Stormwater Master Plan

City of Lloydminster

Final Report
September 2024

ISL Engineering and Land Services Ltd. is an award-winning full-service consulting firm dedicated to working with all levels of government and the private sector to deliver planning and design solutions for transportation, water, and land projects.

At ISL, your identity is part of our identity. Diversity, Equity, and Inclusion (DEI) speaks to our core values and provides space for our teams to bring their authentic selves to work. ISL believes DEI creates the best outcomes for our clients while sustaining a happy and thriving work environment that allows for career development opportunities for all staff. ISL is committed to a focused effort on continuous improvement and development of a respectful and safe workplace

4015 7 Street SE, Calgary AB T2G 2Y9, T: 403.254.0544 F: 403.254.9186

September 20, 2024

Our Reference: 28310

City of Lloydminster
4420 50 Avenue
Lloydminster, AB/SK
T9V 0W2

Attention: Teague Smith, P.Tech.(Eng.) – Project Lead, Engineering Services

Dear Teague Smith:

Reference: City of Lloydminster Stormwater Master Plan – Final Report

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Enclosed is the Final Report for the City of Lloydmindster's Stormwater Master Plan. We trust that it meets your needs.

The key objective of the Stormwater Master Plan is to assess the City of Lloydminster's current stormwater management and drainage infrastructure capacity and the future needs for projected populations and development areas.

The Stormwater Master Plan will provide the City of Lloydminster with direction on infrastructure implementation and associated timelines to service future growth, while ensuring infrastructure remains fully functional in providing an appropriate level of service. This information will aid in making informed decisions on capital projects and will provide solutions for efficient, economic, and sustainable municipal services to residents and businesses.

We sincerely appreciate the opportunity to undertake this project on behalf of the City of Lloydminster. Should you have any questions or concerns, please do not hesitate to contact the undersigned at 403.254.5044

Sincerely,

Geoffrey Schulmeister, P.Eng., SCPM
General Manager, Water and Environment

Corporate Authorization

This document entitled “City of Lloydminster Stormwater Master Plan” has been prepared by ISL Engineering and Land Services Ltd. (ISL) for the use of City of Lloydminster. The information and data provided herein represent ISL’s professional judgment at the time of preparation. ISL denies any liability whatsoever to any other parties who may obtain this report and use it, or any of its contents, without prior written consent from ISL.

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Permit to Practice

ISL Engineering and Land Services Ltd.

RM Signature:

RM APEGA ID: 66731

Date: 2024 October 03

Permit Number P4741

The Association of Professional Engineers and Geoscientists of Alberta

Geoffrey Schulmeister, P.Eng., SCPM
Project Manager

Territory Acknowledgement

City of Lloydminster

The City of Lloydminster acknowledges that we are located on Treaty 6 Territory, and the City of Lloydminster respects the histories, languages, and cultures of First Nations, Metis, Inuit, and all First Peoples of Canada, whose presence continues to enrich our vibrant community.

ISL Engineering and Land Services Ltd.

ISL Engineering and Land Services Ltd. acknowledges that our Calgary office and work takes place on the ancestral, traditional, and present-day territory of the Treaty 7 Nations of Southern Alberta. The confluence of the Bow and Elbow Rivers has been an important meeting place for Indigenous peoples since time immemorial, and we honour the Siksika, Piikani, and Kainai Nations of the Blackfoot Confederacy, the Bearspaw, Chiniki, and Goodstoney First Nations of the Stoney Nakoda Nations, and the Tsuut'ina Nation. We also acknowledge that this is the homeland of the Métis Nation of Alberta, Region 3.

Executive Summary

E1.0 Introduction

The City of Lloydminster (the City) retained ISL Engineering and Land Services Ltd. (ISL) to complete a review of its current stormwater system and assess its capacity to convey the current and future growth stormwater flow volumes effectively. A robust hydrodynamic InfoWorks ICM 1D-2D model was constructed to enable the comprehensive capacity assessment of the stormwater conveyance system, which was used in conjunction with the condition assessment of the storm sewers to generate the updated Stormwater Master Plan (SWMP).

E2.0 Report Summary

The overall SWMP is summarized as follows:

- **Purpose and scope:** The SWMP provides a comprehensive review and assessment of the existing and future stormwater conveyance system in the City. It aims to inventory and analyze the existing infrastructure, calibrate and update the hydraulic model, prepare capacity assessments, develop servicing plans, and provide a framework for future capital planning.
- **Study area:** The study area covers 24 neighbourhoods and approximately 23.5 quarter sections of recently annexed land, with a total area of about 5,870 ha. The study area is divided by the Alberta/Saskatchewan border and is located within the North Saskatchewan River Basin. The development type is classified by several land use districts, such as residential, commercial, industrial, and public service.
- **Development horizons:** The SWMP considers six (6) population horizons for the existing and future system assessment, ranging from existing to ultimate build-out development horizons. Stormwater infrastructure staging plan was developed for each development horizon.
- **Design criteria and level of service:** The SWMP uses the existing stormwater master plan, the City's Municipal Development Standards, and typical municipal servicing standards as the sources for the design criteria. The level of service for the stormwater minor system is based on the 1:5 year 4-hour Modified Chicago design storm, while the major system is based on the 1:100 year 4-hour Modified Chicago design storm and 1:100 year 24-hour Huff design storm. The performance of the minor system is assessed in terms of peak discharge relative to pipe capacity ratio and maximum hydraulic grade line elevation relative to ground (freeboard). The major system is assessed through surface flooding depth and velocity.
- **Existing stormwater system and hydraulic model development:** The existing storm sewer system consists of approximately 130 km of storm sewers and culverts, predominantly made of polyvinyl chloride (PVC) or concrete, with pipe diameters ranging from 100 mm to 2,400 mm in diameter and up to 3,000 mm by 5,000 mm in dimension for box culverts. A 1D-2D integrated hydraulic model was constructed in InfoWorks ICM from scratch using the City's GIS data, LiDAR data, record drawings, and assumptions as necessary.
- **Existing system assessment and proposed capacity upgrades:** The existing storm sewer system assessment identified areas of concern in both the minor storm sewer system and major overland drainage system. The system assessment identified a number of minor storm sewer segments exceeding the peak discharge relative to full pipe capacity ratio and freeboard criteria under the 1:5 year design storm event, and also identified areas with significant surface flooding potentials that may cause damage to residents, properties, and infrastructure under the 1:100 year design storm events.

A total of 27 existing system upgrades were developed to improve system capacity and alleviate surface flooding risks, which include storm sewer upgrades, culvert upgrades, and catch basin upgrades. A generalized overall storm sewer condition assessment was also completed, based on the closed-circuit television (CCTV) storm sewer inspection. Sewer replacement or rehabilitation are also recommended to minimize unexpected servicing disruption possibility. Risk assessment prioritization and class “D” cost estimates for the proposed existing system upgrade are provided to aid the City in infrastructure upgrade planning.

- **Future system assessment and proposed concepts:** A future servicing concept has been developed based on the anticipated development in the City. System assessments were completed to ensure adequate performance of the existing and proposed stormwater system under the future development conditions. A class “D” cost estimate for the proposed future servicing concept, along with a proposed infrastructure staging based on development horizon, have been provided to assist the City in future capital planning.
- **Capital planning:** Based upon recommended upgrades and development horizons, a proposed capital planning table is included, noting upgrades and recommended timelines for implementation for consideration in the City’s overall capital plan.

E3.0 SWMP Conclusions

Conclusions for the storm sewer system are summarized as follows:

- The City’s storm sewer system includes major and minor drainage components. The major system features overland drainage routes with two main channels, the Northwest and East Drainage Channels, which ultimately direct stormwater to the Neale Edmunds Stormwater Complex. Seventeen (17) stormwater ponds within the city manage and regulate runoff.
- The minor system comprises gravity sewers, manholes, catch basins, catch basin leads, and outfalls. These storm pipes are mostly made of concrete (CONC) or PVC and range in size from 100 mm to 2,400 mm in diameter and up to 3,000 mm by 5,000 mm in dimension for box culverts.
- A 1D-2D stormwater model was developed in InfoWorks ICM to evaluate the City’s storm sewer system. This development occurred in two phases: first, constructing the minor (1D) system and then generating a mesh network using LiDAR data for the major (2D) system, as detailed in Section 5.0.
- Design rainfall events, based on the City of Lloydminster’s IDF parameters, were used for assessment. The minor system was tested with a 1:5 year 4-hour Modified Chicago design storm, while the major system was evaluated using a 1:100 year 4-hour Modified Chicago design storm and a 1:100 year 24-hour Huff design storm.
- Model results identified several capacity constraints in the storm sewer (minor system) and significant flooding risks in the overland drainage (major system). Detailed assessments for the minor system are in Section 6.1, and for the major system in Sections 6.1 and 6.2.
- A condition assessment program was conducted, with McGill’s Industrial Services performing CCTV inspections of select storm sewers. The results were used to develop system upgrade recommendations and aid future condition assessment planning, presented in Section 6.3.
- A risk assessment matrix was created to prioritize stormwater system upgrades. The matrix uses a point scoring system based on risk criteria such as historical flooding, proximity to critical infrastructure, and upgrade effectiveness, providing a quantitative approach for prioritization.

- A proposed future stormwater system concept was developed for Lloydminster, considering anticipated future development areas (Section 2.3). This concept includes future stormwater management facilities (SWMFs) and storm sewers, strategically located based on topography in the city. SWMFs are designed to provide adequate storage capacity and control runoff release rates.
- The InfoWorks ICM model was used to evaluate the performance of the existing system with future system connections. The existing stormwater management facilities and storm sewers were estimated to have sufficient capacity to accommodate future development, as discussed in Sections 7.2.2 and 7.3.

E4.0 SWMP Recommendations

Recommendations for the storm sewer system are summarized as follows:

- Based on the existing storm sewer system capacity and condition assessments, several upgrade recommendations were developed to improve system capacity, reduce surface flooding, and enhance system resilience. Proposed upgrades include storm sewer and culvert upgrades, catch basin installations, and sewer rehabilitations. The City may choose to monitor some areas with proposed upgrades to verify the need if no historical issues have been observed there.
- The proposed existing system upgrades are summarized in Tables 6.7 and 6.8, with risk assessment prioritization in Table 6.11. Regular condition assessments are recommended to monitor the physical condition of stormwater assets and reduce the risk of unexpected system disruptions.
- As the City develops, the future stormwater management concept from Section 7.0 should be used as a reference for developing stormwater infrastructure, in accordance with the City’s Municipal Development Standards.
- Drainage to the SWMFs should be considered during subdivision application/development permit processes. Separate reviews should be prepared to support each application to ensure compliance with the overall SWMP.
- Proposed SWMFs should include outlet control structures, and downstream sewers should have an outfall structure at the downstream discharge location. Backflow preventers are recommended for outfalls servicing areas with ground or basement elevations below the local 1:100 year flood level. LID measures should be considered on a site-specific basis and reviewed by the City for potential implementation.
- Class “D” cost estimates for the proposed existing system upgrades amount to approximately $54 million, including a 15% engineering fee and 30% contingency. Detailed cost estimates for each upgrade item are provided in Table 6.12.
- Class “D” cost estimates for the proposed future stormwater system amount to approximately $92.4 million, including a 15% engineering fee and 30% contingency. Detailed cost estimates are in Table 7.10.
- It is recommended that the SWMP be reviewed and updated after significant periods of growth or every five years. This will allow for updates to the hydrodynamic model and analysis with any capital upgrades and the latest growth plans. The review should also consider densification within established areas.

Table of Contents

APPENDICES

TABLES

FIGURES

ACRONYMS

Acronym	Description
AEP	Alberta Environment and Parks
ASP	Area Structure Plan
BMP	best management practices
CCTV	closed-circuit television
CSP	corrugated steel pipe
CONC	concrete
GIS	Geographic Information System
HGL	hydraulic grade line
HWL	high water level
ICD	inlet control device
IDF	Intensity-Duration-Frequency
LID	low-impact development
LiDAR	light detection and ranging
LOS	level of service
NWL	normal water level
PVC	polyvinyl chloride
Q/Q_{man}	peak discharge relative to sewer capacity
QA/QC	quality assurance/quality control
ROW	right-of-way
STL	steel
SWMP	Stormwater Master Plan
TSS	Total suspended solids
VCT	vitrified clay tile
1D	one-dimensional
2D	two-dimensional

UNITS

Unit	Description
$	dollars
%	percentage
Ha	hectares
Hr	hour
Km	kilometre
L/ha/d	litres per hectare per day
L/p/d	litres per person per day
L/s	litres per second
L/s/ha	litres per second per hectare
M	metre
m/s	metres per second
m^2	square metres
m^3	cubic metres
m^3/s	cubic metres per second
Mm	millimetre
mm/hr	millimetre per hour

1.0 Introduction

1.1 Authorization

The City of Lloydminster (the City) retained ISL Engineering and Land Services Ltd. (ISL) to complete a review of its current storm sewer system and assess its capacity to convey the current and future growth storm sewer flow volumes effectively. A robust hydrodynamic InfoWorks ICM 1D-2D model was constructed to enable the comprehensive capacity assessment of the storm sewer system, which was used in conjunction with the condition assessment of the storm sewers to generate the updated Stormwater Master Plan (SWMP).

1.2 Background

The SWMP was most recently updated by Sameng Inc. in 2015. Since then, the City limits have been expanded via the 2022 Annexation Lands, along with various storm sewer system upgrades or replacements being completed. The increased stormwater runoff produced from the annexation and continued development in the city, along with the normal deterioration of pipe condition and storm sewer system upgrades that have occurred since 2015, warrants this SWMP update.

The updated SWMP will help the City understand the implications of servicing new developments and the servicing approach and constraints. By thoroughly reviewing the available background data and the storm sewer system hydraulic model, maintaining consistent approaches to addressing issues, and applying sound engineering principles, this updated SWMP ensures effective infrastructure implementation while safeguarding the natural and human environment. The updated SWMP will also examine the capacity of the storm sewer system to determine the extent of upgrades required to maintain an appropriate level of service for existing and future residents and businesses.

1.3 Purpose of Study

The purpose of developing an updated SWMP is outlined as follows:

- Inventory and analyze the existing storm sewer system under existing conditions;
- Develop a fully integrated 1D-2D stormwater hydraulic model to accurately represent the City's existing storm sewer system;
- Undertake capacity assessments of the existing storm sewer system under the current and future development conditions;
- Develop storm sewer system plans to manage increased and redirected runoff resulting from future development. Locations and timing may be dependent on the following:
  - Availability of sufficient servicing needs;
  - Annexed land locations; and/or
  - Community planning;
- Determine upgrade requirements for the existing storm sewer system based on the condition and capacity assessment findings and recommend future servicing options; and
- Provide a framework for future storm sewer system capital planning, through cost estimates and possible staging of infrastructure installations.

2.0 Study Area

2.1 Location

The City of Lloydminster is divided by the Alberta/Saskatchewan border and is located approximately 250 km southeast of the City of Edmonton. The City is bordered by the County of Vermilion River No. 24 on the Alberta side and both the Rural Municipality of Britannia No. 502 and the Rural Municipality of Wilton No. 472 on the Saskatchewan side. The Yellowhead Highway (Highway 16) is an interprovincial highway that connects Manitoba to British Columbia through Lloydminster, and it is known as 44 Street/Ray Nelson Drive within City limits. Highway 17 runs north/south through Lloydminster along the Alberta/Saskatchewan border and is known as 50 Avenue within City limits. The study area is shown in Figure 2.1.

The study area encompasses 24 neighbourhoods (at present), as well as approximately 23.5 quarter sections of recently annexed land as shown in Figure 2.2. Not all existing neighbourhoods are fully developed; therefore, future growth is anticipated both within these neighbourhoods and within the recently annexed land. The study area encompasses a total area of approximately 5,870 ha.

The highest elevation areas within the City limits are approximately 670 m in elevation and located within the northwest and southwest corners of the city. The lowest elevation area within the City limits is located in the northeast corner of the city at an elevation of approximately 615 m. The topography of the study area is shown in Figure 2.3.

The study area is located almost entirely within the Central North Saskatchewan River Watershed with the southwest corner of the study area adjacent to the boundary of the Battle River Watershed. Both watersheds are part of the North Saskatchewan River Basin, which is part of the Nelson-Churchill (Hudson Bay) Continental Drainage Basin. A map of the watershed boundaries is shown in Figure 2.4.

2.2 Existing Land Use

The land use district shapefile provided by the City was used to determine land use district codes and corresponding descriptions for existing development areas within the city, as summarized in Table 2.1 and illustrated in Figure 2.5.

The land uses were compared to aerial maps and Google Street View to confirm that parcels were properly categorized. For the purposes of the project, many of these land use districts were grouped together to form an overall land use. In this manner, the City was classified more broadly by several unique development types, including residential, commercial, institutional, industrial, and public service. Land use type influences stormwater runoff coefficients/imperviousness ratio and roughness coefficients; therefore, obtaining an appropriate classification was vital to achieving an accurate representation of stormwater runoff volumes and rates.

Table 2.1: Land Use District Descriptions

District Code	Land Use	District Code	Land Use
R1	Single-Detached Residential	C5	Service Commercial
R2	Semi-Detached Residential	I1	Light Industrial
R3	Row House Residential	I2	Medium Industrial
R4	Medium-Density Residential	PS	Public Services
R5	High-Density Residential	PU	Public Utility
RMH	Residential Manufactured Home	UP	Urban Park
C1	Central Commercial	MA1	Municipal Airport Airside
C2	Highway Corridor Commercial	UT	Urban Transition
C3	Neighbourhood Commercial	DC	Direct Control

2.3 Development Horizons

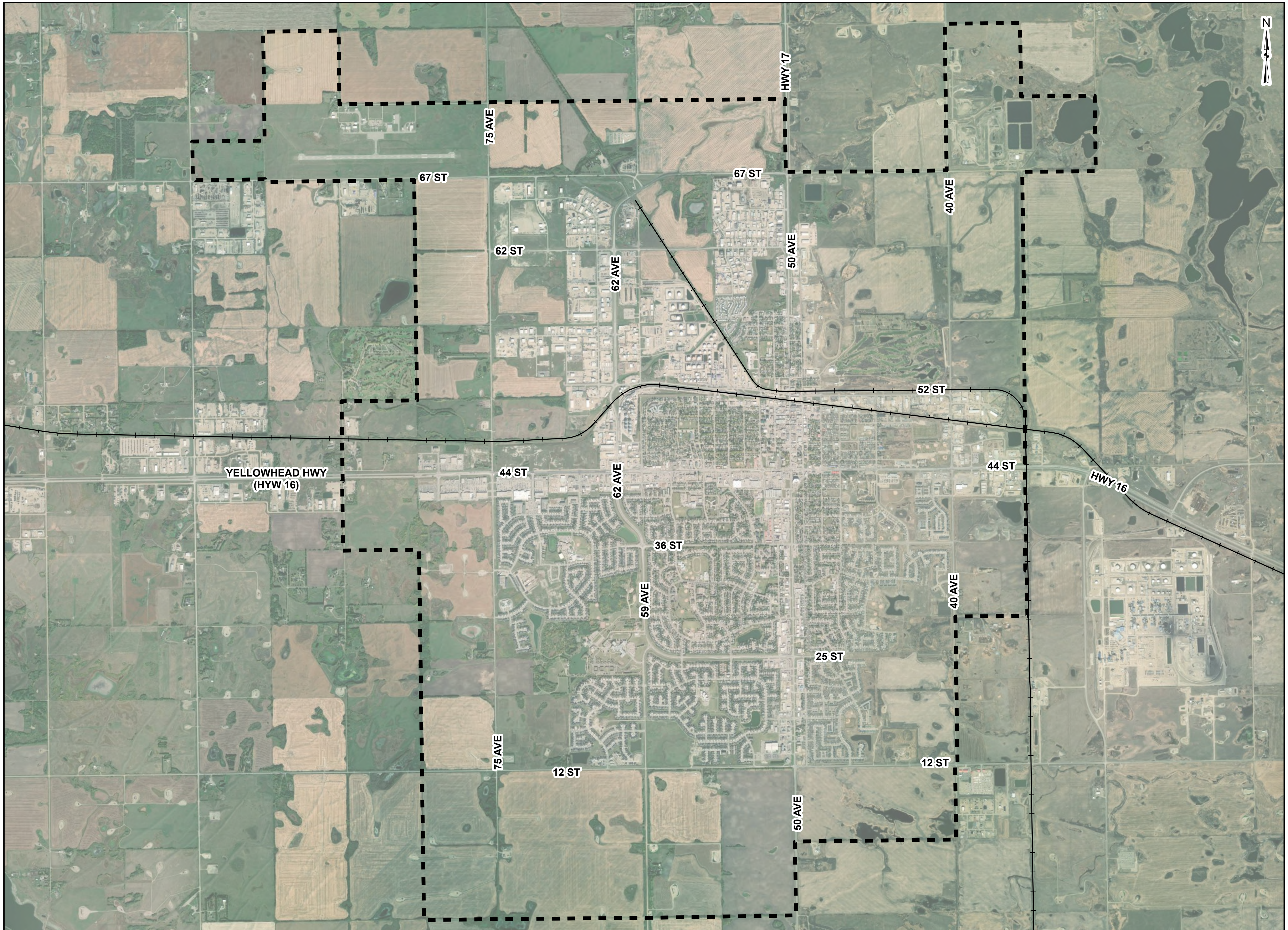
Five (5) future development horizons were considered in this SWMP, including the 3-year, 5-year, 10-year, 20-year, and ultimate (beyond 20-year time horizon) development scenarios. Residential and employment development areas under each growth horizon were determined based on the approved local Area Structure Plans (ASPs), the 2013 Comprehensive Growth Strategy, the 2019 Joint Regional Growth Study, and the 2020 Annexation Application.

Staging of the City's future development areas was refined by the City to align with the anticipated development timelines for each area. Future development areas and land use classifications are shown in Figure 2.6, with the staging of the development areas by growth horizon presented in Figure 2.7.

The future development areas by land use district under each incremental time horizon are summarized in Table 2.2. Note that in the ultimate horizon, there is not any other detailed information on the differentiation between single-family and multi-family residential parcels, and the Municipal Development Plan only specifies residential areas with no densities, so all were assigned as single-family residential.

Table 2.2: Future Development Areas by Land Use District Under Different Time Horizons

District Code	District Description	3-Year Horizon	5-Year Horizon	10-Year Horizon	20-Year Horizon	Ultimate Horizon
		ha	Ha	ha	ha	ha
RES-SF	Single-Family Residential	52.29	40.80	156.26	434.48	399.19
RES-MF	Multi-Family Residential	1.45	2.12	13.69	53.29	0.00
CBD	Commercial Business District	25.38	44.52	53.95	69.63	175.70
IND	Industrial	137.17	45.25	148.40	247.05	378.30
PS	Public Services	7.74	21.90	2.65	0.00	0.00
Total		**224.03**	**154.59**	**374.95**	**804.45**	**953.19**



Legend

Railway

Study Area

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 2.1
STUDY AREA
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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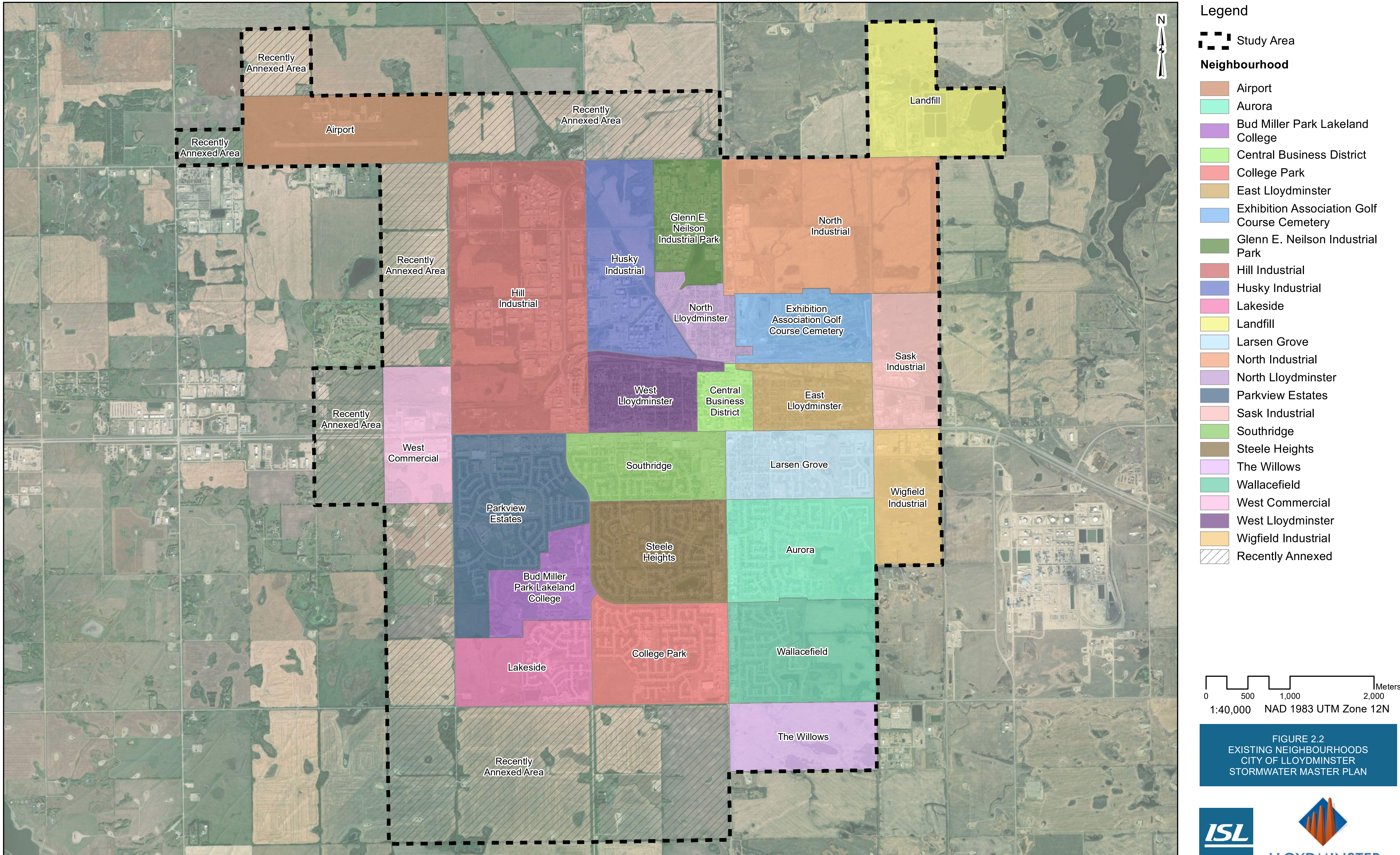

FIGURE 2.2
EXISTING NEIGHBOURHOODS
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

Credits:Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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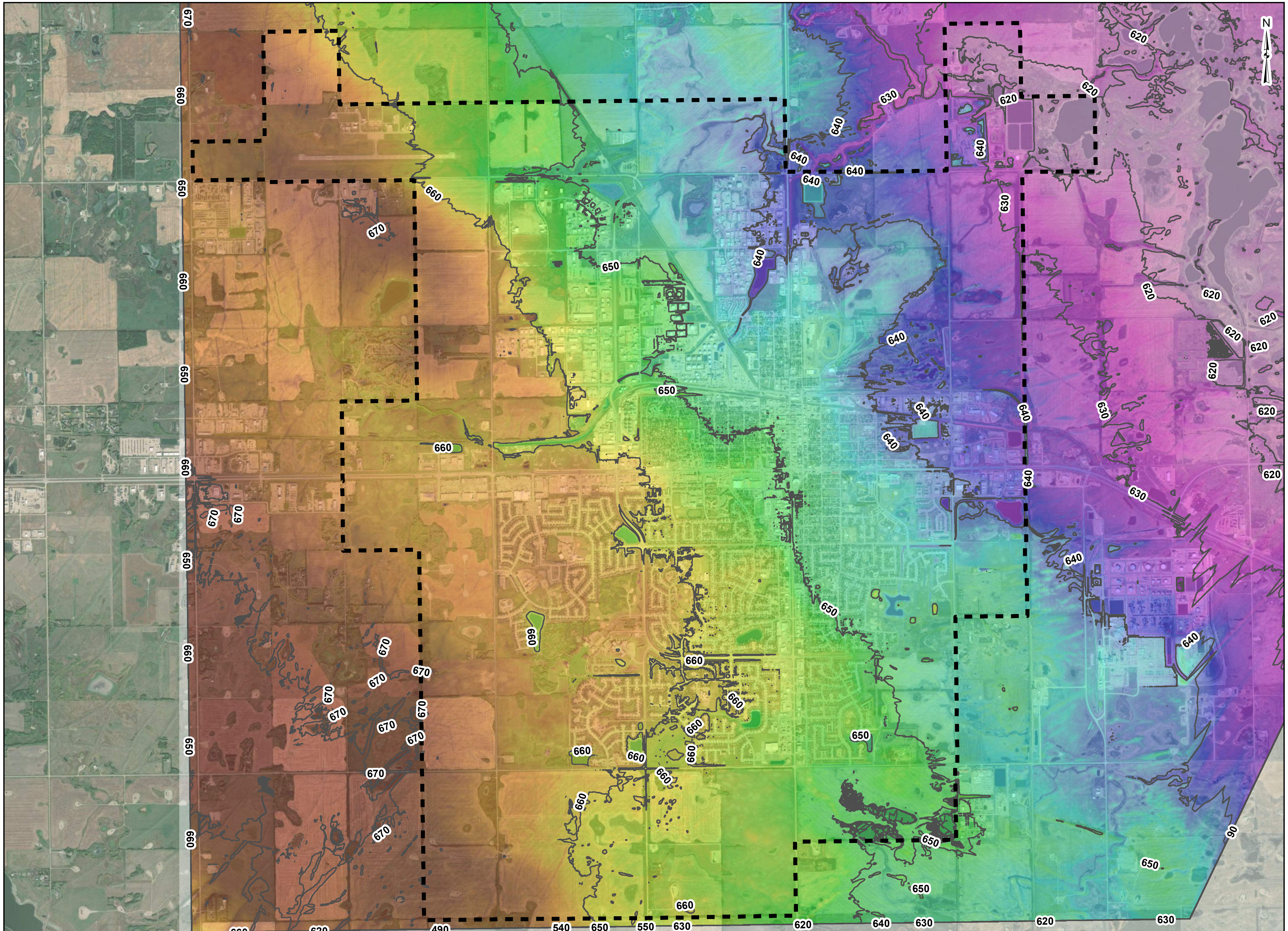

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Major Contour - 10m Interval

Minor Contour - 2m Interval

Study Area

Elevation (m)

High : 676.5

Low : 614.0

* Topography constructed based on 2019 LiDAR supplemented with 3D surfaces from recent projects.

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 2.3
STUDY AREA TOPOGRAPHY
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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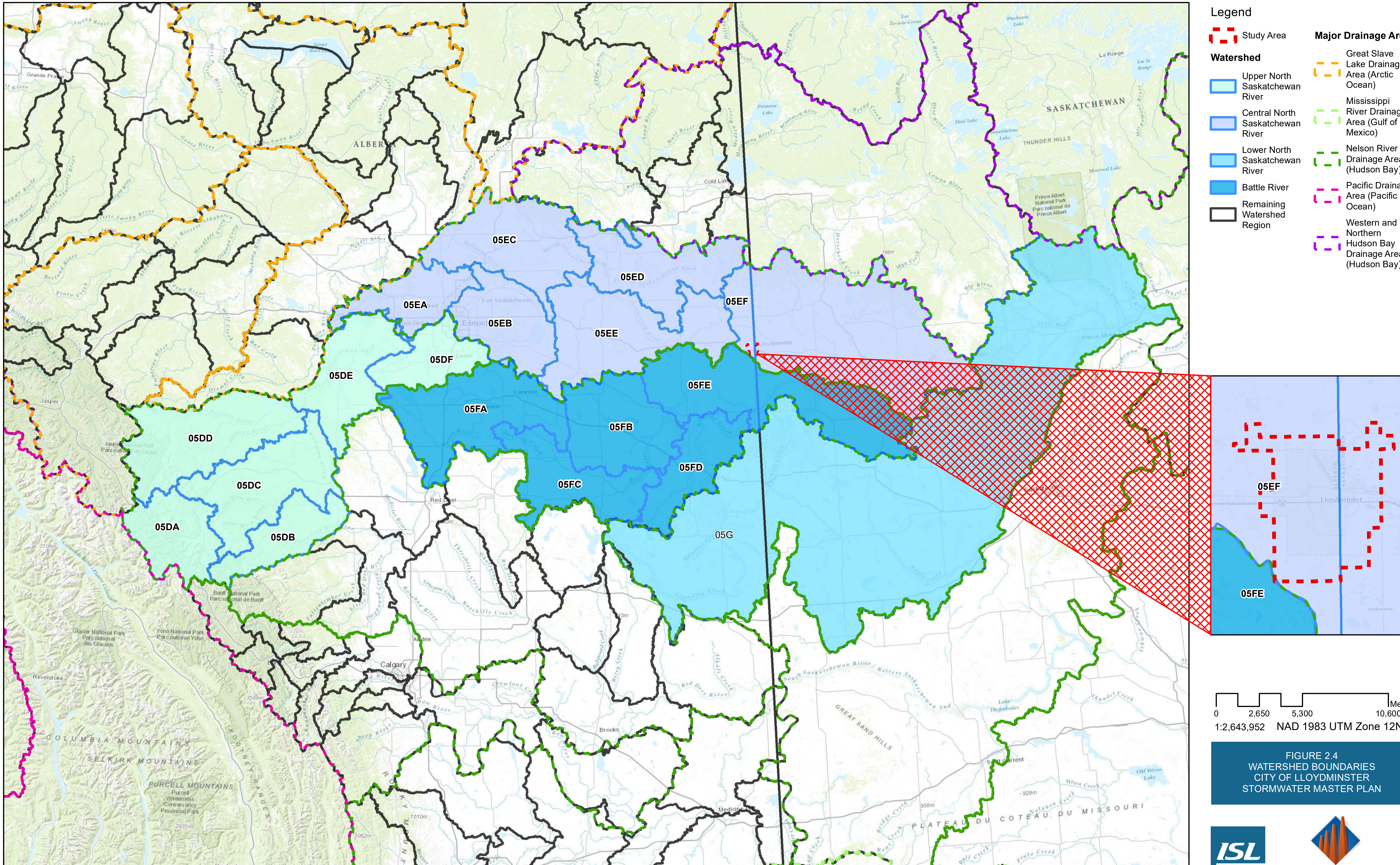

FIGURE 2.4
WATERSHED BOUNDARIES
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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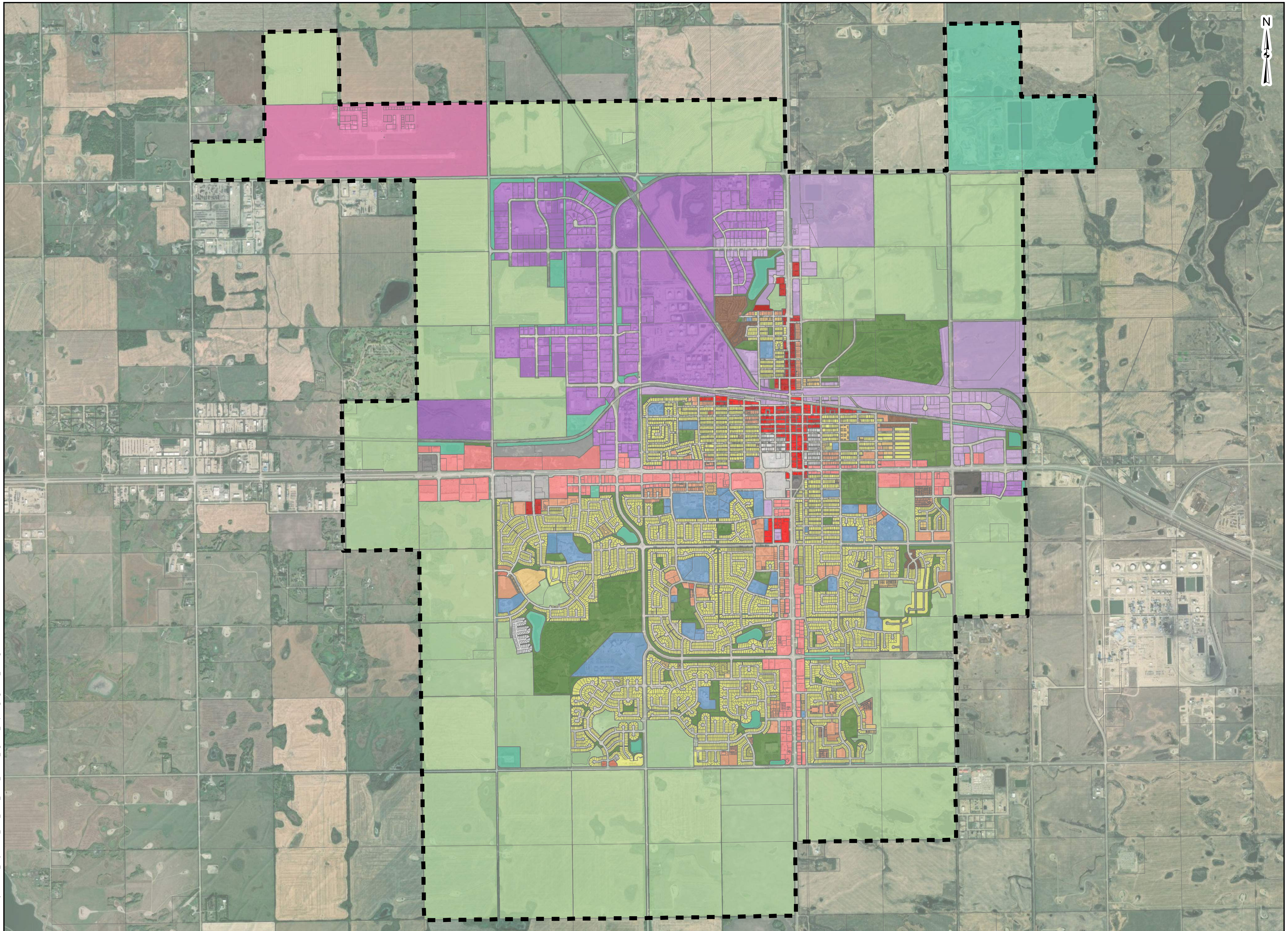

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Study Area

Existing Land Use

- R1: Single-Detached Residential
- R2: Semi-Detached Residential
- R3: Row House Residential
- R4: Medium-Density Residential
- R5: High-Density Residential
- RMH: Residential Manufactured Home
- C1: Central Commercial
- C2: Highway Corridor Commercial
- C3: Neighbourhood Commercial
- C5: Service Commercial
- I1: Light Industrial
- I2: Medium Industrial
- PS: Public Services
- PU: Public Utility
- UP: Urban Park
- MA1: Municipal Airport Airside
- UT: Urban Transition
- DC1: Direct Control 1
- DC2: Direct Control 2
- DC3: Direct Control 3
- DC4: Direct Control 4
- DC5: Direct Control 5
- DC6: Direct Control 6
- DC7: Direct Control 7

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 2.5
EXISTING LAND USE
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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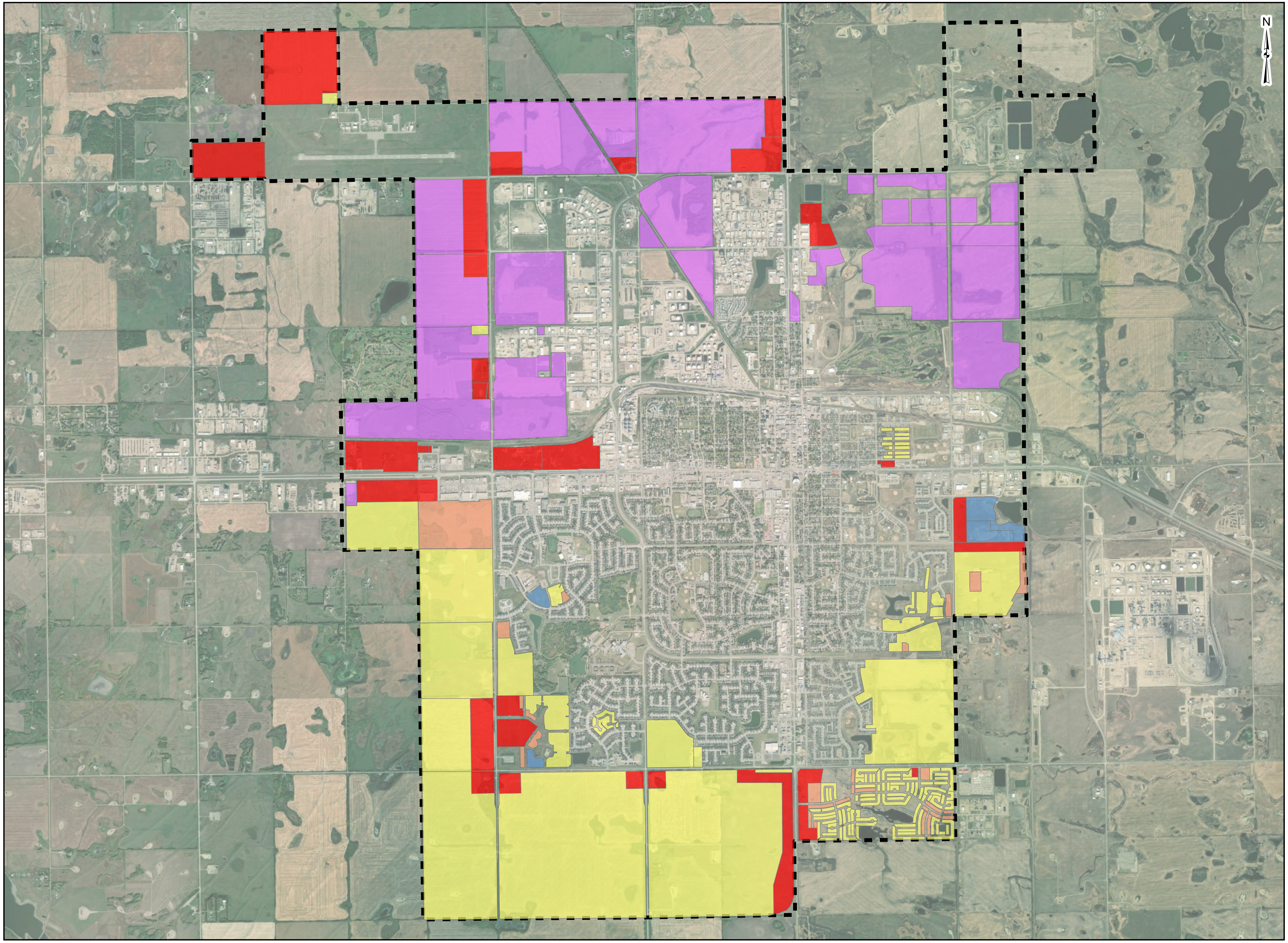

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Study Area

Future Land Use

RES-SF: Single-Family Residential

RES-MF: Multi-Family Residential

CBD: Commercial Business District

IND: Industrial

PS: Public Services

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 2.6
FUTURE DEVELOPMENT LAND USE
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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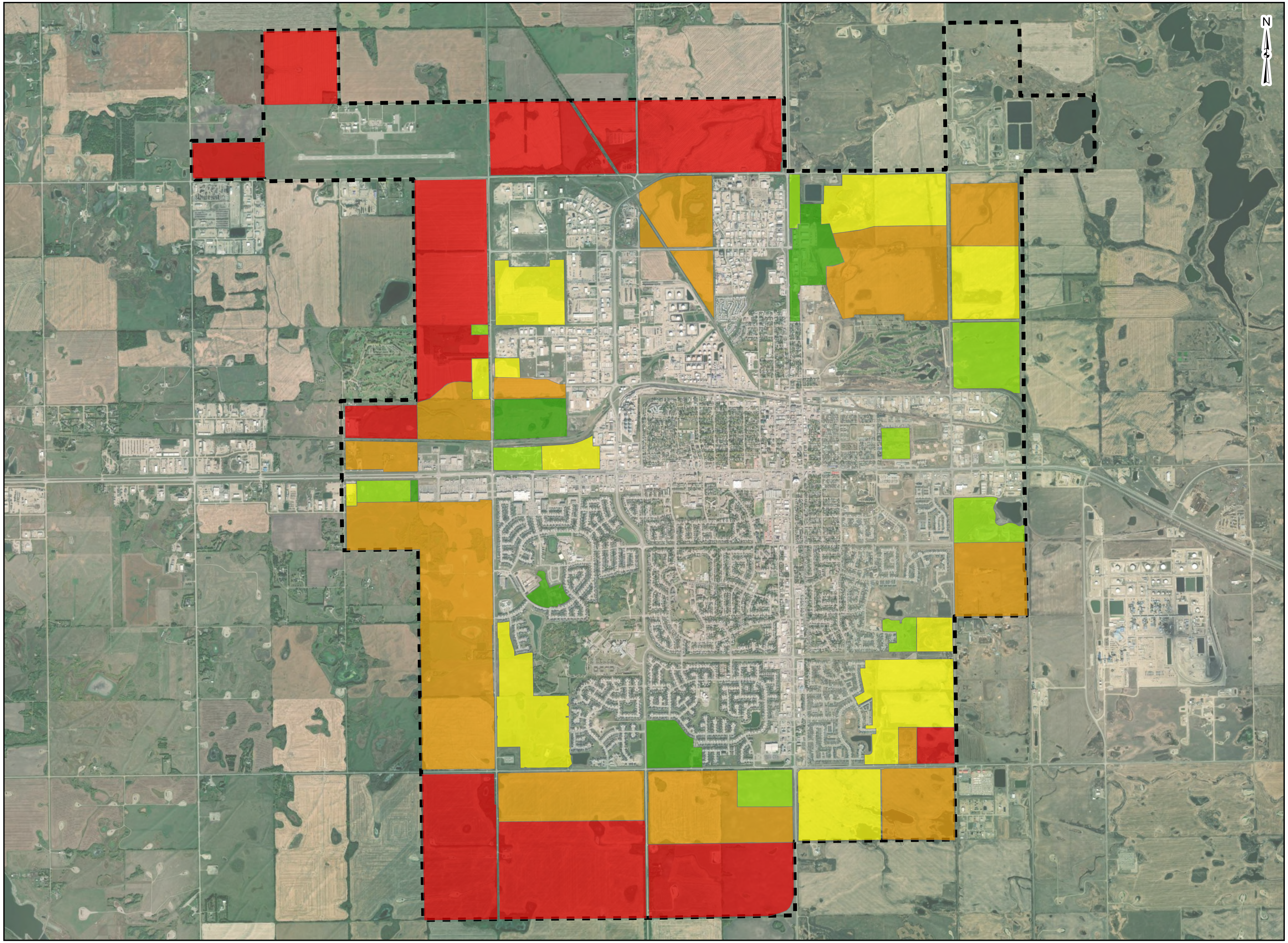

Credits:World Imagery: Vermilion River County, Maxar

Legend

- Study Area

Staging

- 3-Years
- 5-Years
- 10-Years
- 20-Years
- Ultimate

Note: map does not include any vacant parcels under existing conditions that would be developed in the future, or densification to existing development.

