silt, silt, or sand, over silty clay to the depth of exploration in all test holes (up to 31.1 m).

The clay (topsoil) ranges from 0.1 to 0.5 m thick. The topsoil was generally black, moist, soft to firm, and of intermediate plasticity. The underlying clay extends to depths ranging between 0.5 m to 2.0 m deep in test holes TH22-04, -06 to -12, -14, -15, -18 and -24, was generally grey or brown, moist, soft to very stiff, and of high plasticity.

The underlying silt / sand layers extend to a maximum depth of 4.9 m. The silt / sand layers range in constituents from clayey sand and silt to silt containing trace clay. In TH22-02, the silt / sand layers were encountered to the depth of exploration at 3.0 m. The silt / sand layer is generally brown to light brown, moist to wet, and loose to compact and non-plastic, to very soft to firm and of low plasticity.

Underlying the silt / sand layers, silty clay extends to the depth of exploration (up to 31.1 m) in all test holes, except for TH22-06 (near Schanzenfeld) where silt (till) was encountered below the silty clay at a depth of 15.2 m. The silty clay is generally brown or mottled brown and grey becoming grey with depth, is firm to stiff (very stiff in TH22-20) becoming soft with depth, and of high plasticity.

The silt (till) contains trace to some clay, trace sand, trace gravel, is grey, moist, soft and of low plasticity, becoming compact and non-plastic with depth.

3.1.2 Groundwater and Sloughing Conditions

Seepage, sloughing, and squeezing was encountered in all test holes other than TH22-16, 17, 21, and 22. Hollow stem augers were required in test holes TH22-03 to -06 and -14 to drill to target depth of exploration, with blow-up encountered at every 1.5 m interval (except for TH22-14) during sampling. Seepage or sloughing could not be assessed during drilling with hollow stem augers.

Standpipe piezometers were installed in the test holes to the depths outlined in Table 1, below. Water levels were measured in the standpipes after installation and were logged using a down-hole level logger

for three months following installation. Groundwater monitoring results are included in Appendix B; the dates of measurement and range of depth to water level below ground surface is also summarized in Table 1.

Table 1. Groundwater Monitoring Summary

Test Hole	Instrument ID	Tip Depth (mbgs)	Dates Monitored	Range of Depth to Water Level (mbgs)
TH22-03	SP22-03A[Note 1]	14.3	April 6, 2022[Note 2 and Note 3]	*NOTE 2*
	SP22-03B[Note 1]	4.6	April 6 and 7, 2022[Note 3]	2.1 to 2.7
TH22-05B	SP22-05B	2.2	June 29 to May 17, 2023	0.2 to 1.3
TH22-06	SP22-06A	14.9	June 29 to May 17, 2023	1.7 to 2.6
	SP22-06B	3.4	June 29 to May 17, 2023	1.1 to 1.8
TH22-09	SP22-09	3.4	Jan 6 to May 17, 2023	1.3 to 2.6
TH22-18	SP22-18	3.1	Jan 6 to May 17, 2023	2.0 to 3.1
TH22-23	SP22-23	2.4	Jan 6 to May 17, 2023	1.4 to 2.7

1. *A & B refer to two different wells installed in the same test hole.*
2. *SP22-03A was suspected to have been sealed by grout during installation. No water level measured.*
3. *SP22-03A and B were damaged after the April 2022 readings.*

The groundwater observations made during drilling are short-term and should not be considered reflective of (static) groundwater levels at the site which would require monitoring over an extended period (more than one year) to determine. It is important to recognize that groundwater conditions may vary seasonally, annually, or as a result of construction activities.

Additionally, available provincial groundwater information within the vicinity of Reinfeld indicate groundwater levels similar to those observed on site.

4.0 Foundation Recommendations

Based on observed conditions, shallow foundations are likely not feasible as a foundation alternative.

Cast-in-place concrete (CIPC) friction piles are the preferred foundation alternative for developments based on the observed sub-surface and anticipated loading conditions; however, sloughing and seepage was observed within silt and sand layers to depths of up to 4.9 m and would require sleeving during installation. In this regard, helical pile foundations may be the preferred alternative. Driven piles will likely not reach practical refusal given the depth of firm clays at the development locations.

Recommendations according to the NBCC (2010) are provided in the following sections.

4.1 Limit States Design

Limit States Design recommendations for deep foundations in accordance with the NBCC (2010) are provided below. Limit states design requires consideration of distinct loading scenarios comparing the structural loads to the foundation bearing capacity using resistance and load factors that are based on reliability criteria. Two general design scenarios are evaluated corresponding to the serviceability and ultimate capacity requirements.

The **Ultimate Limit State (ULS)** is concerned with ensuring that the maximum structural loads do not exceed the nominal (ultimate) capacity of the foundation units. The ULS foundation bearing capacity is obtained by multiplying the nominal (ultimate) bearing capacity by a resistance factor (reduction factor), which is then compared to the factored (increased) structural loads. The ULS bearing capacity must be greater or equal to the maximum factored load to provide an adequate margin of safety. Table 2 summarizes the resistance factors that can be used for the design of deep foundations as per the NBCC (2010) depending upon the method of analysis and verification testing completed during construction.

The **Service Limit State (SLS)** is concerned with limiting deformation or settlement of the foundation under service loading conditions such that the integrity of the structure will not be impacted. The Service Limit State should generally be analysed by calculating the settlement resulting from applied service loads and comparing this to the settlement tolerance of the structure. However, the settlement tolerance of the structure is typically not yet defined at the preliminary design stage. As such, SLS bearing capacities are often provided that are developed on the basis of limiting settlement to 25 mm or less. A more detailed settlement analysis should be conducted to refine the estimated settlement and/or adjust the SLS capacity if a more stringent settlement tolerance is required or if large groups of piles are used.

Table 2. ULS Resistance Factors for Foundations (NBCC, 2010)

Resistance to Vertical Loads for Shallow Foundations (Analysis Methods)	**Resistance Factor**
Semi-empirical analysis using laboratory and *in-situ* test data	0.5
Resistance to Axial Load for Deep Foundations (Analysis Methods)	**Resistance Factor**
Semi-empirical analysis using laboratory and in-situ test data	0.4
Uplift resistance by semi-empirical analysis.	0.3

Note 1. The number of tests required vary depending on sub-surface conditions and pile layout. If dynamic monitoring or static load testing is under consideration, TREK should be contacted to provide recommendations on testing frequency.

4.2 Cast-in-Place Concrete Friction Piles

CIPC friction piles are a suitable foundation alternative for the observed sub-surface conditions and the anticipated pile loads. This pile type will derive a majority of its resistance in shaft friction (adhesion) with a relatively small contribution from end bearing. Table 3 factored ULS axial (compressive and uplift) unit resistances for shaft adhesion and end bearing. Piles designed based on the factored ULS resistances are expected to exhibit less than 10 mm of settlement under applied service loads (SLS).

Table 3. ULS Resistances for CIPC Friction Piles

Pile Depth Below Existing Site Grade (m approx.)	Factored ULS Unit Resistance (kPa)		
	Compression $\phi = 0.4$		Uplift $\phi = 0.3$
	Shaft Adhesion	End Bearing[1]	Shaft Adhesion
0 to 3[2]	-	-	-
3 to 6	16	NA	12
6 to X [3]	10	70	7

1. *For piles with a diameter of less than 1.0 m. If larger pile diameters are required TREK should be contacted to provide revised end bearing values.*
2. *When determining effective pile lengths, the upper 3 m of the pile shaft below existing site grade or 1 m below crawl space or basement floor level, or the depth of silt, whichever is deeper, should be ignored to account for the presence of fill, silt and the potential for soil shrinkage away from the pile.*
3. *X is the maximum recommended pile length should be taken as 14.0 m at the Schanzenfeld site, or 18 m elsewhere, to avoid penetrating the till unit.*

CIPC Friction Pile Design Recommendations

1. The weight of the embedded portion of the pile may be neglected.
2. Piles at the Schanzenfeld site (TH22-06) should be designed for a maximum depth of 14 m below existing grade to avoid penetration into the underlying silt till and to protect against heaving at the base of the pile shaft. Additional drilling may be required to confirm CIPC pile design, since silt till may be encountered at shallower depths.
3. Piles should have a minimum spacing of 3 pile diameters measured centre to centre. If a closer spacing is required, TREK should be contacted to provide an efficiency (reduction) factor to account for potential group effects.
4. Piles require steel reinforcement designed by a qualified structural engineer for the anticipated axial (compression and tension), lateral and bending loads induced from the structure. Piles subject to frost jacking forces should be reinforced for their entire length.

CIPC Friction Pile Installation Recommendations

1. Groundwater seepage and sloughing of the pile hole was commonly encountered during test hole drilling and should be expected during pile installation, and as such temporary steel casings (sleeves) should be available on-site and used if these conditions are encountered. Care should be taken in removing sleeves to prevent sloughing (necking) of the shaft walls and a reduction in the cross-sectional area of the pile.

2. Concrete should be placed in one continuous operation immediately after the completion of drilling the pile hole to avoid potential construction problems such as sloughing or caving of the pile hole and groundwater seepage. Concrete placed by free-fall methods should be poured under dry conditions. If groundwater is encountered, it should be controlled or removed. If water cannot be controlled or removed, the concrete should be placed using tremie methods.
3. Concrete placed by free-fall methods should be directed through the middle of the pile shaft and steel reinforcing cage to prevent striking of the drilled shaft walls to protect against soil contamination of the concrete.

4.3 Helical Piles

Helical piles installed within firm clay may be appropriate for use at this site. The design and associated capacity of helical piles are typically established by the contractor/supplier and reviewed by the design engineer. For preliminary design purposes, the allowable capacity of an individual helix bearing in clay can be approximated by the following equations, provided the helix diameter is less than 1 m. The serviceability Limit State (SLS) capacity provided is expected to limit settlement to less than 25 mm. For multi-helix piles it is recommended that all helices be installed within one soil unit (within the clay layer).

$$SLS\ Capacity\ (kN) = 1100 \times \pi \times \frac{(D_{heli}{}^2 - D_{shaft}{}^2)}{12}$$

$$ULS\ Capacity\ (kN) = \ \Phi_r \times 1100 \times \pi \times \frac{(D_{helix}{}^2 - D_{shaft}{}^2)}{4}$$

$$Uplift\ Capacity\ (kN) = \Phi_r \times 1100 \times \pi \times \frac{(D_{helix}{}^2 - D_{shaft}{}^2)}{4}$$

Where:

H = Helix embedment depth below final grade (m)
D_{helix} = Helix diameter (m)
D_{shaft} = Pile shaft (pipe) outer diameter (m)
- For calculating the bearing capacity under the lowermost helix, the variable 'D_{shaft}' may be omitted from the above equations

Φ_r = ULS resistance factor, taken as 0.4 for compression and 0.3 for uplift.

In addition to the bearing resistance offered by the helices, shaft friction along the exterior of the pile shaft can be included in the design for the portion of the shaft above the helix. An average unit shaft friction of 10 kPa and 8 kPa can be applied at the ULS and SLS conditions, respectively.

The actual selection of pile dimensions and capacity should be performed by the supplier/contractor and reviewed by TREK. In addition to this, the following should be considered:

Additional Helical Pile Design Recommendations

1. The weight of the embedded portion of the pile may be neglected in the design.
2. Skin friction resistance should be neglected in all fill or silt soils, within the depth of pre-bore, within the depth of frost penetration (2.4 m) in unheated areas or within the upper 1.5 m of the embedded pile in heated areas, whichever is greatest. Shaft resistance should also be neglected within 3 m of the leading helix.
3. Shaft resistance should be neglected entirely for square shaft piles and for piles with a shaft diameter less than 100 mm.
4. Helices should be installed below the silt / sand layer(s) to a minimum depth of 10.0 m below ground surface.
5. The pile supplier/designer should be prepared to advance piles to the required depths. Very dense soil conditions may make pile embedment difficult.
6. Piles must be designed to withstand design loads and to handle stresses encountered during installation. Pile locations may have to be adjusted in the field if obstructions are encountered.
7. Pile spacing should not be less than 3 times the helix diameter, measured centre to centre. Piles may be battered (inclined) to increase spacing between helices. If pile spacing is closer than this a reduction to capacity resulting from group effects will need to be evaluated. TREK should be contacted to re-assess the pile capacity.

Additional Helical Pile Installation Recommendations

1. Helical piles are known to have installation difficulties in frozen ground, very dense conditions and when cobbles/boulders are encountered. Pre-boring of the upper portion of the pile location through frozen material may be required if construction takes place in winter months. Frozen ground, very dense conditions or cobbles and boulders may result in pre-mature refusal or pile damage and should be evaluated by the pile supplier.
2. Piles should be installed under the supervision of TREK personnel.
3. Torque is to be measured and recorded during installation to verify proper installation. However, torque should not be used as a direct measurement of pile capacity.
4. Any piles that are damaged, misaligned an excessive amount, or that do not achieve the target embedment depth may need to be replaced as per recommendations by the structural/geotechnical designer.

4.4 Pile Caps and Grade Beams

A minimum 150 mm void should be provided underneath all grade beams and pile caps to avoid uplift pressures from developing on the underside of the pile cap as a result of swelling or frost action. The void can consist of a compressible layer such as low-density polystyrene void form. Void forms should be selected such that they can deform a minimum of 150 mm with tolerable stresses transferred to the structure. Excavations for grade beams and pile caps should be backfilled with granular fill compacted to a minimum of 98% of the Standard Proctor Maximum Dry Density (SPMDD).

4.5 Ad-freezing Effects

Piles, pile caps, grade beams, and below-grade walls subjected to freezing conditions should be designed to resist adfreeze and uplift forces related to frost action acting along the vertical face of the member within the depth of frost penetration (2.4 m). In this regard, concrete and steel foundation elements may be subject to adfreeze bond stresses of 65 and 100 kPa, respectively within the depth of frost penetration.

Adfreeze forces will be resisted by structural dead loads and the uplift resistance provided by the helix. The following design recommendations apply to piles subject to adfreeze forces:

1. A load factor (α) of 1.2 may be used in the calculation of adfreezing forces.
2. A reduction factor of 0.8 may be used in calculation of the geotechnical resistance for the factored ULS condition. For helical piles the uplift resistance can be calculated as per Equation 3. Uplift resistance along the shaft should be neglected.
3. Structural dead loads should be added to the resistance.
4. The calculated geotechnical resistance plus the structural dead loads must be greater than the factored adfreezing forces.
5. Measures such as flat lying rigid polystyrene insulation could be considered to reduce frost penetration depths and thereby adfreezing and uplift forces.

4.6 Foundation Concrete

All foundation concrete should be designed by a qualified structural engineer for the anticipated axial (compression and uplift), lateral, and bending loads from the structure. Based on total sulphate ion content tests, the degree of exposure for concrete subjected to sulphate attack is classified as severe according to Table 3, CSA A23.1-19 (Concrete Materials and Methods of Concrete Construction). Accordingly, all concrete in contact with the native soil should be made with high sulphate-resistant cement (HS or HSb). Furthermore, the concrete should have a minimum specified 56-day compressive strength of 32 MPa and have a maximum water to cement ratio of 0.45 in accordance with Table 2, CSA A23.1-19 for concrete with severe sulphate exposure (S-2). Concrete that may be exposed to freezing and thawing should be adequately air entrained to improve freeze-thaw durability in accordance with Table 4, CSA A23.1-19.

4.7 Inspection Requirements

In accordance with Section *4.2.2.3 Field Review* of the NBCC (2010), the designer or other suitably qualified person shall carry out a field review on:

a) continuous basis during:

   i. the construction of all deep foundation units with all pertinent information recorded for each *foundation unit*,

   ii. during the installation and removal of retaining structures and related backfilling operations,

   iii. during the placement of engineered fills that are to be used to support the *foundation units*, and

b) as-required, unless otherwise directed by the *authority having jurisdiction*,

i. in the construction of all *shallow foundation units,* and

ii. in excavating, dewatering and other related works

In accordance with Engineers and Geoscientists of Manitoba, a Professional Engineer or delegated staff responsible to them must perform site reviews for the work presented in the documents they've sealed.

For conformance with the NBCC and EGM requirements, TREK should be retained on a full-time basis to observe and document the installation of all pile foundations, shoring or engineered fills supporting the structure, and on an as-required basis for other components such as subgrade inspections and compaction testing. TREK is familiar with the geotechnical conditions present and the underlying design assumptions of our foundation recommendations. TREK is therefore solely qualified to evaluate any design modifications deemed to be necessary should altered subsurface conditions be encountered.

5.0 Concrete Slabs

5.1 Grade Supported Floor Slabs

If some movement can be tolerated, grade supported concrete floor slabs can be used. Vertical deformation of grade supported slabs should be expected due to moisture and volume changes of the underlying soils. Although difficult to predict these movements could be in the order of 50 mm or more. Slabs in unheated areas or near the perimeter of the structure will be subject to additional movements from freeze/thaw of the sub-grade soils. If these movements cannot be tolerated, a structural floor slab will be required.

Additional Recommendations:

1. Organics, fill materials, silt, debris, and any other deleterious material should be stripped such that the sub-grade consists of undisturbed firm to stiff silty clay. This may require removal of up to 4.6 m of loose silt or fine silty sand in some areas. Assuming that removal of this amount of material may not be practical from a cost or constructability perspective, the potential for an increase in risk of settlement or seasonal movements must be recognized and accepted. The subgrade in this case is expected to be highly sensitive to disturbance and the bearing surface should be protected from mechanical disturbance, freezing, drying, or inundation at all times. If any of these conditions occur, the affected soils should be removed to expose undisturbed subgrade. Alternatively, a structural floor slab may be used.
2. Excavation should be completed with an excavator equipped with a smooth-bladed bucket operating from the edge of the excavation. Care should be taken to minimize disturbance to the sub-grade at all times.
3. After excavation, the sub-grade should be inspected by TREK personnel. Soft and/or deleterious areas should be repaired as per directions provided by TREK.
4. In heated areas, the floor slab should be placed on a 150 mm thick layer of 50 mm down crushed granular sub-base underlying a 150 mm thick base consisting of 20 mm down crushed granular base course. In unheated areas (e.g. exterior slabs) the thickness of 50 mm down crushed granular sub-base should be increased to 250 mm. The crushed granular material should be placed in lifts

no greater than 150 mm and compacted to 98% of the SPMDD.

5. The granular base course materials should consist of a well graded, durable crushed rock in accordance with MTI Standard Construction Specification No.901(I) Material Specification for Aggregate – Granular Course (or equivalent as approved by TREK).
6. A vapour barrier should be placed above the granular base and beneath the floor slab.
7. Floor slabs should be designed by a qualified structural engineer to resist all structural loads and to minimize slab cracking associated with movements as a result of swelling, shrinkage, and thermal expansion and contraction of the sub-grade soils.
8. To accommodate slab movements, it may be desirable to provide control joints to reduce random cracking and isolation joints to separate the slab from other structural elements. Allowances should be made to accommodate vertical movements of light weight structures (e.g. partitions) bearing on the slab.
9. A filter-protected drainage system (weeping tile) should be installed around the perimeter of all grade supported slabs and connected to a collection pit complete with a sump pump.

5.2 Structural Slabs

In areas where movement of floor slabs is not tolerable, a structural floor slab should be used. A minimum void space of 150 mm beneath structural floor slabs is recommended to accommodate volumetric changes in the underlying sub-grade soils (i.e. freeze-thaw volume changes and thermal expansion and contraction in unheated areas). The void should consist of a compressible layer (e.g. void form) to permit sub-grade soil movements without causing intolerable stress on the floor slab or, alternatively, a crawl space may be used. A vapour barrier should be placed between the floor slab and the void form (if present). In a crawl space, an additional vapour barrier should be placed on the subgrade to prevent drying of the subgrade and settlement of foundation units.

6.0 Pavement Recommendations

Thick deposits of near surface silts and silty fine sands were encountered throughout the study area and constructing pavements on these materials will result in rutting and/or settlement over time and increased maintenance. Two scenarios are described below for pavement and parking areas above silts and loose silty fine sands.

In both scenarios listed below, prior to granular fill placement, the subgrade should be visually inspected by TREK personnel and proof rolled with a fully loaded tandem axle truck to detect notably soft areas (it may not be possible to complete proof rolling on soft silts). Soft areas should be repaired as per directions provided by TREK. This will likely consist of excavating an additional 150 to 300 mm and placing a non-woven geotextile on the sub-grade and backfilling with a 50 mm down crushed limestone sub-base. The crushed limestone should be placed in lifts no greater than 150 mm and compacted to a minimum of 95% of the SPMDD. Consideration should be given to the use of a reinforcement geosynthetic grid to provide increased strength to the pavement structure.

Scenario 1: Remove All Silt and Backfill

Excavate all silt to native soils (clay) and backfill to underside of pavement structure with well-graded granular soils or clay fill in lifts less than 150 mm thick, compacted to 95% SPMDD. The compacted fill should be expected to settle by 0.5% of the fill thickness if granular fill (GSB-C or GSB-F) is used and between 1% to 2% of the fill thickness if clay fill is used.

Scenario 2: Leave Silt in Place

In some areas, removal of all silt is anticipated to be cost prohibitive and, in this regard, if it is decided to leave the silt in place, long-term settlement should be anticipated (this could be in excess of 100 mm however the magnitude of settlement is difficult to predict). Additionally, silt and fine silty sand are highly frost-susceptible and will contribute to cycles of heave in addition to the settlement, resulting in ongoing maintenance for several years. It is recommended that the ditch bottom be below the subgrade elevation due to the high frost susceptibility of this type of subgrade.

Note that in either scenario, granular fill (GSB-F) should be used to raise grades above prairie.

The pavement structure recommendation in Table 4 is generally consistent with the *RM of Stanley Standard Specifications for Design and Construction of Public Works*. The exception is the requirement for 100% compaction for the base course rather than 98% of Standard Proctor Maximum Dry Density (SPMDD). Granular materials used for the road construction should be in accordance with MTI Standard Construction Specification No.901(I) Material Specification for Aggregate – Granular Coarse.

Table 4. Recommended Pavement Structures

Material	Pavement	Compaction Requirements
MTI GBC-S Granular Surface	50 mm	98% of the SPMDD
MTI GBC-II Granular Base	150 mm	100% of the SPMDD
MTI GSB-C Granular Sub-Base	450 mm – collector 600 mm – commercial	98% of the SPMDD
Non-Woven or Woven Geotextile[Note 1] (TE-8 / Armtec 835 or equivalent)	Required	Install as per manufacturer's recommendations

Note 1: Special consideration should be given between the choice of non-woven or woven geo-textile based on the sub-grade soils present.

The pavement structure provided above is appropriate for collector or commercial roads (as indicated) and is anticipated to provide adequate long-term performance based on our experience, provided it is constructed over an suitable sub-grade with proper road drainage and ditches.

There may be an opportunity to optimize the design by reducing the amount of sub-base if a detailed pavement design (by others) is undertaken (traffic loads, counts, etc.). Thinner granular sections could

be considered however come at additional risk to the owner as increased maintenance (grading, adding more granular, pothole repair, etc.) will be required. Either way, grading and maintenance of paved areas should be anticipated.

Additional Recommendations:

1. Organics and any other deleterious material (as determined by the Engineer) should be stripped such that the sub-grade consists of firm silty clay (scenario 1) or silt (scenario 2).
2. Stripping should be completed with an excavator equipped with a smooth bucket operating from the edge of the excavation in order to minimize disturbance to the exposed sub-grade.
3. The sub-grade should be protected from mechanical disturbance, freezing, drying, or inundation at all times. If any of these conditions occur, the affected soils should be removed to expose undisturbed native subgrade material, or the affected sub-grade should be scarified, moisture conditioned as appropriate, and re-compacted to a minimum of 95% of the SPMDD for clay sub-grades and 98% of the SPMDD for sand sub-grades. The workability of the silts and sand will be poor especially if moisture contents are high and care should be taken when compacting sands.
4. The sub-grade should be crowned in the center at a minimum gradient of 2% to reduce water infiltration, and the pavement surface should be crowned at 4% for proper surficial drainage as per the RM of Stanley standard specifications.
5. As per the RM of Stanley standard specifications, drainage ditches should be designed to keep water levels within the ditches at 0.3 m below the sub-grade elevation to allow for proper drainage and protect against saturation of the sub-grade during wet periods or highwater events. Ditches should be designed with 4H:1V (Horizontal:Vertical) side slopes.
6. A non-woven or woven geotextile (as per Table 4) should be placed in accordance with the manufacturer's recommendations on the prepared sub-grade prior to placement of granular fill or base materials. Titan Environmental TE-8 (non-woven) or Armtec 835 (woven), or equivalent would be appropriate for use.
7. The granular sub-base and base materials should be placed in lift thicknesses no greater than 150 mm and compacted as per recommendations in Table 4.
8. Fill required to raise grades should consist of granular sub-base (MTI GSB-F) compacted to 98% SPMDD.
9. For gravel pavements, proper maintenance of the road will be required to maintain a structurally stable granular section. This will include activities such as regular grading to ensure proper drainage, and routinely supplementing the granular traffic gravel (MTI GBC-S) and base materials (MTI GBC-II) to maintain the design granular thickness, as well as repairing pavement distresses as they appear.

7.0 Site Drainage

Drainage adjacent to structures and exterior slabs should promote runoff away from the structures and slabs. A minimum gradient of about 2% should be used for both landscaped and paved areas and maintained throughout the life of the structures. All paved areas should be provided with minimum

slopes of 2% to improve long-term drainage. The water discharge from roof leaders and run-off from exposed slabs should be directed away from the structures.

8.0 Basement Recommendations

Based on the subsurface conditions encountered, TREK recommends constructing all structures above grade. If underground structures (e.g. basements or crawlspaces) are required, the depth should be limited to 1.0 m below existing ground surface. This will reduce the risk of infiltration of groundwater into basements but will not eliminate this risk entirely. A weeping tile system connected to a sump pit with a sump pump should also be installed to control and remove groundwater within the depth of the basement.

9.0 Stormwater Retention Ponds

Based on the subsurface and groundwater conditions encountered, the capacity of stormwater retention ponds will likely be governed by depth and thickness of near-surface silt and/or fine sand layers, the depth to the groundwater level, and safe side slopes. In this regard, it is expected that groundwater seepage will maintain retention pond water levels as shallow as 1 m below prairie elevation. To increase capacity, berms (above prairie) may be utilized around the perimeter of the retention pond. A slope stability assessment was conducted and indicates safe side slopes of 5H:1V (horizontal to vertical) can be used up to 3 m high. If the exposed face consists of silt or fine sand, additional erosion protection (riprap or covering and/or buttressing with clay) will be required to mitigate unraveling of the silt or fine sand material due to repeated saturation and drawdown events.

It should be understood that these recommendations are preliminary and are intended to aid in selection of the location of the stormwater retention ponds (based on available sub-surface information). Additional geotechnical investigation and monitoring will be required during detailed design of stormwater retention ponds. If stormwater retention ponds are expected to be dry, erosion control to protect from wind/runoff will also need to be assessed.

10.0 Temporary Excavations

Excavations must be carried out in compliance with the appropriate regulations under the Manitoba Workplace Safety and Health Act. Any open-cut excavation greater than 3 m deep must be designed and sealed by a professional engineer and reviewed by the geotechnical engineer of record (TREK). If space is limited or the stability of adjacent structures may be endangered by an excavation, a shoring system may be required to prevent damage to, or movement of, any part of adjacent structures, and the creation of a hazard to workers and the public.

Excavation stability is the responsibility of the Contractor for the duration of construction. Excavations should be monitored regularly and flattened as necessary to maintain stability recognizing that excavation stability is time and weather dependent. Excavated slopes should be covered with polyethylene sheets to prevent wetting and drying.

Stockpiles of excavated material and heavy equipment should be kept away from the edge of any excavation by a distance equal to or greater than the depth of excavation. Dewatering measures should be completed as necessary to maintain a dry excavation and permit proper completion of the work. If seepage is encountered, it should be collected and pumped out of the excavation. If saturated silts or sands are encountered, shoring or slope flattening may be required. To prevent wet silts and sands from entering the excavation, gravel buttressing could be used in conjunction with sump pits for dewatering. Surface water should be diverted away from the excavation and the excavation should be backfilled as soon as possible following construction.

11.0 Buried Infrastructure

Subgrades for buried infrastructure should be evenly graded and compacted to a minimum of 95% SPMDD to provide uniform support. In areas where silt and/or fine sand is encountered at the subgrade elevation, vibration should not be used due to susceptibly of silt and fine sand to liquefy when subjected to vibration. Pipe bedding material should consist of a well graded granular material free from organics or other deleterious material, with a maximum particle size of 25 mm.

The initial pipe backfill lift should extend up to at least three quarters of the pipe diameter to provide adequate side support. Haunching material must be carefully placed and compacted so as not to disturb the pipe from its line and grade while ensuring that it is in firm and intimate contact with the entire bottom surface of the pipe. Pipe bedding and backfill should be placed in uniform lifts not to exceed 300 mm thickness compacted to a minimum of 95% SPMDD. A minimum 300 mm of pipe backfill should be in place above the pipe before the placement of excavation backfill however, minimum pipe cover should be ensured as to not damage the pipe during compaction of the overlying material.

Excavated silty clay soils are suitable for use as backfill above the bedding material provided long-term surface movements are acceptable (i.e. the clay soils compacted to 95% SPMDD will result in settlement of approximately 1-2% of the fill thickness). If these settlements are not acceptable (e.g. along roadways), backfilling should be completed with a well graded granular fill compacted to 95% SPMDD within 1 m of the bedding material and above this, compacted to a minimum of 98% SPMDD in uncompacted lifts not exceeding 150 mm thick. Some settlement along the trench alignment should be expected regardless of backfill materials, methods, and degree of compaction.

11.1 Minimum Cover for Frost Penetration

To reduce the risks of freezing, underground utilities should be buried 3.0 m or deeper below final grade; however, it is anticipated that excavations to this depth will encounter significant complications to installation of pipes as a result of seepage and flowing silts/sands into excavations. Alternatively, measures such as flat lying rigid polystyrene or cellular concrete insulation may be considered to reduce the frost penetration depth. Also, insulated and/or heat trace piping may be considered for buried utilities within the depth of frost penetration (2.4 m at this location). Manufacturers should be consulted for the proper selection of heat trace and insulation. Pipe connections to rigid structures should be fitted with flexible connections to accommodate seasonal movement between pipes and the structures.

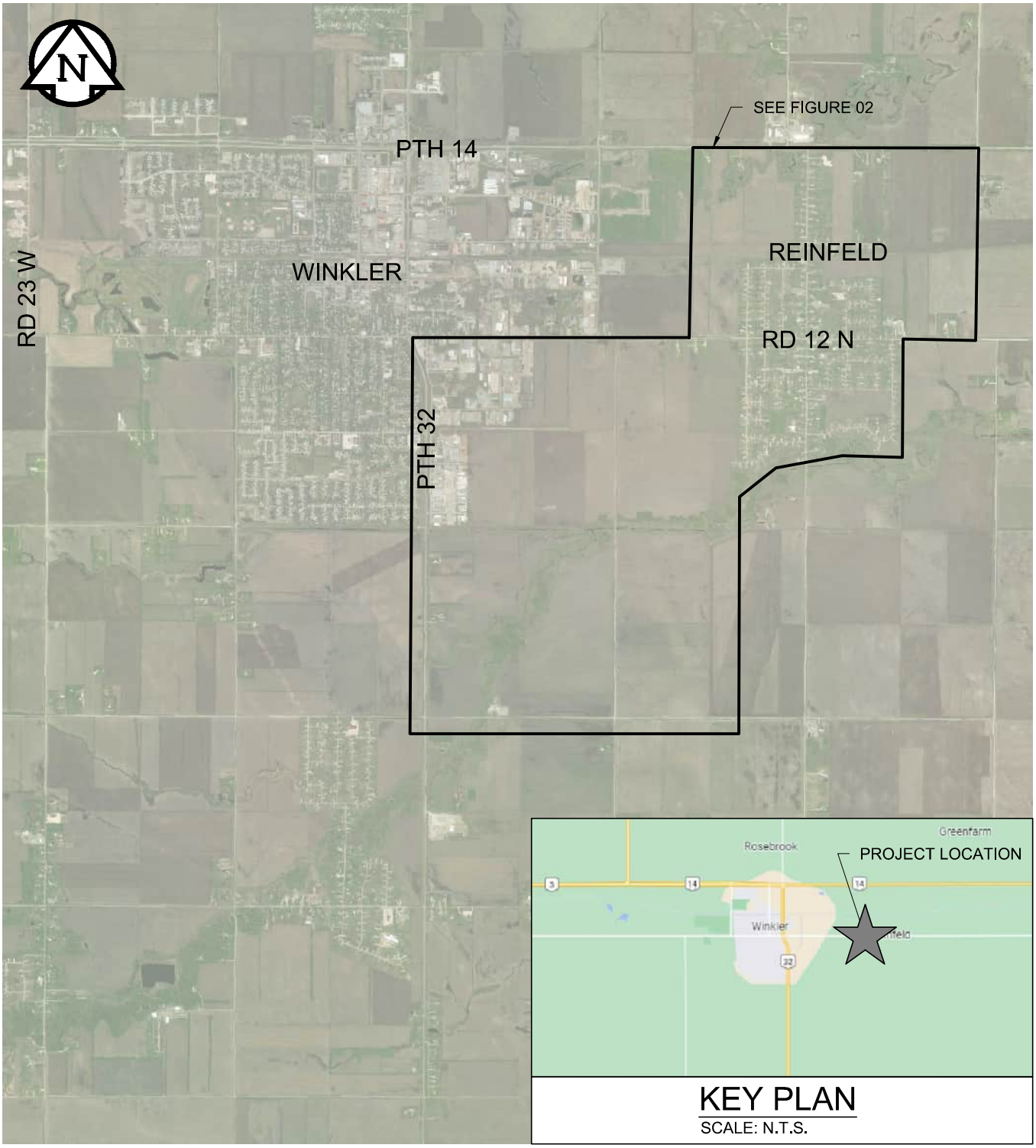
12.0 Closure

The geotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation and laboratory testing). Soil conditions are natural deposits that can be highly variable across a site. If subsurface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work or standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

This report has been prepared by TREK Geotechnical Inc. (the Consultant) for the exclusive use of RM of Stanley (the Client) and their agents for the work product presented in the report. Any findings or recommendations provided in this report are not to be used or relied upon by any third parties, except as agreed to in writing by the Client and Consultant prior to use.

Figures



NOTES:

1. AERIAL IMAGERY FROM BING MAPS (2021).

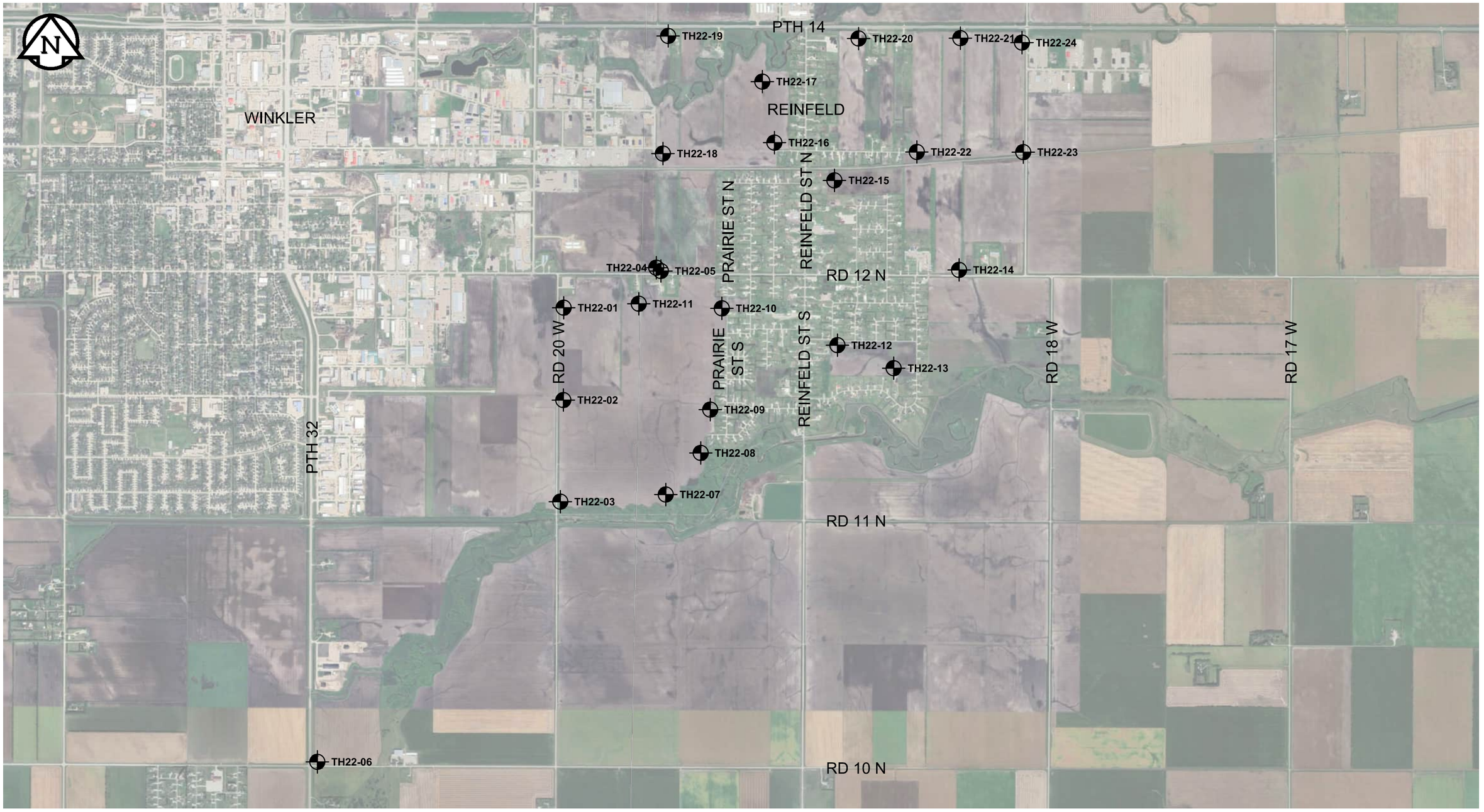
0 500 1000 1500 2000 2500 m
SCALE = 1 : 50 000 (216 mm x 279 mm)

Figure 01
Location Plan

Z:\Projects\0829 RM of Stanley\0829 001 00 Reinfeld Development\3 Survey and Dwg\3.4 CAD\3.4.3 Working Folder\Fig 01 2023-03-30 Reinfeld Development 0_B 0829-001-00.dwg, 2023-03-30 8:23:40 AM

TREK GEOTECHNICAL

0829 001 00
Rural Municipality of Stanley
Reinfeld Developments



0 250 500 750 1000 1250 1500 m
SCALE = 1 : 25 000 (279 mm x 432 mm)

LEGEND: TEST HOLE (TREK, 2022)

NOTES:
1. AERIAL IMAGERY FROM GOOGLE EARTH (2022).
2. TEST HOLE LOCATIONS SURVEYED BY TREK (2022).

Figure 02
Test Hole Location Plan

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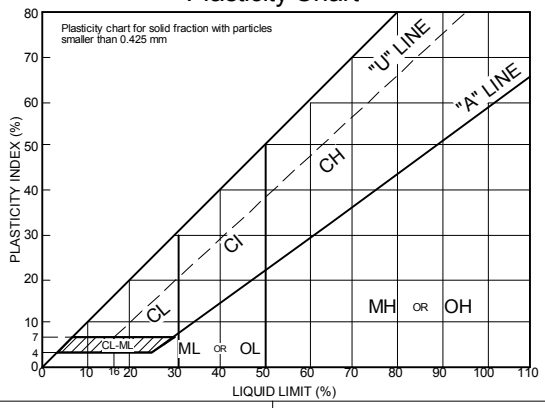
Sub-Surface Logs

EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
2. Descriptions on these test hole logs apply only at the specific test hole locations and at the time the test holes were drilled. Variability of soil and groundwater conditions may exist between test hole locations.
3. When the following classification terms are used in this report or test hole logs, the primary and secondary soil fractions may be visually estimated.

Major Divisions			USCS Classification	Symbols	Typical Names	Laboratory Classification Criteria
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than 4.75 mm)	Clean gravel (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve, depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows: Less than 5 percent..... GW, GP, SW, SP; More than 12 percent..... GM, GC, SM, SC; 6 to 12 percent..... Borderline case4s requiring dual symbols*
			GP		Poorly-graded gravels, gravel-sand mixtures, little or no fines	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
		Gravel with fines (Appreciable amount of fines)	GM		Silty gravels, gravel-sand-silt mixtures	Not meeting all gradation requirements for GW
			GC		Clayey gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 / Atterberg limits above "A" line or P.I. greater than 7 / Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
	Sands (More than half of coarse fraction is smaller than 4.75 mm)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines	$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			SP		Poorly-graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW
		Sands with fines (Appreciable amount of fines)	SM		Silty sands, sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 / Atterberg limits above "A" line or P.I. greater than 7 / Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
			SC		Clayey sands, sand-clay mixtures	
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity	Plasticity Chart
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL		Organic silts and organic silty clays of low plasticity	
	Silts and Clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or distomaceous fine sandy or silty soils, organic silts	
			CH		Inorganic clays of high plasticity, fat clays	
			OH		Organic clays of medium to high plasticity, organic silts	
	Highly Organic Soils		Pt		Peat and other highly organic soils	Von Post Classification Limit: Strong colour or odour, and often fibrous texture



Particle Size			Material
ASTM Sieve sizes	mm		
#10 to #4	2.00 to 4.75		Sand
#40 to #10	0.425 to 2.00		Coarse
#200 to #40	0.075 to 0.425		Medium
< #200	< 0.075		Fine
			Silt or Clay

Particle Size			Material
ASTM Sieve Sizes	mm		
> 12 in.	> 300		Boulders
3 in. to 12 in.	75 to 300		Cobbles
3/4 in. to 3 in.	19 to 75		Gravel
#4 to 3/4 in.	4.75 to 19		Coarse
			Fine

* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Other Symbol Types

	Asphalt		Bedrock (undifferentiated)		Cobbles
	Concrete		Limestone Bedrock		Boulders and Cobbles
	Fill		Cemented Shale		Silt Till
			Non-Cemented Shale		Clay Till

EXPLANATION OF FIELD AND LABORATORY TESTING

LEGEND OF ABBREVIATIONS AND SYMBOLS

LL - Liquid Limit (%)
PL - Plastic Limit (%)
PI - Plasticity Index (%)
MC - Moisture Content (%)
SPT - Standard Penetration Test
RQD - Rock Quality Designation
Qu - Unconfined Compression
Su - Undrained Shear Strength
VW - Vibrating Wire Piezometer
SI - Slope Inclinometer

▽ Water Level at Time of Drilling

▼ Water Level at End of Drilling

▼ Water Level After Drilling as Indicated on Test Hole Logs

FRACTION OF SECONDARY SOIL CONSTITUENTS ARE BASED ON THE FOLLOWING TERMINOLOGY

TERM	EXAMPLES	PERCENTAGE
and	and CLAY	35 to 50 percent
"y" or "ey"	clayey, silty	20 to 35 percent
some	some silt	10 to 20 percent
trace	trace gravel	1 to 10 percent

TERMS DESCRIBING CONSISTENCY OR COMPACTION CONDITION

The Standard Penetration Test blow count (N) of a non-cohesive soil can be related to compactness condition as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

The Standard Penetration Test blow count (N) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very soft	< 2
Soft	2 to 4
Firm	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	> 30

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

Descriptive Terms	Undrained Shear Strength (kPa)
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200

Sub-Surface Log

Test Hole TH22-01

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5447560, E-579580
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	268.01 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	April 5, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
267.7	0.0		TOPSOIL - silty, black, moist, soft, intemediate plasticity		G01	
	0.5		SAND AND SILT - clayey - brown - moist, very soft to soft - no to low plasticity		G02	
	1.0				G03	
266.5	1.5				G04	
			SAND - clayey, silty - brown, moist - non-plastic, coarse sand		G05	
	2.0					
	2.5		- wet below 2.3 m		G06	
265.1	3.0		CLAY - silty, some sand - brownish grey, moist, soft, high plasticity		G07	
			- trace sand, grey, firm to stiff below 3.2 m		G08	
	3.5					
	4.0					
	4.5					
	5.0				T09	
	5.5					
			- soft to firm below 5.6 m		G10	
	6.0					
	6.5					
	7.0				G11	
	7.5					
	8.0					
	8.5				G12	
	9.0					

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL — 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

Logged By: Jashandeep Bhullar **Reviewed By:** Kent Bannister **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-01

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
	10.0		- very soft to soft below 9.9 m		G13	
	10.5					
	11.0					
	11.5				G14	
	12.0					
	12.5					
	13.0				G15	
	13.5					
	14.0					
	14.5				G16	
252.8	15.0					

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21
Particle Size (%): 0 20 40 60 80 100
PL MC LL
0 20 40 60 80 100

Undrained Shear Strength (kPa)
Test Type
△ Torvane △
✤ Pocket Pen. ✤
☒ Qu ☒
○ Field Vane ○
0 50 100 150 200 250

END OF TEST HOLE AT 15.2 m IN CLAY

Notes:
1. Seepage observed 2.3 m and 2.9 m depth below ground surface.
2. No sloughing observed.
3. Test hole squeezing 12.2 m depth below ground surface.
4. Test hole open to 12.2 m depth and dry immediately after drilling.
5. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Jashandeep Bhullar **Reviewed By:** Kent Bannister **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-02

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5446945, E-579590
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	268.47 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	April 5, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type: △ Torvane △, ✤ Pocket Pen. ✤, ☒ Qu ☒, ○ Field Vane ○ 0 50 100 150 200 250
268.2			TOPSOIL - silty, black, moist, soft, intemediate plasticity		G17			
	0.5		SAND AND SILT - clayey - brown, frozen, moist and firm when thawed - no to low plasticity		G18			
267.6	1.0		SILT - trace clay, trace sand - light brown, moist, loose to compact - non-plastic		G19			
266.9	1.5		SAND - silty, trace clay - dark brown, frozen to 1.8 m, moist and compact when thawed - coarse sand		G20			
	2.0		- light brown, wet, and loose below 2.1 m		G21			
265.7	2.5							
265.4	3.0		SILT - clayey, trace sand, brown, moist, soft to firm, low to intermediate plasticity		G22			

END OF TEST HOLE AT 3.0 m IN SILT

Notes:
1. Seepage observed between 2.1 m and 2.7 m depth below ground surface.
2. Sloughing not observed.
3. Test hole open to 3.0 m depth and dry fifteen minutes after drilling.
4. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Jashandeep Bhullar **Reviewed By:** Kent Bannister **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-03

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5446267, E-579583
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	269.14 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	April 6, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Backfill Legend: Bentonite | Cement | Drill Cuttings | Filter Pack Sand | Grout | Slough

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Number	SPT (N)
268.8	0	TOPSOIL - silty, trace to some organics, black, frozen, moist and firm when thawed, intemediate plasticity	G23	
	0.5	SILT - some sand to sandy, trace clay, trace oxidation to 3.0 m - brown - moist, very soft - low plasticity		
	1.0		G24	
	1.5			
	2.0			
	2.5		G25	
	3.0	- firm below 2.7 m		
	3.5			
	4.0			
	4.5		G26	
264.3		- wet below 4.6 m		
	5.0	CLAY - silty - grey - moist, firm to stiff - high plasticity	G27	
	5.5			
	6.0		G28	
	6.5			
	7.0			
	7.5		G29	
	8.0			
	8.5			
	9.0		G30	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type: △ Torvane △ | ✤ Pocket Pen. ✤ | ☒ Qu ☒ | ○ Field Vane ○

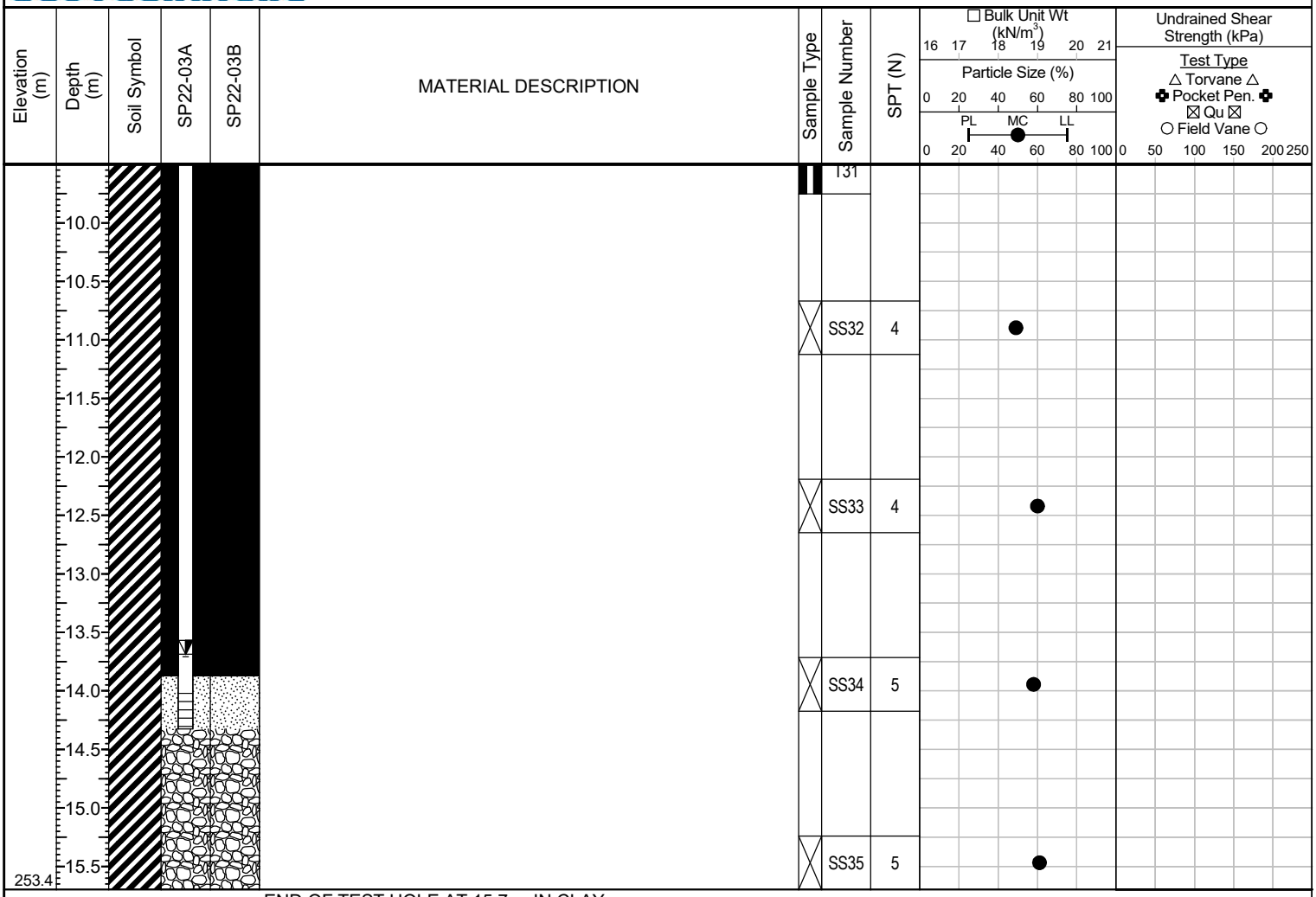
0 50 100 150 200 250

Logged By: Reinhardt Van Rensburg **Reviewed By:** Kent Bannister **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-03



END OF TEST HOLE AT 15.7 m IN CLAY

Notes:

1. Seepage and sloughing between 4.6 m and 4.7 m depth below ground surface.
2. Switched to 170 mm diameter Hollow Stem Auger at 9.1 m depth below ground surface.
3. Standpipe piezometer SP22-03A installed at 14.3 m depth below ground surface in CLAY.
4. Standpipe piezometer SP22-03B installed at 4.6 m depth below ground surface in SILT.
5. Test hole backfilled with auger cuttings, sand and bentonite chips around standpipe to ground surface.
6. Water level measured to be at 13.7 m depth below ground surface in SP22-03A measured 30 minutes after standpipe installation.
7. Water level measured to be at 2.1 m depth below ground surface in SP22-03B measured on April 7, 2022.