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 2.7
FUTURE DEVELOPMENT AREA STAGING
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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3.0 Design Criteria

The design criteria used to assess the storm sewer system were based primarily on the City of Lloydminster's Municipal Development Standards (October 2020) and typical municipal servicing standards in the Province of Alberta and the Province of Saskatchewan. The design criteria selected were then used for input into the InfoWorks ICM model to design and assess the storm sewer system.

3.1 Pre-Development Runoff Release Rate Analysis

The pre-development runoff release rate is required to establish an allowable runoff release rate for new development so future stormwater management facilities can be properly sized in the city. Doing so helps minimize the impact of increased runoff due to future developments on the environment. The previous SWMP (Sameng Inc., 2015) proposed a maximum runoff release rate of 1.5 L/s/ha for future developments both inside and outside of City limits for the following reasons:

- A drainage study completed by Sameng Inc. for the adjacent Blackfoot and Devonia Basins (just west of Lloydminster) indicated a pre-development runoff release rate of approximately 1.65 L/s/ha for the 1:100-year event;
- The culvert crossing the railroad along the Northwest Drainage Channel at the west edge of the City limits, north of 44 Street and west of 75 Avenue, controls the flows through the culvert to be approximately 1.5 L/s/ha; and
- Regulating the same or lower runoff release rate from future developments would help the City maintain existing level of service (LOS) and increase flood protection in the storm sewer system, thereby reducing the need of major storm sewer system upgrades.

The 1.5 L/s/ha release rate falls within the typical range stipulated by many other similar municipalities in Alberta and Saskatchewan. This release rate controls stormwater discharge to a reasonable level while not posing excessive restrictions on development. Therefore, ISL recommends the City continue using 1.5 L/s/ha as the maximum allowable runoff release rate.

The 1.5 L/s/ha rate can be reasonably conformed to by developments without causing significant difficulties. However, it is noted that this rate should be reviewed on a development-specific basis so that no downstream capacity constraints or erosion issues exist that would inhibit it, as downstream capacity constraints or erosion problems could mandate further rate reductions or even total annual discharge volume controls.

3.2 Design Rainfall Events

In assessing the storm sewer system, a design rainfall event is required to generate runoff that will subsequently enter the network. The design storms applied in this SWMP are based on the City of Lloydminster's Municipal Development Standards (October 2020), which stipulates minor storm sewer systems are to be designed and assessed under the 1:5-year return period rainfall event and major storm sewer systems are to be designed and assessed under the 1:100-year return period rainfall event. Rainfall Intensity-Duration-Frequency (IDF) parameters are summarized in Table 3.1 and Table 3.2, respectively. The highlighted 1:5 year and 1:100 year IDF parameters were used for assessment and design in this SWMP.

Table 3.1: City of Lloydminster IDF Intensities (mm/hr)

Duration	1:2 Year	1:5 Year	1:10 Year	1:25 Year	1:50 Year	1:100 Year
5-minute	81.0	**126**	152	190	207	**231**
10-minute	57.9	**86.8**	105	130	143	**182**
60-minute	17.5	**24.9**	30.2	36.4	40.7	**63.1**
1440-minute	1.41	**1.98**	2.34	2.81	3.16	**4.57**

Table 3.2: City of Lloydminster IDF Parameters

Parameter	1:2 Year	1:5 Year	1:10 Year	1:25 Year	1:50 Year	1:100 Year
a	512	**718**	913	1095	1230	**2575**
b	-0.81	**-0.81**	-0.82	-0.82	-0.82	**-0.87**
c	4.74	**3.57**	3.91	3.48	3.8	**11**

For minor storm sewer system capacity assessment and design, the 1:5-year 4-hour Modified Chicago rainfall event was used. For major storm sewer system capacity assessment and design, the 1:100-year 4-hour Modified Chicago rainfall event was used to assess system performance during a shorter yet more peaky event, and the 1:100-year 24-hour Huff rainfall event was used to assess system performance during a prolonged event. Hyetographs of the 1:5-year and 1:100-year design storms are illustrated below in Figure 3.1.

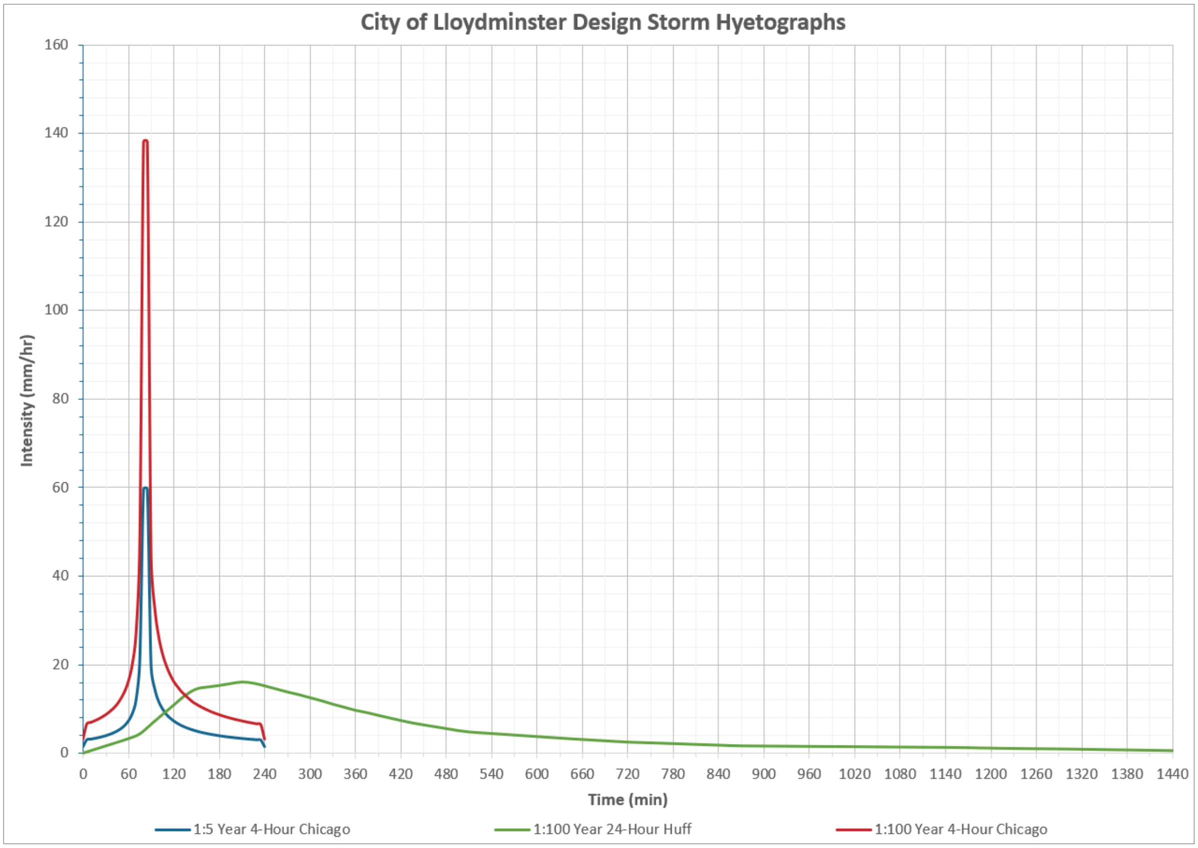


Figure 3.1: Design Storm Hyetographs

3.3 Assessment Criteria

The performance of the storm sewer system under existing conditions is ultimately determined based on the available freeboard between the ground elevation and the high-water level (HWL) elevation represented by the maximum hydraulic grade line (HGL) at each manhole for each assessment design storm.

The existing storm sewer system was analyzed under the following three assessment scenarios per the City of Lloydminster's Municipal Development Standards:

- Minor System:
  - 1:5 Year 4-Hour Modified Chicago Rainfall Event
- Major System:
  - 1:100 Year 4-Hour Modified Chicago Rainfall Event
  - 1:100 Year 24-Hour Huff Rainfall Event

The performance of the existing minor storm sewer system (1D network) was assessed in terms of two indicators as follows:

3.3.1 Maximum HGL Elevation Relative to the Ground Elevation

Maximum HGL elevation relative to the ground elevation is the amount of freeboard between the maximum water elevation and ground elevation at each manhole at the moment when maximum flow passes through.

The maximum allowable surcharge in the gravity portion of the storm sewer system must remain at least 1.5 m based on the minimum depth of cover identified in the City of Lloydminster's Municipal Development Standards.

Hence, the Maximum HGL Elevation Relative to the Ground Elevation with a value of:

- greater than 0.00 m is denoted as a red dot, indicating a surcharge/back-up to surface;
- between -1.5 m and 0.00 m is denoted as an orange dot (maximum HGL peaks within 1.5 m below the ground);
- between -1.5 m and -3.0 m is denoted as a yellow dot (maximum HGL peaks between 1.5 m and 3.0 m below the ground); and
- less than -3.0 m is denoted as a green dot (maximum HGL peaks lower than 3.0 m below the ground).

3.3.2 Peak Discharge Relative to Pipe Capacity

Peak discharge relative to the pipe capacity indicates the ratio of peak flow to the pipe capacity; as a corollary to this, the data can be interpreted to indicate the amount of spare capacity during peak flows. This is calculated by employing a ratio of modelled flow in a pipe and its corresponding capacity. Pipes with ratios greater than one are considered to have no spare capacity, thus indicating a section of pipe that might require upgrading, particularly where the length of the section is long enough to cause surcharge conditions immediately in the upstream reach.

The City of Lloydminster's Municipal Development Standards indicated a preference for pipes to flow no more than 85% of their maximum capacity. Therefore, the peak discharge relative to the pipe's capacity (Q/Q_{man}) with a ratio of:

- greater than 1.00 is denoted as a red line, indicating over capacity, or in another words the capacity is diminishing as the maximum flow theoretically occurs at roughly 94% of the pipe's diameter;
- between 0.86 and 1.00 is denoted as an orange line, with less than 14% of spare capacity available; and
- less than 0.86 is denoted as a green line, with spare capacity available.

3.3.3 Spare Capacity

In addition to the above, the spare capacity of each pipe was determined for the minor storm sewer system. This indicates the amount of additional flow each pipe can handle before its capacity is completely utilized. The amount of spare capacity ranges from less than 0 L/s to over 200 L/s, with the least capacity illustrated in red and the most capacity illustrated in blue. In determining spare capacity, it becomes evident which pipes are available to accommodate any additional flows from future development and which pipes should remain untouched.

3.3.4 2D Assessments

To present and evaluate the major storm sewer system, 2D assessment model files were reviewed, and results data was extracted for both depth and velocity at the maxima for the 1:100-year design storms. The complete model file contains velocity and depth properties at any time step within the simulation results in the event they are required for future analyses.

To increase public safety, the Province of Alberta has stipulated permissible depths for submerged objects in relation to water velocity. This guideline, Stormwater Management Guidelines for the Province of Alberta (1999) was implemented to ensure that a 20 kg child would be able to withstand the force of moving water, thus preventing possible tragedies. Due to the city's unique geographic location, similar guidelines stipulated by the Province of Saskatchewan were researched; however, no additional criteria were determined. Therefore, the Province of Alberta requirements, as depicted on Figure 3.2, were adopted for this SWMP. Note that the guideline only provides values for velocity between 0.5 to 3 m/s, so the values outside of the range were linearly extrapolated for assessment in this study.

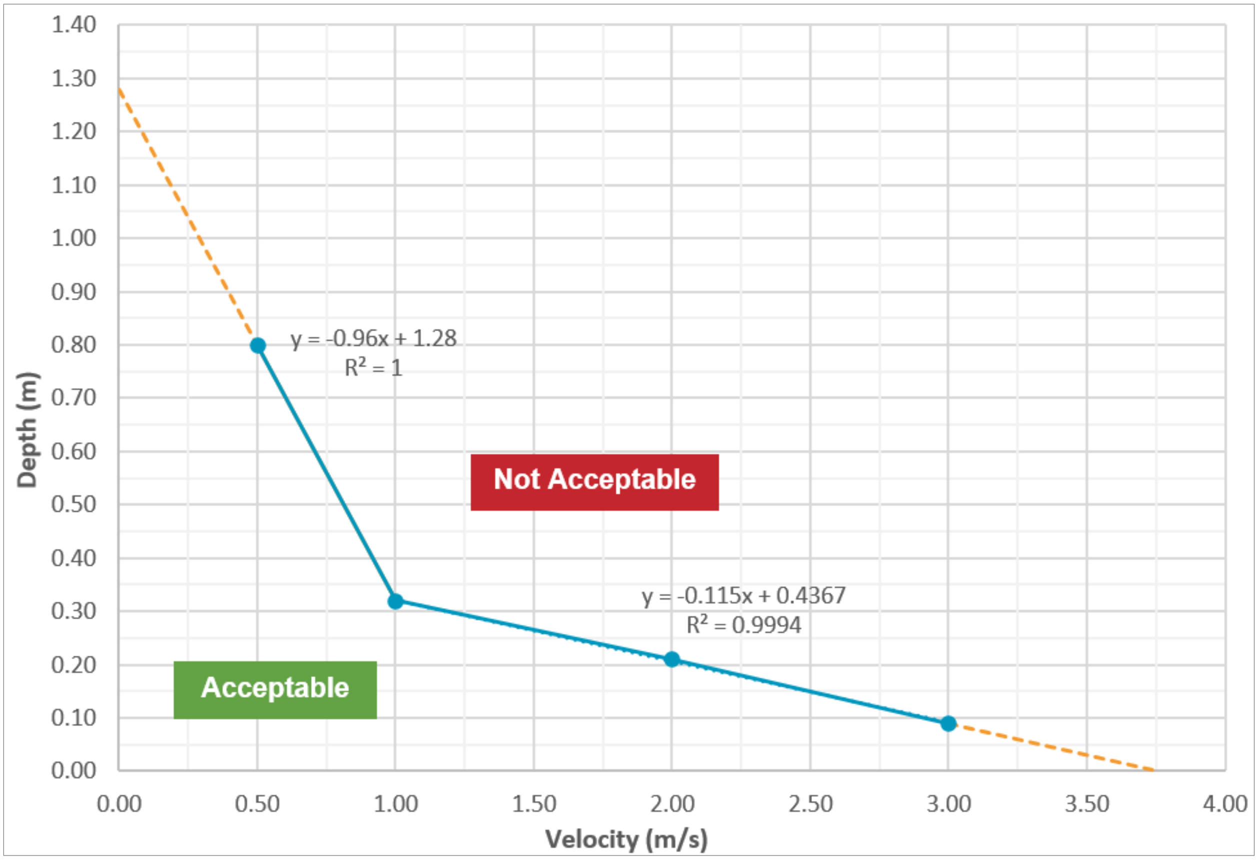


Figure 3.2: Permissible Depths for Submerged Objects

3.3.5 Future Stormwater Management Facilities (SWMF) Design Criteria

In determining future development requirements, the same infiltration surface parameters as specified in Table 5.5 were employed to calculate runoff. In addition, there are several hydraulic design criteria, as described below, necessary to conceptualize future stormwater management systems. Unless otherwise noted, these criteria are based on the Stormwater Management and Storage Facilities, Section 5.6.2.1 Design – Wet Ponds in the City of Lloydminster's Municipal Development Standards.

- Ponds were sized to store runoff from the 1:100-year storm event (larger of the 4-hour Chicago storm and 24-hour Huff storm) with approximately 1.5 m rise from the active storage bottom to HWL. The City's Municipal Development Standards stipulates a maximum of 2.0 m above the NWL; therefore, designing to the 1.5 m water level allows some flexibility during the detailed design.
- A minimum freeboard of 0.30 m above HWL.
- Minimum removal of 85% of total suspended solids (TSS) for particle sizes ≥ 50 microns on an annual basis as per Alberta Environment standards.
  - Note that the Province of Saskatchewan Stormwater Guidelines do not stipulate quantified TSS removal requirement in stormwater pond design. Instead, it specifies the minimum and preferred detention time for stormwater pond design.
- Minimum storage pond depth (NWL to bottom) greater than 2.0 m, or a depth of 25 mm x the catchment area x the overall catchment imperviousness ratio.
- Outlet structures submerged a minimum of 1.2 m below the NWL.
- Minimum orifice size of 100 mm in diameter.
- Maximum allowable runoff release rate of 1.5 L/s/ha under the 1:100-year design storm.
  - Note that the 1.5 L/s/ha runoff release rate is stipulated in the City of Lloydminster's Municipal Development Standards for the 1:5-year event. For conservative purposes, the same 1.5 L/s/ha was used for the 1:100-year design storm.
  - Pond interior side slope of 5:1 to 7:1 (H:V), with the exception of the slope between the NWL to 2 m horizontally where a 3:1 slope is required. It is noted, however, that for the purpose of this SWMP, a 5:1 side slope was maintained throughout.

4.0 Existing Storm Sewer System

Within Lloydminster, the existing storm sewer system consists of both major and minor systems.

The major storm sewer system consists of the following types of drainage infrastructure:

- Surface (Overland) Drainage:
  - Roads;
  - Ditches/swales;
  - Overland escape routes; and
  - Natural watercourses;
- Storage Facilities:
  - Ponds; and
  - Trap lows.

The minor storm sewer system consists of the following types of drainage infrastructure:

- Piped system;
- Catch basins, inlets and leads;
- Manholes and junctions; and
- Outfalls.

Drainage infrastructure, such as culverts, curbs and gutters, and roof leaders are considered to be part of both the major and minor systems, as these features facilitate an exchange of stormwater runoff between the overland (major) and piped (minor) storm sewer systems. In addition, some drainage in undeveloped or open areas is achieved by uncontrolled overland drainage.

4.1 Stormwater Conveyance System

Lloydminster is currently serviced by approximately 130 km of storm sewers and culverts, based on the GIS data provided by the City. The details of the storm sewers and culverts, regarding diameter, material, and installation period, are shown in Figures 4.1, 4.2, and 4.3, respectively. The pipes are predominately made of concrete (CONC) or polyvinyl chloride (PVC) materials, with pipe diameters ranging from 100 mm to 2,400 mm in diameter and up to 3,000 mm by 5,000 mm in dimension for box culverts. Tables 4.1 to 4.3 below summarize the storm sewer system based on pipe diameter, material, and installation period, respectively.

Table 4.1: Existing Storm Sewer and Culvert Diameter Summary

Diameter	Total Length	Percentage of Total Length
mm	m	%
100	43	0.03
200	1,238	0.95
250	1,128	0.87
300	6,606	5.08
375	12,381	9.53
450	16,565	12.75
525	9,469	7.29
600	11,706	9.01
650	30	0.02
675	6,618	5.09
750	11,928	9.18
825	223	0.17
900	12,768	9.82
1000	201	0.15
1050	7,594	5.84
1050	284	0.22
1200	8,491	6.53
1350	8,683	6.68
1500	3,170	2.44
1650	2,224	1.71
1800	3,532	2.72
1950	408	0.31
2100	919	0.71
2400	424	0.33
Box Sections	924	0.71
Unknown Diameter[1]	2,394	1.84
Total	**129,951**	**100.00**

[1] Assumptions were made in the model for storm sewers with unknown diameter, based on upstream and downstream known pipe sizes. Pipe size assumptions are noted in the model's User Text Fields.

Table 4.2: Existing Storm Sewer and Culvert Material Summary

Material	Total Length	Percentage of Total Length
	m	%
Concrete (CONC)	89,005	68.50
Corrugated Steel Pipe (CSP)	204	0.20
Polyvinyl Chloride (PVC)	35,958	27.70
Steel (STL)	500	0.40
Vitrified Clay Tile (VCT)	376	0.30
Unknown	3,908	3.00
Total	**129,951**	**100.00**

Table 4.3: Existing Storm Sewer and Culvert Installation Period Summary

Installation Period	Total Length	Percentage of Total Length
	m	%
1960-1969	13,921	10.71
1970-1979	23,588	18.15
1980-1989	23,254	17.89
1990-1999	9,360	7.2
2000-2009	31,956	24.59
2010-2022	27,835	21.42
Unknown	37	0.03
Total	**129,951**	**100.00**

4.2 Existing Drainage Patterns

Stormwater drainage in Lloydminster primarily follows two main routes towards the northeast, via either the Northwest Drainage Channel or the East Drainage Channel. The existing overall stormwater system's general drainage patterns are shown in Figure 4.4.

The Northwest Drainage Channel originates west of the city within the County of Vermilion River No. 24 and intersects the City limit north of 44 Street (Highway 16), west of 75 Avenue. From here the Northwest Drainage Channel flows northeast through the City crossing various roads and railways via culverts until it reaches Lake V (Brekko Lake) near the city's northeastern boundary. From Lake V, the Northwest Drainage Channel continues northeast towards 67 Street and ultimately terminates at Neale Lake West.

The majority of the northwest area of the city, including a large drainage basin situated to the west, flows into the Northwest Drainage Channel through a network of storm sewers and ditches. Off-site drainage from the County of Vermillion River No. 24, with an approximate contributing area of 2,500 ha, is also conveyed through the city via the Northwest Drainage Channel. Further, the northern portion of the city drains eastwards through swales and small watercourses, which connect to the Northwest Drainage Channel just beyond the city's northern limit.

The East Drainage Channel is an artificial waterway that originates at Lake J, following a northeast trajectory, passing through Lake K, and continuing northward through Lake N. From Lake N it flows northward paralleling the City's eastern most boundary until it crosses 67 Street and goes through a drop structure before converging with the Neale Lake West, which is a part of the Neale Edmunds Complex that receives 93% of all the City's stormwater according to previous assessment studies.

Catchment areas of the East Drainage Channel include the majority of the southeast area of the city, a portion of the land to the southwest, which is initially diverted to Bud Miller Lake and ultimately connects to the East Drainage Channel, and some areas along the east and south boundaries of the city.

The remaining areas at the south end of the city generally drain eastwards to Big Gully Creek via a series of swales, small watercourse tributaries, lakes, and a large drainage channel (informally referred to as the "South Drainage Channel" in the previous SWMP).

4.3 Stormwater Management Facilities

SWMFs are important elements in storm sewer systems. SWMFs are designed to store large volumes of runoff during intense storm events and then slowly release flows afterwards to attenuate the peak flows within the downstream storm sewer system. This reduces the pressure on upstream and downstream major and minor conveyance infrastructure while minimizing flooding potentials.

There are seventeen (17) existing SWMFs in the city, as shown in Figure 4.4 and summarized in Table 4.4. The 2015 SWMP noted that Lake G, Highway 17 Pond (private pond), Lake N, Lake V, and Lake K were undersized. Since the 2015 SWMP, Lake K has been upgraded. In addition to these facilities is the Neale Edmunds Stormwater Complex, which consists of six (6) main lakes and receives nearly all of the city's stormwater.

In addition to the seventeen (17) SWMFs included in the City's GIS inventory, two (2) other SWMFs are also noted based on consultation with City staff and review of aerial imagery. One of the SWMFs is the future Pond U located west of 62 Avenue, north of the railway and south of the City of Lloydminster Operation Centre. The other SWMF is within the Lakeside neighbourhood, located south of 17 Street Close and west of 13 Street Close. Since there is no available information on the two (2) SWMFs, they were represented by regular mesh element with surface elevation extracted from LiDAR data in the 2D model.

The NWLs specified in the table below are used in the hydraulic model; however, it should be noted that the control structures of these waterbodies can be adjusted to increase or decrease the water levels. As such, the NWLs are not always the same.

Table 4.4: Stormwater Management Facility Summary

SWMP Name	Type	Bottom Elevation m	NWL m	Overflow Elevation m	Outlet Structure/Configuration
Pond O	Dry	642.22	0	646.70	1 – 1,200 mm pipe
HWY 17 (Private Pond)	Wet	Not Available	638.35	639.40	1 – 900 mm culvert
Brekko Lake (Lake V)	Wet	634.00	636.70	639.10	2 – 1,800x2,400 mm rectangular culverts (Concrete Box Culverts)
HWY 16 (formerly known as HW 1A)	Wet	654.00	656.50	661.60	1 – 1,350 mm pipe, a 2 m wide weir, and a sluice gate
Pond 2	Dry	633.00	0	636.90	1 – 375 mm culvert
Lake N	Wet	630.46	633.00	636.90	3 – 1,200 mm culverts and a 6 m wide weir
Larsen Grove	Wet	635.00	637.00	640.30	1 - 600 mm pipe connected with outlet control structure (housing 100 mm orifice and a 2.24 m wide weir), which connects to a lift station that houses a pump with 127 L/s capacity and a 600 mm gravity overflow pipe
Lake L	Wet	651.80	655.60	659.40	1 – 675 mm pipe
Lake K	Wet	632.00	634.50	639.90	2 – 1,350 mm pipes, each with 1.6 m wide weir
Parkview Lake (Pond 1)	Wet	654.50	658.00	661.30	1 – 750 mm pipe connected to 2 pumps, which discharge into a channel flowing to Lake G via a 300 mm forcemain
Bud Miller Lake (Lake G)	Wet	653.50	660.40	661.10	1 – 600 mm culvert
Lake H	Wet	651.00	653.70	656.60	1 – 750 mm culvert and a 0.82 m weir
Jaycee Lake (Lake J)	Wet	640.00	642.70	645.50	2 – 1,650 mm culverts and a 2 m wide weir
Lakeside Pond (Pond 5)	Wet	654.50	656.40	661.00	1 – 1,050 mm pipe
Lake C	Wet	649.50	652.10	656.15	1 – 1,200 mm pipe
Lake D	Wet	Not Available	648.00	651.60	548 mm orifice with a 2.4 m wide weir at HWL
Multiplex	Wet	649.50	651.70	655.30	1 – 375 mm culvert

4.4 Historical Flooding Records

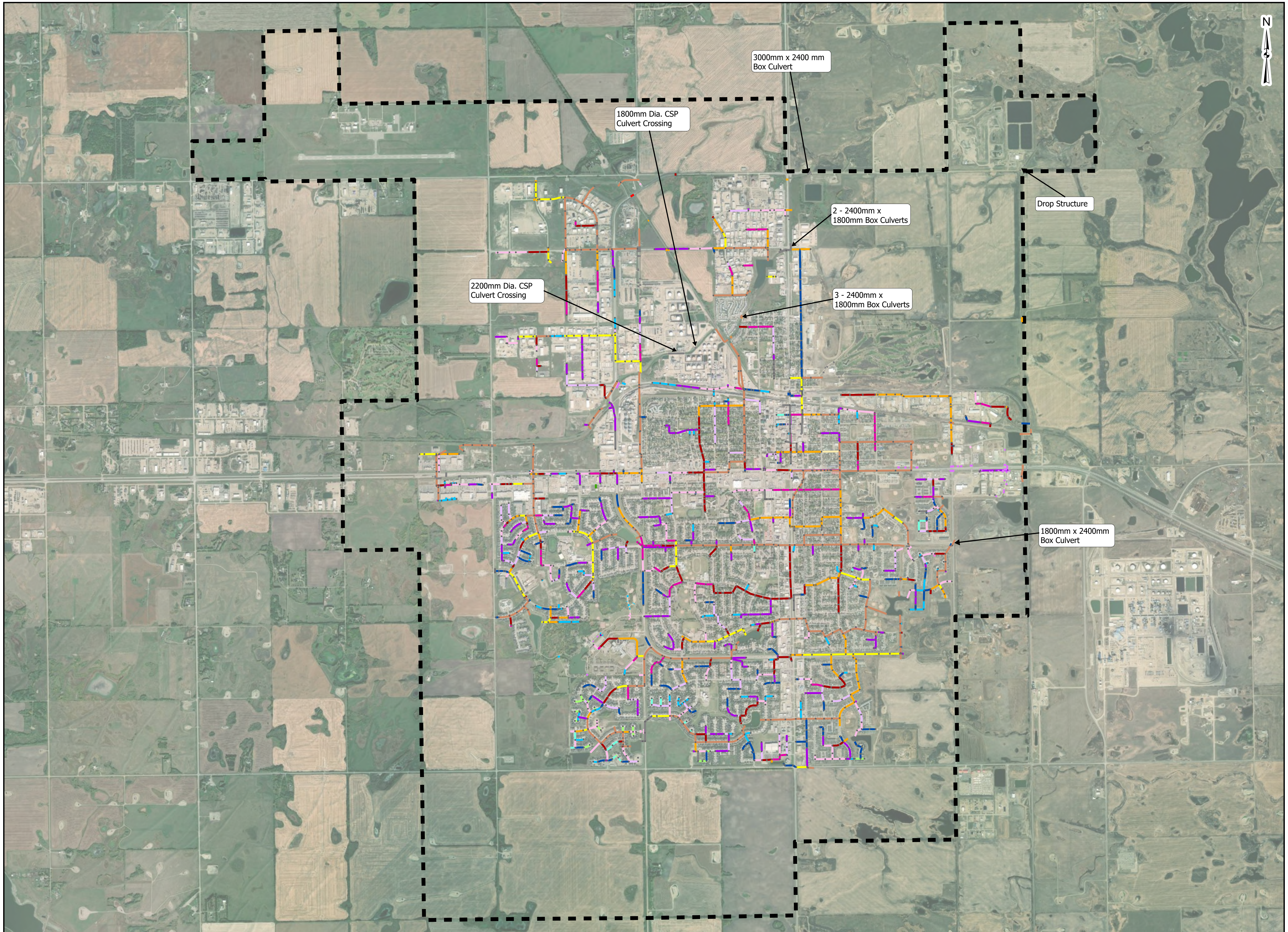
The City experienced several severe precipitation events between 2010-2020 with anecdotal flooding observations, insurance claims, and residents' complaints documented by City staff. These events include the June 27, 2012 event, July 11, 2016 event, and June 9, 2017 event. The available flooding records including surface and road flooding, sewer backup, insurance claims, and residents' complaints from the three events are illustrated in Figure 4.5.

These available historical flooding records were used to verify model accuracy and prioritize recommended existing system upgrades.

4.5 Wetland Conservation and Protection

ISL recommends retention of reasonably permanent, large, and/or complex wetlands due to the potential landscape hydrologic impact. Typically, these basins have limited anthropogenic disturbance, resulting in native plant communities, high potential for rare species, and stable wildlife habitat for waterfowl, shorebirds, amphibians, and invertebrate species. Additionally, these basins typically hold more water than other wetlands and may be significant to catchment hydrology. To infill them during development would not only displace this water, but also likely impact the overland flow dynamics, which could lead to flooding and/or spring melt and stormwater management issues.

It should also be noted that less permanent wetlands also provide important wetland functions, such as stormwater retention, sediment and nutrient retention, and wildlife habitat. The impact of their disturbance is anticipated to be less since there is a greater chance that they have been historically disturbed by cultivation. ISL recommends that during development, conservation of these wetlands should be considered.



Credits:World Imagery: Vermilion River County, Maxar

Legend

- Manhole

Pipe Diameter

- 100 mm
- 150 mm
- 200 mm
- 250 mm
- 300 mm
- 350 mm
- 375 mm
- 400 mm
- 450 mm
- 500 mm
- 525 mm
- 530 mm
- 600 mm
- 650 mm
- 675 mm
- 750 mm
- 800 mm
- 825 mm
- 900 mm
- 1000 mm
- 1050 mm
- 1067 mm
- 1200 mm and Greater
- Unknown

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

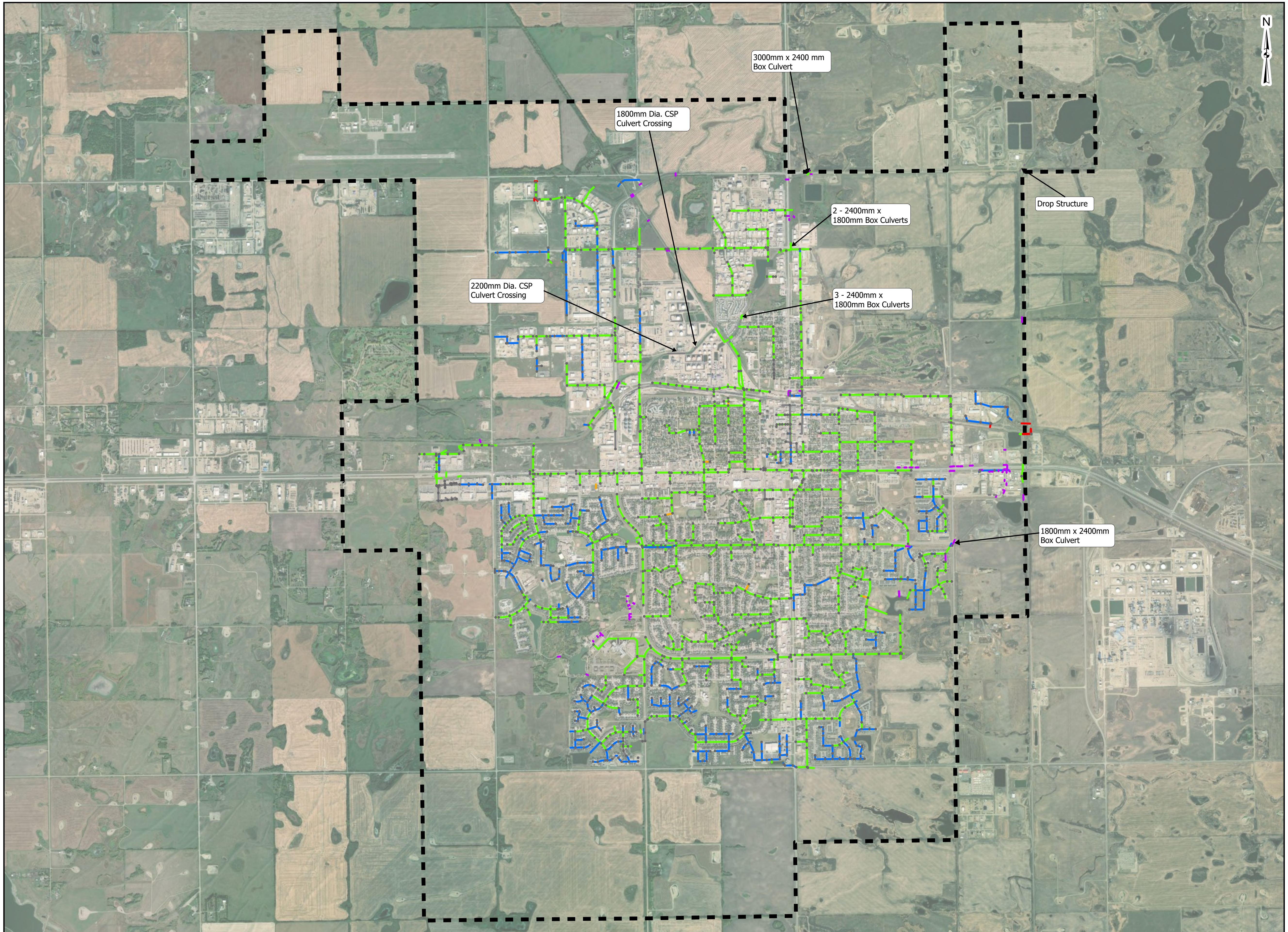
FIGURE 4.1
EXISTING STORM SEWER/CULVERT DIAMETER
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Integrated Expertise. Locally Delivered.

Date: 2024-09-12 Document: C:\Users\lche\Desktop\L.Che\Projects\28310 Lloydminster Stormwater Master Plan\30_Technical\GIS\28310_Lloydminster SWMP Report Figures\28310_Lloydminster SWMP Report Figures.aprx



Credits:World Imagery: Vermilion River County, Maxar

Legend

- Manhole

Pipe Material

- Concrete
- Polyvinyl Chloride
- Steel
- Vitrified Clay
- Corrugated Steel
- Unknown

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 4.2
EXISTING STORM SEWER/CULVERT MATERIAL
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

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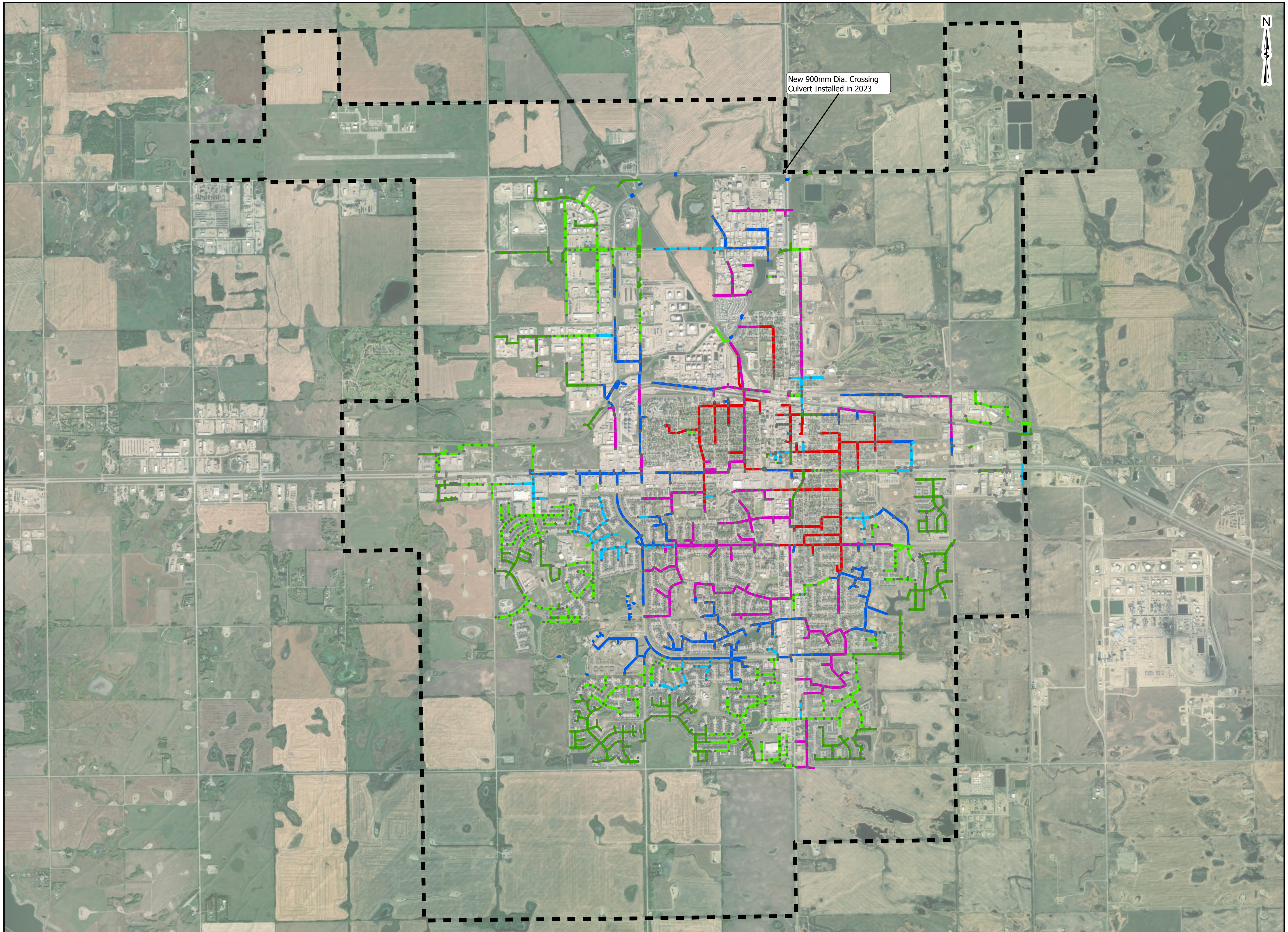
Date: 2024-07-11 Document: C:\Users\lche\Desktop\L.Che\Projects\28310 Lloydminster Stormwater Master Plan\30_Technical\GIS\28310_Lloydminster SWMP Report Figures\28310_Lloydminster SWMP Report Figures.aprx



Credits:World Imagery: Vermilion River County, Maxar

Legend

- Manhole

Installation Year

- 1960-1969
- 1970-1979
- 1980-1989
- 1990-1999
- 2000-2009
- 2010-2022
- Unkown

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 4.3
EXISTING STORM SEWER/CULVERT INSTALLATION YEAR
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

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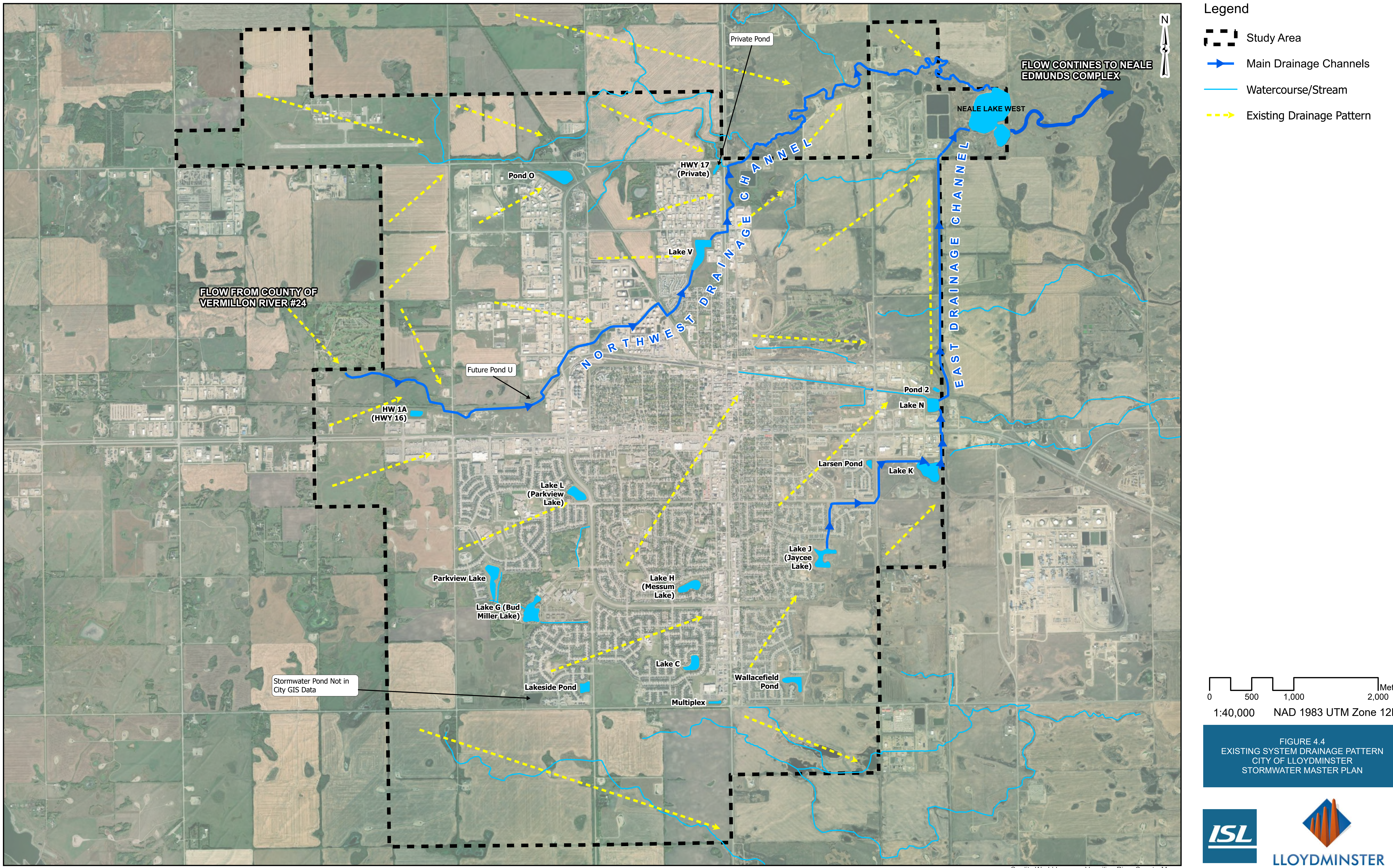

FIGURE 4.4
EXISTING SYSTEM DRAINAGE PATTERN
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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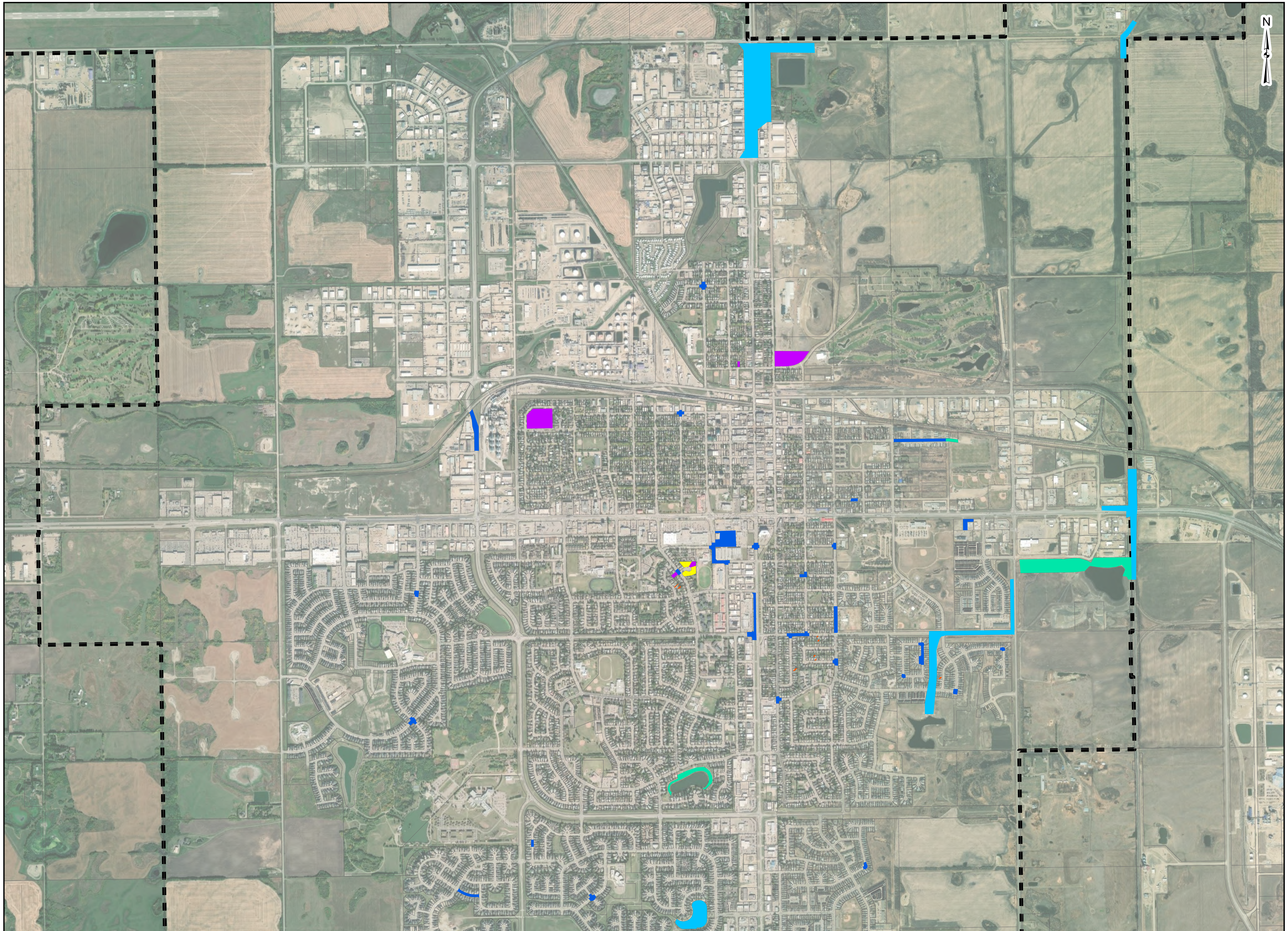
Date: 2024-07-18 Document: C:\Users\lche\Desktop\L.Che\Projects\28310 Lloydminster Stormwater Master Plan\30_Technical\GIS\28310_Lloydminster SWMP Report Figures\28310_Lloydminster SWMP Report Figures.aprx



Legend

Historical Flood Events

- Flooded Area/Road, June 9 2017
- Insurance Claim, June 9 2017
- Complaint, June 9 2017
- Sewer Back Up, June 9 2017
- Flooded Area/Road, July 11 2016
- Flooded Area/Road, June 27 2012

Note: flooding locations and extents are approximate based on photos and anecdotal descriptions of flooding records provided by the City

0 315 630 1,260 Meters

1:25,000 NAD 1983 UTM Zone 12N

FIGURE 4.5
HISTORICAL FLOODING RECORDS
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL LLOYDMINSTER

Integrated Expertise. Locally Delivered.

Credits:World Imagery: Vermilion River County, Maxar

Date: 2024-07-11 Document: C:\Users\lche\Desktop\L.Che\Projects\28310 Lloydminster Stormwater Master Plan\30_Technical\GIS\28310_Lloydminster SWMP Report Figures\28310_Lloydminster SWMP Report Figures.aprx

5.0 Hydraulic Model Development

5.1 Computer Model

The computer model software package used for this SWMP was InfoWorks ICM, which was selected for its advanced capabilities associated with 2D modelling. InfoWorks ICM is a powerful analysis tool that computes rainfall generated runoff based on surface parameters and routes surface stormwater flows overland, as well as through the hydraulic system network. Based on the hydraulic simulation, the model can be used to evaluate locations with surcharge or flooding conditions under various rainfall events. Storm sewer flows are also determined to identify over-capacity sewers based on peak flows and pipe capacities. The InfoWorks ICM software is significantly integrated with the ArcGIS platform, which was used to assist in the construction of the model.

5.2 Model Set-Up

The Lloydminster model is a 1D-2D integrated stormwater model, in which the storm sewer network is represented by 1D network of links and that connect manhole to manhole or catch basin to manhole. The overland major drainage system is modelled using a 2D mesh network created by the City's 2022 Light Detection and Ranging (LiDAR) surface. With this set-up, water can travel in two dimensions across the surface, depending on the ground terrain. Catch basins and manholes represent the connection points between the 1D and 2D network, where the inlet/discharge rates between the 1D and 2D network follow head-discharge curves (i.e., rating curves) defined by the geometry and properties of the inlet openings. Water in excess of catch basin inlet capacity will either pond on the surface or find its way to continue flowing downstream, just as in the real world.

The InfoWorks ICM model was constructed using the geographic information system (GIS) data provided by the City, combined with record drawings, referencing the previous MIKE URBAN model, and making assumptions as necessary. The model's pipe network was developed from scratch so that the most up-to-date system data, consistent with the City's GIS information, was incorporated and all revisions or assumptions tracked for the City's reference. This was also done so that new or upgraded infrastructure that was not previously included was accounted for, while eliminating duplicate network elements.

The process undertaken to develop the 1D and 2D portions of the model is described below.

5.2.1 Minor System (1D) Model Development

The pipe network data was first processed in ArcGIS to remove duplicate entries and combine pipe segments with matching NAMENUM shapefile fields to simplify the pipe network for importing into InfoWorks ICM, as well as reduce the number of artificial nodes required in the model. Any abandoned or inactive network elements were filtered out, as these would not be needed in the model. Once this process was complete, the pipe network and associated infrastructure was imported into InfoWorks ICM for verification.

One of the critical steps as part of updating the SWMP was to determine if the inputted data appeared accurate for the proper connectivity of the system and review tie-in elevations, pipe diameters, and pipe slopes, to determine if the inputted data appeared accurate. This process was completed by producing longitudinal profiles (LPs) of every pipe network in the city. For the purposes of system verification, the LPs were used to identify:

- Missing data:
  - Connectivity errors;
  - Missing pipes or nodes; and
  - Reversed pipe direction;
- Potentially erroneous pipe gradients:
  - Flat slopes;
  - Steep slopes; and
  - Adverse slopes;
- Inconsistent profiles:
  - Upstream invert of downstream pipe above downstream invert of upstream pipe;
  - Two pipes with identical elevations in series; and
  - Suspicious pipe drops.

If any of the above issues were identified, they were remediated though the request and review of any available record drawings. Assumptions were applied when no other information was available. Changes to the pipe network details, including the source of new information, and assumptions were noted in the network element properties, with the status marked as "modified."

Missing information and pipe assumptions included:

- Missing downstream invert information was taken from the downstream neighbouring pipes;
- Missing upstream invert information was calculated based on the City's minimum design slope for each pipe diameter, as stipulated in Table 5.1; and
- Culvert inverts were extracted from the City's LiDAR surface where invert information was not provided and/or available.

Table 5.1: Minimum Design Slopes for Sewers

Nominal Pipe Diameter	Minimum Design Slope
mm	%
200	0.74
250	0.55
300	0.44
375	0.32
450	0.26
525	0.22
600	0.18
675	0.15
750	0.13
≥ 900	0.10

Manning's coefficients for pipe roughness were assigned as outlined in Table 5.2.

Table 5.2: Manning's 'n' Pipe Roughness Coefficient

Material	Manning's 'n' Coefficient
Concrete (CONC)	0.013
Corrugated Steel Pipe (CSP)	0.024
Polyvinyl Chloride (PVC)	0.011
Steel (STL)	0.016
Vitrified Clay Tile (VCT)[1]	0.017
Unknown	0.013

[1] This roughness coefficient assumes that the pipe's integrity remains and that broken pieces are not laying in the flow channel.

Where manhole or catch basin rim elevations were missing from the City's GIS data, the rim elevation was also extracted from the City's 2022 LiDAR surface. Many of the manholes were missing sump elevation data, in which case the lowest connected pipe invert was assumed as the manhole sump elevation. Like the pipe network elements, the node status was set to "modified" where any assumptions were applied. For manholes that did not have a manhole diameter provided, a manhole area was applied based on the maximum diameter of the connecting pipes.

Artificial nodes were added as needed, primarily where connections existed along the pipe rather than at the manhole (i.e., blind connection). Artificial nodes were considered to have zero chamber and shaft area.

Head-discharge curves were assigned to each catch basin based on the inlet type found in the GIS data provided by the City. Where this information was missing, an assumption was made based on other catch basins in the area or via Google Street View. Catch basin head-discharge curve values were obtained from the manufacturers' specifications (Trojan Industries Inc. and Norwood Foundry Ltd.), as illustrated in Figure 5.1.

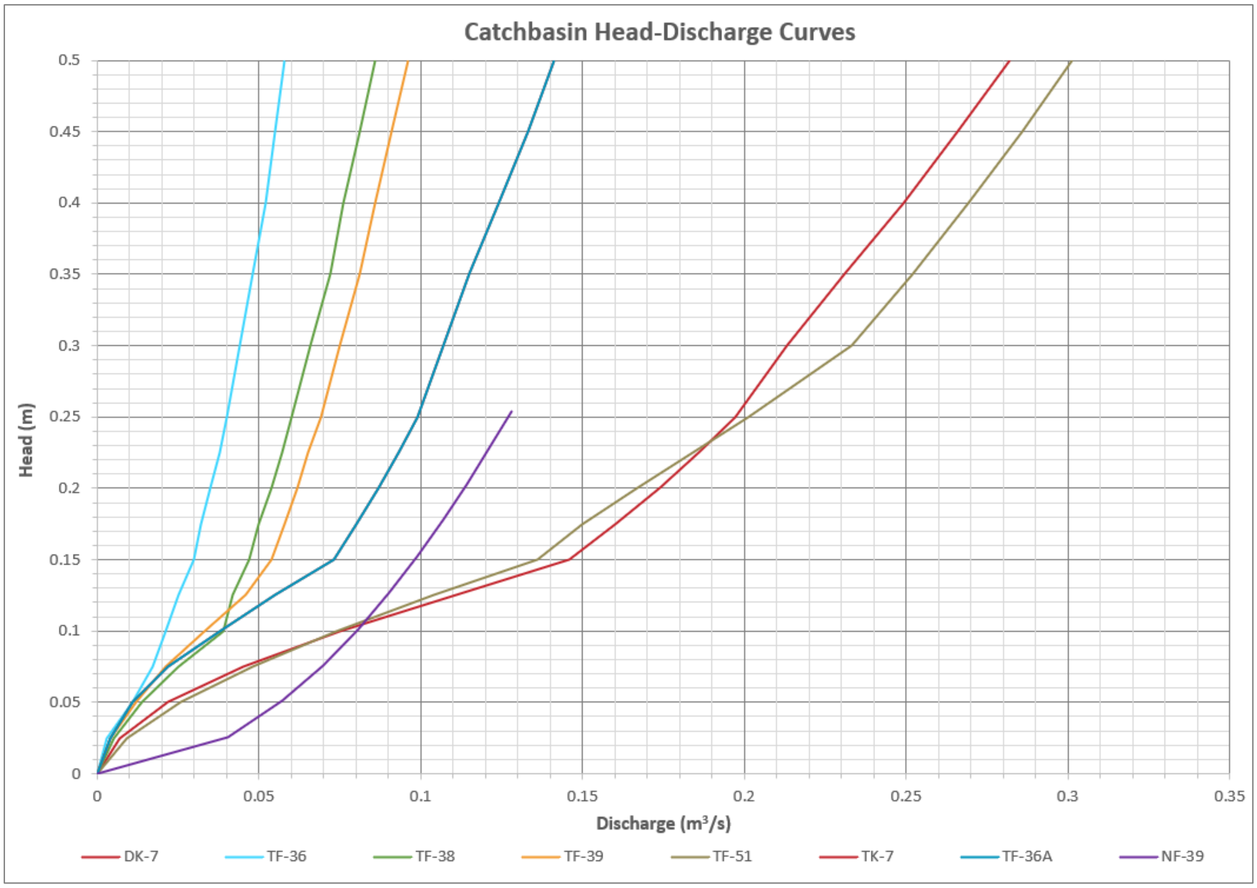


Figure 5.1: Catch Basin Head Discharge Curves

5.2.2 Major System (2D) Model Development

The major storm sewer system consists of all overland drainage infrastructure listed above. In Lloydminster, the following parameters were considered to develop a mesh, which ultimately represents the overland drainage system:

- 2D Zone;
- Mesh Zones;
- Mesh Level Zones;
- Roughness Zones;
- Infiltration Zones; and
- Building Footprints.

The 2D Zone represents the city boundary, within which the 2D analysis was completed. The 2D model makes use of LiDAR data by constructing a triangular irregular network (TIN) surface mesh model in the computer. The TIN surface is made up of a series of triangular mesh elements that represent the ground surface contours with each corner/vertex being assigned horizontal and vertical (i.e., elevation) coordinates in space.

There are several parameters associated with the mesh generation that have significant impact on overall model accuracy and quality, as well as capacity assessment results, including Mesh Zone, Mesh Level Zone, Roughness Zone, and Infiltration Zone.

The Mesh Zone specifies different mesh element densities for various zones, to either increase or decrease the resolution (i.e., triangle size) of a zone depending on its importance. For example, to capture pertinent features within critical areas of the 2D Zone (i.e., roads and buildings), parcels are generally defined by denser, smaller elements. Alternatively, green spaces that do not impact existing developments could be considered as larger mesh elements. The maximum and minimum triangle sizes used in the mesh generation by land use are summarized in Tables 5.3.

Table 5.3: Mesh Zone Parameters per Land Use Type

Land Use	Maximum Triangle Area	Minimum Triangle Area
	m^2	m^2
Airport	50	25
Building	15	5
Commercial	50	25
Neighbourhood Commercial	50	25
Light Industrial	50	25
Heavy Industrial	50	25
Institutional	50	25
Direct Control	50	25
Open Space	100	50
Mobile Home Residential	50	25
Low-Density Residential	50	25
Medium-Density Residential	50	25
High-Density Residential	50	25
Roads	15	5
Water	25	5

Mesh Level Zones were used to adjust the elevations of the Mesh Zones at ponds where an existing pipe inlet or outlet elevation is lower than the surface elevation of the LiDAR data, which is the water elevation in the pond at the time the LiDAR was captured. The starting water level was then raised using initial model conditions to bring the water elevation back to the NWL but facilitate the pressure impacts of the water on the pond inlet and outlet elevations below the water level.

The Roughness Zone allows various Manning’s roughness coefficients (i.e., n-values) for different parts of the mesh. Each Roughness Zone is designated a Roughness Definition, where a roughness coefficient can be specified for each land use. The Manning’s formula (in a 2D differential equation form) is consequently used to evaluate the overland flow characteristics on any given mesh element using the slope and overland flow distance inherent in the 2D surface. The roughness coefficients applied in the model by land use are summarized in Table 5.4.

Table 5.4: Roughness Zone Parameters per Land Use Type

Land Use	Roughness Coefficient
Airport	0.0272
Building	0.0160
Commercial	0.0175
Neighbourhood Commercial	0.0191
Light Industrial	0.0191
Heavy Industrial	0.0191
Institutional	0.0238
Direct Control	0.0238
Open Space	0.0300
Mobile Home Residential	0.0238
Low-Density Residential	0.0254
Medium-Density Residential	0.0222
High-Density Residential	0.0206
Roads	0.0160
Water	0.0425

The Infiltration Zone allows for various infiltration parameters across the mesh, depending on the different surfaces that are apparent within the mesh. Each Infiltration Zone is designated an Infiltration Surface, where an Infiltration Type can be specified for each land use. Infiltration Surface defines the imperviousness ratio (i.e., runoff coefficient) and the infiltration model associated with pervious surfaces for different land uses; therefore, it is ultimately the deciding factor for runoff quantity and rate. Water not infiltrated on the mesh element becomes runoff and flows off the mesh element to neighbouring elements according to grades. If runoff from impervious mesh elements discharge into pervious mesh element, the infiltration model for the pervious area will apply to the runoff, thereby reducing the runoff rate.

The infiltration parameters applied per land use type are presented in Table 5.5. The fixed runoff coefficients were calculated based on the estimated grass and pavement percentages on each of the land use surface, with assumptions that grass surfaces have additional 10% imperviousness and impervious surfaces have 5% detention storage and 10% of pervious surfaces become direct runoff. These parameters are based on the percent impervious of each land use type identified in the City's Municipal Development Standards, the previous SWMP, and typical industry standards. It is recommended that the City conduct flow monitoring programs to verify runoff characteristics of different land use surfaces.

Table 5.5: Infiltration Zone Parameters per Land Use Type

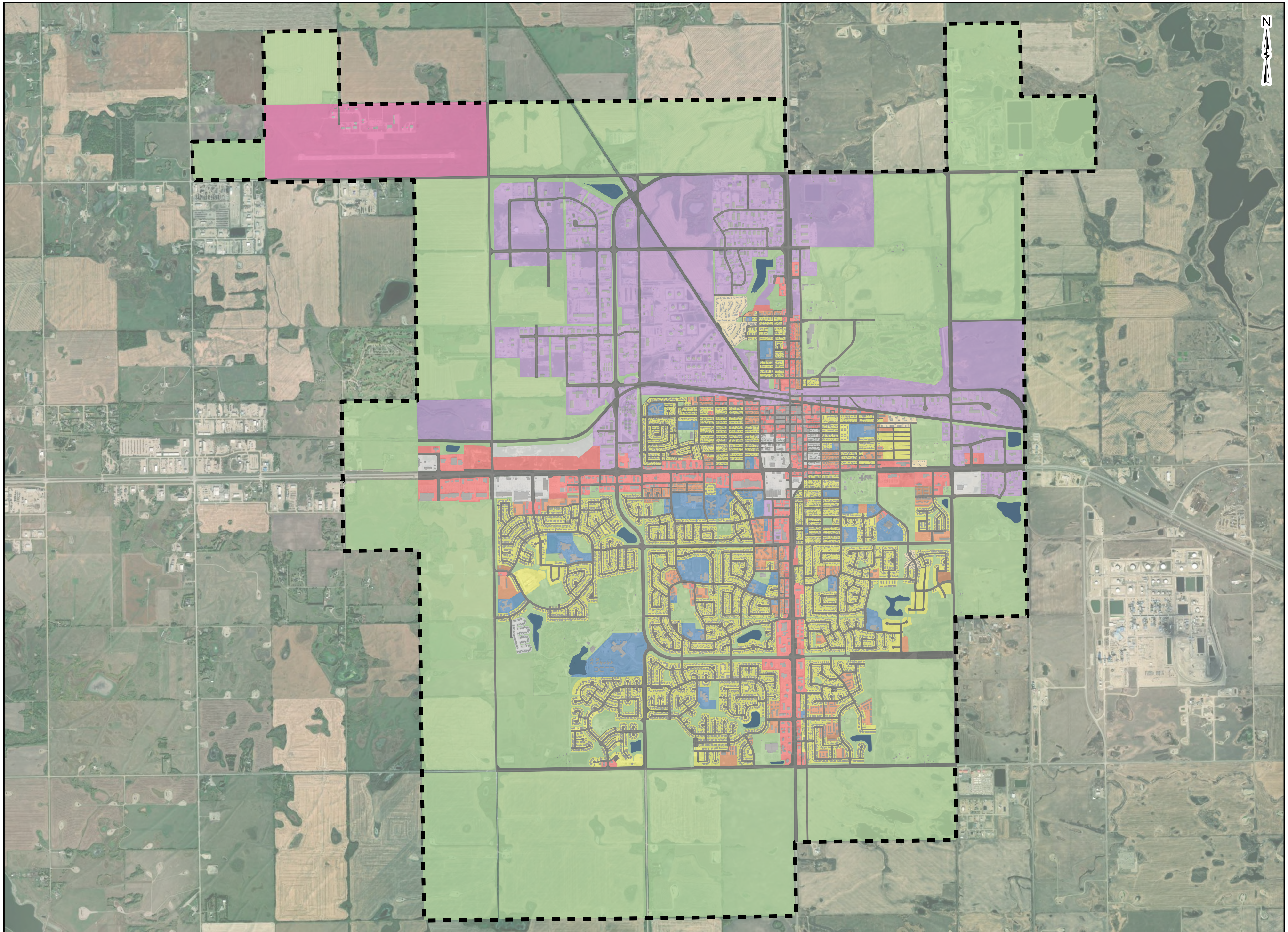
Land Use	Grass	Pavement	Infiltration Type	Calculated Fixed Runoff Coefficient	Horton Parameters		
					Initial Rate	Limiting Rate	Decay Rate
	%	%			mm/hr	mm/hr	1/hr
Airport	80	20	Fixed	0.338	-	-	-
Building	0	100	Fixed	0.950	-	-	-
Commercial	11	89	Fixed	0.865	-	-	-
Neighbourhood Commercial	22	78	Fixed	0.780	-	-	-
Light Industrial	22	78	Fixed	0.780	-	-	-
Heavy Industrial	22	78	Fixed	0.780	-	-	-
Institutional	56	44	Fixed	0.525	-	-	-
Direct Control	56	44	Fixed	0.525	-	-	-
Open Space	n/a	n/a	Horton	-	76.320	5.690	4.140
Mobile Home Residential	56	44	Fixed	0.525	-	-	-
Low-Density Residential	67	33	Fixed	0.440	-	-	-
Medium-Density Residential	44	56	Fixed	0.610	-	-	-
High-Density Residential	33	67	Fixed	0.695	-	-	-
Roads	0	100	Fixed	0.950	-	-	-
Water	0	100	Fixed	0.950	-	-	-

The Mesh, Roughness, and Infiltration Zones were generated through the geospatial development type information, to be able to specify different criteria depending on the land use type. It is noted that the physical boundaries of each Mesh, Roughness, and Infiltration Zone polygon are identical; however, the parameters vary depending on the type of polygon (i.e., whether it is a Mesh, Roughness or Infiltration Zone). Maintaining the same extent for each polygon type ensured there would be no errors regarding overlaps between the different polygon layers. These polygons, differentiated based on land use type, are illustrated in Figure 5.2.

Default Mesh, Roughness, and Infiltration parameters were defined in the 2D Zone to represent impervious areas, such as roadways and buildings. Additionally, the options to “apply rainfall etc. directly to mesh” and “terrain-sensitive meshing” were selected. The “apply rainfall etc. directly to mesh” option ensures that rainfall is falling directly onto the surface, which provides a more accurate representation of overland flows. The “terrain-sensitive meshing” option better represents the surface topography among the mesh elements.

Incorporating buildings into the 2D model was a major consideration. Ultimately, utilizing a rain-on-mesh approach, the most conservative and effective solution involved raising the buildings on the LiDAR surface. This prevents runoff from penetrating the buildings and allows rainfall to land on the rooftops and naturally flow off.

Mesh generation was an iterative process to produce a smooth mesh with limited unnecessary mesh elements caused by small gaps between polygons or excessive vertices. With the mesh elements loaded to the network, these small clusters of mesh elements could be easily identified, as they appeared darker than other areas of the mesh. These issues were mitigated by closing the gaps between polygons, or by removing any unnecessary vertices. The result of this iterative process was a smooth mesh without excess mesh elements.



Legend

Existing 2D Land Use

- Mobile Home Residential
- Low-Density Residential
- Medium-Density Residential
- High-Density Residential
- Commercial
- Industrial
- Institutional
- Airport
- Open Space
- Direct Control
- Building
- Road
- Water Body

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 5.2
2D MODEL EXISTING LAND USE SURFACES
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

Credits:World Imagery: Vermilion River County, Maxar

ISL LLOYDMINSTER

Integrated Expertise. Locally Delivered.

Date: 2024-07-11 Document: C:\Users\lche\Desktop\L.Che\Projects\28310 Lloydminster Stormwater Master Plan\30_Technical\GIS\28310_Lloydminster SWMP Report Figures\28310_Lloydminster SWMP Report Figures.aprx

6.0 Existing System Assessment

The existing storm sewer system was assessed using the design criteria stipulated above in Section 3.3. The minor storm sewer system was assessed under the 1:5-year 4-hour Modified Chicago design storm and the major storm sewer system was assessed under the 1:100-year 4-hour Modified Chicago and the 1:100-year 24-hour Huff design storms. Simulation results under each rainfall return period are described in Sections 6.1 and 6.2, respectively. Longitudinal profiles of some key locations in the City's existing storm sewer system are included in Appendix A. The profiles show the 1:5 and 1:100-year Modified Chicago storm HGLs, with the latter exhibiting a more pronounced peak and likely resulting in a more severe scenario than the 1:100-year 24-hour Huff design storm, offering more conservatism in system performance assessment.

6.1 1:5 Year Event Result Summary

The results under the 1:5-year 4-hour Modified Chicago design storm for the peak flow to full pipe capacity ratio and the peak HGL elevation relative to ground elevation are shown in Figure 6.1. The pipes spare capacity results are illustrated in Figure 6.2. Model results indicated that approximately 13.6% of the total manholes would have less than 1.5 m freeboard (i.e., peak HGL within 1.5 m below ground) and approximately 10.7% of the pipes were estimated to convey peak flow exceeding pipe capacity.

Since some pipes were installed shallow (e.g., close to the 1.5 m below ground minimum cover requirement), assessing the storm sewer system's performance solely based on the peak flow to pipe capacity ratio or maximum HGL relative to ground was not the most appropriate method. Thus, minor system areas of concern were focused on segments with peak flow exceeding pipe capacity and connected to an upstream or downstream manhole with the peak HGL within 1.5 m below ground elevation. For areas connected to pipe segments with less than 2.5 m HGL freeboard from ground elevation, it is recommended that the City investigates storm service connection presence and implement mitigation measures if basement flooding risks are identified. These locations are summarized in Table 6.1 (HGL profile shown in Appendix A).

Table 6.1: 1D Model Result Areas of Concern Under 1:5 Year Event

HGL Profile No.	Location	Diameter	Length	Maximum q/Q	Minimum HGL Freeboard
		mm	m	%	m
1	From Lakeside Pond to Lake C via 59 Avenue, 20 Street, and 15 Street	1,050 – 1,650	1,680	145	2.10
2	56 Avenue from 20 Street to 21 Street Close	200 – 600	392	106	1.96
3	52B Avenue and 53 Avenue from 22 Street to 25 Street	375 – 1800	577	135	1.25
4	29 Street, 51a Avenue and 31 Street from 54 Avenue to 50 Avenue	300 – 750	812	169	0.78
5	50 Avenue from 31 Street to 36 Street	750	581	233	0.84
6	36 Street from 50 Avenue to 43 Avenue	1,350 – 1,800	1,256	348	1.22
7	46 Avenue at 31 Street and 32 Street	525 – 1,050	300	176	0.94
8	50 Avenue to 25 Street via 18 Street, 19 Street, 47 Avenue, 20 Street, 46 Avenue, and 24 Street	900 – 1,200	1,297	200	0.62
9	59 Avenue from 29 Street to 36 Street	375 – 675	984	399	1.19
10	40 Street to 36 Street via 57a Avenue, 37 Street, and 57 Avenue	450 – 1,050	728	169	0.29
11	42 Street to 65 Avenue via 67 Avenue, 40 Street, and 66 Avenue	375 – 1,050	715	221	0.24
12	39 Street to Lake L via 65 Avenue	600 – 1,650	633	221	1.34
13	38 Street to 44 Street via 48 Avenue, 39 Street, and 47 Avenue	900 – 1,200	798	172	0.62
14	44 Street from 52 Avenue to 47 Avenue	450 – 1,200	848	118	1.75
15	62 Avenue between railway and 47 Street	300 – 450	534	122	0.59
16	51 Street at 56 Avenue to back of 56b Street across railway	900 – 1,350	1,195	112	1.27
17	52 Street between 59 Avenue and 53 Avenue	300 – 675	1,002	225	0.32
18	52 Street near 52 Avenue to back of 56 Street across railway	300 – 1,500	817	194	0.24
19	48 Avenue at 50 Street to channel south of VLA Soccer Fields via 45 Avenue	450 – 1,350	1,392	260	0.35
20	52 Street at 47 Avenue to 47 Street at 40 Avenue	750 – 900	1,711	121	-0.34

In addition to the areas of concern listed in Table 6.1, there are also some catch basin leads throughout the existing storm sewer system found lacking capacity; however, catch basin leads are generally not considered high risks as there are typically no direct service connections. Therefore, they do not pose a significant concern to the minor storm sewer system. Because the Lloydminster stormwater model is a 1D-2D integrated model, insufficient catch basin lead capacity may limit the rate of flow entering the storm sewer system and cause water to pond on the surface. Thus, catch basin lead capacity and catch basin inlet capacity assessment should be conducted in conjunction with the 2D results under the 1:100-year event, as it is more related to the major system performance.

It is evident from the spare capacity results that there are a number of pipes that possess some spare capacity. These results align well with the peak discharge relative to the pipe capacity results. Though there are stretches of pipes with some spare capacity, there are also stretches of pipes either upstream or downstream of many of those nodes that are lacking capacity. Tying additional potential pipes into many of these sections would likely still require some existing pipes to be upsized. Additionally, in areas with spare pipe capacity, catch basin upgrades could be considered if there are issues with ponding.

Furthermore, under the 1:5-year 4-hour Modified Chicago storm event, the model results showed no culvert surcharging. This is expected since culverts, as major system components, should be designed to handle flows from events with a return period longer than 1:5-years.

6.2 1:100 Year Event Result Summary

To assess the City’s existing overland drainage system, model results were extracted at the maxima for both water depth relative to the LiDAR surface and surface flow velocity. It is noted that the maxima represent the peak depth/velocity value of each mesh element at a specific point in time. That said, the time stamps for each mesh element do not necessarily overlap, and each occurrence is independent of the next. The water depth and surface flow velocity results under the 1:100-year 4-hour Modified Chicago event are illustrated in Figures 6.3 and 6.4, respectively. In comparison, the water depth and surface flow velocity results under the 1:100-year 24-hour Huff event are illustrated in Figures 6.5 and Figure 6.6, respectively.

Generally, the 1:100-year 4-hour Modified Chicago storm event produced more surface flooding than the 1:100-year 24-hour Huff storm event, as it is more intense over a shorter period. This trend is within expectations as the shorter and more intense rainfall would overwhelm the minor storm sewer system more quickly, which makes the system more susceptible to backup, and more runoff would be generated when the infiltration rate cannot keep up with the rate of precipitation.

The results shown on Figures 6.3 through 6.6 indicate that there are several locations throughout the city that would experience surface flooding to some extent under the 1:100-year storm event. A summary of the areas of concern is presented in Table 6.2. Note that the areas of concern are identified with a focus on developed areas where property or infrastructure damages have a more pronounced consequence. Flooding in open fields, vacant land, or away from established properties is not considered critical. The locations corresponding to the location indicator numbers are illustrated in Figure 6.3.

Table 6.2: 2D Model Areas of Concern Under 1:100 Year Events

Location Indicator No.	Location	Comments
1	Open field NW of the Lloydminster Municipal Airport	There is approximately 0.3 m of ponding in the low-lying area. The flooding is contained within the open field and does not infringe the runway. No mitigation measure required.
2	Intersection of Township Road 502 and 75 Avenue	Model suggested over 1 m of surface flooding in the ditch. Review of the model indicated that the 600 mm culverts are limiting flow passage. However, since there are no developments upstream of this intersection and the flooding in the south ditch does not appear to extend into the yard to south, the flooding is not considered critical. No mitigation measure required.
3	East of 59 Avenue, north of 62 Street, rail crossing	Generally, 0.8 – 1.0 m ponding water, largely caused by culvert capacity restriction. The surface flooding east of 59 Ave and west of 62 Avenue, north of 62 Street does not appear to infringe developments in vicinity, so the flooding risk is not considered critical. No mitigation measure required.
4	Ditches along 50 Avenue north of 62 Street	Maximum overland depth exceeds 1.0 m in the ditches, caused by the combination of crossing culvert capacity limitation and discharge from Lake V. Flooding seems to be contained within the drainage channel. Thus, no mitigation measures are required.
5	Intersection of 63 Street and 51 Avenue	Maximum overland depth of approximately 0.6 – 0.8 m. Caused by backwater from high Lake V level. Flooding appears mostly to be in the roadway and does not infringe buildings. *Expanding Lake V capacity would help alleviate flooding risks in this area*.
6	Intersection of 62 Avenue and 56 Street	Approximately 0.5 m of ponding at the intersection of 62 Ave and 56 St, and in the MRC Global parking lot. Roadway flooding is caused by lack of catch basins and insufficient catch basin lead capacity, and MRC Global parking lot flooding is caused by lack of drainage infrastructure onsite. *Suggest confirming MRC Global onsite drainage infrastructure and improve grading if needed.*
7	Ditch south of 56 Street, west of Wolseley Plumbing/HVAC	Maximum surface ponding depth exceeds 1.0 m, caused by inadequate downstream pipe capacity. Flow is contained within the ditch and thus considered no issue. No mitigation measure required.
8	Cenovus Energy Refinery	Varying flooding depths throughout entire site. No onsite drainage infrastructure included in GIS. Poor site grading in general. *Suggest confirming onsite drainage infrastructure and improve grading with site owner.*
9	North of 51 Street, between 55 Avenue and 52 Avenue	Approximately 0.5 – 0.6 m maximum flooding from the ditch south of railway between 55 Ave and 52 Ave, extending into some yards, but does not appear to endanger surrounding buildings. *Suggest upgrading sewer on 51 Street and installing catch basins on Canora Street.*
10	45 Street and 44 Street between 55 Avenue and 54 Avenue	Approximately 0.5 m maximum flood depth on street, caused by insufficient storm sewer capacity and catch basin inlet capacity. Instances are near a residential area and on a major road. *Suggest upgrading sewers on 44 Street and 45 Street between 55 Avenue and 54 Avenue to reduce water backup in the sewer system.*
11	Nearby intersection of 52 Avenue and 41 Street	Maximum surface flooding depth over 0.6 m near a residential area. Flooding appears to be caused by insufficient catch basin inlet capacity. *Suggest installing additional catch basins or increasing catch basin inlet grate capacity.*

Location Indicator No.	Location	Comments
12	Ditch west of 50 Avenue between 39 Street and 36 Street	Over 1.0 m flooding in ditch and about 0.6 m surface ponding in the parking lot in front of Co-op Marketplace and BMO Bank of Montreal. Flooding appears to be caused by an undersized 375 mm pipe and insufficient catch basin inlet capacity. *Suggest upgrading the undersized pipe and catch basin inlet grate to increase capacity.*
13	36 Street between 59 Avenue and 57 Avenue	Maximum surface ponding of over 0.6 m on roadway caused by insufficient catch basin inlet capacity. *Suggest installing additional catch basins or upgrading existing catch basin inlet capacity.*
14	Intersection of 35 Street and 54 Avenue	Maximum surface ponding of over 0.6 m in a residential area caused by insufficient catch basin inlet capacity. *Suggest installing additional catch basins or upgrading existing catch basin inlet capacity.*
15	47 Avenue at Barr Cresent	Maximum surface ponding of over 0.6 m on roadway caused by insufficient catch basin inlet and lead capacities. *Suggest installing additional catch basins or upgrading existing catch basin inlet capacity.*
16	46 Avenue between 31 Street and 32 Street	Approximately 0.6 – 0.8 m of surface flooding at peak, endangering the residential properties nearby. Flooding appears to be caused by insufficient sewer capacity and catch basin inlet capacity. *Suggest upgrading the undersized pipes.*
17	Intersection of 45 Avenue and 29 Street	About 0.5 – 0.6 m of surface flooding on the roadway caused by insufficient catch basin inlet capacity. *Suggest installing additional catch basins or upgrading existing catch basin inlet capacity.*
18	Near the intersection of 30 Street and 55b Avenue	Generally, 0.4 – 0.5 m of ponding on street suggested by the model. The flooding is due to the lack of catch basins from GIS/model at the sag location on the street. Review of Google Street View indicated two catch basins present. No mitigation measure required.
19	Intersection of 27 Street and 54 Avenue	Up to 0.6 m of surface flooding at peak caused by insufficient catch basin inlet capacity. *Suggest installing additional catch basins or upgrading existing catch basin inlet capacity.*
20	Intersection of 26 Street and 57a Avenue	Maximum ponding of over 0.6 m on street, which resulted from downstream undersized pipe capacity and catch basin leads restriction. *Suggest upgrading downstream pipe to improve capacity.*
21	Condo/apartment buildings east of 22 Street at 47 Avenue	Maximum surface flooding depth exceeds 0.6 m in the parking lot. No catch basins in the parking lot available in GIS/model. *Suggest confirming onsite drainage infrastructure with site owner.*
22	49 Avenue south of 15 Street	Up to 0.6 – 0.8 m of surface ponding on the street. Review of model suggests that the flooding is caused by insufficient sewer capacity and catch basin inlet capacities. *Suggest upgrading the undersized pipe and catch basin inlet grate to increase capacity.*
23	60 Street at 53 Avenue	Over 0.6 m of ponding water is predicted by the model, which is caused by insufficient catch basin capacity. *Increasing the catch basin inlet capacity or installing additional catch basin would help alleviate flooding.*

Figures 6.7 and 6.8 illustrate the overland flow depth and the velocity's compliance compared to the Province of Alberta's requirements as described in Section 3.3.4. The vast majority of the overland system meets the maximum depth-velocity guideline, with exceptions in stormwater ponds, drainage channels, and some smaller ditches. SWMFs and drainage channels are intended to store or convey large volume of flow; thus, overland flow depth and velocity non-compliance in those locations is considered acceptable. However, it is recommended that inlet and outlet gratings be installed on the drainage channel and ditch culverts to prevent vandalism and children's access. Included grates should be installed at the pipe inlet for debris removal and limiting pinning forces. Additionally, should outlet grates be desired and installed upon further review, they should consist of horizontal bars designed to break away if clogged.

The estimated peak water levels in the stormwater storage ponds under the 1:100-year 4-hour Modified Chicago and 24-hour Huff storm events are summarized in Table 6.3. Generally, there are no capacity issues identified in the SWMFs, except for Lake V and Lake J where the estimated freeboard is close to 0.3 m.

Table 6.3: SWMF Pond Model Results

SWMP Name	Overflow Elevation	Peak Elevation 1:100 Yr 4Hr Chicago	Peak Elevation 1:100 Yr 24Hr Huff	Capacity Assessment
	m	m	m	
Pond O	646.70	643.86	643.79	No capacity issue
HWY 17 (Private Pond)	639.40	638.48	638.45	No capacity issue
Brekko Lake (Lake V)	639.10	638.80	638.80	No overflow but 0.3 m freeboard estimated
HW 1A (HWY 16)	661.60	657.25	657.18	No capacity issue
Pond 2	636.90	634.66	634.76	No capacity issue
Lake N	636.90	634.66	634.38	No capacity issue
Larsen Grove	640.30	639.42	639.65	No capacity issue
Lake L	659.40	656.95	656.98	No capacity issue
Lake K	639.90	635.57	635.55	No capacity issue
Parkview Lake (Pond 1)	661.30	658.76	658.87	No capacity issue
Bud Miller Lake (Lake G)	661.10	660.50	660.46	No capacity issue
Lake H	656.60	655.54	655.65	No capacity issue
Jaycee Lake (Lake J)	645.50	644.80	645.19	No overflow but only 0.31 m freeboard under the 24-hr Huff event
Lakeside Pond (Pond 5)	661.00	656.90	656.40	No capacity issue
Lake C	656.15	653.32	653.28	No capacity issue
Lake D	651.60	648.82	649.32	No capacity issue
Multiplex	655.30	652.71	652.41	No capacity issue

6.3 Condition Assessment

The 2015 SWMP established a preliminary framework for storm sewer system inspection and condition evaluation, and categorized inspection priorities for the City's storm sewer system based on consequence of structural failure and several other factors, such as location and age of the pipe.

As part of the scope in this study, select storm sewers within Lloydminster were televised to evaluate pipe condition throughout the city. Stormwater sewers included in the closed-circuit television (CCTV) inspection were selected based on a combination of age, material, incident reports (backup etc.), as well as input from the City. The proposed condition assessment pipes are shown in Figure 6.9.

Condition assessments for drainage channels and associated culverts is not a part of the scope of work, and were not included in the inspection program. However, the City has noted some known issues with erosion, sedimentation, and slope stability within the Northwest Drainage Channel and the East Drainage Channel. Therefore, it is recommended that the City conducts regular condition assessment programs for the drainage channels and implements upgrades to address these issues as necessary.

McGill's Industrial Services (McGill's) was subcontracted to conduct the CCTV inspections of the proposed assessment pipes based on priority. The CCTV reports provided by McGill's are included in Appendix B.

ISL reviewed the CCTV inspection reports, which provided a general condition rating for each section of inspected pipe and each overall assessment segment. The condition ratings adopted in the inspection report and their descriptions are summarized as follows:

- Rating 1 – Excellent Condition: No further action required.
- Rating 2 – Good Condition: Maintenance is recommended. This category was applied to pipe sections with service connection intrusions into the sewer, attached deposits or debris in the pipes, and root intrusions.
- Rating 3 – Fair Condition: Repairs are recommended in the next 10 to 20 years. This category was applied to pipe sections with visible ponding due to sags in the pipes or at the joints and pipe surface damage.
- Rating 4 – Poor Condition: Repairs are recommended in the next five to 10 years. This rating was applied to pipe sections with visible cracks, breakage, and displacement at joints.
- Rating 5 – Failing Condition: Repairs are recommended immediately. This category was applied to pipe sections that have collapsed or when pipes have produced a hole with a visible void.

ISL also compared the pipe age based on the data provided by the City to the expected service life based on pipe material. The typical service life of various pipe materials is summarized in Table 6.4.

Table 6.4: Pipe Material Expected Service Life

Material	Typical Service Life[1]
	Years
Corrugated Steel Pipe (CSP)	50
Concrete (CONC)	60
Polyvinyl Chloride (PVC)	60
Steel (STL)	50
Vitrified Clay Tile (VCT)	60

[1] Varies depending on installation methods and pipe application.

The results of the CCTV inspection are tabulated in Table 6.5 and shown in Figure 6.10.

Table 6.5: Pipe CCTV Inspection Results Summary

Segment No.	U/S MH	D/S MH	Surveyed Length	Diameter	Material	Installation Year	Pipe Age	Expected Remaining Service Life[2]	Structural Notes	O&M Notes	Overall Condition Rating
			m	mm			Year	Year			
1	A79	A78	34.7[1]	600	Concrete	1974	49	11	-	Deposits Settled Gravel	Good
2	A78	A77	142.2[1]	600	Concrete	1974	49	11	-	Deposits Settled Gravel and Other	Good
3	A76	A33	81.9	600	Concrete	1974	49	11	-	Deposits Settled Gravel, Obstacle Rocks, Obstacle Through Wall, Tap Break-in Defective	Failing
4	A77	A76	57.6	600	Concrete	1974	49	11	-	Deposits Settled Gravel and Obstacle Pipe Material	Good
5	A32	A33	44.2[1]	675	Concrete	1965	58	2	-	Deposits Settled Gravel and Rocks	Good
6	A32	A31	142.0[1]	675	Concrete	1965	58	2	Water Level Sag	Deposits Settled Gravel, Debris, Obstacle Through Wall	Failing
7	A226	A225	75.4	525	Concrete	1976	47	13	Water Level Sag	Obstacle Pipe Material and Rocks	Fair
8	A225	A224	84.5	675	Concrete	1976	47	13	Water Level Sag	Deposits Settled Gravel and Fine	Good
9	A466	A437	80.8	1200	Concrete	1979	44	16	-	Obstacle Construction Debris and Deposits Settled Fine	Good
10	A466	A465	164.3	1200	Concrete	1979	44	16	Hole Soil Visible	Obstacle Through Wall	Failing
11	A613	A517	74.8	1350	Concrete	1986	37	23	-	Obstacle Rocks	Good
12	A613	A241	2.8[1]	1350	Concrete	1986	37	23	-	Obstacle Debris	Good
13	A786	A785	99.0	900	Concrete	1997	26	34	Crack Spiral and Longitudinal	-	Poor
14	A1059	A1060	158.9	1200	Concrete	2004	19	41	-	Obstacle Rocks and Deposits Settled Gravel	Good
15	A119	A116	147.1	900	Concrete	1965	58	2	-	Deposits Settled Gravel	Good
16	A379	A380	103.1[1]	750	PVC	1978	45	15	-	Obstacle Pipe Material	Good
17	A379	A378	98.3	900	PVC	1978	45	15	-	Deposits Settled Gravel and Other, Obstacle Rocks	Good
18	A156	A472	54.1	450	Concrete	1982	41	19	Crack Longitudinal	-	Poor
19	A156	A155	60.7	450	Concrete	1974	49	11	Joint Offset Large	Deposits Settled Gravel	Poor

[1] Minor discrepancies between the GIS lengths and measured CCTV pipe lengths were observed, likely due to noted differences in the field.
[2] The remaining expected life of the pipe is based on the pipe age and material only with the condition rating recommending the timeline for replacement as needed.