Logged By: Reinhardt Van Rensburg **Reviewed By:** Kent Bannister **Project Engineer:** Reinhardt Jansen van Rensburg

Sub-Surface Log

Test Hole TH22-04
1 of 1

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5447839, E-580192
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	266.85 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	April 7, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
266.6	0.0		TOPSOIL - silty, trace to some organics, black, frozen, moist and firm when thawed, intemediate plasticity		G36	
266.4	0.2		CLAY - silty, grey, frozen, moist and firm when thawed, high plasticity		G37	
	0.5		SILT - trace clay, trace sand - brown - moist, firm - low plasticity		G38	
	1.0					
	1.5		- loose, non-plastic below 1.5 m		SS39	6
	2.0					
	2.5				G40	
	3.0		- moist to wet below 2.7 m - 150 mm thick of clay seam, grey, moist, firm at 3.0 m		SS41	6
	3.5		- some clay, wet, very soft, low plasticity below 3.4 m			
	4.0		- clayey, trace sand, trace gravel below 4.0 m		G42	
262.6	4.2		CLAY - silty - grey, moist, stiff - high plasticity		SS43	10
	4.5					
	5.0		- intermixed layers of silt below 4.9 m		G44	
	5.5					
	6.0		- firm below 6.1 m		SS45	5
260.3	6.5					

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21
Particle Size (%): 0 20 40 60 80 100
PL MC LL: 0 20 40 60 80 100
Undrained Shear Strength (kPa)
Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○
0 50 100 150 200 250

END OF TEST HOLE AT 6.6 m IN CLAY

Notes:
1. Seepage between 2.7 m and 4.3 m depth below ground surface.
2. Switched to 170 mm diameter Hollow Stem Auger at 6.1 m depth below ground surface.
3. Test hole was terminated at 6.6 m depth below ground surface due to unsafe ground conditions.
4. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Van Rensburg **Reviewed By:** Kent Bannister **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-05

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5447818, E-580223
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	267.01 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	June 27, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
266.7	0.0		TOPSOIL - silty, trace sand, trace gravel (<5 mm diam.), trace organics, trace organics, trace rootlets, black, moist, firm, intemediate plasticity		G46	
	0.5		SILT - trace clay, trace oxidation - brown - moist, firm - low to intermediate plasticity		G47	
	1.5		- moist to wet, very loose to loose, no to low plasticity below 1.5 m		SS48	4
	2.1		- wet below 2.1 m		G49	
264.3	2.7		CLAY - silty, trace silt inclusions (<3 mm diam.) - brown, grey below 3.0 m - moist, firm to stiff - high plasticity		SS50	4
					G51	
					SS52	5
	5.2		- soft to firm below 5.2 m		G53	
					SS54	5
					G55	
					SS56	6
					G57	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

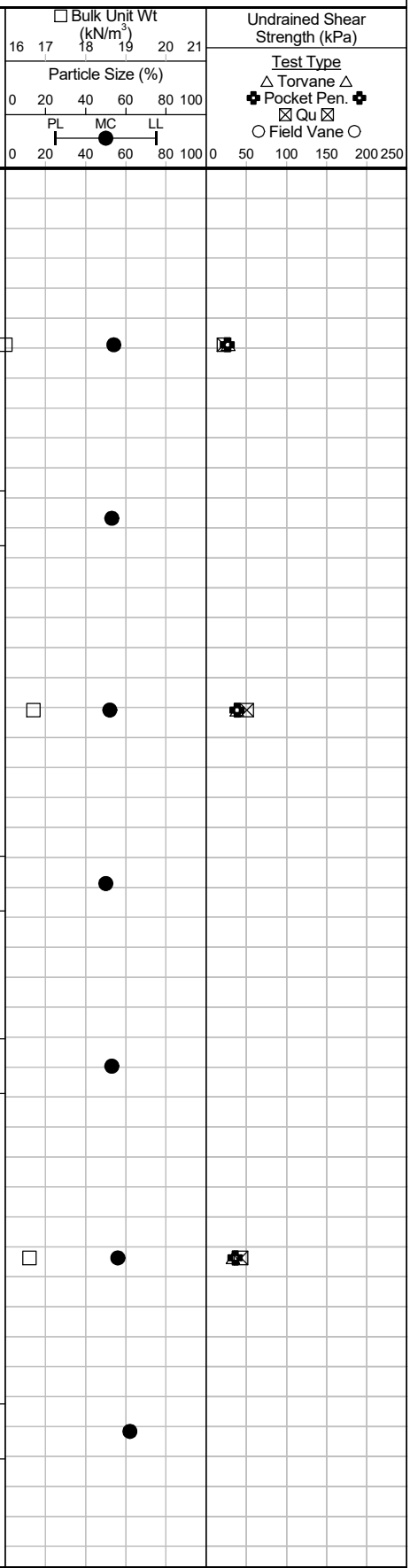
Logged By: Beta Taryana **Reviewed By:** Kent Bannister **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-05

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
	10.0					
	10.5		- firm below 10.7 m			
	11.0				T58	15.8
	11.5					
	12.0					
	12.5				SS59	4
	13.0					
	13.5					
	14.0				T60	
	14.5					
	15.0					
	15.5				SS61	6
	16.0					
	16.5					
	17.0				SS62	5
	17.5					
	18.0					
	18.5				T63	
	19.0					
	19.5					
	20.0				SS64	5
	20.5					
	21.0					



Logged By: Beta Taryana **Reviewed By:** Kent Bannister **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-05

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
	21.5		- trace till inclusions below 21.3 m		SS65	7
	22.0					
	22.5					
	23.0				SS66	5
	23.5					
	24.0					
	24.5				T67	
	25.0					
	25.5					
	26.0		- stiff below 25.9 m		SS68	8
	26.5					
	27.0					
	27.5				SS69	8
	28.0					
	28.5					
	29.0				SS70	8
	29.5					
	30.0					
	30.5		- firm below 30.5 m		T71	
235.9	31.0		END OF TEST HOLE AT 31.1 m IN CLAY			

Bulk Unit Wt (kN/m^3): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL

0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

0 50 100 150 200 250

Notes:
1. Seepage and sloughing between 1.5 m and 2.7 m depth below ground surface.
2. Switched to 170 mm diameter Hollow Stem Auger at 9.1 m below ground surface.
3. Test hole open to 1.0 m below ground surface and dry measured prior drilling with HSA (test hole at 9.1 m depth below ground surface).
4. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Beta Taryana **Reviewed By:** Kent Bannister **Project Engineer:** Reinhardt Jansen van Rensburg

Sub-Surface Log

Test Hole TH22-05B

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5447822, E-580223
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	267.01 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	June 27, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Backfill Legend: Bentonite | Cement | Drill Cuttings | Filter Pack Sand | Grout | Slough

Elevation (m)	Depth (m)	Soil Symbol	SP22-05B	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL	Undrained Shear Strength (kPa) Test Type: Torvane, Pocket Pen., Qu, Field Vane 0 50 100 150 200 250
266.7	0			TOPSOIL - silty, trace sand, trace gravel (<5 mm diam.), trace organics, trace organics, trace rootlets, black, moist, firm, intemediate plasticity					
	0.5			SILT - trace clay, trace oxidation - brown - moist, firm - low to intermediate plasticity					
	1.0								
	1.5			- wet, very loose to loose, no to low plasticity below 1.5 m					
264.9	2.0			CLAY - silty, trace silt inclusions (<3 mm diam.) - brown, grey below 3.0 m - moist, firm to stiff - high plasticity					
264.0	3.0			END OF TEST HOLE AT 3.1 m IN CLAY					

Notes:
1. Test hole located 2.3 m east from TH22-05.
2. Seepage observed between 1.5 m and 2.1 m depth below surface.
3. Sloughing not observed.
4. Standpipe piezometer SP22-05B installed at 2.1 m depth below ground surface in SILT.
5. Test hole backfilled with auger cuttings, sand and bentonite chips around stand pipe to ground surface.
6. Water level meter logger installed in SP22-05B.
7. Water level at 1.3 m depth below ground surface in SP22-05B measured on August 10, 2022.
8. Water level at 0.3 m depth below ground surface in SP22-05B measured on April 25, 2023.
9. Water level at 0.8 m depth below ground surface in SP22-05B measured on May 17, 2023.

Logged By: Beta Taryana **Reviewed By:** Kent Bannister **Project Engineer:** Reinhardt Jansen van Rensburg

Sub-Surface Log

Test Hole TH22-06
1 of 2

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5444501, E-577998
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	June 29, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Backfill Legend: Bentonite | Cement | Drill Cuttings | Filter Pack Sand | Grout | Slough

Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
0.0	TOPSOIL - silty, trace sand, trace organics, black, moist, stiff, intemediate plasticity		G72	
			G73	
0.5	SILT - some clay, trace sand, brown, moist, firm, intermediate plasticity			
	CLAY - silty, some silt inclusions (<15 mm diam.) - mottled brown and grey - moist, stiff - high plasticity		G74	
1.5			SS75	9
2.0	SILT - trace clay, trace oxidation - brown - wet, loose - non-plastic		G76	
3.0	- very loose to loose below 3.0 m		SS77	4
3.5	CLAY - silty, trace silt inclusions (<3 mm diam.) - grey - moist, stiff to very stiff - high plasticity		G78	
4.5	- firm to stiff below 4.6 m		SS79	6
			G80	
6.0	- trace gypsum (<5 mm diam.) below 6.1 m		SS81	7
6.5			G82	
7.5			T83	
9.0			SS84	7

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21
Particle Size (%): 0 20 40 60 80 100
PL MC LL: 0 20 40 60 80 100
Undrained Shear Strength (kPa): 0 50 100 150 200 250
Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

SP22-06A
SP22-06B

Logged By: Beta Taryana **Reviewed By:** Kent Bannister **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-06
2 of 2

Depth (m)	Soil Symbol	SP22-06A	SP22-06B	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
10.0							
10.5							
11.0						T85	
11.5							
12.0							
12.5				- trace till inclusions below 12.2 m		SS86	6
13.0							
13.5							
14.0						T87	
14.5							
15.0							
15.5				SILT (TILL) - some clay, trace sand, trace gravel (<20 mm diam.), grey, moist, soft, low plasticity - trace clay, compact, non-plastic below 15.4 m		SS88	21

END OF TEST HOLE AT 15.7 m IN SILT (TILL)

Notes:
1. Seepage and sloughing between 2.0 m and 3.5 m depth below ground surface.
2. Switched to 170 mm diameter Hollow Stem Auger at 7.6 m depth below ground surface.
3. Test hole open to 3.1 m and groundwater level at 2.4 m depth below ground surface measured prior drilling with HSA (Test hole at 7.6 m below ground surface).
4. Standpipe piezometer SP22-06A installed at 14.9 m depth below ground surface in CLAY.
5. Standpipe piezometer SP22-06B insatlled at 3.4 m depth below ground surface in SILT.
6. Test hole backfilled with sand and bentonite chips around stand pipe to ground surface.
7. Water level meter logger installed in SP22-06B.
8. Water level measured to be at 1.6 m depth below ground surface in SP22-06A and at 1.6 m depth below ground surface in SP22-06B measured on August 10, 2022.
9. Water level measured to be at 1.7 m depth below ground surface in SP22-06A and at 1.8 m depth below ground surface in SP22-06B measured on April 25, 2023.
10. Water level measured to be at 2.1 m depth below ground surface in SP22-06A and at 1.8 m depth below ground surface in SP22-06B measured on May 17, 2023.

Logged By: Beta Taryana **Reviewed By:** Kent Bannister **Project Engineer:** Reinhardt Jansen van Rensburg

Sub-Surface Log

Test Hole TH22-07
1 of 1

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5446328, E-580284
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	267.61 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 12, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
267.2	0.0		CLAY (TOPSOIL) - silty, black, moist, firm, intemediate plasticity		G89	
	0.5		CLAY - silty, some sand - mottled black and dark grey - moist, very stiff - high plasticity		G90	
266.2	1.0		- soft below 0.9 m		G91	
	1.5		SILT - some clay, trace oxidation - brown - moist, soft - low plasticity			
	2.0		- moist to wet below 2.1 m			
	2.5				G92	
	3.0					
263.8	3.5		- sandy below 3.4 m		G93	
	4.0		CLAY - silty - mottled grey and brown - moist, stiff - high plasticity			
263.0	4.5				G94	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21
Particle Size (%): 0 20 40 60 80 100
PL MC LL: 0 20 40 60 80 100
Undrained Shear Strength (kPa): 0 50 100 150 200 250
Test Type: △ Torvane △ | ✤ Pocket Pen. ✤ | ☒ Qu ☒ | ○ Field Vane ○

END OF TEST HOLE AT 4.6 m IN CLAY

Notes:
1. Seepage observed below 2.9 m depth.
2. Sloughing observed below 3.2 m depth.
2. Test hole open to 3.2 m depth immediately after drilling.
3. Water level at 2.9 m depth immediately after drilling.
4. Test hole backfilled with bentonite chips and auger cuttings to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-08

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5446609, E-580512
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	266.76 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 12, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
266.5	0.0		CLAY (TOPSOIL) - silty, black, moist, firm, intermediate plasticity		G95	
266.2	0.5		CLAY - silty, friable, dark grey, moist, very stiff, high plasticity		G96	
	1.0		SILT - some clay, trace oxidation - brown - moist, soft - low plasticity		G97	
	1.5					
	2.0		- trace sand below 1.8 m			
	2.5		- moist to wet below 2.4 m			
	3.0				G98	
263.6	3.3		CLAY - silty, trace precipitates (<10 mm diam.) - mottled grey and brown - moist, stiff - high plasticity			
	3.5					
	4.0					
	4.5				G99	
	5.0					
	5.5		- firm below 5.3 m			
	6.0					
	6.5				T100	
	7.0					
	7.5				G101	
	8.0		- trace silt inclusions (<5 mm diam.), trace oxidation (<10 mm diam.), soft below 7.7 m			
	8.5					
	9.0				G102	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL — 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-08

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
	10.0					
	10.5				G103	
	11.0					
	11.5					
	12.0				G104	
	12.5					
	13.0					
	13.5				G105	
	14.0					
	14.5					
251.5	15.0		END OF TEST HOLE AT 15.2 m IN CLAY		G106	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL

0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type
△ Torvane △
✤ Pocket Pen. ✤
☒ Qu ☒
○ Field Vane ○

0 50 100 150 200 250

Notes:
1. Seepage not observed.
2. Sloughing observed below 2.7 m depth.
2. Test hole open to 2.7 m depth and dry immediately after drilling.
3. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-09

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5446899, E-580569
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	266.61 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 12, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Backfill Legend: Bentonite | Cement | Drill Cuttings | Filter Pack Sand | Grout | Slough

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
266.5	0.0	CLAY (TOPSOIL) - silty, black, moist, firm, intermediate plasticity			
266.1	0.5	CLAY - silty, grey, moist, very stiff, high plasticity		G107	
		SILT - sandy, trace clay, trace oxidation - brown - moist, soft - low plasticity		G108	
	1.0			G109	
	1.5				
	2.0				
	2.5				
	3.0			G110	
262.8	3.5	CLAY - silty - mottled grey and brown - moist, stiff - high plasticity		G111	
262.0	4.5				

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

0 50 100 150 200 250

END OF TEST HOLE AT 4.6 m IN CLAY

Notes:

1. Seepage not observed.
2. Sloughing observed below 3.0 m depth.
3. Test hole open to 3.0 m depth immediately after drilling.
4. Water level measured at 3.0 m depth immediately after drilling.
5. Standpipe SP22-09 installed to 3.4 m depth.
6. Test hole backfilled with sand and bentonite chips around standpipe to ground surface.
7. Water level measured at 2.7 m depth in SP22-09 on December 23, 2022.
8. Water level measured at 2.0 m depth in SP22-09 on January 6, 2023.
9. Water level measured at 2.4 m depth in SP22-09 on April 5, 2023.
10. Water level measured at 1.3 m depth in SP22-09 on April 25, 2023.
11. Water level measured at 1.3 m depth in SP22-09 on May 17, 2023.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-10
1 of 1

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5447576, E-580634
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	265.08 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 12, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
264.8	0		CLAY (TOPSOIL) - silty, black, moist, frozen, intermediate plasticity		G112	
264.3	0.5		CLAY - silty - mottled trace brown and dark grey, moist, firm to stiff, high plasticity		G113	
	1.0		SILT - some clay, trace oxidation - brown - moist, soft - low plasticity		G114	
	1.5					
	2.0					
	2.5					
	3.0				G115	
261.3	3.5					
	4.0		CLAY - silty - mottled grey and brown - moist, stiff - high plasticity		G116	
260.5	4.5					

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

END OF TEST HOLE AT 4.6 m IN CLAY

Notes:
1. Seepage and sloughing observed below 1.8 m depth.
2. Test hole open to 1.8 m depth immediately after drilling.
3. Water level at 1.8 m depth immediately after drilling.
4. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-11

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5447596, E-580079
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	267.22 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 12, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
267.1	0		CLAY (TOPSOIL) - silty, black, moist, frozen, intermediate plasticity			
	0.5		CLAY - silty - grey, moist, very stiff - high plasticity		G117	
266.3			- sandy below 0.9 m		G118	
	1.0		SILT - some clay, trace oxidation - brown - moist, soft - low plasticity		G119	
	1.5					
264.9	2.0					
	2.5		CLAY - silty - mottled grey and brown - moist, stiff - high plasticity		G120	
264.2	3.0					

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ | ✤ Pocket Pen. ✤ | ☒ Qu ☒ | ○ Field Vane ○

END OF TEST HOLE AT 3.1 m IN CLAY

Notes:
1. Seepage not observed.
2. Sloughing observed below 1.2 m depth.
3. Test hole open to 1.2 m depth and dry immediately after drilling.
4. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-12

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5447345, E-581408
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	264.72 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 13, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
264.6	0		CLAY (TOPSOIL) - silty, black, moist, frozen, intermediate plasticity			
	0.5		CLAY - silty - grey, moist, stiff - high plasticity		G121	
263.8			- firm below 0.9 m		G122	
	1.0		SILT - tracee clay - brown - moist to wet, very soft - low plasticity		G123	
	1.5					
	2.0					
	2.5					
	3.0				G124	
261.2	3.5		CLAY - silty - mottled grey and brown - moist, stiff - high plasticity			
	4.0				G125	
260.1	4.5					

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

END OF TEST HOLE AT 4.6 m IN CLAY

Notes:
1. Seepage not observed.
2. Sloughing observed below 1.5 m depth.
3. Test hole open to 1.5 m depth and dry immediately after drilling.
4. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-13

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5447200, E-581786
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	264.29 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 13, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
263.4	0.0		CLAY (TOPSOIL) - silty, trace sand, trace organics - black - moist, stiff - high plasticity		G126	
	1.0		SILT - trace to some clay, some sand, trace rootlets - grey - moist, soft - low plasticity		G127	
	1.5		- sandy from 1.5 m to 1.8 m		G128	
	2.5				G129	
260.8	3.5		CLAY - silty, trace silt inclusions (<5 mm diam.) - grey - moist, stiff - high plasticity		G130	
	4.5		- trace precipitates (<10 mm diam.) below 4.6 m		G131	
	6.0		- firm, trace oxidation (<10 mm diam.) below 6.1 m		G132	
	7.5		- firm below 7.3 m		G133	
	9.0					

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ | ✤ Pocket Pen. ✤ | ☒ Qu ☒ | ○ Field Vane ○

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-13

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
	10.0					
	10.5		- trace red silt inclusions, soft to firm below 10.7 m		G134	
	11.0					
	11.5					
	12.0				G135	
	12.5					
	13.0					
	13.5				G136	
	14.0					
	14.5					
249.1	15.0				G137	
			END OF TEST HOLE AT 15.2 m IN CIAY			

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL

0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type
△ Torvane △
✤ Pocket Pen. ✤
☒ Qu ☒
○ Field Vane ○

0 50 100 150 200 250

Notes:
1. Seepage observed below 1.4 m depth.
2. Sloughing observed below 2.4 m.
3. Test hole open to 2.4 m depth measured immediately after drilling.
4. Water level at 2.4 m depth immediately after drilling.
4. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

Sub-Surface Log

Test Hole TH22-14

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5447864, E-582209
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	263.63 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 13, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
263.5	0.0		TOPSOIL - silty, trace sand, trace organics, black, moist, stiff, intermediate plasticity		G138	
263.2	0.3		CLAY - silty, trace sand, grey, moist, soft, intermediate plasticity		G139	
	0.5		SILT - some sand, trace clay - brown - moist, soft to firm - low plasticity - sandy below 0.8 m		G140	
261.8	1.8		CLAY - silty, trace silt inclusions (<5 mm diam.) - mottled brown and light brown - moist, stiff - high plasticity - mottled grey and brown below 2.4 m		G141	
					G142	
					G143	
	6.1		- grey below 6.1 m		T144	
					S145	4
	9.1		- firm to stiff below 9.1 m			

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ | ✤ Pocket Pen. ✤ | ☒ Qu ☒ | ○ Field Vane ○

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-14

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
	10.0				T146	
	10.5					
	11.0				S147	3
	11.5					
	12.0					
	12.5				T148	
	13.0					
	13.5					
	14.0				S149	4
	14.5					
	15.0					
	15.5				T150	
247.8			END OF TEST HOLE AT 15.8 m IN CLAY			

Bulk Unit Wt (kN/m^3): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL — 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type
△ Torvane △
✤ Pocket Pen. ✤
☒ Qu ☒
○ Field Vane ○

0 50 100 150 200 250

Notes:
1. Seepage observed below 1.0 m depth.
2. Sloughing observed below 1.0 m depth.
3. Test hole open to 1.2 m depth immediately after drilling.
4. Switched to hollow stem auger drilling at 3.0 m depth.
5. Water level not measured due to method of drilling.
6. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-15

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5448444, E-581367
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	264.69 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 13, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
264.5	0.0	TOPSOIL - silty, trace sand, trace organics, black, moist, stiff, intermediate plasticity			
264.1	0.5	CLAY - silty, trace sand - grey, moist, firm, intermediate plasticity		G151	
	1.0	SILT - some sand to sandy, trace clay - grey - moist, loose - low plasticity		G152	
262.9	1.5	- brown below 0.9 m			
	2.0	CLAY - silty, trace silt inclusions (<5 mm diam.) - mottled brown and light brown - moist, stiff - high plasticity		G153	
	2.5				
	3.0			G154	
	3.5				
	4.0				
	4.5			G155	
	5.0				
	5.5	- grey, firm below 5.9 m			
	6.0			G156	
	6.5				
	7.0				
	7.5	- soft below 7.3 m		G157	
	8.0				
	8.5				
	9.0			G158	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL — 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ | ✤ Pocket Pen. ✤ | ☒ Qu ☒ | ○ Field Vane ○

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-15

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
	10.0					
	10.5				G159	
	11.0					
	11.5					
	12.0				G160	
	12.5					
	13.0					
	13.5				G161	
	14.0					
	14.5					
249.4	15.0				G162	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21
Particle Size (%): 0 20 40 60 80 100
PL MC LL
0 20 40 60 80 100

Undrained Shear Strength (kPa)
Test Type
△ Torvane △
✤ Pocket Pen. ✤
☒ Qu ☒
○ Field Vane ○
0 50 100 150 200 250

END OF TEST HOLE AT 15.24 m IN CLAY

Notes:
1. Seepage observed below 1.8 m depth.
2. Sloughing observed below 1.8 m depth.
3. Test hole open to 1.8 m depth immediately after drilling.
4. Water level measured at 1.8 m depth immediately after drilling.
5. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

Sub-Surface Log

Test Hole TH22-16

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5448688, E-580963
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	265.10 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 14, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
265.0	0		CLAY (TOPSOIL) - silty, black, moist, frozen, intermediate plasticity					
	0.5		SILT - clayey to 0.3 m depth, trace clay below - brown - moist, stiff - low plasticity		G163		●	✤
	1.0		- brown, some sand below 0.8 m					
263.6	1.5				G164		●	
			CLAY - silty - mottled grey and brown - moist, stiff - high plasticity		G165		●	✤
	2.5							✤
	3.0				T166		●	☒ ✤
261.4	3.5							

END OF TEST HOLE AT 3.7 m IN CLAY

Notes:
1. Seepage and sloughing not observed.
2. Test hole open to 3.7 m depth and dry immediately after drilling.
3. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-17

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5449093, E-580873
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	265.13 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 14, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL	Undrained Shear Strength (kPa) 0 50 100 150 200 250 / Test Type: △ Torvane △, ✤ Pocket Pen. ✤, ☒ Qu ☒, ○ Field Vane ○
264.8	0		CLAY (TOPSOIL) - silty, black, moist, frozen, intermediate plasticity					
	0.5		SILT - some sand, trace clay - brown - moist, soft - low plasticity		G167		●	
	1.0							
	1.5				G168		●	
263.3								
	2.0		CLAY - silty - mottled grey and brown - moist, stiff - high plasticity		G169		●	✤
	2.5							
	3.0							
					T170		●	☒✤
261.5	3.5							

END OF TEST HOLE AT 3.7 m IN CLAY

Notes:
1. Seepage and sloughing not observed.
2. Test hole open to 3.7 m depth and dry immediately after drilling.
3. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-18

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5448600, E-580221
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	265.92 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 14, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Backfill Legend: Bentonite | Cement | Drill Cuttings | Filter Pack Sand | Grout | Slough

Elevation (m)	Depth (m)	Material Description	Sample Type	Sample Number	SPT (N)
265.8	0	CLAY (TOPSOIL) - silty, black, moist, frozen, intermediate plasticity			
265.3	0.5	CLAY - silty, grey to dark grey - moist, frozen, stiff and high plasticity when thawed	G	G171	
	1.0	SILT - some clay, some sand - brown - moist, soft - low plasticity	G	G172	
	1.5	- sandy below 1.5 m	G	G173	
	2.0				
	2.5				
263.0					
262.9	3.0	CLAY - silty, trace precipetates (<10 mm diam.), brown, moist, stiff, high plasticity	G	G174	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL

Undrained Shear Strength (kPa) — Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ — 0 50 100 150 200 250

END OF TEST HOLE AT 3.0 m IN CLAY

Notes:
1. Seepage not observed.
2. Sloughing observed below 2.4 m depth.
3. Test hole open to 2.4 m depth and dry immediately after drilling.
4. Standpipe SP22-18 installed to 3.0 m depth.
5. Test hole backfilled with sand and bentonite chips around standpipe to ground surface.
6. Water level measured at 2.1 m depth in SP22-18 on January 6, 2023.
7. Water level measured at 3.0 m depth in SP22-18 on April 5, 2023.
8. Water level measured at 2.2 m depth in SP22-18 on May 17, 2023.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-19

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5449386, E-580240
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	266.05 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 14, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
265.7	0	TOPSOIL - silty, trace sand, trace organics, black, moist, stiff, intermediate plasticity		G175	
	0.5	SILT - some sand, trace clay - brown - moist, soft - low plasticity			
	1.0			G176	
	1.5	- sandy below 1.5 m			
	2.0				
	2.5				
	3.0			G177	
262.7	3.5	CLAY - silty, trace silt inclusions (<5 mm diam.) - grey - moist, firm - high plasticity			
	4.0				
	4.5			G178	
	5.0				
	5.5				
	6.0			G179	
	6.5				
	7.0	- soft to firm below 7.4 m			
	7.5			G180	
	8.0				
	8.5				
	9.0			G181	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL — 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-19

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
	10.0					
	10.5		- soft below 10.3 m		G182	
	11.0					
	11.5					
	12.0				G183	
	12.5					
	13.0					
	13.5				G184	
	14.0					
	14.5					
250.8	15.0				G185	

Bulk Unit Wt (kN/m^3): 16 17 18 19 20 21
Particle Size (%): 0 20 40 60 80 100
PL MC LL
0 20 40 60 80 100

Undrained Shear Strength (kPa)
Test Type
△ Torvane △
✤ Pocket Pen. ✤
☒ Qu ☒
○ Field Vane ○
0 50 100 150 200 250

END OF TEST HOLE AT 15.24 m IN CLAY

Notes:
1. Seepage observed below 3.0 m depth.
2. Sloughing observed below 3.0 m depth.
3. Test hole open to 3.0 m depth and dry immediately after drilling.
4. Water level measured to be at 3.0 m depth immediately after drilling.
5. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

Sub-Surface Log

Test Hole TH22-20

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5449392, E-581509
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	264.11 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 14, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
264.0	0.0		TOPSOIL - silty, trace sand, trace organics, black, moist, stiff, intermediate plasticity			
	0.5		SILT - some sand, trace clay - brown, moist, soft - low plasticity	G	G186	
263.2	1.0		CLAY - silty - brown - moist, stiff to very stiff - high plasticity	G	G187	
	1.5			G	G188	
	2.0			T	T189	
	2.5					
	3.0					
	3.5					
	4.0					
	4.5		- grey, soft to firm below 4.4 m	G	G190	
	5.0					
	5.5					
	6.0			G	G191	
	6.5			T	T192	
	7.0					
	7.5		- soft below 7.5 m	G	G193	
	8.0					
	8.5					
	9.0					

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ | ✿ Pocket Pen. ✿ | ☒ Qu ☒ | ○ Field Vane ○

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-20

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
	10.0				T194	
	10.5				G195	
	11.0					
	11.5					
	12.0				G196	
	12.5					
	13.0					
	13.5				G197	
	14.0					
	14.5					
248.9	15.0				G198	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL

0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type
△ Torvane △
✤ Pocket Pen. ✤
☒ Qu ☒
○ Field Vane ○

0 50 100 150 200 250

END OF TEST HOLE AT 15.24 m IN CLAY

Notes:
1. Seepage not observed.
2. Squeezing observed below 11.9 m depth.
3. Test hole open to 11.9 m depth and dry immediately after drilling.
4. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-21
1 of 1

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5449408, E-582188
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	264.02 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 14, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL	Undrained Shear Strength (kPa) Test Type: △ Torvane △, ✤ Pocket Pen. ✤, ☒ Qu ☒, ○ Field Vane ○ — 0 50 100 150 200 250
263.8	0		CLAY (TOPSOIL) - silty, black, moist, frozen, intermediate plasticity		G199			
	0.5		SILT - sandy, trace to some clay - grey - moist, soft - low plasticity		G200			
	1.0		- brown below 0.7 m		G201			
262.2	1.5							
	2.0		CLAY - silty - mottled brown and grey - moist, stiff - high plasticity					
	2.5				G202			
261.0	3.0							

END OF TEST HOLE AT 3.0 m IN CLAY

Notes:
1. Seepage and sloughing not observed.
2. Test hole open to 3.0 m depth and dry immediately after drilling.
3. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-22

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5448644, E-581912
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	264.57 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 15, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
264.5	0		CLAY (TOPSOIL) - silty, black, moist, frozen, intermediate plasticity			
	0.5		SILT - sandy, trace clay - dark brown - moist, soft - low plasticity		G203	
	1.0		- damp, brown below 0.8 m		G204	
	1.5					
262.7	2.0		CLAY - silty - mottled brown and grey - moist, stiff - high plasticity		G205	
261.5	3.0		END OF TEST HOLE AT 3.0 m IN CLAY			

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

0 50 100 150 200 250

Notes:
1. Seepage and sloughing not observed.
2. Test hole open to 3.0 m depth and dry immediately after drilling.
3. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-23

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5448656, E-582621
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	264.48 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 15, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Backfill Legend: Bentonite | Cement | Drill Cuttings | Filter Pack Sand | Grout | Slough

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
264.4	0	CLAY (TOPSOIL) - silty, black, moist, frozen, intermediate plasticity			
	0.5	SILT - trace clay - dark brown - moist, soft - low plasticity	G	G206	
	1.0	- brown below 1.0 m	G	G207	
	1.5				
	2.0				
262.0	2.5	- moist to wet below 2.3 m	G	G208	
		CLAY - silty - mottled brown and grey - moist, stiff, high plasticity	G	G209	
261.4	3.0				

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

0 50 100 150 200 250

END OF TEST HOLE AT 3.0 m IN CLAY

Notes:

1. Seepage observed below 2.1 m depth.
2. Sloughing observed below 1.8 m depth.
3. Test hole open to 1.8 m depth immediately after drilling.
4. Water level measured at 1.8 m depth immediately after drilling.
5. Standpipe SP22-23 installed to 2.4 m depth.
6. Test hole backfilled with sand and bentonite chips around standpipe to ground surface.
7. Water level measured at 2.0 m depth in SP22-23 on January 6, 2023.
8. Water level measured at 2.2 m depth in SP22-23 on April 5, 2023.
9. Water level measured at 1.4 m depth in SP22-23 on May 17, 2023.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-24

Client:	RM of Stanley	**Project Number:**	0829 001 00
Project Name:	Reinfeld Development	**Location:**	UTM N-5449387, E-582598
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	263.35 m
Method:	125 mm Solid Stem Auger, Mobile B48 Track Mount	**Date Drilled:**	December 15, 2022

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) / SPT | Split Barrel (SB) / LPT | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
263.3	0		TOPSOIL - silty, trace sand, trace organics, black, moist, stiff, intermediate plasticity			
262.6	0.5		CLAY - silty - dark brown, moist, soft, high plasticity	G	G210	
	1.0		SILT - sandy, trace to some clay - brown, moist - soft - low plasticity	G	G211	
261.1	2.0			G	G212	
	2.5		CLAY - silty - brown - moist, stiff - high plasticity	G	G213	
	3.0					
	3.5					
	4.0		- mottled grey and brown below 3.9 m	G	G214	
	4.5					
	5.0					
	5.5					
	6.0		- grey, firm below 6.1 m	G	G215	
	6.5					
	7.0					
	7.5		- soft below 7.4 m	G	G216	
	8.0					
	8.5					
	9.0			G	G217	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100 — PL MC LL

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ | ✤ Pocket Pen. ✤ | ☒ Qu ☒ | ○ Field Vane ○

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

SUB-SURFACE LOG LOGS 2023-05-19 REINFELD DEVELOPMENT 0_B_JSS 0829-001-00.GPJ TREK.GDT 12/12/23

Sub-Surface Log

Test Hole TH22-24

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
	10.0							
	10.5				G218		●	△
	11.0							
	11.5							
	12.0				G219		●	△
	12.5							
	13.0							
	13.5				G220		●	✤
	14.0							
	14.5							
248.1	15.0				G221		●	✤

END OF TEST HOLE AT 15.2 m IN CLAY

Notes:

1. Seepage observed below 2.1 m depth.
2. Sloughing observed below 2.1 m depth.
3. Test hole open to 2.1 m depth immediately after drilling.
4. Water level measured to be at 2.1 m depth immediately after drilling.
5. Test hole backfilled with auger cuttings and bentonite chips to ground surface.

Logged By: Reinhardt Jansen Van Rensburg **Reviewed By:** Michael Van Helden **Project Engineer:** Reinhardt Jansen van Rensburg

Appendix A

Laboratory Testing Results

MEMORANDUM

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

Date	July 20, 2022
To	Beta Taryana
From	Angela Fidler-Kliewer
Project No.	0829-001-00
Project	Reinfeld Development
Subject	Laboratory Testing Results – Lab Req. R22-335
Distribution	Beta Taryana

Attached are the laboratory testing results for the above noted project. The testing includes moisture content determination and unconfined compression and related testing using Shelby tubes.

Two samples (TH22-05 (SS48) and TH22-06 (T83)) were sent to ALS for sulphates and will be reported upon completion.

Regards,

Angela Fidler-Kliewer, C.Tech.

Review Control:

Prepared By: JD	*Reviewed By:* *AFK*	*Checked By:* NJF

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Moisture Content Report
ASTM D2216-10

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Development

Sample Date 05-Apr-22
Test Date 11-Jul-22
Technician JD

Test Hole	TH22-01	TH22-01	TH22-01	TH22-01	TH22-01	TH22-01
Depth (m)	0.0 - 0.3	0.3 - 0.6	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	2.3 - 2.6
Sample #	G01	G02	G03	G04	G05	G06
Tare ID	A1	AA18	W02	A28	A106	E117
Mass of tare	8.2	6.0	8.6	8.2	8.2	8.6
Mass wet + tare	244.6	272.0	255.0	254.0	271.6	319.2
Mass dry + tare	202.4	232.5	227.1	229.6	219.5	263.8
Mass water	42.2	39.5	27.9	24.4	52.1	55.4
Mass dry soil	194.2	226.5	218.5	221.4	211.3	255.2
Moisture %	21.7%	17.4%	12.8%	11.0%	24.7%	21.7%

Test Hole	TH22-01	TH22-01	TH22-01	TH22-01	TH22-01	TH22-01
Depth (m)	2.9 - 3.0	3.2 - 3.4	5.6 - 5.8	7.0 - 7.2	8.4 - 8.5	9.9 - 10.1
Sample #	G07	G08	G10	G11	G12	G13
Tare ID	H34	N91	E85	E42	F126	AB51
Mass of tare	8.6	8.6	8.6	8.6	8.6	6.6
Mass wet + tare	266.0	274.0	275.4	271.8	266.0	278.4
Mass dry + tare	188.9	192.9	191.8	191.3	185.1	189.9
Mass water	77.1	81.1	83.6	80.5	80.9	88.5
Mass dry soil	180.3	184.3	183.2	182.7	176.5	183.3
Moisture %	42.8%	44.0%	45.6%	44.1%	45.8%	48.3%

Test Hole	TH22-01	TH22-01	TH22-01	TH22-02	TH22-02	TH22-02
Depth (m)	11.4 - 11.6	13.0 - 13.1	14.5 - 14.6	0.0 - 0.3	0.6 - 0.8	0.9 - 1.1
Sample #	G14	G15	G16	G17	G18	G19
Tare ID	Z138	Z73	Z114	N96	F66	AB95
Mass of tare	8.6	8.6	8.2	8.6	8.6	6.8
Mass wet + tare	267.4	266.8	256.6	256.0	274.6	280.0
Mass dry + tare	181.6	177.9	165.4	196.3	215.8	249.6
Mass water	85.8	88.9	91.2	59.7	58.8	30.4
Mass dry soil	173.0	169.3	157.2	187.7	207.2	242.8
Moisture %	49.6%	52.5%	58.0%	31.8%	28.4%	12.5%

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Moisture Content Report
ASTM D2216-10

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Development

Sample Date 05-Apr-22
Test Date 11-Jul-22
Technician JD

Test Hole	TH22-02	TH22-02	TH22-02	TH22-03	TH22-03	TH22-03
Depth (m)	1.5 - 1.7	2.1 - 2.3	2.7 - 3.0	0.2 - 0.3	1.2 - 1.4	2.4 - 2.7
Sample #	G20	G21	G22	G23	G24	G25
Tare ID	W59	F54	H54	N02	Z72	D17
Mass of tare	8.6	8.6	8.4	8.6	8.8	8.6
Mass wet + tare	326.2	326.4	266.0	257.0	279.2	286.4
Mass dry + tare	267.4	256.7	209.9	194.5	223.3	218.1
Mass water	58.8	69.7	56.1	62.5	55.9	68.3
Mass dry soil	258.8	248.1	201.5	185.9	214.5	209.5
Moisture %	22.7%	28.1%	27.8%	33.6%	26.1%	32.6%

Test Hole	TH22-03	TH22-03	TH22-03	TH22-03	TH22-03	TH22-03
Depth (m)	4.3 - 4.6	5.0 - 5.2	5.8 - 5.9	7.3 - 7.5	8.8 - 9.0	10.7 - 11.1
Sample #	G26	G27	G28	G29	G30	SS32
Tare ID	W06	W01	D11	P40	F153	N109
Mass of tare	8.6	8.6	9.0	8.6	8.4	8.6
Mass wet + tare	267.0	260.4	282.2	267.2	283.4	266.2
Mass dry + tare	206.4	188.2	203.4	191.1	199.5	181.6
Mass water	60.6	72.2	78.8	76.1	83.9	84.6
Mass dry soil	197.8	179.6	194.4	182.5	191.1	173.0
Moisture %	30.6%	40.2%	40.5%	41.7%	43.9%	48.9%

Test Hole	TH22-03	TH22-03	TH22-03	TH22-04	TH22-04	TH22-04
Depth (m)	12.2 - 12.6	13.7 - 14.2	15.2 - 15.7	0.0 - 0.2	0.3 - 0.5	1.1 - 1.2
Sample #	SS33	SS34	SS35	G36	G37	G38
Tare ID	E24	E69	Z18	Z107	F7	H69
Mass of tare	8.6	8.6	8.8	8.6	8.6	9.4
Mass wet + tare	279.8	275.2	268.2	269.0	257.0	273.8
Mass dry + tare	177.7	177.0	169.6	214.6	211.3	227.8
Mass water	102.1	98.2	98.6	54.4	45.7	46.0
Mass dry soil	169.1	168.4	160.8	206.0	202.7	218.4
Moisture %	60.4%	58.3%	61.3%	26.4%	22.5%	21.1%

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Moisture Content Report
ASTM D2216-10

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Development

Sample Date 05-Apr-22
Test Date 11-Jul-22
Technician JD

Test Hole	TH22-04	TH22-04	TH22-04	TH22-04	TH22-04	TH22-04
Depth (m)	1.5 - 2.0	2.3 - 2.4	3.0 - 3.5	3.8 - 4.0	4.6 - 5.0	5.3 - 5.5
Sample #	SS39	G40	SS41	G42	SS43	G44
Tare ID	W65	H27	N48	F108	E61	F35
Mass of tare	8.6	8.6	8.6	8.4	8.8	8.8
Mass wet + tare	270.6	289.2	268.6	287.6	260.0	273.8
Mass dry + tare	212.8	229.1	191.0	217.1	188.1	206.0
Mass water	57.8	60.1	77.6	70.5	71.9	67.8
Mass dry soil	204.2	220.5	182.4	208.7	179.3	197.2
Moisture %	28.3%	27.3%	42.5%	33.8%	40.1%	34.4%

Test Hole	TH22-04	TH22-05	TH22-05	TH22-05	TH22-05	TH22-05
Depth (m)	6.1 - 6.6	0.0 - 0.3	0.6 - 0.9	1.5 - 2.0	2.1 - 2.4	3.0 - 3.5
Sample #	SS45	G46	G47	SS48	G49	SS50
Tare ID	P12	C6	F124	P06	E25	P34
Mass of tare	8.8	8.6	8.6	8.6	9.0	9.0
Mass wet + tare	236.0	273.0	287.6	270.2	281.4	252.0
Mass dry + tare	171.7	226.1	231.2	208.4	225.5	177.1
Mass water	64.3	46.9	56.4	61.8	55.9	74.9
Mass dry soil	162.9	217.5	222.6	199.8	216.5	168.1
Moisture %	39.5%	21.6%	25.3%	30.9%	25.8%	44.6%

Test Hole	TH22-05	TH22-05	TH22-05	TH22-05	TH22-05	TH22-05
Depth (m)	3.7 - 4.0	4.6 - 5.0	5.2 - 5.5	6.1 - 6.6	6.7 - 7.0	7.6 - 8.1
Sample #	G51	SS52	G53	SS54	G55	SS56
Tare ID	AA13	Z114	F100	Z74	N35	F79
Mass of tare	6.6	8.4	8.6	8.8	8.6	8.8
Mass wet + tare	270.0	278.0	267.6	262.0	260.6	258.4
Mass dry + tare	192.3	194.9	189.5	185.6	185.5	181.3
Mass water	77.7	83.1	78.1	76.4	75.1	77.1
Mass dry soil	185.7	186.5	180.9	176.8	176.9	172.5
Moisture %	41.8%	44.6%	43.2%	43.2%	42.5%	44.7%

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Moisture Content Report
ASTM D2216-10

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Development

Sample Date 05-Apr-22
Test Date 11-Jul-22
Technician JD

Test Hole	TH22-05	TH22-05	TH22-05	TH22-05	TH22-05	TH22-05
Depth (m)	8.2 - 8.5	12.2 - 12.6	15.2 - 15.7	16.8 - 17.2	19.8 - 20.3	21.3 - 21.8
Sample #	G57	SS59	SS61	SS62	SS64	SS65
Tare ID	K2	N06	AB40	Z90	AB98	E470
Mass of tare	8.4	8.6	6.8	8.6	6.8	8.6
Mass wet + tare	252.8	259.8	276.4	269.6	263.6	262.6
Mass dry + tare	179.3	172.8	186.0	179.0	164.9	172.8
Mass water	73.5	87.0	90.4	90.6	98.7	89.8
Mass dry soil	170.9	164.2	179.2	170.4	158.1	164.2
Moisture %	43.0%	53.0%	50.4%	53.2%	62.4%	54.7%

Test Hole	TH22-05	TH22-05	TH22-05	TH22-05	TH22-06	TH22-06
Depth (m)	22.9 - 23.3	25.9 - 26.4	27.4 - 27.9	29.0 - 29.4	0.0 - 0.2	0.2 - 0.3
Sample #	SS66	SS68	SS69	SS70	G72	G73
Tare ID	D32	Z57	W76	P31	E52	D24
Mass of tare	8.6	8.6	8.6	8.4	8.6	8.8
Mass wet + tare	275.8	273.2	272.8	261.8	257.2	283.6
Mass dry + tare	174.1	180.3	178.2	175.4	203.4	225.7
Mass water	101.7	92.9	94.6	86.4	53.8	57.9
Mass dry soil	165.5	171.7	169.6	167.0	194.8	216.9
Moisture %	61.5%	54.1%	55.8%	51.7%	27.6%	26.7%

Test Hole	TH22-06	TH22-06	TH22-06	TH22-06	TH22-06	TH22-06
Depth (m)	0.6 - 0.9	1.5 - 2.0	2.1 - 2.4	3.0 - 3.5	3.7 - 4.0	4.6 - 5.0
Sample #	G74	SS75	G76	SS77	G78	SS79
Tare ID	W86	W44	Z19	AB96	P28	F154
Mass of tare	8.8	8.5	9	6.8	8.7	8.5
Mass wet + tare	272.0	146.6	272.8	220.9	273.2	263.0
Mass dry + tare	217.0	113.3	210.0	172.4	201.7	188.5
Mass water	55.0	33.3	62.8	48.5	71.5	74.5
Mass dry soil	208.2	104.8	201.0	165.6	193.0	180.0
Moisture %	26.4%	31.8%	31.2%	29.3%	37.0%	41.4%

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Moisture Content Report
ASTM D2216-10

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Development

Sample Date 05-Apr-22
Test Date 11-Jul-22
Technician JD

Test Hole	TH22-06	TH22-06	TH22-06	TH22-06	TH22-06	TH22-06
Depth (m)	5.2 - 5.5	6.1 - 6.6	6.7 - 7.0	9.1 - 9.6	12.2 - 12.6	15.2 - 15.7
Sample #	G80	SS81	G82	SS84	SS86	SS88
Tare ID	W45	AA02	F110	F37	F129	W59
Mass of tare	8.4	6.8	8.2	8.4	8.6	8.6
Mass wet + tare	287.0	262.0	262.2	266.6	270.2	245.6
Mass dry + tare	205.7	185.2	184.8	186.8	186.7	226.7
Mass water	81.3	76.8	77.4	79.8	83.5	18.9
Mass dry soil	197.3	178.4	176.6	178.4	178.1	218.1
Moisture %	41.2%	43.0%	43.8%	44.7%	46.9%	8.7%

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Shelby Tube Visual

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Development
Test Hole	TH22-01
Sample #	T09
Depth (m)	4.6 - 5.2
Sample Date	05-Apr-22
Test Date	14-Jul-22
Technician	JD

Tube Extraction

Recovery (mm) 700

5.13 m	4.93 m	4.83 m	4.65 m
Bottom - 5.2 m			**Top - 4.5 m**
Toss	Keep	Visual M/C TV / PP	QU Bulk	Keep
70 mm	200 mm	100 mm	180 mm	150 mm

Visual Classification

Material	CLAY
Composition	silty
Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.38
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	37.3

Pocket Penetrometer

Reading	**1**	1.00
	2	0.90
	3	0.90
	Average	0.93
Undrained Shear Strength (kPa)		45.8

Moisture Content

Tare ID	Z33
Mass tare (g)	8.3
Mass wet + tare (g)	238.4
Mass dry + tare (g)	162.8
Moisture %	48.9%

Unit Weight

Bulk Weight (g)		1066.0
Length (mm)	**1**	147.15
	2	147.06
	3	147.80
	4	147.33
Average Length (m)		0.147
Diam. (mm)	**1**	73.33
	2	73.37
	3	73.26
	4	73.40
Average Diameter (m)		0.073
Volume (m^3)		6.22E-04
Bulk Unit Weight (kN/m^3)		16.8
Bulk Unit Weight (pcf)		106.9
Dry Unit Weight (kN/m^3)		11.3
Dry Unit Weight (pcf)		71.8

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Development
Test Hole	TH22-01
Sample #	T09
Depth (m)	4.6 - 5.2
Sample Date	5-Apr-22
Test Date	14-Jul-22
Technician	JD

Unconfined Strength

	kPa	ksf
Max q_u	66.2	1.4
Max S_u	33.1	0.7

Specimen Data

Description CLAY - silty, grey, moist, firm, high plasticity

Length	147.3	(mm)	**Moisture %**	49%	
Diameter	73.3	(mm)	**Bulk Unit Wt.**	16.8	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	11.3	(kN/m^3)
Initial Area	0.00422	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.38	37.3	0.78

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	1.00	49.1	1.02
	0.90	44.1	0.92
	0.90	44.1	0.92
Average	**0.93**	**45.8**	**0.96**

Failure Geometry

Sketch:

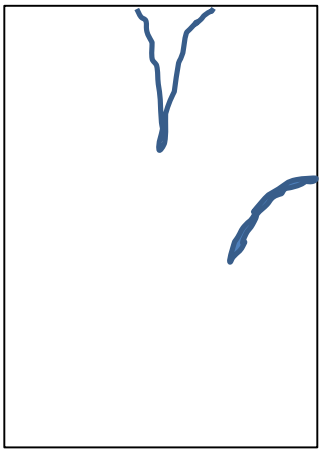

Photo:

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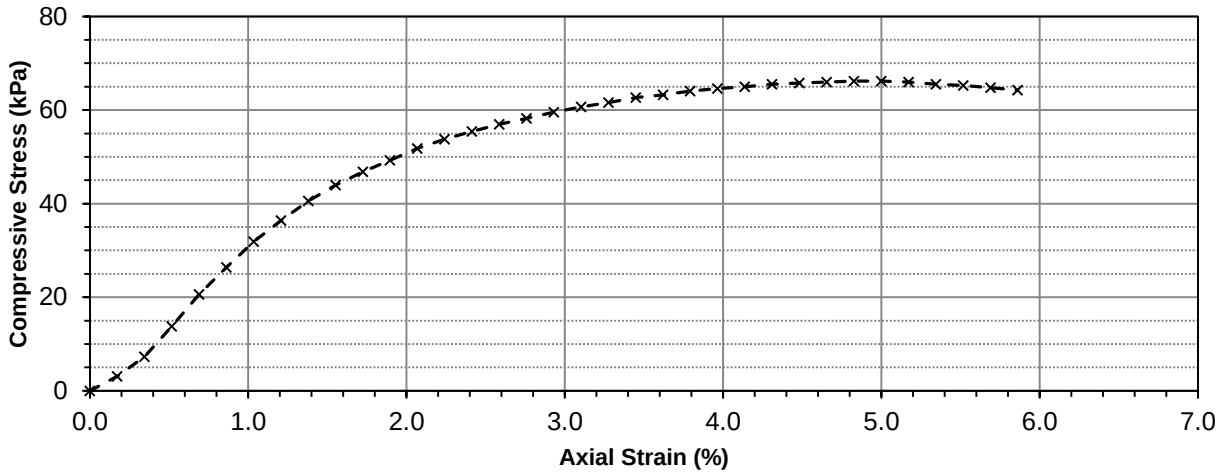
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.01	0.0000	0.00	0.004224	0.0	0.00	0.00
10	0.27	0.2540	0.17	0.004232	13.1	3.10	1.55
20	0.62	0.5080	0.34	0.004239	30.7	7.25	3.63
30	1.17	0.7620	0.52	0.004246	58.5	13.77	6.88
40	1.75	1.0160	0.69	0.004254	87.7	20.62	10.31
50	2.24	1.2700	0.86	0.004261	112.4	26.38	13.19
60	2.71	1.5240	1.03	0.004269	136.1	31.88	15.94
70	3.10	1.7780	1.21	0.004276	155.7	36.42	18.21
80	3.46	2.0320	1.38	0.004284	173.9	40.59	20.30
90	3.75	2.2860	1.55	0.004291	188.5	43.93	21.97
100	4.00	2.5400	1.72	0.004299	201.1	46.78	23.39
110	4.22	2.7940	1.90	0.004306	212.2	49.28	24.64
120	4.44	3.0480	2.07	0.004314	223.3	51.76	25.88
130	4.62	3.3020	2.24	0.004321	232.4	53.77	26.89
140	4.77	3.5560	2.41	0.004329	239.9	55.42	27.71
150	4.91	3.8100	2.59	0.004337	247.0	56.95	28.48
160	5.03	4.0640	2.76	0.004344	253.0	58.24	29.12
170	5.15	4.3180	2.93	0.004352	259.1	59.53	29.76
180	5.26	4.5720	3.10	0.004360	264.6	60.70	30.35
190	5.35	4.8260	3.28	0.004368	269.2	61.63	30.81
200	5.45	5.0800	3.45	0.004375	274.2	62.67	31.33
210	5.51	5.3340	3.62	0.004383	277.2	63.25	31.62
220	5.59	5.5880	3.79	0.004391	281.2	64.05	32.03
230	5.65	5.8420	3.97	0.004399	284.3	64.62	32.31

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Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	5.69	6.0960	4.14	0.004407	286.3	64.97	32.48
250	5.75	6.3500	4.31	0.004415	289.3	65.53	32.77
260	5.78	6.6040	4.48	0.004423	290.8	65.76	32.88
270	5.81	6.8580	4.65	0.004431	292.3	65.98	32.99
280	5.84	7.1120	4.83	0.004439	293.8	66.20	33.10
290	5.85	7.3660	5.00	0.004447	294.4	66.19	33.10
300	5.84	7.6200	5.17	0.004455	293.8	65.96	32.98
310	5.81	7.8740	5.34	0.004463	292.3	65.50	32.75
320	5.80	8.1280	5.52	0.004471	291.8	65.27	32.64
330	5.77	8.3820	5.69	0.004479	290.3	64.81	32.41
340	5.73	8.6360	5.86	0.004487	288.3	64.25	32.12

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Shelby Tube Visual

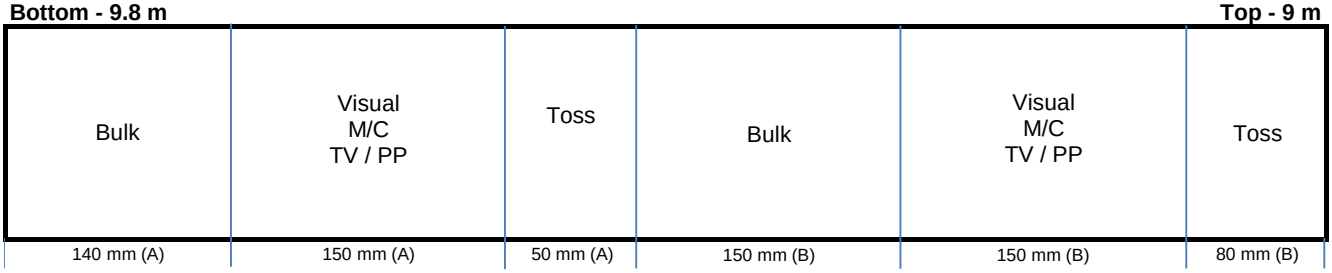
Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Development
Test Hole	TH22-03
Sample #	T31
Depth (m)	9.1 - 9.8
Sample Date	06-Apr-22
Test Date	17-Jul-22
Technician	JD

Tube Extraction

Recovery (mm) 720

9.66 m A 9.51 m 9.46 m 9.31 m B 9.16 m

Bottom - 9.8 m **Top - 9 m**



Visual Classification

	A	B
Material	CLAY	SILT
Composition	silty	trace to some clay
		trace oxidation
		trace organics
Color	grey	grey
Moisture	moist	moist
Consistency	firm to stiff	soft
Plasticity	high plasticity	high plasticity
Structure	-	-
Gradation	-	-

Torvane

	A	B	
Reading	0.5	0.14	
Vane Size (s,m,l)	m	m	
Undrained Shear Strength	49.0	13.7	(kPa)

Pocket Penetrometer

		A	B	
Reading	**1**	1.20	0.40	
	2	1.10	0.40	
	3	0.90	0.30	
	Average	1.067	0.367	
Undrained Shear Strength		52.3	18.0	(kPa)

Moisture Content

	A	B
Tare ID	AB11	W63
Mass tare (g)	7.0	8.8
Mass wet + tare (g)	272.0	307.6
Mass dry + tare (g)	190.3	219.8
Moisture %	44.6%	41.6%

Unit Weight

Bulk Weight (g)		619.00	728.40
Length (mm)	**1**	91.64	89.60
	2	91.73	89.76
	3	91.42	89.90
	4	91.89	91.54
Average Length (m)		0.092	0.090
Diam. (mm)	**1**	70.08	69.11
	2	71.16	70.53
	3	71.54	73.22
	4	69.29	72.53
Average Diameter (m)		0.071	0.071
Volume (m^3)		3.58E-04	3.61E-04
Bulk Unit Weight (kN/m^3)		17.0	19.8
Bulk Unit Weight (pcf)		107.9	126.1
Dry Unit Weight (kN/m^3)		11.7	14.0
Dry Unit Weight (pcf)		74.7	89.0

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Shelby Tube Visual

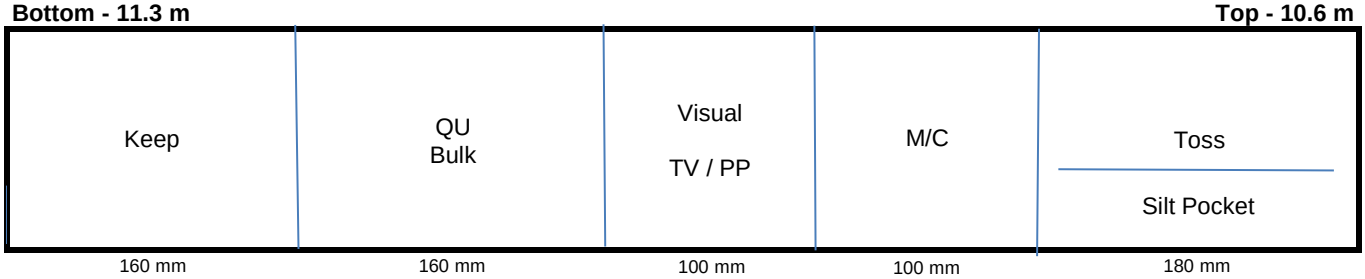
Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Development
Test Hole	TH22-05
Sample #	T58
Depth (m)	10.7 - 11.3
Sample Date	27-Jun-22
Test Date	17-Jul-22
Technician	JD

Tube Extraction

Recovery (mm) 700

11.14 m 10.98 m 10.88 m 10.78 m

Bottom - 11.3 m **Top - 10.6 m**



Visual Classification

Material	CLAY
Composition	silty

trace silt inclusions (<5 mm diam.)

Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.28
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	27.5

Pocket Penetrometer

Reading	**1**	0.60
	2	0.50
	3	0.50
	Average	0.53
Undrained Shear Strength (kPa)		26.2

Moisture Content

Tare ID	H64
Mass tare (g)	8.6
Mass wet + tare (g)	264.0
Mass dry + tare (g)	174.0
Moisture %	54.4%

Unit Weight

Bulk Weight (g)		971.0
Length (mm)	**1**	146.08
	2	145.90
	3	145.80
	4	146.04
Average Length (m)		0.146
Diam. (mm)	**1**	72.58
	2	72.86
	3	73.15
	4	71.55
Average Diameter (m)		0.073
Volume (m^3)		6.03E-04
Bulk Unit Weight (kN/m^3)		15.8
Bulk Unit Weight (pcf)		100.5
Dry Unit Weight (kN/m^3)		10.2
Dry Unit Weight (pcf)		65.1

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Development
Test Hole	TH22-05
Sample #	T58
Depth (m)	10.7 - 11.3
Sample Date	27-Jun-22
Test Date	17-Jul-22
Technician	JD

Unconfined Strength

	kPa	ksf
Max q_u	44.3	0.9
Max S_u	22.2	0.5

Specimen Data

Description CLAY - silty, trace silt inclusions (<5 mm diam.), grey, moist, firm, high plasticity

Length	146.0	(mm)	**Moisture %**	54%	
Diameter	72.5	(mm)	**Bulk Unit Wt.**	15.8	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	10.2	(kN/m^3)
Initial Area	0.00413	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.28	27.5	0.57

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	0.60	29.4	0.61
	0.50	24.5	0.51
	0.50	24.5	0.51
Average	**0.53**	**26.2**	**0.55**

Failure Geometry

Sketch:

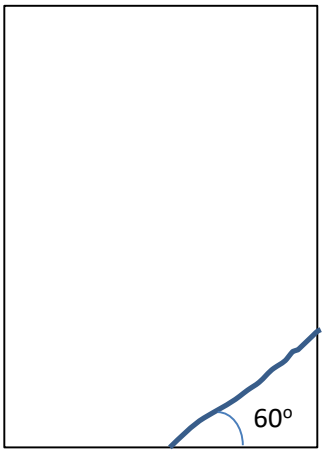

Photo:

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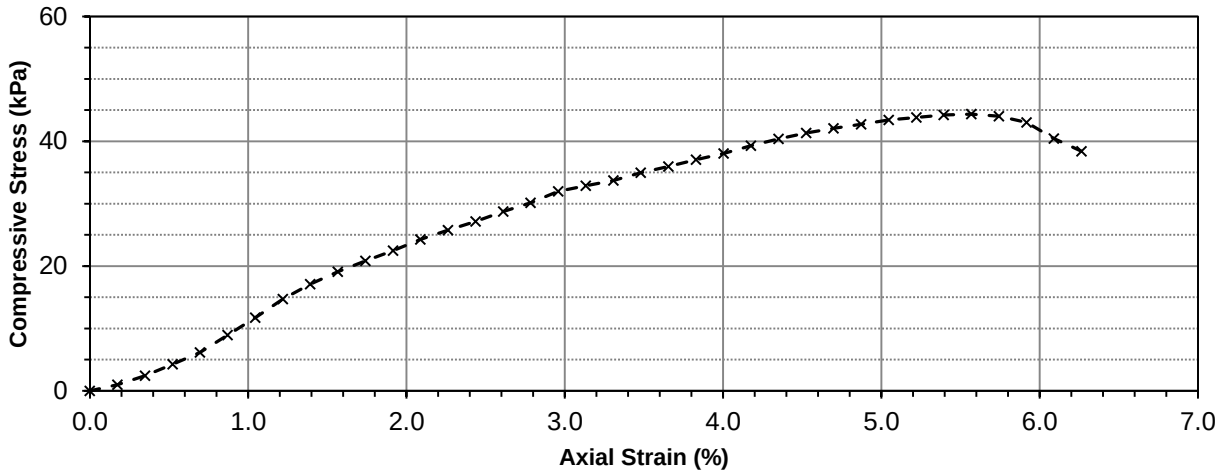
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.03	0.0000	0.00	0.004132	0.0	0.00	0.00
10	0.11	0.2540	0.17	0.004139	4.0	0.97	0.49
20	0.23	0.5080	0.35	0.004147	10.1	2.43	1.22
30	0.38	0.7620	0.52	0.004154	17.6	4.25	2.12
40	0.54	1.0160	0.70	0.004161	25.7	6.18	3.09
50	0.77	1.2700	0.87	0.004169	37.3	8.95	4.47
60	1.00	1.5240	1.04	0.004176	48.9	11.71	5.85
70	1.25	1.7780	1.22	0.004183	61.5	14.70	7.35
80	1.45	2.0320	1.39	0.004191	71.6	17.08	8.54
90	1.62	2.2860	1.57	0.004198	80.1	19.09	9.55
100	1.77	2.5400	1.74	0.004205	87.7	20.85	10.43
110	1.91	2.7940	1.91	0.004213	94.8	22.49	11.25
120	2.06	3.0480	2.09	0.004220	102.3	24.24	12.12
130	2.19	3.3020	2.26	0.004228	108.9	25.75	12.88
140	2.31	3.5560	2.44	0.004235	114.9	27.13	13.57
150	2.45	3.8100	2.61	0.004243	122.0	28.75	14.37
160	2.57	4.0640	2.78	0.004251	128.0	30.12	15.06
170	2.73	4.3180	2.96	0.004258	136.1	31.96	15.98
180	2.81	4.5720	3.13	0.004266	140.1	32.85	16.42
190	2.89	4.8260	3.31	0.004274	144.2	33.73	16.87
200	3.00	5.0800	3.48	0.004281	149.7	34.97	17.48
210	3.09	5.3340	3.65	0.004289	154.2	35.96	17.98
220	3.19	5.5880	3.83	0.004297	159.3	37.07	18.53
230	3.28	5.8420	4.00	0.004305	163.8	38.06	19.03

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Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	3.39	6.0960	4.18	0.004312	169.4	39.27	19.64
250	3.49	6.3500	4.35	0.004320	174.4	40.37	20.18
260	3.58	6.6040	4.52	0.004328	178.9	41.34	20.67
270	3.65	6.8580	4.70	0.004336	182.5	42.08	21.04
280	3.71	7.1120	4.87	0.004344	185.5	42.70	21.35
290	3.78	7.3660	5.05	0.004352	189.0	43.43	21.72
300	3.82	7.6200	5.22	0.004360	191.0	43.82	21.91
310	3.86	7.8740	5.39	0.004368	193.0	44.20	22.10
320	3.88	8.1280	5.57	0.004376	194.1	44.35	22.17
330	3.86	8.3820	5.74	0.004384	193.0	44.03	22.02
340	3.78	8.6360	5.92	0.004392	189.0	43.03	21.52
350	3.56	8.8900	6.09	0.004400	177.9	40.43	20.22
360	3.39	9.1440	6.26	0.004408	169.4	38.42	19.21

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Shelby Tube Visual

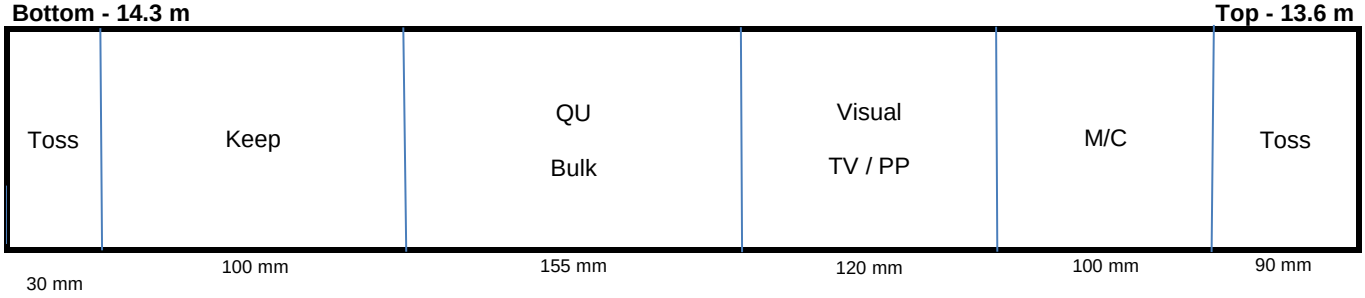
Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Development
Test Hole	TH22-05
Sample #	T60
Depth (m)	13.7 - 14.3
Sample Date	27-Jun-22
Test Date	17-Jul-22
Technician	JD

Tube Extraction

Recovery (mm) 700

14.27 m 14.11 m 13.95 m 13.83 m 13.73 m

Bottom - 14.3 m **Top - 13.6 m**



Visual Classification

Material	CLAY
Composition	silty
Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.39
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	38.3

Pocket Penetrometer

Reading	**1**	0.80
	2	0.75
	3	0.80
	Average	0.78
Undrained Shear Strength (kPa)		38.4

Moisture Content

Tare ID	F144
Mass tare (g)	8.6
Mass wet + tare (g)	287.8
Mass dry + tare (g)	192.9
Moisture %	51.5%

Unit Weight

Bulk Weight (g)		1021.4
Length (mm)	**1**	145.04
	2	145.26
	3	145.50
	4	144.96
Average Length (m)		0.145
Diam. (mm)	**1**	72.02
	2	72.45
	3	72.93
	4	72.31
Average Diameter (m)		0.072
Volume (m^3)		5.98E-04
Bulk Unit Weight (kN/m^3)		16.7
Bulk Unit Weight (pcf)		106.6
Dry Unit Weight (kN/m^3)		11.1
Dry Unit Weight (pcf)		70.4

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Development
Test Hole	TH22-05
Sample #	T60
Depth (m)	13.7 - 14.3
Sample Date	27-Jun-22
Test Date	17-Jul-22
Technician	JD

Unconfined Strength

	kPa	ksf
Max q_u	101.4	2.1
Max S_u	50.7	1.1

Specimen Data

Description CLAY - silty, grey, moist, firm, high plasticity

Length	145.2	(mm)	**Moisture %**	51%	
Diameter	72.4	(mm)	**Bulk Unit Wt.**	16.7	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	11.1	(kN/m^3)
Initial Area	0.00412	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.39	38.3	0.80

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	0.80	39.2	0.82
	0.75	36.8	0.77
	0.80	39.2	0.82
Average	**0.78**	**38.4**	**0.80**

Failure Geometry

Sketch:

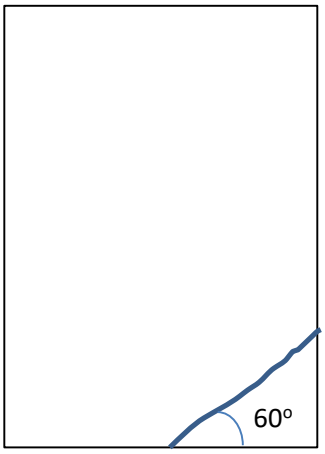

Photo:

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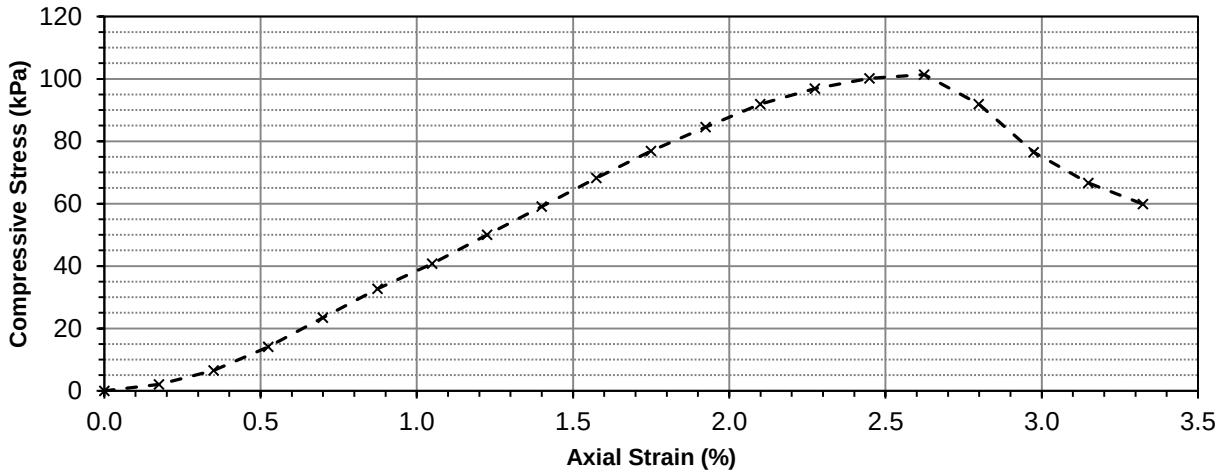
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.05	0.0000	0.00	0.004120	0.0	0.00	0.00
10	0.22	0.2540	0.17	0.004127	8.6	2.08	1.04
20	0.59	0.5080	0.35	0.004134	27.2	6.58	3.29
30	1.21	0.7620	0.52	0.004142	58.5	14.12	7.06
40	1.98	1.0160	0.70	0.004149	97.3	23.45	11.72
50	2.75	1.2700	0.87	0.004156	136.1	32.74	16.37
60	3.42	1.5240	1.05	0.004164	169.9	40.79	20.40
70	4.19	1.7780	1.22	0.004171	208.7	50.03	25.01
80	4.95	2.0320	1.40	0.004178	247.0	59.11	29.55
90	5.72	2.2860	1.57	0.004186	285.8	68.27	34.14
100	6.45	2.5400	1.75	0.004193	322.6	76.93	38.46
110	7.10	2.7940	1.92	0.004201	355.3	84.59	42.29
120	7.72	3.0480	2.10	0.004208	386.6	91.86	45.93
130	8.15	3.3020	2.27	0.004216	408.3	96.84	48.42
140	8.44	3.5560	2.45	0.004223	422.9	100.13	50.06
150	8.56	3.8100	2.62	0.004231	428.9	101.38	50.69
160	7.78	4.0640	2.80	0.004239	389.6	91.92	45.96
170	6.49	4.3180	2.97	0.004246	324.6	76.44	38.22
180	5.67	4.5720	3.15	0.004254	283.3	66.59	33.29
190	5.11	4.8260	3.32	0.004262	255.0	59.85	29.92

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Shelby Tube Visual

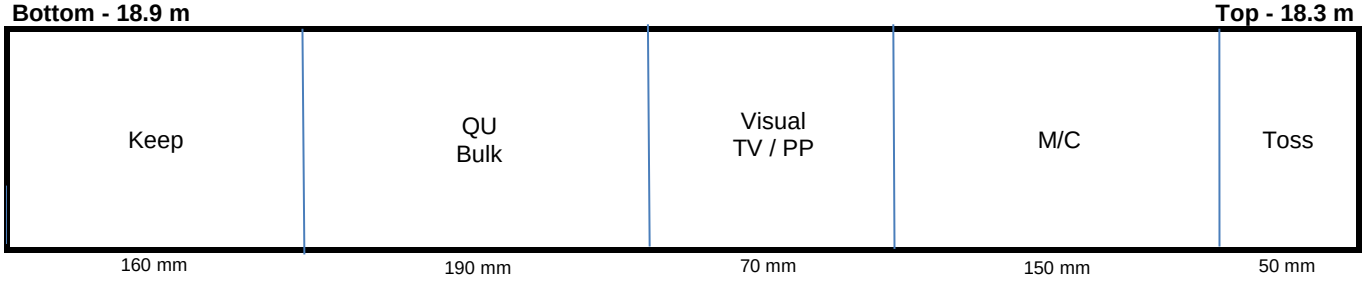
Project No.	0829-001-00
Client	RM Of Stanley
Project	Reinfeld Development
Test Hole	TH22-05
Sample #	T63
Depth (m)	18.3 - 18.9
Sample Date	27-Jun-22
Test Date	17-Jul-22
Technician	JD

Tube Extraction

Recovery (mm) 620

18.74 m | 18.55 m | 18.48 m | 18.33 m

Bottom - 18.9 m **Top - 18.3 m**



Visual Classification

Material	CLAY
Composition	silty

trace silt inclusions (<5 mm diam.)

Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.34
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	33.3

Pocket Penetrometer

Reading	**1**	0.80
	2	0.70
	3	0.70
	Average	0.73
Undrained Shear Strength (kPa)		36.0

Moisture Content

Tare ID	AC28
Mass tare (g)	6.6
Mass wet + tare (g)	305.8
Mass dry + tare (g)	198.9
Moisture %	55.6%

Unit Weight

Bulk Weight (g)		1031.0
Length (mm)	**1**	146.92
	2	146.54
	3	146.98
	4	146.48
Average Length (m)		0.147
Diam. (mm)	**1**	72.78
	2	72.65
	3	72.48
	4	73.03
Average Diameter (m)		0.073
Volume (m^3)		6.10E-04
Bulk Unit Weight (kN/m^3)		16.6
Bulk Unit Weight (pcf)		105.6
Dry Unit Weight (kN/m^3)		10.7
Dry Unit Weight (pcf)		67.9

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM Of Stanley
Project	Reinfeld Development
Test Hole	TH22-05
Sample #	T63
Depth (m)	18.3 - 18.9
Sample Date	27-Jun-22
Test Date	17-Jul-22
Technician	JD

Unconfined Strength

	kPa	ksf
Max q_u	86.7	1.8
Max S_u	43.3	0.9

Specimen Data

Description CLAY - silty, trace silt inclusions (<5 mm diam.), grey, moist, firm, high plasticity

Length	146.7	(mm)	**Moisture %**	56%	
Diameter	72.7	(mm)	**Bulk Unit Wt.**	16.6	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	10.7	(kN/m^3)
Initial Area	0.00416	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.34	33.3	0.70

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	0.80	39.2	0.82
	0.70	34.3	0.72
	0.70	34.3	0.72
Average	**0.73**	**36.0**	**0.75**

Failure Geometry

Sketch:

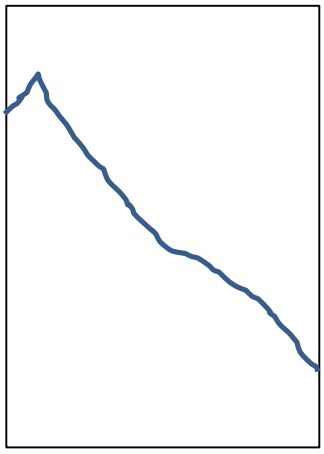

Photo:

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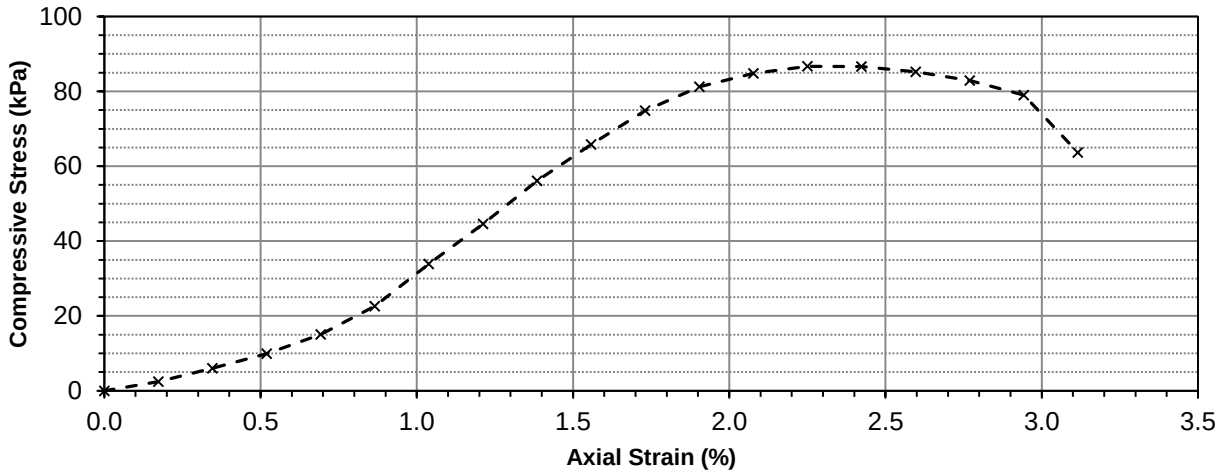
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM Of Stanley
Project Reinfeld Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.03	0.0000	0.00	0.004155	0.0	0.00	0.00
10	0.23	0.2540	0.17	0.004162	10.1	2.42	1.21
20	0.53	0.5080	0.35	0.004169	25.2	6.04	3.02
30	0.85	0.7620	0.52	0.004177	41.3	9.90	4.95
40	1.28	1.0160	0.69	0.004184	63.0	15.06	7.53
50	1.91	1.2700	0.87	0.004191	94.8	22.61	11.30
60	2.85	1.5240	1.04	0.004199	142.1	33.85	16.93
70	3.75	1.7780	1.21	0.004206	187.5	44.58	22.29
80	4.72	2.0320	1.38	0.004213	236.4	56.10	28.05
90	5.54	2.2860	1.56	0.004221	277.7	65.80	32.90
100	6.31	2.5400	1.73	0.004228	316.5	74.86	37.43
110	6.86	2.7940	1.90	0.004236	344.3	81.27	40.64
120	7.17	3.0480	2.08	0.004243	359.9	84.81	42.41
130	7.34	3.3020	2.25	0.004251	368.4	86.68	43.34
140	7.35	3.5560	2.42	0.004258	368.9	86.64	43.32
150	7.24	3.8100	2.60	0.004266	363.4	85.19	42.60
160	7.06	4.0640	2.77	0.004273	354.3	82.92	41.46
170	6.74	4.3180	2.94	0.004281	338.2	79.00	39.50
180	5.45	4.5720	3.12	0.004289	273.2	63.70	31.85

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Shelby Tube Visual

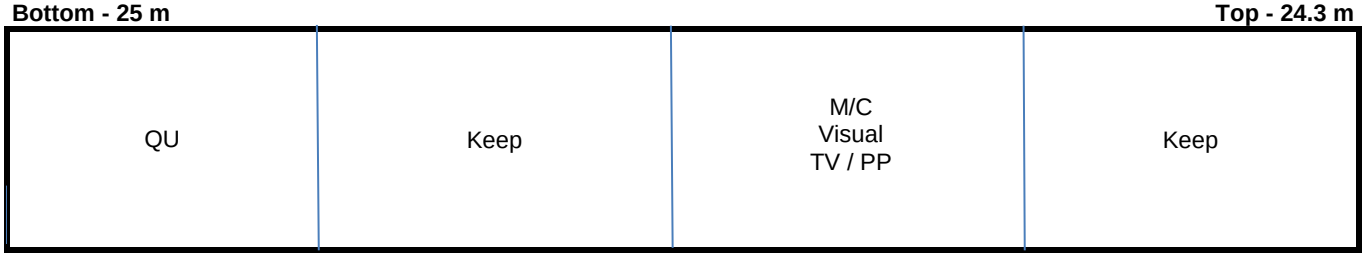
Project No.	0829-001-00
Client	RM Of Stanley
Project	Reinfeld Development
Test Hole	TH22-05
Sample #	T67
Depth (m)	24.4 - 25.0
Sample Date	28-Jun-22
Test Date	17-Jul-22
Technician	DS

Tube Extraction

Recovery (mm) 665

24.84 m 24.67 m 24.51 m

Bottom - 25 m **Top - 24.3 m**



Visual Classification

Material	CLAY
Composition	silty

trace silt inclusions (<5 mm diam.)

Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.40
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	39.2

Pocket Penetrometer

Reading	**1**	0.90
	2	0.90
	3	0.90
	Average	0.90
Undrained Shear Strength (kPa)		44.1

Moisture Content

Tare ID	H50
Mass tare (g)	8.6
Mass wet + tare (g)	290.2
Mass dry + tare (g)	188.6
Moisture %	56.4%

Unit Weight

Bulk Weight (g)		989.4
Length (mm)	**1**	146.34
	2	146.26
	3	146.12
	4	146.31
Average Length (m)		0.146
Diam. (mm)	**1**	70.40
	2	72.25
	3	70.76
	4	72.06
Average Diameter (m)		0.071
Volume (m^3)		5.85E-04
Bulk Unit Weight (kN/m^3)		16.6
Bulk Unit Weight (pcf)		105.6
Dry Unit Weight (kN/m^3)		10.6
Dry Unit Weight (pcf)		67.5

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM Of Stanley
Project	Reinfeld Development
Test Hole	TH22-05
Sample #	T67
Depth (m)	24.4 - 25.0
Sample Date	28-Jun-22
Test Date	17-Jul-22
Technician	DS

Unconfined Strength

	kPa	ksf
Max q_u	114.9	2.4
Max S_u	57.5	1.2

Specimen Data

Description CLAY - silty, trace silt inclusions (<5 mm diam.), grey, moist, firm, high plasticity

Length	146.3	(mm)	**Moisture %**	56%	
Diameter	71.4	(mm)	**Bulk Unit Wt.**	16.6	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	10.6	(kN/m^3)
Initial Area	0.00400	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.40	39.2	0.82

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	0.90	44.1	0.92
	0.90	44.1	0.92
	0.90	44.1	0.92
Average	**0.90**	**44.1**	**0.92**

Failure Geometry

Sketch:

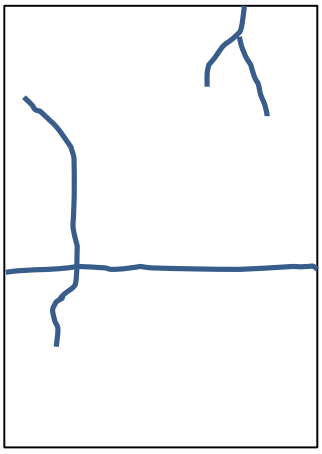

Photo:

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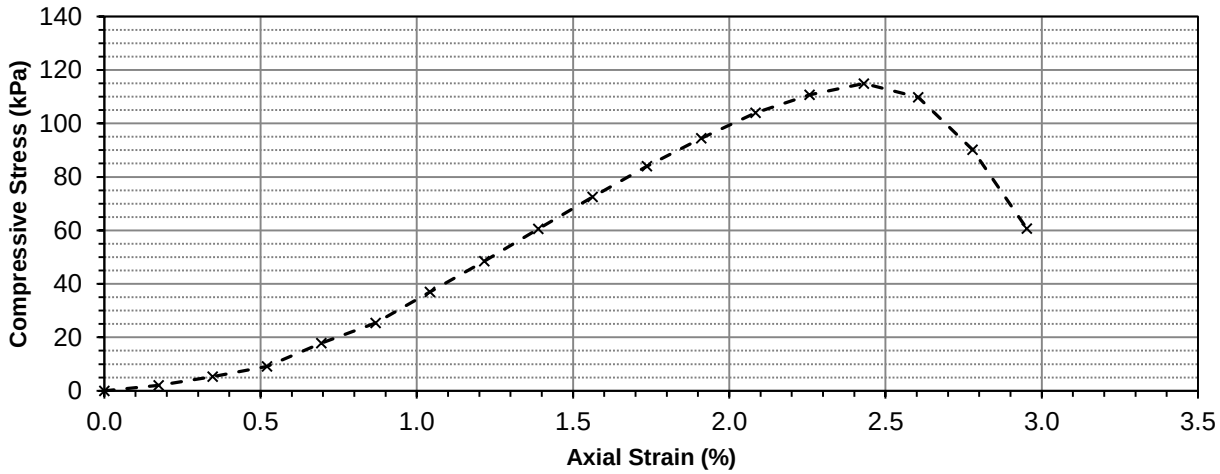
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM Of Stanley
Project Reinfeld Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.05	0.0000	0.00	0.004000	0.0	0.00	0.00
10	0.21	0.2540	0.17	0.004007	8.1	2.01	1.01
20	0.47	0.5080	0.35	0.004014	21.2	5.27	2.64
30	0.78	0.7620	0.52	0.004021	36.8	9.15	4.57
40	1.48	1.0160	0.69	0.004028	72.1	17.89	8.95
50	2.08	1.2700	0.87	0.004035	102.3	25.36	12.68
60	3.02	1.5240	1.04	0.004042	149.7	37.03	18.52
70	3.95	1.7780	1.22	0.004050	196.6	48.54	24.27
80	4.92	2.0320	1.39	0.004057	245.5	60.51	30.25
90	5.90	2.2860	1.56	0.004064	294.9	72.56	36.28
100	6.84	2.5400	1.74	0.004071	342.2	84.07	42.03
110	7.69	2.7940	1.91	0.004078	385.1	94.42	47.21
120	8.48	3.0480	2.08	0.004085	424.9	104.00	52.00
130	9.04	3.3020	2.26	0.004093	453.1	110.72	55.36
140	9.40	3.5560	2.43	0.004100	471.3	114.94	57.47
150	9.00	3.8100	2.60	0.004107	451.1	109.83	54.92
160	7.41	4.0640	2.78	0.004115	371.0	90.16	45.08
170	5.01	4.3180	2.95	0.004122	250.0	60.65	30.33

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Shelby Tube Visual

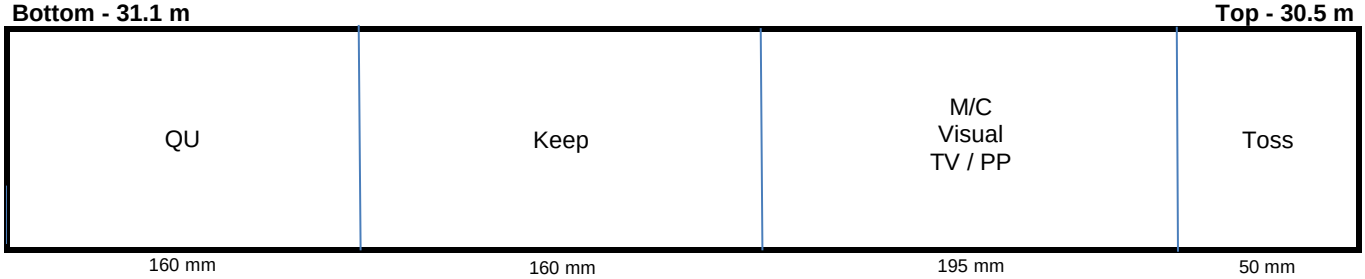
Project No.	0829-001-00
Client	RM Of Stanley
Project	Reinfeld Development
Test Hole	TH22-05
Sample #	T71
Depth (m)	30.5 - 31.1
Sample Date	28-Jun-22
Test Date	17-Jul-22
Technician	DS

Tube Extraction

Recovery (mm) 565

30.94 m 30.78 m 30.585 m

Bottom - 31.1 m **Top - 30.5 m**



Visual Classification

Material	CLAY
Composition	silty

trace silt inclusions (<5 mm diam.)

Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.38
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	37.3

Pocket Penetrometer

Reading	**1**	0.90
	2	0.80
	3	0.80
	Average	0.83
Undrained Shear Strength (kPa)		40.9

Moisture Content

Tare ID	P05
Mass tare (g)	8.6
Mass wet + tare (g)	264.4
Mass dry + tare (g)	170.6
Moisture %	57.9%

Unit Weight

Bulk Weight (g)		992.0
Length (mm)	**1**	146.44
	2	146.25
	3	146.48
	4	146.36
Average Length (m)		0.146
Diam. (mm)	**1**	72.17
	2	72.09
	3	72.31
	4	72.08
Average Diameter (m)		0.072
Volume (m^3)		5.99E-04
Bulk Unit Weight (kN/m^3)		16.2
Bulk Unit Weight (pcf)		103.4
Dry Unit Weight (kN/m^3)		10.3
Dry Unit Weight (pcf)		65.5

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM Of Stanley
Project	Reinfeld Development
Test Hole	TH22-05
Sample #	T71
Depth (m)	30.5 - 31.1
Sample Date	28-Jun-22
Test Date	17-Jul-22
Technician	DS

Unconfined Strength

	kPa	ksf
Max q_u	73.4	1.5
Max S_u	36.7	0.8

Specimen Data

Description CLAY - silty, trace silt inclusions (<5 mm diam.), grey, moist, firm, high plasticity

Length	146.4	(mm)	**Moisture %**	58%	
Diameter	72.2	(mm)	**Bulk Unit Wt.**	16.2	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	10.3	(kN/m^3)
Initial Area	0.00409	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.38	37.3	0.78

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	0.90	44.1	0.92
	0.80	39.2	0.82
	0.80	39.2	0.82
Average	**0.83**	**40.9**	**0.85**

Failure Geometry

Sketch:

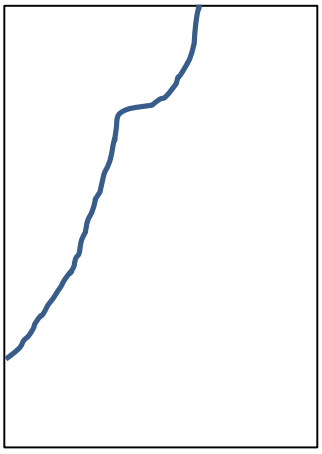

Photo:

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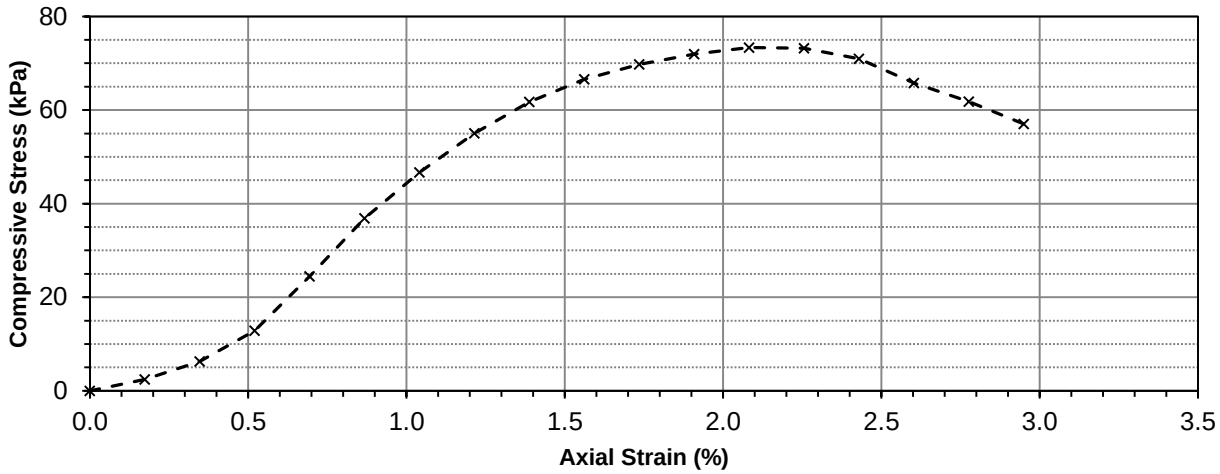
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM Of Stanley
Project Reinfeld Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.04	0.0000	0.00	0.004090	0.0	0.00	0.00
10	0.24	0.2540	0.17	0.004097	10.1	2.46	1.23
20	0.55	0.5080	0.35	0.004104	25.7	6.26	3.13
30	1.09	0.7620	0.52	0.004111	52.9	12.87	6.44
40	2.04	1.0160	0.69	0.004118	100.8	24.48	12.24
50	3.06	1.2700	0.87	0.004126	152.2	36.89	18.45
60	3.87	1.5240	1.04	0.004133	193.0	46.71	23.35
70	4.56	1.7780	1.21	0.004140	227.8	55.03	27.51
80	5.12	2.0320	1.39	0.004147	256.0	61.74	30.87
90	5.53	2.2860	1.56	0.004155	276.7	66.60	33.30
100	5.80	2.5400	1.74	0.004162	290.3	69.75	34.88
110	5.99	2.7940	1.91	0.004169	299.9	71.93	35.96
120	6.12	3.0480	2.08	0.004177	306.5	73.37	36.68
130	6.12	3.3020	2.26	0.004184	306.5	73.24	36.62
140	5.94	3.5560	2.43	0.004192	297.4	70.94	35.47
150	5.52	3.8100	2.60	0.004199	276.2	65.78	32.89
160	5.20	4.0640	2.78	0.004207	260.1	61.83	30.91
170	4.81	4.3180	2.95	0.004214	240.4	57.05	28.53

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Shelby Tube Visual

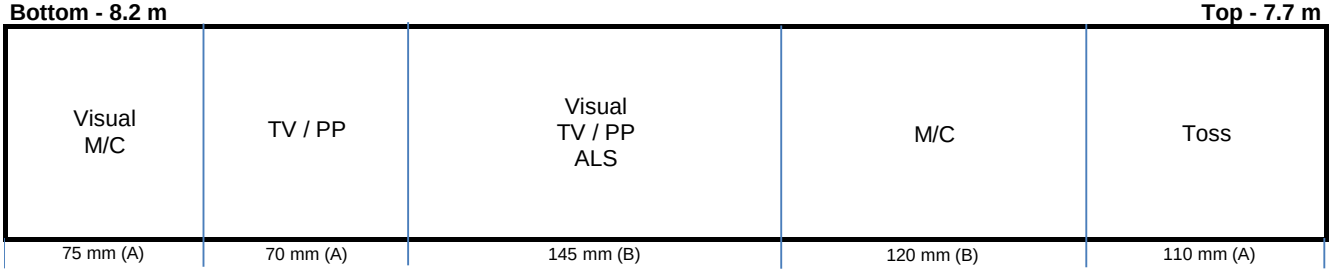
Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Development
Test Hole	TH22-06
Sample #	T83
Depth (m)	7.6 - 8.2
Sample Date	29-Jun-22
Test Date	17-Jul-22
Technician	JD

Tube Extraction

Recovery (mm) 520

8.125 m A 8.055 m 7.91 m B 7.79 m A

Bottom - 8.2 m **Top - 7.7 m**



Visual Classification

	A	B
Material	CLAY	SILT
Composition	silty	trace oxidation
	trace to some silt	trace organics
Color	greyish brown	brown
Moisture	moist	moist
Consistency	soft to firm	very soft
Plasticity	high plasticity	high plasticity
Structure	Stratified	-
Gradation	-	-

Torvane

	A	B	
Reading	0.15	0.11	
Vane Size (s,m,l)	m	m	
Undrained Shear Strength	14.7	10.8	(kPa)

Pocket Penetrometer

		A	B	
Reading	**1**	0.60	0.20	
	2	0.70	0.20	
	3	0.60	0.20	
	Average	0.633	0.200	
Undrained Shear Strength		31.1	9.8	(kPa)

Moisture Content

	A	B
Tare ID	K12	D42
Mass tare (g)	8.6	8.7
Mass wet + tare (g)	250.4	304.5
Mass dry + tare (g)	177.1	238.3
Moisture %	43.5%	28.8%

Unit Weight

Bulk Weight (g)		-	-
Length (mm)	**1**	-	-
	2	-	-
	3	-	-
	4	-	-
Average Length (m)		-	-
Diam. (mm)	**1**	-	-
	2	-	-
	3	-	-
	4	-	-
Average Diameter (m)		-	-
Volume (m^3)		-	-
Bulk Unit Weight (kN/m^3)		-	-
Bulk Unit Weight (pcf)		-	-
Dry Unit Weight (kN/m^3)		-	-
Dry Unit Weight (pcf)		-	-

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Shelby Tube Visual

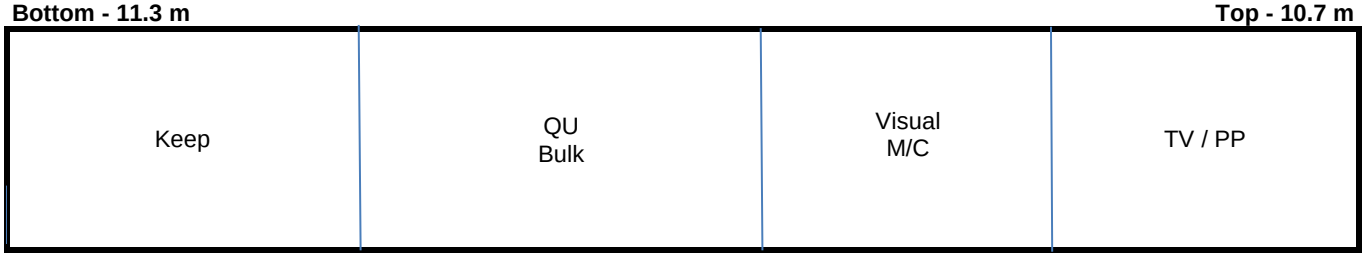
Project No.	0829-001-00
Client	RM Of Stanley
Project	Reinfeld Development
Test Hole	TH22-06
Sample #	T85
Depth (m)	10.7 - 11.3
Sample Date	29-Jun-22
Test Date	18-Jul-22
Technician	JD

Tube Extraction

Recovery (mm) 570

11.14 m 10.98 m 10.86 m

Bottom - 11.3 m **Top - 10.7 m**



Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<15 mm diam.)	
trace precipitates (<5 mm diam.)	
Color	greyish brown
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.54
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	53.0

Pocket Penetrometer

Reading	**1**	1.40
	2	1.30
	3	1.40
	Average	1.37
Undrained Shear Strength (kPa)		67.0

Moisture Content

Tare ID	W81
Mass tare (g)	8.5
Mass wet + tare (g)	276.3
Mass dry + tare (g)	196.6
Moisture %	42.4%

Unit Weight

Bulk Weight (g)		1084.4
Length (mm)	**1**	144.06
	2	144.22
	3	144.33
	4	144.48
Average Length (m)		0.144
Diam. (mm)	**1**	73.62
	2	72.67
	3	74.01
	4	72.60
Average Diameter (m)		0.073
Volume (m^3)		6.08E-04
Bulk Unit Weight (kN/m^3)		17.5
Bulk Unit Weight (pcf)		111.4
Dry Unit Weight (kN/m^3)		12.3
Dry Unit Weight (pcf)		78.3

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM Of Stanley
Project	Reinfeld Development
Test Hole	TH22-06
Sample #	T85
Depth (m)	10.7 - 11.3
Sample Date	29-Jun-22
Test Date	18-Jul-22
Technician	JD

Unconfined Strength

	kPa	ksf
Max q_u	94.8	2.0
Max S_u	47.4	1.0

Specimen Data

Description CLAY - silty, trace silt inclusions (<15 mm diam.), trace precipitates (<5 mm diam.), greyish brown, moist, stiff, high plasticity

Length	144.3	(mm)	**Moisture %**	42%	
Diameter	73.2	(mm)	**Bulk Unit Wt.**	17.5	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	12.3	(kN/m^3)
Initial Area	0.00421	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.54	53.0	1.11

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	1.40	68.7	1.43
	1.30	63.8	1.33
	1.40	68.7	1.43
Average	**1.37**	**67.0**	**1.40**

Failure Geometry

Sketch:

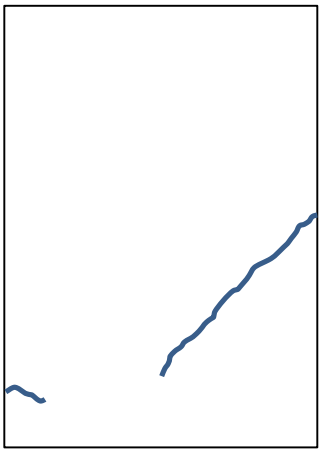

Photo:

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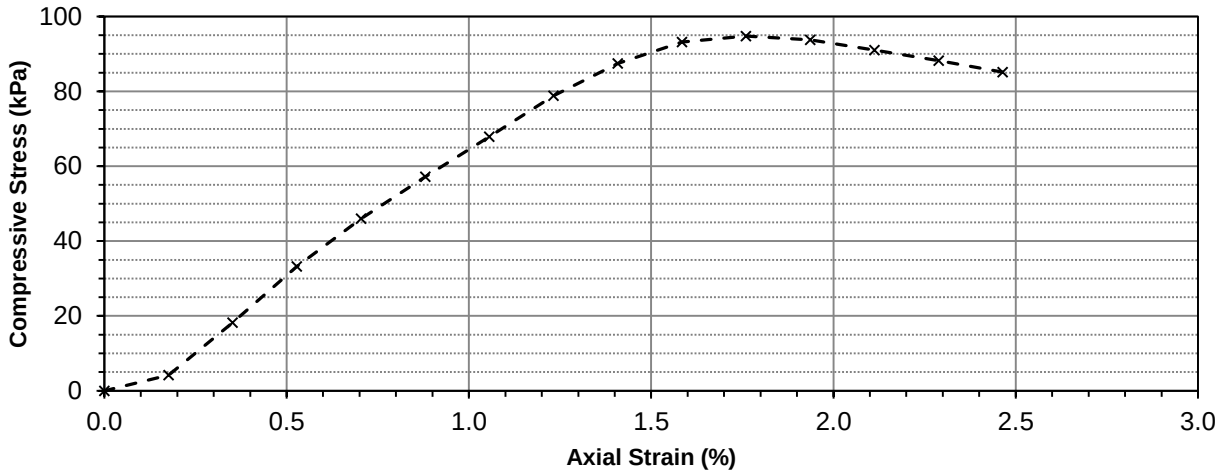
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM Of Stanley
Project Reinfeld Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.04	0.0000	0.00	0.004211	0.0	0.00	0.00
10	0.39	0.2540	0.18	0.004219	17.6	4.18	2.09
20	1.57	0.5080	0.35	0.004226	77.1	18.25	9.12
30	2.83	0.7620	0.53	0.004234	140.6	33.22	16.61
40	3.91	1.0160	0.70	0.004241	195.1	45.99	23.00
50	4.86	1.2700	0.88	0.004249	242.9	57.18	28.59
60	5.77	1.5240	1.06	0.004256	288.8	67.86	33.93
70	6.71	1.7780	1.23	0.004264	336.2	78.85	39.42
80	7.45	2.0320	1.41	0.004271	373.5	87.44	43.72
90	7.95	2.2860	1.58	0.004279	398.7	93.17	46.59
100	8.10	2.5400	1.76	0.004287	406.2	94.77	47.38
110	8.03	2.7940	1.94	0.004294	402.7	93.78	46.89
120	7.81	3.0480	2.11	0.004302	391.6	91.03	45.52
130	7.58	3.3020	2.29	0.004310	380.0	88.18	44.09
140	7.33	3.5560	2.46	0.004318	367.4	85.10	42.55

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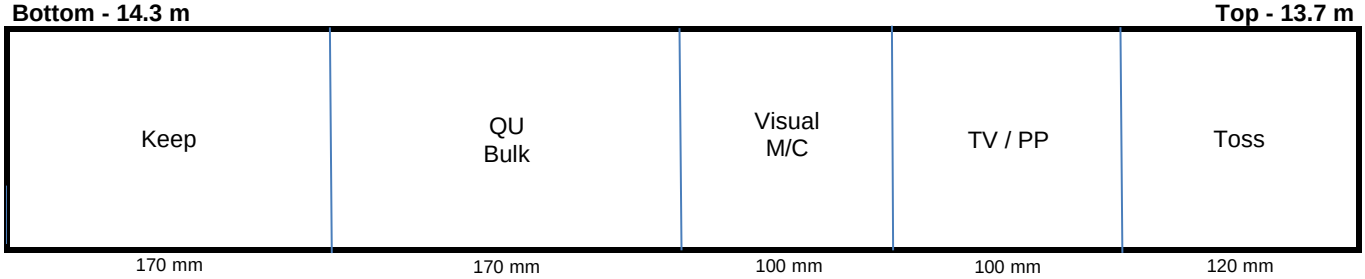
Shelby Tube Visual

Project No.	0829-001-00
Client	RM Of Stanley
Project	Reinfeld Development
Test Hole	TH22-06
Sample #	T87
Depth (m)	13.7 - 14.3
Sample Date	29-Jun-22
Test Date	18-Jul-22
Technician	JD

Tube Extraction

Recovery (mm)	660				
	14.13 m	13.96 m	13.86 m	13.76 m	
Bottom - 14.3 m					**Top - 13.7 m**



Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<10 mm diam.)	
trace oxidation	
trace sand	
Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.37
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	36.3

Pocket Penetrometer

Reading	**1**	0.80
	2	0.70
	3	0.70
	Average	0.73
Undrained Shear Strength (kPa)		36.0

Moisture Content

Tare ID	Z75
Mass tare (g)	8.6
Mass wet + tare (g)	280.4
Mass dry + tare (g)	183.0
Moisture %	55.8%

Unit Weight

Bulk Weight (g)		1025.8
Length (mm)	**1**	146.61
	2	146.50
	3	146.18
	4	146.77
Average Length (m)		0.147
Diam. (mm)	**1**	73.06
	2	72.72
	3	72.56
	4	73.11
Average Diameter (m)		0.073
Volume (m^3)		6.11E-04
Bulk Unit Weight (kN/m^3)		16.5
Bulk Unit Weight (pcf)		104.8
Dry Unit Weight (kN/m^3)		10.6
Dry Unit Weight (pcf)		67.3

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM Of Stanley
Project	Reinfeld Development
Test Hole	TH22-06
Sample #	T87
Depth (m)	13.7 - 14.3
Sample Date	29-Jun-22
Test Date	18-Jul-22
Technician	JD

Unconfined Strength

	kPa	ksf
Max q_u	101.7	2.1
Max S_u	50.8	1.1

Specimen Data

Description CLAY - silty, trace silt inclusions (<10 mm diam.), trace oxidation, trace sand, grey, moist, firm, high plasticity

Length	146.5	(mm)	**Moisture %**	56%	
Diameter	72.9	(mm)	**Bulk Unit Wt.**	16.5	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	10.6	(kN/m^3)
Initial Area	0.00417	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.37	36.3	0.76

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	0.80	39.2	0.82
	0.70	34.3	0.72
	0.70	34.3	0.72
Average	**0.73**	**36.0**	**0.75**

Failure Geometry

Sketch:

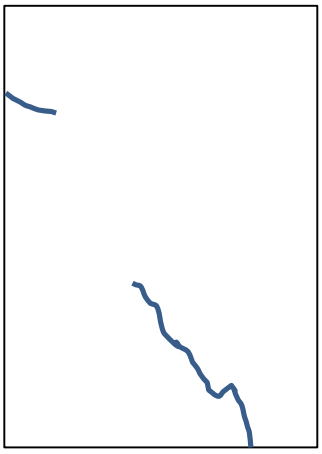

Photo:

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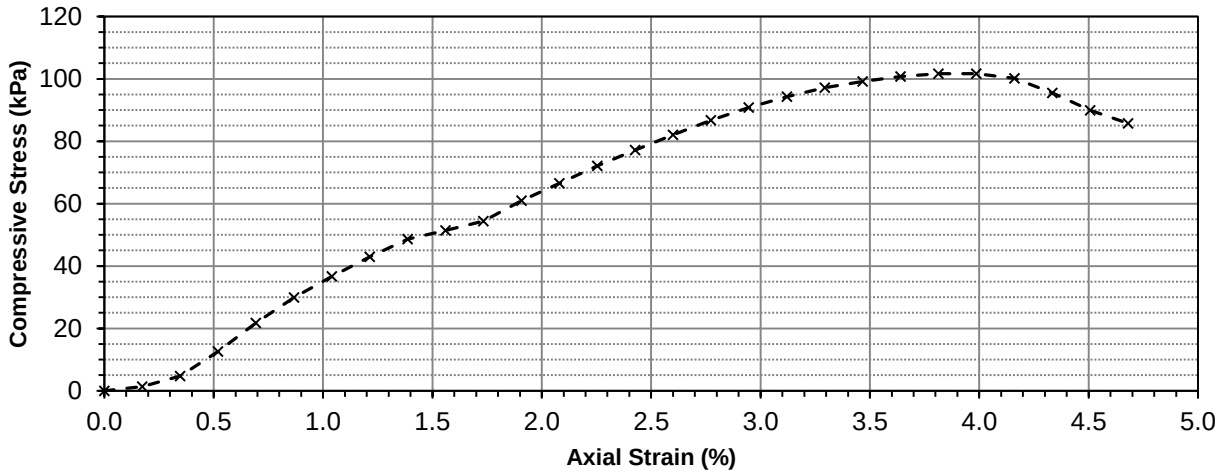
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM Of Stanley
Project Reinfeld Development

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.04	0.0000	0.00	0.004170	0.0	0.00	0.00
10	0.15	0.2540	0.17	0.004177	5.5	1.33	0.66
20	0.43	0.5080	0.35	0.004184	19.7	4.70	2.35
30	1.09	0.7620	0.52	0.004191	52.9	12.63	6.31
40	1.85	1.0160	0.69	0.004199	91.2	21.73	10.86
50	2.54	1.2700	0.87	0.004206	126.0	29.96	14.98
60	3.11	1.5240	1.04	0.004213	154.7	36.72	18.36
70	3.64	1.7780	1.21	0.004221	181.5	42.99	21.49
80	4.12	2.0320	1.39	0.004228	205.6	48.64	24.32
90	4.36	2.2860	1.56	0.004236	217.7	51.41	25.70
100	4.62	2.5400	1.73	0.004243	230.8	54.40	27.20
110	5.18	2.7940	1.91	0.004251	259.1	60.95	30.47
120	5.66	3.0480	2.08	0.004258	283.3	66.52	33.26
130	6.14	3.3020	2.25	0.004266	307.5	72.08	36.04
140	6.58	3.5560	2.43	0.004273	329.6	77.14	38.57
150	7.01	3.8100	2.60	0.004281	351.3	82.06	41.03
160	7.42	4.0640	2.77	0.004289	372.0	86.74	43.37
170	7.78	4.3180	2.95	0.004296	390.1	90.80	45.40
180	8.09	4.5720	3.12	0.004304	405.7	94.27	47.14
190	8.35	4.8260	3.29	0.004312	418.8	97.14	48.57
200	8.54	5.0800	3.47	0.004319	428.4	99.19	49.59
210	8.69	5.3340	3.64	0.004327	436.0	100.76	50.38
220	8.78	5.5880	3.81	0.004335	440.5	101.62	50.81
230	8.80	5.8420	3.99	0.004343	441.5	101.67	50.83

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Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM Of Stanley
Project Reinfeld Development

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	8.69	6.0960	4.16	0.004351	436.0	100.21	50.11
250	8.30	6.3500	4.33	0.004359	416.3	95.52	47.76
260	7.83	6.6040	4.51	0.004366	392.6	89.92	44.96
270	7.48	6.8580	4.68	0.004374	375.0	85.73	42.86

MEMORANDUM

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

Date	January 5, 2023
To	Reinhardt Van Rensburg, TREK Geotechnical
From	Angela Fidler-Kliewer, TREK Geotechnical
Project No.	0829-001-00
Project	Reinfeld Development
Subject	Laboratory Testing Results – Lab Req. R22-681
Distribution	Kent Bannister

Attached are the laboratory testing results for the above noted project. The testing includes moisture content determination, Atterberg Limits, particle size distribution (hydrometer method) and unconfined compression and related testing using Shelby tubes.

Two samples (TH22-13 (G131) and TH22-18 (G174)) were sent to ALS for sulphates and will be reported upon completion.

Regards,

Angela Fidler-Kliewer, C.Tech.

Review Control:

Prepared By: JC	*Reviewed By:* *AFK*	*Checked By:* NJF

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Moisture Content Report
ASTM D2216-10

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Sample Date 12-Dec-22
Test Date 22-Dec-22
Technician LB

Test Hole	TH22-07	TH22-07	TH22-07	TH22-07	TH22-07	TH22-07
Depth (m)	0.2 - 0.3	0.6 - 0.8	1.2 - 1.4	2.6 - 2.7	3.7 - 3.8	4.4 - 4.6
Sample #	G89	G90	G91	G92	G93	G94
Tare ID	N25	F77	P23	AB50	W53	Z96
Mass of tare	8.7	8.5	8.4	6.8	8.4	8.5
Mass wet + tare	218.0	308.8	217.9	223.5	219.7	208.6
Mass dry + tare	167.3	243.8	175.1	172.7	176.5	150.1
Mass water	50.7	65.0	42.8	50.8	43.2	58.5
Mass dry soil	158.6	235.3	166.7	165.9	168.1	141.6
Moisture %	32.0%	27.6%	25.7%	30.6%	25.7%	41.3%

Test Hole	TH22-08	TH22-08	TH22-08	TH22-08	TH22-08	TH22-08
Depth (m)	0.2 - 0.3	0.5 - 0.6	1.2 - 1.4	2.7 - 2.9	4.3 - 4.4	7.5 - 7.6
Sample #	G95	G96	G97	G98	G99	G101
Tare ID	H17	D17	W05	D19	F66	AC15
Mass of tare	8.6	8.5	8.4	8.4	8.6	6.9
Mass wet + tare	210.1	220.4	214.1	219.8	213.2	307.2
Mass dry + tare	170.3	181.7	168.8	169.9	153.6	213.5
Mass water	39.8	38.7	45.3	49.9	59.6	93.7
Mass dry soil	161.7	173.2	160.4	161.5	145.0	206.6
Moisture %	24.6%	22.3%	28.2%	30.9%	41.1%	45.4%

Test Hole	TH22-08	TH22-08	TH22-08	TH22-08	TH22-08	TH22-09
Depth (m)	9.0 - 9.1	10.5 - 10.7	12.0 - 12.2	13.6 - 13.7	15.1 - 15.2	0.2 - 0.3
Sample #	G102	G103	G104	G105	G106	G107
Tare ID	N39	W59	K22	F88	P25	Z115
Mass of tare	8.4	8.6	8.5	8.7	8.4	8.3
Mass wet + tare	213.6	216.9	209.5	215.5	217.0	216.4
Mass dry + tare	142.8	148.3	141.8	143.3	139.7	172.9
Mass water	70.8	68.6	67.7	72.2	77.3	43.5
Mass dry soil	134.4	139.7	133.3	134.6	131.3	164.6
Moisture %	52.7%	49.1%	50.8%	53.6%	58.9%	26.4%

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Moisture Content Report
ASTM D2216-10

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Sample Date 12-Dec-22
Test Date 22-Dec-22
Technician LB

Test Hole	TH22-09	TH22-09	TH22-09	TH22-09	TH22-10	TH22-10
Depth (m)	0.8 - 0.9	1.2 - 1.4	2.7 - 2.9	4.3 - 4.4	0.0 - 0.2	0.6 - 0.8
Sample #	G108	G109	G110	G111	G112	G113
Tare ID	AB60	E55	D3	K4	D27	Z116
Mass of tare	6.7	8.6	8.3	8.4	8.4	8.4
Mass wet + tare	212.2	216.3	215.3	227.7	220.1	221.9
Mass dry + tare	172.3	166.8	161.9	167.2	169.1	178.2
Mass water	39.9	49.5	53.4	60.5	51.0	43.7
Mass dry soil	165.6	158.2	153.6	158.8	160.7	169.8
Moisture %	24.1%	31.3%	34.8%	38.1%	31.7%	25.7%

Test Hole	TH22-10	TH22-10	TH22-10	TH22-11	TH22-11	TH22-11
Depth (m)	1.2 - 1.4	2.7 - 2.9	4.3 - 4.4	0.3 - 0.5	0.8 - 0.9	1.4 - 1.5
Sample #	G114	G115	G116	G117	G118	G119
Tare ID	D11	D13	F148	A8	F131	H35
Mass of tare	8.7	8.4	8.4	8.4	8.4	8.3
Mass wet + tare	213.9	220.0	215.1	217.2	214.7	214.0
Mass dry + tare	170.0	171.0	152.1	170.0	174.2	169.5
Mass water	43.9	49.0	63.0	47.2	40.5	44.5
Mass dry soil	161.3	162.6	143.7	161.6	165.8	161.2
Moisture %	27.2%	30.1%	43.8%	29.2%	24.4%	27.6%

Test Hole	TH22-11	TH22-12	TH22-12	TH22-12	TH22-12	TH22-12
Depth (m)	2.7 - 2.9	0.2 - 0.3	0.6 - 0.8	1.2 - 1.4	2.7 - 2.9	4.1 - 4.3
Sample #	G120	G121	G122	G123	G124	G125
Tare ID	F61	P36	F114	W65	D20	E85
Mass of tare	8.4	8.5	8.3	8.4	8.5	8.6
Mass wet + tare	228.9	220.7	215.3	214.1	212.1	213.2
Mass dry + tare	166.4	171.3	170.1	174.5	164.7	157.1
Mass water	62.5	49.4	45.2	39.6	47.4	56.1
Mass dry soil	158.0	162.8	161.8	166.1	156.2	148.5
Moisture %	39.6%	30.3%	27.9%	23.8%	30.3%	37.8%

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ASTM D2216-10

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Sample Date 12-Dec-22
Test Date 22-Dec-22
Technician LB

Test Hole	TH22-13	TH22-13	TH22-13	TH22-13	TH22-13	TH22-13
Depth (m)	0.3 - 0.5	1.2 - 1.4	1.7 - 1.8	2.7 - 2.9	4.3 - 4.4	5.8 - 5.9
Sample #	G126	G127	G128	G129	G130	G131
Tare ID	Z01	F124	AC37	W102	N01	E87
Mass of tare	8.5	8.5	6.7	8.5	8.5	8.6
Mass wet + tare	218.3	218.5	216.6	234.5	219.7	259.1
Mass dry + tare	171.7	178.3	175.7	176.0	154.7	184.8
Mass water	46.6	40.2	40.9	58.5	65.0	74.3
Mass dry soil	163.2	169.8	169.0	167.5	146.2	176.2
Moisture %	28.6%	23.7%	24.2%	34.9%	44.5%	42.2%

Test Hole	TH22-13	TH22-13	TH22-13	TH22-13	TH22-13	TH22-13
Depth (m)	7.3 - 7.5	8.8 - 9.0	10.4 - 10.5	11.9 - 12.0	13.4 - 13.6	14.9 - 15.1
Sample #	G132	G133	G134	G135	G136	G137
Tare ID	Z40	K11	N35	E22	F23	AC38
Mass of tare	8.4	8.7	8.4	8.6	8.4	6.8
Mass wet + tare	211.2	218.7	210.1	225.9	220.6	227.8
Mass dry + tare	147.1	149.0	140.2	153.6	151.8	153.0
Mass water	64.1	69.7	69.9	72.3	68.8	74.8
Mass dry soil	138.7	140.3	131.8	145.0	143.4	146.2
Moisture %	46.2%	49.7%	53.0%	49.9%	48.0%	51.2%

Test Hole	TH22-14	TH22-14	TH22-14	TH22-14	TH22-14	TH22-14
Depth (m)	0.0 - 0.2	0.3 - 0.5	1.1 - 1.2	1.8 - 2.0	2.7 - 2.9	4.3 - 4.4
Sample #	G138	G139	G140	G141	G142	G143
Tare ID	D31	P28	Z47	F110	AC16	Z37
Mass of tare	8.3	8.6	8.6	8.2	6.7	8.3
Mass wet + tare	214.3	217.5	230.4	222.6	227.9	210.8
Mass dry + tare	176.9	152.9	187.7	163.7	164.7	153.7
Mass water	37.4	64.6	42.7	58.9	63.2	57.1
Mass dry soil	168.6	144.3	179.1	155.5	158.0	145.4
Moisture %	22.2%	44.8%	23.8%	37.9%	40.0%	39.3%

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ASTM D2216-10

Project No. 0829-001-00
Client RM of Stanley
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Sample Date 12-Dec-22
Test Date 22-Dec-22
Technician LB

Test Hole	TH22-14	TH22-14	TH22-14	TH22-15	TH22-15	TH22-15
Depth (m)	7.6 - 8.1	10.7 - 11.1	13.7 - 14.2	0.5 - 0.6	1.2 - 1.4	2.3 - 2.4
Sample #	S145	S147	S149	G151	G152	G153
Tare ID	AB75	D30	D10	Z123	C30	W74
Mass of tare	6.9	8.4	8.4	8.4	8.3	6.5
Mass wet + tare	218.0	210.3	222.2	213.6	230.7	221.3
Mass dry + tare	153.1	142.2	145.2	169.4	186.8	178.4
Mass water	64.9	68.1	77.0	44.2	43.9	42.9
Mass dry soil	146.2	133.8	136.8	161.0	178.5	171.9
Moisture %	44.4%	50.9%	56.3%	27.5%	24.6%	25.0%

Test Hole	TH22-15	TH22-15	TH22-15	TH22-15	TH22-15	TH22-15
Depth (m)	2.7 - 2.9	4.3 - 4.4	5.8 - 5.9	7.3 - 7.5	8.8 - 9.0	10.4 - 10.5
Sample #	G154	G155	G156	G157	G158	G159
Tare ID	W91	F128	D12	F58	W48	P34
Mass of tare	8.5	8.5	8.4	8.6	8.3	8.6
Mass wet + tare	225.9	223.8	223.2	218.1	216.8	222.9
Mass dry + tare	164.7	162.6	160.9	149.5	145.1	151.2
Mass water	61.2	61.2	62.3	68.6	71.7	71.7
Mass dry soil	156.2	154.1	152.5	140.9	136.8	142.6
Moisture %	39.2%	39.7%	40.9%	48.7%	52.4%	50.3%

Test Hole	TH22-15	TH22-15	TH22-15	TH22-16	TH22-16	TH22-16
Depth (m)	11.9 - 12.0	13.4 - 13.6	14.9 - 15.1	0.5 - 0.6	1.2 - 1.4	1.8 - 2.0
Sample #	G160	G161	G162	G163	G164	G165
Tare ID	AA22	Z121	Z44	A28	K34	A20
Mass of tare	6.8	8.7	8.5	8.2	8.4	8.7
Mass wet + tare	211.8	220.2	215.9	219.2	211.8	232.0
Mass dry + tare	137.8	153.3	146.9	179.3	173.1	171.7
Mass water	74.0	66.9	69.0	39.9	38.7	60.3
Mass dry soil	131.0	144.6	138.4	171.1	164.7	163.0
Moisture %	56.5%	46.3%	49.9%	23.3%	23.5%	37.0%

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Moisture Content Report
ASTM D2216-10

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Sample Date 12-Dec-22
Test Date 22-Dec-22
Technician LB

Test Hole	TH22-17	TH22-17	TH22-17	TH22-18	TH22-18	TH22-18
Depth (m)	0.3 - 0.5	1.2 - 1.4	1.8 - 2.0	0.3 - 0.5	1.1 - 1.2	2.3 - 2.4
Sample #	G167	G168	G169	G171	G172	G173
Tare ID	Z25	AB87	E115	N98	Z05	Z74
Mass of tare	8.3	6.7	8.7	8.5	8.3	8.4
Mass wet + tare	220.0	214.0	221.5	211.6	219.6	225.0
Mass dry + tare	180.7	181.1	167.6	171.3	177.1	173.7
Mass water	39.3	32.9	53.9	40.3	42.5	51.3
Mass dry soil	172.4	174.4	158.9	162.8	168.8	165.3
Moisture %	22.8%	18.9%	33.9%	24.8%	25.2%	31.0%

Test Hole	TH22-18	TH22-19	TH22-19	TH22-19	TH22-19	TH22-19
Depth (m)	2.9 - 3.0	0.2 - 0.3	0.9 - 1.2	2.7 - 2.9	4.3 - 4.4	5.8 - 5.9
Sample #	G174	G175	G176	G177	G178	G179
Tare ID	Z85	Z51	H31	F131	F135	Q01
Mass of tare	8.4	8.5	8.5	8.5	8.5	8.4
Mass wet + tare	258.7	217.7	218.1	218.5	213.3	217.6
Mass dry + tare	182.4	170.6	180.5	173.2	149.3	151.1
Mass water	76.3	47.1	37.6	45.3	64.0	66.5
Mass dry soil	174.0	162.1	172.0	164.7	140.8	142.7
Moisture %	43.9%	29.1%	21.9%	27.5%	45.5%	46.6%

Test Hole	TH22-19	TH22-19	TH22-19	TH22-19	TH22-19	TH22-19
Depth (m)	7.3 - 7.5	8.8 - 9.0	10.4 - 10.5	11.9 - 12.0	13.4 - 13.6	14.9 - 15.1
Sample #	G180	G181	G182	G183	G184	G185
Tare ID	C3	F24	N54	E62	N43	N71
Mass of tare	8.5	8.6	8.6	8.4	8.5	8.6
Mass wet + tare	214.7	211.0	213.7	210.5	209.5	211.6
Mass dry + tare	148.2	145.1	146.1	136.5	140.2	139.4
Mass water	66.5	65.9	67.6	74.0	69.3	72.2
Mass dry soil	139.7	136.5	137.5	128.1	131.7	130.8
Moisture %	47.6%	48.3%	49.2%	57.8%	52.6%	55.2%

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Moisture Content Report
ASTM D2216-10

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Sample Date 12-Dec-22
Test Date 22-Dec-22
Technician LB

Test Hole	TH22-20	TH22-20	TH22-20	TH22-20	TH22-20	TH22-20
Depth (m)	0.3 - 0.5	1.2 - 1.4	2.1 - 2.3	4.4 - 4.6	5.8 - 5.9	7.5 - 7.6
Sample #	G186	G187	G188	G190	G191	G193
Tare ID	D28	AB98	N07	D22	Z78	F98
Mass of tare	8.5	6.7	8.6	8.7	8.4	8.6
Mass wet + tare	220.0	210.6	217.3	216	217.2	214.4
Mass dry + tare	187.5	158.9	160.7	152.9	154.1	141.2
Mass water	32.5	51.7	56.6	63.1	63.1	73.2
Mass dry soil	179.0	152.2	152.1	144.2	145.7	132.6
Moisture %	18.2%	34.0%	37.2%	43.8%	43.3%	55.2%

Test Hole	TH22-20	TH22-20	TH22-20	TH22-20	TH22-21	TH22-21
Depth (m)	10.4 - 10.5	11.9 - 12.0	13.4 - 13.6	14.9 - 15.1	0.0 - 0.2	0.3 - 0.5
Sample #	G195	G196	G197	G198	G199	G200
Tare ID	Z80	AC09	F57	D39	F76	W28
Mass of tare	8.5	6.8	8.5	8.3	8.7	8.6
Mass wet + tare	222.5	219.6	212.4	211.2	208.9	209.6
Mass dry + tare	152.3	149.7	136.3	136.4	169.8	156.1
Mass water	70.2	69.9	76.1	74.8	39.1	53.5
Mass dry soil	143.8	142.9	127.8	128.1	161.1	147.5
Moisture %	48.8%	48.9%	59.5%	58.4%	24.3%	36.3%

Test Hole	TH22-21	TH22-21	TH22-22	TH22-22	TH22-22	TH22-23
Depth (m)	1.1 - 1.2	2.6 - 2.7	0.3 - 0.5	0.9 - 1.2	2.1 - 2.4	0.3 - 0.6
Sample #	G201	G202	G203	G204	G205	G206
Tare ID	E120	D24	AC34	W67	E125	N09
Mass of tare	8.4	8.5	6.6	8.4	8.3	8.6
Mass wet + tare	209.0	281.7	212.8	213.1	209.5	209.3
Mass dry + tare	170.5	159.1	169.9	179.6	150.6	171.2
Mass water	38.5	122.6	42.9	33.5	58.9	38.1
Mass dry soil	162.1	150.6	163.3	171.2	142.3	162.6
Moisture %	23.8%	81.4%	26.3%	19.6%	41.4%	23.4%

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ASTM D2216-10

Project No. 0829-001-00
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Sample Date 12-Dec-22
Test Date 22-Dec-22
Technician LB

Test Hole	TH22-23	TH22-23	TH22-23	TH22-24	TH22-24	TH22-24
Depth (m)	1.1 - 1.4	2.3 - 2.4	2.7 - 2.9	0.3 - 0.6	1.1 - 1.4	2.0 - 2.1
Sample #	G207	G208	G209	G210	G211	G212
Tare ID	AC28	H65	Z109	Z114	W24	N80
Mass of tare	6.7	8.5	8.5	8.4	8.4	8.5
Mass wet + tare	214.0	214.5	214.0	216.5	309.0	212.3
Mass dry + tare	173.6	171.8	156.3	166.9	258.5	168.8
Mass water	40.4	42.7	57.7	49.6	50.5	43.5
Mass dry soil	166.9	163.3	147.8	158.5	250.1	160.3
Moisture %	24.2%	26.1%	39.0%	31.3%	20.2%	27.1%

Test Hole	TH22-24	TH22-24	TH22-24	TH22-24	TH22-24	TH22-24
Depth (m)	2.7 - 2.9	4.3 - 4.4	5.8 - 5.9	7.3 - 7.5	8.8 - 9.0	10.4 - 10.5
Sample #	G213	G214	G215	G216	G217	G218
Tare ID	AH18	W79	H30	N12	F141	H53
Mass of tare	8.6	8.6	8.6	8.6	8.6	8.5
Mass wet + tare	211.8	359.4	209.5	308.6	210.8	208.6
Mass dry + tare	154.9	261.9	149.0	203.4	139.9	138.3
Mass water	56.9	97.5	60.5	105.2	70.9	70.3
Mass dry soil	146.3	253.3	140.4	194.8	131.3	129.8
Moisture %	38.9%	38.5%	43.1%	54.0%	54.0%	54.2%

Test Hole	TH22-24	TH22-24	TH22-24			
Depth (m)	11.9 - 12.0	13.4 - 13.6	14.9 - 15.1			
Sample #	G219	G220	G221			
Tare ID	D44	N79	H03			
Mass of tare	8.4	8.5	8.5			
Mass wet + tare	215.1	209.5	214			
Mass dry + tare	139.7	137.1	140.6			
Mass water	75.4	72.4	73.4			
Mass dry soil	131.3	128.6	132.1			
Moisture %	57.4%	56.3%	55.6%			

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Atterberg Limits
ASTM D4318-10e1

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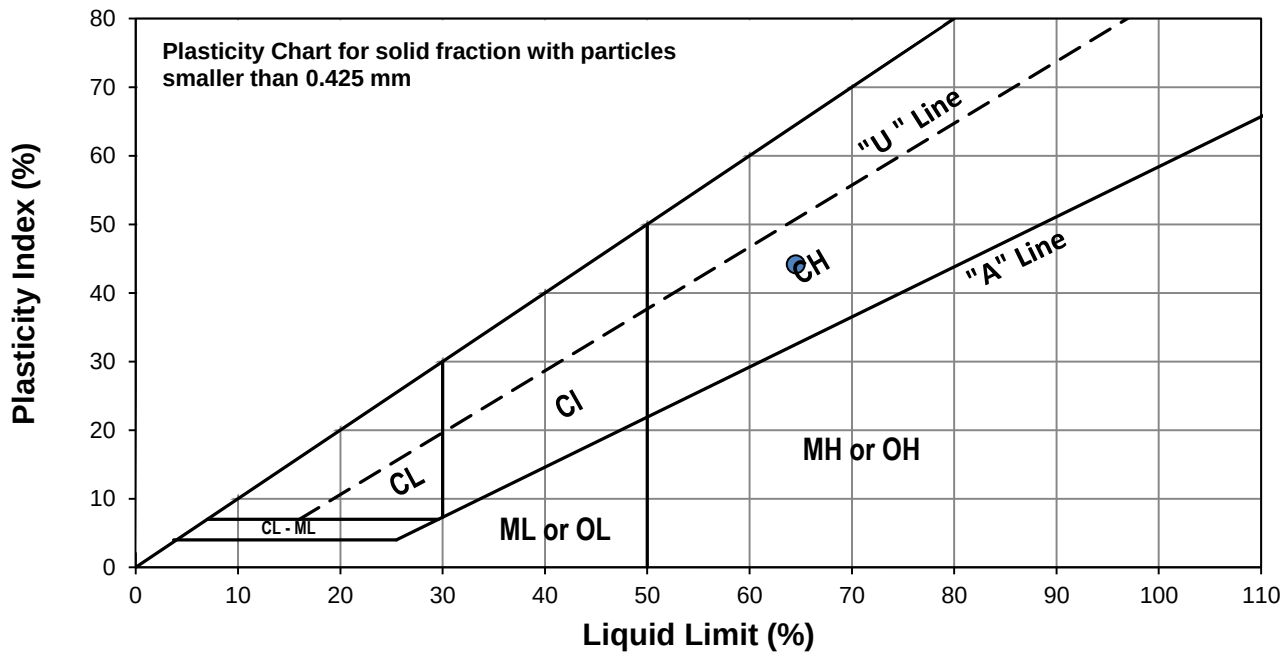
Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-08
Sample #	G101
Depth (m)	7.5 - 7.6
Sample Date	12-Dec-22
Test Date	28-Dec-22
Technician	DS

Liquid Limit	65
Plastic Limit	20
Plasticity Index	44

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	18	20	35		
Mass Tare (g)	13.920	13.977	14.200		
Mass Wet Soil + Tare (g)	23.077	23.075	22.711		
Mass Dry Soil + Tare (g)	19.402	19.457	19.452		
Mass Water (g)	3.675	3.618	3.259		
Mass Dry Soil (g)	5.482	5.480	5.252		
Moisture Content (%)	67.038	66.022	62.053		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.103	14.085			
Mass Wet Soil + Tare (g)	22.957	23.357			
Mass Dry Soil + Tare (g)	21.482	21.765			
Mass Water (g)	1.475	1.592			
Mass Dry Soil (g)	7.379	7.680			
Moisture Content (%)	19.989	20.729			

Note: Additional information recorded/measured for this test is available upon request.

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Atterberg Limits
ASTM D4318-10e1

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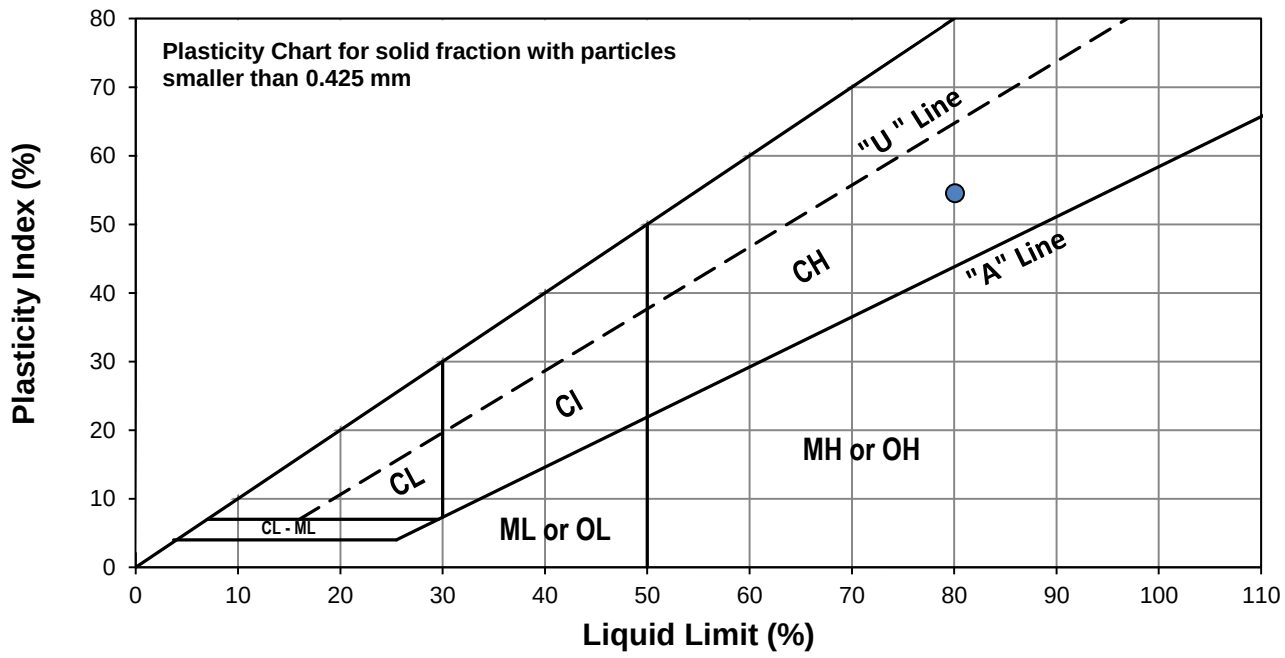
Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-24
Sample #	G214
Depth (m)	4.3 - 4.4
Sample Date	15-Dec-22
Test Date	29-Dec-22
Technician	DS

Liquid Limit	80
Plastic Limit	26
Plasticity Index	55

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	16	27	35		
Mass Tare (g)	13.961	13.994	14.183		
Mass Wet Soil + Tare (g)	22.726	23.603	22.248		
Mass Dry Soil + Tare (g)	18.725	19.350	18.736		
Mass Water (g)	4.001	4.253	3.512		
Mass Dry Soil (g)	4.764	5.356	4.553		
Moisture Content (%)	83.984	79.406	77.136		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.319	14.022			
Mass Wet Soil + Tare (g)	21.931	22.852			
Mass Dry Soil + Tare (g)	20.403	21.028			
Mass Water (g)	1.528	1.824			
Mass Dry Soil (g)	6.084	7.006			
Moisture Content (%)	25.115	26.035			

Note: Additional information recorded/measured for this test is available upon request.

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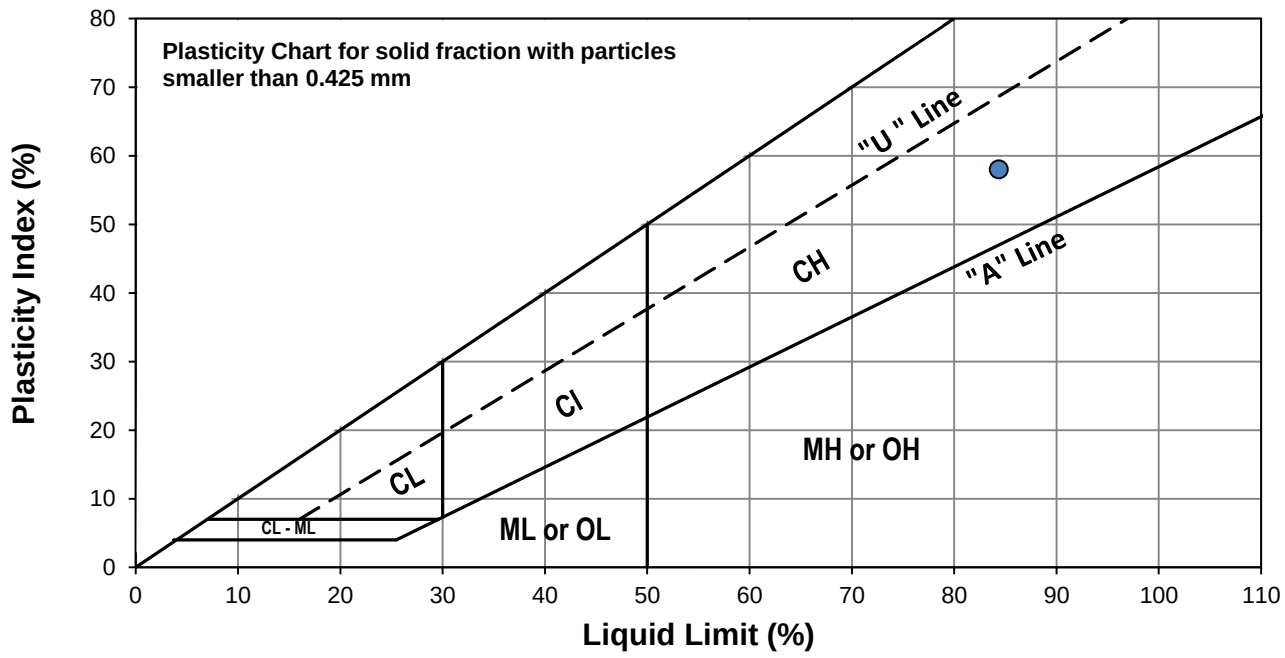
Atterberg Limits
ASTM D4318-10e1

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-24
Sample #	G216
Depth (m)	7.3 - 7.5
Sample Date	15-Dec-22
Test Date	29-Dec-22
Technician	DS

Liquid Limit	84
Plastic Limit	26
Plasticity Index	58

Liquid Limit

Trial #	1	2	3		
Number of Blows (N)	16	21	35		
Mass Tare (g)	14.049	14.285	14.109		
Mass Wet Soil + Tare (g)	22.858	24.454	21.499		
Mass Dry Soil + Tare (g)	18.720	19.755	18.186		
Mass Water (g)	4.138	4.699	3.313		
Mass Dry Soil (g)	4.671	5.470	4.077		
Moisture Content (%)	88.589	85.905	81.261		



Plastic Limit

Trial #	1	2	3	4	5
Mass Tare (g)	14.066	14.109			
Mass Wet Soil + Tare (g)	23.854	22.089			
Mass Dry Soil + Tare (g)	21.810	20.424			
Mass Water (g)	2.044	1.665			
Mass Dry Soil (g)	7.744	6.315			
Moisture Content (%)	26.395	26.366			

Note: Additional information recorded/measured for this test is available upon request.

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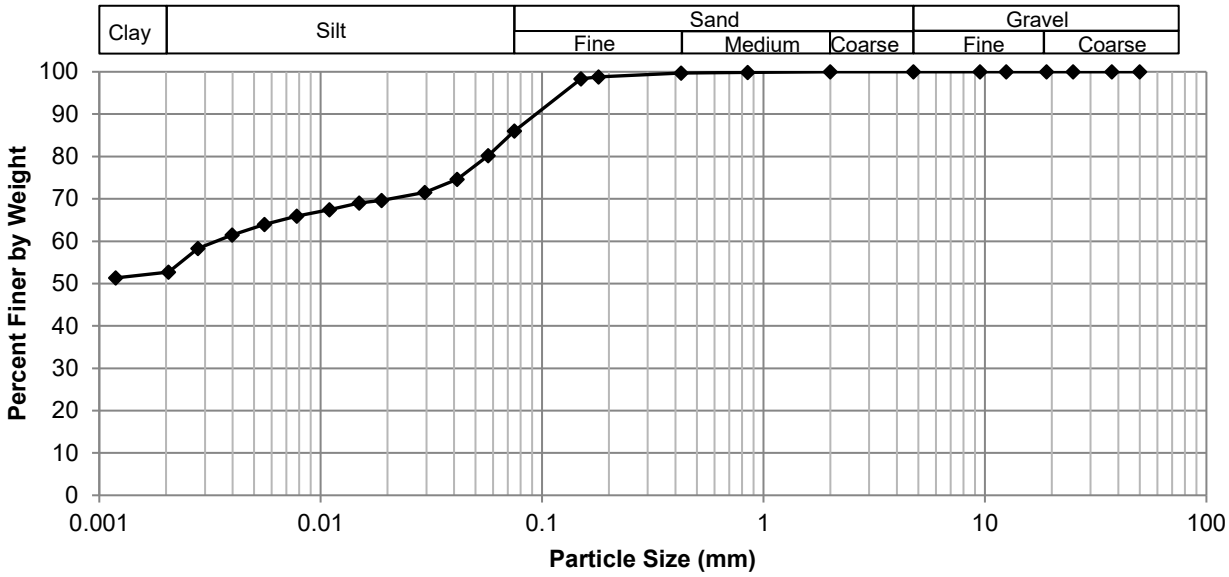
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-07
Sample #	G90
Depth (m)	0.6 - 0.8
Sample Date	12-Dec-22
Test Date	27-Dec-22
Technician	DS

Gravel	0.0%
Sand	14.0%
Silt	33.4%
Clay	52.6%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	86.00
37.5	100.00	2.00	100.00	0.0570	80.24
25.0	100.00	0.850	99.89	0.0413	74.62
19.0	100.00	0.425	99.70	0.0296	71.53
12.5	100.00	0.180	98.83	0.0188	69.66
9.50	100.00	0.150	98.38	0.0149	69.03
4.75	100.00	0.075	86.00	0.0110	67.47
				0.0078	65.90
				0.0056	63.99
				0.0040	61.44
				0.0028	58.32
				0.0021	52.73
				0.0012	51.33

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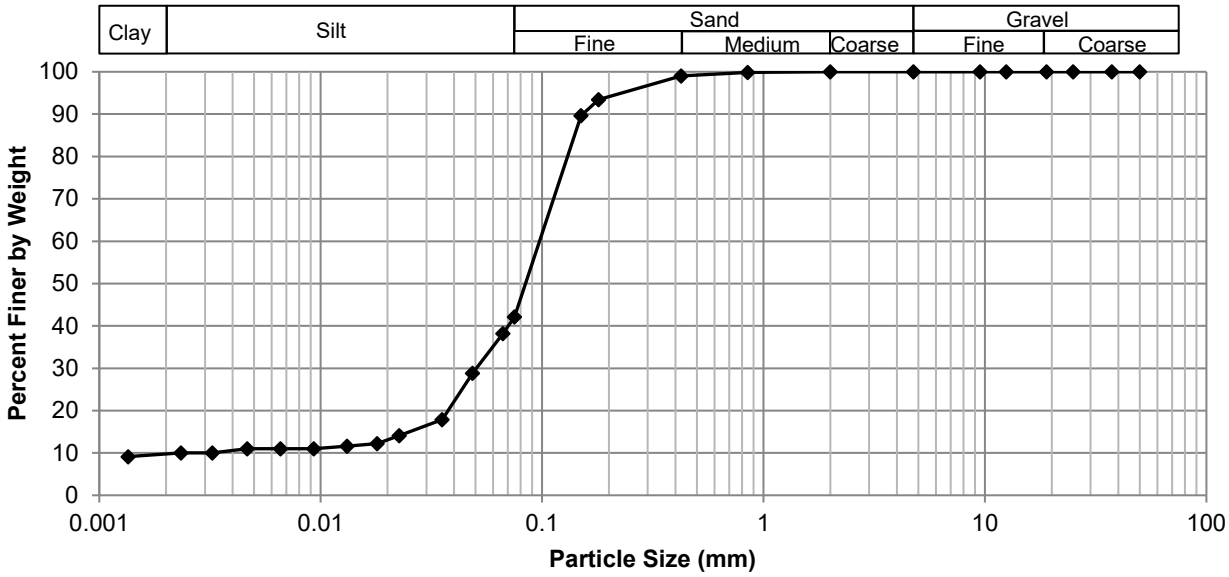
Grain Size Analysis (Hydrometer Method)
AASHTO T 88

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-24
Sample #	G211
Depth (m)	1.1 - 1.4
Sample Date	15-Dec-22
Test Date	28-Dec-22
Technician	DS

Gravel	0.0%
Sand	57.9%
Silt	32.4%
Clay	9.7%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	42.11
37.5	100.00	2.00	99.99	0.0665	38.21
25.0	100.00	0.850	99.86	0.0485	28.83
19.0	100.00	0.425	99.06	0.0354	17.89
12.5	100.00	0.180	93.43	0.0227	14.09
9.50	100.00	0.150	89.65	0.0180	12.21
4.75	100.00	0.075	42.11	0.0132	11.59
				0.0093	10.96
				0.0066	10.96
				0.0047	10.96
				0.0032	9.98
				0.0023	9.98
				0.0014	9.13

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Shelby Tube Visual

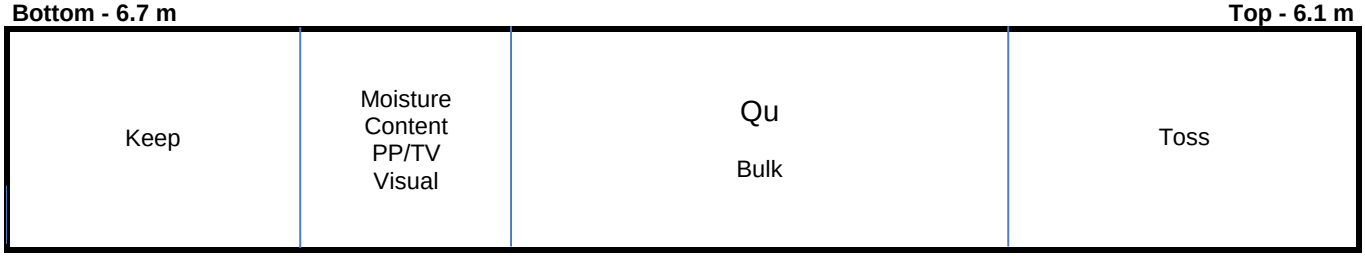
Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-08
Sample #	T100
Depth (m)	6.1 - 6.7
Sample Date	12-Dec-22
Test Date	23-Dec-22
Technician	JC

Tube Extraction

Recovery (mm) 570

6.57 m 6.49 m 6.29 m

Bottom - 6.7 m **Top - 6.1 m**



Visual Classification

Material	CLAY
Composition	silty
trace precipitates (gypsum, <15mm diam)	
trace silt inclusions (<5mm diam)	
trace sand	
Color	mottled (brown & grey)
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.56
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	54.9

Pocket Penetrometer

Reading	**1**	1.30
	2	1.10
	3	1.20
	Average	1.20
Undrained Shear Strength (kPa)		58.8

Moisture Content

Tare ID	W76
Mass tare (g)	8.6
Mass wet + tare (g)	303.4
Mass dry + tare (g)	208.7
Moisture %	47.3%

Unit Weight

Bulk Weight (g)		1108.8
Length (mm)	**1**	151.50
	2	150.97
	3	151.09
	4	150.96
Average Length (m)		0.151
Diam. (mm)	**1**	73.13
	2	72.85
	3	72.16
	4	73.18
Average Diameter (m)		0.073
Volume (m^3)		6.30E-04
Bulk Unit Weight (kN/m^3)		17.3
Bulk Unit Weight (pcf)		109.9
Dry Unit Weight (kN/m^3)		11.7
Dry Unit Weight (pcf)		74.6

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-08
Sample #	T100
Depth (m)	6.1 - 6.7
Sample Date	12-Dec-22
Test Date	23-Dec-22
Technician	JC

Unconfined Strength

	kPa	ksf
Max q_u	76.4	1.6
Max S_u	38.2	0.8

Specimen Data

Description CLAY - silty, trace precipitates (gypsum, <15mm diam), trace silt inclusions (<5mm diam), trace sand, mottled (brown & grey), moist, stiff, high plasticity

Length	151.1	(mm)	**Moisture %**	47%	
Diameter	72.8	(mm)	**Bulk Unit Wt.**	17.3	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	11.7	(kN/m^3)
Initial Area	0.00417	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.56	54.9	1.15

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	1.30	63.8	1.33
	1.10	54.0	1.13
	1.20	58.9	1.23
Average	**1.20**	**58.9**	**1.23**

Failure Geometry

Sketch:

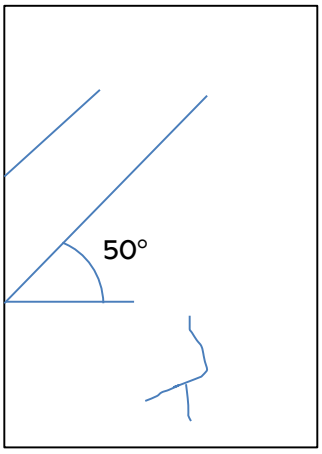

Photo:

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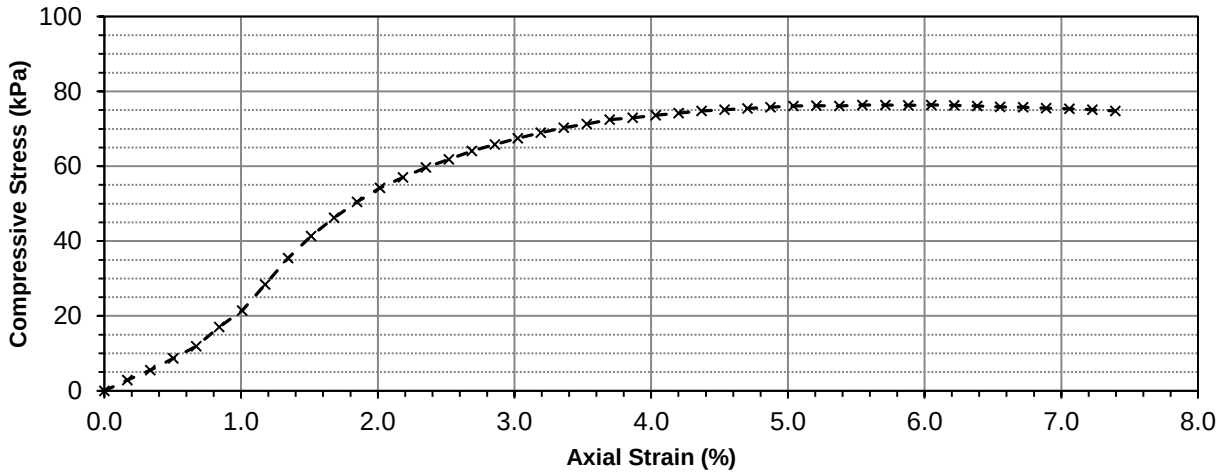
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.37	0.0000	0.00	0.004166	0.0	0.00	0.00
10	0.61	0.2540	0.17	0.004173	12.1	2.90	1.45
20	0.83	0.5080	0.34	0.004180	23.2	5.55	2.77
30	1.09	0.7620	0.50	0.004187	36.3	8.67	4.33
40	1.36	1.0160	0.67	0.004194	49.9	11.90	5.95
50	1.79	1.2700	0.84	0.004201	71.6	17.04	8.52
60	2.16	1.5240	1.01	0.004208	90.2	21.44	10.72
70	2.75	1.7780	1.18	0.004216	120.0	28.46	14.23
80	3.34	2.0320	1.34	0.004223	149.7	35.45	17.73
90	3.84	2.2860	1.51	0.004230	174.9	41.35	20.67
100	4.26	2.5400	1.68	0.004237	196.1	46.27	23.14
110	4.62	2.7940	1.85	0.004244	214.2	50.47	25.23
120	4.94	3.0480	2.02	0.004252	230.3	54.18	27.09
130	5.19	3.3020	2.18	0.004259	242.9	57.04	28.52
140	5.42	3.5560	2.35	0.004266	254.5	59.66	29.83
150	5.61	3.8100	2.52	0.004274	264.1	61.80	30.90
160	5.81	4.0640	2.69	0.004281	274.2	64.05	32.02
170	5.97	4.3180	2.86	0.004288	282.3	65.82	32.91
180	6.12	4.5720	3.03	0.004296	289.8	67.46	33.73
190	6.26	4.8260	3.19	0.004303	296.9	68.99	34.49
200	6.38	5.0800	3.36	0.004311	302.9	70.27	35.14
210	6.48	5.3340	3.53	0.004318	308.0	71.32	35.66
220	6.59	5.5880	3.70	0.004326	313.5	72.47	36.24
230	6.64	5.8420	3.87	0.004333	316.0	72.93	36.46

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Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	6.71	6.0960	4.03	0.004341	319.6	73.61	36.81
250	6.77	6.3500	4.20	0.004349	322.6	74.18	37.09
260	6.83	6.6040	4.37	0.004356	325.6	74.74	37.37
270	6.87	6.8580	4.54	0.004364	327.6	75.07	37.54
280	6.91	7.1120	4.71	0.004372	329.6	75.40	37.70
290	6.95	7.3660	4.87	0.004379	331.7	75.73	37.87
300	6.99	7.6200	5.04	0.004387	333.7	76.06	38.03
310	7.01	7.8740	5.21	0.004395	334.7	76.15	38.08
320	7.02	8.1280	5.38	0.004403	335.2	76.13	38.07
330	7.05	8.3820	5.55	0.004411	336.7	76.34	38.17
340	7.06	8.6360	5.71	0.004418	337.2	76.32	38.16
350	7.07	8.8900	5.88	0.004426	337.7	76.29	38.15
360	7.09	9.1440	6.05	0.004434	338.7	76.39	38.19
370	7.09	9.3980	6.22	0.004442	338.7	76.25	38.12
380	7.09	9.6520	6.39	0.004450	338.7	76.11	38.06
390	7.08	9.9060	6.55	0.004458	338.2	75.86	37.93
400	7.08	10.1600	6.72	0.004466	338.2	75.73	37.86
410	7.07	10.4140	6.89	0.004474	337.7	75.48	37.74
420	7.07	10.6680	7.06	0.004482	337.7	75.34	37.67
430	7.06	10.9220	7.23	0.004490	337.2	75.09	37.55
440	7.04	11.1760	7.39	0.004499	336.3	74.77	37.38

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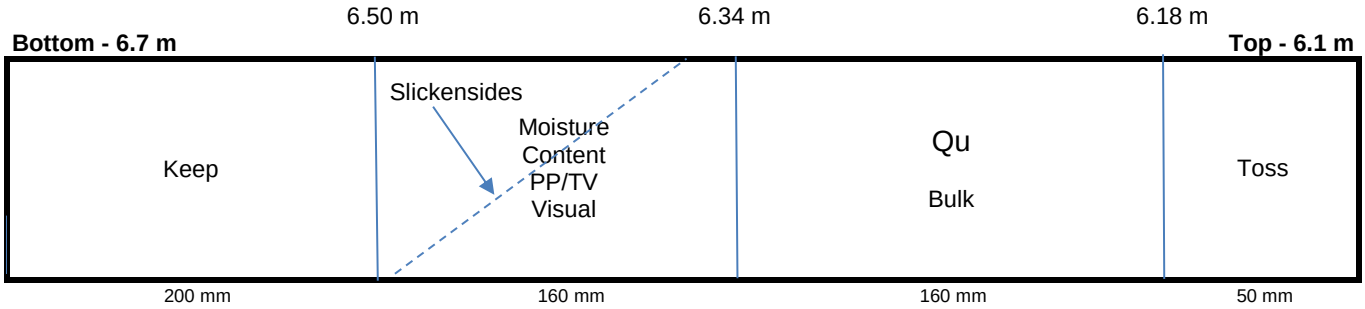
Shelby Tube Visual

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-14
Sample #	T144
Depth (m)	6.1 - 6.7
Sample Date	12-Dec-22
Test Date	23-Dec-22
Technician	JC

Tube Extraction

Recovery (mm) 570



Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<15mm diam)	
Color	dark grey
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	slickensides
Gradation	-

Torvane

Reading	0.65
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	63.8

Pocket Penetrometer

Reading	**1**	1.30
	2	1.30
	3	1.50
	Average	1.37
Undrained Shear Strength (kPa)		67.0

Moisture Content

Tare ID	Z97
Mass tare (g)	8.8
Mass wet + tare (g)	321.8
Mass dry + tare (g)	224.2
Moisture %	45.3%

Unit Weight

Bulk Weight (g)		1079.2
Length (mm)	**1**	148.91
	2	149.34
	3	149.29
	4	149.10
Average Length (m)		0.149
Diam. (mm)	**1**	71.70
	2	72.57
	3	72.10
	4	71.67
Average Diameter (m)		0.072
Volume (m^3)		6.07E-04
Bulk Unit Weight (kN/m^3)		17.4
Bulk Unit Weight (pcf)		110.9
Dry Unit Weight (kN/m^3)		12.0
Dry Unit Weight (pcf)		76.3

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-14
Sample #	T144
Depth (m)	6.1 - 6.7
Sample Date	12-Dec-22
Test Date	23-Dec-22
Technician	JC

Unconfined Strength

	kPa	ksf
Max q_u	112.2	2.3
Max S_u	56.1	1.2

Specimen Data

Description CLAY - silty, trace silt inclusions (<15mm diam), dark grey, moist, stiff, high plasticity, slickensides

Length	149.2	(mm)	**Moisture %**	45%	
Diameter	72.0	(mm)	**Bulk Unit Wt.**	17.4	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	12.0	(kN/m^3)
Initial Area	0.00407	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.65	63.8	1.33

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	1.30	63.8	1.33
	1.30	63.8	1.33
	1.50	73.6	1.54
Average	**1.37**	**67.0**	**1.40**

Failure Geometry

Sketch:

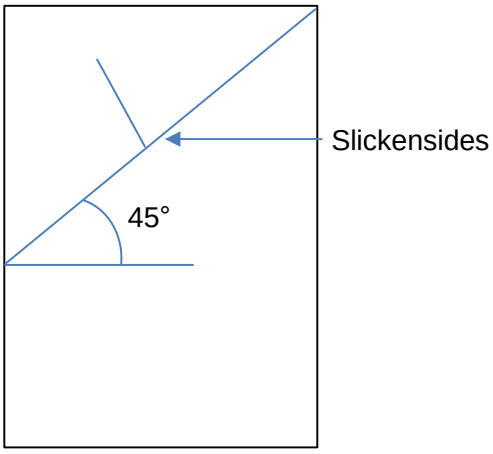

Photo:

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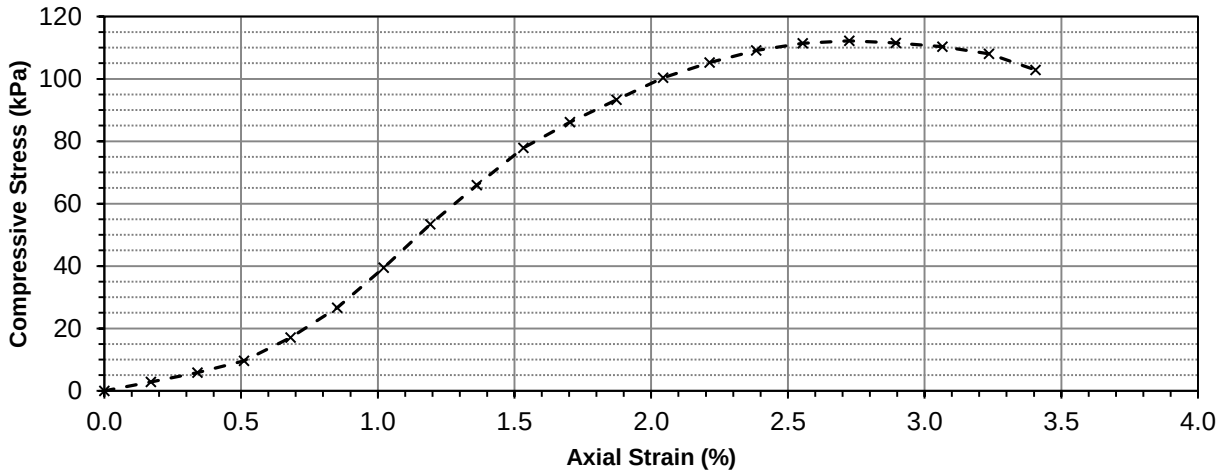
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.39	0.0000	0.00	0.004073	0.0	0.00	0.00
10	0.62	0.2540	0.17	0.004080	11.6	2.84	1.42
20	0.86	0.5080	0.34	0.004087	23.7	5.80	2.90
30	1.17	0.7620	0.51	0.004094	39.3	9.60	4.80
40	1.78	1.0160	0.68	0.004101	70.1	17.09	8.54
50	2.56	1.2700	0.85	0.004108	109.4	26.63	13.31
60	3.61	1.5240	1.02	0.004115	162.3	39.44	19.72
70	4.76	1.7780	1.19	0.004122	220.3	53.44	26.72
80	5.79	2.0320	1.36	0.004129	272.2	65.92	32.96
90	6.78	2.2860	1.53	0.004136	322.1	77.87	38.94
100	7.47	2.5400	1.70	0.004143	356.9	86.13	43.07
110	8.07	2.7940	1.87	0.004150	387.1	93.27	46.63
120	8.67	3.0480	2.04	0.004158	417.3	100.38	50.19
130	9.09	3.3020	2.21	0.004165	438.5	105.29	52.64
140	9.42	3.5560	2.38	0.004172	455.1	109.09	54.55
150	9.63	3.8100	2.55	0.004179	465.7	111.43	55.72
160	9.71	4.0640	2.72	0.004187	469.8	112.20	56.10
170	9.67	4.3180	2.89	0.004194	467.7	111.52	55.76
180	9.59	4.5720	3.07	0.004201	463.7	110.37	55.18
190	9.41	4.8260	3.24	0.004209	454.6	108.02	54.01
200	8.99	5.0800	3.41	0.004216	433.5	102.81	51.40

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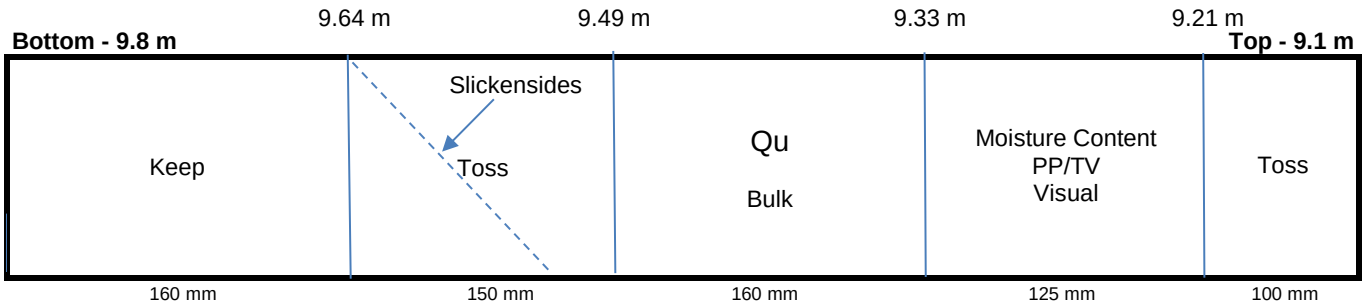
Shelby Tube Visual

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-14
Sample #	T146
Depth (m)	9.1 - 9.8
Sample Date	13-Dec-22
Test Date	21-Dec-22
Technician	JC

Tube Extraction

Recovery (mm) 695 (over pushed)



Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<10mm diam)	
Color	dark grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	slickensides
Gradation	-

160 mm

Torvane

Reading	0.43
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	42.2

Pocket Penetrometer

Reading	**1**	0.80
	2	0.80
	3	0.70
	Average	0.77
Undrained Shear Strength (kPa)		37.6

Moisture Content

Tare ID	AC40
Mass tare (g)	7
Mass wet + tare (g)	372
Mass dry + tare (g)	242.8
Moisture %	54.8%

Unit Weight

Bulk Weight (g)		1049.2
Length (mm)	**1**	148.63
	2	148.76
	3	148.92
	4	148.48
Average Length (m)		0.149
Diam. (mm)	**1**	73.03
	2	72.41
	3	72.78
	4	73.36
Average Diameter (m)		0.073
Volume (m^3)		6.21E-04
Bulk Unit Weight (kN/m^3)		16.6
Bulk Unit Weight (pcf)		105.6
Dry Unit Weight (kN/m^3)		10.7
Dry Unit Weight (pcf)		68.2

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-14
Sample #	T146
Depth (m)	9.1 - 9.8
Sample Date	13-Dec-22
Test Date	21-Dec-22
Technician	JC

Unconfined Strength

	kPa	ksf
Max q_u	86.1	1.8
Max S_u	43.1	0.9

Specimen Data

Description CLAY - silty, trace silt inclusions (<10mm diam), dark grey, moist, firm, high plasticity, slickensides

Length	148.7	(mm)	**Moisture %**	55%	
Diameter	72.9	(mm)	**Bulk Unit Wt.**	16.6	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	10.7	(kN/m^3)
Initial Area	0.00417	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.43	42.2	0.88

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	0.80	39.2	0.82
	0.80	39.2	0.82
	0.70	34.3	0.72
Average	**0.77**	**37.6**	**0.79**

Failure Geometry

Sketch:

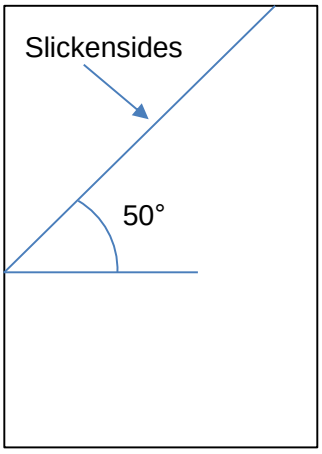

Photo:

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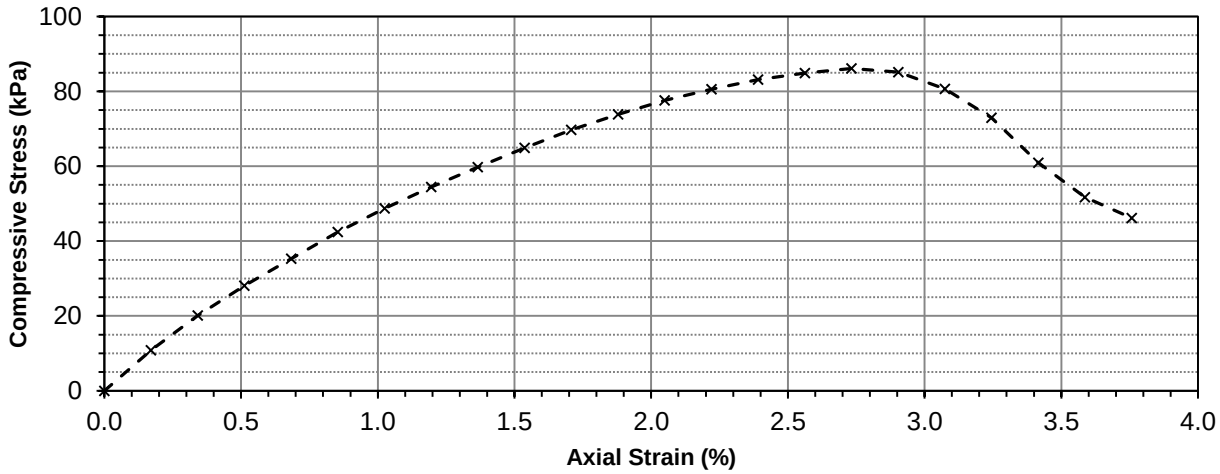
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.39	0.0000	0.00	0.004173	0.0	0.00	0.00
10	1.29	0.2540	0.17	0.004180	45.4	10.85	5.43
20	2.06	0.5080	0.34	0.004188	84.2	20.10	10.05
30	2.73	0.7620	0.51	0.004195	117.9	28.12	14.06
40	3.33	1.0160	0.68	0.004202	148.2	35.26	17.63
50	3.93	1.2700	0.85	0.004209	178.4	42.39	21.19
60	4.47	1.5240	1.02	0.004217	205.6	48.77	24.39
70	4.95	1.7780	1.20	0.004224	229.8	54.41	27.21
80	5.41	2.0320	1.37	0.004231	253.0	59.80	29.90
90	5.85	2.2860	1.54	0.004239	275.2	64.93	32.46
100	6.26	2.5400	1.71	0.004246	295.9	69.68	34.84
110	6.62	2.7940	1.88	0.004253	314.0	73.83	36.91
120	6.95	3.0480	2.05	0.004261	330.6	77.60	38.80
130	7.21	3.3020	2.22	0.004268	343.7	80.54	40.27
140	7.44	3.5560	2.39	0.004276	355.3	83.11	41.55
150	7.60	3.8100	2.56	0.004283	363.4	84.85	42.42
160	7.72	4.0640	2.73	0.004291	369.5	86.11	43.05
170	7.65	4.3180	2.90	0.004298	365.9	85.14	42.57
180	7.28	4.5720	3.07	0.004306	347.3	80.65	40.33
190	6.63	4.8260	3.25	0.004313	314.5	72.92	36.46
200	5.61	5.0800	3.42	0.004321	263.1	60.89	30.44
210	4.83	5.3340	3.59	0.004329	223.8	51.70	25.85
220	4.36	5.5880	3.76	0.004336	200.1	46.15	23.07

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Shelby Tube Visual

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-14
Sample #	T148
Depth (m)	12.2 - 12.8
Sample Date	13-Dec-22
Test Date	21-Dec-22
Technician	JC

Tube Extraction

Recovery (mm) 675 (over pushed)

12.70 m	12.54 m	12.38 m	12.22 m
Bottom - 12.8 m			**Top - 12.1 m**
Toss	Keep	Moisture Content PP/TV Visual	Qu Bulk	Toss
100 mm	160 mm	160 mm	160 mm	95 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<10mm diam)	
Color	dark grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.38
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	37.3

Pocket Penetrometer

Reading	**1**	0.90
	2	0.80
	3	0.90
	Average	0.87
Undrained Shear Strength (kPa)		42.5

Moisture Content

Tare ID	E119
Mass tare (g)	8.6
Mass wet + tare (g)	319.2
Mass dry + tare (g)	221.8
Moisture %	45.7%

Unit Weight

Bulk Weight (g)		1055.4
Length (mm)	**1**	150.65
	2	151.05
	3	150.77
	4	151.11
Average Length (m)		0.151
Diam. (mm)	**1**	72.63
	2	73.03
	3	72.81
	4	72.50
Average Diameter (m)		0.073
Volume (m^3)		6.27E-04
Bulk Unit Weight (kN/m^3)		16.5
Bulk Unit Weight (pcf)		105.1
Dry Unit Weight (kN/m^3)		11.3
Dry Unit Weight (pcf)		72.1

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-14
Sample #	T148
Depth (m)	12.2 - 12.8
Sample Date	13-Dec-22
Test Date	21-Dec-22
Technician	JC

Unconfined Strength

	kPa	ksf
Max q_u	72.0	1.5
Max S_u	36.0	0.8

Specimen Data

Description CLAY - silty, trace silt inclusions (<10mm diam), dark grey, moist, firm, high plasticity

Length	150.9	(mm)	**Moisture %**	46%	
Diameter	72.7	(mm)	**Bulk Unit Wt.**	16.5	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	11.3	(kN/m^3)
Initial Area	0.00416	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.38	37.3	0.78

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	0.90	44.1	0.92
	0.80	39.2	0.82
	0.90	44.1	0.92
Average	**0.87**	**42.5**	**0.89**

Failure Geometry

Sketch:

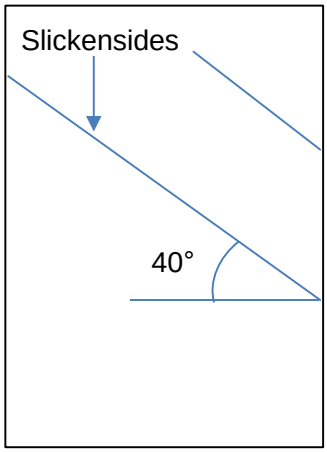

Photo:

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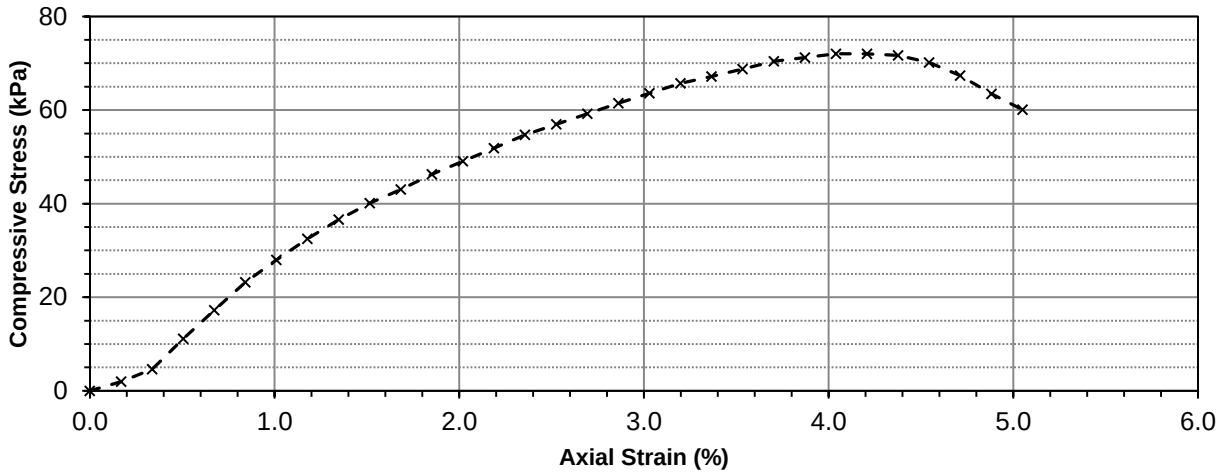
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.36	0.0000	0.00	0.004156	0.0	0.00	0.00
10	0.52	0.2540	0.17	0.004163	8.1	1.94	0.97
20	0.74	0.5080	0.34	0.004170	19.2	4.59	2.30
30	1.28	0.7620	0.50	0.004177	46.4	11.10	5.55
40	1.79	1.0160	0.67	0.004184	72.1	17.23	8.61
50	2.29	1.2700	0.84	0.004191	97.3	23.21	11.61
60	2.69	1.5240	1.01	0.004198	117.4	27.97	13.99
70	3.07	1.7780	1.18	0.004205	136.6	32.48	16.24
80	3.42	2.0320	1.35	0.004213	154.2	36.61	18.31
90	3.72	2.2860	1.51	0.004220	169.4	40.13	20.07
100	3.97	2.5400	1.68	0.004227	182.0	43.05	21.52
110	4.25	2.7940	1.85	0.004234	196.1	46.30	23.15
120	4.49	3.0480	2.02	0.004242	208.2	49.08	24.54
130	4.73	3.3020	2.19	0.004249	220.3	51.84	25.92
140	4.98	3.5560	2.36	0.004256	232.9	54.71	27.36
150	5.18	3.8100	2.52	0.004264	242.9	56.98	28.49
160	5.38	4.0640	2.69	0.004271	253.0	59.24	29.62
170	5.58	4.3180	2.86	0.004278	263.1	61.50	30.75
180	5.77	4.5720	3.03	0.004286	272.7	63.62	31.81
190	5.96	4.8260	3.20	0.004293	282.3	65.74	32.87
200	6.09	5.0800	3.37	0.004301	288.8	67.15	33.58
210	6.24	5.3340	3.53	0.004308	296.4	68.79	34.40
220	6.39	5.5880	3.70	0.004316	303.9	70.42	35.21
230	6.47	5.8420	3.87	0.004323	308.0	71.23	35.62

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Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	6.55	6.0960	4.04	0.004331	312.0	72.04	36.02
250	6.56	6.3500	4.21	0.004338	312.5	72.03	36.01
260	6.54	6.6040	4.38	0.004346	311.5	71.67	35.84
270	6.42	6.8580	4.54	0.004354	305.4	70.16	35.08
280	6.19	7.1120	4.71	0.004361	293.8	67.37	33.69
290	5.86	7.3660	4.88	0.004369	277.2	63.45	31.72
300	5.58	7.6200	5.05	0.004377	263.1	60.11	30.06

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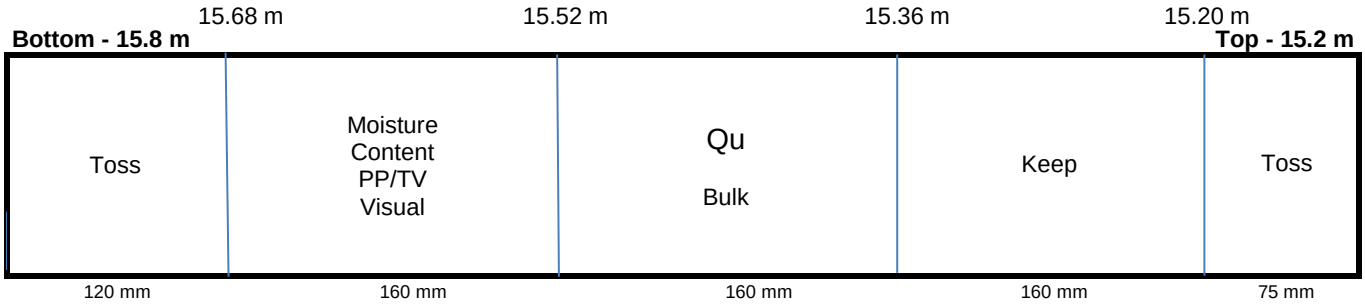
Shelby Tube Visual

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-14
Sample #	T150
Depth (m)	15.2 - 15.8
Sample Date	13-Dec-22
Test Date	21-Dec-22
Technician	JC

Tube Extraction

Recovery (mm) 675 (over pushed)



Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<15mm diam)	
Color	grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.35
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	34.3

Pocket Penetrometer

Reading	**1**	0.80
	2	0.80
	3	0.90
	Average	0.83
Undrained Shear Strength (kPa)		40.9

Moisture Content

Tare ID	F145
Mass tare (g)	9
Mass wet + tare (g)	326
Mass dry + tare (g)	211.6
Moisture %	56.5%

Unit Weight

Bulk Weight (g)		1058.2
Length (mm)	**1**	151.41
	2	151.18
	3	151.27
	4	151.34
Average Length (m)		0.151
Diam. (mm)	**1**	72.06
	2	72.98
	3	72.58
	4	72.89
Average Diameter (m)		0.073
Volume (m^3)		6.27E-04
Bulk Unit Weight (kN/m^3)		16.6
Bulk Unit Weight (pcf)		105.4
Dry Unit Weight (kN/m^3)		10.6
Dry Unit Weight (pcf)		67.4

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-14
Sample #	T150
Depth (m)	15.2 - 15.8
Sample Date	13-Dec-22
Test Date	21-Dec-22
Technician	JC

Unconfined Strength

	kPa	ksf
Max q_u	124.4	2.6
Max S_u	62.2	1.3

Specimen Data

Description CLAY - silty, trace silt inclusions (<15mm diam), grey, moist, firm, high plasticity

Length	151.3	(mm)	**Moisture %**	56%	
Diameter	72.6	(mm)	**Bulk Unit Wt.**	16.6	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	10.6	(kN/m^3)
Initial Area	0.00414	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.35	34.3	0.72

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	0.80	39.2	0.82
	0.80	39.2	0.82
	0.90	44.1	0.92
Average	**0.83**	**40.9**	**0.85**

Failure Geometry

Sketch:

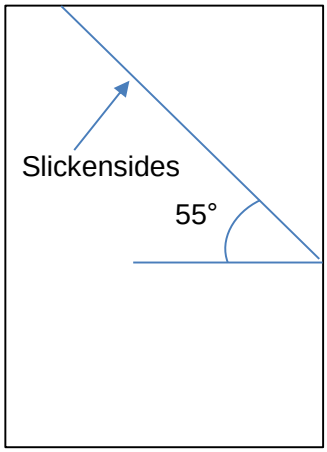

Photo:

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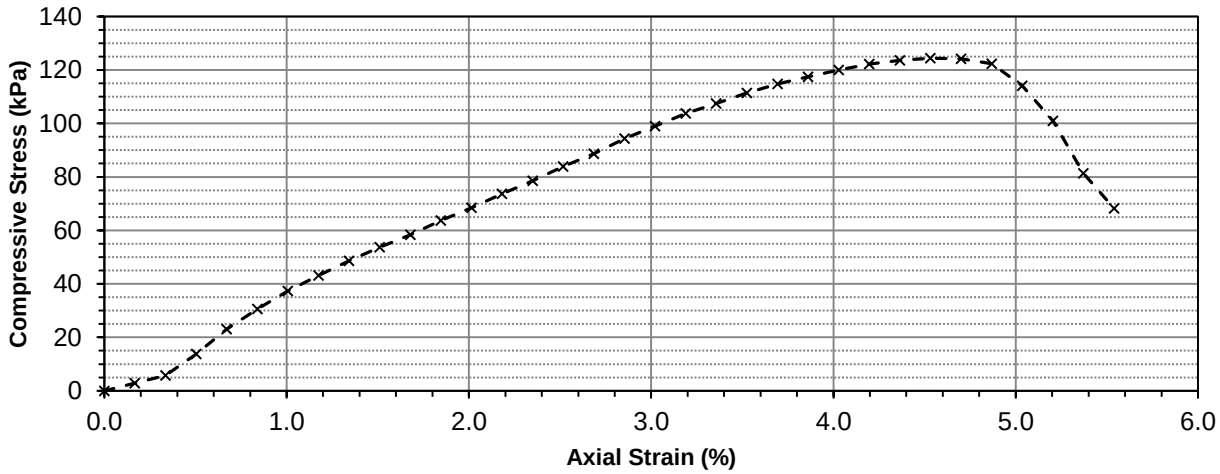
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.38	0.0000	0.00	0.004143	0.0	0.00	0.00
10	0.62	0.2540	0.17	0.004150	12.1	2.92	1.46
20	0.86	0.5080	0.34	0.004157	24.2	5.82	2.91
30	1.52	0.7620	0.50	0.004164	57.5	13.80	6.90
40	2.29	1.0160	0.67	0.004171	96.3	23.08	11.54
50	2.92	1.2700	0.84	0.004178	128.0	30.64	15.32
60	3.48	1.5240	1.01	0.004185	156.2	37.34	18.67
70	3.97	1.7780	1.18	0.004192	180.9	43.16	21.58
80	4.43	2.0320	1.34	0.004199	204.1	48.61	24.31
90	4.86	2.2860	1.51	0.004206	225.8	53.68	26.84
100	5.26	2.5400	1.68	0.004214	246.0	58.38	29.19
110	5.71	2.7940	1.85	0.004221	268.6	63.65	31.82
120	6.12	3.0480	2.01	0.004228	289.3	68.43	34.21
130	6.57	3.3020	2.18	0.004235	312.0	73.67	36.83
140	6.99	3.5560	2.35	0.004242	333.2	78.53	39.27
150	7.45	3.8100	2.52	0.004250	356.3	83.85	41.93
160	7.87	4.0640	2.69	0.004257	377.5	88.68	44.34
170	8.36	4.3180	2.85	0.004264	402.2	94.32	47.16
180	8.77	4.5720	3.02	0.004272	422.9	98.99	49.50
190	9.19	4.8260	3.19	0.004279	444.1	103.77	51.88
200	9.52	5.0800	3.36	0.004287	460.7	107.47	53.73
210	9.87	5.3340	3.53	0.004294	478.3	111.39	55.69
220	10.18	5.5880	3.69	0.004302	493.9	114.83	57.41
230	10.42	5.8420	3.86	0.004309	506.0	117.43	58.72

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Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	10.66	6.0960	4.03	0.004317	518.1	120.03	60.02
250	10.86	6.3500	4.20	0.004324	528.2	122.15	61.08
260	11.00	6.6040	4.36	0.004332	535.3	123.57	61.78
270	11.09	6.8580	4.53	0.004339	539.8	124.40	62.20
280	11.09	7.1120	4.70	0.004347	539.8	124.18	62.09
290	10.95	7.3660	4.87	0.004355	532.8	122.34	61.17
300	10.25	7.6200	5.04	0.004362	497.5	114.04	57.02
310	9.13	7.8740	5.20	0.004370	441.0	100.92	50.46
320	7.45	8.1280	5.37	0.004378	356.3	81.40	40.70
330	6.32	8.3820	5.54	0.004386	299.4	68.27	34.13

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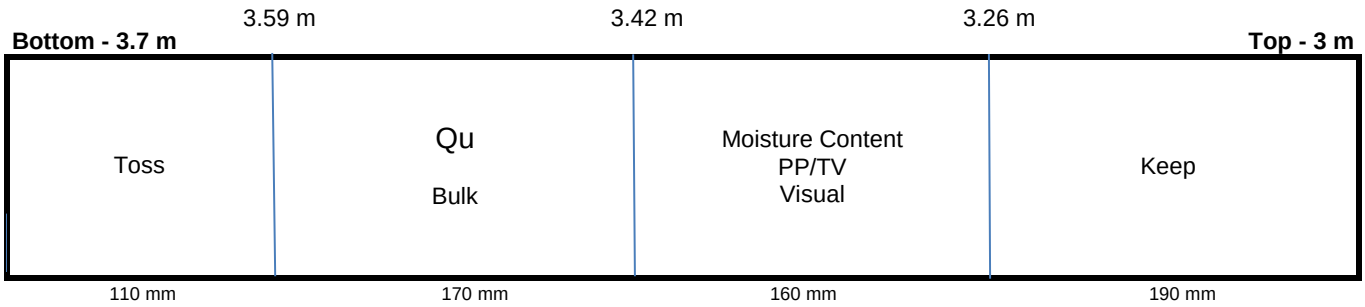
Shelby Tube Visual

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-16
Sample #	T166
Depth (m)	3.0 - 3.7
Sample Date	14-Dec-22
Test Date	20-Dec-22
Technician	JC

Tube Extraction

Recovery (mm) 630 (over pushed)



Visual Classification

Material	CLAY
Composition	silty
trace precipitates (gypsum, <10mm diam)	
trace silt inclusions (<10mm diam)	
trace oxidation	
trace organics	
Color	mottled (brown & grey)
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.95
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	93.2

Pocket Penetrometer

Reading	**1**	1.80
	2	2.10
	3	1.90
	Average	1.93
Undrained Shear Strength (kPa)		94.8

Moisture Content

Tare ID	D5
Mass tare (g)	8
Mass wet + tare (g)	282
Mass dry + tare (g)	202.8
Moisture %	40.7%

Unit Weight

Bulk Weight (g)		1140.4
Length (mm)	**1**	153.86
	2	153.48
	3	153.61
	4	153.87
Average Length (m)		0.154
Diam. (mm)	**1**	71.76
	2	71.94
	3	72.16
	4	71.77
Average Diameter (m)		0.072
Volume (m^3)		6.24E-04
Bulk Unit Weight (kN/m^3)		17.9
Bulk Unit Weight (pcf)		114.1
Dry Unit Weight (kN/m^3)		12.7
Dry Unit Weight (pcf)		81.1

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-16
Sample #	T166
Depth (m)	3.0 - 3.7
Sample Date	14-Dec-22
Test Date	20-Dec-22
Technician	JC

Unconfined Strength

	kPa	ksf
Max q_u	94.3	2.0
Max S_u	47.1	1.0

Specimen Data

Description CLAY - silty, trace precipitates (gypsum, <10mm diam), trace silt inclusions (<10mm diam), trace oxidation, trace organics, mottled (brown & grey), moist, stiff, high plasticity

Length	153.7	(mm)	**Moisture %**	41%	
Diameter	71.9	(mm)	**Bulk Unit Wt.**	17.9	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	12.7	(kN/m^3)
Initial Area	0.00406	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.95	93.2	1.95

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	1.80	88.3	1.84
	2.10	103.0	2.15
	1.90	93.2	1.95
Average	**1.93**	**94.8**	**1.98**

Failure Geometry

Sketch:

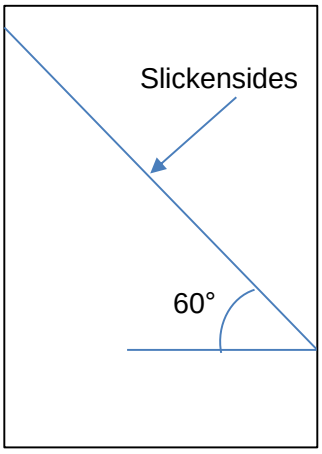

Photo:

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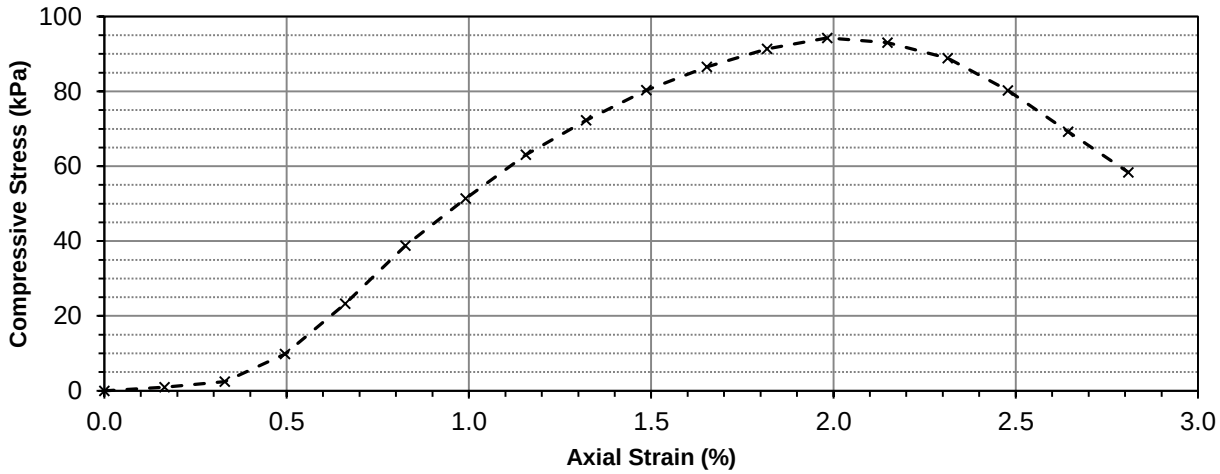
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.39	0.0000	0.00	0.004061	0.0	0.00	0.00
10	0.47	0.2540	0.17	0.004068	4.0	0.99	0.50
20	0.59	0.5080	0.33	0.004075	10.1	2.47	1.24
30	1.19	0.7620	0.50	0.004081	40.3	9.88	4.94
40	2.28	1.0160	0.66	0.004088	95.3	23.30	11.65
50	3.54	1.2700	0.83	0.004095	158.8	38.77	19.39
60	4.57	1.5240	0.99	0.004102	210.7	51.36	25.68
70	5.53	1.7780	1.16	0.004109	259.1	63.06	31.53
80	6.29	2.0320	1.32	0.004115	297.4	72.26	36.13
90	6.96	2.2860	1.49	0.004122	331.1	80.33	40.16
100	7.48	2.5400	1.65	0.004129	357.4	86.54	43.27
110	7.89	2.7940	1.82	0.004136	378.0	91.39	45.70
120	8.14	3.0480	1.98	0.004143	390.6	94.28	47.14
130	8.05	3.3020	2.15	0.004150	386.1	93.03	46.51
140	7.72	3.5560	2.31	0.004157	369.5	88.87	44.44
150	7.02	3.8100	2.48	0.004164	334.2	80.25	40.12
160	6.12	4.0640	2.64	0.004171	288.8	69.24	34.62
170	5.23	4.3180	2.81	0.004178	244.0	58.38	29.19

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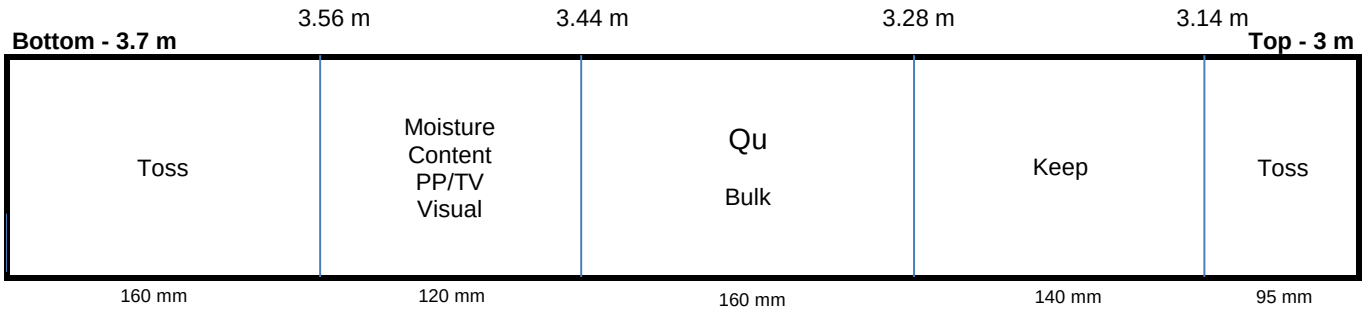
Shelby Tube Visual

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-17
Sample #	T170
Depth (m)	3.0 - 3.7
Sample Date	14-Dec-22
Test Date	20-Dec-22
Technician	JC

Tube Extraction

Recovery (mm) 675 (over pushed)



Visual Classification

Material	CLAY
Composition	silty

trace precipitates (gypsum, <5mm diam)
trace oxidation
trace organics

Color	mottled (brown & grey)
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.75
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	73.6

Pocket Penetrometer

Reading	**1**	1.50
	2	1.70
	3	1.60
	Average	1.60
Undrained Shear Strength (kPa)		78.5

Moisture Content

Tare ID	K14
Mass tare (g)	8.6
Mass wet + tare (g)	314.8
Mass dry + tare (g)	224
Moisture %	42.2%

Unit Weight

Bulk Weight (g)		1112.4
Length (mm)	**1**	149.57
	2	149.19
	3	149.46
	4	149.42
Average Length (m)		0.149
Diam. (mm)	**1**	72.64
	2	71.92
	3	72.19
	4	72.81
Average Diameter (m)		0.072
Volume (m^3)		6.15E-04
Bulk Unit Weight (kN/m^3)		17.7
Bulk Unit Weight (pcf)		112.9
Dry Unit Weight (kN/m^3)		12.5
Dry Unit Weight (pcf)		79.4

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-17
Sample #	T170
Depth (m)	3.0 - 3.7
Sample Date	14-Dec-22
Test Date	20-Dec-22
Technician	JC

Unconfined Strength

	kPa	ksf
Max q_u	107.2	2.2
Max S_u	53.6	1.1

Specimen Data

Description CLAY - silty, trace precipitates (gypsum, <5mm diam), trace oxidation, trace organics, mottled (brown & grey), moist, stiff, high plasticity

Length	149.4	(mm)	**Moisture %**	42%	
Diameter	72.4	(mm)	**Bulk Unit Wt.**	17.7	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	12.5	(kN/m^3)
Initial Area	0.00412	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.75	73.6	1.54

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	1.50	73.6	1.54
	1.70	83.4	1.74
	1.60	78.5	1.64
Average	**1.60**	**78.5**	**1.64**

Failure Geometry

Sketch:

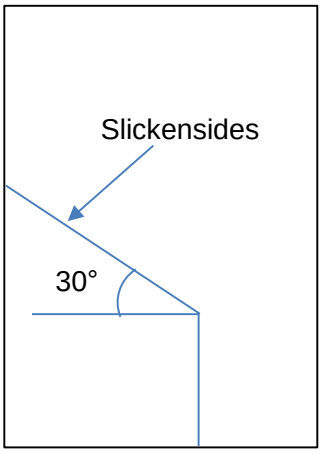

Photo:

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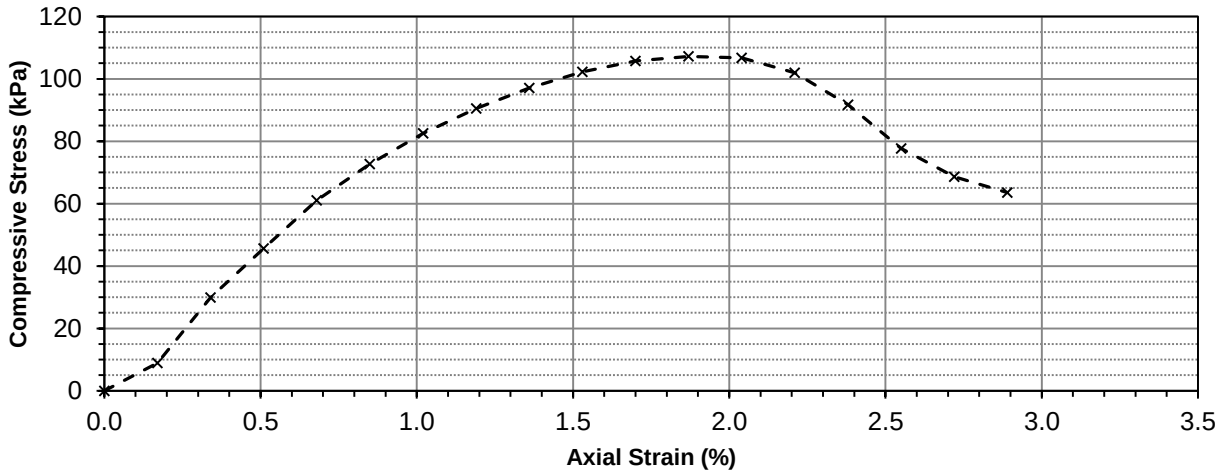
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.36	0.0000	0.00	0.004116	0.0	0.00	0.00
10	1.09	0.2540	0.17	0.004123	36.8	8.92	4.46
20	2.81	0.5080	0.34	0.004130	123.5	29.90	14.95
30	4.11	0.7620	0.51	0.004137	189.0	45.69	22.84
40	5.38	1.0160	0.68	0.004144	253.0	61.06	30.53
50	6.35	1.2700	0.85	0.004151	301.9	72.73	36.37
60	7.17	1.5240	1.02	0.004158	343.2	82.55	41.27
70	7.84	1.7780	1.19	0.004165	377.0	90.51	45.26
80	8.40	2.0320	1.36	0.004172	405.2	97.12	48.56
90	8.84	2.2860	1.53	0.004180	427.4	102.26	51.13
100	9.14	2.5400	1.70	0.004187	442.5	105.70	52.85
110	9.28	2.7940	1.87	0.004194	449.6	107.20	53.60
120	9.26	3.0480	2.04	0.004201	448.6	106.77	53.38
130	8.87	3.3020	2.21	0.004209	428.9	101.91	50.96
140	8.03	3.5560	2.38	0.004216	386.6	91.69	45.85
150	6.87	3.8100	2.55	0.004223	328.1	77.69	38.85
160	6.12	4.0640	2.72	0.004231	290.3	68.62	34.31
170	5.70	4.3180	2.89	0.004238	269.2	63.51	31.75

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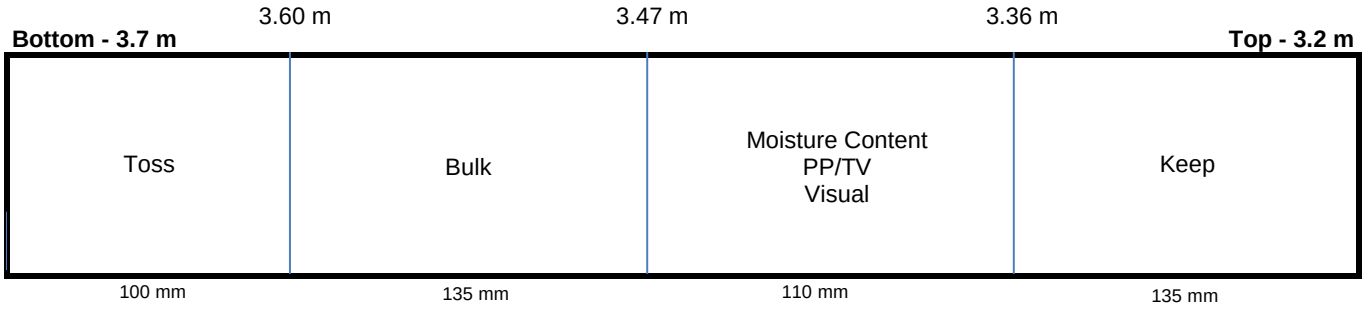
Shelby Tube Visual

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-20
Sample #	T189
Depth (m)	3.0 - 3.7
Sample Date	14-Dec-23
Test Date	23-Dec-23
Technician	JC

Tube Extraction

Recovery (mm) 480



Visual Classification

Material	CLAY
Composition	silty
trace precipitates (gypsum, <5mm diam)	
trace precipitates (sulphate, <10mm diam)	
trace silt inclusions (<10mm diam)	
trace oxidation	
trace rootlets	
Color	mottled (brown & grey)
Moisture	moist
Consistency	very stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.44
Vane Size (s,m,l)	s
Undrained Shear Strength (kPa)	107.9

Pocket Penetrometer

Reading	**1**	2.90
	2	3.00
	3	3.10
	Average	3.00
Undrained Shear Strength (kPa)		147.1

Moisture Content

Tare ID	Z64
Mass tare (g)	8.8
Mass wet + tare (g)	302.6
Mass dry + tare (g)	220
Moisture %	39.1%

Unit Weight

Bulk Weight (g)		934.4
Length (mm)	**1**	123.60
	2	124.03
	3	123.62
	4	123.69
Average Length (m)		0.124
Diam. (mm)	**1**	72.30
	2	72.49
	3	72.19
	4	72.33
Average Diameter (m)		0.072
Volume (m^3)		5.08E-04
Bulk Unit Weight (kN/m^3)		18.0
Bulk Unit Weight (pcf)		114.7
Dry Unit Weight (kN/m^3)		13.0
Dry Unit Weight (pcf)		82.5

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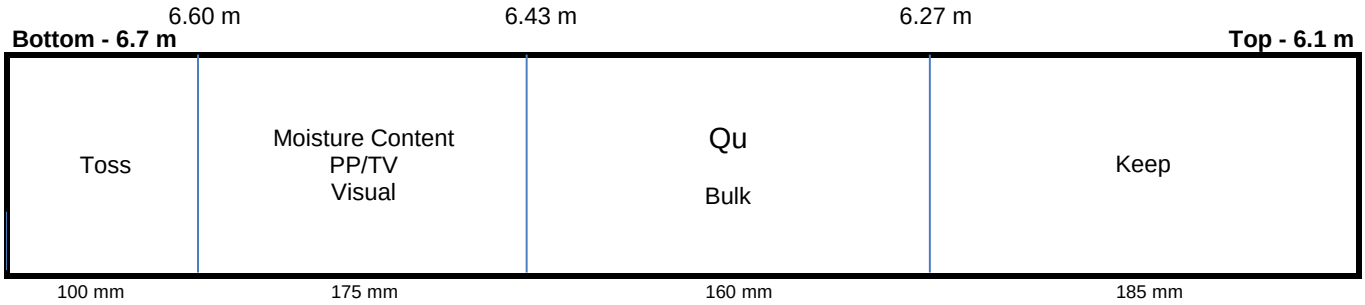
Shelby Tube Visual

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-20
Sample #	T192
Depth (m)	6.1 - 6.7
Sample Date	14-Dec-22
Test Date	20-Dec-22
Technician	JC

Tube Extraction

Recovery (mm) 620 (over pushed)



Visual Classification

Material	CLAY
Composition	silty

trace silt inclusions (<5 mm diam.)