Based on the condition assessment findings, an estimated condition rating was developed for the entire storm sewer system. These results were combined with the pipe installation period and material information to estimate each pipe section's relative condition rating. A summary of the generalized condition assessment results by decade is presented in Table 6.6 with a graphical illustration shown in Figure 6.11.

Table 6.6: Generalized Condition Assessment Summary by Decade

Installation Period	Material	Condition Rating
1960-1969	All	Poor
1970-1979	All	Poor
1980-1989	All	Poor
1990-1999	All	Fair
2000-2009	All	Good
2010-2022	All	Excellent
Unknown	All	Inconclusive

Approximately 30% of the City's existing storm sewer system was installed in the 1970s and prior with a generalized condition rating of poor as noted in Table 6.6. Based on the typical expected service life of 60 years for concrete pipes, these portions of the system are approaching their expected service life in the next 5 to 15 years. However, the CCTV inspection results suggested that some pipes installed in the 1960s and 1970s may still be in fair-good condition with no significant structural deteriorations, such that they may remain in service beyond their typical service life.

That said, it should be noted that the generalized condition ratings are based on the sections of pipe that were included in the condition assessment completed in 2023 only. Actual conditions of other pipes may differ from the generalizations as pipes deterioration varies greatly depending on a number of factors. Therefore, it is recommended that the City conducts on-going condition assessment programs to monitor and verify storm sewer conditions throughout the system with lower generalized condition ratings to plan and prioritize asset rehabilitation and replacement.

6.4 Recommendations for Observed Areas of Concern

6.4.1 Capacity Improvement Recommendations

Based on the findings of the 1:5-year and 1:100-year storm event model results, ISL developed a list of recommended storm sewer system upgrades to improve the system's capacity and rectify areas of concern noted in Table 6.1 and 6.2. Recommended storm sewer system upgrades are illustrated in Figure 6.12, with storm sewer upgrade recommendations and catch basins recommended summarized in Tables 6.7 and 6.8, respectively. Storm sewer upgrades were developed primarily to improve minor system conveyance capacity under the 1:5-year event, whereas proposed catch basin upgrades or culvert upgrades were developed to alleviate surface flooding potentials. That said, storm sewer upgrades could also help reduce surface flooding caused by inadequate sewer capacity. All storm sewer system upgrades were developed assuming the existing inverts remained unchanged unless otherwise noted. Should pipe inverts be modified during future design stages, pipe capacity should be confirmed to ensure the desired level of service can still be provided.

It is highly recommended that the existing storm sewer system be confirmed onsite prior to undertaking the proposed upgrades due to the number of assumptions embedded as required when constructing the hydraulic model. These assumptions may include pipe size, invert, and catch basin inlet grate type. Therefore, confirming the existing storm sewer system configuration is crucial to avoid completing unnecessary upgrades. Further, it is recommended that the City considers amalgamating some upgrades into other capital works, such as roadway works or any other underground infrastructure work to save costs if opportunity permits.

In addition, because the hydraulic model is not calibrated against flow monitoring data in the system, the City may also choose to flag and monitor some of the areas noted below in the interim, rather than implementing upgrades immediately if no historical issues have been observed at any of these locations, to verify system capacity and upgrade requirements.

Table 6.7: Existing Sewer Upgrade Recommendations

Upgrade No.	Location	Area of Concern Table and No.	Description
EX UPG #1	62 Avenue between 48 Street and 52 Street	Table 6.1, No. 15	• Upsize approximately 43 m of 450 mm pipe to 525 mm from MH A154 to MH A155. • Upsize approximately 142 m of 450 mm pipe to 675 mm from MH A155 to the discharge location in the Northwest Drainage Channel.
EX UPG #2	52 Street between 59 Avenue and 50 Avenue	Table 6.1, No. 17 and 18	• Upsize approximately 264 m of 300 mm pipe to 375 mm from MH A722 to MH A719. • Upsize approximately 162 m of 450 mm pipe to 525 mm from MH A719 to MH A717. • Upsize approximately 94 m of 450 mm pipe to 600 mm from MH A717 to MH A716. • Upsize approximately 388 m of 600 mm pipe to 750 mm from MH A716 to MH A737. • Upsize approximately 93 m of 675 mm pipe to 750 mm from MH A737 to MH A102. • Upsize approximately 111 m of 300 mm pipe to 375 mm from MH A701 to MH A138. • Replace approximately 67 m of 375 mm pipe from MH A138 to MH A916. • Upsize approximately 108 m of 375 mm pipe to 600 mm from MH A916 to MH A455.
EX UPG #3	51 Street between 55 Avenue and 53 Avenue	Table 6.1, No. 16	• Upgrade approximately 148 m of 900 mm pipe to 1,050 mm from MH A119 to MH A116. • Upgrade approximately 175 m of 900 mm pipe to 1,200 mm from MH A116 to MH A106. • Install catch basins on Canora Street
EX UPG #4	From 50 Street at 47 Avenue to east of 47 Street via 45 Avenue	Table 6.1, No. 19	• Upsize approximately 96 m of 450 mm pipe to 1,350 mm from MH A317 to MH A306. • Upsize approximately 353 m of 600 mm pipe to 1,350 mm from MH A306 to MH A301. • Upsize approximately 320 m of 675 mm pipe to 1,350 mm from MH A301 to MH A56. • Upsize approximately 418 m of 1,350 mm pipe to 1,500 mm from MH A56 to ditch outfall.
EX UPG #5	52 Street to 40 Avenue	Table 6.1, No. 20	• Replace approximately 256 m of 900 mm pipe from MH A418 and MH A281. • Upgrade approximately 835 m of 900 mm pipe to 1,050 mm from MH A281 to MH A259. • Replace MH A259 to connect with the 1,500 mm north segment of the twin crossing culverts. • Install a new MH (A259a) to connect with the 1,500 mm south segment of the twin crossing culverts. • Replace approximately 215 m of 900 mm pipe from MH A468 to MH A259a (this proposed upgrade includes flow reversal from existing system configuration). • Install 2.5 m 900 mm pipe to connect MH A259a and MH A259.

Upgrade No.	Location	Area of Concern Table and No.	Description
EX UPG #6	42 Street at 67 Avenue to 40 Street at 66 Avenue	Table 6.1, No. 11	• Upgrade approximately 140 m of 450 mm pipe to 600 mm from MH A883 to MH A881. • Upgrade approximately 93 m of 450 mm pipe to 675 mm from MH A881 to MH A836.
EX UPG #7	39 Street between 63a Avenue and 65 Avenue	Table 6.1, No. 12	• Upgrade approximately 152 m of 600 mm pipe to 750 mm from MH A823 to MH A821.
EX UPG #8	65 Avenue from 39 Street to Lake L	Table 6.1, No. 12	• Upgrade approximately 86 m of 1,050 mm pipe to 1,200 mm from MH A820 to MH A804. • Upgrade approximately 87 m of 1,350 mm pipe to 1,650 mm from MH A804 to MH A803. • Upgrade approximately 143 m of 1,500 mm pipe to 1,650 mm from MH A803 to MH A802.
EX UPG #9	40 Street at 58 Avenue Close to 57 Avenue at 37 Street via 57a Avenue	Table 6.1, No. 10	• Upgrade approximately 205 m of 450 mm pipe to 675 mm from MH A579 to MH A576. • Upgrade approximately 59 m of 600 mm pipe to 675 mm from MH A576 to MH A575. • Upgrade approximately 79 m of 600 mm pipe to 750 mm from MH A575 to MH A574. • Upgrade approximately 107 m of 600 mm pipe and 103 m of 675 mm pipe to 900 mm from MH A574 to MH A396.
EX UPG #10	59 Avenue at 36 Street to 36 Street at 57 Avenue	Table 6.1, No. 9	• Upgrade approximately 350 m of 450 mm pipe to 900 mm from MH A760 to the wye connecting to the downstream 1,350 mm pipe.
EX UPG #11	47 Avenue between 39 Street and 44 Street	Table 6.1, No. 13	• Upgrade approximately 290 m of 900 mm pipe to 1,200 mm from MH A36 to MH A25. • Upgrade approximately 212 m of 1,200 mm pipe to 1,350 mm from MH A25 to MH A18.
EX UPG #12	50 Avenue at 31 Street to 36 Street at 46 Avenue	Table 6.1, No. 5 and 6	• Upgrade approximately 199 m of 750 mm pipe to 900 mm from MH A88 to MH A86. • Upgrade approximately 274 m of 750 mm pipe to 1,050 mm from MH A86 to MH A65. • Upgrade approximately 846 m of 1,350 mm pipe to 1,500 mm from MH A65 to MH A535.
EX UPG #13	46 Avenue between 31 Street and 32 Street	Table 6.1, No. 7	• Upgrade approximately 53 m of 300 mm pipe to 450 mm from MH A571 to MH A569. • Upgrade approximately 84 m of 600 mm pipe to 750 mm from MH A569 to MH A530.
EX UPG #14	52 Avenue at 29 Street to 31 Street at 51a Avenue	Table 6.1, No. 4	• Upgrade approximately 325 m of 450 mm pipe to 525 mm from MH A186 to MH A181. • Upgrade approximately 167 m of 450 mm pipe to 600 mm from MH A181 to MH A149.
EX UPG #15	23 Street at 52b Avenue to 25 Street at 53 Avenue	Table 6.1, No. 3	• Upgrade approximately 95 m of 525 mm pipe to 600 mm from MH A598 to MH A597. • Upgrade approximately 121 m of 525 mm pipe to 675 mm from MH A597 to MH A596. • Upgrade approximately 106 m of 600 mm pipe to 750 mm from MH A596 to MH A594.

Upgrade No.	Location	Area of Concern Table and No.	Description
EX UPG #16	18 Street at 47a Avenue to east of 25 Street at 47 Avenue	Table 6.1, No. 8	• Upgrade approximately 875 m of 900 mm pipe to 1,050 mm from MH A1264 to MH A1196.
EX UPG #17	44 Street and 45 Street at 56 Avenue	Table 6.2, No. 10	• Upgrade approximately 66 m of 300 mm pipe to 450 mm from MH A131 to MH A125. • Upgrade approximately 125 m of 450 mm pipe to 600 mm from MH A193 to MH A195. • Upgrade approximately 500 m of 750 mm pipe to 900 mm from MH A125 to MH A121.
EX UPG #18	Intersection of 52 Avenue and 41 Street	Table 6.2, No. 11	• Catch basin upgrade recommendation only. See Table 6.8.
EX UPG #19	50 Avenue at 38 Street to 47 Avenue at 39 Street	Table 6.2, No. 12	• Upgrade approximately 202 m of 900 mm pipe to 1,050 mm from MH A37 to MH A36. • Upgrade approximately 455 m of 900 mm pipe to 1,050 mm from MH A429 to MH A37.
EX UPG #20	36 Street between 59 Avenue and 57 Avenue	Table 6.2, No. 13	• Catch basin upgrade recommendation only. See Table 6.8.
EX UPG #21	Intersection of 35 Street and 54 Avenue	Table 6.2, No. 14	• Upgrade 75 m of 900 mm pipe to 1,050 mm from MH A163 to MH A74 at 0.36%.
EX UPG #22	47 Avenue at Barr Cresent	Table 6.2, No. 15	• Catch basin upgrade recommendation only. See Table 6.8.
EX UPG #23	Intersection of 45 Avenue and 29 Street	Table 6.2, No. 17	• Catch basin upgrade recommendation only. See Table 6.8.
EX UPG #24	Intersection of 27 Street and 54 Avenue	Table 6.2, No. 19	• Catch basin upgrade recommendation only. See Table 6.8.
EX UPG #25	Intersection of 26 Street and 57a Avenue	Table 6.2, No. 20	• Upgrade approximately 136 m of 750 mm pipe to 900 mm from MH A583 to MH A489.
EX UPG #26	49 Avenue south of 18 Street	Table 6.2, No. 22	• Upgrade approximately 210 m of 450 mm pipe to 750 mm from MH A370 to MH A371. • Upgrade approximately 89 m of 375 mm pipe to 450 mm from MH A1355 to MH A370.
EX UPG #27	60 Street at 53 Avenue	Table 6.2, No. 23	• Catch basin upgrade recommendation only. See Table 6.8.

Table 6.8: Existing System Catch Basin Upgrade Recommendations

Upgrade No.	Location	Area of Concern Table & No.	Description
EX UPG #17	44 Street and 45 Street at 56 Avenue	Table 6.2, No. 10	• Upgrade catch basin CB1196 and CB1165 to larger capacity inlet (TK-7 equivalent or larger), and upgrade associated catch basin leads to 300 mm if needed.
EX UPG #18	Intersection of 52 Avenue and 41 Street	Table 6.2, No. 11	• Upgrade catch basins CB443, CB444, and CB446 to larger capacity inlet (TK-7 equivalent or larger), and upgrade associated catch basin leads to 375 mm if needed.
EX UPG #20	36 Street between 59 Avenue and 57 Avenue	Table 6.2, No. 13	• Upgrade catch basins CB1339 and CB1346 to larger capacity inlet (TF-51 equivalent or larger), and upgrade associated catch basin leads to 300 mm if needed.
EX UPG #21	Intersection of 35 Street and 54 Avenue	Table 6.2, No. 14	• Upgrade catch basins CB691, CB690, CB687, and CB692 to larger capacity inlet (TF-51 equivalent or larger), and upgrade associated catch basin leads to 375 mm if needed.
EX UPG #22	47 Avenue at Barr Cresent	Table 6.2, No. 15	• Upgrade catch basins CB157, CB158, CB159, CB162, and CB166 to larger capacity inlet (TF-51 equivalent or larger), and upgrade associated catch basin leads to 375 mm if needed.
EX UPG #23	Intersection of 45 Avenue and 29 Street	Table 6.2, No. 17	• Upgrade catch basins CB263, CB264, and CB265 to larger capacity inlet (TK-7 equivalent or larger), and upgrade associated catch basin leads if needed.
EX UPG #24	Intersection of 27 Street and 54 Avenue	Table 6.2, No. 19	• Upgrade catch basins CB809, CB810, and CB817 to larger capacity inlet (TF-51 equivalent or larger), and upgrade associated catch basin leads to 375 mm if needed.
EX UPG #25	Intersection of 26 Street and 57a Avenue	Table 6.2, No. 20	• Add two catch basins or twin existing catch basins CB726 and CB743.
EX UPG #26	49 Avenue south of 18 Street	Table 6.2, No. 22	• Upgrade catch basins CB56, CB57, CB88, and CB1632 to larger capacity inlet (TF-51 equivalent or larger), and upgrade associated catch basin leads to 300 mm if needed.
EX UPG #27	60 Street at 53 Avenue	Table 6.2, No. 23	• Upgrade catch basins CB971, CB975, CB976, CB1111, and CB1118 to larger capacity inlet (TF-51 equivalent or larger), and upgrade associated catch basin leads to 375 mm if needed.

Surcharged catch basin leads throughout the city are not considered critical, as assumptions were made at the start of the model construction process for lead diameters and slopes. It is likely that these assumptions were overly conservative for these catch basin leads. Therefore, it would be more prudent to monitor the catch basin leads, and if capacity constraints are evident, upgrading options can then be developed at that time.

2D modelling results from the 1:100-year event indicated that there are a number of areas exhibiting large surface water depths and enhanced velocities. Generally, areas with depth to velocity ratios greater than the permissible water depths described in Figure 6.7 and Figure 6.8 should be considered for improvements. Methods of reducing velocities such as check dams, recessed catch basins, or modified site grading could be implemented to resolve these issues.

Additionally, implementing more efficient overland flow paths from some of the outfalls to the creeks could resolve some ponding issues. It is also recommended that the City considers monitoring and potentially implementing erosion control measures in areas where high velocities were noted. Some possible erosion control measures are discussed in Section 7.6.

Figures 6.13 and 6.14 are provided to show the peak flow to full pipe capacity ratio, peak HGL elevation relative to ground elevation, and spare pipe capacity under the 1:5-year 4-hour Modified Chicago design storm, with the proposed system upgrades. Longitudinal profiles illustrating HGL comparisons between the existing and with the proposed upgrades scenarios are presented in Appendix C. Additionally, Figure 6.15 demonstrates the estimated maximum overland water depth under the 1:100-year 4-hour Modified Chicago event with the proposed system upgrades.

6.4.2 Condition Improvement Recommendations

Based on the findings from the condition assessment, it is recommended that the City replace or rehabilitate pipes in poor condition to prevent failure and potential service disruptions. There are several techniques available to rehabilitate pipes, with varying costs depending on several factors, such as rehabilitation methodology and site conditions. Because of this, cost estimates for pipe rehabilitations may range significantly. It is recommended that the City explores pipe rehabilitation options as it often presents as an economically viable alternative to replacement. As mentioned, bundling storm sewer replacements with other capital projects in construction tender packages, such as road works, will provide cost saving opportunities.

6.4.3 Risk Assessment and Existing System Upgrade Prioritization

While the proposed storm sewer system upgrades should ideally be implemented from downstream to upstream to avoid upstream flow overwhelming the downstream storm sewer system, it is also prudent to consider several other criteria when planning for upgrades, such as prioritizing areas with historical flooding instances, areas close to critical infrastructure and buildings, and effectiveness of the proposed upgrade (i.e., HGL and flooding reductions).

To better aid the City in prioritizing the proposed existing storm sewer system upgrades, ISL developed a point scoring system that considers various risk criteria to determine the scoring and weight of importance of each criterion. The risk assessment scoring system allowed for a quantitative approach to prioritize required existing system upgrades. However, it should be noted that the scoring criteria was based on internal discussions and review with the City, and it may be considered subjective to some extent. The risk assessment criteria and scoring matrix are presented in Table 6.9.

Table 6.9: Existing System Upgrade Risk Assessment – Risk Criteria and Scoring

Criteria			Scoring	
ID	**Name**	**Definition**	**Scale**	**Description**
C.1	Historical Flooding	Historical flooding observations	5	Historical Flooding Issues Observed
			0	No Historical Flooding Issues
C.2	Surface Flooding Alleviation	Reduction in surface flood inundation and depth	5	Significant (>0.3 m)
			4	Moderate to Significant (0.2 - 0.3 m)
			3	Moderate (0.1 - 0.2 m)
			2	Minimal to Moderate (0.05 - 0.10 m)
			1	Minimal (< 0.05 m)
C.3	Peak HGL Reduction	Change in HGL between existing conditions and proposed upgrade conditions	5	Significant (> 1/0 m)
			4	Moderate to Significant (0.75 – 1.0 m)
			3	Moderate (0.5 - 0.75 m)
			2	Minimal to Moderate (0.25 - 0.5 m)
			1	Minimal (< 0.25 m)
C.4	Proximity to Critical Infrastructure and Buildings	Proximity of the flooding potentials to critical infrastructure and buildings, such as schools, hospitals, and emergency services	5	Close to schools, hospitals, and essential emergency services
			4	Residential neighbourhood and non-essential commercial establishment
			3	Arterial and collector roadway
			2	Parking lot of commercial/industrial/warehouse
			1	Open field/no properties nearby
C.5	Generalized Pipe Condition	General condition of existing pipe based on condition assessment	5	Failing
			4	Poor
			3	Average
			2	Good
			1	Excellent
C.6	Road Condition Upgrade Potential	Potential for upgrades to be coupled with roadworks or future development that is likely to incorporate new roadworks	5	Failing
			4	Poor
			3	Average
			2	Good
			1	Excellent

Based on the above criteria, a pairwise comparison was conducted to allocate a weighting to each criterion as the baseline multiplier for calculating the risk score. The pairwise comparison and weighting of each criterion is shown in Table 6.10.

Table 6.10: Existing System Upgrade Risk Assessment – Criteria Ranking

Risk Criteria - Pairwise Comparison							Count	Weighting
	C.1	C.2	C.3	C.4	C.5	C.6		
C.1	C.1	C.1	C.1	C.1	C.1	C.1	6	28.6%
C.2		C.2	C.2	C.2	C.2	C.2	5	23.8%
C.3			C.3	C.3	C.3	C.3	4	19.0%
C.4				C.4	C.4	C.4	3	14.3%
C.5					C.5	C.5	2	9.5%
C.6						C.6	1	4.8%
						Total	**21**	**100.0%**

Each proposed upgrade was then assigned a score based on anecdotal information, model results, and pipe and roadway condition. The prioritization results of the risk assessment are summarized in Table 6.11 with detailed assessment and scoring calculations provided in Appendix D.

In case of an overall risk assessment score tie, the upgrade with the higher score on higher risk criteria weight takes precedence. For instance, EX UPG #2 and EX UPG #6 have the same score of 3.52, but the EX UPG #6 is ranked higher because its C.3 criteria score is higher than EX UPG #2. Note that the upgrade length was assumed as zero if the upgrade is only comprised of catch basin upgrades or installation.

Table 6.11: Existing System Upgrades Risk Assessment Priority Summary

Priority	Upgrade No.	Name	Category	Upgrade Sewer Length (m)	Overall Score
1	EX UPG #12	50 Avenue and 36 Street Storm Sewer Upgrade	Inadequate Pipe Capacity	1,319	3.86
2	EX UPG #4	45 Avenue and 47 Street Storm Sewer Upgrade	Inadequate Pipe Capacity	1,187	3.81
3	EX UPG #6	67 Avenue and 40 Street Storm Sewer Upgrade	Inadequate Pipe Capacity	233	3.52
4	EX UPG #2	52 Street Storm Sewer Upgrade	Inadequate Pipe Capacity	1,287	3.52
5	EX UPG #22	47 Avenue Catch Basin Upgrade	Surface Flooding	0	3.43
6	EX UPG #18	52 Avenue/41 Street Catch Basin Upgrade	Surface Flooding	0	3.38
7	EX UPG #1	62 Avenue Storm Sewer Upgrade	Inadequate Pipe Capacity	185	3.38
8	EX UPG #11	39 Street and 47 Avenue Storm Sewer Upgrade	Inadequate Pipe Capacity	502	3.19
9	EX UPG #3	51 Street Storm Sewer Upgrade	Inadequate Pipe Capacity	323	3.19
10	EX UPG #16	46 Avenue Storm Sewer Upgrade	Inadequate Pipe Capacity	875	3.10
11	EX UPG #19	38 Street Storm Sewer Upgrade	Surface Flooding	657	2.95
12	EX UPG #23	45 Avenue/29 Street Catch Basin Upgrade	Surface Flooding	0	2.43

Priority	Upgrade No.	Name	Category	Upgrade Sewer Length (m)	Overall Score
13	EX UPG #21	54 Avenue Storm Sewer Upgrade	Surface Flooding	75	2.29
14	EX UPG #10	36 Street Storm Sewer Upgrade	Inadequate Pipe Capacity	350	2.19
15	EX UPG #5	52 Street and 40 Avenue Storm Sewer Upgrade	Inadequate Pipe Capacity	1,309	2.14
16	EX UPG #13	46 Avenue/31 Street Storm Sewer Upgrade	Inadequate Pipe Capacity	137	2.14
17	EX UPG #9	57A Avenue Storm Sewer Upgrade	Inadequate Pipe Capacity	553	2.05
18	EX UPG #20	36 Street Catch Basin Upgrade	Surface Flooding	0	2.05
19	EX UPG #26	49 Avenue Storm Sewer Upgrade	Surface Flooding	299	2.00
20	EX UPG #14	29 Street and 51A Avenue Storm Sewer Upgrade	Inadequate Pipe Capacity	492	1.90
21	EX UPG #25	26 Street/57A Avenue Storm Sewer Upgrade	Surface Flooding	136	1.81
22	EX UPG #17	56 Avenue between 44 Street and 50 Street Storm Sewer Upgrade	Surface Flooding	691	1.76
23	EX UPG #24	27 Street/54 Avenue Catch Basin Upgrade	Surface Flooding	0	1.71
24	EX UPG #27	60 Street/53 Avenue Catch Basin Upgrade	Surface Flooding	0	1.67
25	EX UPG #15	53 Avenue at 23 Street Storm Sewer Upgrade	Inadequate Pipe Capacity	322	1.62
26[1]	EX UPG #7	39 Street Storm Sewer Upgrade	Inadequate Pipe Capacity	152	1.62
26[1]	EX UPG #8	65 Avenue to Lake L Storm Sewer Upgrade	Inadequate Pipe Capacity	316	1.62

[1] Risk assessment scoring ties in all risk criteria. EX UPG #7 and EX UPG #8 can be combined into one capital project.

6.5 Cost Estimates

Class ‘D’ cost estimates of the existing storm sewer system proposed upgrades were developed based on typical representative unit costs from ISL’s past project experience in similar municipalities in Alberta, escalated for 2024 dollars. An additional 15% engineering allowance and a 30% contingency are also included in the estimates. It should be noted that there are a number of factors affecting the cost estimates which ISL cannot readily forecast, including the volume of work in hand or in prospect for contractors and suppliers at the time of tender calls, future labour contract settlement, labour and material availability, and escalation rates.

A summary of the Class ‘D’ cost estimates for the proposed existing system upgrades are presented in Table 6.12, with the full breakdown available in Appendix E. Note that the list reflects upgrade IDs only and does not indicate upgrade priority. Also, the cost estimates include catch basin installation and replacement, but it is recommended that the City confirms the actual inlet grate onsite and monitors catch basin and leads, and only proceeds with the catch basin upgrade if capacity constraints are evident.

Table 6.12: Class D Cost Estimates for Existing System Upgrade Recommendations

Upgrade	Construction Cost ($)	Engineering (15%) ($)	Contingency (30%) ($)	Total ($)
EX UPG #1	$ 375,000	$ 56,000	$ 112,000	$ 543,000
EX UPG #2	$ 3,015,000	$ 452,000	$ 905,000	$ 4,372,000
EX UPG #3	$ 1,202,000	$ 180,000	$ 360,000	$ 1,742,000
EX UPG #4	$ 4,682,000	$ 702,000	$ 1,404,000	$ 6,788,000
EX UPG #5	$ 4,311,000	$ 645,000	$ 1,294,000	$ 6,250,000
EX UPG #6	$ 581,000	$ 88,000	$ 174,000	$ 843,000
EX UPG #7	$ 443,000	$ 67,000	$ 133,000	$ 643,000
EX UPG #8	$ 1,574,000	$ 236,000	$ 473,000	$ 2,283,000
EX UPG #9	$ 1,554,000	$ 234,000	$ 467,000	$ 2,255,000
EX UPG #10	$ 1,108,000	$ 166,000	$ 333,000	$ 1,607,000
EX UPG #11	$ 1,924,000	$ 289,000	$ 577,000	$ 2,790,000
EX UPG #12	$ 5,169,000	$ 776,000	$ 1,551,000	$ 7,496,000
EX UPG #13	$ 373,000	$ 57,000	$ 111,000	$ 541,000
EX UPG #14	$ 1,114,000	$ 167,000	$ 334,000	$ 1,615,000
EX UPG #15	$ 826,000	$ 124,000	$ 248,000	$ 1,198,000
EX UPG #16	$ 2,969,000	$ 445,000	$ 891,000	$ 4,305,000
EX UPG #17	$ 2,037,000	$ 305,000	$ 611,000	$ 2,953,000
EX UPG #18	$ 20,000	$ 3,000	$ 6,000	$ 29,000
EX UPG #19	$ 2,245,000	$ 337,000	$ 674,000	$ 3,256,000
EX UPG #20	$ 13,000	$ 2,000	$ 4,000	$ 19,000
EX UPG #21	$ 311,000	$ 47,000	$ 93,000	$ 451,000
EX UPG #22	$ 27,000	$ 4,000	$ 8,000	$ 39,000
EX UPG #23	$ 20,000	$ 3,000	$ 6,000	$ 29,000
EX UPG #24	$ 20,000	$ 3,000	$ 6,000	$ 29,000
EX UPG #25	$ 452,000	$ 68,000	$ 136,000	$ 656,000
EX UPG #26	$ 813,000	$ 123,000	$ 244,000	$ 1,180,000
EX UPG #27	$ 33,000	$ 5,000	$ 10,000	$ 48,000
Total	**$ 37,211,000**	**$ 5,584,000**	**$ 11,165,000**	**$ 53,960,000**

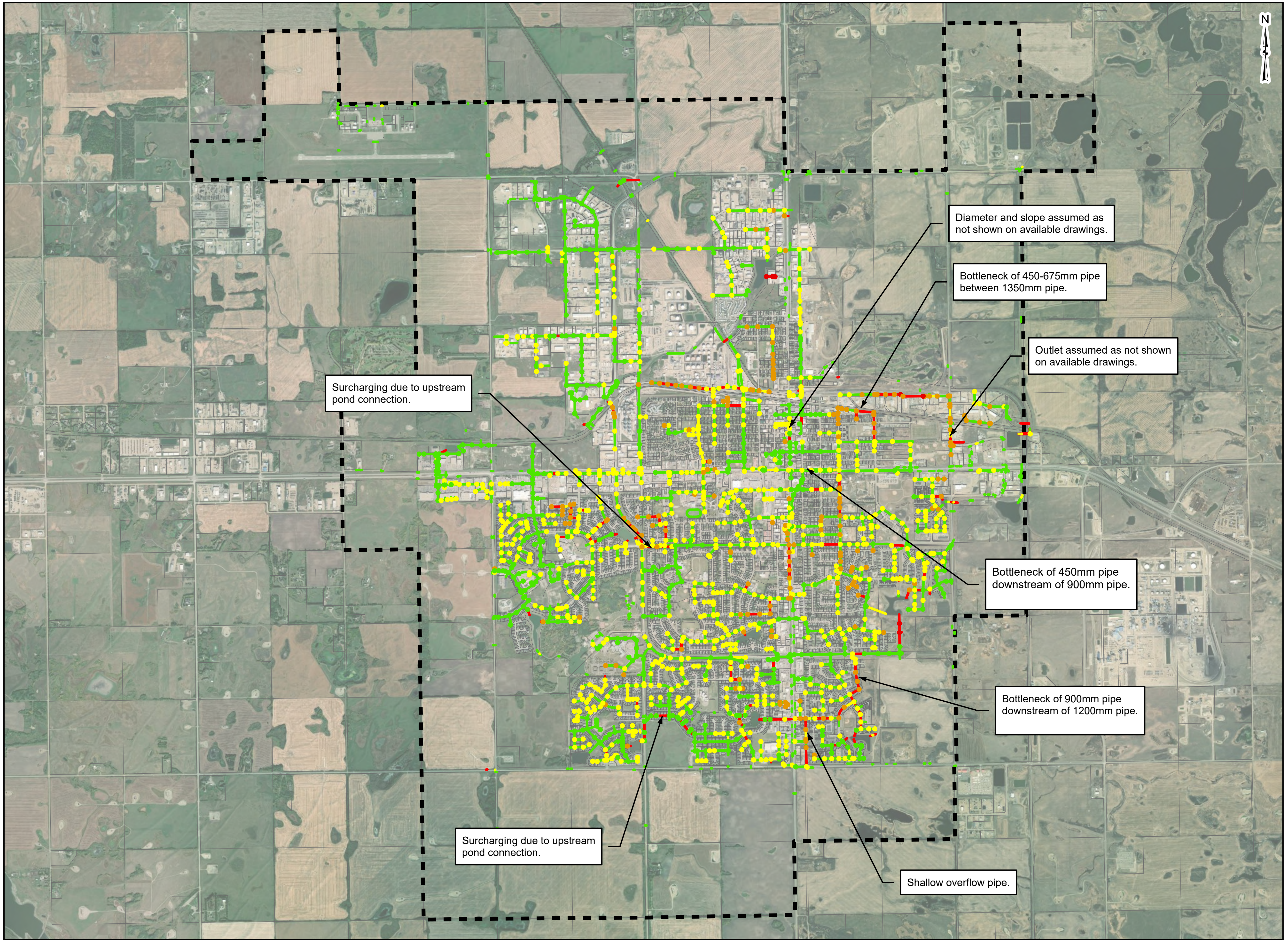


FIGURE 6.1
MINOR SYSTEM MODEL RESULTS - EXISTING
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL
LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

Date: 2024-09-13 Document: C:\Users\lche\Desktop\L.Che\Projects\28310 Lloydminster Stormwater Master Plan\30_Technical\GIS\28310_Lloydminster SWMP Report Figures\28310_Lloydminster SWMP Report Figures.aprx

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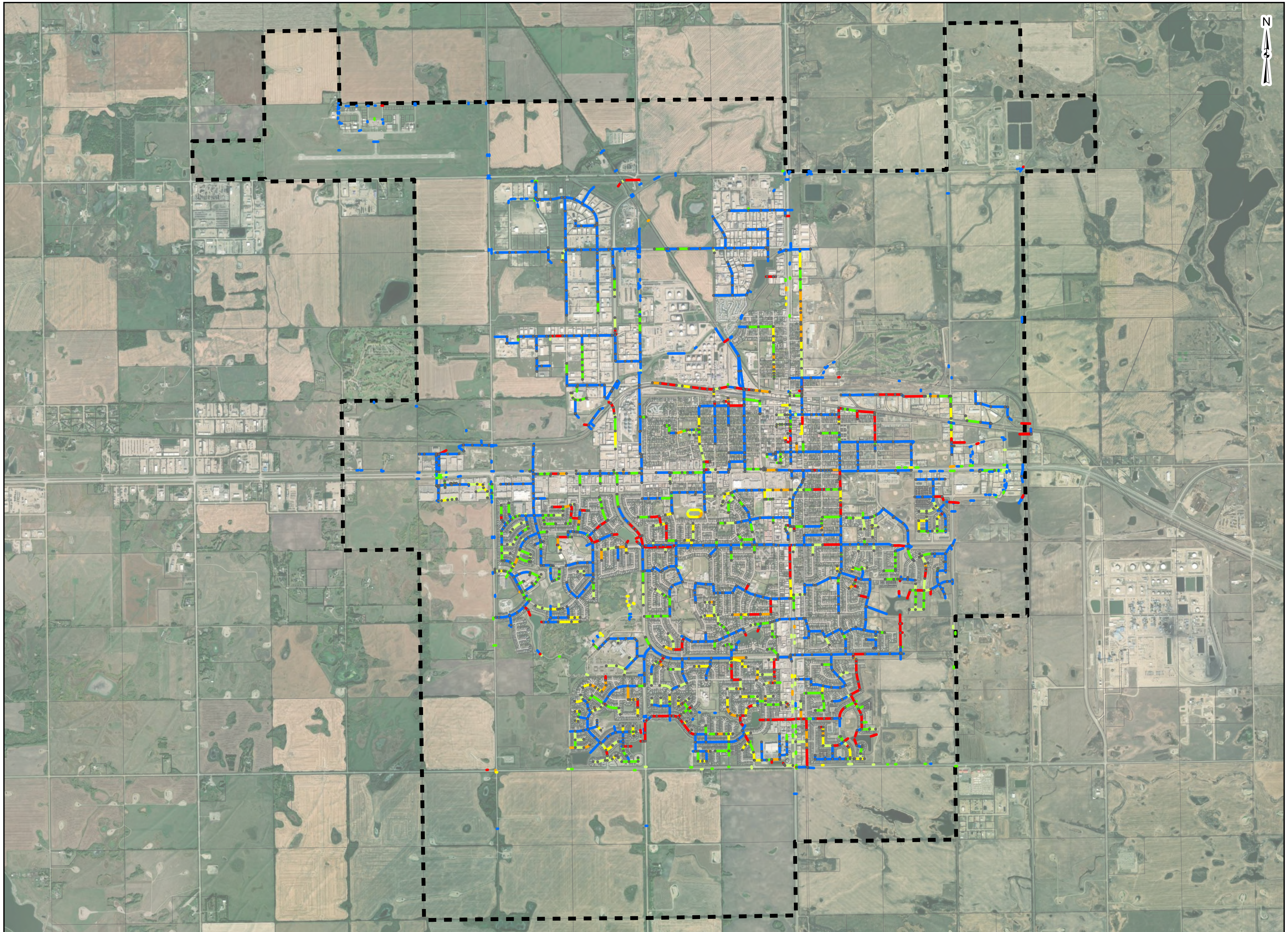

Legend

Manhole

Links

Pipe Spare Capacity

- No spare capacity
- 0 - 25 L/s
- 25 - 50 L/s
- 50 - 100 L/s
- 100 - 200 L/s
- > 200 L/s

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 6.2
EXISTING MODEL SPARE CAPACITY
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

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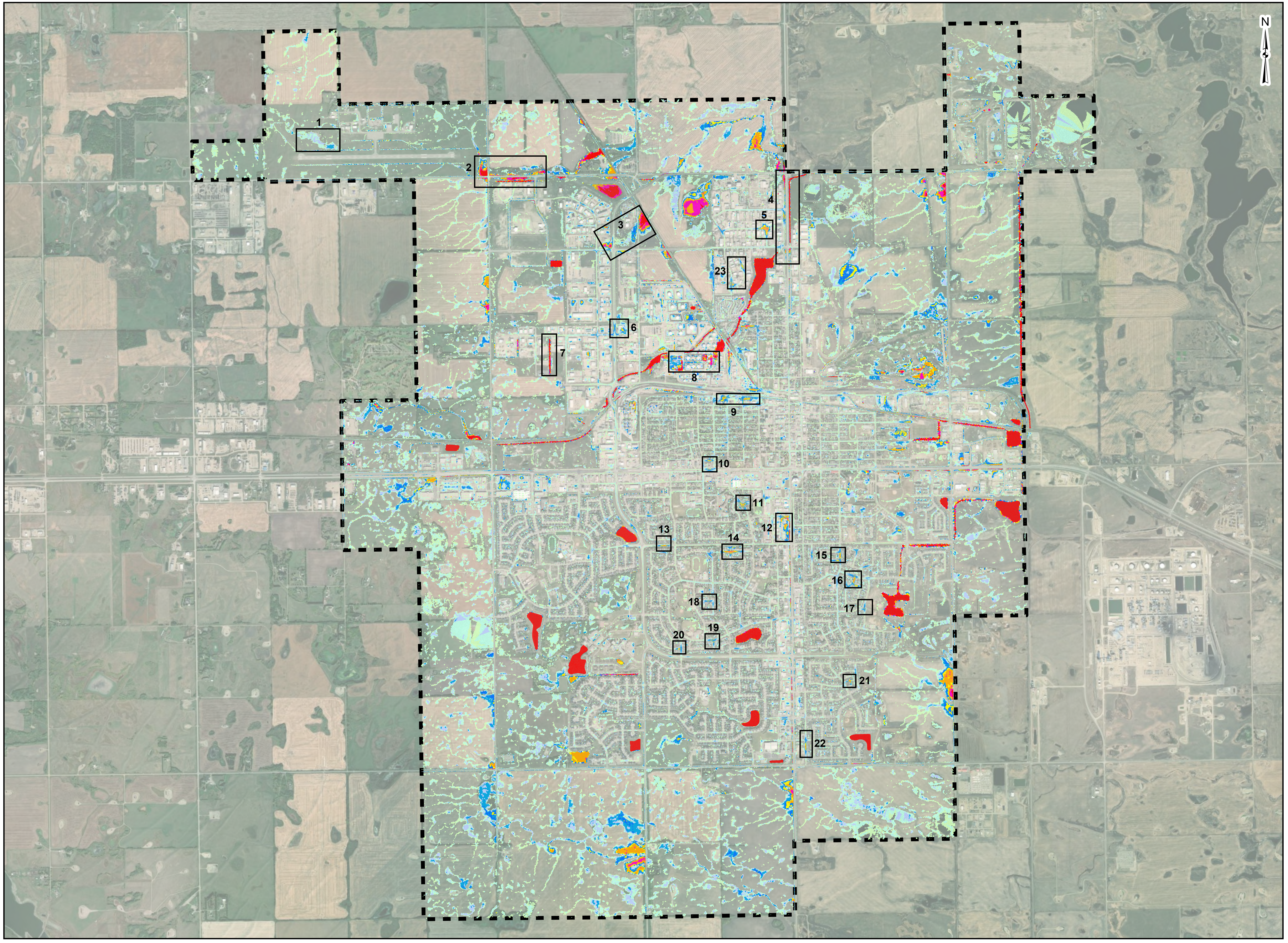

Legend

Maximum Depth (m)

Less than 0.05 m

0.05 - 0.1 m

0.1 - 0.2 m

0.2 - 0.3 m

0.3 - 0.4 m

0.4 - 0.5 m

0.5 - 0.6 m

0.6 - 0.8 m

0.8 - 1.0 m

Greater than 1.0 m

Note: black boxes and location indicator numbers denote the 2D model areas of concern, as described in Table 6.2 in the City of Lloydminster Stormwater Master Plan Report

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 6.3
EXISTING CONDITION MAXIMUM WATER DEPTH
1:100 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

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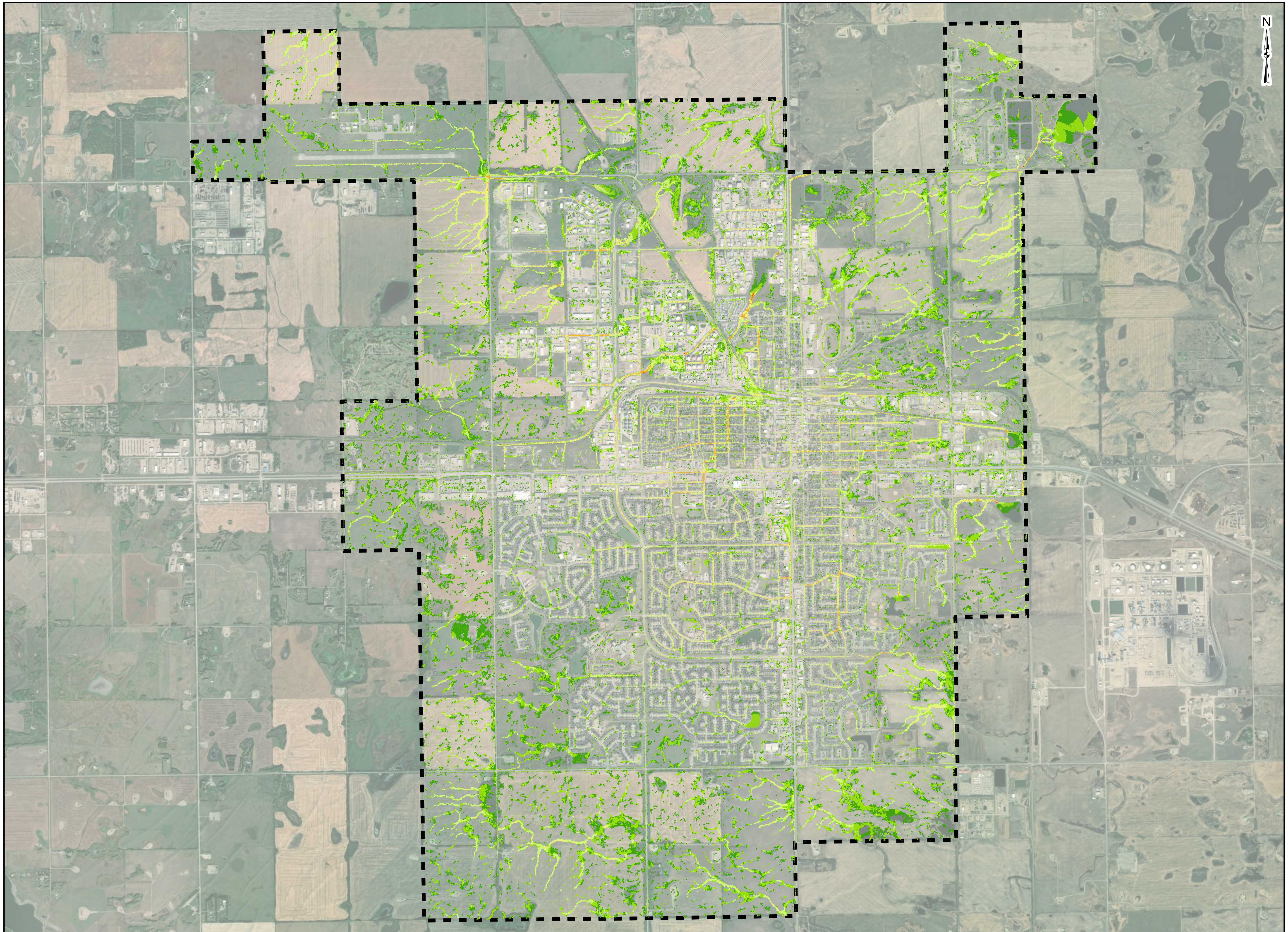

Legend

Maximum Flow Velocity (m/s)

- Less than 0.05 m/s
- 0.05 - 0.1 m/s
- 0.1 - 0.25 m/s
- 0.25 - 0.5 m/s
- 0.5 - 1.0 m/s
- 1.0 - 2.0 m/s
- 2.0 - 3.0 m/s
- Greater than 3.0 m/s

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 6.4
EXISTING CONDITION
MAXIMUM SURFACE FLOW VELOCITY
1:100 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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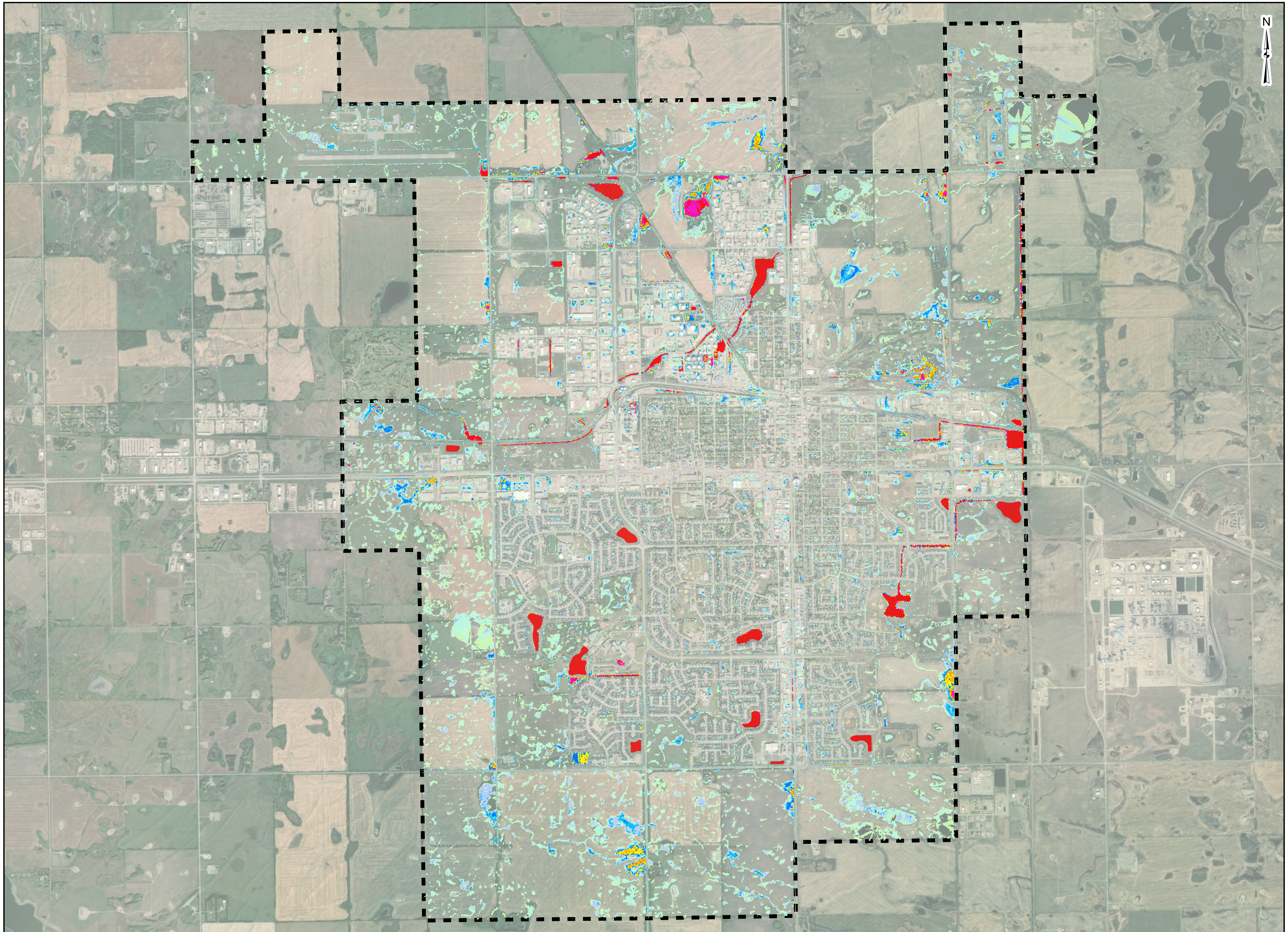

Credits:World Imagery: Vermilion River County, Maxar

Legend

Maximum Depth (m)

Less than 0.05 m

0.05 - 0.1 m

0.1 - 0.2 m

0.2 - 0.3 m

0.3 - 0.4 m

0.4 - 0.5 m

0.5 - 0.6 m

0.6 - 0.8 m

0.8 - 1.0 m

Greater than 1.0 m

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 6.5
EXISTING CONDITION MAXIMUM WATER DEPTH
1:100 YEAR 24-HOUR HUFF DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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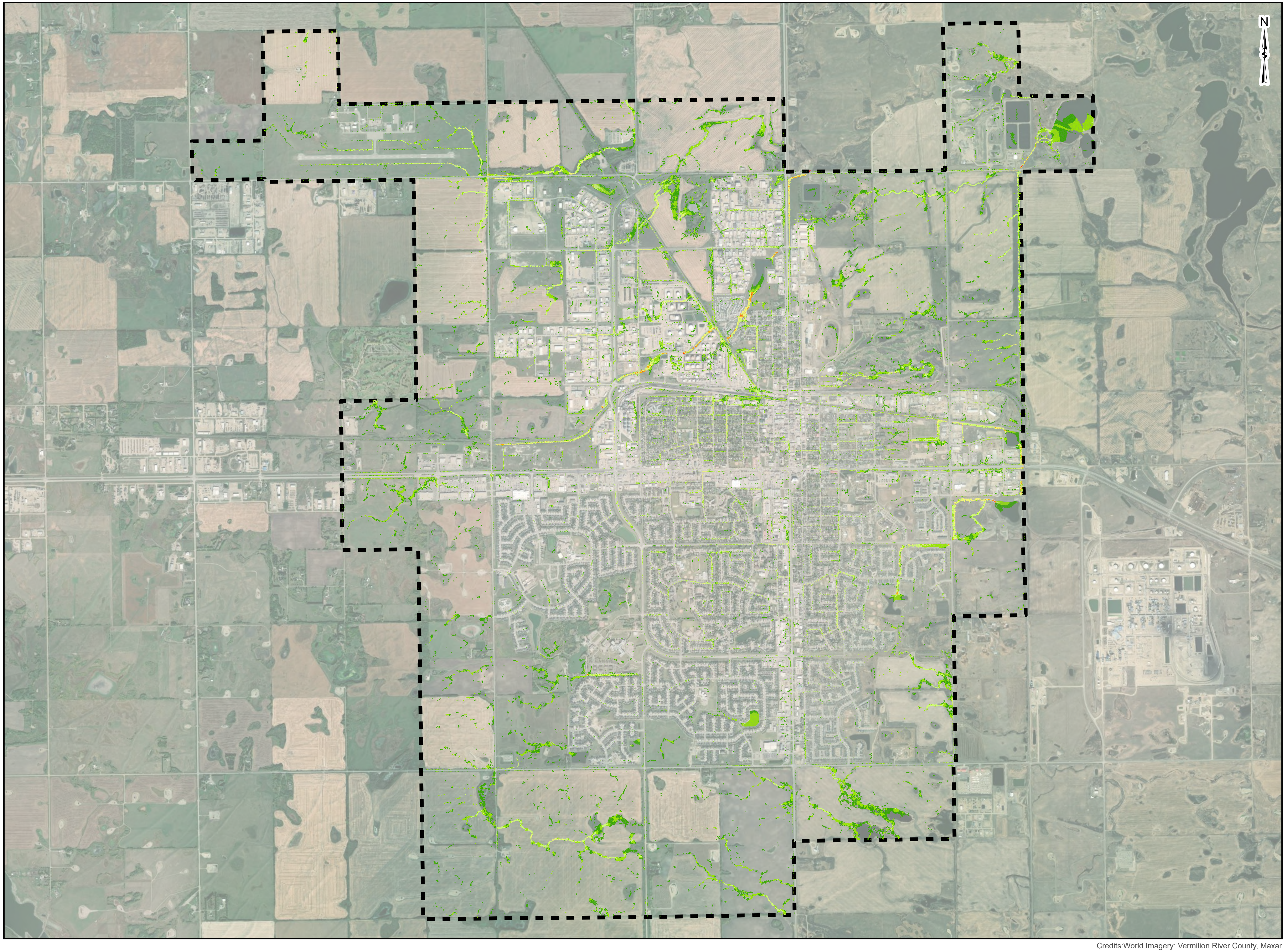

Legend

Maximum Flow Velocity (m/s)

Less than 0.05 m/s
0.05 - 0.1 m/s
0.1 - 0.25 m/s
0.25 - 0.5 m/s
0.5 - 1.0 m/s
1.0 - 2.0 m/s
2.0 - 3.0 m/s
Greater than 3.0 m/s

FIGURE 6.6
EXISTING CONDITION
MAXIMUM SURFACE FLOW VELOCITY
1:100 YEAR 24-HOUR HUFF DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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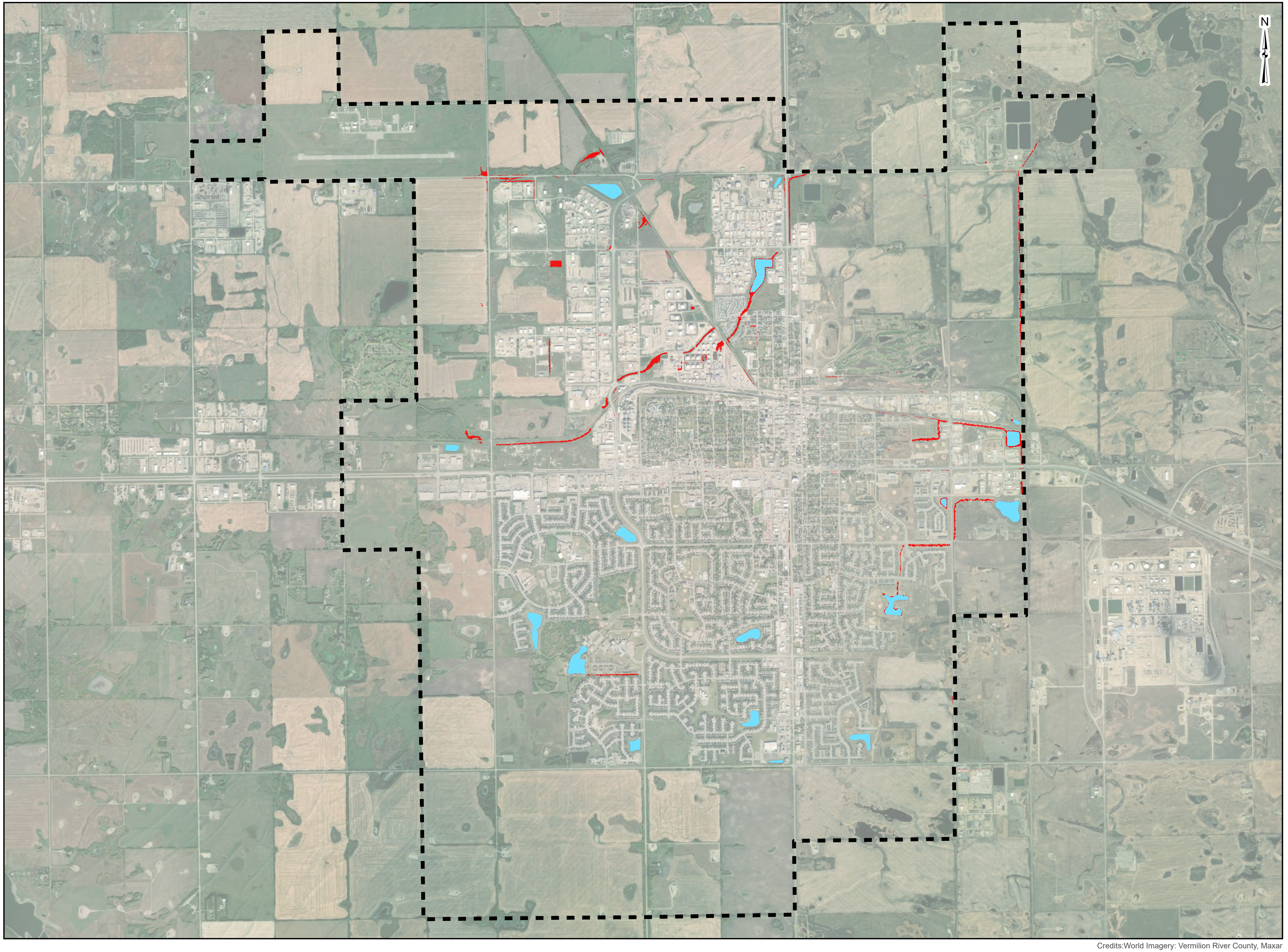

FIGURE 6.7
EXISTING CONDITION
MAXIMUM DEPTH VS. VELOCITY COMPLIANCE
1:100 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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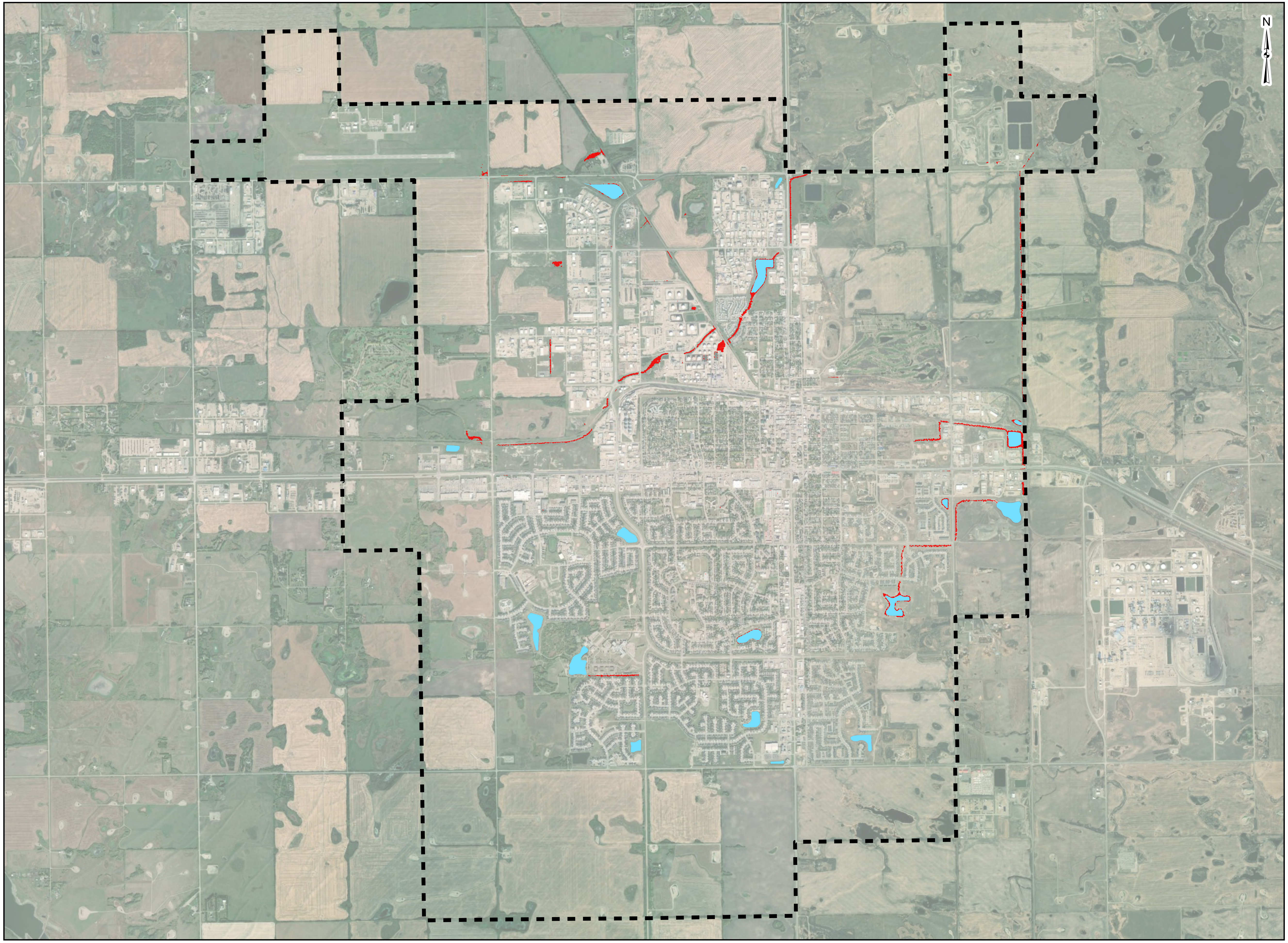

Legend

Stormwater Pond

Area exceeding depth vs velocity criteria

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 6.8
EXISTING CONDITION
MAXIMUM DEPTH VS VELOCITY COMPLIANCE
1:100 YEAR 24-HOUR HUFF DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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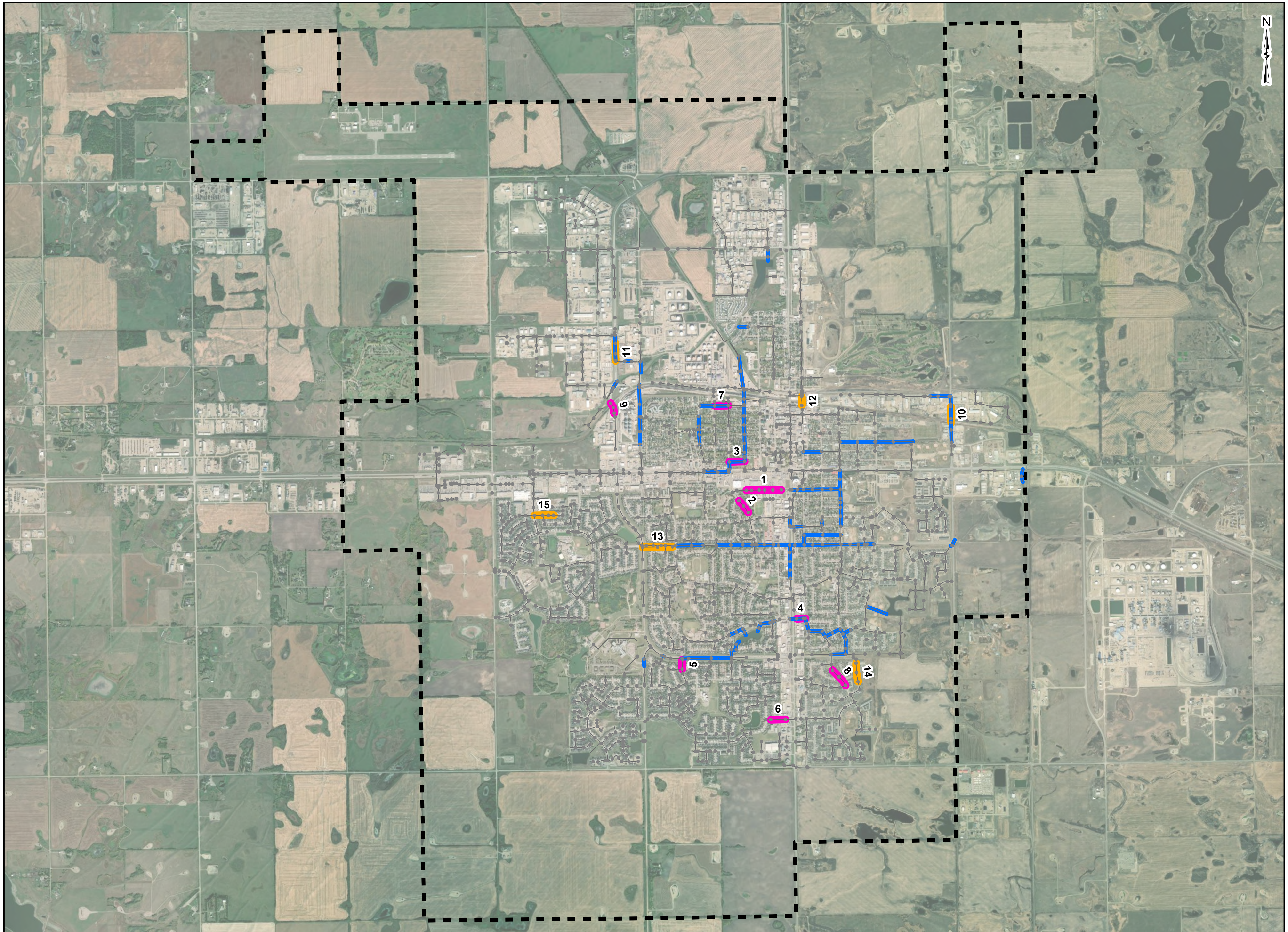

Legend

- Manhole
- Storm Pipe

2015 Stormwater Master Plan

- High Priority
- N/A

2023 Condition Assessment

- Priority 1 (1,546 m)
- Priority 2 (1,204 m)

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 6.9
PROPOSED CONDITION ASSESSMENT PIPES
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL LLOYDMINSTER

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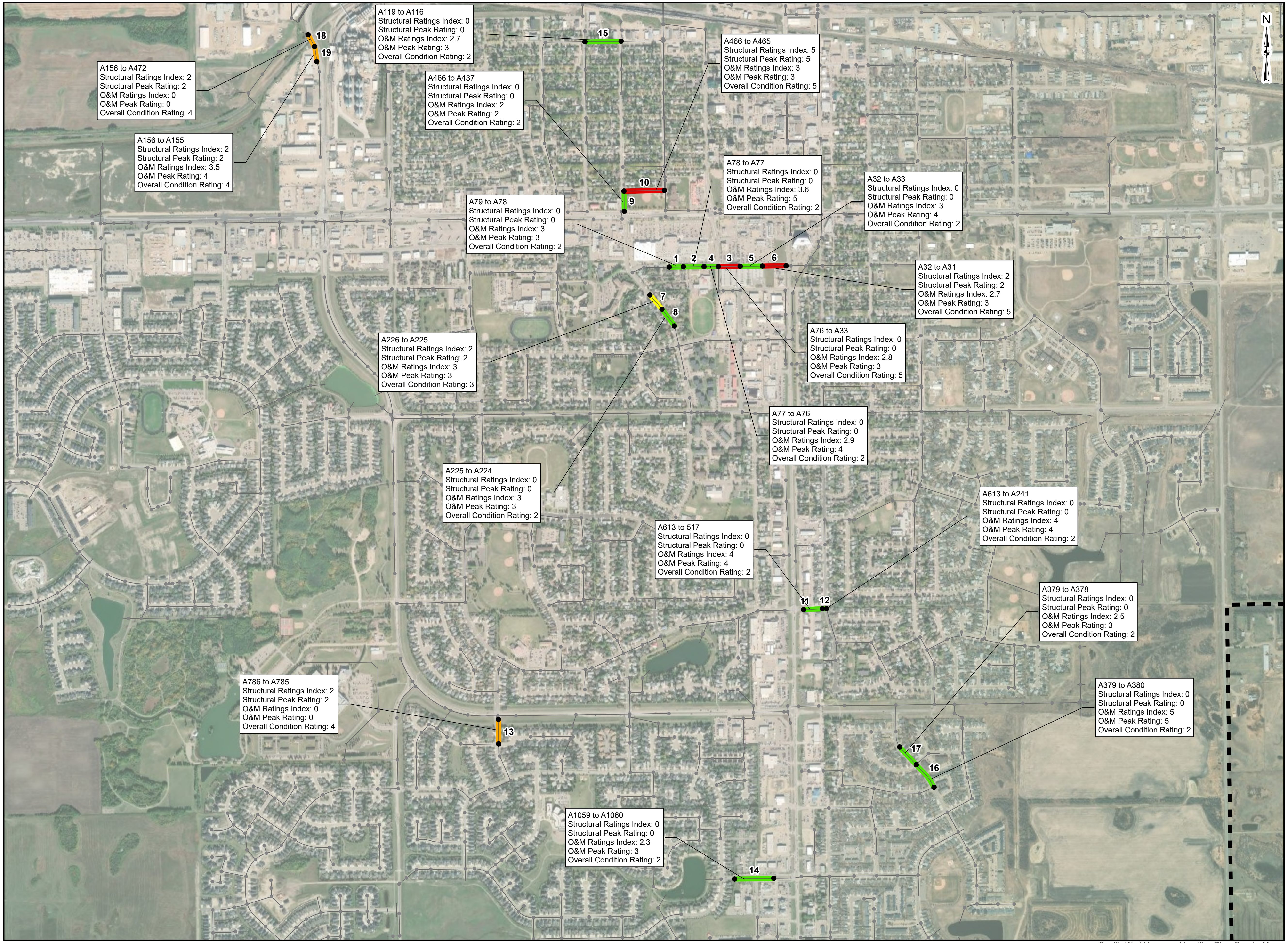

Credits:World Imagery: Vermilion River County, Maxar

Legend

Condition Rating

- Excellent
- Good
- Fair
- Poor
- Failing

0 187.5 375 750 Meters

1:15,000 NAD 1983 UTM Zone 12N

FIGURE 6.10
CONDITION ASSESSMENT RESULTS
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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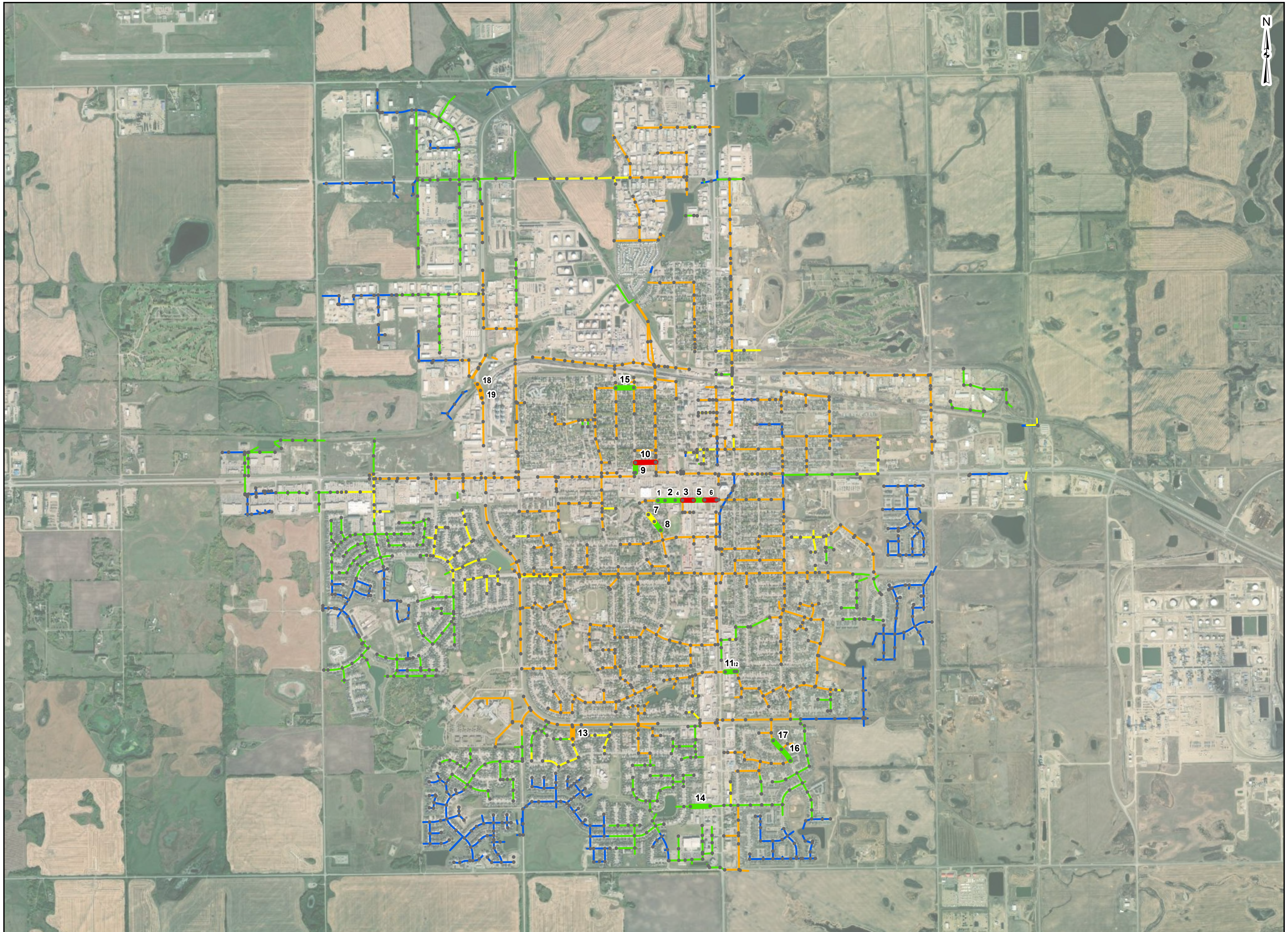

Legend

Manhole

Study Area

2023 SWMP CCTV Condition Assessment Rating

- Excellent
- Good
- Fair
- Poor
- Failing

Estimated Condition Rating By Installation Year and Material

- Excellent
- Good
- Fair
- Poor
- Inclonclusive

0 375 750 1,500 Meters

1:30,000 NAD 1983 UTM Zone 12N

FIGURE 6.11
SYSTEM WIDE ESTIMATED PIPE CONDITION
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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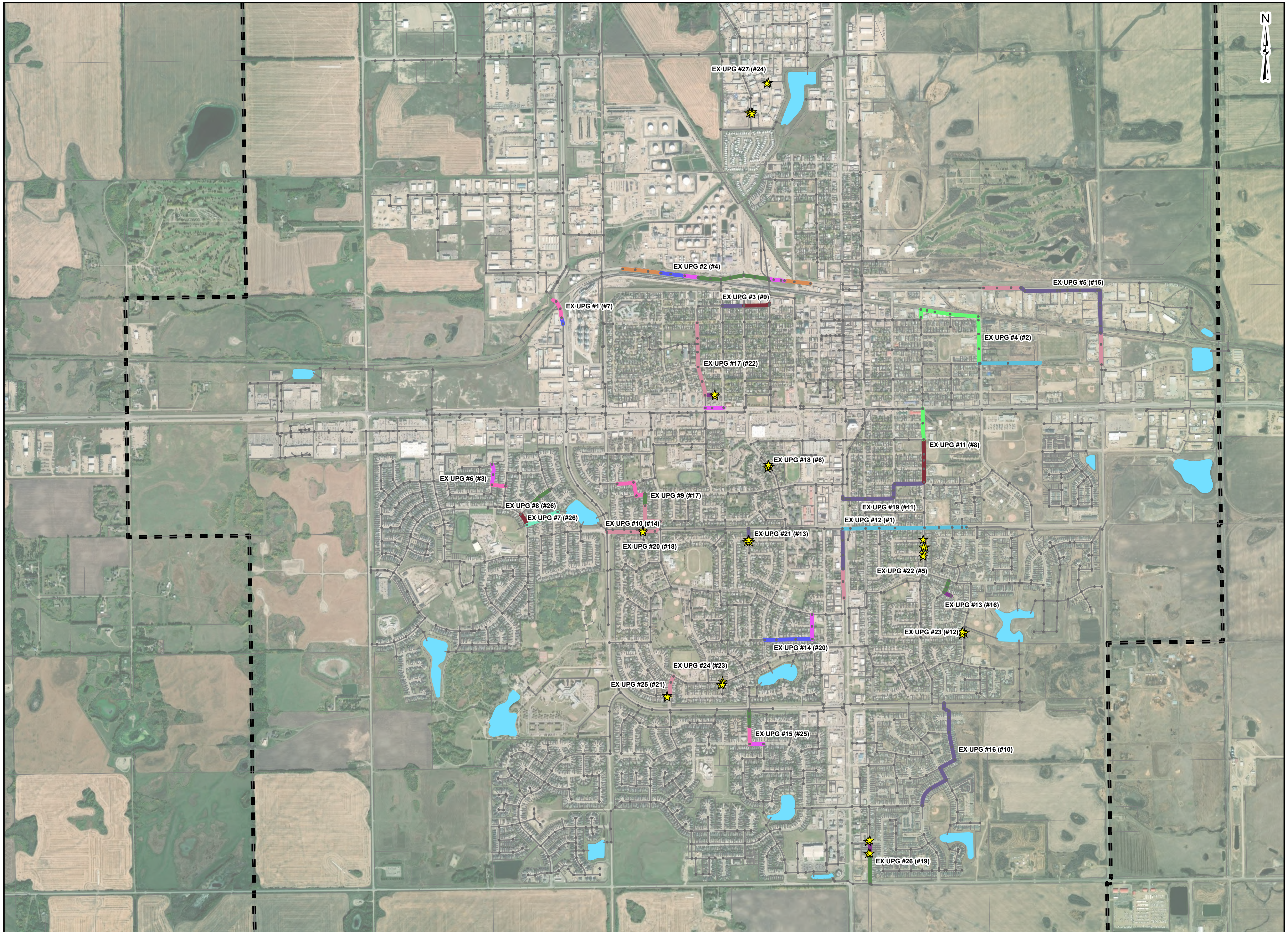

Legend

Study Area

Storm Pond

Proposed Manhole/Catchbasin Upgrades

Proposed Sewer Upgrades

300 mm
375 mm
450 mm
525 mm
600 mm
675 mm
750 mm
900 mm
1050 mm
1200 mm
1350 mm
1500 mm
1650 mm

Note: number in bracket denotes the priority of the proposed upgrade based on risk assessment.

0 315 630 1,260 Meters

1:25,000 NAD 1983 UTM Zone 12N

FIGURE 6.12
PROPOSED EXISTING SYSTEM UPGRADES
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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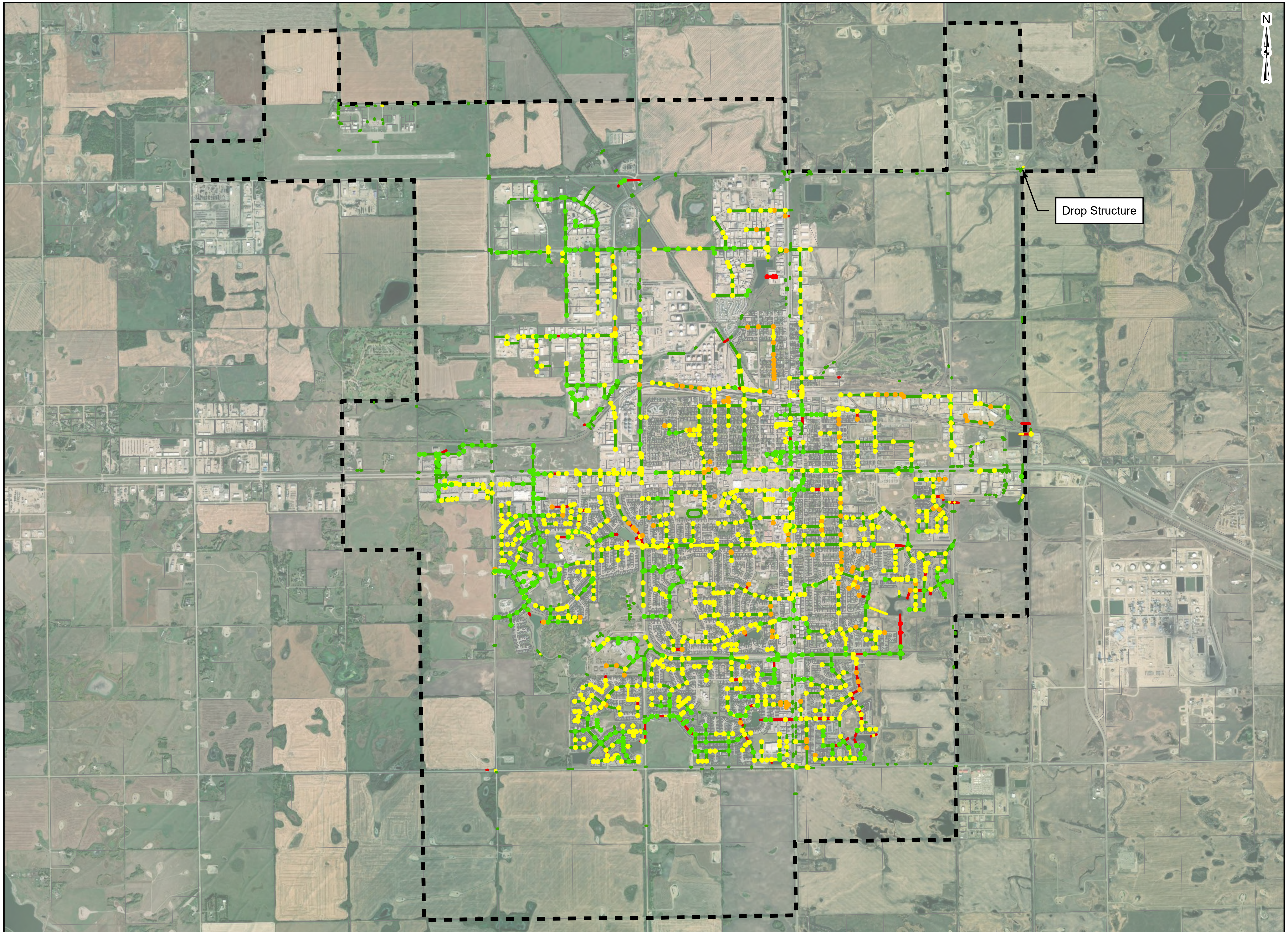

Legend

Nodes

Max HGL Relative to Ground

- Less than -3.0 m
- Between -3.0 and -1.5 m
- Between -1.5 and 0 m
- Greater than 0 m

Links

Peak Flow to Pipe Capacity Ratio

- Less than 86%
- Between 86% and 100%
- Greater than 100%

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 6.13
MINOR SYSTEM MODEL RESULTS - EXISTING WITH PROPOSED UPGRADES
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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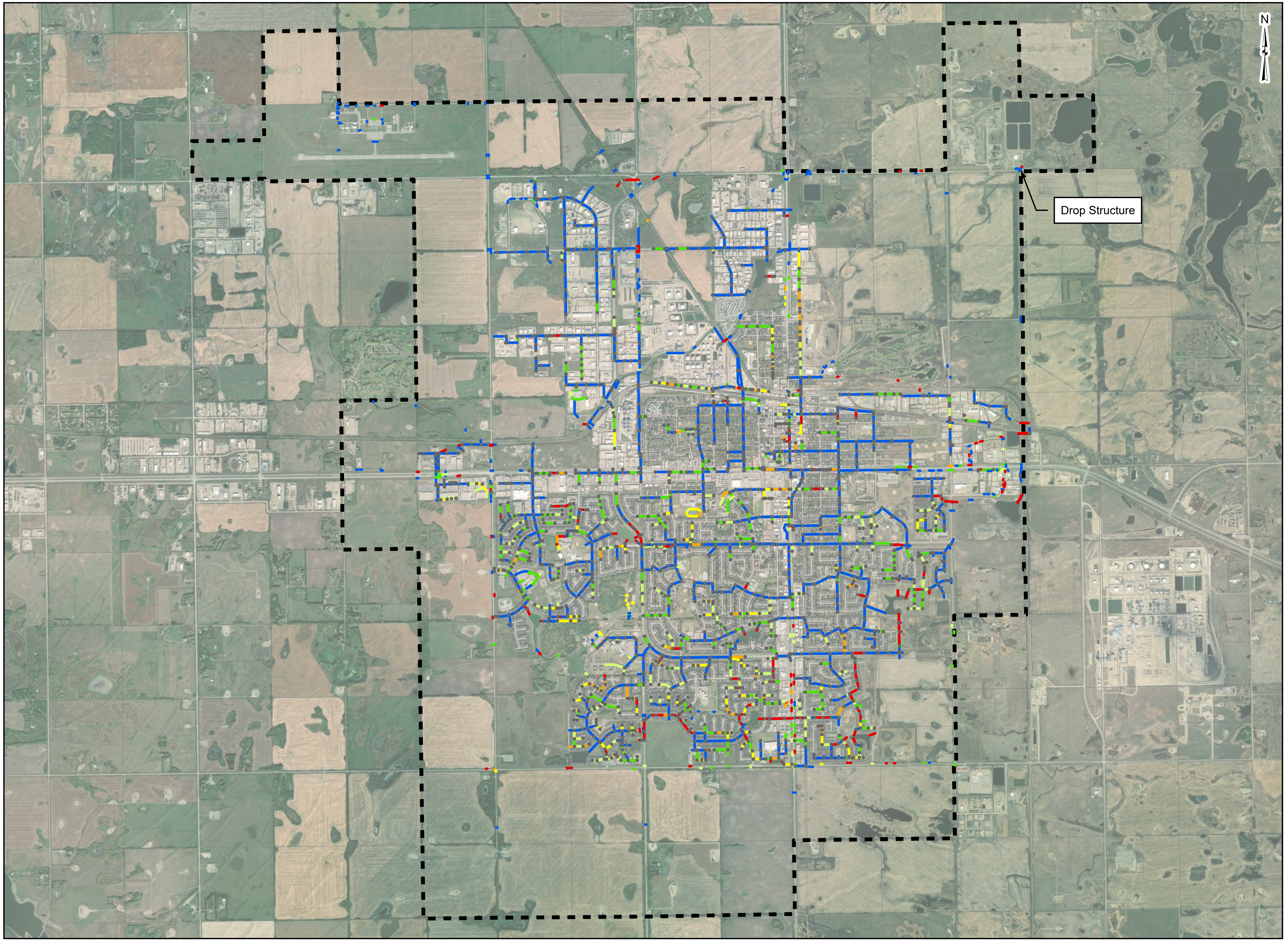

Credits:World Imagery: Vermilion River County, Maxar

FIGURE 6.14
SPARE PIPE CAPACITY
EXISTING W/ PROPOSED UPGRADES
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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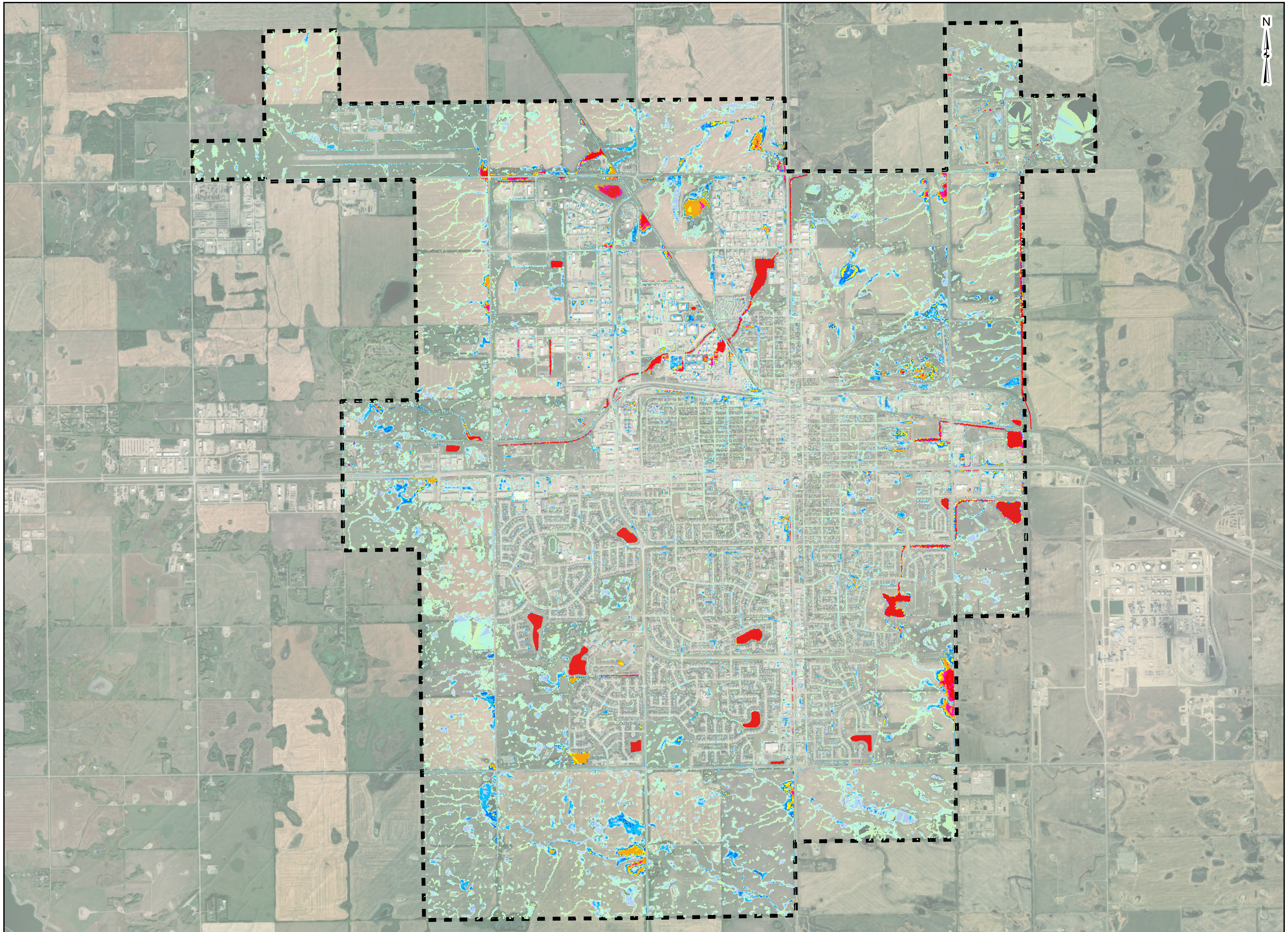

Legend

2D Zones

Maximum Depth (m)

- Less than 0.05 m
- 0.05 - 0.1 m
- 0.1 - 0.2 m
- 0.2 - 0.3 m
- 0.3 - 0.4 m
- 0.4 - 0.5 m
- 0.5 - 0.6 m
- 0.6 - 0.8 m
- 0.8 - 1.0 m
- Greater than 1.0 m

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 6.15
MAXIMUM WATER DEPTH
EXISTING SYSTEM WITH PROPOSED UPGRADES
1:100 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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7.0 Future System Concept and Assessment

The City has a number of undeveloped parcels, including infill development and future annexation areas. Future development land uses and staging are discussed in Section 2.3.