Color	dark grey
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.65
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	63.8

Pocket Penetrometer

Reading	**1**	1.30
	2	1.40
	3	1.30
	Average	1.33
Undrained Shear Strength (kPa)		65.4

Moisture Content

Tare ID	N96
Mass tare (g)	8.6
Mass wet + tare (g)	350.6
Mass dry + tare (g)	242.4
Moisture %	46.3%

Unit Weight

Bulk Weight (g)		1085.0
Length (mm)	**1**	149.36
	2	150.12
	3	149.28
	4	149.66
Average Length (m)		0.150
Diam. (mm)	**1**	72.49
	2	72.08
	3	71.92
	4	72.28
Average Diameter (m)		0.072
Volume (m^3)		6.12E-04
Bulk Unit Weight (kN/m^3)		17.4
Bulk Unit Weight (pcf)		110.6
Dry Unit Weight (kN/m^3)		11.9
Dry Unit Weight (pcf)		75.6

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Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-20
Sample #	T192
Depth (m)	6.1 - 6.7
Sample Date	14-Dec-22
Test Date	20-Dec-22
Technician	JC

Unconfined Strength

	kPa	ksf
Max q_u	184.2	3.8
Max S_u	92.1	1.9

Specimen Data

Description CLAY - silty, trace silt inclusions (<5 mm diam.), dark grey, moist, stiff, high plasticity

Length	149.6	(mm)	**Moisture %**	46%	
Diameter	72.2	(mm)	**Bulk Unit Wt.**	17.4	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	11.9	(kN/m^3)
Initial Area	0.00409	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.65	63.8	1.33

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	1.30	63.8	1.33
	1.40	68.7	1.43
	1.30	63.8	1.33
Average	**1.33**	**65.4**	**1.37**

Failure Geometry

Sketch:

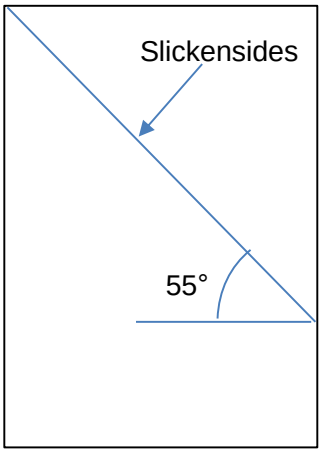

Photo:

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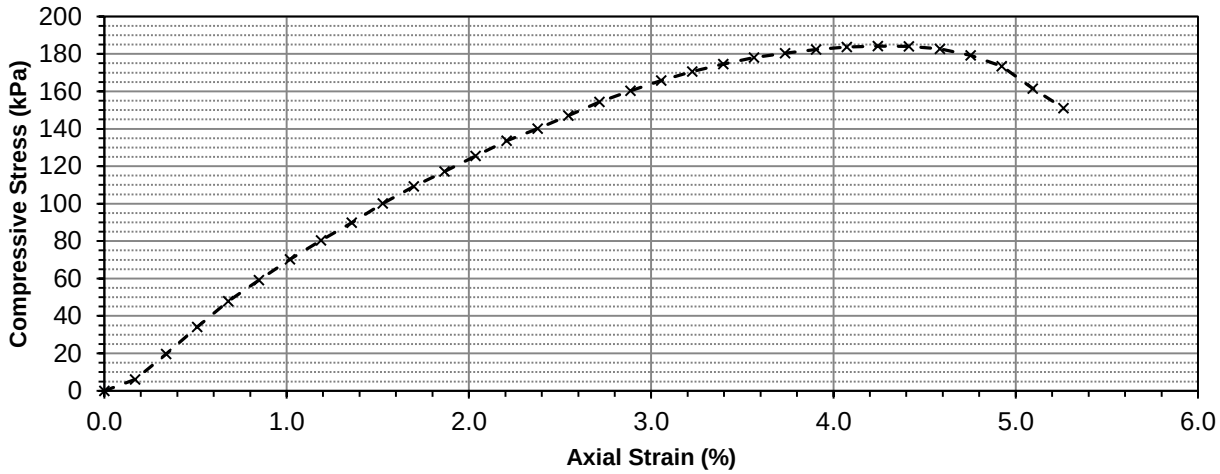
Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.36	0.0000	0.00	0.004093	0.0	0.00	0.00
10	0.85	0.2540	0.17	0.004100	24.7	6.02	3.01
20	1.96	0.5080	0.34	0.004107	80.6	19.63	9.82
30	3.15	0.7620	0.51	0.004114	140.6	34.18	17.09
40	4.27	1.0160	0.68	0.004121	197.1	47.82	23.91
50	5.20	1.2700	0.85	0.004128	244.0	59.09	29.55
60	6.12	1.5240	1.02	0.004135	290.3	70.20	35.10
70	6.97	1.7780	1.19	0.004143	333.2	80.43	40.21
80	7.75	2.0320	1.36	0.004150	372.5	89.76	44.88
90	8.62	2.2860	1.53	0.004157	416.3	100.16	50.08
100	9.38	2.5400	1.70	0.004164	454.6	109.18	54.59
110	10.06	2.7940	1.87	0.004171	488.9	117.21	58.61
120	10.76	3.0480	2.04	0.004178	524.2	125.45	62.73
130	11.45	3.3020	2.21	0.004186	559.0	133.54	66.77
140	12.02	3.5560	2.38	0.004193	587.7	140.16	70.08
150	12.62	3.8100	2.55	0.004200	617.9	147.12	73.56
160	13.25	4.0640	2.72	0.004208	649.7	154.41	77.20
170	13.77	4.3180	2.89	0.004215	675.9	160.36	80.18
180	14.25	4.5720	3.06	0.004222	700.1	165.81	82.90
190	14.68	4.8260	3.23	0.004230	721.8	170.64	85.32
200	15.03	5.0800	3.40	0.004237	739.4	174.51	87.25
210	15.35	5.3340	3.57	0.004245	755.5	178.00	89.00
220	15.58	5.5880	3.74	0.004252	767.1	180.41	90.21
230	15.77	5.8420	3.90	0.004260	776.7	182.34	91.17

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Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	15.91	6.0960	4.07	0.004267	783.8	183.67	91.84
250	15.98	6.3500	4.24	0.004275	787.3	184.17	92.09
260	16.00	6.6040	4.41	0.004282	788.3	184.08	92.04
270	15.91	6.8580	4.58	0.004290	783.8	182.70	91.35
280	15.64	7.1120	4.75	0.004298	770.2	179.21	89.60
290	15.17	7.3660	4.92	0.004305	746.5	173.38	86.69
300	14.18	7.6200	5.09	0.004313	696.6	161.51	80.75
310	13.30	7.8740	5.26	0.004321	652.2	150.95	75.48

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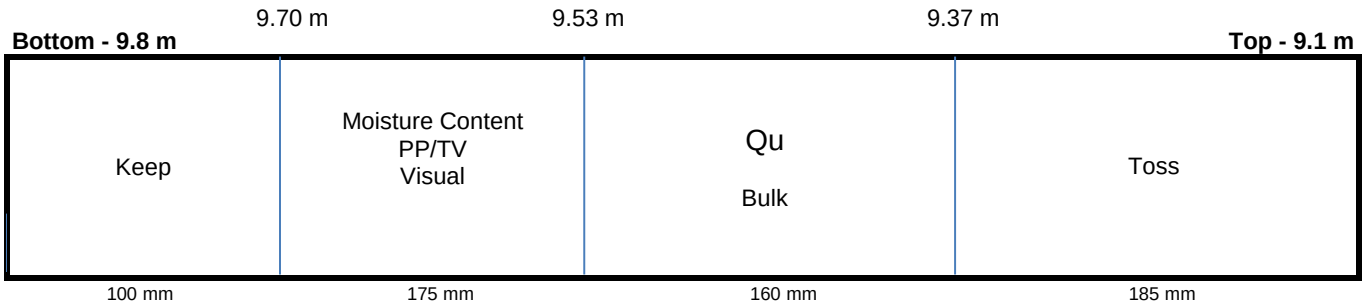
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Shelby Tube Visual

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-20
Sample #	T194
Depth (m)	9.1 - 9.8
Sample Date	14-Dec-22
Test Date	20-Dec-22
Technician	JC

Tube Extraction

Recovery (mm) 690 (over pushed)



Visual Classification

Material	CLAY
Composition	silty

trace silt inclusions (<5 mm diam.)

Color	dark grey
Moisture	moist
Consistency	firm to stiff
Plasticity	high plasticity
Structure	-
Gradation	-

Torvane

Reading	0.40
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	39.2

Pocket Penetrometer

Reading	**1**	1.00
	2	1.00
	3	1.10
	Average	1.03
Undrained Shear Strength (kPa)		50.7

Moisture Content

Tare ID	AB38
Mass tare (g)	6.8
Mass wet + tare (g)	315
Mass dry + tare (g)	214
Moisture %	48.7%

Unit Weight

Bulk Weight (g)		1086.6
Length (mm)	**1**	152.53
	2	151.82
	3	151.64
	4	152.40
Average Length (m)		0.152
Diam. (mm)	**1**	71.69
	2	72.35
	3	71.71
	4	72.50
Average Diameter (m)		0.072
Volume (m^3)		6.20E-04
Bulk Unit Weight (kN/m^3)		17.2
Bulk Unit Weight (pcf)		109.4
Dry Unit Weight (kN/m^3)		11.5
Dry Unit Weight (pcf)		73.5

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Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength

ASTM D2166

Project No.	0829-001-00
Client	RM of Stanley
Project	Reinfeld Developments
Test Hole	TH22-20
Sample #	T194
Depth (m)	9.1 - 9.8
Sample Date	14-Dec-22
Test Date	20-Dec-22
Technician	JC

Unconfined Strength

	kPa	ksf
Max q_u	66.3	1.4
Max S_u	33.2	0.7

Specimen Data

Description CLAY - silty, trace silt inclusions (<5 mm diam.), dark grey, moist, firm to stiff, high plasticity

Length	152.1	(mm)	**Moisture %**	49%	
Diameter	72.1	(mm)	**Bulk Unit Wt.**	17.2	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	11.5	(kN/m^3)
Initial Area	0.00408	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.40	39.2	0.82

Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	1.00	49.1	1.02
	1.00	49.1	1.02
	1.10	54.0	1.13
Average	**1.03**	**50.7**	**1.06**

Failure Geometry

Sketch:

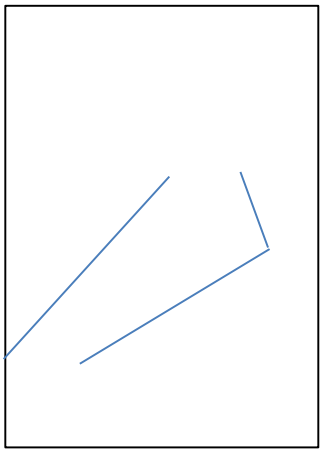


Photo:

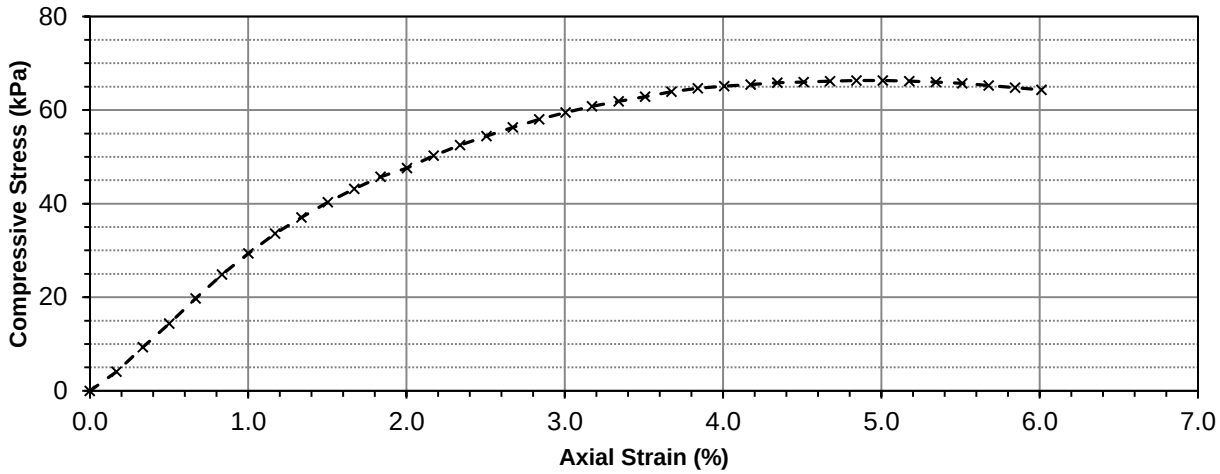
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0.39	0.0000	0.00	0.004079	0.0	0.00	0.00
10	0.72	0.2540	0.17	0.004085	16.6	4.07	2.04
20	1.15	0.5080	0.33	0.004092	38.3	9.36	4.68
30	1.56	0.7620	0.50	0.004099	59.0	14.39	7.19
40	2.00	1.0160	0.67	0.004106	81.1	19.76	9.88
50	2.42	1.2700	0.83	0.004113	102.3	24.88	12.44
60	2.79	1.5240	1.00	0.004120	121.0	29.36	14.68
70	3.14	1.7780	1.17	0.004127	138.6	33.59	16.79
80	3.43	2.0320	1.34	0.004134	153.2	37.07	18.53
90	3.70	2.2860	1.50	0.004141	166.8	40.29	20.15
100	3.94	2.5400	1.67	0.004148	178.9	43.14	21.57
110	4.16	2.7940	1.84	0.004155	190.0	45.73	22.87
120	4.32	3.0480	2.00	0.004162	198.1	47.59	23.80
130	4.55	3.3020	2.17	0.004169	209.7	50.29	25.15
140	4.74	3.5560	2.34	0.004176	219.3	52.50	26.25
150	4.91	3.8100	2.50	0.004183	227.8	54.46	27.23
160	5.07	4.0640	2.67	0.004191	235.9	56.29	28.15
170	5.22	4.3180	2.84	0.004198	243.4	57.99	29.00
180	5.35	4.5720	3.01	0.004205	250.0	59.45	29.73
190	5.47	4.8260	3.17	0.004212	256.0	60.79	30.39
200	5.57	5.0800	3.34	0.004220	261.1	61.88	30.94
210	5.66	5.3340	3.51	0.004227	265.6	62.84	31.42
220	5.76	5.5880	3.67	0.004234	270.7	63.92	31.96
230	5.83	5.8420	3.84	0.004241	274.2	64.65	32.32

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Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength

ASTM D2166

Project No. 0829-001-00
Client RM of Stanley
Project Reinfeld Developments

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	5.88	6.0960	4.01	0.004249	276.7	65.13	32.56
250	5.92	6.3500	4.17	0.004256	278.7	65.49	32.74
260	5.96	6.6040	4.34	0.004264	280.7	65.85	32.92
270	5.98	6.8580	4.51	0.004271	281.8	65.97	32.98
280	6.01	7.1120	4.68	0.004279	283.3	66.20	33.10
290	6.03	7.3660	4.84	0.004286	284.3	66.32	33.16
300	6.04	7.6200	5.01	0.004294	284.8	66.32	33.16
310	6.04	7.8740	5.18	0.004301	284.8	66.21	33.10
320	6.03	8.1280	5.34	0.004309	284.3	65.97	32.99
330	6.02	8.3820	5.51	0.004316	283.8	65.74	32.87
340	5.99	8.6360	5.68	0.004324	282.3	65.28	32.64
350	5.96	8.8900	5.84	0.004332	280.7	64.81	32.41
360	5.93	9.1440	6.01	0.004339	279.2	64.35	32.17

TREK Geotechnical Inc.
ATTN: BETA TARYANA
1712 St. James Street
Winnipeg MB R3H 0L3

Date Received: 20-JUL-22
Report Date: 05-AUG-22 07:19 (MT)
Version: FINAL

Client Phone: 204-889-8442

Certificate of Analysis

Lab Work Order #: L2723568

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

[redacted]
Hua Wo
Chemistry Laboratory Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2723568-1 TH22-05 SS48 (5.0'-6.5')							
Sampled By: CLIENT on 27-JUN-22							
Matrix: GRAB							
Miscellaneous Parameters							
Total Sulphate Ion Content	<0.050		0.050	%	03-AUG-22	03-AUG-22	R5834458
L2723568-2 TH22-06 T83 (25.0'-27.0')							
Sampled By: CLIENT on 29-JUN-22							
Matrix: GRAB							
Miscellaneous Parameters							
Total Sulphate Ion Content	1.19		0.050	%	03-AUG-22	03-AUG-22	R5834458

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

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
SO4-T-CSA-A23-ED	Soil	Total Sulphate Ion Content	CSA INTERNATIONAL A23.2-3B

Total sulphate content is determined by mixing soil with water then hydrochloric acid, and digesting just below boiling point, for 15 minutes. Analysis by ion chromatography follows.
NOTE: the CSA-A23 method states that for a total sulphate ion content greater than 0.2%, soluble sulphate ion content shall be determined on the basis of a water extraction. This water extraction requires the total sulphate ion content result to calculate the correct ratio for the water extraction.

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

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

Laboratory Definition Code	Laboratory Location
ED	ALS ENVIRONMENTAL - EDMONTON, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: TREK Geotechnical Inc.
1712 St. James Street
Winnipeg MB R3H 0L3
Contact: BETA TARYANA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-T-CSA-A23-ED	**Soil**							
Batch R5834458								
WG3754347-3 CRM		**ED-634A_CEMENT**						
Total Sulphate Ion Content			84.1		%		80-120	03-AUG-22
WG3754347-4 DUP		**L2723568-1**						
Total Sulphate Ion Content		<0.050	<0.050	RPD-NA	%	N/A	30	03-AUG-22
WG3754347-2 LCS								
Total Sulphate Ion Content			106.2		%		70-130	03-AUG-22
WG3754347-1 MB								
Total Sulphate Ion Content			<0.050		%		0.05	03-AUG-22

Quality Control Report

Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

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

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

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

Chain of Custody (COC) / Analytical Request Form

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2723568-COFC

Report To	Contact and company name below will appear on the final report
Company:	Trek Geotechnical
Contact:	Beta Taryana
Phone:	204-889-8442
	Company address below will appear on the final report
Street:	1712 St James Street
City/Province:	Winnipeg, MB
Postal Code:	R3H 0L3
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☑ YES ☐ NO
Company:	Trek Geotechnical
Contact:	

Reports / Recipients

Select Report Format: ☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)

Merge QC/QCI Reports with COA ☐ YES ☐ NO ☐ N/A

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax btaryana@trekgeotechnical.ca

Email 2

Email 3

Invoice Recipients

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax accounts@trekgeotechnical.ca

Email 2

Turnaround Time (TAT) Requested

☑ Routine [R] if received by 3pm M-F - no surcharges apply
☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum
☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum
☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum
☐ 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum
☐ Same day [E2] if received by 10am M-S - 200% rush surcharge.

Additional fees may apply to rush requests on weekends, statutory holidays and for non-routine tests.

Date and Time Required for all E&P TATs:

For all tests with rush TATs requested, please contact your AM to confirm availability.

AFFIX ALS BARCODE LABEL HERE (ALS use only)

Project Information

ALS Account # / Quote #:	W10728
Job #:	0829-001-00
PO / AFE:	
LSD:	
ALS Lab Work Order # (ALS use only):	

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact:	Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	SO4-Water-Soluble (CSA-A23.2-3B)	PH-WT	RESISTIVITY-CALC-WT	CONDUCTIVITY-EC-WT	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	TH22-05 SS48 (5.0' - 6.5')	27-06-2022		Grab		R						
	TH22-06 T83 (25.0' - 27.0')	29-06-2022		Grab		R						

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human consumption/ use?
☐ YES ☑ NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: ☐ NONE ☐ ICE ☐ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO

Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			4.8

SHIPMENT RELEASE (client use)

Released by: [redacted] Date: July 19/22 Time:

SHIPMENT RECEPTION (ALS use only)

Received by: [redacted] Date: JUL 20

FINAL SHIPMENT RECEPTION (ALS use only)

Received by: Date: Time:

REFER [redacted] TIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

FEB 2022 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

ALS Canada Ltd.

right solutions. right partner.

CERTIFICATE OF ANALYSIS

Work Order	: **WP2300036**	Page	: 1 of 3
Amendment	: **1**		
Client	: **TREK Geotechnical Inc.**	Laboratory	: Winnipeg - Environmental
Contact	: Reinhardt van Rensburg	Account Manager	: Craig Riddell
Address	: 1712 St. James Street Winnipeg MB Canada R3H 0L3	Address	: 1329 Niakwa Road East, Unit 12 Winnipeg MB Canada R2J 3T4
Telephone	: 204 975 9433	Telephone	: +1 204 255 9720
Project	: 0829-001-00	Date Samples Received	: 03-Jan-2023 16:13
PO	: ----	Date Analysis Commenced	: 07-Jan-2023
C-O-C number	: ----	Issue Date	: 09-Jan-2023 11:56
Sampler	: ----		
Site	: ----		
Quote number	: 2022 Pricing		
No. of samples received	: 2		
No. of samples analysed	: 2		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Alex Drake	Lab Analyst	Inorganics, Edmonton, Alberta

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	*Description*
%	percent

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

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

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Workorder Comments

Amendment (09/01/2023): This report has been amended as a result of changes to the contacts for the distribution of the report. All analysis results are as per the previous report.

Analytical Results

Sub-Matrix: **Soil/Solid** (Matrix: **Soil/Solid**)					*Client sample ID*	**TH22-13 G131 (19.'-13.5')**	**TH22-18 G174 (8.5'-10.0')**	**----**	**----**	**----**
					Client sampling date / time	13-Dec-2022	14-Dec-2022	----	----	----
Analyte	*CAS Number*	*Method*	*LOR*	*Unit*		**WP2300036-001**	**WP2300036-002**	--------	--------	--------
						Result	Result	----	----	----
Inorganics										
sulfate, total, ion content	14808-79-8	E246.SO4	0.050	%		0.996	<0.050	----	----	----
sulfate, soluble ion content	14808-79-8	E246A.SO4	0.05	%		----	NR	----	----	----
sulfate, soluble ion content	14808-79-8	E246A.SO4	0.050	%		0.987	----	----	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

ALS Canada Ltd.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **WP2300036**	Page	: 1 of 5
Amendment	: 1		
Client	: **TREK Geotechnical Inc.**	Laboratory	: Winnipeg - Environmental
Contact	: Reinhardt van Rensburg	Account Manager	: Craig Riddell
Address	: 1712 St. James Street Winnipeg MB Canada R3H 0L3	Address	: 1329 Niakwa Road East, Unit 12 Winnipeg, Manitoba Canada R2J 3T4
Telephone	: 204 975 9433	Telephone	: +1 204 255 9720
Project	: 0829-001-00	Date Samples Received	: 03-Jan-2023 16:13
PO	: ----	Issue Date	: 09-Jan-2023 11:56
C-O-C number	: ----		
Sampler	: ----		
Site	: ----		
Quote number	: 2022 Pricing		
No. of samples received	: 2		
No. of samples analysed	: 2		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Inorganics : Soluble Sulfate ion in soil by boiling water extraction, IC.										
Glass soil jar/Teflon lined cap TH22-18 G174 (8.5'-10.0')	E246A.SO4	14-Dec-2022	07-Jan-2023	180 days	25 days	✓	07-Jan-2023	28 days	0 days	✓
Inorganics : Soluble Sulfate ion in soil by boiling water extraction, IC.										
Glass soil jar/Teflon lined cap TH22-13 G131 (19.'-13.5')	E246A.SO4	13-Dec-2022	07-Jan-2023	180 days	26 days	✓	07-Jan-2023	28 days	0 days	✓
Inorganics : Total Sulfate ion in soil by acidic boiling water extraction, IC										
Glass soil jar/Teflon lined cap TH22-18 G174 (8.5'-10.0')	E246.SO4	14-Dec-2022	07-Jan-2023	180 days	24 days	✓	07-Jan-2023	28 days	0 days	✓
Inorganics : Total Sulfate ion in soil by acidic boiling water extraction, IC										
Glass soil jar/Teflon lined cap TH22-13 G131 (19.'-13.5')	E246.SO4	13-Dec-2022	07-Jan-2023	180 days	25 days	✓	07-Jan-2023	28 days	0 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Soil/Solid**

Evaluation: × = *QC frequency outside specification*; ✓ = *QC frequency within specification.*

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4	796531	1	2	50.0	5.0	✓
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4	796385	1	2	50.0	5.0	✓
Laboratory Control Samples (LCS)							
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4	796531	4	2	200.0	10.0	✓
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4	796385	2	2	100.0	10.0	✓
Method Blanks (MB)							
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4	796531	2	2	100.0	5.0	✓
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4	796385	1	2	50.0	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by “mod”).

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Total Sulfate ion in soil by acidic boiling water extraction, IC	E246.SO4 Edmonton - Environmental	Soil/Solid	CSA-A23.2-3B	The dried solid is mixed with water and acid then heated. After filtration the liquid is ready for analysis by IC with conductivity detector.
Soluble Sulfate ion in soil by boiling water extraction, IC.	E246A.SO4 Edmonton - Environmental	Soil/Solid	CSA-A23.2-3B	The dried solid is mixed with water at a specified ratio then heated. After filtration the liquid is ready for analysis by IC with conductivity detector. A result of "NR" indicates that the total sulfate analysis was <0.2% and based on CSA-A23.2-3B no analysis for soluble sulfate is required.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Soluble ion Sulfate in soil or concrete preparation.	EP246.S Edmonton - Environmental	Soil/Solid	CSA-A23.2B	The dried solid is mixed with water then heated. After filtration the liquid is ready for analysis.
Total ion Sulfate in soil or concrete preparation	EP246.T Edmonton - Environmental	Soil/Solid	CSA-A23.2B	The dried solid is mixed with water and acid then heated. After filtration the liquid is ready for analysis.

ALS Canada Ltd.

QUALITY CONTROL REPORT

Work Order	: **WP2300036**	Page	: 1 of 4
Amendment	: **1**		
Client	: TREK Geotechnical Inc.	Laboratory	: Winnipeg - Environmental
Contact	: Reinhardt van Rensburg	Account Manager	: Craig Riddell
Address	: 1712 St. James Street Winnipeg MB Canada R3H 0L3	Address	: 1329 Niakwa Road East, Unit 12 Winnipeg, Manitoba Canada R2J 3T4
Telephone	:	Telephone	: +1 204 255 9720
Project	: 0829-001-00	Date Samples Received	: 03-Jan-2023 16:13
PO	: ----	Date Analysis Commenced	: 07-Jan-2023
C-O-C number	: ----	Issue Date	: 09-Jan-2023 12:04
Sampler	: ---- 204 975 9433		
Site	: ----		
Quote number	: 2022 Pricing		
No. of samples received	: 2		
No. of samples analysed	: 2		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percent Difference (RPD) and Data Quality Objectives
- Reference Material (RM) Report; Recovery and Data Quality Objectives
- Method Blank (MB) Report; Recovery and Data Quality Objectives
- Laboratory Control Sample (LCS) Report; Recovery and Data Quality Objectives

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Alex Drake	Lab Analyst	Edmonton Inorganics, Edmonton, Alberta

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percent Difference
# = Indicates a QC result that did not meet the ALS DQO.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test-specific).

Sub-Matrix: **Soil/Solid**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Inorganics (QC Lot: 796385)											
WP2300036-001	TH22-13 G131 (19.'-13.5')	sulfate, total, ion content	14808-79-8	E246.SO4	500	mg/kg	0.996 %	9930	0.277%	30%	----
Inorganics (QC Lot: 796531)											
WP2300036-001	TH22-13 G131 (19.'-13.5')	sulfate, soluble ion content	14808-79-8	E246A.SO4	500	mg/kg	0.987 %	9300	5.90%	30%	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Soil/Solid**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Inorganics (QCLot: 796385)						
sulfate, total, ion content	14808-79-8	E246.SO4	500	mg/kg	<500	----
Inorganics (QCLot: 796531)						
sulfate, soluble ion content	14808-79-8	E246A.SO4	500	mg/kg	<500	----
Inorganics (QCLot: 796578)						
sulfate, soluble ion content	14808-79-8	E246A.SO4	500	mg/kg	NR	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Soil/Solid**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Concentration	LCS	Low	High	Qualifier
Inorganics (QCLot: 796385)									
sulfate, total, ion content	14808-79-8	E246.SO4	500	mg/kg	10000 mg/kg	101	70.0	130	----
Inorganics (QCLot: 796531)									
sulfate, soluble ion content	14808-79-8	E246A.SO4	500	mg/kg	200 mg/kg	101	60.0	140	----

Reference Material (RM) Report

A Reference Material (RM) is a homogenous material with known and well-established analyte concentrations. RMs are processed in an identical manner to test samples, and are used to monitor and control the accuracy and precision of a test method for a typical sample matrix. RM results are expressed as percent recovery of the target analyte concentration. RM targets may be certified target concentrations provided by the RM supplier, or may be ALS long-term mean values (for empirical test methods).

Sub-Matrix:

					Reference Material (RM) Report				
					RM Target	Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Concentration	RM	Low	High	Qualifier
Inorganics (QCLot: 796385)									
	RM	sulfate, total, ion content	14808-79-8	E246.SO4	33400 mg/kg	88.1	80.0	120	----
Inorganics (QCLot: 796531)									
	RM	sulfate, soluble ion content	14808-79-8	E246A.SO4	2600 mg/kg	113	80.0	120	----

Chain of Custody (COC) / Analytical Request Form

COC Number: 22 -

Page of

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

Report To	Contact and company name below will appear on the final report
Company:	Trek Geotechnical
Contact:	Reinhardt Van Rensburg
Phone:	204-795-7929
	Company address below will appear on the final report
Street:	1712 St James Street
City/Province:	Winnipeg, MB
Postal Code:	R3H 0L3
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☑ YES ☐ NO
Company:	Trek Geotechnical
Contact:	

Reports / Recipients

Select Report Format: ☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)

Merge QC/QCI Reports with COA ☐ YES ☐ NO ☐ N/A

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: rvanrensburg@trekgeotechnical.ca

Email 2: afidler-kliewer@trekgeotechical.ca

Email 3:

Invoice Recipients

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: accounts@trekgeotechnical.ca

Email 2:

Turnaround Time (TAT) Requested

☑ Routine [R] if received by 3pm M-F - no surcharges apply
☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum
☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum
☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum
☐ 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum
☐ Same day [E2] if received by 10am M-S - 200% rush surcharge.

Additional fees may apply to rush requests on weekends, statutory holidays and for non-routine tests.

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm am/pm

For all tests with rush TATs requested, please contact your AM to confirm availability.

AFFIX ALS BARCODE LABEL HERE (ALS use only)

Project Information

ALS Account # / Quote #:	W10728
Job #:	0829-001-00
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#:
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (ALS use only):

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINER	SO4-Water-Soluble (CSA-A23.2-3B)	PH-WT	RESISTIVITY-CALC-WT	CONDUCTIVITY-EC-WT	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	TH22-13 G131 (19.0' - 19.5')	13/12/2022		Grab		R						
	TH22-18 G174 (9.5' - 10.0')	14/12/2022		Grab		R						

Environmental Division
Winnipeg
Work Order Reference
WP2300036

Telephone : +1 204 255 9720

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human consumption/ use? ☐ YES ☑ NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: ☐ NONE ☐ ICE ☐ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO

Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)

Released by: [redacted] Date: JAN 3, 2022 Time: 2:20 PM

INITIAL SHIPMENT RECEPTION (ALS use only)

Received by: [redacted] Date: JAN 03 2023 Time: 4:13

FINAL SHIPMENT RECEPTION (ALS use only)

Received by: Date: Time:

[redacted] IONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY FEB 2022 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

0036

15.4°C

Appendix B

Groundwater Monitoring Plots

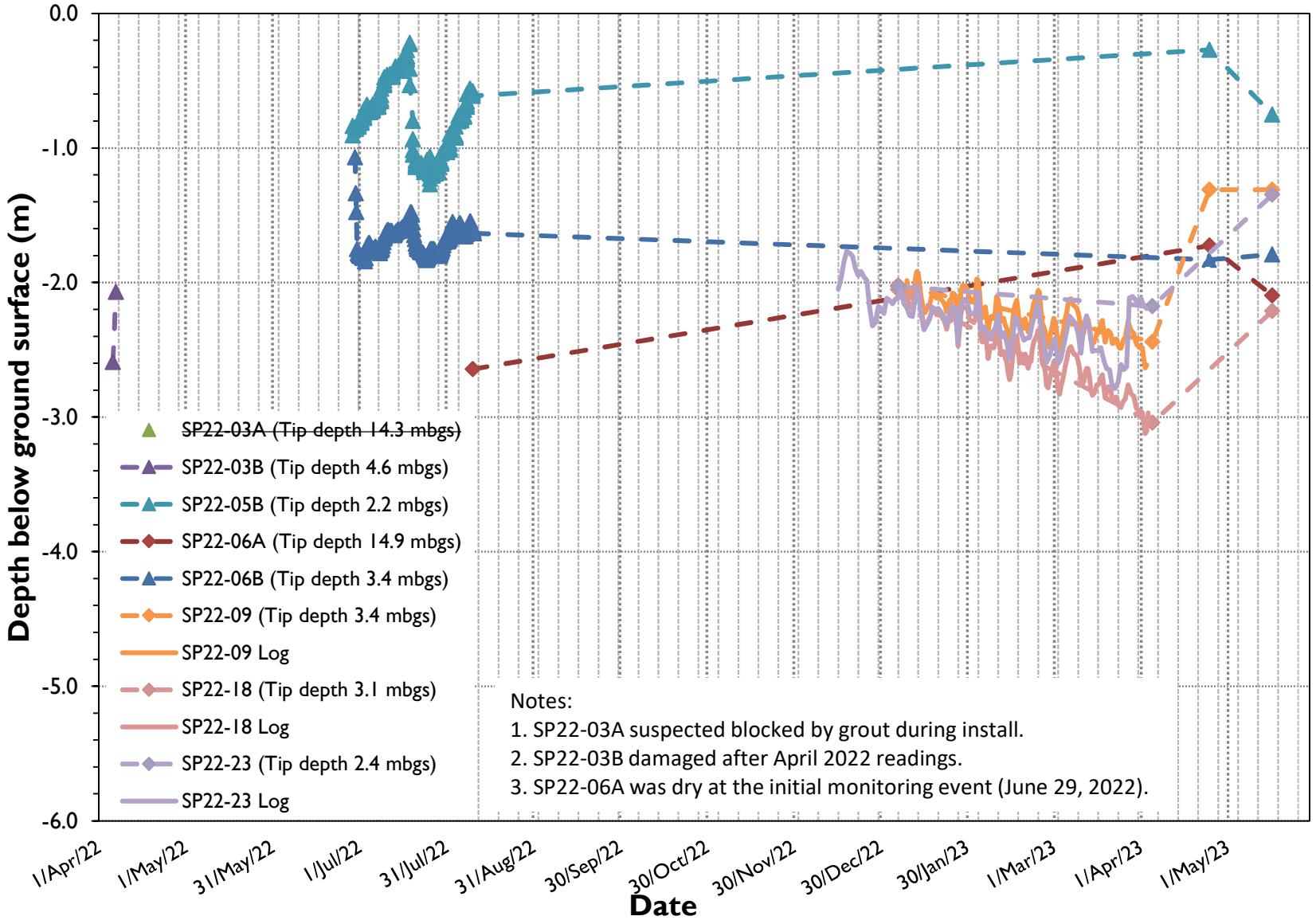


Figure B-1
Piezometer Summary Plot (one year)

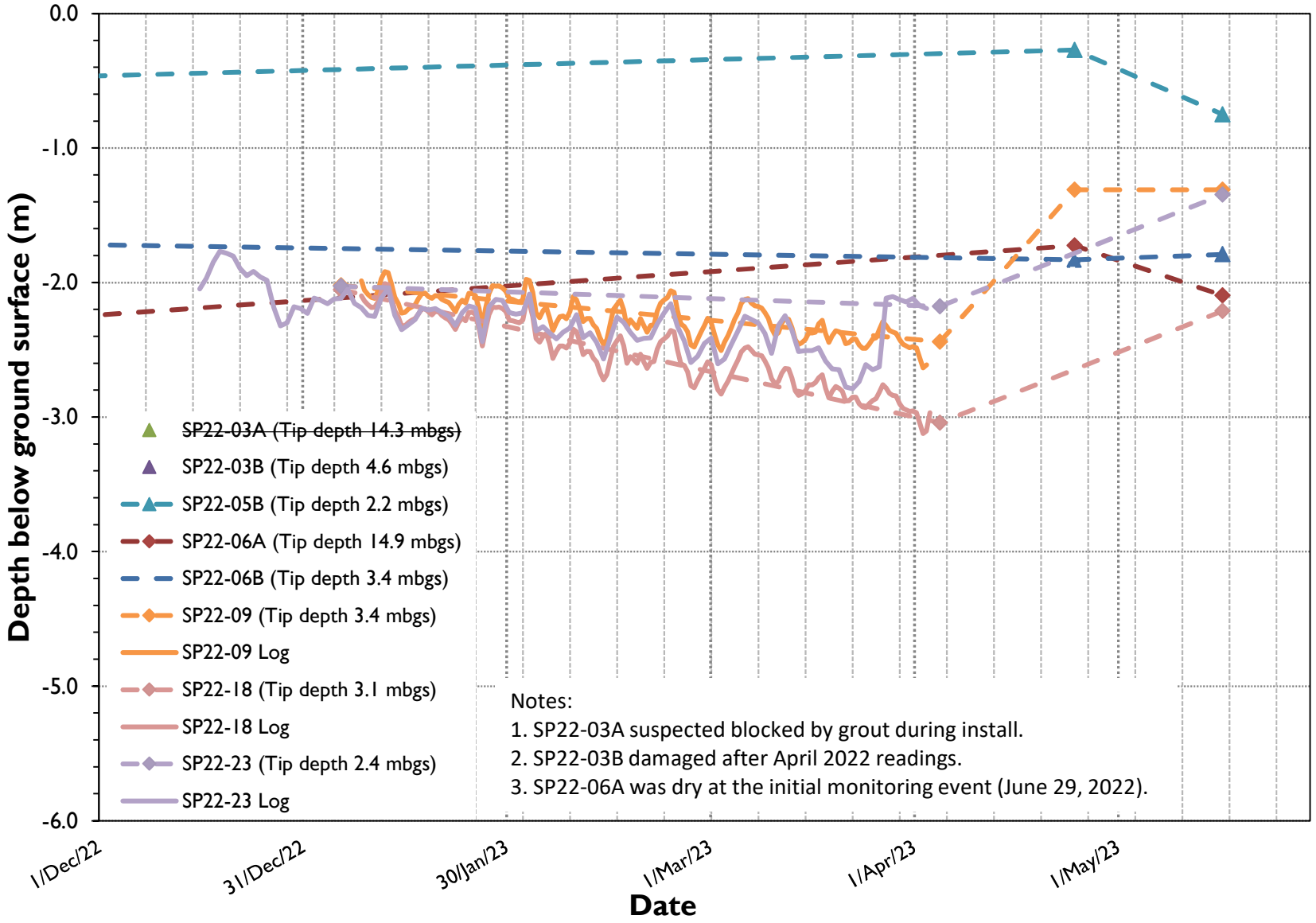


Figure B-2
Piezometer Summary Plot (three months)

Appendix G

Canadian Pacific (CP) Geotechnical Protocol for Pipeline and Utility Crossing(s) Under Railway Tracks

GEOTECHNICAL PROTOCOL

FOR

PIPELINE AND UTILITY CROSSING(S) UNDER

RAILWAY TRACKS

Engineering

Geotechnical and Public Works – Utilities

Last Updated: May 16, 2022

2	May 16, 2022	DJW	Fig C – Pg 39 & other sections highlighted
1	Feb 25, 2020	MR	Level 2 criteria – Pg 36
No	Date	By	Revision

Table of Contents

1.0 Limitations of the Document……..……..……..4

2.0 General Terminology 4

3.0 Introduction.....5

4.0 Emergencies.....6

5.0 Winter Work Restriction within CP ROW 6

6.0 Application Process Identification.....6

7.0 Minimum Information Requirements 8

8.0 Process 1 – Minimum 12
8.1 Criteria ……11
8.2 Application Requirements.....13
8.3 Application Review and Approval Process.....13

9.0 Process 2 – Intermediate 13
9.1 Criteria 14
9.2 Application Requirements.....15
9.3 Application Review and Approval Process 16

10.0 Process 3 – Detailed 17
10.1 Criteria 17
10.2 Application Requirements.....18
10.3 Application Review and Approval Process 18

11.0 Pre-Construction Meeting Requirement ..……..……..……18

12.0 Daily Inspection & Reporting during Construction……..…..……18

13.0 Review Steps.....20

14.0 Abandoned Pipe/Track Crossing(s)……..……...22

Appendices

Appendix A – Sample Figures 1 to 3

Appendix B – Sample Daily Report and Settlement Report

Appendix C – Track Movement Guidleine for Trenchless Pipe Installation

1.0 Limitations of the Document

The following protocol is independent of the requirements for assessing the structural components of the pipeline and pipeline crossing. The structural requirements for all pipeline crossings are included in CP – SP-TS-2.39- Pipeline and Cable Installations within Railway Right of Way. An agreement or permit from Canadian Pacific Railway's Public Works - Utilities is required before commencing with any work within the railway corridor. **Proposals for pipelines and utilities parallel to the track(s) are not covered under this protocol.**

In addition, this document does not cover review on any of the engineering design aspects of the proposed pipelines and utility crossings. Suitable engineering design is the sole responsibility of the applicant. Geotechnical approval of a proposed pipeline crossing by Canadian Pacific (CP) in no way warrants the suitability of construction methods/techniques for anticipated ground conditions, nor does it warrant the suitability of existing ground and site conditions for the use proposed by the applicant of the crossing. CP does not take any responsibility for the suitability of the construction method or warrantee the ground and/or site conditions. CP geotechnical approval of a pipeline and utility installation application merely indicates that based on the provided and available information, the proposed construction and design addresses CP's needs at the time of review and approval. CP does not provide engineering recommendations, directions or minimum standards to the applicant or their contractor(s) for design and execution of their work within CP Right-of-Way (ROW).

Due to third party work on CP ROW, CP will not be liable for any damages or delays to the applicant and/or CP assets and operation because of its approval of an application. In addition, any damages incurred to CP due to third party pipeline and utility crossing(s) will be the responsibility of the applicant.

CP requires that the applicant provide adequate documentation as outlined in this protocol; clearly identify the responsible Professional Engineer of Record and the components of the project for which they are responsible.

2.0 General Terminology

Base of Rail (BOR): is the bottom surface of the rail and is frequently used as a local datum from which vertical measurements are referenced. If an external datum is utilized the elevation of the BOR will be identified.

Geotechnical Engineer of Record's onsite designate/representative: A geotechnical trained and competent person assigned by the Geotechnical Engineer of Record to act as site inspector

who will be present onsite during the full duration of the construction and installation within railway operating corridor, unless, otherwise directed by CP Public Works - Utilities Supervisor. The site inspector must have the required training, experience and understanding of the site conditions, proposed design, and construction methodology to make sound engineering judgement and decisions, and reports during the course of the work.

Service Provider(s): include professional engineering firm(s) or individual(s) representing relevant or applicable engineering disciplines, to be retained on behalf of CP for engineering related review and/or oversight of fieldwork and track settlement monitoring results, for which the compensation will be paid by the applicant.

Zone of Potential Track Loading (ZPTL): is considered as the area under the track and within a 1V to 1.5H soil zone extending down from a point at the level of the BOR and 2 m (6.6 ft.) from The centerline of track as shown in Figure 3.

FRA: Federal Railroad Administration.

TC: Transport Canada.

3.0 Introduction

The purpose of this document is to ensure efficient application process and ensure safety and uninterrupted operation of Canadian Pacific (CP) Railway's operations during the execution of proposed third party pipeline and utility crossing(s) within CP ROW. This document is intended to guide the applicant of the minimum application requirements, review and approval process for proposed pipeline and utility crossing(s) as completed by CP Public Works - Utilities and Geotechnical groups. The goal of this protocol is to:

3.1 Provide safe track(s) conditions during and after the installation of proposed pipeline and utility crossing(s);

3.2 Establish requirements and procedures to be followed by the applicant(s) to minimize difficulties and risks to CP's operations and its assets during the installation and operation of pipeline and utility crossing(s) under CP's tracks and within its ROW;

3.3 Specify minimum criteria to be met for CP's review;

3.4 Ensure adequate subsurface information including geotechnical and groundwater information is available and an assessment by CP's geotechnical group or a CP approved service provider has been completed prior to providing approval; and

3.5 Allow timely processing of application for pipeline and utility crossing(s) approvals.

4.0 Emergencies

In the event of any occurrence due to construction/contractor activities that does or could pose a hazard, immediately contact CP at **1-800-716-9132**.

5.0 Winter Work Restriction within CP ROW

No construction and installation of pipeline and utility crossing(s) will take place from January 1st to March 31st. This restriction is particularly critical to areas where frost penetrates the ground and may make it difficult to observe surface settlement and loss of soil from underneath the track substructure due to misperception of a levelled frozen surface. Such conditions pose a risk to the stability of CP's track and its substructure during thawing season and are not acceptable.

In areas where the applicant does not consider frost as a potential risk, the applicant is required to assure and demonstrate to CP as to why winter work restriction is not applicable to their proposed work. Exceptions to winter work restriction will be evaluated on case by case basis.

6.0 Application Process Identification

To identify the applicable process, complete appropriate level of assessment and allow timely processing of a pipeline and utility crossing(s) proposal, the requirement criteria have been divided into three levels as identified in Table 1, i.e. Minimum, Intermediate and Detailed. These processes are categorized based on the size, cover, location and proximity of pipeline from tracks and other structures, and construction methodology of the proposed pipeline and utility crossing(s).

Applicant is expected to consult Table 1 to identify the level of effort and detail of submission required to meet CP review requirements for review. Details of each process are discussed in the following sections.

Table 1 – Process Identification

		Process Levels		
		1. Minimum[1]	**2. Intermediate**	**3. Detailed**
Dimension Criteria	Outside diameter of pipe	Less than 300 mm (12 in.)	300 mm (12 inches) to 1500 mm (59 in.)	Greater than 1500 mm (59 in.)
	Cover between BOR and top of pipe	Greater than 1.5 m (5 ft.) or three pipe diameters whichever is greater.	Greater than 1.5 m (5 ft.) or two (2) pipe diameters whichever is greater.	Less than 1.5 m (5 ft.) or two (2) pipe diameters.
	Adjacent structures including switches and signals	Greater than 10 m (32.8 ft.) from centerline	Within 2.5 times, cover between BOR and top of pipe.	
	Depth of pipes outside ZPTL	Refer to SP-TS 2.39 All pipes will be at least 0.91 m (3 ft.) below ground (below sub-ballast layer) where pipes are not below the ZPTL.	Less than 0.91 m (3 ft.) burial within ZPTL.	
Excavation Criteria	Excavation close to CP track(s)	Jacking/access pits shall be more than 10 m (32.8 ft.) from the closest track centerline and shall not encroach on the ZPTL.	Excavations or jacking/access pits within 10 m (32.8 ft.) of the closest track centerline.	
	Crossing angle	Less than 45 degrees off perpendicular to the track.	More than 45 degrees off perpendicular to the track.	

<table>
<tr><td></td><td colspan="3">Process Levels</td></tr>
<tr><td></td><td>1. Minimum[1]</td><td>2. Intermediate</td><td>3. Detailed</td></tr>
<tr><td rowspan="2">Construction Method</td><td colspan="2">Trenchless method[2]</td><td rowspan="2">All methods considered.</td></tr>
<tr><td colspan="2">Pipe bursting will only be considered where the predicted heave is less than 10% of the movement that would result in a change of the FRA or TC track class.</td></tr>
<tr><td>Approval Process</td><td>Public Works - Utility group to approve with no geotechnical submission.</td><td colspan="2">Full review of design, geotechnical and construction method Applicant to pay for the review cost of CP approved service provider.</td></tr>
</table>

[1] Move to next class if one or more criteria are not met.

[2] Trenchless methods include Auger Boring (AB), Pipe Jacking, Pipe Ramming (PR), Horizontal Directional Drilling (HDD) except high pressure fluid jetting method, Microtunnelling (MT) but exclude any type of mining techniques where any stand up time is required before the tunnel support is placed.

7.0 Minimum Information Requirements

7.1 All proposals for pipeline and utility crossing(s) approvals will be under the signature and seal of a locally registered professional Geotechnical Engineer referred to as Geotechnical Engineer of Record (GER). The objective is to ensure that a registered professional from applicant's design firm or organization is given the opportunity and responsibility to assess the site and subsurface conditions and demonstrates due diligence to assure CP that the proposal is appropriate for such conditions. This, however, depending on the complexity of design and proposal, may be in addition to the requirements of meeting industry standards or current regulatory requirements for structural integrity of the pipeline/utility. Such design will also require signature and seal by a professional geotechnical and/or structural engineer.

7.2 The application package must include a construction plan that specifies the terms and conditions for the execution of the proposed work, including assignment of responsibility. The applicant of the crossing(s) is responsible to ensure that the work is executed in accordance with the terms of the agreement with CP.

7.3 **Engineering Drawings:** All pipeline and utility crossing(s) application packages will be accompanied by following documents, at minimum, showing features on drawings in true scale.

7.3.1 Plan of the proposed pipe and utility crossing(s) under the track (Appendix A, Figure 1). This drawing will show the following features:

7.3.1.1 Location of the crossing(s), referencing identifiable landmarks including Mileage and Subdivision of the proposed crossing(s) as per CP Subdivision naming and Mileage convention. Applicant can obtain the Mileage and Subdivision information from CP Public Works - Utilities group; The title of the plan will include the subdivision name and mileage of the location.