7.1 Future Drainage Patterns

To facilitate the future developments, major and minor stormwater drainage systems are required to collect and control runoff in these areas. Runoff due to development in these areas must be controlled to ensure public safety and minimize property damage and environmental impacts. This is best accomplished by collecting storm runoff by storm sewers and conveying it to a storm pond where the release rate can be controlled. Based on AEP's regulations, it is specified that post-development flows released should not exceed pre-development flows.

Future drainage catchments were delineated based on the existing topography, as summarized in Table 7.1 and shown in Figure 7.1. Drainage patterns are generally divided on a per quarter section basis and further split or grouped based on major changes in topography. There are also some future development areas within existing catchments that are expected to utilize existing stormwater infrastructure. However, it should be noted that these catchments should be revisited at the development stage so that the proposed grading of each development site is accounted for.

Table 7.1: Summary of Future Development Area Drainage Pattern

ID	Location	Drainage Direction	Area
			ha
FUT-Catchment 1	West of Lloydminster Airport	Southwest to proposed FUT_SWMF_1	30.58
FUT-Catchment 2	North of Lloydminster Airport	Northeast to proposed FUT_SWMF_2	64.50
FUT-Catchment 3	Northeast of intersection at Township Road 502 and 75 Avenue	Southeast to proposed FUT_SWMF_3	63.50
FUT-Catchment 4	North of Township Road 502, west of Range Road 11	Southeast to proposed FUT_SWMF_4	61.28
FUT-Catchment 5	North of 67 Street, east of Range Road 11	Southeast to proposed FUT_SWMF_5	64.22
FUT-Catchment 6	North of 67 Street, west of 50 Avenue	Southeast to proposed FUT_SWMF_6	61.04
FUT-Catchment 7	Southwest of intersection at Township Road 502 and 75 Avenue	Northeast to proposed FUT_SWMF_7	64.06
FUT-Catchment 8	South of 67 Street and east of 49 Avenue	East to proposed FUT_SWMF_8	17.49
FUT-Catchment 9	South of 67 Street, west and east sides of 40 Avenue	East and Northeast to proposed FUT_SWMF_9	67.05
FUT-Catchment 10	South of 62 Street, west of 75 Avenue	East to proposed FUT_SWMF_10	62.35
FUT-Catchment 11	South of 62 Street, east of 75 Avenue	Northeast to proposed FUT_SWMF_11	60.31
FUT-Catchment 12	South of 62 Street, east of 50 Avenue	East to proposed FUT_SWMF_12	12.45
FUT-Catchment 13	North of Lloydminster Cemetery	East to proposed FUT_SWMF_13	81.49
FUT-Catchment 14	North of 57 Street, east of 40 Avenue	Northeast to proposed FUT_SWMF_14	58.93
FUT-Catchment 15	West of 75 Avenue, east of Rolling Green Fairways Golf Course	Southwest to proposed FUT_SWMF_15	62.73
FUT-Catchment 16	Northeast of intersection at 40 Avenue and 52 Street	Northeast to proposed FUT_SWMF_16	45.25
FUT-Catchment 17	North of Highway 16, just inside of west City boundary	East to proposed FUT_SWMF_17	56.29
FUT-Catchment 18	North of CN rails, east of 75 Avenue	Southeast to proposed FUT_SWMF_18	68.80
FUT-Catchment 19	South of Highway 16, just inside of west city boundary	Northeast to proposed FUT_SWMF_19	59.52
FUT-Catchment 20	South of Highway 16, west of 75 Avenue	North to proposed FUT_SWMF_20	46.87
FUT-Catchment 21	Southeast of intersection at 36 Street and 40 Avenue	North to proposed FUT_SWMF_21	58.89
FUT-Catchment 22	Southwest of intersection at 29 Street and 75 Avenue	Northeast to proposed FUT_SWMF_22	65.30
FUT-Catchment 23	East of 27 Street, southeast of Lake J	Southeast to proposed FUT_SWMF_23	19.13
FUT-Catchment 24	North of Township Road 494, west of 75 Avenue	Southeast to proposed FUT_SWMF_24	62.54
FUT-Catchment 25	North of 12 Street, east of 75 Avenue	Southeast to proposed FUT_SWMF_25	44.90
FUT-Catchment 26	North of 12 Street, west of 40 Avenue	East to proposed FUT_SWMF_26	108.25

ID	Location	Drainage Direction	Area
			ha
FUT-Catchment 27	Southwest of intersection at 12 Street and 75 Avenue	Northeast to proposed FUT_SWMF_27	64.97
FUT-Catchment 28	Southeast of intersection at 12 Street and 75 Avenue	Southeast to proposed FUT_SWMF_28	63.28
FUT-Catchment 29	Southwest of intersection at 12 Street and Range Road 11	Southeast to proposed FUT_SWMF_29	63.25
FUT-Catchment 30	Southeast of intersection at 12 Street and Range Road 11	Southeast to proposed FUT_SWMF_30	63.04
FUT-Catchment 31	Southwest of intersection at 12 Street and 50 Avenue	Southeast to proposed FUT_SWMF_31	62.15
FUT-Catchment 32	Southeast of intersection at 12 Street and 50 Avenue	South to proposed FUT_SWMF_32	78.51
FUT-Catchment 33	South of FUT-Catchment 27	Northeast to proposed FUT_SWMF_33	64.47
FUT-Catchment 34	South of FUT-Catchment 28	Northeast to proposed FUT_SWMF_34	64.37
FUT-Catchment 35	South of FUT-Catchment 29	Northeast to proposed FUT_SWMF_35	64.04
FUT-Catchment 36	South of FUT-Catchment 30	East to proposed FUT_SWMF_36	64.31
FUT-Catchment 37	South of FUT-Catchment 31	Southeast to proposed FUT_SWMF_37	61.80
FUT-Catchment 38	South of 62 Avenue, north of 62 Street, and flanking the CP rails	East to proposed FUT_SWMF_38	57.72
FUT-Catchment 39	South of CN rail, between 75 Avenue and 62 Avenue	North to proposed FUT_SWMF_39	31.72
FUT-Catchment 40	West of 75 Avenue at 34 Street	Northeast to proposed FUT_SWMF_40	64.41
FUT-Catchment 41	South of 62 Street, east of CP rails	Southeast to proposed FUT_SWMF_41	17.75
FUT-Catchment 42	North of 12 Street, east of 59 Avenue	East to proposed FUT_SWMF_42	26.38
FUT-Catchment 43	North of CN rail, west of 75 Avenue	Southeast to proposed FUT_SWMF_43	34.96
HW 1A (HWY 16)[1]	West of HW 1A Storm Pond	East to HW 1A Pond	1.10
Lake J[1]	East of Lake J Storm Pond	West to Lake J Pond	9.87
Lake K[1]	South of 41 Street, east of 40 Avenue	East to Lake K Pond	28.85
Lake N[1]	East of 45 Avenue, between 49 Street and 44 Street	East to Lake N Pond	7.83
Lakeside Pond[1]	Southeast of 61 Avenue, north of 18 Street	Southeast to Lakeside Pond	4.04
Parkview Lake[1]	South of 29 Street, east of 75 Avenue	Northeast to Parkview Lake	30.70

[1] Future development areas within existing catchments.

7.2 Future System Concept Development

The future stormwater management servicing concept generally includes a proposed SWMF in each quarter section of future development land, an orifice to regulate outlet discharge rate, and sections of storm sewer to convey flow from SWMF to a downstream outfall. New development areas within existing catchments would connect to adjacent existing stormwater systems and drain to the respective existing SWMF downstream (this assumes the system was previously receiving pre-development level flows, which as an assumption has been broadly validated). The overall future stormwater management servicing concept is illustrated in Figure 7.2. It should be noted that onsite stormwater drainage and management infrastructure are not included in this SWMP, as their design and construction will be completed by the respective developers at the time of development.

7.2.1 Proposed Future Stormwater Management Facilities

SWMFs are designed to provide sufficient storage capacity to temporarily store and attenuate the peak flow in the stormwater pond, while controlling the flow release rate below the stipulated limit and not infringing the freeboard requirements. The runoff coefficients specified in Table 5.5 were used to calculate the weighted average of all parcels in each catchment, which were then used to estimate total runoff volume. The maximum flow release rates were calculated based on the 1.5 L/s/ha rate as stipulated in the City's Municipal Development Standards. The greater of the required storage volume calculated using the 1:100-year 4-hour Modified Chicago storm and 1:100-year 24-hour Huff storm was used to design the stormwater pond geometry, which provides the required storage capacity at the HWL. Design parameters used to size the proposed SWMFs are shown in Table 7.2. It should be noted that, despite not being shown in the City's GIS data, some proposed future SWMFs may already exist or are under development based on aerial imagery review and discussions with the City. Design parameters of such future SWMFs are still provided in the tables below for reference.

As one of the best management practices (BMP), the City could consider implementing low impact development (LID) techniques in the new development areas to assist with reducing stormwater runoff and increasing the quality of stormwater being distributed into the downstream receiving bodies of water. Some of these techniques include rain gardens, green roofs and pervious pavement. A summary of various available BMP options is discussed in Section 7.5.

Table 7.2: Proposed Future SWMF Design Parameters

ID	Area	Runoff Coefficient	Maximum Flow Release Rate	Required Storage Volume[1,2]	
				1:100 Yr 4 Hr Chicago	1:100 Yr 24 Hr Huff
	ha		L/s	m^3	m^3
FUT_SWMF_1	30.58	0.865	45.9	19,400	**26,900**
FUT_SWMF_2	64.50	0.852	96.8	40,100	**55,500**
FUT_SWMF_3	63.50	0.792	95.3	36,700	**50,400**
FUT_SWMF_4	61.28	0.786	91.9	35,100	**48,100**
FUT_SWMF_5	64.22	0.780	96.3	36,500	**50,200**
FUT_SWMF_6	61.04	0.814	91.6	36,300	**49,800**
FUT_SWMF_7	64.06	0.808	96.1	37,800	**52,100**
FUT_SWMF_8	17.49	0.835	26.2	10,700	**14,900**
FUT_SWMF_9	67.05	0.780	100.6	38,200	**52,700**

ID	Area	Runoff Coefficient	Maximum Flow Release Rate	Required Storage Volume[1,2]	
				1:100 Yr 4 Hr Chicago	1:100 Yr 24 Hr Huff
	ha		L/s	m³	m³
FUT_SWMF_10	62.35	0.789	93.5	35,900	**49,300**
FUT_SWMF_11	60.31	0.780	90.5	34,300	**46,900**
FUT_SWMF_12	12.45	0.780	18.7	7,100	**9,500**
FUT_SWMF_13	81.49	0.780	122.2	46,100	**61,500**
FUT_SWMF_14	58.93	0.780	88.4	33,500	**45,700**
FUT_SWMF_15	62.73	0.781	94.1	35,700	**49,000**
FUT_SWMF_16	45.25	0.780	67.9	25,600	**34,000**
FUT_SWMF_17	56.29	0.818	84.4	33,600	**45,800**
FUT_SWMF_18[3] (Future Pond U)	68.80	0.780	103.2	39,200	**54,100**
FUT_SWMF_19	59.52	0.570	89.3	24,500	**32,500**
FUT_SWMF_20	46.87	0.637	70.3	21,500	**28,100**
FUT_SWMF_21	58.89	0.514	88.3	21,900	**28,600**
FUT_SWMF_22	65.30	0.440	98.0	20,700	**26,900**
FUT_SWMF_23	19.13	0.447	28.7	6,200	**8,200**
FUT_SWMF_24	62.54	0.574	93.8	26,000	**34,700**
FUT_SWMF_25[3]	44.90	0.620	67.4	20,400	**28,400**
FUT_SWMF_26	108.25	0.440	162.4	34,200	**44,100**
FUT_SWMF_27	64.97	0.480	97.5	22,500	**29,500**
FUT_SWMF_28	63.28	0.476	94.9	21,700	**28,300**
FUT_SWMF_29	63.25	0.464	94.9	21,200	**27,500**
FUT_SWMF_30	63.04	0.464	94.6	21,100	**27,500**
FUT_SWMF_31	62.15	0.539	93.2	24,200	**32,000**
FUT_SWMF_32	78.51	0.535	117.8	30,600	**41,300**
FUT_SWMF_33	64.47	0.440	96.7	20,400	**26,500**
FUT_SWMF_34	64.37	0.440	96.6	20,400	**26,400**
FUT_SWMF_35	64.04	0.440	96.1	20,300	**26,200**
FUT_SWMF_36	64.31	0.440	96.5	20,400	**26,400**
FUT_SWMF_37	61.80	0.532	92.7	23,800	**31,300**
FUT_SWMF_38[3]	57.72	0.780	86.6	32,800	**44,700**
FUT_SWMF_39	31.72	0.865	47.6	20,100	**27,900**
FUT_SWMF_40	64.41	0.440	96.6	20,400	**26,500**
FUT_SWMF_41	17.75	0.780	26.6	10,100	**14,000**
FUT_SWMF_42	26.38	0.440	39.6	8,400	**10,700**
FUT_SWMF_43	34.96	0.780	52.4	19,800	**27,400**

[1] Required storage volume is calculated based on the design rainfall intensity, discounting the estimated orifice discharge rate, and rounded to the nearest hundred cubic metres.
[2] Bold values are the governing storage capacity requirement between the 1:100 year 4-hour Chicago and 1:100 year 24-hour Huff storm events
[3] Proposed future SWMF that may already exist or be under development.

When sizing the proposed future SWMFs, the allowable discharge flow rates were applied to the orifice equation to determine the required orifice size, with the assumption that the orifice is submerged and that the maximum flow release rate occurs when the water level reaches HWL in the SWMF. The orifices were then rounded down to the nearest commercially available orifice size (nominal diameter) so that the SWMFs would be able to accommodate the total volume without exceeding the maximum release rate.

The storm sewers were designed to adequately convey the anticipated peak flow from the SWMFs. This design was based on the minimum slope required to achieve the full pipe flow self-cleansing velocity of 0.9 m/s, in accordance with the City's Municipal Development Standards (as detailed in Table 7.3). All proposed storm sewers were assumed to follow relatively straight alignments along the quarter section boundaries before reaching the discharge outfall.

Table 7.3: Minimum Storm Sewer Grade Requirements

Pipe Diameter	Minimum Design Slope		Full Pipe Capacity[1]
mm	%	m/m	L/s
200	0.74	0.0075	28.2
250	0.55	0.0055	44.1
300	0.44	0.0044	64.1
375	0.32	0.0032	99.2
450	0.26	0.0026	145.4
525	0.22	0.0022	201.7
600	0.18	0.0018	260.5
675	0.15	0.0015	325.6
750	0.13	0.0013	401.4
900 (and larger)	0.10	0.0010	572.5[2]

[1] Assuming a Manning's 'n' of 0.013
[2] Reflects a sewer diameter of 900 mm, noting that anything larger will have increased full-sewer velocities and capacities.

Based on the design parameters specified above, the proposed future SWMF sizing is summarized in Table 7.4, the outlet orifice and SWMF outlet pipe sizing are summarized in Table 7.5, and the proposed future servicing storm sewers are summarized in Table 7.6.

Table 7.4: Proposed Future Stormwater Management Facility Design Summary

SWMF ID	Bottom		NWL		HWL		Top		Dead Storage Volume	Live Storage Volume	Freeboard Storage Volume	Total Storage Volume	Percent of Catchment Area
	Elev.	Area	Elev.	Area	Elev.	Area	Elev.	Area					
	m	m^2	m	m^2	m	m^2	m	m^2	m^3	m^3	m^3	m^3	%
FUT_SWMF_1	660.61	8,000	662.61	11,500	664.61	15,600	664.91	16,200	19,400	26,900	4,800	51,100	5.30
FUT_SWMF_2	655.08	19,600	657.08	24,900	659.08	30,800	659.38	31,700	44,400	55,500	9,400	109,300	4.91
FUT_SWMF_3	641.40	17,500	643.40	22,400	645.40	28,100	645.70	29,000	39,900	50,400	8,600	98,900	4.57
FUT_SWMF_4	639.06	16,500	641.06	21,400	643.06	26,800	643.36	27,700	37,800	48,100	8,200	94,100	4.52
FUT_SWMF_5	636.17	17,400	638.17	22,400	640.17	28,000	640.47	28,900	39,700	50,200	8,600	98,500	4.50
FUT_SWMF_6	633.80	17,200	635.80	22,200	637.80	27,800	638.10	28,700	39,300	49,800	8,500	97,600	4.70
FUT_SWMF_7	648.09	18,200	650.09	23,200	652.09	29,000	652.39	29,900	41,400	52,100	8,900	102,400	4.67
FUT_SWMF_8	634.88	3,600	636.88	6,000	638.88	9,000	639.18	9,500	9,600	14,900	2,800	27,300	5.43
FUT_SWMF_9	627.20	18,400	629.20	23,500	631.20	29,300	631.50	30,200	41,900	52,700	9,000	103,600	4.50
FUT_SWMF_10	658.30	17,000	660.30	21,900	662.30	27,500	662.60	28,400	38,900	49,300	8,400	96,600	4.55
FUT_SWMF_11	645.64	16,000	647.64	20,800	649.64	26,200	649.94	27,100	36,700	46,900	8,000	91,600	4.49
FUT_SWMF_12	635.36	1,800	637.36	3,600	639.36	6,000	639.66	6,400	5,400	9,500	1,900	16,800	5.14
FUT_SWMF_13	633.04	22,100	635.04	27,700	637.04	33,900	637.34	34,900	49,700	61,500	10,400	121,600	4.28
FUT_SWMF_14	625.36	15,500	627.36	20,200	629.36	25,600	629.66	26,400	35,700	45,700	7,800	89,200	4.48
FUT_SWMF_15	657.02	16,900	659.02	21,800	661.02	27,300	661.32	28,200	38,700	49,000	8,400	96,100	4.50
FUT_SWMF_16	629.28	10,800	631.28	14,800	633.28	19,400	633.58	20,100	25,500	34,000	6,000	65,500	4.44
FUT_SWMF_17	656.55	15,600	658.55	20,300	660.55	25,700	660.85	26,500	35,900	45,800	7,900	89,600	4.71
FUT_SWMF_18[1] (Future Pond U)	651.61	19,000	653.61	24,200	655.61	30,000	655.91	31,000	43,100	54,100	9,200	106,400	4.51
FUT_SWMF_19	658.38	10,200	660.38	14,100	662.38	18,600	662.68	19,300	24,200	32,500	5,700	62,400	3.24
FUT_SWMF_20	657.98	8,400	659.98	12,000	661.98	16,200	662.28	16,900	20,300	28,100	5,000	53,400	3.61
FUT_SWMF_21	637.64	8,600	639.64	12,200	641.64	16,500	641.94	17,200	20,700	28,600	5,100	54,400	2.92
FUT_SWMF_22	659.10	8,000	661.10	11,500	663.10	15,600	663.40	16,200	19,400	26,900	4,800	51,100	2.48
FUT_SWMF_23	641.04	1,400	643.04	3,100	645.04	5,300	645.34	5,700	4,400	8,200	1,700	14,300	2.98
FUT_SWMF_24	660.04	11,100	662.04	15,100	664.04	19,700	664.34	20,500	26,200	34,700	6,100	67,000	3.28
FUT_SWMF_25[1]	654.04	8,600	656.04	12,200	658.04	16,400	658.34	17,100	20,700	28,400	5,100	54,200	3.81
FUT_SWMF_26	639.83	14,800	641.83	19,400	643.83	24,700	644.13	25,500	34,200	44,100	7,600	85,900	2.36
FUT_SWMF_27	659.23	9,000	661.23	12,700	663.23	17,000	663.53	17,700	21,600	29,500	5,200	56,300	2.72
FUT_SWMF_28	655.23	8,600	657.23	12,100	659.23	16,300	659.53	17,000	20,700	28,300	5,000	54,000	2.69
FUT_SWMF_29	653.86	8,200	655.86	11,700	657.86	15,900	658.16	16,600	19,900	27,500	4,900	52,300	2.62
FUT_SWMF_30	651.50	8,200	653.50	11,700	655.50	15,900	655.80	16,500	19,900	27,500	4,900	52,300	2.62

SWMF ID	Bottom		NWL		HWL		Top		Dead Storage Volume	Live Storage Volume	Freeboard Storage Volume	Total Storage Volume	Percent of Catchment Area
	Elev.	Area	Elev.	Area	Elev.	Area	Elev.	Area					
	m	m^2	m	m^2	m	m^2	m	m^2	m^3	m^3	m^3	m^3	%
FUT_SWMF_31	648.70	10,000	650.70	13,800	652.70	18,300	653.00	19,000	23,800	32,000	5,600	61,400	3.06
FUT_SWMF_32	645.66	13,700	647.66	18,200	649.66	23,300	649.96	24,100	31,800	41,300	7,100	80,200	3.07
FUT_SWMF_33	660.24	7,800	662.24	11,300	664.24	15,400	664.54	16,000	19,000	26,500	4,700	50,200	2.48
FUT_SWMF_34	655.53	7,800	657.53	11,200	659.53	15,300	659.83	16,000	19,000	26,400	4,700	50,100	2.49
FUT_SWMF_35	653.28	7,800	655.28	11,200	657.28	15,200	657.58	15,900	19,000	26,200	4,700	49,900	2.48
FUT_SWMF_36	651.20	7,800	653.20	11,200	655.20	15,300	655.50	15,900	19,000	26,400	4,700	50,100	2.47
FUT_SWMF_37	648.35	9,700	650.35	13,500	652.35	18,000	652.65	18,700	23,200	31,300	5,500	60,000	3.03
FUT_SWMF_38[1]	636.69	15,100	638.69	19,800	640.69	25,100	640.99	25,900	34,800	44,700	7,700	87,200	4.49
FUT_SWMF_39	653.82	8,400	655.82	11,900	657.82	16,100	658.12	16,800	20,300	27,900	5,000	53,200	5.30
FUT_SWMF_40	658.48	7,800	660.48	11,300	662.48	15,300	662.78	16,000	19,000	26,500	4,700	50,200	2.48
FUT_SWMF_41	638.70	3,300	640.70	5,600	642.70	8,500	643.00	9,000	8,900	14,000	2,700	25,600	5.07
FUT_SWMF_42	653.55	2,200	655.55	4,100	657.55	6,700	657.85	7,100	6,300	10,700	2,100	19,100	2.69
FUT_SWMF_43	656.86	8,200	658.86	11,700	660.86	15,900	661.16	16,600	19,900	27,400	4,900	52,200	4.75

[1] Proposed future SWMF that may already exist or under development.

Table 7.5: Proposed Future SWMF Orifice and Outlet Pipe Sizing Summary

SWMF ID	Maximum Allowable Release Rate	Conceptual Orifice Size	Nominal Orifice Size	SWMF Outlet Pipe Design Flow[1]	Required Nominal Pipe Diameter	Pipe Total Capacity[2]	Pipe Spare Capacity
	L/s	mm	mm (in)	L/s	mm	L/s	L/s
FUT_SWMF_1	45.9	125	102 (4")	53.3	300	64.1	10.8
FUT_SWMF_2	96.8	181	152 (6")	112.5	450	145.4	32.9
FUT_SWMF_3	95.3	180	152 (6")	110.8	450	145.4	34.6
FUT_SWMF_4	91.9	176	152 (6")	106.9	450	145.4	38.5
FUT_SWMF_5	96.3	181	152 (6")	112.0	450	145.4	33.4
FUT_SWMF_6	91.6	176	152 (6")	106.5	450	145.4	38.9
FUT_SWMF_7	96.1	180	152 (6")	111.7	450	145.4	33.6
FUT_SWMF_8	26.2	94	76 (3")	30.5	250	44.1	13.6
FUT_SWMF_9	100.6	185	152 (6")	116.9	450	145.4	28.4
FUT_SWMF_10	93.5	178	152 (6")	108.8	450	145.4	36.6
FUT_SWMF_11	90.5	175	152 (6")	105.2	450	145.4	40.2
FUT_SWMF_12	18.7	80	76 (3")	21.7	200	28.2	6.5
FUT_SWMF_13	122.2	203	202 (8")	142.1	450	145.4	3.2
FUT_SWMF_14	88.4	173	152 (6")	102.8	450	145.4	42.6
FUT_SWMF_15	94.1	179	152 (6")	109.4	450	145.4	36.0
FUT_SWMF_16	67.9	152	152 (6")	78.9	375	99.2	20.3
FUT_SWMF_17	84.4	169	152 (6")	98.2	375	99.2	1.0
FUT_SWMF_18[3] (Future Pond U)	103.2	187	152 (6")	120.0	450	145.4	25.4
FUT_SWMF_19	89.3	174	152 (6")	103.8	450	145.4	41.6
FUT_SWMF_20	70.3	154	152 (6")	81.8	375	99.2	17.4
FUT_SWMF_21	88.3	173	152 (6")	102.7	450	145.4	42.7
FUT_SWMF_22	98.0	182	152 (6")	113.9	450	145.4	31.5
FUT_SWMF_23	28.7	99	76 (3")	33.4	250	44.1	10.7
FUT_SWMF_24	93.8	178	152 (6")	109.1	450	145.4	36.3
FUT_SWMF_25[3]	67.4	151	102 (4")	78.3	375	99.2	20.9
FUT_SWMF_26	162.4	235	202 (8")	188.8	525	201.7	12.9
FUT_SWMF_27	97.5	182	152 (6")	113.3	450	145.4	32.1
FUT_SWMF_28	94.9	179	152 (6")	110.4	450	145.4	35.0
FUT_SWMF_29	94.9	179	152 (6")	110.3	450	145.4	35.1

SWMF ID	Maximum Allowable Release Rate	Conceptual Orifice Size	Nominal Orifice Size	SWMF Outlet Pipe Design Flow[1]	Required Nominal Pipe Diameter	Pipe Total Capacity[2]	Pipe Spare Capacity
	L/s	mm	mm (in)	L/s	mm	L/s	L/s
FUT_SWMF_30	94.6	179	152 (6”)	110.0	450	145.4	35.4
FUT_SWMF_31	93.2	178	152 (6”)	108.4	450	145.4	37.0
FUT_SWMF_32	117.8	200	152 (6”)	136.9	450	145.4	8.4
FUT_SWMF_33	96.7	181	152 (6”)	112.4	450	145.4	32.9
FUT_SWMF_34	96.6	181	152 (6”)	112.3	450	145.4	33.1
FUT_SWMF_35	96.1	180	152 (6”)	111.7	450	145.4	33.7
FUT_SWMF_36	96.5	181	152 (6”)	112.2	450	145.4	33.2
FUT_SWMF_37	92.7	177	152 (6”)	107.8	450	145.4	37.6
FUT_SWMF_38[3]	86.6	171	152 (6”)	100.7	450	145.4	44.7
FUT_SWMF_39	47.6	127	102 (4”)	55.3	300	64.1	8.8
FUT_SWMF_40	96.6	181	152 (6”)	112.3	450	145.4	33.0
FUT_SWMF_41	26.6	95	76 (3”)	31.0	250	44.1	13.1
FUT_SWMF_42	39.6	116	102 (4”)	46.0	300	64.1	18.1
FUT_SWMF_43	52.4	133	102 (4”)	61.0	300	64.1	3.2

[1] SWMF outlet design flow was calculated by assuming the maximum allowable release rate equals 86% of the outlet pipe full flow (q/Q).
[2] Based on minimum pipe slope stipulated in the City’s Municipal Development Standards and a Manning’s n of 0.013.
[3] Proposed future SWMF that may already exist or under development.

Table 7.6: Proposed Future Servicing Storm Sewers

PIPE ID	Servicing Future Catchment	Length	Design Flow	Pipe Size	Pipe Capacity	Comments
		m	L/s	Mm	L/s	
FUT_STM_1	FUT-Catchment 1	325	53.4	300	64.1	Discharge to drain ditch
FUT_STM_2	FUT-Catchment 2	800	112.6	450	145.4	Discharge to drain ditch in Airport
FUT_STM_3	FUT-Catchment 3	80	110.8	450	145.4	Connect to FUT_STM_55
FUT_STM_4	FUT-Catchment 4	255	106.9	450	145.4	Connect to FUT_STM_56
FUT_STM_5	FUT-Catchment 5	166	112	450	145.4	Connect to FUT_STM_57
FUT_STM_6	FUT-Catchment 6	40	106.5	450	145.4	Connect to FUT_STM_58
FUT_STM_7	FUT-Catchment 7	920	111.7	450	145.4	Connect to FUT_STM_55
FUT_STM_8	FUT-Catchment 8	590	30.5	250	44.1	Connect to FUT_STM_52
FUT_STM_9	FUT-Catchment 9	80	117	450	145.4	Discharge to East Drainage Channel
FUT_STM_10	FUT-Catchment 10	420	108.7	450	145.5	Tie-in to existing 600 mm storm sewer on 62 Street
FUT_STM_11	FUT-Catchment 11	10	105.2	450	145.4	Connect to existing 600 mm pipe at pond outlet
FUT_STM_12	FUT-Catchment 12	20	21.7	200	28.2	Connect to FUT_STM_52
FUT_STM_13	FUT-Catchment 13	122	142.1	450	145.4	Connect to FUT_STM_53
FUT_STM_14	FUT-Catchment 14	20	102.8	450	145.4	Discharge to East Drainage Channel
FUT_STM_15	FUT-Catchment 15	180	109.4	450	145.4	Discharge to Northwest Drainage Channel
FUT_STM_16	FUT-Catchment 16	78	79	375	99.2	Discharge to East Drainage Channel
FUT_STM_17	FUT-Catchment 17	90	98.1	375	99.2	Discharge to HW 1A Pond
FUT_STM_18	FUT-Catchment 18	57	120	450	145.4	Tie-in to existing 450 mm pipe at pond outlet
FUT_STM_19	FUT-Catchment 19	278	103.8	450	145.4	Tie-in to existing 1,500 mm sewer at 44 Street/80 Avenue
FUT_STM_20	FUT-Catchment 20	78	81.7	375	99.2	Tie-in to existing 1,500 mm sewer at south end of 80 Avenue
FUT_STM_21	FUT-Catchment 21	143	102.7	450	145.4	Connect to FUT_STM_54
FUT_STM_22	FUT-Catchment 22	158	114	450	145.4	Connect to FUT_STM_45
FUT_STM_23	FUT-Catchment 23	73	33.4	250	44.1	Connect to FUT_STM_44
FUT_STM_24	FUT-Catchment 24	330	109.1	450	145.4	Connect to FUT_STM_46
FUT_STM_25	FUT-Catchment 25	135	78.4	375	99.2	Tie-in to existing 600 mm pipe at pond outlet
FUT_STM_26	FUT-Catchment 26	520	188.8	525	201.7	Connect to FUT_STM_44
FUT_STM_27	FUT-Catchment 27	115	113.4	450	145.4	Connect to FUT_STM_46
FUT_STM_28	FUT-Catchment 28	230	110.3	450	145.4	Connect to FUT_STM_48
FUT_STM_29	FUT-Catchment 29	185	110.3	450	145.4	Connect to FUT_STM_49
FUT_STM_30	FUT-Catchment 30	58	110	450	145.4	Connect to FUT_STM_50
FUT_STM_31	FUT-Catchment 31	222	108.4	450	145.4	Connect to FUT_STM_51

PIPE ID	Servicing Future Catchment	Length	Design Flow	Pipe Size	Pipe Capacity	Comments
		m	L/s	Mm	L/s	
FUT_STM_32	FUT-Catchment 32	40	137	450	145.4	Discharge to South Drainage Channel
FUT_STM_33	FUT-Catchment 33	50	112.4	450	145.4	Connect to FUT_STM_47
FUT_STM_34	FUT-Catchment 34	94	112.3	450	145.4	Connect to FUT_STM_48
FUT_STM_35	FUT-Catchment 35	110	111.7	450	145.4	Connect to FUT_STM_49
FUT_STM_36	FUT-Catchment 36	480	112.2	450	145.4	Connect to FUT_STM_50
FUT_STM_37	FUT-Catchment 37	780	107.8	450	145.4	Connect to FUT_STM_51
FUT_STM_38	FUT-Catchment 38	180	100.7	450	145.4	Connect to existing 750 mm pipe at 65 Street/53 Avenue
FUT_STM_39	FUT-Catchment 39	40	55.3	300	64.1	Discharge to Northwest Drainage Channel
FUT_STM_40	FUT-Catchment 40	750	112.3	450	145.4	Connect to FUT_STM_45
FUT_STM_41	FUT-Catchment 41	62	30.9	250	44.1	Tie-in to existing 375 mm near 62 Street
FUT_STM_42	FUT-Catchment 42	95	46	300	64.1	Tie-in to existing 450 mm pipe at west end of 14 Street
FUT_STM_43	FUT-Catchment 43	50	60.9	300	64.1	Discharge to Northwest Drainage Channel
FUT_STM_44	FUT-Catchment 23+26	1,077	222.2	600	260.5	Connect to FUT_STM_54
FUT_STM_45	FUT-Catchment 22+40	195	226.3	600	260.5	Tie-in to existing 1,500 mm storm sewer west of 29 Street
FUT_STM_46	FUT-Catchment 24+27	570	222.4	600	260.5	Connect to FUT_STM_47
FUT_STM_47	FUT-Catchment 24+27+33	820	334.9	750	401.4	Connect to FUT_STM_48
FUT_STM_48	FUT-Catchment 24+27+33+28+34	800	557.6	900	572.5	Connect to FUT_STM_49
FUT_STM_49	FUT-Catchment 24+27+33+28+34+29+35	820	779.7	1050	863.5	Connect to FUT_STM_50
FUT_STM_50	FUT-Catchment 24+27+33+28+34+29+35+30+36	800	1001.9	1200	1,232.9	Connect to FUT_STM_51
FUT_STM_51	FUT-Catchment 24+27+33+28+34+29+35+30+36+31+37	830	1218	1200	1,232.9	Discharge to South Drainage Channel
FUT_STM_52	FUT-Catchment 8+12	814	52.2	300	64.1	Connect to FUT_STM_53
FUT_STM_53	FUT-Catchment 8+12+13	1,570	194.3	525	201.7	Discharge to East Drainage Channel
FUT_STM_54	FUT-Catchment 26+23+21	96	324.9	675	325.6	Discharge to East Drainage Channel
FUT_STM_55	FUT-Catchment 3+7	860	222.6	600	260.5	Connect to FUT_STM_56
FUT_STM_56	FUT-Catchment 3+7+4	820	329.4	750	401.4	Connect to FUT_STM_57
FUT_STM_57	FUT-Catchment 3+7+4+5	720	441.3	900	572.5	Connect to FUT_STM_58
FUT_STM_58	FUT-Catchment 3+7+4+5+6	360	547.8	900	572.5	Discharge to Northwest Drainage Channel

7.2.2 Existing Stormwater Management Facilities

There are a number of future development areas within existing catchments in the City, as illustrated in Figure 7.1. These areas will leverage existing SWMFs' capacity, with the intent to maintain the post-development water level below the overflow elevation. Existing SWMFs that will receive additional flow from future development areas include:

- HW 1A;
- Lake J;
- Lake K;
- Lake N;
- Lakeside Pond; and
- Parkview Lake.

The capacity of existing SWMFs to accommodate additional flow from future developments was assessed using the original integrated 1D-2D modelling approach. Future development areas were modelled as sub-catchments with runoff coefficient assigned based on the land use type. Note that under the future development condition, all the proposed existing system upgrades are assumed implemented.

Table 7.6 summarizes the modelling results of the existing SWMF capacity to accommodate the future developments. Both the 1:100-year 4-hour Modified Chicago storm and 1:100-year 24-hour Huff storm were considered in the assessment so that the worst scenario can be accounted for.

Table 7.6: Existing Stormwater Management Facility Capacity Review with Future Developments

SWMF Name	Overflow	1:100 Yr 4 Hr Chicago		1:100 Yr 24 Hr Huff	
		Pre-Development Max. Level	Post-Development Max. Level	Pre-Development Max. Level	Post-Development Max. Level
	m	m	m	m	m
HW 1A (HWY 16)	661.60	657.25	658.00	657.18	657.50
Lake J	645.50	644.80	644.90	645.19	645.22
Lake K	639.90	635.57	635.55	635.55	635.81
Lake N	636.90	634.66	635.13	634.38	634.87
Lakeside Pond	661.00	656.90	656.93	656.40	656.40
Parkview Lake	661.30	658.76	659.12	658.86	659.66

The modelling results suggested that all the existing SWMFs servicing future development areas would be able to accommodate the additional flow without infringing the overflow elevation. However, the estimated peak water level in Lake J under the 1:100 year 24-hour Huff design storm, with future developments, is within the 0.3 m freeboard zone (0.28 m freeboard), which prompts a potential upgrade requirement to accommodate the future developments in vicinity. Due to the high-level nature of the SWMP, it is strongly recommended that the City confirms the capacity of existing SWMFs in more detail prior to accepting any additional flows from future development, such that a satisfactory level of service can be maintained in the system.

7.3 Future System Assessment

The proposed future SWMFs and conveyance system were set up in the model to assess the adequacy of the proposed stormwater management system to accommodate the anticipated future development in the City. Because most of the proposed network is independent of the existing stormwater system, the modelling exercise was primarily used to assess the existing system capacity downstream of the proposed future development connections and to determine any existing system upgrade requirements.

Following the City's Municipal Development Standards, the model was run under the 1:5 year 4-hour Modified Chicago design storm event to evaluate the performance of the existing storm sewer system with the proposed future development connections. Figure 7.3 shows the peak flow to full pipe capacity ratio and Figure 7.4 shows the sewer spare capacity under the 1:5 year 4-hour Modified Chicago design storm.

Based on the model results, it appears that under the 1:5 year 4-hour Modified Chicago design storm the existing storm sewers would be able to convey the additional flow from future development, and there are no capacity deficiencies caused by the future development. Therefore, no additional system upgrades would be required as part of the future servicing concept.

Due to the uncertainty of site grading and detailed configuration of the future development lands, 2D modelling results are not included in this SWMP as it would not be accurate enough to reflect the actual post-development site conditions. Consequently, it is recommended that the 2D model be updated and assessed on a regular basis as future developments commence.

7.4 Recommendations

Apart from the recommended existing storm sewer system upgrades specified in Section 6.4, upgrades to the storm sewer network for future development are generally limited to construction of new SWMFs, outlet control structures, gravity mains, and outfalls. However, it is recommended that backflow prevention valves be installed at outfalls servicing catchment areas with ground or basement elevations below the local 1:100 year waterbody flood level.

7.5 Low Impact Developments (LIDs)

In order to reduce the overall runoff produced by the developed site, several LID (also known as Green Infrastructure) options may be integrated into the stormwater design. LID generally functions to improve stormwater conditions by providing a combination of peak flow attenuation, water quality improvement, and volume reduction through the promotion of infiltration and evapotranspiration.

Integrating LID into the stormwater design of individual sites within the overall development will improve the volumes and quality of water flowing to the proposed SWMFs, resulting in a reduced required SWMF size as discussed above. In addition to this, LID implementation can provide reductions in the total loadings to the receiving waters. As such, LID would support the development in adhering to the recommendation to reduce TSS, carbonaceous biochemical oxygen demand (CBOD), nitrogen, and phosphorus, and thus promote the overall health of the watershed in the City.

7.5.1 Available Source Control Measures

Source control measures are physical measures that are located at the beginning of a drainage system, generally on private properties, which may include residential properties, community centers, municipal buildings, places of worship, schools, and parks. It is recommended that the City employ a selection of the technologies in conjunction with the SWMFs in order to achieve an optimal stormwater runoff water quality and volume reduction. Source control options to be considered are summarized in Table 7.7.

Table 7.7: Source Control Practice Summary

Source Control Practice	Description	Driving Forces
Stormwater Re-use/ Rainwater Harvesting	Stormwater could be captured in SWMFs or underground storage tanks and used for non-potable uses such as irrigation. This would need to be assessed at the time of development as to whether suitable guidelines for stormwater re-use exist at that stage.	• Potentially significant use of stormwater runoff • Stormwater pollutants retained by storage ponds • Highly applicable to both residential and commercial areas
Bioswales /Vegetated Swales	Stormwater is diverted into surface drainage swales that are vegetated. The net effect is similar to a combination of a grassed swale and an infiltration trench. Significant vegetation is planted to provide additional quality treatment. Subdrains are often installed in soils with infiltration rates below 12.5 mm/hr.	• Provides high amount of volume/rate control • Provides high amount of stormwater pollutant control by retaining pollutants in the swales • Highly applicable to both residential, light commercial, and industrial areas
Absorbent Landscapes	Stormwater runoff is reduced by promoting infiltration into the soil as runoff flows overland. This is often accomplished by designing for significant greenspace. Increased depth of topsoil and reduced soil compaction are also provided for the landscaped areas. This promoted infiltration can allow the soil to work like a sponge to absorb stormwater. Given this technology operates through the promotion of infiltration, soil with a high infiltration rate (low fines content) is recommended. Effectiveness of this option may be limited due to the geological conditions in the city as most of the soils within the city are low-permeable clay. A geotechnical report is recommended if this source control is to be implemented.	• Provides high amount of volume/rate control • Highly applicable for low-intensity commercial areas • Somewhat applicable for residential areas • Minimal maintenance required
Green Roofs	Stormwater runoff is reduced by using vegetated roofs. Stormwater is absorbed into soil and is then either evaporated naturally or collected by a subdrain system.	• Works well for roofs of larger buildings (normally commercial and industrial) • Provides high amount of volume/rate control, particularly for small events • Can be used as on-lot stormwater control for commercial/industrial areas

Source Control Practice	Description	Driving Forces
Bioretention Areas	Bioretention areas consist of of depressed, landscaped areas utilized to improve water quality, attenuate peak flows to the stormwater minor system, and to reduce overall stormwater volume through promotion of evapotranspiration. Stormwater is absorbed into soil and is then either evaporated naturally or collected by a subdrain system. Plantings are chosen specifically to optimize the uptake of stormwater nutrient loadings (nitrogen, phosphorus) in the geographic location of interest. Municipalities should be mindful that some maintenance of these systems is required when sediment buildup occurs and following the winter frost.	• Works well for most land uses (can be incorporated into parks, roadway medians, parking lots, sidewalk planting strips, etc.) • Can be used as on-lot stormwater control for commercial, residential, and industrial areas. • Provides high amount of volume/rate control, particularly for small events • Provides high amount of stormwater pollutant control by retaining pollutants

7.5.2 LID Performance

Water quality improvements begin with filtration of particulates as runoff flows over the surface of the LID and through vegetation, mulch, soil layers and or aggregate layers. For vegetated practices, soil microbes provide decomposition for pollutants such as hydrocarbons and nutrients. Soils also allow metals and chemicals to sorb to soil particles and compounds within the soil, preventing their release to receiving streams.

Through various pilot studies and research, ISL has characterized that the theoretical reduction in peak flow is greater for small common events and nearly 100% reduction can be expected. During small flood events, such as the two-year, or five-year return period, the peak flow reduction can achieve up to 80%. During large flood events, greater than the 25-year return period, the peak flow reduction is expected to be minimal, typically much less than 50%. The literature review analyzed nine LID installations where performance of the LID installation had monitored data. Sites included:

- Site 1 – Quarters Armature (96 Street) – Edmonton, Alberta;
- Site 2 – Central Parkway, Mississauga, Ontario;
- Site 3 – Wilmington, North Carolina;
- Site 4 – Manchester, England;
- Site 5 – Holden Arboretum, Ohio;
- Site 6 – Ursuline College, Ohio;
- Site 7 – Charlotte, North Carolina;
- Site 8 – Connecticut; and
- Site 9 – Australia.

The sites include both soil cell and rain garden installations. As shown in Figure 7.5, the monitored performance of the LID systems reduces peak flows up to 60 – 80%.

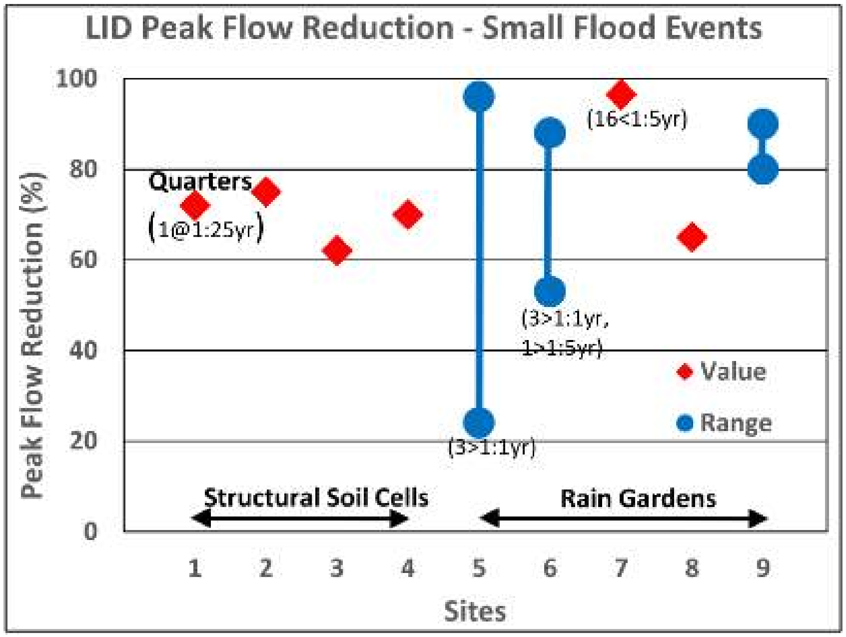


Figure 7.5: Monitored Peak Flow Reductions with LID Implementation

Table 7.9 outlines the LID peak flow reduction expectation and performance for various flood events. It is observed that the monitored performance of LID installations generally meets the theoretical peak flow reductions.

Table 7.9: LID Peak Flow Reduction Expectations

Event	Peak Flow Reduction Expectation	Literature Review
Small common events (majority in a season)	No outflow (100% reduction)	Confirmed
Typical Summer Storm (a few each year)	High (>95% reduction)	Confirmed
Small flood event (two-year, five-year)	Moderate (>80% reduction)	60 – 90% (majority)
Large flood event (25-year, 100 year)	Minimal (<50% reduction)	N/A

7.6 Erosion and Sediment Control

The City of Lloydminster Municipal Development Standards require an Erosion and Sedimentation Control (ESC) Plan to facilitate erosion control and prevent sediment transportation. All developments are required to submit an ESC Plan in accordance with the most recent edition of the City of Edmonton's Erosion and Sedimentation Control Guidelines. This details the potential off-site impacts, temporary and permanent measures to be implemented throughout the construction and post-construction periods to mitigate potential sedimentation and erosion problems both within and in downstream areas, and responsible parties to implement, monitor and maintain the ESC measures.

A priority of this master plan is to minimize environmental impacts and support the health of the watersheds in the face of increasing developments. During construction, the removal of topsoil and vegetation will expose subsoils that are more susceptible to erosion since they are not as compacted. Developments, which result in an increase of runoff, may also contribute to erosion if not properly managed.

Erosive agents, such as wind and water, have the ability of detaching, entraining, and transporting soil particles, causing erosion. This process is dependent on the cohesion and texture of the soils, as well as the erosive energy of the agent, such as gravitational and fluid forces. Deposition/sedimentation will occur when the fluid forces of the erosive agent are less than the force of gravity of the soil particles. As the soil particles can no longer be entrained in the air or water, they begin to settle and form depositions. Generally, this is caused by a reduction in flow velocity or turbulence.

If temporary construction and permanent development ESC practices are not implemented, it can lead to the transport of sediment and other contaminants, polluting downstream waterbodies. This can result in the following negative impacts:

- Transportation of hydrocarbons, metals, and nutrients with the eroded soils to a water source;
- Destruction of aquatic habitats;
- Sediment deposition in infrastructure and waterbodies;
- Reduced quality of water supply;
- Limitations to the effectiveness of flood control measures; and
- Affect recreational areas.

The most effective and economical method of controlling erosion is at the source. This includes the implementation of methods, such as controlling stormwater runoff (generally accomplished by stipulating maximum allowable area release rates) or by stabilizing exposed soils. Due to the large number of available ESC measures, selection of ESE measures should be based on site assessment, project design requirements, construction requirement and limitations, regulatory requirements, and economic factors. Two potential options to mitigate negative impacts of erosion, as recommended in the City of Edmonton's Erosion and Sedimentation Control Guidelines, are outlined below. More available ESC control measures are provided in the City of Edmonton's Erosion and Sedimentation Control Guidelines, should the City wish to explore different options.

7.6.1 Vegetative Check Dams

Vegetative check dams act as low-lying barriers within a drainage ditch or channel to decrease the flow velocity and improve water quality. These control measures are generally used for a combination of erosion and sediment control. The dams sit perpendicular to the direction of flow and only allow a certain amount of water to pass through at a time while also retaining sediment. There are limitations involved with vegetative check dams including a maximum feasible slope for implementation of approximately 8% and a minimum slope of 1% to 2%. However, this erosion mitigation measure serves this purpose and achieves the improved water quality objective.

7.6.2 Erosion Control Blankets

Erosion control blankets are the most appropriate erosion mitigation measure when runoff quantity and velocities are the driving force behind the erosion risk. They offer a typical erosion reduction of 95% to 99%. Two of these types of erosion control measures include:

- Straw Blankets:
  - Ideal for short-term erosion control;
- Turf Reinforcement Mats:
  - Synthetic material;
  - Recommended for additional shear resistance;
  - Promotes longevity of a channel; and
  - Ideal for more long-term erosion control.

A substantial length of erosion control blankets would be required due to the long length of steep sloping channels. This steepness may also create issues with feasibility of installation; considerations for the environmental implications must also be made. The soil characteristics of these existing channels may affect the overall performance of erosion control measures and will also need to be accounted for.

7.7 Cost Estimates

7.7.1 Recommended Stormwater Servicing Concept

Cost estimates have been prepared for the proposed future stormwater system. The costs for new SWMFs, gravity sewers, and outfall structures are summarized in Table 7.10, with the detailed cost breakdown provided in Appendix F. Separate reviews should be prepared to support each subdivision application/development permit to ensure compliance with the overarching SWMP.

Table 7.10: Class D Cost Estimates for Proposed Future System

Name	Construction Cost ($)	Engineering (15%) ($)	Contingency (30%) ($)	Total ($)
Proposed Future SWMFs				
FUT_SWMF_1	$ 702,000	$ 106,000	$ 210,000	$ 1,018,000
FUT_SWMF_2	$ 1,295,000	$ 195,000	$ 389,000	$ 1,879,000
FUT_SWMF_3	$ 1,190,000	$ 179,000	$ 357,000	$ 1,726,000
FUT_SWMF_4	$ 1,141,000	$ 172,000	$ 343,000	$ 1,656,000
FUT_SWMF_5	$ 1,187,000	$ 179,000	$ 356,000	$ 1,722,000
FUT_SWMF_6	$ 1,177,000	$ 177,000	$ 353,000	$ 1,707,000
FUT_SWMF_7	$ 1,226,000	$ 185,000	$ 368,000	$ 1,779,000
FUT_SWMF_8	$ 455,000	$ 69,000	$ 136,000	$ 660,000
FUT_SWMF_9	$ 1,237,000	$ 186,000	$ 372,000	$ 1,795,000
FUT_SWMF_10	$ 1,167,000	$ 175,000	$ 350,000	$ 1,692,000
FUT_SWMF_11	$ 1,116,000	$ 168,000	$ 335,000	$ 1,619,000
FUT_SWMF_12	$ 345,000	$ 53,000	$ 103,000	$ 501,000
FUT_SWMF_13	$ 1,420,000	$ 214,000	$ 426,000	$ 2,060,000
FUT_SWMF_14	$ 1,091,000	$ 165,000	$ 327,000	$ 1,583,000
FUT_SWMF_15	$ 1,161,000	$ 175,000	$ 348,000	$ 1,684,000
FUT_SWMF_16	$ 850,000	$ 128,000	$ 255,000	$ 1,233,000
FUT_SWMF_17	$ 1,095,000	$ 165,000	$ 328,000	$ 1,588,000
FUT_SWMF_18[1] (Future Pond U)	$ 1,267,000	$ 191,000	$ 381,000	$ 1,839,000
FUT_SWMF_19	$ 819,000	$ 124,000	$ 246,000	$ 1,189,000
FUT_SWMF_20	$ 727,000	$ 109,000	$ 218,000	$ 1,054,000
FUT_SWMF_21	$ 737,000	$ 111,000	$ 221,000	$ 1,069,000
FUT_SWMF_22	$ 702,000	$ 106,000	$ 210,000	$ 1,018,000
FUT_SWMF_23	$ 318,000	$ 48,000	$ 95,000	$ 461,000
FUT_SWMF_24	$ 865,000	$ 130,000	$ 260,000	$ 1,255,000
FUT_SWMF_25[1]	$ 734,000	$ 111,000	$ 221,000	$ 1,066,000
FUT_SWMF_26	$ 1,057,000	$ 159,000	$ 317,000	$ 1,533,000
FUT_SWMF_27	$ 756,000	$ 114,000	$ 227,000	$ 1,097,000
FUT_SWMF_28	$ 732,000	$ 111,000	$ 219,000	$ 1,062,000
FUT_SWMF_29	$ 715,000	$ 108,000	$ 215,000	$ 1,038,000
FUT_SWMF_30	$ 714,000	$ 108,000	$ 214,000	$ 1,036,000

Name	Construction Cost	Engineering (15%)	Contingency (30%)	Total
	($)	($)	($)	($)
FUT_SWMF_31	$ 808,000	$ 122,000	$ 242,000	$ 1,172,000
FUT_SWMF_32	$ 1,000,000	$ 150,000	$ 300,000	$ 1,450,000
FUT_SWMF_33	$ 693,000	$ 105,000	$ 208,000	$ 1,006,000
FUT_SWMF_34	$ 693,000	$ 105,000	$ 208,000	$ 1,006,000
FUT_SWMF_35	$ 690,000	$ 104,000	$ 207,000	$ 1,001,000
FUT_SWMF_36	$ 692,000	$ 105,000	$ 207,000	$ 1,004,000
FUT_SWMF_37	$ 794,000	$ 120,000	$ 238,000	$ 1,152,000
FUT_SWMF_38[1]	$ 1,071,000	$ 162,000	$ 321,000	$ 1,554,000
FUT_SWMF_39	$ 724,000	$ 109,000	$ 218,000	$ 1,051,000
FUT_SWMF_40	$ 693,000	$ 105,000	$ 208,000	$ 1,006,000
FUT_SWMF_41	$ 437,000	$ 66,000	$ 131,000	$ 634,000
FUT_SWMF_42	$ 369,000	$ 56,000	$ 111,000	$ 536,000
FUT_SWMF_43	$ 714,000	$ 108,000	$ 215,000	$ 1,037,000
SWMF Subtotal	**$ 37,376,000**	**$ 5,638,000**	**$ 11,214,000**	**$ 54,228,000**
Storm Sewers (By Size)				
200 mm	$ 10,000	$ 2,000	$ 3,000	$ 15,000
250 mm	$ 420,000	$ 62,000	$ 127,000	$ 609,000
300 mm	$ 921,000	$ 138,000	$ 277,000	$ 1,336,000
375 mm	$ 324,000	$ 49,000	$ 98,000	$ 471,000
450 mm	$ 7,060,000	$ 1,062,000	$ 2,118,000	$ 10,240,000
525 mm	$ 2,375,000	$ 357,000	$ 712,000	$ 3,444,000
600 mm	$ 3,299,000	$ 495,000	$ 990,000	$ 4,784,000
675 mm	$ 122,000	$ 18,000	$ 37,000	$ 177,000
750 mm	$ 2,540,000	$ 382,000	$ 762,000	$ 3,684,000
900 mm	$ 3,661,000	$ 549,000	$ 1,098,000	$ 5,308,000
1050 mm	$ 1,796,000	$ 269,000	$ 539,000	$ 2,604,000
1200 mm	$ 3,804,000	$ 571,000	$ 1,141,000	$ 5,516,000
Storm Sewer Subtotal	**$ 26,332,000**	**$ 3,954,000**	**$ 7,902,000**	**$ 38,188,000**
Total	**$ 63,708,000**	**$ 9,592,000**	**$ 19,116,000**	**$ 92,416,000**

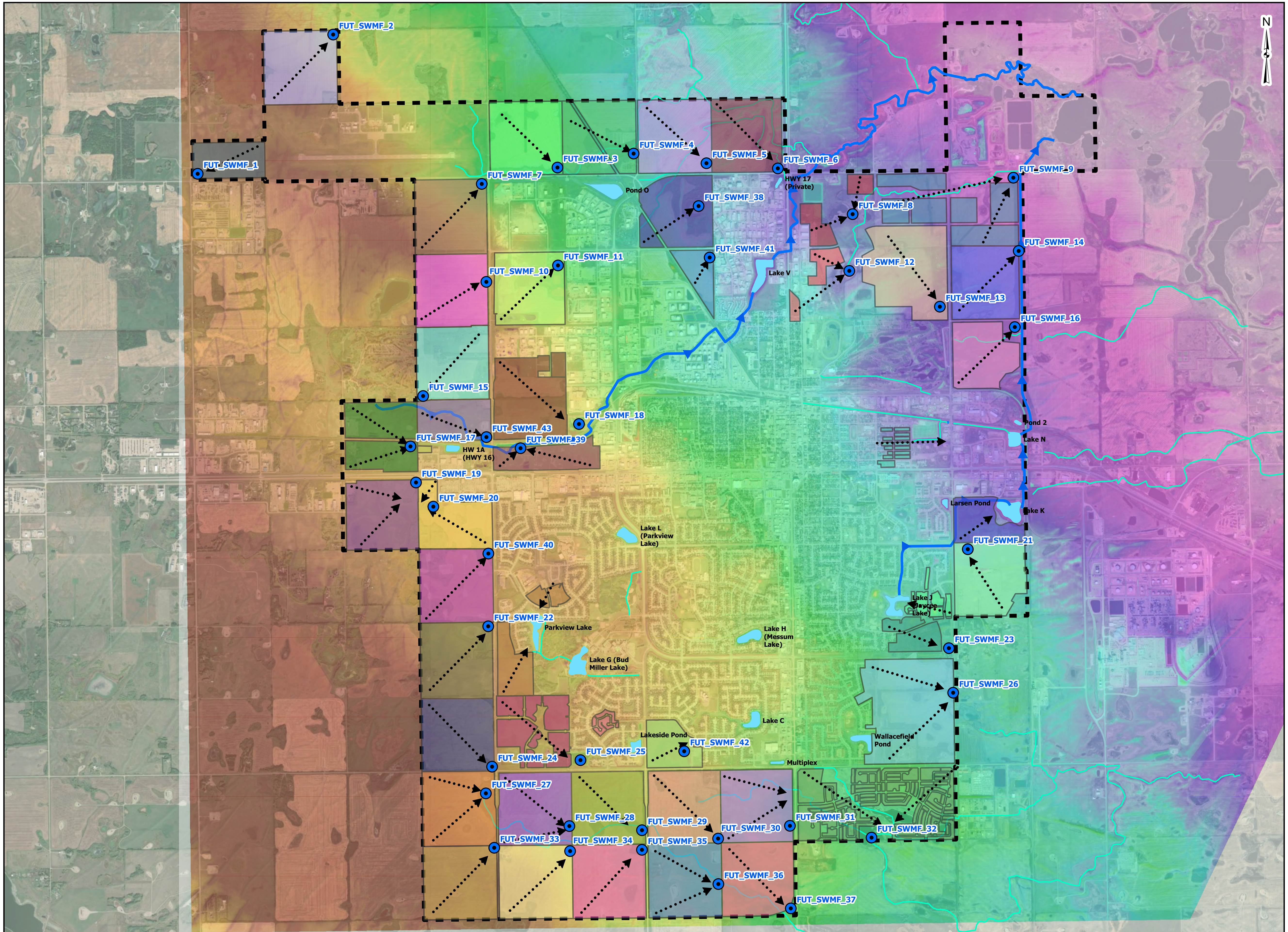
[1] Proposed future SWMF that may already exist or under development.

7.7.2 Typical Source Control Implementation Costs

Typical construction unit costs for LID practices are tabulated in Table 7.11 for reference only. Costs may vary significantly depending on site-specific factors, including soil infiltration rates. By performing in-situ testing of the site-specific soils using a Guelph Permeameter, double ring infiltrometers, pit tests and others, the infiltration rate of the native site soils can be scientifically verified and used in developing cost estimates, and in subsequent phases of design.

Table 7.11: Typical Source Control Unit Costs

BMP Technique	Unit Construction Cost
Rainwater Harvesting (underground storage and irrigation)	\$300 to \$1,200 / m^3 stored
Green Roofs	\$145 to \$360 / m^2 roof area
Infiltration Trenches and Chambers	\$515 to \$660 / m^3 stored
Bioretention	\$720 to \$900 / m^2 of facility (\$62,400 / imp. ha treated)
Bioretention Planters (contained within concrete curbing or urban container)	Bioretention Planter (small) \$1,200 to \$1,920 / m^3 treated Stormwater Tree Pits \$2,880 to \$4,080 / m^3 treated



Legend

- City Limit
- Drainage Direction
- Proposed Future Pond
- Existing Storm Pond
- Main Drainage Channels
- Watercourse/Stream

Elevation (m)

- High : 676.81
- Low : 0

Catchment

- FUT-Catchment 1
- FUT-Catchment 2
- FUT-Catchment 26
- FUT-Catchment 3
- FUT-Catchment 4
- FUT-Catchment 5
- FUT-Catchment 6
- FUT-Catchment 7
- FUT-Catchment 8
- FUT-Catchment 10
- FUT-Catchment 11
- FUT-Catchment 12
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- FUT-Catchment 38
- FUT-Catchment 39
- FUT-Catchment 40
- FUT-Catchment 41
- FUT-Catchment 42
- FUT-Catchment 43
- HW 1A
- Lake J
- Lake K
- Lake N
- Lakeside Pond
- Parkview Lake

Note: FUT_SWMF_25 and FUT_SWMF_38 appear to be existing already based on aerial imagery and street view. However, they are not in the City's GIS data.

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

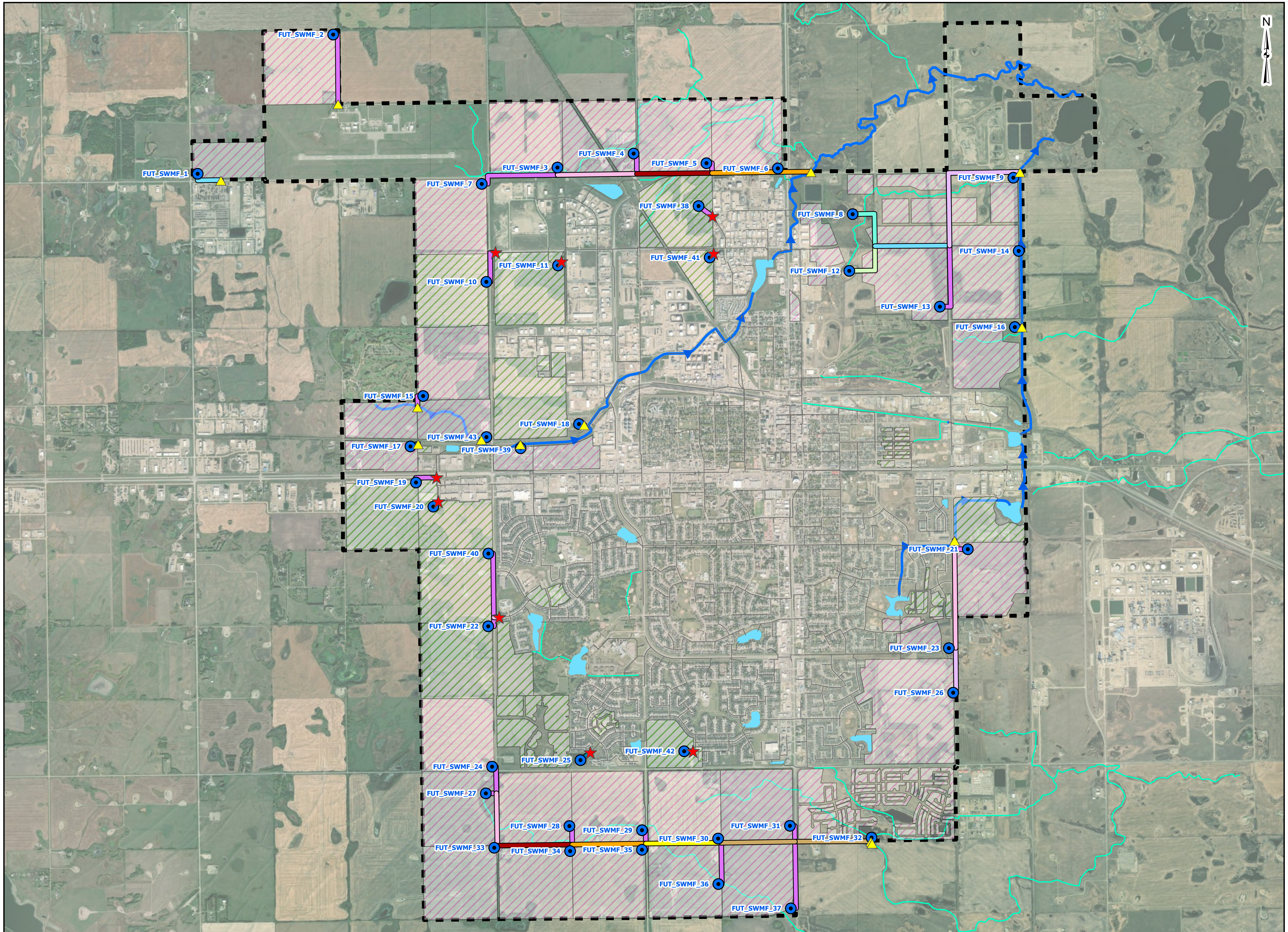
FIGURE 7.1
FUTURE DRAINAGE PATTERN
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL LLOYDMINSTER

Integrated Expertise. Locally Delivered.

Credits:World Imagery: Vermilion River County, Maxar

Date: 2024-07-19 Document: C:\Users\lche\Desktop\L.Che\Projects\28310 Lloydminster Stormwater Master Plan\30_Technical\GIS\28310_Lloydminster SWMP Report Figures\28310_Lloydminster SWMP Report Figures.aprx



Legend

- City Limit
- Existing Storm Pond
- Existing Storm Pipe
- Main Drainage Channels
- Watercourse & Stream
- Proposed Future SWMF
- Discharge to Watercourse
- Tie-in to Existing System
- Future Development Serviced by Future System
- Future Development Tie-in to Existing System

Pipe Size

- 200 mm
- 250 mm
- 300 mm
- 375 mm
- 450 mm
- 525 mm
- 600 mm
- 675 mm
- 750 mm
- 900 mm
- 1050 mm
- 1200 mm

Note: FUT_SWMF_25 and FUT_SWMF_38 appear to be existing already based on aerial imagery and street view. However, they are not in the City's GIS data.

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 7.2
PROPOSED FUTURE DEVELOPMENT SERVICING CONCEPT
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Earthstar Geographics

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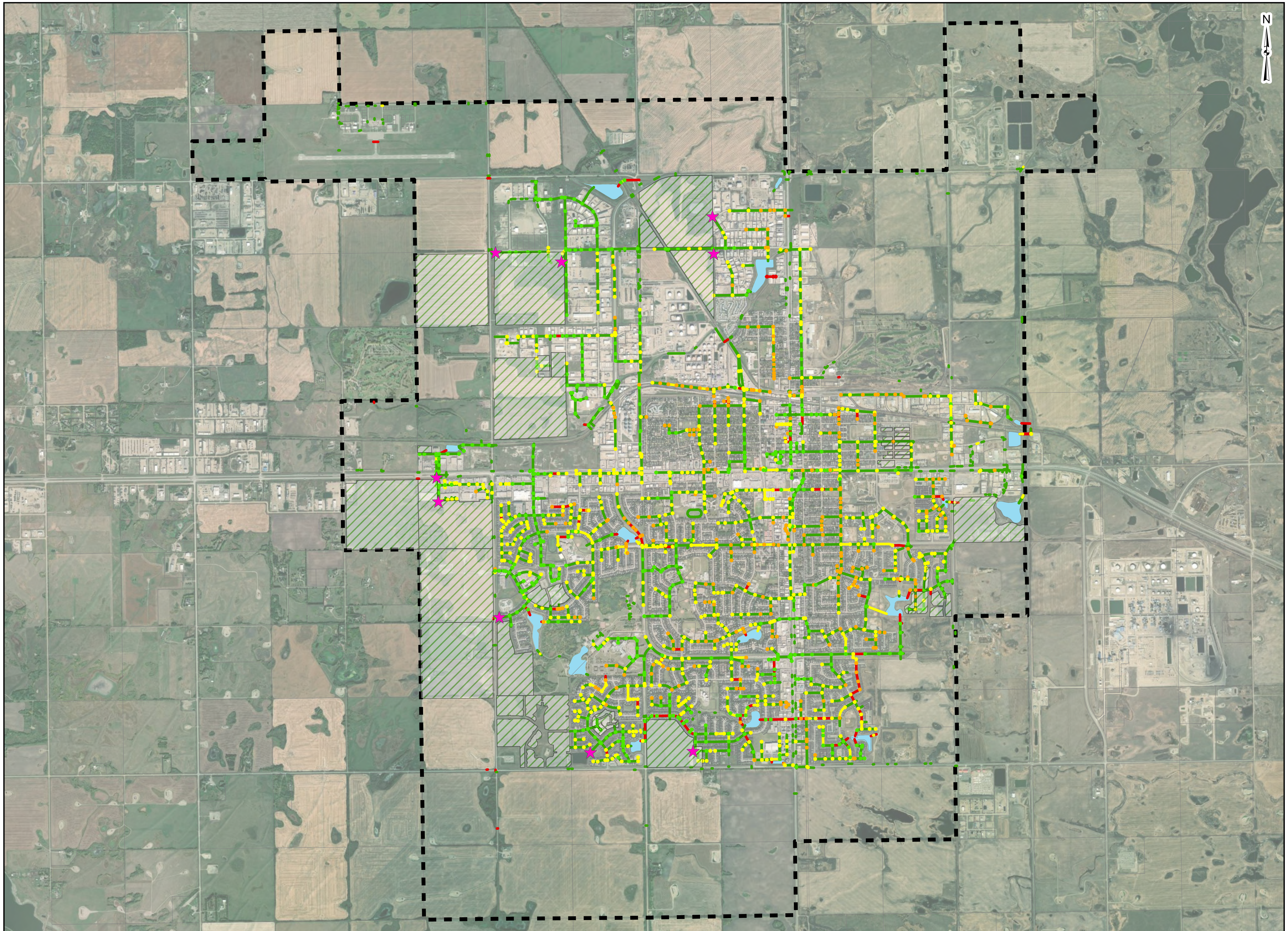
Integrated Expertise. Locally Delivered.



Legend

Study Area

Legal Parcel

Future SWMF Tie-in Location

Future Development Serviced By Existing System

Nodes

Max HGL Relative to Ground

Less than -3.0 m

Between -3.0 and -1.5 m

Between -1.5 and 0 m

Greater than 0 m

Links

Peak Flow to Pipe Capacity Ratio

Less than 86%

Between 86% and 100%

Greater than 100%

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 7.3
MINOR SYSTEM MODEL RESULTS - FUTURE
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

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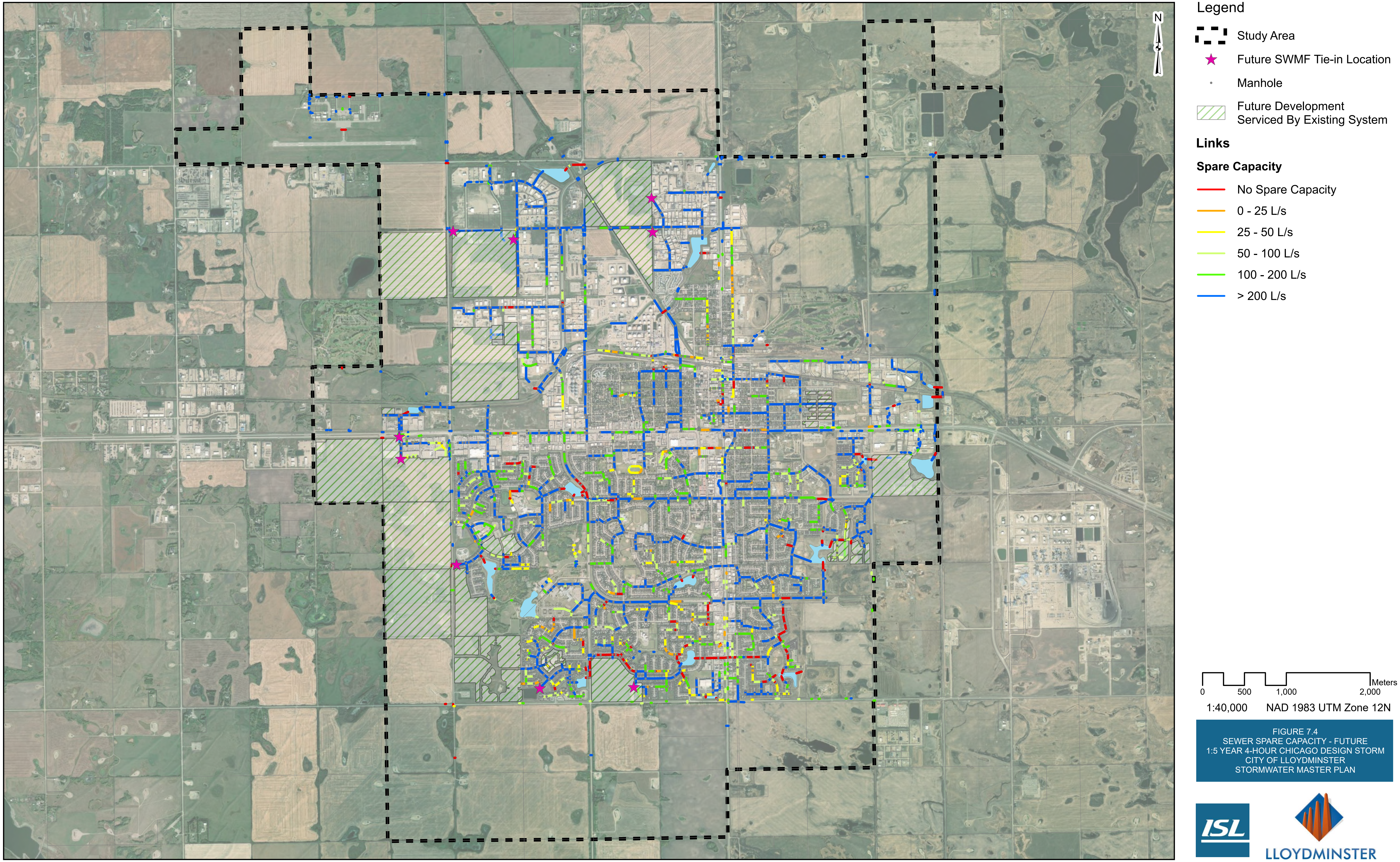

FIGURE 7.4
SEWER SPARE CAPACITY - FUTURE
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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8.0 Capital Plan Staging

A Capital Plan staged to the ultimate development horizon has been developed from the recommendations made by this SWMP. An overview of the capital plan, including all upgrades required to the stormwater system by full-build-out and proposed servicing scheme is illustrated in Figure 8.1. When reviewing the staging plan, the following should be considered:

- A 2.0% inflation increase per year (escalation rate could vary from time to time) should be considered to the base costs;
- The annual capital budget allowance is meant to hold funding each year for maintenance and “one off” instances where repairs are required;
- The horizon in which the upgrade is suggested is based on discussion between the City and ISL on when development could occur based on a full build-out scenario; and
- High level cost estimates provided are a Class “D” with an accuracy of +75% to -40%.

To provide interim measures so that areas of the city are growth ready, the following staging plan is recommended to align with the capital plan:

- Complete the capacity upgrades recommended to the existing stormwater system based on the priority noted in Table 6.11. It is noted that upgrades to this infrastructure could also be completed in conjunction with the City’s roadworks program to minimize pavement rehabilitation costs.
- Conduct regular condition assessments on storm sewers and drainage channels to monitor asset physical conditions, help identify infrastructure requiring rehabilitation or replacement, and reduce the likelihood of unexpected servicing disruptions.
- Conduct periodic flow monitoring programs to verify runoff characteristics of different land use surface.
- Monitor areas flagged for capacity and flooding risks and verify upgrade requirements.
- Progress the future servicing concept as development proceeds, prioritizing infrastructure required to service development in the short-term. Consider implementing LID when planning future development in the city.

A generalized staging plan was also developed based on the future growth projections discussed in Section 2.3, as shown in Figure 8.2 and summarized in Table 8.1. These are provided with the intent that the SWMP will be integrated into an overall capital plan and budget.

In essence, the timeline of the improvements will primarily correlate with the progress of the build-out based on size and type of development, staging of development, and location of development. When new developments are planned, it is recommended that the stormwater concepts are revisited so that the proposed grading of each development site is accounted for.

SWMFs and downstream sewer infrastructure to the discharge locations should be in place prior to the new developments coming online. This will ensure that the additional flows as a result of increased impervious surfaces are accommodated. Since the proposed future sewers are based on the full build-out condition, the proposed size may be too large for interim development conditions. In such cases, the City could consider installing a smaller size to accommodate short-term future development and replace or twin the sewers to provide larger capacity when more upstream developments come online.

Table 8.1: Capital Planning Horizons and Associated Costs

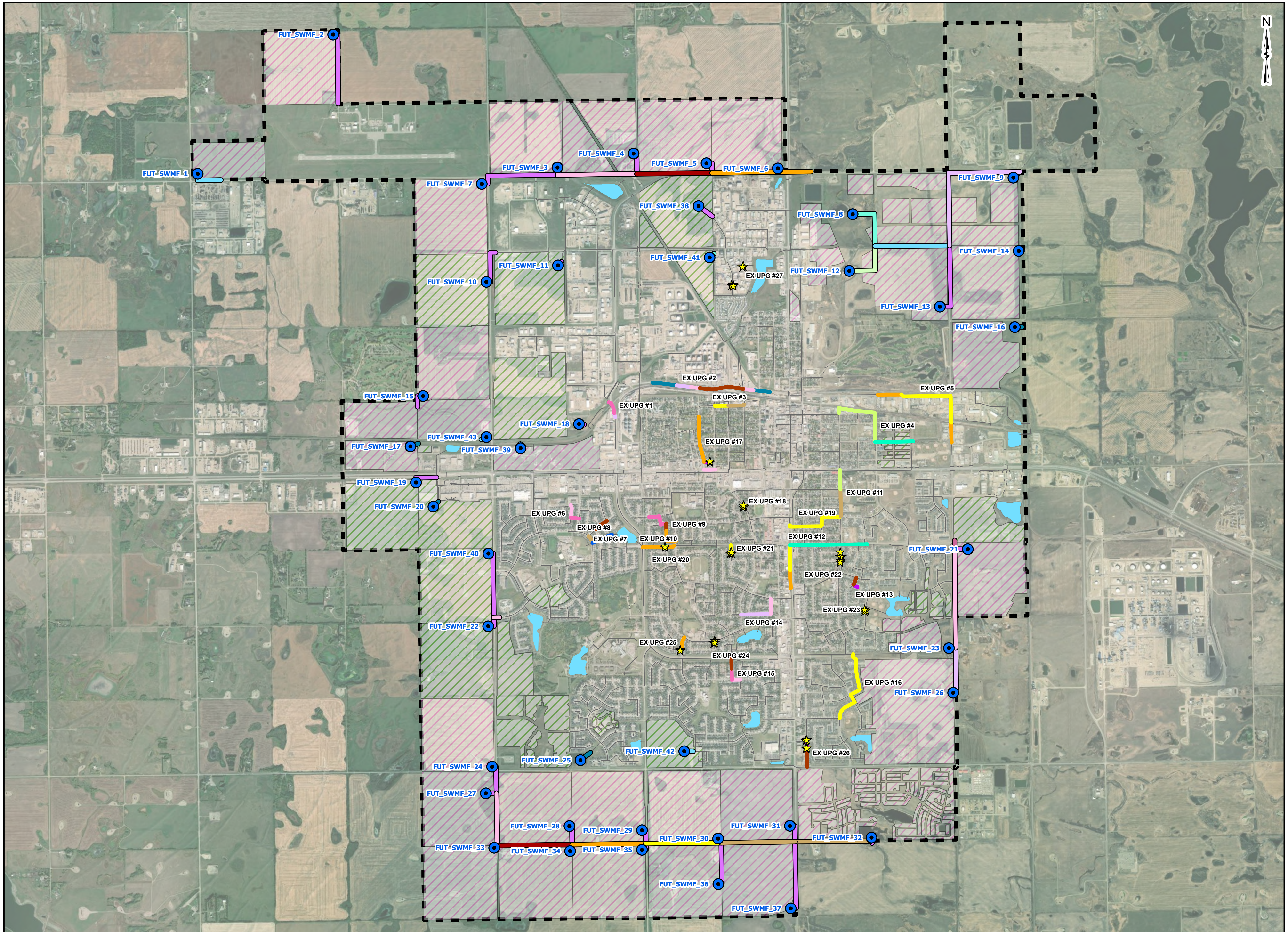
Item	Description	Class "D" Cost Estimate
Existing Upgrades		
Existing System Upgrades	All existing system upgrades in Table 6.7 and Table 6.8	$53,960,000
	Existing Upgrades Total	**$53,960,000**
3-Year Horizon (2024 to 2027)		
FUT_SWMF_8	Construction of proposed future Pond 8	$660,000
FUT_SWMF_18[1] (Future Pond U)	Construction of proposed future Pond 18	$1,839,000
FUT_SWMF_19	Construction of proposed future Pond 19	$1,189,000
FUT_SWMF_42	Construction of proposed future Pond 42	$536,000
FUT_STM_8	Installation of approximately 590 m of 250 mm outlet pipe for proposed future Pond 8	$496,000
FUT_STM_18	Installation of approximately 57 m of 450 mm outlet pipe from proposed future Pond 18 to connect to existing 450 mm storm sewer	$80,000
FUT_STM_19	Installation of approximately 280 m of 450 mm outlet pipe from proposed future Pond 19 to connect to existing 1,500 mm storm sewer at 44 Street/80 Avenue	$387,000
FUT_STM_42	Installation of approximately 95 m of 300 mm outlet pipe from proposed future Pond 42 to connect to existing 450 mm storm sewer on 14 Street	$96,000
FUT_STM_52	Installation of approximately 810 m of 300 mm storm sewer east of 49 Avenue and 62 Street	$821,000
FUT_STM_53	Installation of approximately 1,570 m of 525 mm storm sewer along 40 Avenue and 67 Street	$2,587,000
	3-Year Horizon Total	**$8,691,000**
5-Year Horizon (2027 to 2029)		
FUT_SWMF_16	Construction of proposed future Pond 16	$1,233,000
FUT_SWMF_31	Construction of proposed future Pond 31	$1,172,000
FUT_SWMF_39	Construction of proposed future Pond 39	$1,051,000
FUT_STM_16	Installation of approximately 78 m of 375 mm outlet pipe for proposed future Pond 16	$96,000
FUT_STM_31	Installation of approximately 220 m of 450 mm outlet pipe for proposed future Pond 31	$309,000
FUT_STM_39	Installation of approximately 40 m of 300 mm outlet pipe for proposed future Pond 39	$40,000
FUT_STM_51	Installation of approximately 830 m of 1,200 mm gravity sewer from south end of Highway 17 within the city boundary towards east to discharge to the South Drainage Channel	$2,809,000
	5-Year Horizon Total	**$6,710,000**
10-Year Horizon (2029 to 2034)		
FUT_SWMF_11	Construction of proposed future Pond 11	$1,619,000
FUT_SWMF_14	Construction of proposed future Pond 14	$1,583,000
FUT_SWMF_23	Construction of proposed future Pond 23	$461,000
FUT_SWMF_25[1]	Construction of proposed future Pond 25	$1,066,000

Item	Description	Class "D" Cost Estimate
FUT_SWMF_26	Construction of proposed future Pond 26	$1,533,000
FUT_SWMF_32	Construction of proposed future Pond 32	$1,450,000
FUT_STM_11	Installation of approximately 10 m of 450 mm outlet pipe from proposed future Pond 11 to connect to existing 600 mm storm sewer on 62 Street	$15,000
FUT_STM_14	Installation of approximately 20 m of 450 mm outlet pipe for proposed future Pond 14	$28,000
FUT_STM_23	Installation of approximately 70 m of 250 mm outlet pipe for proposed future Pond 23	$61,000
FUT_STM_25	Installation of approximately 135 m of 375 mm outlet pipe from proposed future Pond 25 to connect to existing 600 mm west of 61 Avenue/18 Street	$167,000
FUT_STM_26	Installation of approximately 520 m of 525 mm storm sewer on 40 Avenue north of 12 Street	$857,000
FUT_STM_32	Installation of approximately 40 m of 450 mm outlet pipe for proposed future Pond 32	$55,000
FUT_STM_44	Installation of approximately 1,080 m of 600 mm storm sewer on 40 Avenue south of 36 Street	$1,907,000
FUT_STM_54	Installation of approximately 96 m of 675 mm gravity sewer near 40 Avenue/36 Street	$177,000
	10-Year Horizon Total	**$10,979,000**
20-Year Horizon (2034 to 2044)		
FUT_SWMF_12	Construction of proposed future Pond 12	$501,000
FUT_SWMF_13	Construction of proposed future Pond 13	$2,060,000
FUT_SWMF_17	Construction of proposed future Pond 17	$1,588,000
FUT_SWMF_20	Construction of proposed future Pond 20	$1,054,000
FUT_SWMF_21	Construction of proposed future Pond 21	$1,069,000
FUT_SWMF_22	Construction of proposed future Pond 22	$1,018,000
FUT_SWMF_24	Construction of proposed future Pond 24	$1,255,000
FUT_SWMF_28	Construction of proposed future Pond 28	$1,062,000
FUT_SWMF_29	Construction of proposed future Pond 29	$1,038,000
FUT_SWMF_30	Construction of proposed future Pond 30	$1,036,000
FUT_SWMF_38[1]	Construction of proposed future Pond 38	$1,554,000
FUT_SWMF_40	Construction of proposed future Pond 40	$1,006,000
FUT_SWMF_41	Construction of proposed future Pond 41	$634,000
FUT_SWMF_43	Construction of proposed future Pond 43	$1,037,000
FUT_SWMF_9	Construction of proposed future Pond 9	$1,795,000
FUT_STM_12	Installation of approximately 500 m of 200 mm outlet pipe for proposed future Pond 12	$15,000
FUT_STM_13	Installation of approximately 120 m of 450 mm outlet pipe for proposed future Pond 13	$170,000
FUT_STM_17	Installation of approximately 90 m of 375 mm outlet pipe for proposed future Pond 17	$112,000

Item	Description	Class "D" Cost Estimate
FUT_STM_20	Installation of approximately 80 m of 375 mm outlet pipe for proposed future Pond 20 and connect to existing 1,500 mm storm sewer at south end of 80 Avenue	$96,000
FUT_STM_21	Installation of approximately 140 m of 450 mm outlet pipe for proposed future Pond 21	$199,000
FUT_STM_22	Installation of approximately 160 m of 450 mm outlet pipe for proposed future Pond 22	$221,000
FUT_STM_24	Installation of approximately 330 m of 450 mm outlet pipe for proposed future Pond 24	$460,000
FUT_STM_28	Installation of approximately 230 m of 450 mm outlet pipe for proposed future Pond 28	$320,000
FUT_STM_29	Installation of approximately 185 m of 450 mm outlet pipe for proposed future Pond 29	$258,000
FUT_STM_30	Installation of approximately 60 m of 450 mm outlet pipe for proposed future Pond 30	$81,000
FUT_STM_38	Installation of approximately 180 m of 450 mm outlet pipe for proposed future Pond 38 and connect to existing 750 mm storm sewer on 65 Street	$251,000
FUT_STM_40	Installation of approximately 750 m of 450 mm storm sewer north of 75 Avenue/29 Street	$1,044,000
FUT_STM_41	Installation of approximately 60 m of 250 mm outlet pipe for proposed future Pond 41 and connect to existing 900 mm storm sewer on 62 Street	$52,000
FUT_STM_43	Installation of approximately 50 m of 300 mm outlet pipe for proposed future Pond 43	$51,000
FUT_STM_45	Installation/replacement of approximately195 m of 600 mm storm sewer on 29 Street west of 75 Avenue	$345,000
	20-Year Horizon Total	**$31,915,000**
Ultimate Horizon (2044 to Full Build-out)		
FUT_SWMF_1	Construction of proposed future Pond 1	$1,018,000
FUT_SWMF_10	Construction of proposed future Pond 10	$1,692,000
FUT_SWMF_15	Construction of proposed future Pond 15	$1,684,000
FUT_SWMF_2	Construction of proposed future Pond 2	$1,879,000
FUT_SWMF_27	Construction of proposed future Pond 27	$1,097,000
FUT_SWMF_3	Construction of proposed future Pond 3	$1,726,000
FUT_SWMF_33	Construction of proposed future Pond 33	$1,006,000
FUT_SWMF_34	Construction of proposed future Pond 34	$1,006,000
FUT_SWMF_35	Construction of proposed future Pond 35	$1,001,000
FUT_SWMF_36	Construction of proposed future Pond 36	$1,004,000
FUT_SWMF_37	Construction of proposed future Pond 37	$1,152,000
FUT_SWMF_4	Construction of proposed future Pond 4	$1,656,000
FUT_SWMF_5	Construction of proposed future Pond 5	$1,722,000
FUT_SWMF_6	Construction of proposed future Pond 6	$1,707,000
FUT_SWMF_7	Construction of proposed future Pond 7	$1,779,000
FUT_STM_1	Installation of approximately 325 m of 300 mm outlet pipe for proposed future Pond 1	$328,000

Item	Description	Class "D" Cost Estimate
FUT_STM_10	Installation of approximately 420 m of 450 mm outlet pipe for proposed future Pond 10 and connect to existing 600 mm storm sewer on 62 Street	$584,000
FUT_STM_15	Installation of approximately 180 m of 450 mm outlet pipe for proposed future Pond 15	$251,000
FUT_STM_2	Installation of approximately 800 m of 450 mm outlet pipe for proposed future Pond 2	$1,113,000
FUT_STM_27	Installation of approximately 115 m of 450 mm outlet pipe for proposed future Pond 27	$160,000
FUT_STM_3	Installation of approximately 80 m of 450 mm outlet pipe for proposed future Pond 3	$112,000
FUT_STM_33	Installation of approximately 50 m of 450 mm outlet pipe for proposed future Pond 33	$69,000
FUT_STM_34	Installation of approximately 90 m of 450 mm outlet pipe for proposed future Pond 34	$131,000
FUT_STM_35	Installation of approximately 110 m of 450 mm outlet pipe for proposed future Pond 35	$154,000
FUT_STM_36	Installation of approximately 480 m of 450 mm outlet pipe for proposed future Pond 36	$668,000
FUT_STM_37	Installation of approximately 780 m of 450 mm outlet pipe for proposed future Pond 37	$1,086,000
FUT_STM_4	Installation of approximately 255 m of 450 mm outlet pipe for proposed future Pond 4	$356,000
FUT_STM_5	Installation of approximately 165 m of 450 mm outlet pipe for proposed future Pond 5	$231,000
FUT_STM_55	Installation of approximately 860 m of 600 mm storm sewer on 67 Street west of Range Road 11	$1,523,000
FUT_STM_56	Installation of approximately 820 m of 750 mm storm sewer on 67 Street east of Range Road 11	$1,842,000
FUT_STM_57	Installation of approximately 720 m of 900 mm storm sewer on 67 Street near 52 Avenue	$2,033,000
FUT_STM_58	Installation of approximately 360 m of 900 mm storm sewer on 67 Street near 50 Avenue	$1,016,000
FUT_STM_6	Installation of approximately 40 m of 450 mm outlet pipe for proposed future Pond 6	$55,000
FUT_STM_7	Installation of approximately 920 m of 450 mm outlet pipe for proposed future Pond 7	$1,280,000
	Ultimate Horizon Total	**$34,121,000**

[1] Proposed future SWMF that may already exist or under development.