7.3.1.2 Pipe centerline, diameter, length, size, limits, thickness and material;

7.3.1.3 Location of any adjacent structures including but not limited to signals, switches, culverts, other existing underground/buried services including Fibre Optics Transmission Systems (FOTS) and relevant distances from the centerline of the track(s);

7.3.1.4 Location of the ditch line and any breaks in slope;

7.3.1.5 Location of drilled boreholes or test pits from geotechnical investigation;

7.3.1.6 Location of all tracks and distances from track centerline to the proposed work area location; and

7.3.1.7 Location of all access pits, size, depth and details of support of excavation, if applicable.

7.3.2 Profile of the track and proposed pipeline and utility crossing(s) along the centerline of the track (Appendix A, Figure 2). The profile will show the following features:

7.3.2.1 Location of the crossing(s), referencing identifiable landmarks including Mileage and Subdivision of the proposed crossing(s) as per CP Subdivision naming and Mileage convention. Applicant can obtain the Mileage and Subdivision information from CP Public Works - Utilities Group;

7.3.2.2 Pipe centerline, diameter, length, size, limits, thickness and material;

7.3.2.3 Location of any adjacent structures including but not limited to signals, switches, culverts, other existing underground/buried services including Fibre Optics Transmission Systems (FOTS) and vertical distance from BOR;

7.3.2.4 Elevation of surface water in ditches, elevation of the ground water table in all boreholes and the date it was measured;

7.3.2.5 Test pit/borehole locations along with the stratigraphic profile as determined through the geotechnical investigation;

7.3.2.6 Depth of top of pipe to the BOR; and

7.3.2.7 Location of all jacking/access pits, size, depth and details of support of excavation, if applicable.

7.3.3 Section of the track along the centerline of the proposed pipeline and utility crossing(s) (Appendix A, Figure 3). This drawing will show the following features:

7.3.3.1 Location of the crossing(s), referencing identifiable landmarks including Mileage and Subdivision of the proposed crossing(s) as per CP Subdivision naming and Mileage convention. Applicant can obtain the Mileage and Subdivision information from CP Public Works - Utilities group;

7.3.3.2 Pipe centerline, diameter, length, size, limits, thickness and material;

7.3.3.3 Any adjacent structures including but not limited to signals, switches, culverts, other existing underground/buried services including FOTS and vertical distance from BOR;

7.3.3.4 Elevation of surface water in ditches, elevation of the ground water table in all boreholes and the date they were measured;

7.3.3.5 Test pit/borehole locations along with the stratigraphic profile as determined through the geotechnical investigation;

7.3.3.6 Location of jacking or access pits and proposed cut slope angles;

7.3.3.7 Location of the centerline of all tracks;

7.3.3.8 Depth of the top of pipe to the BOR; and

7.3.3.9 Any excavations that encroach on the ZPTL; Indicate ZPTL and distance from ground to the top of pipe.

7.3.3.10 Cross-Sections of perpendicular to the track shall be displayed as viewing in the direction of increasing CPR mileage; left and right-hand being so determined.

7.4 Geotechnical Investigation Report (if applicable) signed and sealed by a locally registered professional Geotechnical Engineer;

7.5 Settlement Monitoring Plan indicating layout and types of settlement monitors to be installed, frequency of measurements, alarm thresholds i.e. “Warning” and “Critical” thresholds, reporting protocol, and immediate actions to take when required. General track movement monitoring guidelines are provided in Appendix C.

7.6 Other Information: This includes information related to additional design and requirements based on the ground conditions and proposed construction. This may include excavation support/shoring, dewatering requirements etc. If required, complete design and relevant drawings will be required.

7.7 Applicant is expected to restore the site to its original condition.

7.8 Proposals for open cut will only be considered at sites where conditions make other installation techniques impractical or where rail traffic is low. This, however, will be assessed on case by case basis.

7.9 Installations using high pressure fluid jetting will not be considered.

7.10 The cost of remediation incurred to CP as a result of pipeline and utility crossing(s) construction and installation and related activities will be borne by the crossing(s) applicant. Some of the issues include settlement or soil heave induced by the crossing(s) installation during and after the construction.

7.11 All pipelines and utilities installed below the highest ground water level predicted will be sealed during construction.

7.12 All pipelines that will or could carry water shall be:

7.12.1 Installed with even bearing throughout its length to limit local settlement; and

7.12.2 Sloped to one end and prevent standing water. Special exemptions will be considered for inverted siphons or other applications requiring level pipes.

8.0 Process 1 – Minimum

8.1 Criteria

The general requirements included in Table 1 in conjunction with the following requirements must be met to obtain approval for a pipeline and utility crossing(s) that qualifies as a Process 1 crossing(s).

Table 2: Process 1 – Minimum

Dimension Criteria	
Outside pipe diameter	Less than 300 mm (12 in.)
Cover between BOR and top of pipe	Greater than 1.5 m (5 ft.) or three pipe diameters whichever is greater.
Adjacent structures including switches and signals	Greater than 10 m (32.8 ft.) centerline.
Depth of pipes outside ZPTL	Refer to SP-TS 2.39 All pipes will be at least 0.91 m (3 ft.) below ground where pipes are not below the ZPTL.
Excavation Criteria	
Excavation close to CP track(s)	Jacking/access pits shall be more than 10 m (33 ft.) from the closest track centerline and not encroach on the ZPTL.
Crossing angle	Less than 45 degrees off perpendicular to the track.
Construction Method	

1. Trenchless method[1]
2. Pipe bursting will only be considered where the predicted soil heave is less than 10% of the movement that would result in a change of the FRA or TC track class.

[1] Trenchless methods include Auger Boring (AB), Pipe Jacking, Pipe Ramming (PR), Horizontal Directional Drilling (HDD) except high pressure fluid jetting method, Microtunnelling (MT) but exclude any type of mining techniques where any stand up time is required before the tunnel support is placed.

8.2 Application Requirements

8.2.1 The applicant will provide documents and drawings containing the information identified in Section 7.0.

8.2.2 Generally,a geotechnical investigation is not required. However, in areas or conditions where problems have arisen with similar pipe crossings CP reserves the right to require a geotechnical investigation to be completed and submitted with the application.

8.2.3 Even if not required by CP, a geotechnical investigation may be completed at the discretion of the applicant.

8.3 Application Review and Approval Process

8.3.1 Applicant submits engineering documents to CP Public Works - Utilities.

8.3.2 CP Public Works – Utilities reviews documents to ensure applicable and complete engineering documents are provided.

8.3.3 An assessment is completed by CP Public Works – Utilities to provide decision/approval documentation.

9.0 Process 2 – Intermediate

The Intermediate process pertains to those proposed pipeline/track crossing(s) that exceed the minimum criteria but do not exceed the maximum criteria. The applicant will be required to submit information for review and approval by CP Geotechnical group, Public Works – Utilities or a CP

approved service provider but may not be subjected to additional engineering, monitoring and construction requirements.

9.1 Criteria

The general requirements included in Table 1 in conjunction with the following requirements must be met to obtain approval for a pipeline and utility crossing(s) that qualifies as a Process 2 crossing(s).

Table 3: Process 2 – Intermediate

Dimension Criteria	
Outside pipe diameter	300 mm (12 in.) to 1500 mm (59 in.)
Cover between BOR and top of pipe	Greater than 1.5 m (5 ft.) or two (2) pipe diameters whichever is greater.
Adjacent structures including switches and signals	Within 2.5 times, cover between BOR and top of pipe.
Depth of pipes outside ZPTL	Less than 0.91 m (3 ft.) burial within ZPTL.
Excavation Criteria	
Excavation close to CP track(s)	Excavations or jacking/access pits within 10 m (32.8 ft.) of the closest track centerline.

Crossing angle	More than 45 degrees off perpendicular to the track.
Construction Method	
	1. Trenchless method[1] 2. Pipe bursting will only be considered where the predicted soil heave is less than 10% of the movement that would result in a change of the FRA or TC track class.

[1] Trenchless methods include Auger Boring (AB), Pipe Jacking, Pipe Ramming (PR), Horizontal Directional Drilling (HDD) except high pressure fluid jetting method, Microtunnelling (MT) but exclude any type of mining techniques where any stand up time is required before the tunnel support is placed.

9.2 Application Requirements

9.2.1 Identification of the Geotechnical Engineer of Record (GER). The GER will be responsible for the proposed works on CP's ROW from project start up to project closeout including submission of construction summary report and as-built drawing.

9.2.2 Description of the subsurface soil and ground water conditions within and adjacent to CP embankment along the proposed pipe/track crossing alignment and to a depth no less that 1.5 times the invert depth below the BOR. This will consider the impact of silt, fine sand or sand soil, and their relation to the water table and pipe depth.

9.2.3 An estimate of the expected extent and magnitude of ground movement over time based on the proposed pipe installation method will be provided.

9.2.4 A program of ground surface and subsurface (settlement plates) movement monitoring will be implemented. The program must be capable of detecting movement of no less than 50 percent of the movement that would result in a change of the track class as determined by the FRA or TC track safety rules.

9.2.5 A procedure for notification of the appropriate CP personnel in the event that excessive or unexpected settlement occurs. A complete 24HR CP Emergency

contact list, including local personnel and OC will be compiled and in place before any work proceeds within the railway right of way.

9.2.6 A recovery plan will be provided outlining the steps to be implemented in the event of failure (excessive ground loss or settlement / collapse, heaving etc).

9.2.7 Design of de-watering control measures where applicable for the proposed construction method.

9.2.8 Temporary track support system will be required if any of the excavation is closer than 6 m (19.7 feet) from the centre of track and encroaches on the zone of potential track loading. The length of the excavation and an estimated stand-up time of the proposed cut within these limits must be provided and demonstrated to be safe.

9.2.9 A complete description of the proposed construction method.

9.2.10 Confirmation that the proposed construction/installation technique is suited to the site conditions and performance criteria. An assessment of the influence of construction on the track structure including estimated settlement/heave and assessment of risk associated with uncontrolled loss of ground or heaving.

9.2.11 Based on CP's review of the conditions, CP Geotechnical group may elevate a proposed crossing to Process 3 if deemed necessary.

9.2.12 A qualified independent CP approved engineer is required to provide periodic or continuous (at the discretion of CP) on-site supervision and document conditions during construction.

9.3 Application Review and Approval Process

9.3.1 Applicant submits engineering documents and applications to CP Public Works – Utilities.

9.3.2 CP Public Works – Utilities reviews documents to check if appropriate engineering documents have been provided.

9.3.3 CP approved service provider to review initially & sign off on behalf of CP at applicant's expense. CP Geotechnical to provide final geotechnical approval.

9.3.4 CP Structural Engineering Group may have to provide structural approval, if required.

9.3.5 CP Public Works – Utilities to provide final decision or permits.

10.0 Process 3 – Detailed

Process 3 will be applicable to those crossing(s) applications that do not meet the conditions of Process 2. In this case, expert engineering submissions are required, along with additional work such as dewatering as well as monitoring by on site engineering consultants during construction.

10.1 Criteria

The general requirements included in Table 1 in conjunction with the following requirements must be met to obtain approval for a pipeline crossing(s) that qualifies as a Process 3 crossing.

Table 4: Process 3 – Detailed

Dimension Criteria	
Outside pipe diameter	Greater than 1500 mm (59 in.)
Cover between BOR and top of pipe	Less than 1.5 m (5 ft.) or two (2) pipe diameters.
Adjacent structures, switches and signals	Within 2.5 times, cover between BOR and top of pipe.
Depth of pipes outside ZPTL	Less than 0.91 m (3 ft.) burial within ZPTL.

Excavation close to CP track(s)	Excavations or jacking/access pits within 10 m (33 ft.) of the closest track centerline.
Excavation Criteria	
Excavation close to CP track(s)	Excavations or jacking/access pits within 10 m (30 ft) of the closest track centerline.
Crossing angle	More than 45 degrees off perpendicular to the track.
Construction Method	
All methods considered	
Ground conditions, complex installation method, and/or the complexity of the project warrant that specialist-engineering personnel review the design and or construction of the pipe/track crossing(s).	

10.2 Application Requirements

10.2.1 The applicant will meet the requirement outlined in Process 2 - Section 9.2.

10.2.2 The applicant will provide resources for CP to retain CP approved service provider(s) or experts(s) to assess and review the application and advise CP on the impact of the applicant's proposal on CP ROW.

10.3 Application Process and Approval Process

10.3.1 Applicant submits engineering documents to CP Public Works – Utilities. All applications will be processed as per the procedure outlined in Section 9.3.

11.0 Pre-Construction Meeting Requirement

Prior to commencement of any work within CP property/ROW, the Geotechnical Engineer of Record (GER) or their designate shall arrange a pre-construction meeting with all stakeholders to discuss project and construction details including work description, construction methods and

schedule, restrictions, safety, hours/days of work, start time, Daily Reporting & other CP requirements and agreed upon Protocols governing Extreme Weather/Rainfall Warning Alerts issued from Local/National weather offices. This may mean that drilling operations ceases until these Alerts are no longer in effect. It is the responsibility of the GER or their designate to ensure that flagging protection has been arranged for the duration of the project, all construction oversight and track settlement monitoring review has been arranged with CP approved service provider and that the expectations have been clearly communicated before construction commences.

12.0 Daily Inspection & Reporting during Construction

This section is applicable to Process Levels 2 and 3 application proposals. The agreement holder or applicant will identify a Geotechnical Engineer of Record (GER) responsible for the complete work and installation of proposed crossing/excavation within CP ROW from start to finish. The Geotechnical Engineer of Record may assign a competent/trained person to act as Site Inspector/Engineer who will be present onsite during the full duration of the bore or any other ground disturbance activity within railway operating corridor, unless, otherwise directed by CP Public Works - Utilities Supervisor. Depending on the complexity of the installation and or field issues encountered during the installation that may adversely impact CP Infrastructure, CP may, at their discretion, assign a full time Geotech Monitor, of their choice, to be on site, at the Applicant's expense.

CP flagger or assigned representative must be present at all times when working or drilling within CP property or rail operating corridor. The Site Inspector/Engineer must have the required training, experience and understanding of the site conditions, proposed design, and construction methodology to make sound engineering judgement and decisions, and reports during the course of the work.

The Site Inspector/Engineer must ensure that the work is being carried out in accordance with the approved designs, permits and procedures, and/or relevant specifications. The Site Inspector/Engineer must immediately report any issues encountered during construction work and could have an impact on CP assets and its operations. Some examples include instability or potential of instability of the embankment or potential ground settlements either future or immediate.

Any concerns about the imminent stability of the grade shall immediately be escalated to CP Flagger or representative in order to protect against train operations. In addition, refer to CP 24HR Emergency Contact list to use in case of emergency. The concerns shall also be escalated to the GER and CP Public Work - Utilities supervisor so immediate remediation plans can be implemented.

The Site Inspector/Engineer will provide a daily report to CP approved service provider, copying CP Public Works – Utilities supervisor, CP's Director Geotechnical Engineering and the GER, outlining the progress during the day, any deviations from the original plans, any unexpected ground conditions, or any issues that were encountered during the construction. The report shall also contain relevant information that assures CP that the field activities are being monitored and documented to ensure that the installation is proceeding in accordance with approved plans and no unexpected conditions/issues are expected. Some examples of relevant information examples include some of the following information:

- A quantitative estimation of amount of material removed versus theoretical material;
- Auger location - Location of both, the leading edge of the pipe and the location of the leading edge of the auger should be documented;
- A description of the progress and any observations or issues encountered during the pipe installation including geologic conditions, change in material composition, characteristics, etc.

The daily report will also include all settlement monitoring data, along with any pertinent photos. If applicable, this report will also make notes and highlight any measures taken for "out of compliance" practice or when conditions requiring attention are expected or encountered. See Appendix B for a Sample Report.

Upon completion of the construction and installation of pipeline and utility crossing(s), the GER will provide a final sealed and stamped letter/construction report to CP approved service provider with a copy to CP Public Works – Utilities supervisor confirming that the work has been completed in accordance with the approved plans and procedures. If there are any deviations from the approved plans/procedures, these must be noted in the final letter/report. As-built stamped drawings are to be submitted to the CP Public Works – Utilities along with final settlement data collected and correspondence.

All costs associated with above mentioned i.e. complete geotechnical review, track settlement monitoring, flagging and construction oversight provided CP approved service provider will be borne by the applicant.
A contract between CP approved service provider(s) and the applicant must be place before proceeding with this work proposal.

13.0 Review Steps

The following is a checklist of steps that will be completed to ensure that the appropriate level of care has been taken for Process 2 and 3 pipe crossings below the track.

Table 5 – Review Steps

No.	Step	Action/Review by
13.1	Submission of crossing(s) proposal by applicant including details of the crossing(s) specification and potential construction method(s) to CP Public Works - Utilities.	Applicant
13.2	Review of the proposal as per this protocol to determine what level of geotechnical engineering and review is required.	CP Public Works - Utilities
13.3	Designation of review i.e. CP approved service provider. (ASP)	CP Public Works - Utilities
13.4	Identification of the Applicant's Geotechnical Engineer of Record.	CP Geotech Engineering/ASP
13.5	Assessment of adequacy of the geotechnical investigation and other required information.	CP Geotech Engineering/ASP
13.6	Applicant's geotechnical engineer determines that the proposed construction/installation method will not cause settlement of the CP track or structures.	CP Geotech Engineering/ASP
13.7	Settlement monitoring program, if required and developed by the applicant's geotechnical engineer.	CP Geotech Engineering/ASP
13.8	Once a contractor has been selected, the Geotechnical Engineer of Record (GER) will review the shop drawings submitted by the contractor or the sub-contractor(s) to determine if the tunnelling and dewatering (if required) method proposed could cause track settlement.	CP Geotech Engineering/ASP
13.9	Applicant will provide CP with written documentation of who will be completing the onsite review of the contractor's construction practice and the specifics of the assignment.	CP Geotech Engineering/ASP
13.10	Applicant will enlist the services of a Geotechnical Engineer of Record(GER) with the responsibility for inspection of the tunnelling contractor's work. They will also assure that adequate measures are in place to minimize the potential for track settlement. The intention is to assign an appropriate group with the task of assuring that actions undertaken by the contractor do not endanger the track structure because of ground loss during tunneling which may affect CP Train operations.	CP Geotech Engineering/ASP

No.	Step	Action/Review by
13.11	An emergency response will be developed and posted on site and will reside with key personnel.	CP Geotech Engineering/ASP
13.12	A contingency plan will be prepared and submitted by Tunneling contractor prior to start of construction, identifying tasks/activities that can be completed within hours to get track back in service, if significant track settlement is experienced.	CP Geotech Engineering/ASP
13.13	24 Hour Emergency Contact List to be provided prior to commencement of construction.	CP Public Works - Utilities

14.0 Abandoned Pipe/Track Crossing(s)

In the event that an existing installation is abandoned or a proposed crossing(s) is abandoned during construction, all potential hazards to CP property must be removed or abated. This may be achieved by removal of any buried pipes and the backfill and compaction of any excavations. Alternately, upon approval of the CP Geotechnical group any voids within ground may be backfilled with non-shrinkable fill, or pressured grout sufficient to prevent future sloughing or track settlement. Any buried material (wood or metal) that could increase or decrease volume over time due to chemical reaction (oxidation) or decomposition must be removed or stabilized to the satisfaction of CP.

----------*END OF TEXT*----------

APPENDIX A

SAMPLE FIGURES 1 TO 3

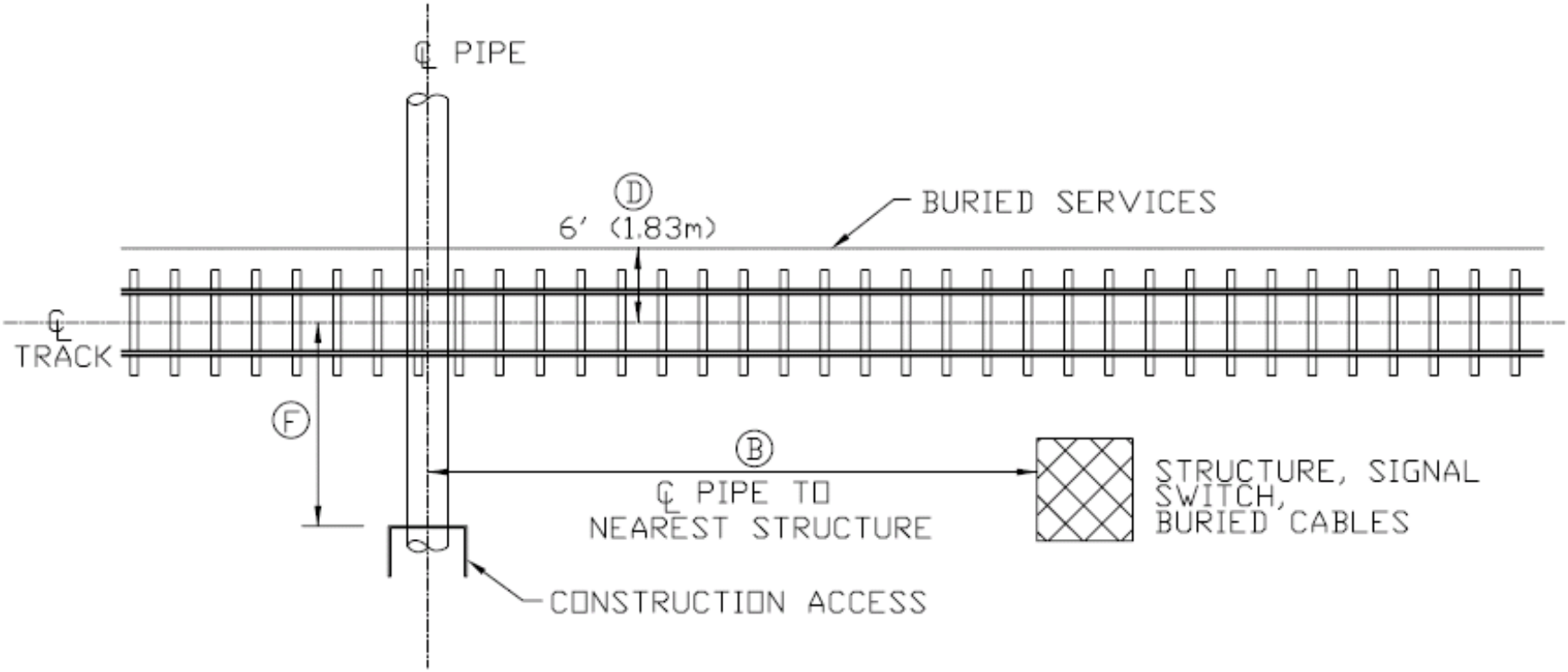


Figure 1 – Plan of the proposed pipe crossing

SAMPLE

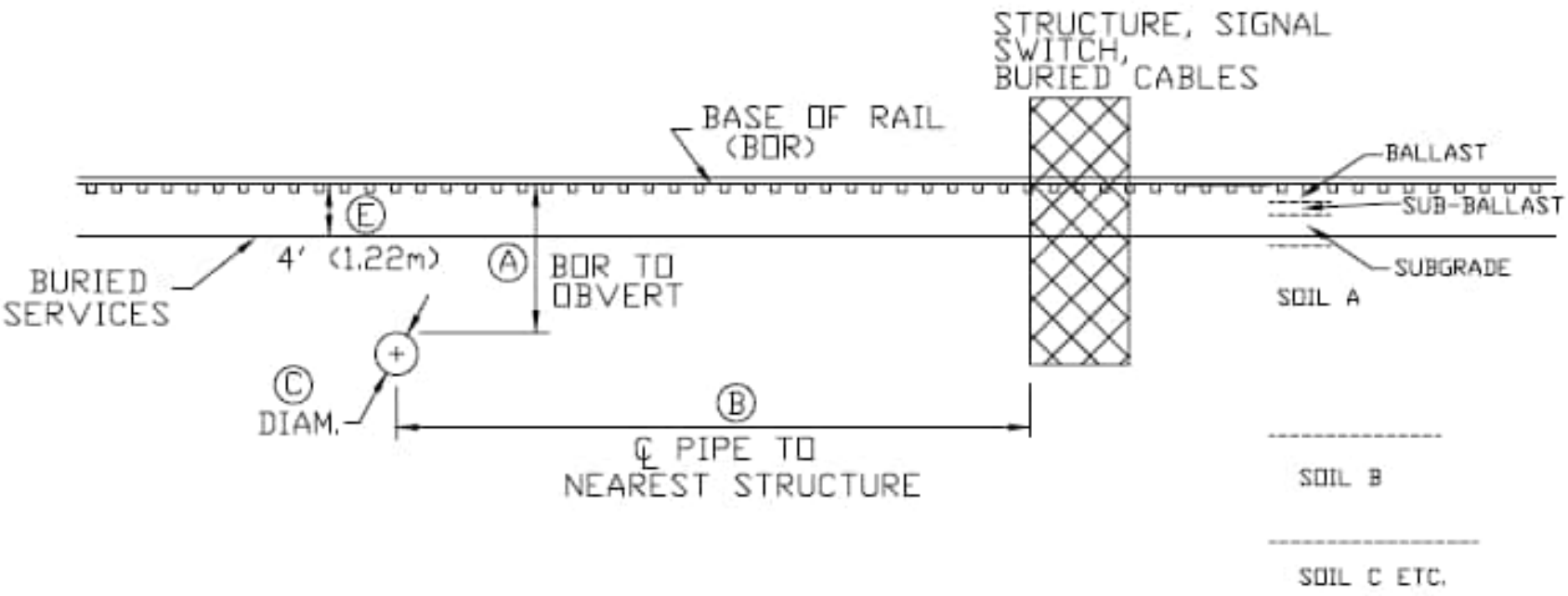


Figure 2 – Profile of the track and proposed pipe crossing along the centerline of track

SAMPLE

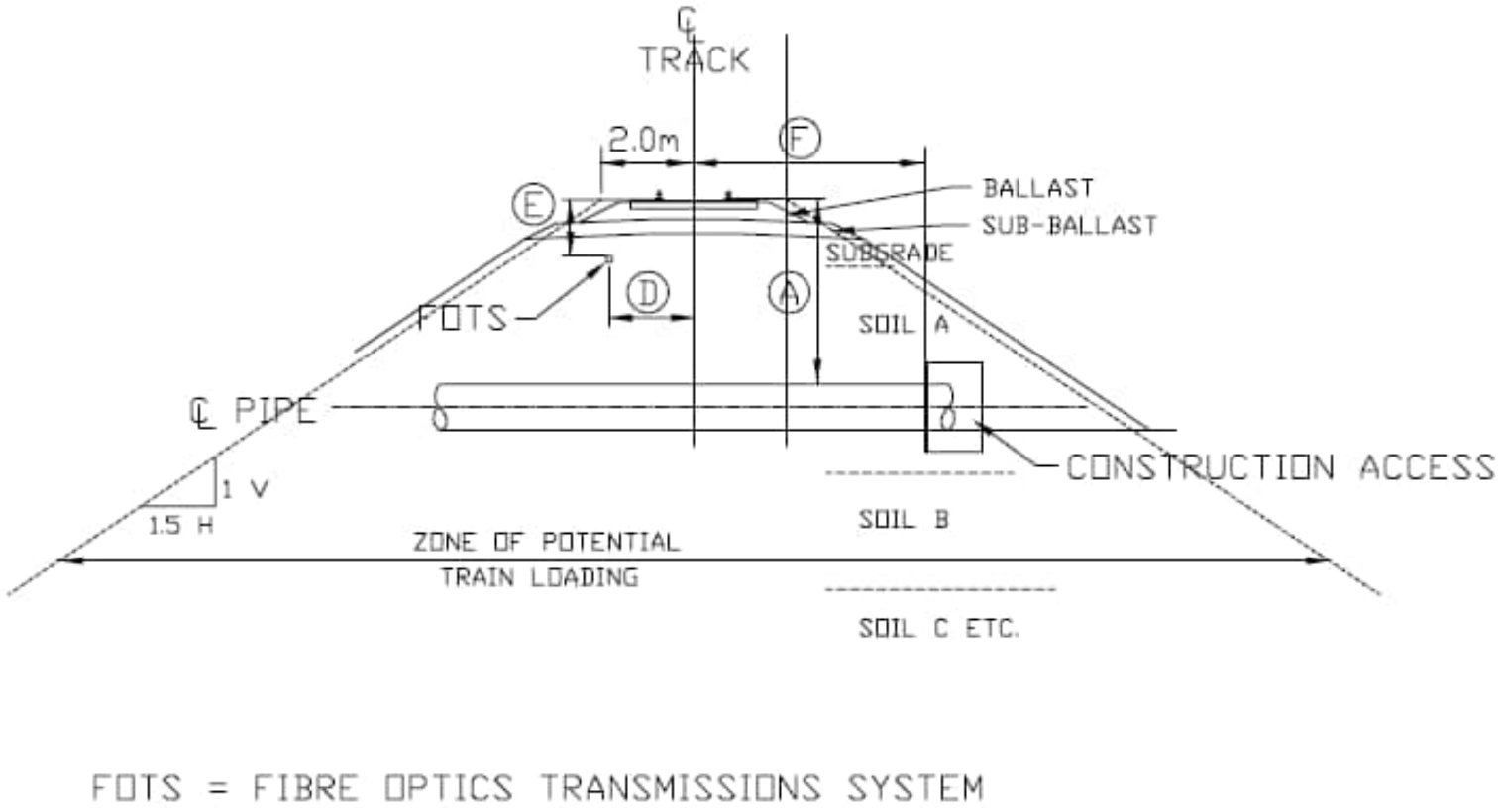


Figure 3 – Section of Track along centerline of proposed pipe

SAMPLE

Appendix B

SAMPLE DAILY REPORT AND SETTLEMENT REPORT

SAMPLE DAILY REPORT

PROJECT INFORMATION

Project Name:		**Date:**	July 11, 2019
Location:		**Contractor:**	
Client:		Site Rep:	

DAILY SUMMARY

Excavation Details: [i.e., depth, sideslopes, trench boxes, sloughing, etc.]	No additional casing installed today. No sloughing of CPR embankment noted. See attached sketch.
Construction Summary: [i.e., soil type, issues, etc.]	Contractor attaching shoes (wedges) to the casing exterior near the casing head behind the gravel plug (approx. station 0+031). One shoe on track west side of casing approx. 250 mm X 300 mm X 50 mm(deep outside of casing). One shoe on bottom of casing approx. 275 mm X 300 mm X 25 mm(deep outside of casing).
Cumulative Settlement Movement (mm):	☒ Minimal Movement (<8) ☐ Level 1 – Warning (≥8 to <16) ☐ Level 2 – Critical (≥16)
Compliance with Design:	☐ Yes ☒ No If No, discuss below
Issues with Installation:	☒ Yes ☐ No If Yes, discuss below
Other Notes, if any:	Casing was out of alignment by approximately 40 mm track west and 25 mm lower than designed location at about station 0+031. Contractor attaching shoes (wedges) to the casing exterior near the casing head behind the gravel plug (approx. station 0+031) for alignment correction.

Prepared By: Reviewed By:

SAMPLE

SAMPLE DAILY SETTLEMENT MONITORING REPORT

SETTLEMENT MONITORING

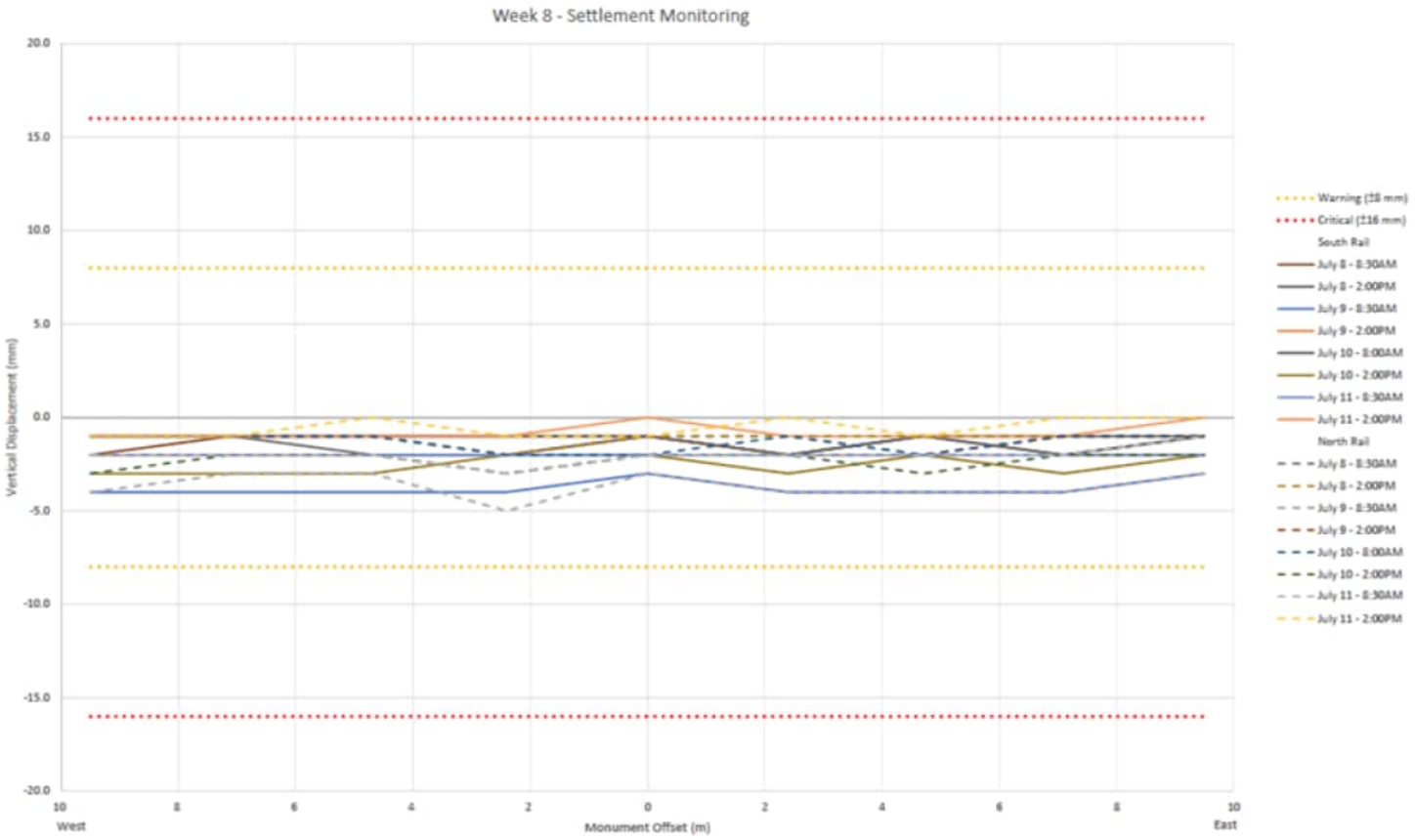
Surveyor: CP Flagger **Date:** July 11, 2019

Weather: Sunny **Temperature:** 16°C at 8:30 am; 27°C at 2:00 pm

*Survey locations along the top of the rails. **Baseline elevation is average of 2 surveys on June 12, 2019. ***Positive numbers correspond to heave and negative numbers correspond to settlement

Rail Location	Location Description and Monument ID*	Baseline Elevation (m)**	Reading 1			Reading 2		
			Time	Elevation (m)	Cumulative Movement (mm)***	Time	Elevation (m)	Cumulative Movement (mm)***
South Rail	9.45 m East (S9)	1034.587	8:30 am	1034.585	-2	2:00 pm	1034.587	0
	7.08 m East (S8)	1034.593		1034.591	-2		1034.592	-1
	4.72 m East (S7)	1034.597		1034.595	-2		1034.596	-1
	2.36 m East (S6)	1034.601		1034.599	-2		1034.600	-1
	Centerline (S5)	1034.605		1034.603	-2		1034.605	0
	2.36 m West (S4)	1034.612		1034.610	-2		1034.611	-1
	4.75 m West (S3)	1034.618		1034.616	-2		1034.617	-1
	7.08 m West (S2)	1034.622		1034.620	-2		1034.621	-1
	9.45 m West (S1)	1034.626		1034.624	-2		1034.625	-1
North Rail	9.45 m West (N1)	1034.624		1034.622	-2		1034.623	-1
	7.08 m West (N2)	1034.621		1034.619	-2		1034.620	-1
	4.75 m West (N3)	1034.617		1034.615	-2		1034.617	0
	2.36 m West (N4)	1034.612		1034.609	-3		1034.611	-1
	Centerline (N5)	1034.604		1034.602	-2		1034.603	-1
	2.36 m East (N6)	1034.599		1034.597	-2		1034.599	0
	4.75 m East (N7)	1034.597		1034.595	-2		1034.596	-1
	7.08 m East (N8)	1034.590		1034.588	-2		1034.590	0
	9.45 m East (N9)	1034.586		1034.585	-1		1034.586	0

SAMPLE


Week 8 - Settlement Monitoring
Vertical Displacement (mm)
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
10
8
6
4
2
0
2
4
6
8
10
West
Monument Offset (m)
East
Warning (±8 mm)
Critical (±16 mm)
South Rail
July 8 - 8:30AM
July 8 - 2:00PM
July 9 - 8:30AM
July 9 - 2:00PM
July 10 - 8:00AM
July 10 - 2:00PM
July 11 - 8:30AM
July 11 - 2:00PM
North Rail
July 8 - 8:30AM
July 8 - 2:00PM
July 9 - 8:30AM
July 9 - 2:00PM
July 10 - 8:00AM
July 10 - 2:00PM
July 11 - 8:30AM
July 11 - 2:00PM

SAMPLE

SAMPLE TRENCHLESS INSTALLATION MONITORING REPORT

TRENCHLESS INSTALLATION MONITORING

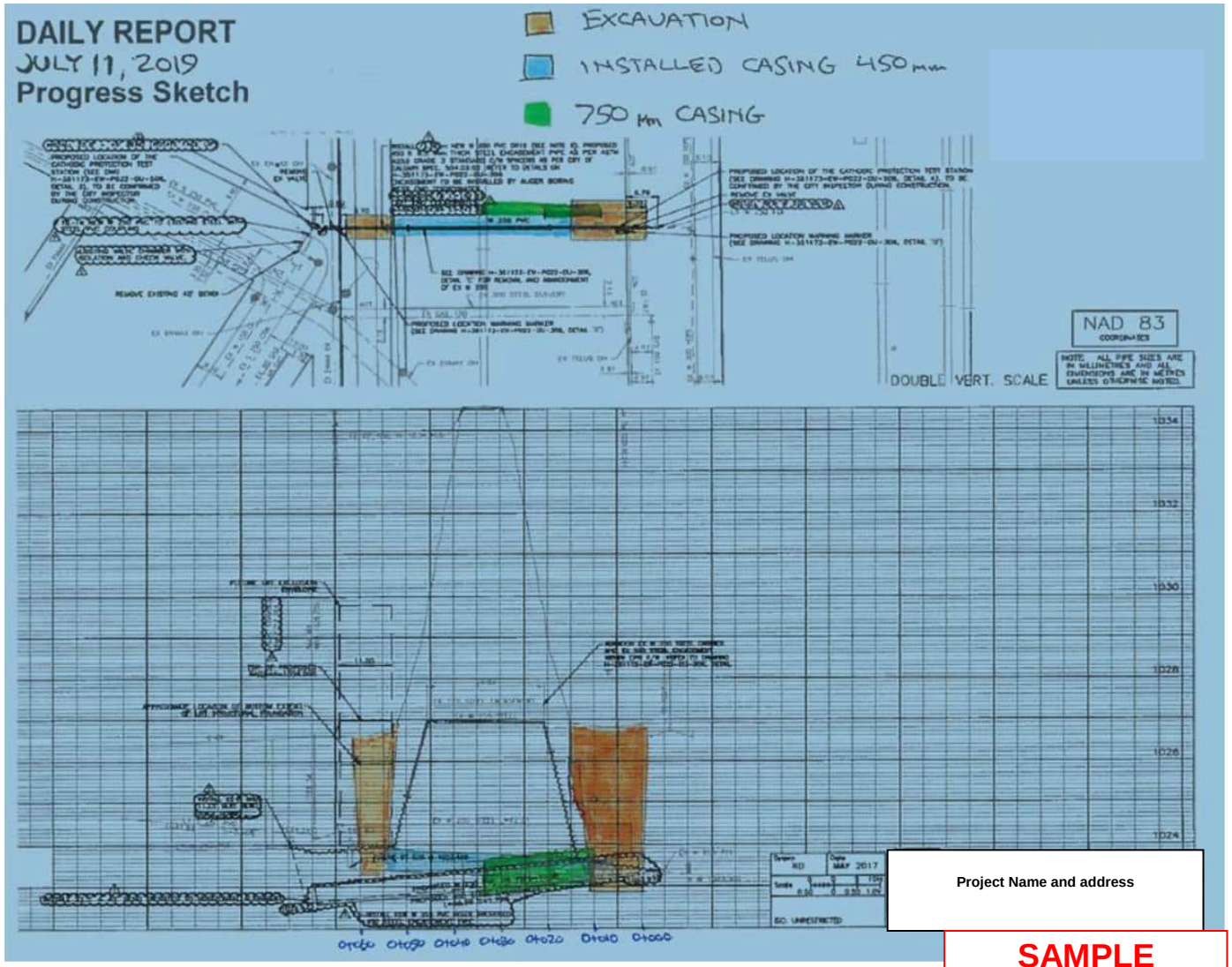
Equipment:	Air Hammer	**Operator:**	
Casing Pipe Diameter:	750 mm	16 mm overcut on casing head	
Date:	July 11, 2019	2m plug at casing head during installation	

Date	Segment No.	Segment Length (m)	Station Interval along the Face of Installation	Length of Pipe Installed (m)	Distance of Head to CL Track (S or N) (m)	Soils Condition/Description
July 7, 2019	1	6.0	0+015	6.0	18 m N	Gravel, sandy, some silt, trace clay. Dry
July 8, 2019	2	6.0	0+021	6.0	12 m N	Gravel, sandy, some silt, trace clay. Dry
July 9, 2019	3	6.0	0+027	6.0	6 m N	Gravel, sandy, some silt. Damp
July 9, 2019	4	6.0	0+033	6.0	0 m (CL Track)	Gravel, sandy, some silt. Damp
July 10, 2019 July 11, 2019						No casing installed, contractor attaching shoes (wedges) to casing at station 0+031

SAMPLE

N1
N2
N3
N4
N5
N6
N7
N8
N9
S1
S2
S3
S4
S5
S6
S7
S8
S9
UPDATED CL OF WATERMAIN
CL OF 450 WATERMAIN (ORIGINAL)
26A STREET SE
LEGEND
SURFACE SETTLEMENT MONITORING POINT (PREVIOUS)
UPDATED SURFACE SETTLEMENT MONITORING POINT (JUNE 12)
0
20m
LOCATION OF
SETTLEMENT MONITORING MONUMENTS
C1210360OPKG-022.4
LCH
KH
0
TT Cal
May 2019
Figure

SAMPLE


DAILY REPORT
JULY 11, 2019
Progress Sketch
EXCAVATION
INSTALLED CASING 450 mm
750 mm CASING
NAD 83
DOUBLE VERT. SCALE
Project Name and address
SAMPLE

Appendix C

TRACK MOVEMENT MONITORING GUIDELINES FOR TRENCHLESS PIPE INSTALLATION

Track Movement Monitoring Guidelines for Trenchless Pipe and Utility Crossing(s) Installation under Railway Tracks

(Last updated – May 16, 2022)

The monitoring of track settlement should be carried out by means of surface and subsurface settlement points. The intent of subsurface settlement points is to measure voids created just in the vicinity and above the pipe during construction in order to predict the potential movement of overlying CP tracks.

The settlement point essentially consists of a small diameter pipe anchored at the bottom of a vertical borehole and an outer casing to isolate the pipe from down drag forces caused by settlement of soil above the anchor (see Figure B). The subsurface settlement points would be installed to 1 m above the crown of the casing profile. The total number of subsurface settlement points within CP Right-of-Way (ROW) along the axis of the proposed pipe crossing(s) would be installed as per the configuration shown in Figure A – Sample Surface and Subsurface Settlement Monitoring Layout.

Surface points installed directly along the base of both rails at a spacing of 9.45 m (31 ft.) over the projected settlement trough would be used to monitor differential transversal elevation between both rails. The total number of surface settlement points within CP ROW would be installed as per the configuration shown in Figure A – Sample Surface and Subsurface Settlement Monitoring Layout. These points shall be monitored simultaneously with the subsurface settlement points that would act as a precursor to potential surface movement during pipe installation.

Once the installation is complete, a monitoring program of all points is to be carried out in accordance with the following instructions:

1. Monitoring should start before the excavation of the pits and pipe installation begins and readings should be taken at least twice per day for no less than two days. This is required to establish a reliable methodology and demonstrate the accuracy to be achieved.

2. Monitoring should proceed through the construction period and should be completed:

    1) For branch lines/lines with low traffic - (Class 1-2 Track) - At least twice daily.

    2) For main lines and heavy traffic lines – (Class 3-5 Track) Every 2 hours or after each train, whichever provides the most number of readings while the boring operation is within the ZPTL (Zone of Potential Train Loading).

3. Monitoring should continue for at least 3 days after the completion of construction.

4. If there is any loss of ground during pipe installation, any reason to believe settlement may be delayed or any settlement is identified during the installation of pipe or subsequent

monitoring period, the monitoring must be continued until the applicant's Geotechnical Engineer of Record deems it is safe to discontinue such monitoring. This must be approved by CP Geotechnical Engineering group or CP approved service provider reviewing the monitoring results.

Monitoring measurements should be taken with sufficient frequency (as noted above) to capture the unexpected performance at the earliest possible stage and be evaluated in a timely manner. Additional measures will be proposed should this monitoring protocol be considered insufficient based on the ground conditions or installation process. Track survey preference would be for survey shots to be taken remotely (i.e. off CP property) and without the requirement of a CP Flagger or representative presence on site.

Two alarm levels are proposed:-

Level 1:

"WARNING/ALERT" will be indicated on the field memo/report when a settlement of **50 (%)** of the critical monitoring threshold is obtained from the subsurface and/or surface settlement points. A survey of the surface points will then be carried out and work will be authorized to continue if no movement of the subsurface point has been measured from the previous reading. If movement of the rails is recorded, monitoring will be continued until rail movement is stopped. At this point, the drilling work will then be authorized to continue. See Figure C – Track Settlement Monitoring Review and Alert Threshold for Threshold values per Class of Track designation. Please contact CP Public Work-Utilities Supervisor to obtain Class of Track designation pertaining to the proposed Utility Crossing location.

Level 2:

"CRITICAL/REVIEW" will be indicated on the field memo/report when a settlement of specified monitoring threshold is obtained from the subsurface settlement point. A survey of the surface points will then be carried out and work will be authorized to continue if no movement is measured for at least two (2) readings taken 12 hours apart. If movement of the rails is recorded, monitoring will be continued until movement is stopped and the applicant has submitted a new pipe installation procedure. This procedure must be reviewed and approved by CP Geotechnical Engineering group or CP approved service provider reviewing the monitoring results.

The applicant and their Geotechnical Engineer of Record are responsible for ensuring that track settlement does not occur and for notifying CP Roadmaster or their designate, as indicated on the 24 hr Emergency Contact List, should unforeseeable track settlement occur or be expected.

The above guidelines do not relieve the applicant and their engineer(s) of this responsibility. The applicant or their engineer(s) shall provide the settlement information and their interpretation of the data including information such as. no track settlement, deep settlement etc., a quantitative number of how much track settlement has occurred, is likely to occur and when it is likely to occur. This information should be provided in easily understandable terms for

all parties involved in the construction and monitoring and should be directed to local CP Roadmaster, CP approved service provider, Supervisor – CP Public Works – Utilities and Director of Geotechnical Engineering.

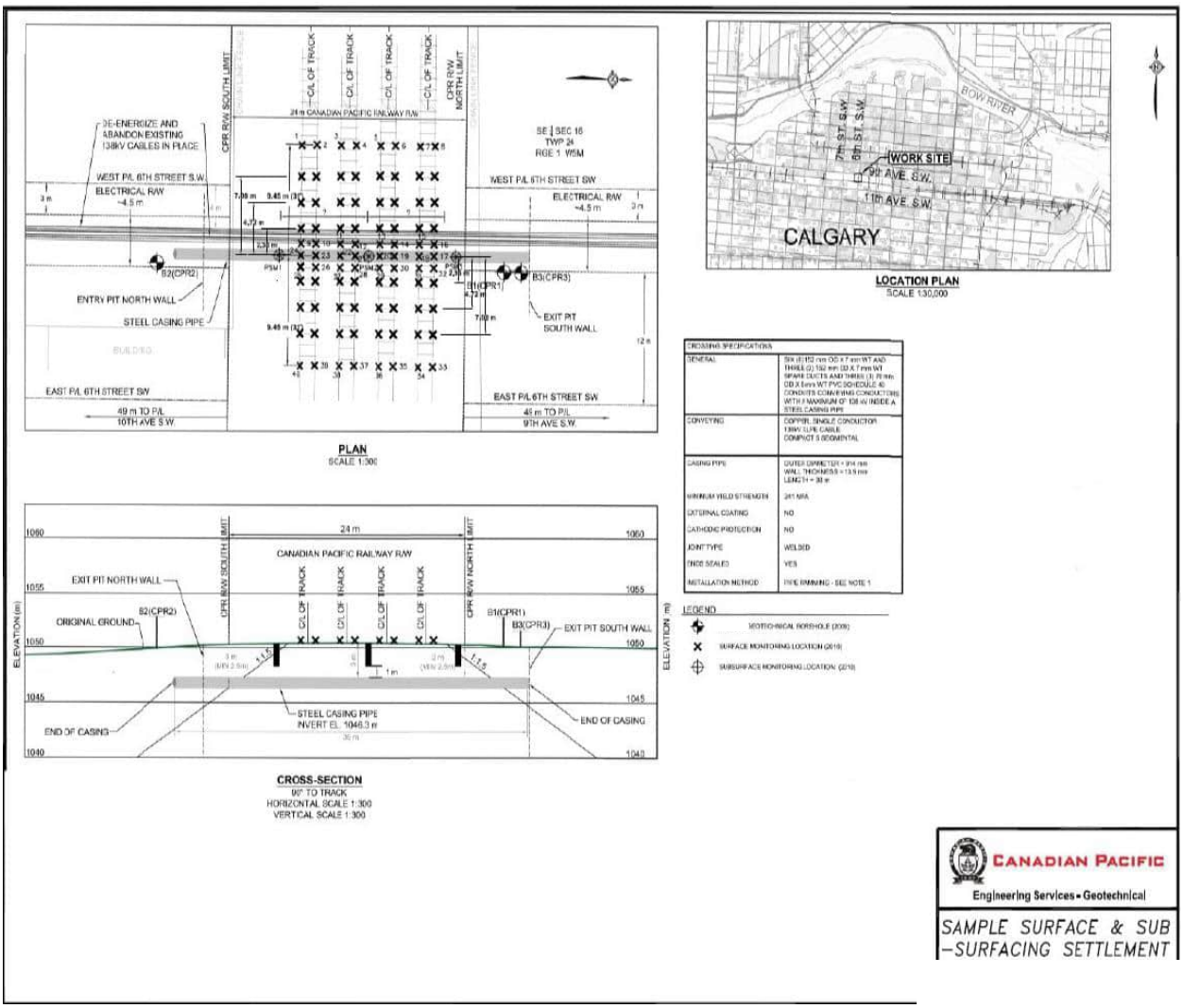


Figure A - Sample Surface and Subsurface Settlement Monitoring Layout

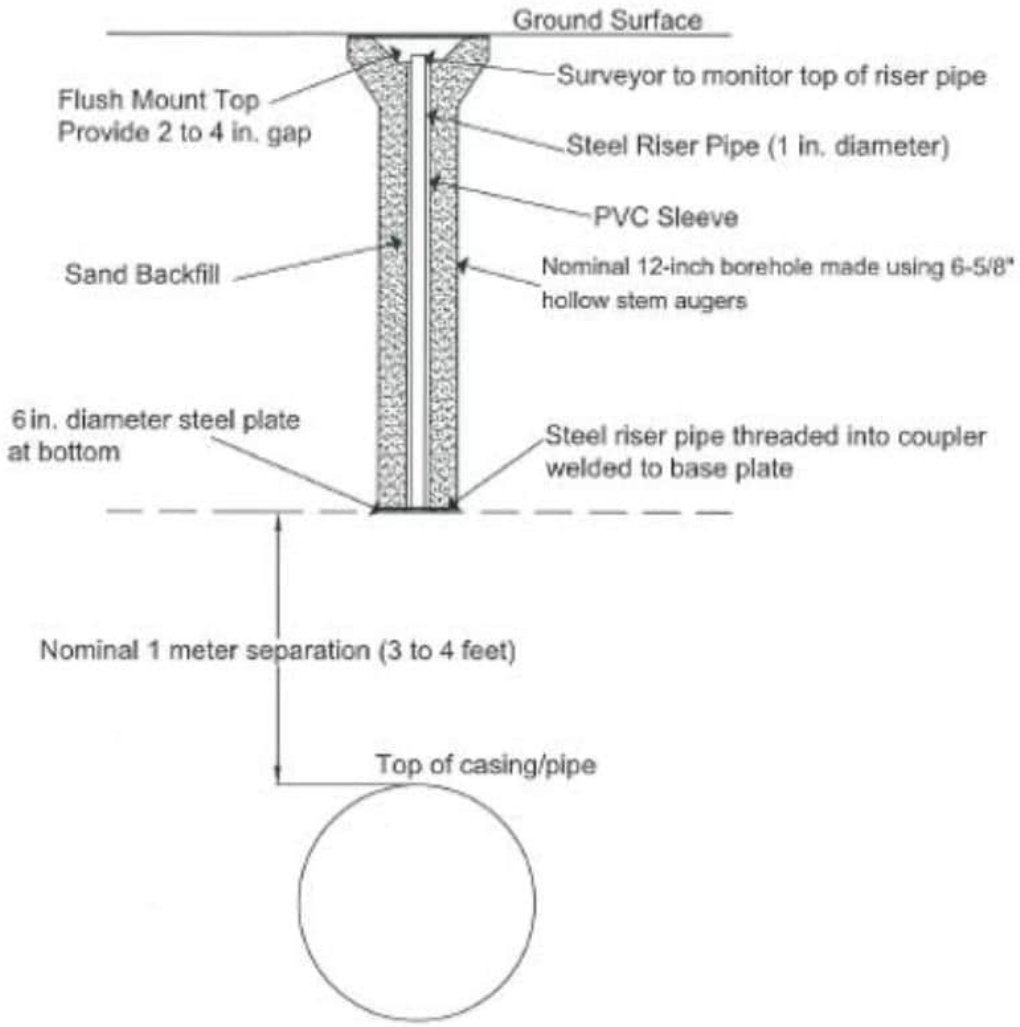


Figure B - Typical Subsurface Settlement Point Detail

Figure C – Track Settlement Monitoring Review and Alert Thresholds (Surface and Subsurface)

Class of track	Critical/Review Threshold	Alert/Warning Threshold
1	22 mm	11 mm
2	22 mm	11 mm
3	19 mm	10 mm
4	16 mm	8 mm
5	13 mm	6 mm
6	10 mm	5 mm

Note – All above numbers are maximum values

Class of Track

TRACK CLASSES

Class	Freight Train Speed	Passenger Train Speed
1	10 MPH	15MPH
2	25 MPH	30 MPH
3	40 MPH	60 MPH
4	60 MPH	80 MPH
5	80 MPH	95 MPH* 90 MPH **
*Denotes for LRC trains – 100 MPH	** - Applies to US only	Note – Numbers above are maximum values

Appendix H

AECOM – Crossing Profiles

Project Management Initials: ____ Designer: ____ Checked: ____ Approved: ____ ISO A1 594mm x 841mm

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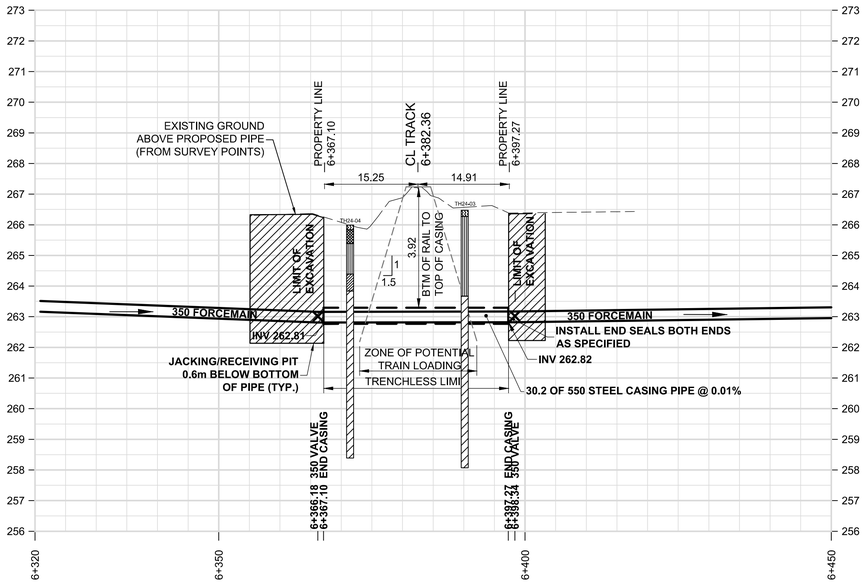
Printed on ___ % Post-Consumer Recycled Content Paper

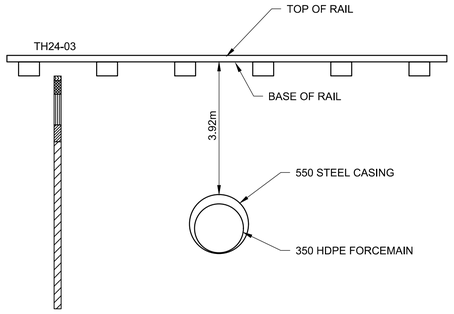


SECTION ON ℄ TRACK

Scale NTS

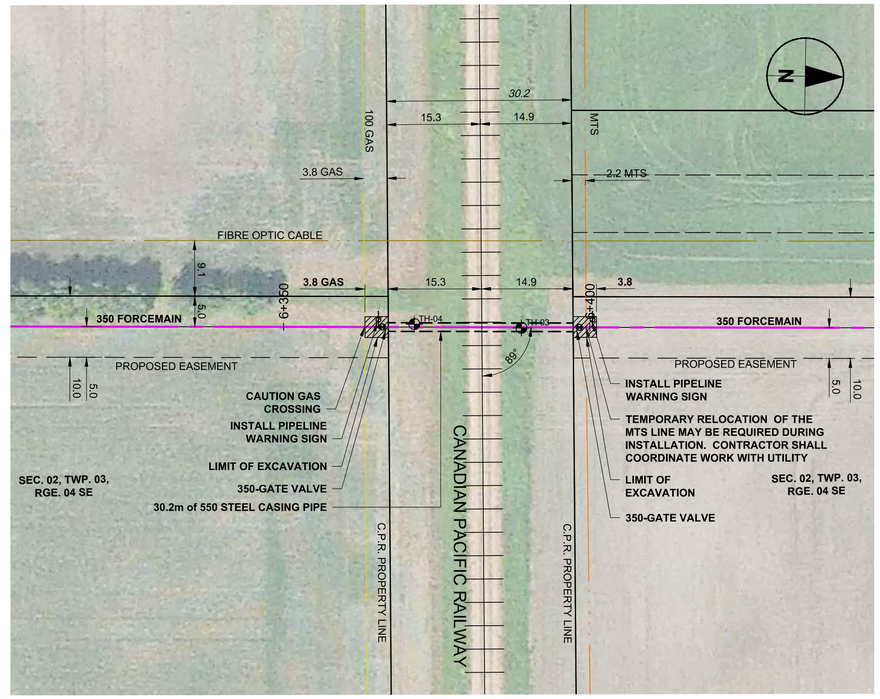
BOREHOLE LEGEND:

- FILL
- SILT
- FAT CLAY



RAIL CROSSING NOTES:		
RAILWAY MILEAGE AND SUBDIVISION :	MILE 70.15 CP LA RIVIERE SUBDIVISION	
MUNICIPAL DESCRIPTION OF ADJACENT PROPERTIES:		
NAME OF PIPELINE OWNER:	RURAL MUNICIPALITY OF STANLEY	
CONTENTS TO BE HANDLED:	MUNICIPAL WASTEWATER	
MAXIMUM OPERATING PRESSURE:	520 KPa (75 psi)	
MAXIMUM TEST PRESSURE:	1000 KPa (145 psi)	
MAXIMUM OPERATING TEMPERATURE:	20°C	
MINIMUM OPERATING TEMPERATURE:	4°C	
PIPING MATERIALS:	CARRIER	CASING
NOMINAL DIAMETER:	350mm	550mm
OUTSIDE DIAMETER:	350mm	550mm
MATERIAL:	HDPE DR 17	STEEL
SPECIFICATION & GRADE:	PE 4710/CSA B137.1	ASTM 453 GRADE B WELDED STEEL MIN. YIELD STRENGTH 242 MPa
WALL THICKNESS:	20.9mm MIN.	15.8mm MIN.
TYPE OF JOINT:	BUTT FUSED	WELDED
COATING:	N/A	N/A
LOCATION OF SHUT OFF VALVES FOR 350 MUNICIPAL WASTEWATER PIPE LINE:	16.2 SOUTH OF TRACKS	
LOCATION OF SHUT OFF VALVES FOR 350 MUNICIPAL WASTEWATER PIPE LINE:	16.0 NORTH OF TRACKS	
METHOD OF INSTALLATION:	TRENCHLESS CONSTRUCTION	
VENTS: NUMBER: N/A	HEIGHT ABOVE GROUND: N/A	
SEALS: BOTH ENDS:	YES	
SEALS: TYPE:	PERMEABLE GEOTEXTILE FABRIC	
BURY: BASE OF RAIL TO TOP OF CASING:	3.92m	
BURY: NOT BENEATH TRACKS:	N/A	
BURY: ROADWAY DITCHES:	N/A	
BURY: BASE OF RAIL TO BOTTOM OF JACKING/RECIEVING PITS:	5.07m	
EXTENT OF CASING MEASURED PERPENDICULAR TO CENTERLINE OF TRACK:	15.2m SOUTH / 14.9m NORTH	
CENTERLINE OF TRACK TO FACE OF JACKING/RECIEVING PITS:	15.3m /14.9m	
TYPE, SIZE & SPACING OF INSULATORS OR SUPPORTS:	SEE DETAIL 1	
CATHODIC PROTECTION:	NO	
GEOTECHNICAL BOREHOLES:	YES, SEE SPECIFICATIONS	
SOIL TYPE:	YES, SEE SPECIFICATIONS	
BASE OF RAIL TO GROUND WATER:	N/A	
TO BE CONSTRUCTED & MAINTAINED IN ACCORDANCE WITH TC-E10		

REFER TO REPORT CPR CROSSING GEOTECHNICAL REPORT 300mm PVC WATERMAIN IN A 500mm STEEL CASING, AECOM, JULY 2023.



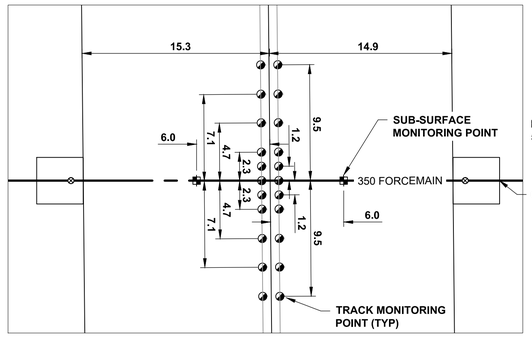
1 | FORCEMAIN RAIL CROSSING

C-0001

Scale Horz. 1:500

EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PROFILE	NEW
150 WM	WATERMAIN	150 WM		CURB STOP		150 WM	WATERMAIN	150 WM
	HYDRANT			REDUCER			HYDRANT	
	VALVE			GAS			VALVE	
300 LDS	LAND DRAINAGE SEWER	300 LDS		MTS		300 LDS	LAND DRAINAGE SEWER	300 LDS
250 WWS	WASTE WATER SEWER	250 WWS		CABLE		250 WWS	WASTE WATER SEWER	250 WWS
	MANHOLE			CONDUIT			PAVEMENT CROWN	
	CATCH BASIN			PRIMARY POWER			N/W PROPERTY LINE	
	RAILWAY TRACKS			FIBRE OPTIC			S/E PROPERTY LINE	
	CULVERT			TESTHOLE			N/W GUTTER	
	PIPE ABANDONMENTS			LAMP STANDARD			S/E GUTTER	
	SURVEY BAR		TH-	TREE			AIR RELEASE VALVE	
	TERMINAL CLEANOUT			VALVE (NORMALLY CLOSED)	NC			
	CLEANOUT							

SUB-SURFACE MONITORING POINTS (2) TO BE INSTALLED TO 1m ABOVE CASING OBVERT IN ACCORDANCE WITH CP GEOTECHNICAL PROTOCAL FIGURE B



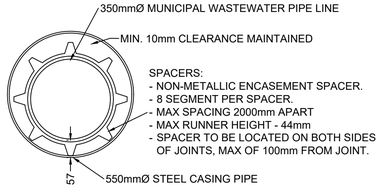
TRACK MONITORING PLAN

Scale 1:250

TRACK MONITORING

1. MONITOR RAIL TRACK IN ACCORDANCE WITH TRACK MONITORING PLAN, SEE SPECIFICATIONS.
2. REPORT MONITORING THRESHOLDS: CRITICAL / REVIEW THRESHOLD: >22mm; ALERT / WARNING THRESHOLD: >11mm
3. SETTLEMENT MONITORING OF THE RAIL TRACK SHALL COMMENCE A MINIMUM OF 2 DAYS PRIOR TO CONSTRUCTION/EXCAVATION IN ORDER TO ESTABLISH BASELINE COORDINATES AND ELEVATIONS.
4. MONITORING POINTS SHOULD BE SURVEYED AT LEAST TWICE PER DAY DURING THE DURATION OF CONSTRUCTION AND AT LEAST 3 DAYS AFTER THE COMPLETION OF CONSTRUCTION.

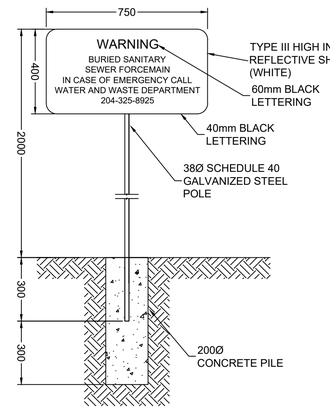
SURVEY RESULTS SHALL BE SUBMITTED DAILY TO GEOTECHNICAL ENGINEER FOR REVIEW.



1 | CASING PIPE DETAIL

-

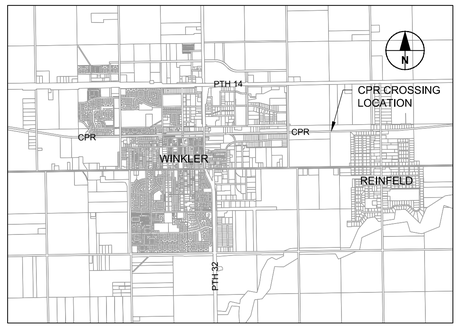
Scale 1:100



2 | WARNING SIGN DETAIL

-

Scale N.T.S.



SITE PLAN

NOTICE:
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PRELIMINARY

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

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AECOM

PROJECT

RM OF STANLEY
REGIONAL WASTEWATER SYSTEM - FORCEMAINS
MWSB No. 1769

CLIENT

The Manitoba Water Services Board
2010 Currie Blvd.
Brandon MB, R7A 6Y9
204.726.6076 tel 204.726.7196 fax
Email: mwsb@gov.mb.ca
www.gov.mb.ca/ia/mwsb/mwsb.html

CONSULTANT

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www.aecom.com

REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
B	2018.08.01	ISSUED FOR 100% REVIEW
A	2018.03.14	ISSUED FOR REVIEW

PROJECT NUMBER

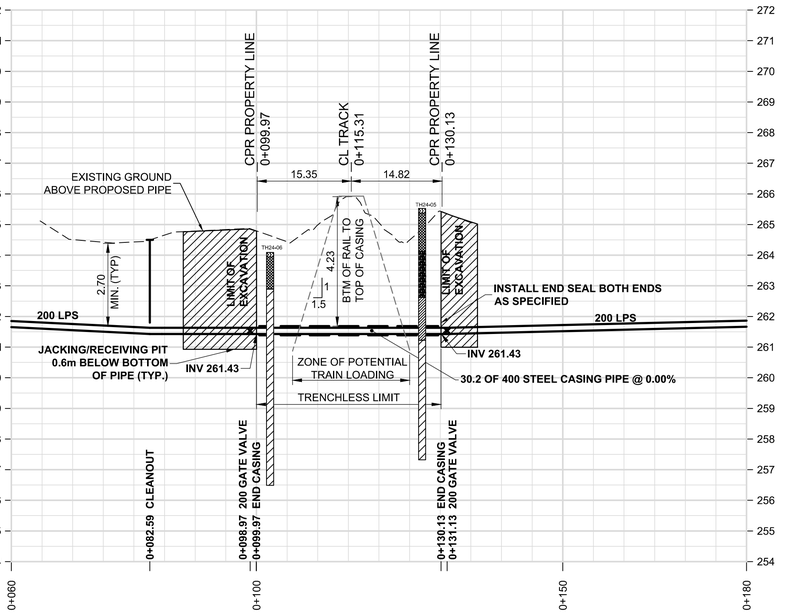
60539657

SHEET TITLE

WASTEWATER FORCEMAIN MISCELLANEOUS CROSSING PROFILES 3 - PIPING LAYOUT

SHEET NUMBER

C-0005

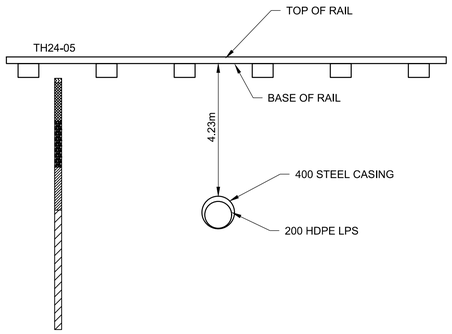


SECTION ON ℄ TRACK

Scale NTS

BOREHOLE LEGEND:

- FILL
- SILT
- FAT CLAY



RAIL CROSSING NOTES:

RAILWAY MILEAGE AND SUBDIVISION :	MILE 69.54 CP LA RIVIERE SUBDIVISION	
MUNICIPAL DESCRIPTION OF ADJACENT PROPERTIES:		
NAME OF PIPELINE OWNER:	RURAL MUNICIPALITY OF STANLEY	
CONTENTS TO BE HANDLED:	MUNICIPAL WASTEWATER	
MAXIMUM OPERATING PRESSURE:	520 KPa (75 psi)	
MAXIMUM TEST PRESSURE:	1000 KPa (145 psi)	
MAXIMUM OPERATING TEMPERATURE:	20°C	
MINIMUM OPERATING TEMPERATURE:	4°C	
PIPING MATERIALS:	CARRIER	CASING
NOMINAL DIAMETER:	200mm	400mm
OUTSIDE DIAMETER:	219mm	400mm
MATERIAL:	HDPE DR 17	STEEL
SPECIFICATION & GRADE:	PE 4710/CSA B137.1	ASTM A53 GRADE B WELDED STEEL MIN. YIELD STRENGTH 242 MPa
WALL THICKNESS:	12.9mm MIN.	11.1mm MIN.
TYPE OF JOINT:	BUTT FUSED	WELDED
COATING:	N/A	N/A
LOCATION OF SHUT OFF VALVE FOR 200 MUNICIPAL WASTEWATER PIPE LINE:	15.4 SOUTH OF TRACKS	
LOCATION OF SHUT OFF VALVE FOR 200 MUNICIPAL WASTEWATER PIPE LINE:	14.8 NORTH OF TRACKS	
METHOD OF INSTALLATION:	TRENCHLESS	

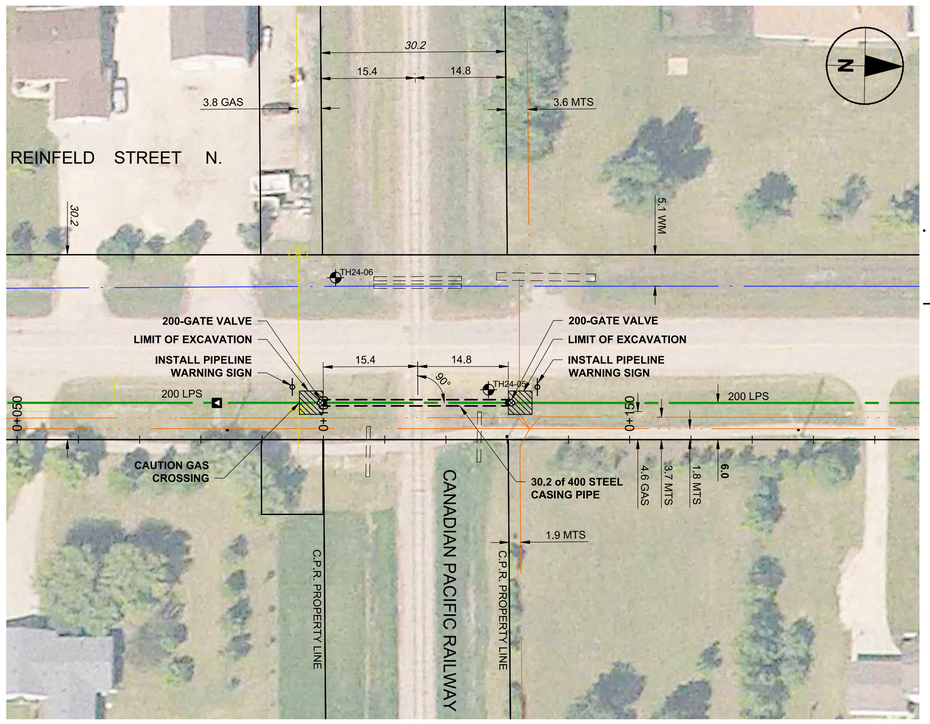
VENTS:	N/A	NUMBER:	N/A
	HEIGHT ABOVE GROUND:		N/A
SEALS:	BOTH ENDS:	YES	
	TYPE:	PERMEABLE GEOTEXTILE FABRIC	
BURY:	BASE OF RAIL TO TOP OF CASING:		4.23m
	NOT BENEATH TRACKS:		N/A
	ROADWAY DITCHES:		N/A
	BASE OF RAIL TO BOTTOM OF JACKING/RECIEVING PITS:		5.23m

EXTENT OF CASING MEASURED PERPENDICULAR TO CENTERLINE OF TRACK: 15.35m SOUTH / 14.82m NORTH

CENTERLINE OF TRACK TO FACE OF JACKING/RECIEVING PITS: 15.35m /14.82m

TYPE, SIZE & SPACING OF INSULATORS OR SUPPORTS:	SEE DETAIL 1
CATHODIC PROTECTION:	NO
GEOTECHNICAL BOREHOLES:	YES
SOIL TYPE:	SEE SPECIFICATIONS
BASE OF RAIL TO GROUND WATER:	SEE SPECIFICATIONS

TO BE CONSTRUCTED & MAINTAINED IN ACCORDANCE WITH TC-E10

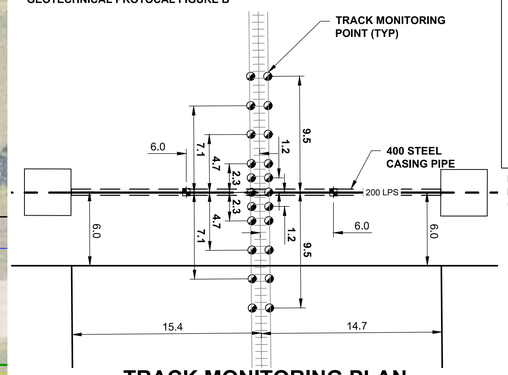


1 REINFELD ST. RAIL CROSSING

C-0010

Scale Horz. 1:500

SUB-SURFACE MONITORING POINTS (2) TO BE INSTALLED TO 1m ABOVE CASING OBVERT IN ACCORDANCE WITH CP GEOTECHNICAL PROTOCAL FIGURE B



TRACK MONITORING PLAN

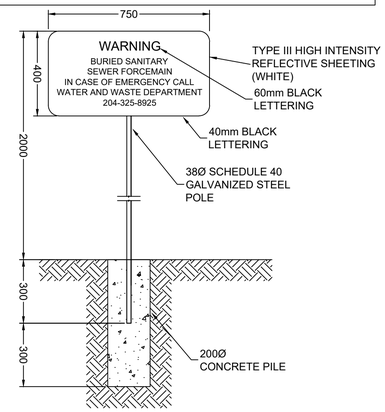
Scale 1:250

TRACK MONITORING

1. MONITOR RAIL TRACK IN ACCORDANCE WITH TRACK MONITORING PLAN, SEE SPECIFICATIONS.
2. REPORT MONITORING THRESHOLDS: CRITICAL / REVIEW THRESHOLD: >22mm; ALERT / WARNING THRESHOLD: >11mm
3. SETTLEMENT MONITORING OF THE RAIL TRACK SHALL COMMENCE A MINIMUM OF 2 DAYS PRIOR TO CONSTRUCTION/EXCAVATION IN ORDER TO ESTABLISH BASELINE COORDINATES AND ELEVATIONS.
4. MONITORING POINTS SHOULD BE SURVEYED AT LEAST TWICE PER DAY DURING THE DURATION OF CONSTRUCTION AND AT LEAST 3 DAYS AFTER THE COMPLETION OF CONSTRUCTION.

SURVEY RESULTS SHALL BE SUBMITTED DAILY TO GEOTECHNICAL ENGINEER FOR REVIEW.

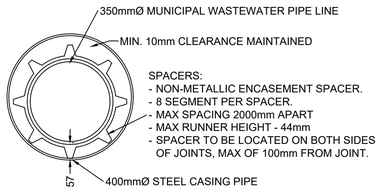
REFER TO REPORT CPR CROSSING GEOTECHNICAL REPORT 300mm PVC WATERMAIN IN A 500mm STEEL CASING, AECOM, JULY 2023.



2 WARNING SIGN DETAIL

-

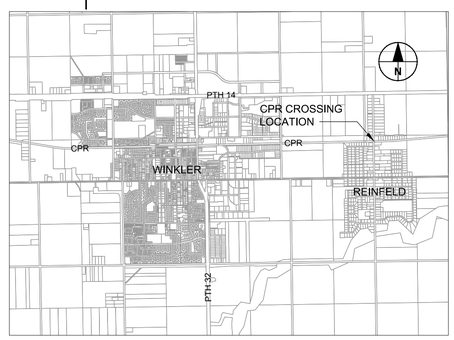
Scale N.T.S.



1 CASING PIPE DETAIL

-

Scale 1:100



SITE PLAN

150 WM	WATERMAIN	150 WM		CURB STOP		150 WM	WATERMAIN	150 WM
	HYDRANT			REDUCER			HYDRANT	
	VALVE			GAS			VALVE	
300 LDS	LAND DRAINAGE SEWER	300 LDS		MTS		300 LDS	LAND DRAINAGE SEWER	300 LDS
250 WWS	WASTE WATER SEWER	250 WWS		CABLE		250 WWS	WASTE WATER SEWER	250 WWS
	MANHOLE			CONDUIT			PAVEMENT CROWN	
	CATCH BASIN			PRIMARY POWER			N/W PROPERTY LINE	
	RAILWAY TRACKS			FIBRE OPTIC			S/E PROPERTY LINE	
	CULVERT			TESTHOLE			N/W GUTTER	
	PIPE ABANDONMENTS			LAMP STANDARD			S/E GUTTER	
	SURVEY BAR		TH-	TREE			AIR RELEASE VALVE	
	TERMINAL CLEANOUT			VALVE (NORMALLY CLOSED)	NC			
	CLEANOUT							
EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PROFILE	NEW

NOTICE:
THE EXISTENCE, LOCATION AND ELEVATION OF UTILITIES AND/OR CONCEALED STRUCTURES AT THE PROJECT SITE ARE NOT GUARANTEED BY AECOM CANADA LTD.

THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE EXISTENCE, LOCATION AND ELEVATION OF ALL SUCH UTILITIES AND/OR STRUCTURES AND IS RESPONSIBLE FOR NOTIFYING THE APPROPRIATE COMPANY, DEPARTMENT OR PERSON(S) OF ITS INTENTION TO CARRY OUT ITS OPERATIONS.

PRELIMINARY

METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

AECOM

PROJECT

RM OF STANLEY
REGIONAL WASTEWATER SYSTEM - FORCEMAINS
MWSB No. 1769

CLIENT

The Manitoba Water Services Board
2010 Currie Blvd.
Brandon MB, R7A 6Y9
204.726.6076 tel 204.726.7196 fax
Email: mwsb@gov.mb.ca
www.gov.mb.ca/ia/mwsb/mwsb.html

CONSULTANT

AECOM Canada Ltd.
99 Commerce Dr.
Winnipeg, MB R3P 0Y7
204.477.6076 tel 204.726.7196 fax
www.aecom.com

REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
B	2018.08.01	ISSUED FOR 100% REVIEW
A	2018.03.14	ISSUED FOR REVIEW

PROJECT NUMBER

60539657

SHEET TITLE

REINFELD
LOW PRESSURE SEWER SYSTEM
PLAN PROFILE

SHEET NUMBER

C-0006

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Project Management Initials: ____ Designer: ____ Checked: ____ Approved: ____ ISO A1 594mm x 841mm
Last saved by: LACOSTEG(2024-12-11) Last Plotted: 2024-12-11
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Appendix I

AECOM – Monitoring Drawing Sheets

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Project Management Initials: Designer: Checked: Approved: ANSI A 8.5" x 11"

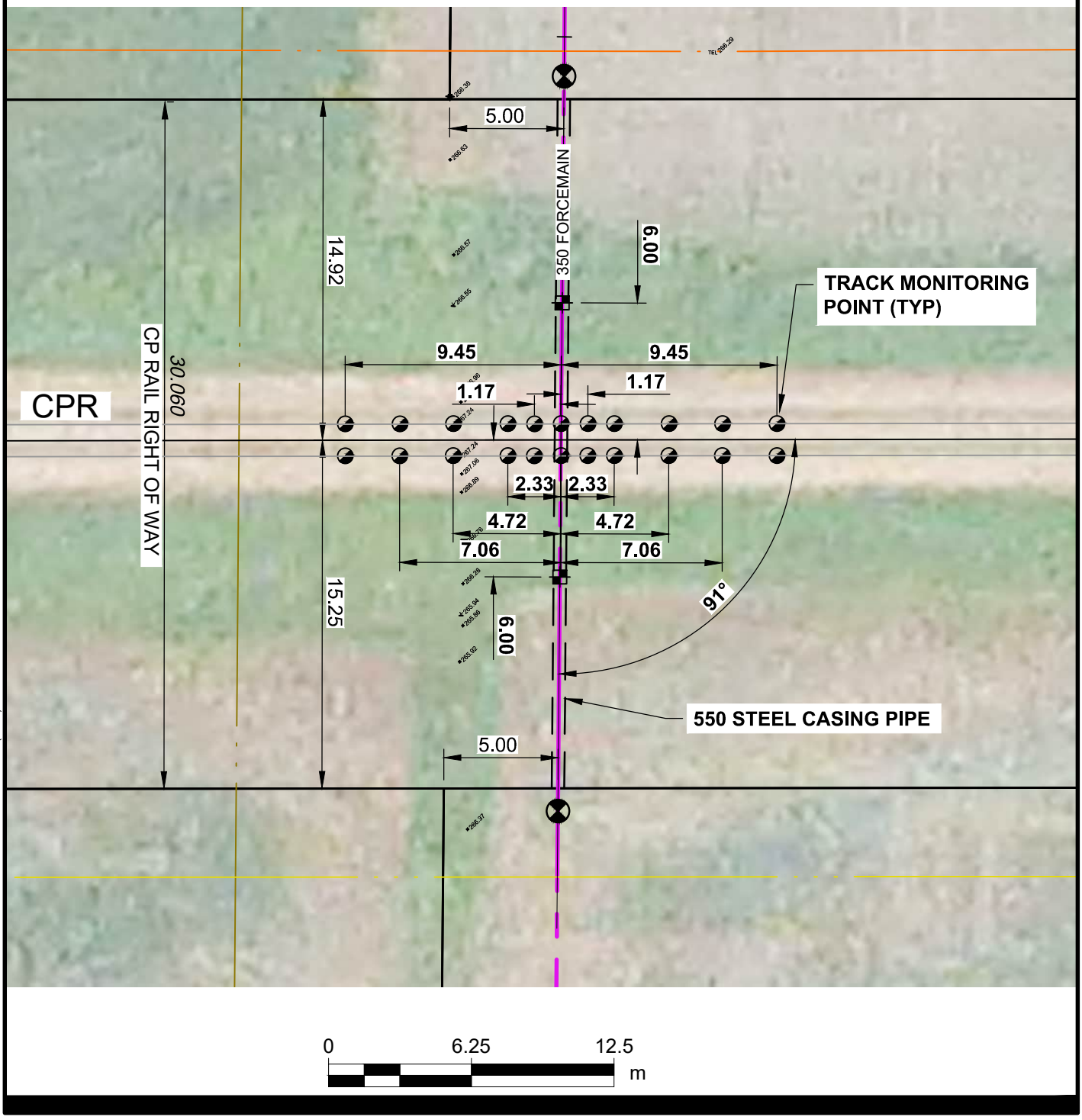
LEGEND:

SUB-SURFACE MONITORING POINT

SURFICIAL MONITORING POINT

N

NOTES:
THE SUBSURFACE MONITORING POINTS TO BE INSTALLED 1.0m ABOVE ENCASEMENT PIPE OBVERT (BOTTOM ELEV. 264.32m)



RM of STANLEY
REGIONAL WASTEWATER SYSTEM
The Manitoba Water Services Board
Project No.: 60735871 Date: 2024-11-06

350 FORCEMAIN CROSSING
AT MILE 70.15 OF CP LaRIVIERE SUBD.

AECOM

Figure: 1

Last saved by: LACOSTEG(2024-11-06) Last Plotted: 2024-11-06
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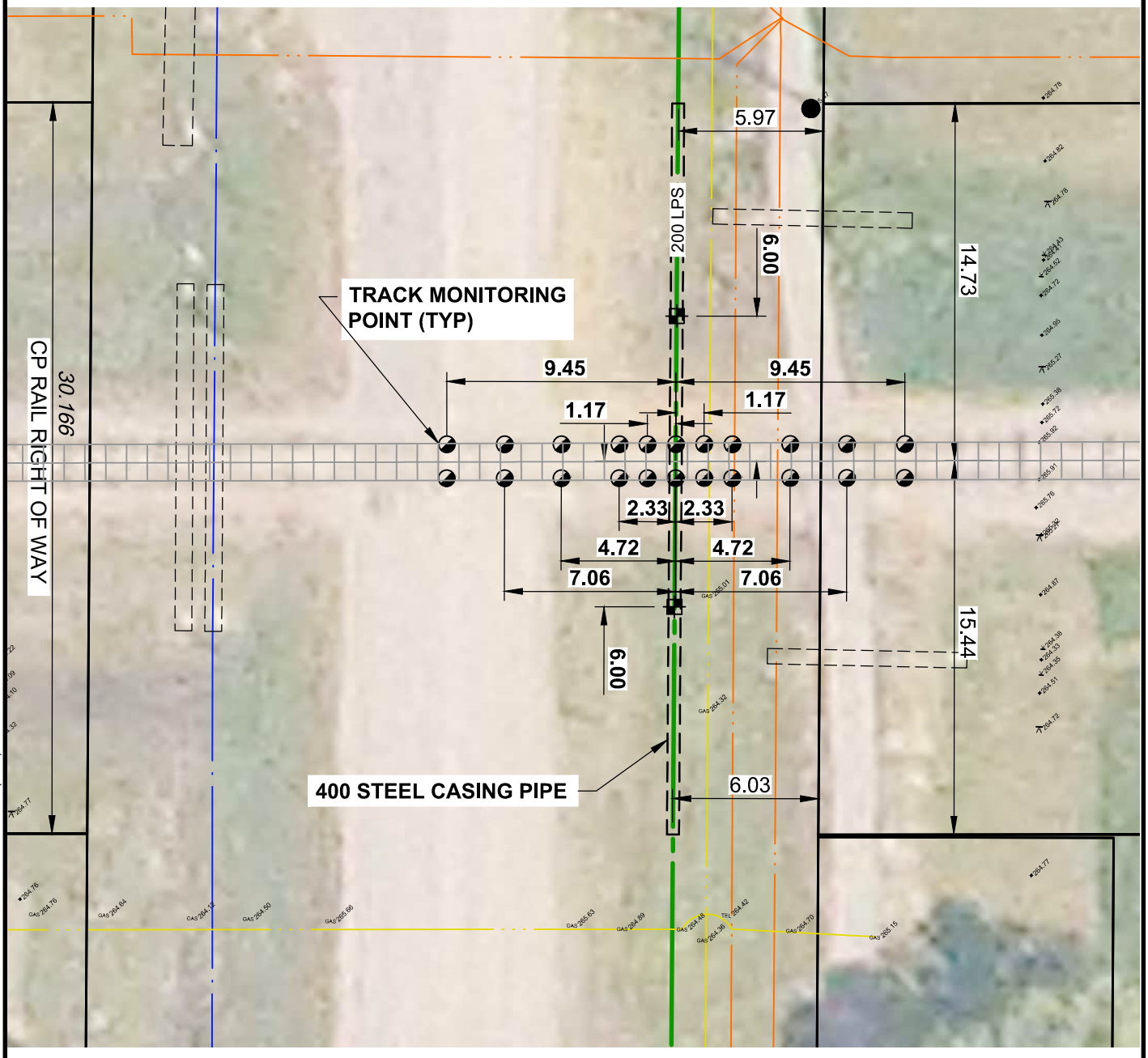
LEGEND:

SUB-SURFACE MONITORING POINT

SURFICIAL MONITORING POINT

N

NOTES:
THE SUBSURFACE MONITORING POINTS TO BE INSTALLED 1.0m ABOVE ENCASEMENT PIPE OBVERT (BOTTOM ELEV. 262.57m)



RM of STANLEY
REGIONAL WASTEWATER SYSTEM
The Manitoba Water Services Board
Project No.: 60735871 Date: 2024-11-06

200 LOW PRESSURE SEWER CROSSING AT MILE 69.54 OF CP LaRIVIERE SUBD.

AECOM

Figure: 2

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Appendix G

Historical Resources Branch Communication

Manitoba

Memorandum

DATE: **2024-10-01**

TO: **Marlene Gifford**
Biologist, Environmental Assessor
AECOM
99 Commerce Drive
Winnipeg MB R3P 0Y7

FROM: **Archaeological Assessment Services Unit**
Historic Resources Branch
Manitoba Sport, Culture, Heritage and Tourism
Main Floor – 213 Notre Dame Avenue
Winnipeg MB R3B 1N3

T: (204) 945-2118 F: (204) 948-2384
e: HRB.archaeology@gov.mb.ca

SUBJECT: **Regional Wastewater Conveyance System**
AAS File AAS-24-22564
Rural Municipality of Stanley

Conditional Approval – Implement a heritage resource protection plan (HRPP)
Further to your e-mail regarding the above noted application, Manitoba's Historic Resources Branch (HRB) has examined the location in conjunction with Branch records for areas of potential concern. The potential to impact heritage resources is believed to be low based on analysis of current data, therefore, the Historic Resources Branch has no concerns with the proposed project at this time. HRB requires a HRPP be included in planning, development, and operations, in the event heritage resources (including human remains and palaeontological resources) are accidentally encountered.

Legislation
Under Section 46 and 51 of the Heritage Resources Act (the Act), if at any time, heritage resources are encountered in association with these lands during testing and development, there is an obligation to report any heritage resources and a prohibition on destruction, damage or alteration of said resources. HRB may require that an acceptable heritage resource management strategy be implemented by the proponent/developer to mitigate the effects of their activity on the heritage resources.

Under Section 12(2) of the Act, the minister may require such other plans, documents, material and information, with respect to the work, activity, development or project, prior to commencement.

Heritage Resource Protection Plan
The HRPP consists of operational procedures to limit damage or destruction of heritage resources. This document assists proponents, landowners, managers, employees, and/or contractors etc. on what to do and whom to call should heritage resources accidentally be encountered when testing and development is underway on site.

If you have any questions, please contact as above for proper assignment and queueing.

Historic Resources Branch
Archaeological Assessment Services Unit

Enclosure: Heritage Resources Protection Plan (HRPP)

AECOM

Appendix H

Heritage Resources Protection Plan (Draft)

Heritage Resources Protection Plan

Purpose of HRPP – Preventative Action:

To assist the Rural Municipality (RM) of Stanley with informing managers, employees, contractors on what to do and whom to call should heritage resources accidentally be encountered when testing and development is underway on site. The HRPP consists of operational procedures to limit damage or destruction of heritage resources accidentally found during site work.

Key Steps:

1. All workers on-site should be informed of the HRPP in advance of work proceeding and who to contact should there be a chance encounter during on-site activity.
2. If heritage objects or human remains are discovered on site, activities are to stop at that location immediately and the Historic Resources Branch be notified. (HRB.archaeology@gov.mb.ca, (204) 945-2118)
3. In the case of human remains, the nearest law enforcement agency (i.e., RCMP or local police department) must be contacted to first rule out any forensic issues.

Why Report?

Many people find heritage objects accidentally. If these items are reported to the Historic Resources Branch, their significance can be assessed and the resulting information can generally shared with the public. Some heritage objects can be several thousand years old.

Legislation and Policy:

The Heritage Resources Act (The Act) and the *Province of Manitoba Policy Concerning the Reporting, Exhumation and Reburial of Found Human Remains* (Burials Policy) apply to protecting heritage resources.

What are Heritage Resources?

Heritage resources and heritage objects are defined under the *Heritage Resources Act*:

"heritage resource" includes

(a) a heritage site,

(b) a heritage object, and

(c) any work or assembly of works of nature or of human endeavour that is of value for its archaeological, palaeontological, pre-historic, historic, cultural, natural, scientific or aesthetic features, and may be in the form of sites or objects or a combination thereof

"heritage object" includes

(a) an archaeological object,

(b) a palaeontological object,

(c) a natural heritage object, and

(d) an object designated as a heritage object by the Lieutenant Governor in Council under subsection (2);

"archaeological object" means an object

(a) that is the product of human art, workmanship or use, including plant and animal remains that have been modified by or deposited due to human activities,

(b) that is of value for its historic or archaeological significance, and

(c) that is or has been discovered on or beneath land in Manitoba, or submerged or partially submerged beneath the surface of any watercourse or permanent body of water in Manitoba;

"palaeontological object" means the remains or fossil or other object indicating the existence of extinct or prehistoric animals, but does not include human remains.

"natural heritage object" means a work of nature consisting of or containing evidence of flora or fauna or geological processes;

"human remains" means remains of human bodies that in the opinion of the minister have heritage significance and that are situated or discovered outside a recognized cemetery or burial ground in respect of which there is some manner of identifying the persons buried therein;

Examples of heritage resource objects (below)

Examples of Archaeological Objects (above)

Example of a Palaeontological Object

Discovery and notification structure:

Better safe than sorry: do not hesitate to report potential or suspected finds. The Historic Resources Branch is here to provide advice and expertise ***at no cost to the developer****.*

1. If heritage resources, including human remains are encountered, stop work immediately.

2. Notify the on-site manager about the discovery.

   [Name of Site Manager to be added once assigned, including name, position, email and phone numbers]

3. Mark-off area with "flagging tape" to identify and restrict the area.

4. The on-site manager will contact the Historic Resources Branch at (204) 945-2118

5. In the case of possible found human remains, the on-site manager will contact

   a. Historic Resources Branch at (204) 945-2118

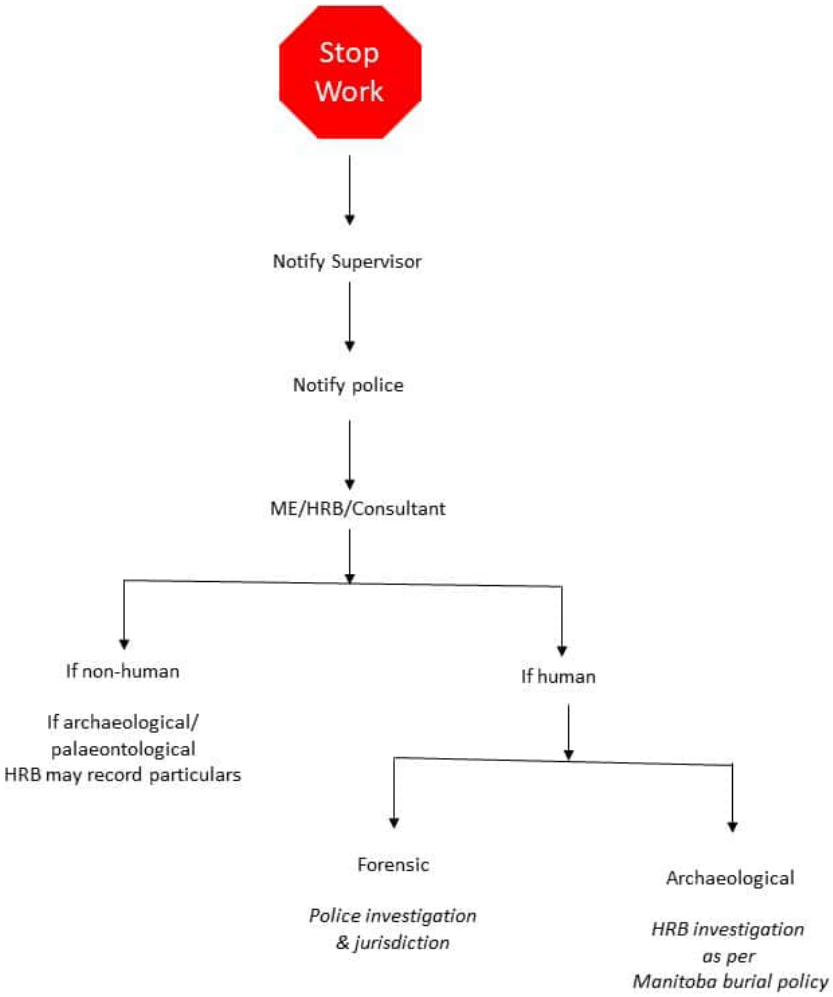
   b. RCMP - Morden detachment at (204) 822-5469.

Under no circumstances should site information be shared with the media or the public. Site locations are protected by the Freedom of Information and Protection of Privacy Act (FIPPA).

Communication should be limited to the local police authority or the Historic Resources Branch.

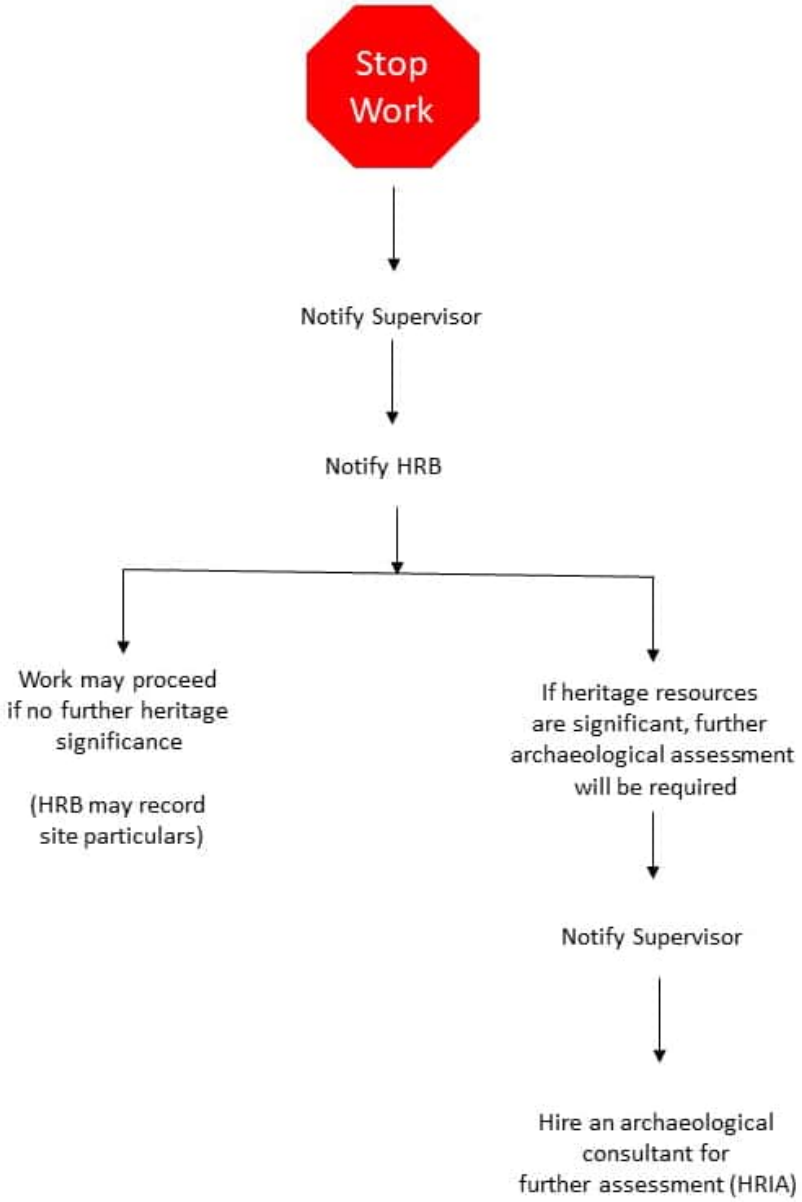
What to expect after notification for possible found human remains:

1. The local police authority will immediately attend the site and further secure the site.
2. The local police authority may notify the Medical Examiner's (M.E.) Office of a potential case of founding human remains as per *The Fatalities Inquiries Act.*
3. The local police authority and/or the ME's office may contact the Historic Resources Branch (HRB) or their own forensic anthropology consultant.
4. The police and their consultant will determine if the remains are:
    a. Human or animal
    b. Forensic or archaeological in nature.
5. If the remains are forensic in nature or cannot be immediately assessed, the police authority and ME will have jurisdiction over the area.
6. If remains are determined to be non-forensic (i.e., archaeological) in nature and their removal is required, HRB will be responsible for their exhumation and reburial as per Manitoba Burial Policy



What to expect after notification for heritage objects other than human remains:

1. The Historic Resources Branch (HRB) will visit the site
2. The HRB will determine if additional heritage mitigation work will be required.
3. If further mitigation work is required, the developer may need to contract a qualified archaeological consultant to conduct a Heritage Resources Impact assessment (HRIA) of the proposed development location, in order to identify and assess any heritage resources that may be negatively impacted by development. If desirable, the Branch will work with the developer/land owners and its consultant to draw up terms of reference for this project.



Potential penalties

Under the *Manitoba Heritage Resources Act* 69(1), *any person who contravenes or fails to observe a provision of this Act or a regulation, order, by-law, direction or requirement made or imposed thereunder is guilty of an offence and liable, on summary conviction, where the person is an individual, to a fine of not more than $5,000 for each day that the offence continues and, where the person is a corporation, to a fine of not more than $50,000 for each day that the offence continues.*

Useful Resources:

Government of Manitoba

Heritage Objects: A Precious Resource for all Manitobans. Winnipeg, Manitoba: Manitoba Culture, Heritage and Citizenship, 1996. Accessible online at: www.gov.mb.ca/chc/hrb/pdf/heritage_objects.pdf

Managing Our Heritage Resources: Impact Assessment. Winnipeg, Manitoba: Manitoba Culture, Heritage and Citizenship, 1993. Accessible online at: www.gov.mb.ca/chc/hrb/pdf/impact_assessment_booklet.pdf

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