Legend

- Study Area
- Existing Storm Pond
- Existing Storm Pipe
- Proposed Future SWMF
- Future Development Serviced by Future System
- Future Development Tie-in to Existing System
- Proposed Manhole/Catchbasin Upgrades

Proposed Existing Pipe Upgrade Size

- 300 mm
- 375 mm
- 450 mm
- 525 mm
- 600 mm
- 675 mm
- 750 mm
- 900 mm
- 1050 mm
- 1200 mm
- 1350 mm
- 1500 mm
- 1650 mm

Proposed Future Pipe Size

- 200 mm
- 250 mm
- 300 mm
- 375 mm
- 450 mm
- 525 mm
- 600 mm
- 675 mm
- 750 mm
- 900 mm
- 1050 mm
- 1200 mm

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 8.1
CAPITAL PLAN OVERVIEW
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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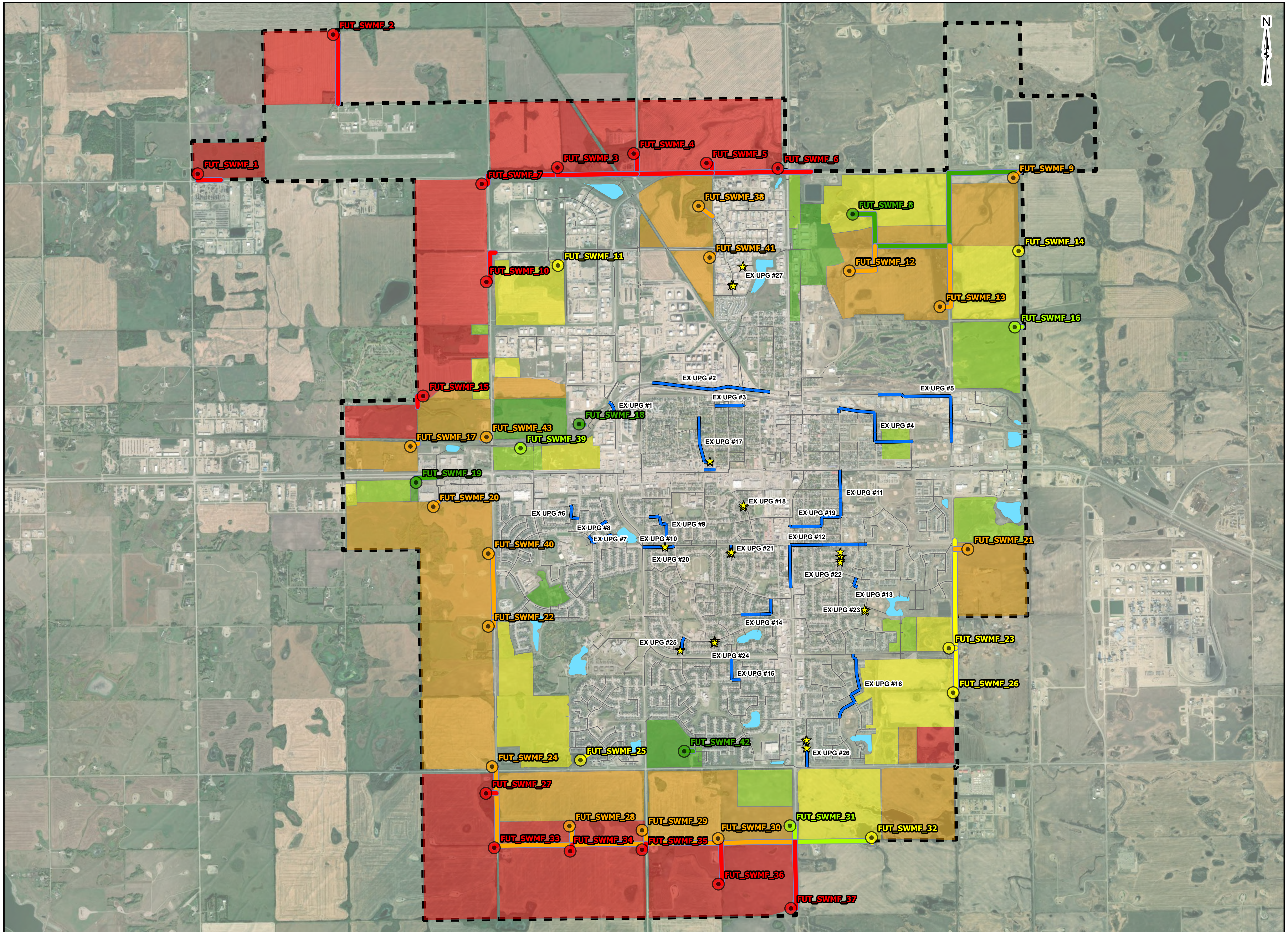

Legend

- Study Area
- Existing Storm Pond
- Existing Storm Pipe
- Proposed Existing Manhole/ Catchbasin Upgrade
- Proposed Existing Sewer Upgrade

Proposed Future SWMF Horizon

- 3-Years
- 5-Years
- 10-Years
- 20-Years
- Ultimate

Proposed Future Pipe Horizon

- 3-Years
- 5-Years
- 10-Years
- 20-Years
- Ultimate

Development Horizon

- 3-Years
- 5-Years
- 10-Years
- 20-Years
- Ultimate

0 500 1,000 2,000 Meters

1:40,000 NAD 1983 UTM Zone 12N

FIGURE 8.2
CAPITAL PLAN STAGING HORIZON
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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9.0 Conclusions and Recommendations

ISL was retained by the City of Lloydminster to complete a SWMP update, including an assessment of the City's existing stormwater conveyance infrastructure capacity and the City's future stormwater infrastructure needs. The SWMP was initiated to provide an update to the previous SWMP, which was completed in 2015, and to account for the changes in the stormwater system and recent developments within the city boundary. This document is intended to provide a road map of system infrastructure upgrades that will improve performance of the existing system, as well as new stormwater infrastructure to service proposed development areas.

The objectives of the SWMP included the following:

- Inventory and analyze the existing storm sewer system under existing conditions;
- Develop a fully integrated 1D-2D stormwater hydraulic model to accurately represent the City's existing storm sewer system;
- Undertake capacity assessments of the existing storm sewer system under the current and future development conditions;
- Develop storm sewer system plans to manage increased and redirected runoff resulting from future development;
- Determine upgrade requirements for the existing storm sewer system based on the condition and capacity assessment findings and recommend future servicing options; and
- Provide a framework for future storm sewer system capital planning, through cost estimates and possible staging of infrastructure installations.

9.1 Conclusions

Conclusions for the storm sewer system are summarized as follows:

- The City's storm sewer system includes major and minor drainage components. The major system features overland drainage routes with two main channels, the Northwest and East Drainage Channels, which ultimately direct stormwater to the Neale Edmunds Stormwater Complex. Seventeen (17) stormwater ponds within the city manage and regulate runoff.
- The minor system comprises gravity sewers, manholes, catch basins, catch basin leads, and outfalls. These storm pipes are mostly made of concrete (CONC) or polyvinyl chloride (PVC) and range in size from 100 mm to 2,400 mm in diameter and up to 3,000 mm by 5,000 mm in dimension for box culverts.
- A 1D-2D stormwater model was developed in InfoWorks ICM to evaluate the City's storm sewer system. This development occurred in two phases: first, constructing the minor (1D) system and then generating a mesh network using LiDAR data for the major (2D) system, as detailed in Section 5.0.
- Design rainfall events, based on the City of Lloydminster's IDF parameters, were used for assessment. The minor system was tested with a 1:5 year 4-hour Modified Chicago design storm, while the major system was evaluated using a 1:100 year 4-hour Modified Chicago design storm and a 1:100 year 24-hour Huff design storm.
- Model results identified several capacity constraints in the storm sewer (minor system) and significant flooding risks in the overland drainage (major system). Detailed assessments for the minor system are in Section 6.1, and for the major system in Sections 6.1 and 6.2.
- A condition assessment program was conducted, with McGill's Industrial Services performing CCTV inspections of select storm sewers. The results were used to develop system upgrade recommendations and aid future condition assessment planning, presented in Section 6.3.

- A risk assessment matrix was created to prioritize stormwater system upgrades. The matrix uses a point scoring system based on risk criteria such as historical flooding, proximity to critical infrastructure, and upgrade effectiveness, providing a quantitative approach for prioritization.
- A proposed future stormwater system concept was developed for Lloydminster, considering anticipated future development areas (Section 2.3). This concept includes future stormwater management facilities (SWMFs) and storm sewers, strategically located based on topography in the city. SWMFs are designed to provide adequate storage capacity and control runoff release rates.
- The InfoWorks ICM model was used to evaluate the performance of the existing system with future system connections. The existing stormwater management facilities and storm sewers were estimated to have sufficient capacity to accommodate future development, as discussed in Sections 7.2.2 and 7.3.

9.2 Recommendations

Recommendations for the stormwater system are summarized as follows:

- Based on the existing storm sewer system capacity and condition assessments, several upgrade recommendations were developed to improve system capacity, reduce surface flooding, and enhance system resilience. Proposed upgrades include storm sewer and culvert upgrades, catch basin installations, and sewer rehabilitations. The City may choose to monitor some areas with proposed upgrades to verify the need if no historical issues have been observed there.
- The proposed existing system upgrades are summarized in Tables 6.7 and 6.8, with risk assessment prioritization in Table 6.11. Regular condition assessments are recommended to monitor the physical condition of stormwater assets and reduce the risk of unexpected system disruptions.
- As the City develops, the future stormwater management concept from Section 7.0 should be used as a reference for developing stormwater infrastructure, in accordance with the City's Municipal Development Standards.
- Drainage to the SWMFs should be considered during subdivision application/development permit processes. Separate reviews should be prepared to support each application to ensure compliance with the overall SWMP.
- Proposed SWMFs should include outlet control structures, and downstream sewers should have an outfall structure at the downstream discharge location. Backflow preventers are recommended for outfalls servicing areas with ground or basement elevations below the local 1:100 year flood level. LID measures should be considered on a site-specific basis and reviewed by the City for potential implementation.
- Class "D" cost estimates for the proposed existing system upgrades amount to approximately $54 million, including a 15% engineering fee and 30% contingency. Detailed cost estimates for each upgrade item are provided in Table 6.12.
- Class "D" cost estimates for the proposed future stormwater system amount to approximately $92.4 million, including a 15% engineering fee and 30% contingency. Detailed cost estimates are in Table 7.10.
- It is recommended that the SWMP be reviewed and updated after significant periods of growth or every five (5) years. This will allow for updates to the hydrodynamic model and analysis with any capital upgrades and the latest growth plans. The review should also consider densification within established areas.

10.0 References

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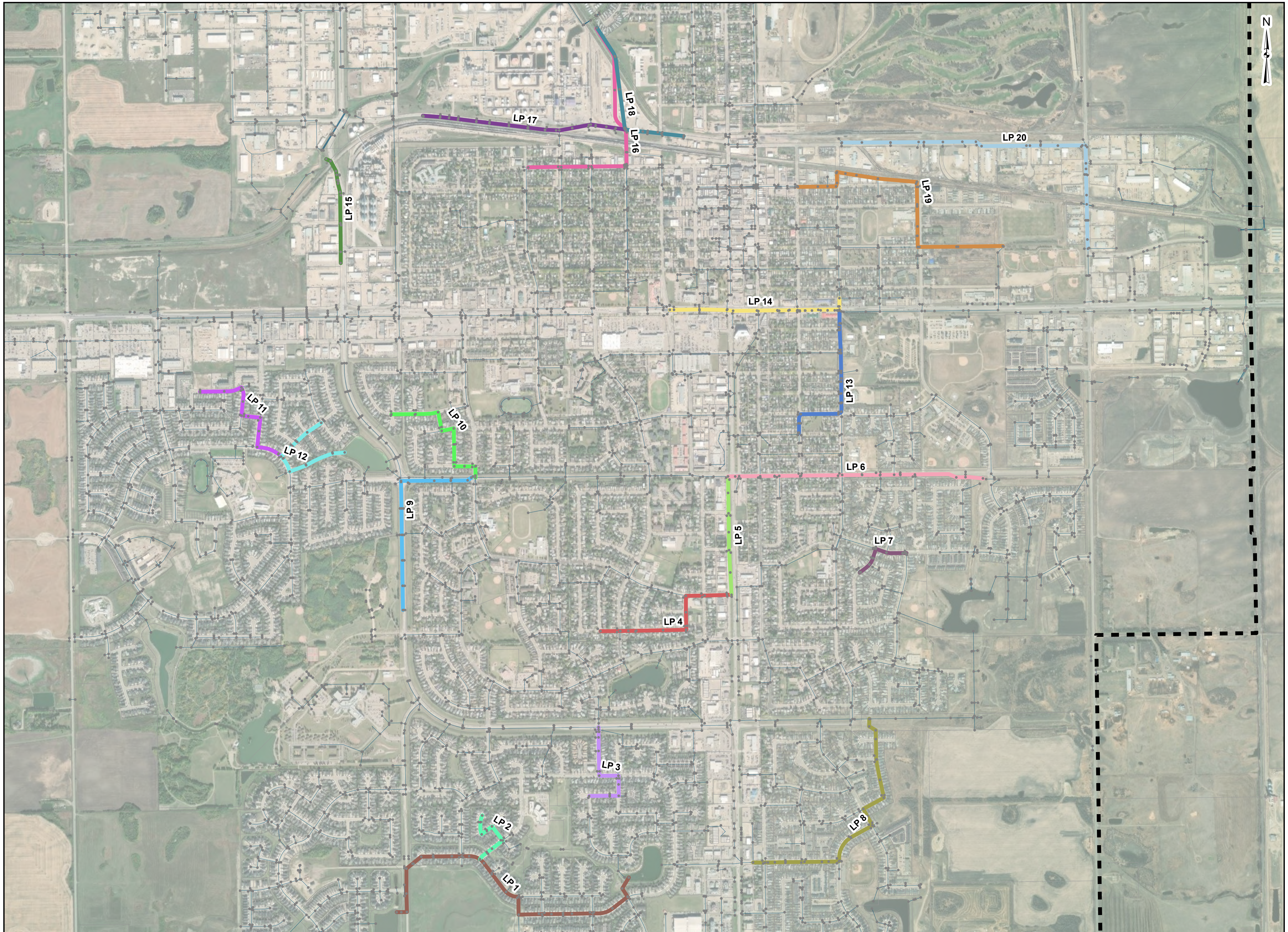
APPENDIX A
Existing System Performance HGL Profiles



Credits:World Imagery: Vermilion River County, Maxar

Legend

- Study Area
- Legal Parcel
- Manhole
- Storm Pipe

HGL Profile No.

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

0 225 450 900 Meters

1:18,000 NAD 1983 UTM Zone 12N

FIGURE APPENDIX A.1
LONGITUDINAL PROFILE
KEY PLAN
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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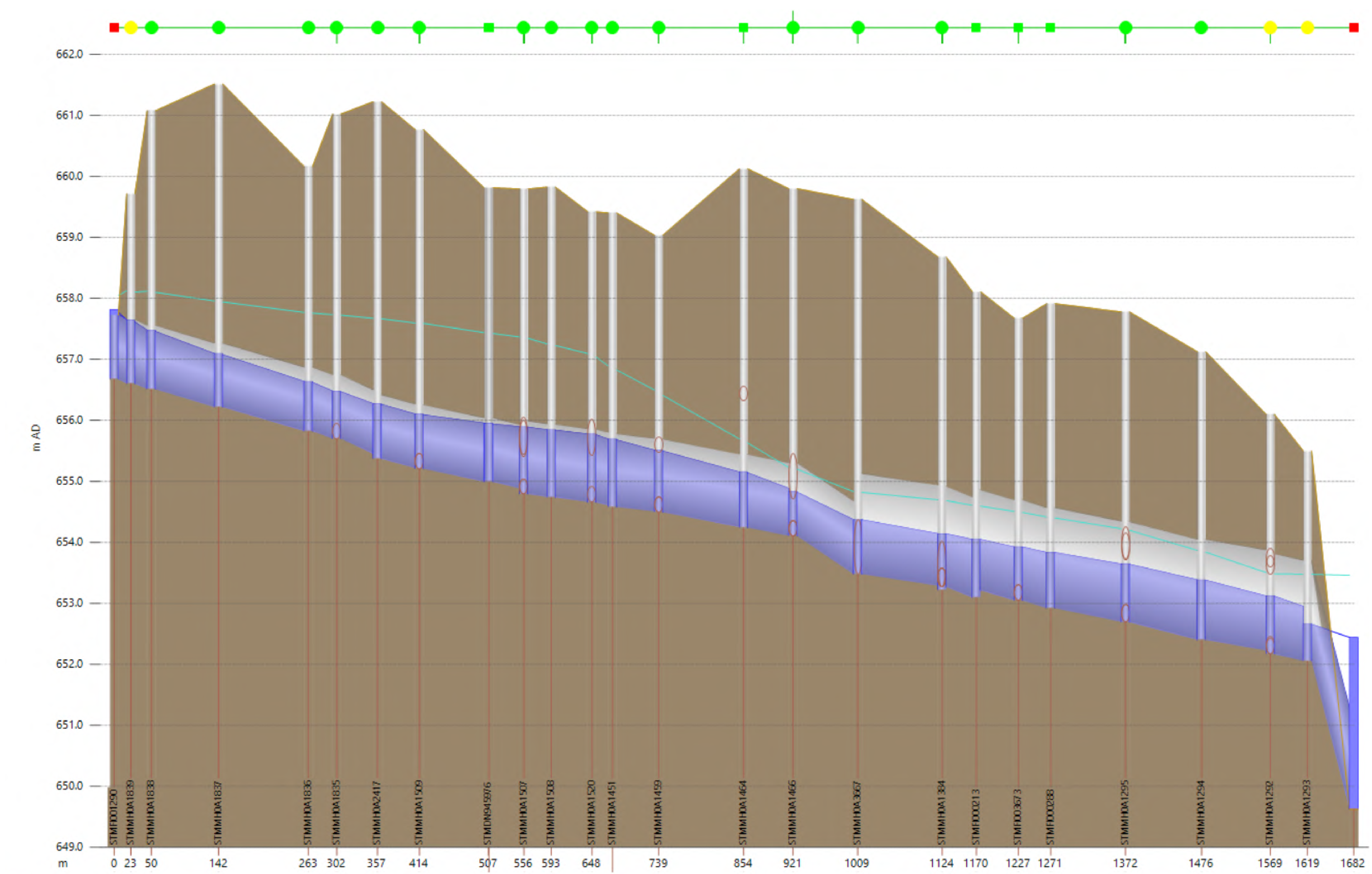

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r.pfc (m3/s)		-	-	1.550	1.552	-	1.838	1.403	1.309	1.312	-	1.445	-	1.332	1.800	1.771	3.292	3.709	5.600	4.901	4.901	4.277	4.815	3.949	4.240	17.940	
DS flow (m3/s)		-	-	1.73124	1.57356	-	-	-	1.38726	-	-	-	-	1.90934	1.98279	1.97793	1.99884	2.19627	-	-	-	2.38989	2.91308	2.90759	-	-	

Legend

- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation

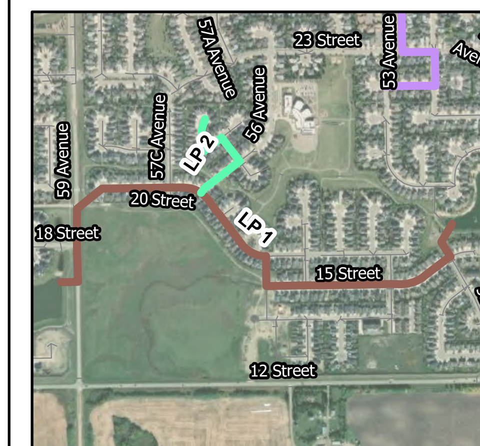

FIGURE APPENDIX A.2
EXISTING CONDITIONS - HGL PROFILE 1
CITY OF LLOYDMINSTER
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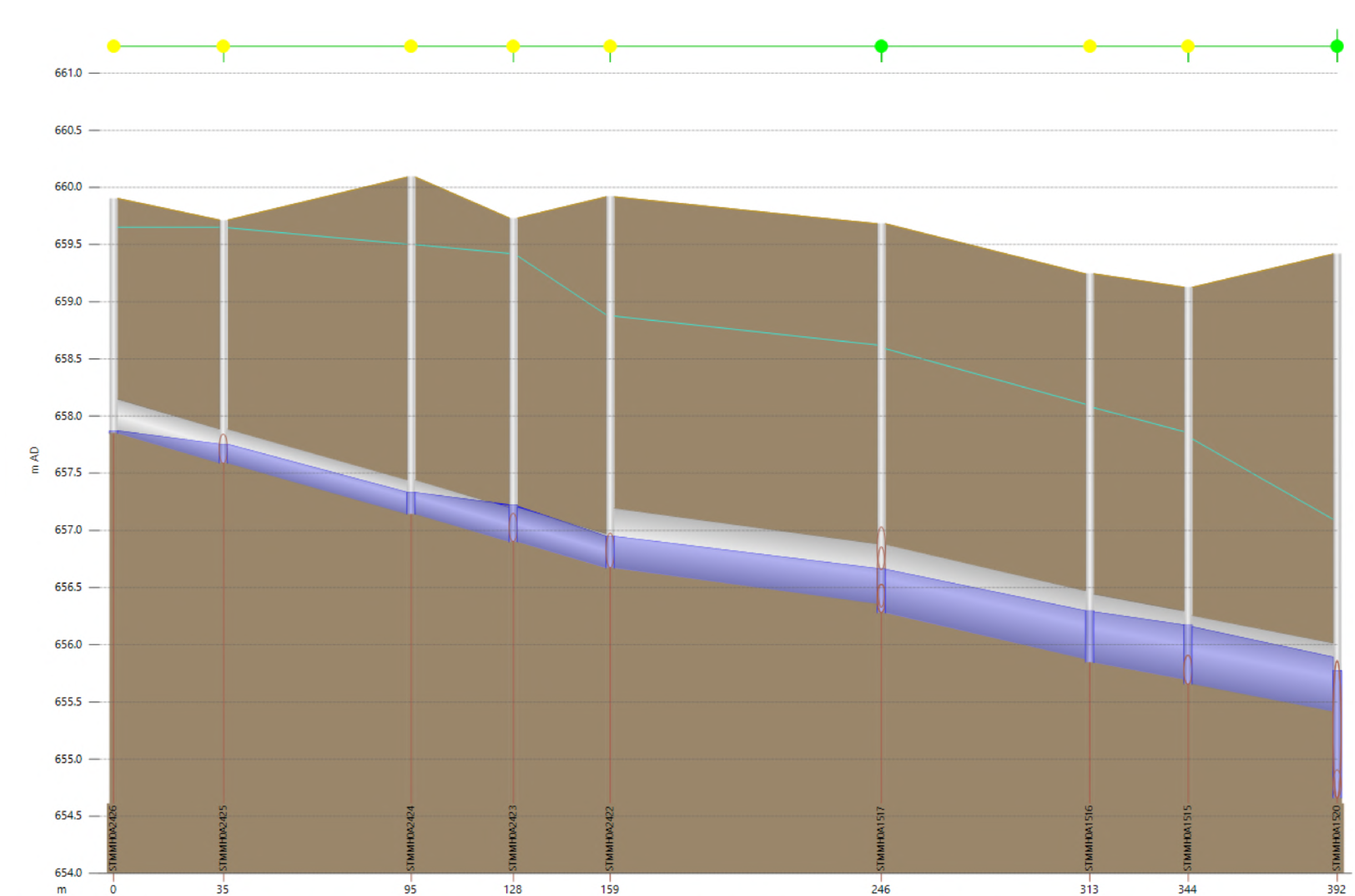
Legend

- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation



Link	STMMH0A2426.1	STMMH0A2425.1	STMMH0A2424.1	STMMH0A2423.1	STMMH0A2422.1	STMMH0A1517.1	STMMH0A1516.1	STMMH0A1515.1
r.pfc (m3/s)	0.098	0.098	0.098	0.098	0.305	0.565	0.495	0.515
DS flow (m3/s)	0.00106	0.05552	0.05589	0.10375	0.16059	0.40031	0.39918	0.52079

FIGURE APPENDIX A.3
EXISTING CONDITIONS - HGL PROFILE 2
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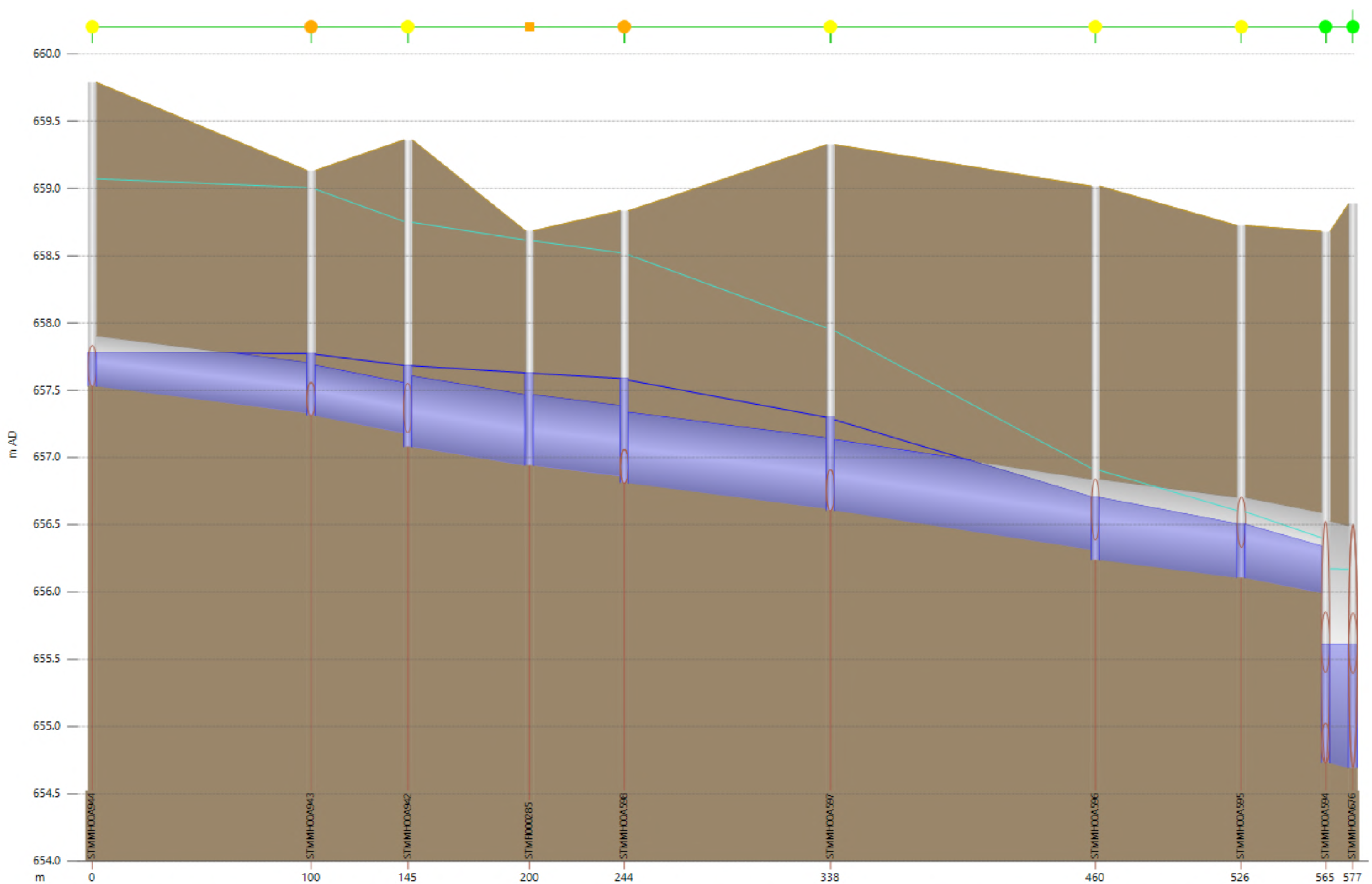

Link		STMMH00A944.1	STMMH00A943.1	STMMH00A942.1	STMFI000285.1	STMMH00A598.1	STMMH00A597.1	STMMH00A596.1	-	-	
r.pfc (m3/s)		0.093	0.112	0.216	0.185	0.193	0.211	0.275	0.333	-	
DS flow (m3/s)		0.03246	0.10872	0.13181	0.13296	0.23127	0.28450	0.28382	0.28368	-	

Legend

- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation

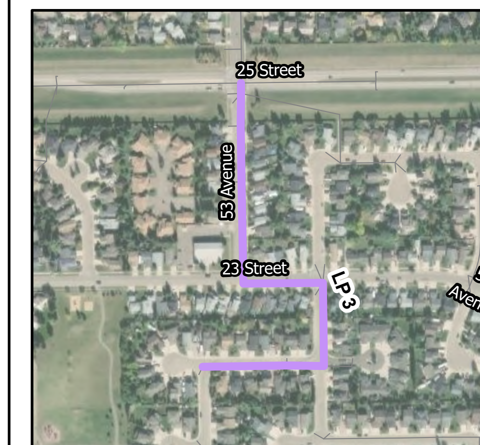

FIGURE APPENDIX A.4
EXISTING CONDITIONS - HGL PROFILE 3
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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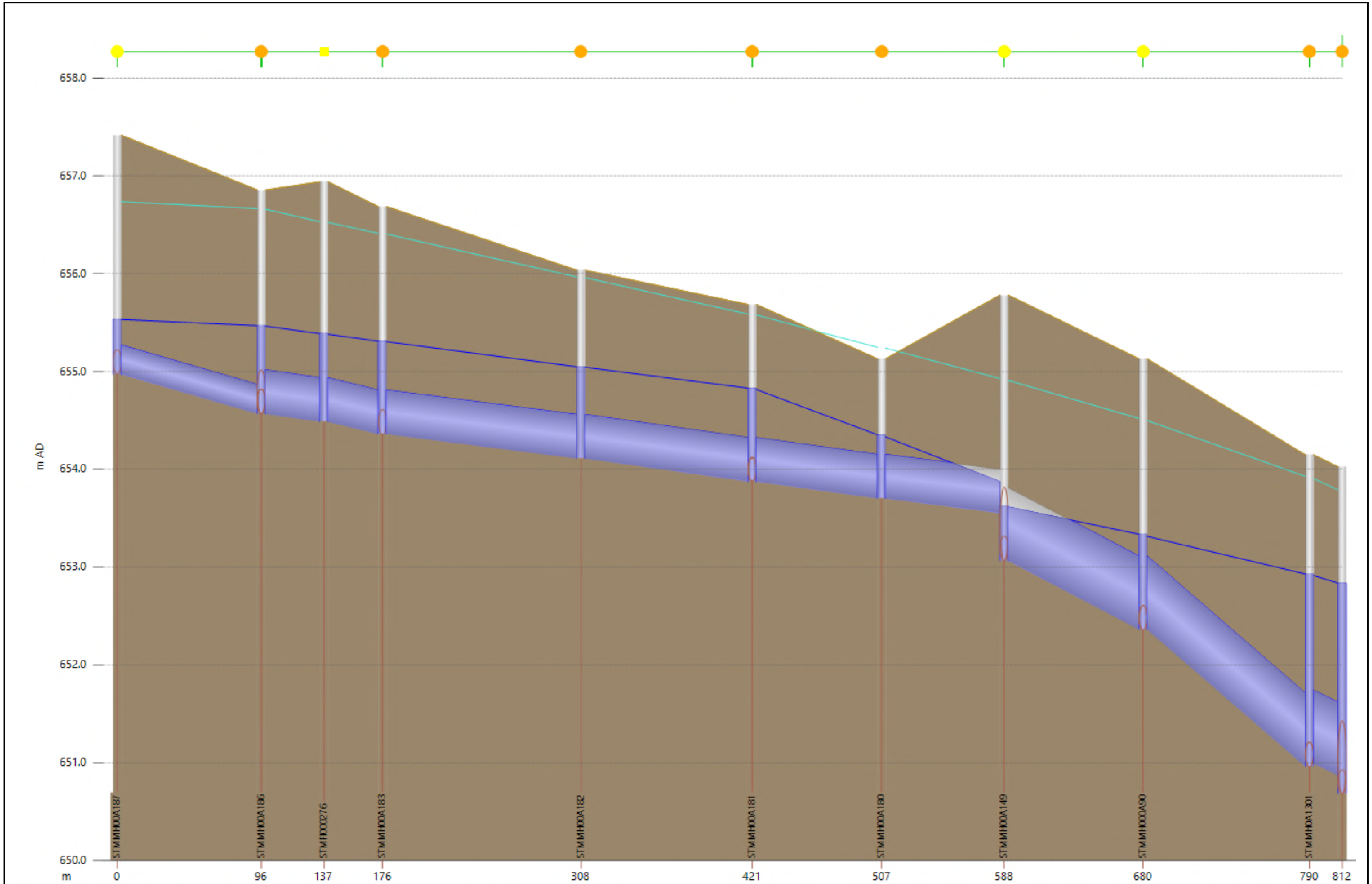

Link	STMMH00A187.1	-	-	STMMH00A183.1	STMMH00A182.1	STMMH00A181.1	STMMH00A180.1	STMMH00A149.1	STMMH000A90.1	-
r.pfc (m3/s)	0.063	0.127	0.162	0.124	0.130	0.128	0.123	0.971	1.255	0.831
DS flow (m3/s)	0.04309	0.12397	0.12380	0.12694	0.12912	0.20718	0.20706	0.60161	0.64192	-

Legend

100 Yr 4 Hr Chicago Storm HGL

5 Yr 4 Hr Chicago Storm HGL

Ground Elevation

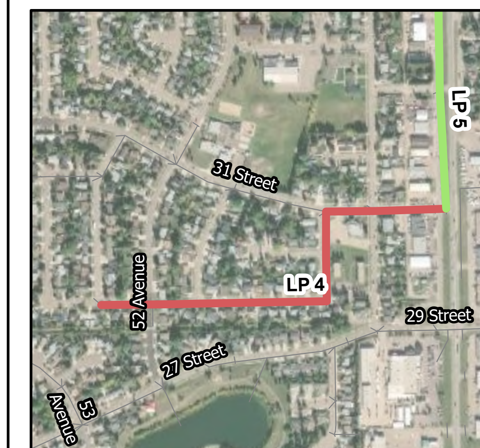

FIGURE APPENDIX A.5
EXISTING CONDITIONS - HGL PROFILE 4
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

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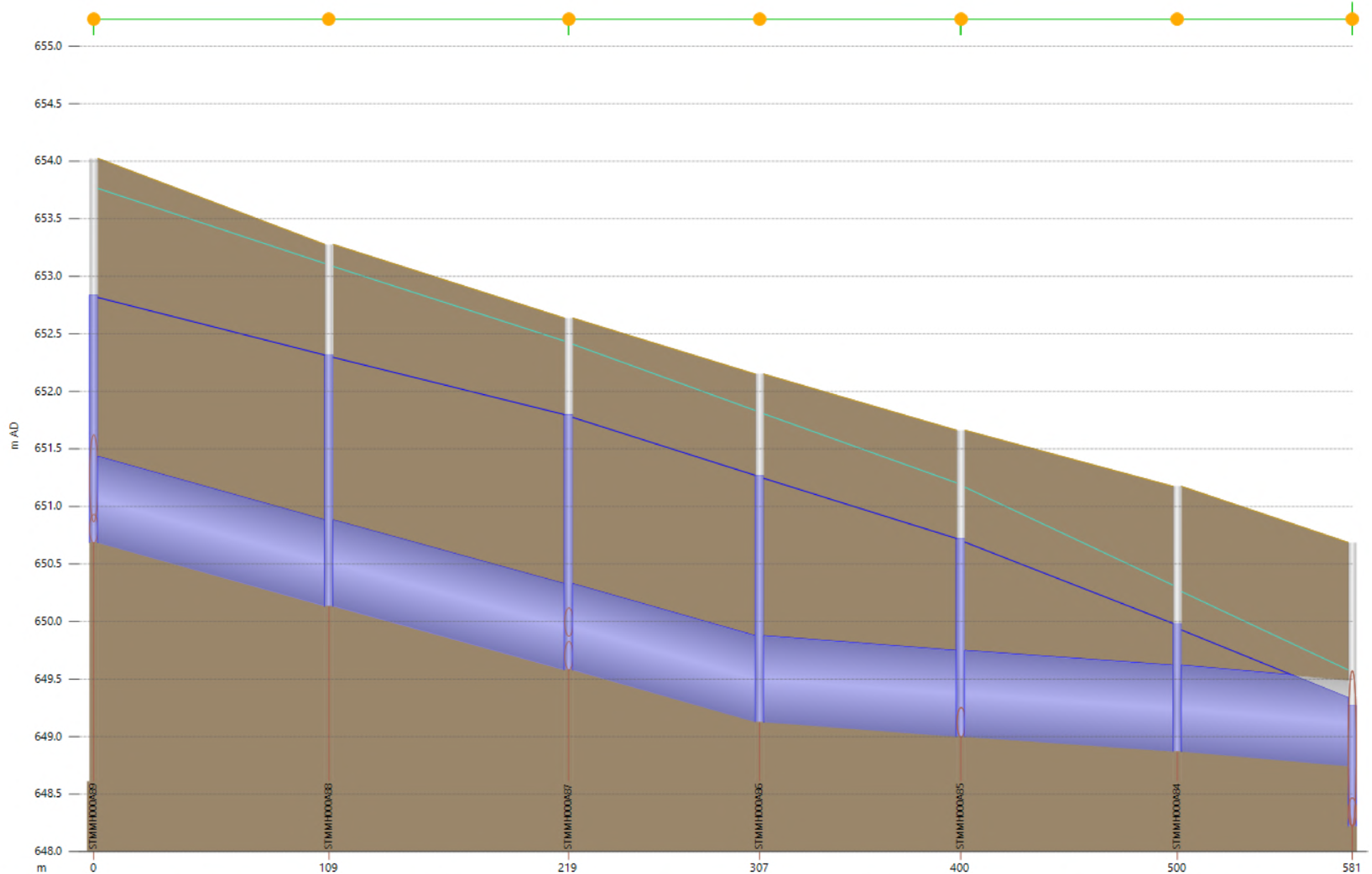

Link	STMMH000A89.1	STMMH000A88.1	STMMH000A87.1	STMMH000A86.1	STMMH000A85.1	STMMH000A84.1
r.pfc (m3/s)	0.794	0.788	0.797	0.413	0.398	0.444
DS flow (m3/s)	0.75444	0.76005	0.83625	0.83329	0.92622	0.92601

Legend
- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation

FIGURE APPENDIX A.6
EXISTING CONDITIONS - HGL PROFILE 5
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL
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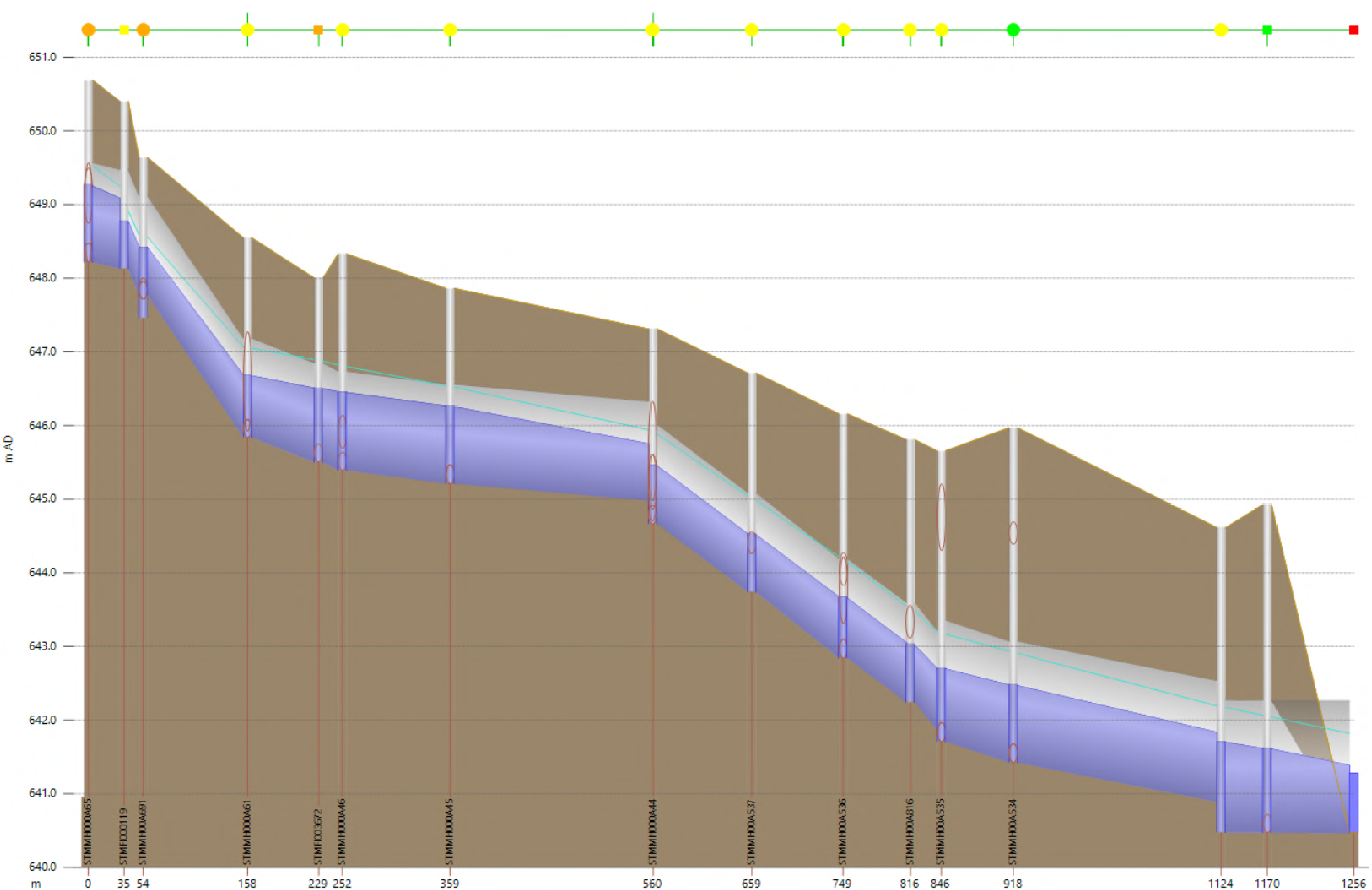
Credits:World Imagery: Vermilion River County, Maxar



Link		-	-	STMMH00A691.1	-	-	STMMH000A46.1	STMMH000A45.1	STMMH000A44.1	-	-	-	-	STMMH00A534.1	-	STMFI003656.1	
r.pfc (m3/s)		2.704	-	7.295	3.675	-	2.172	1.823	5.192	5.306	5.067	-	5.775	4.633	1.003	1.003	
DS flow (m3/s)		-	-	3.18942	2.00430	-	2.09388	2.09873	3.26620	3.26723	3.37471	-	3.44040	3.46146	3.46235	3.48247	

Legend

- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation

FIGURE APPENDIX A.7
EXISTING CONDITIONS - HGL PROFILE 6
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

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Credits:World Imagery: Vermilion River County, Maxar

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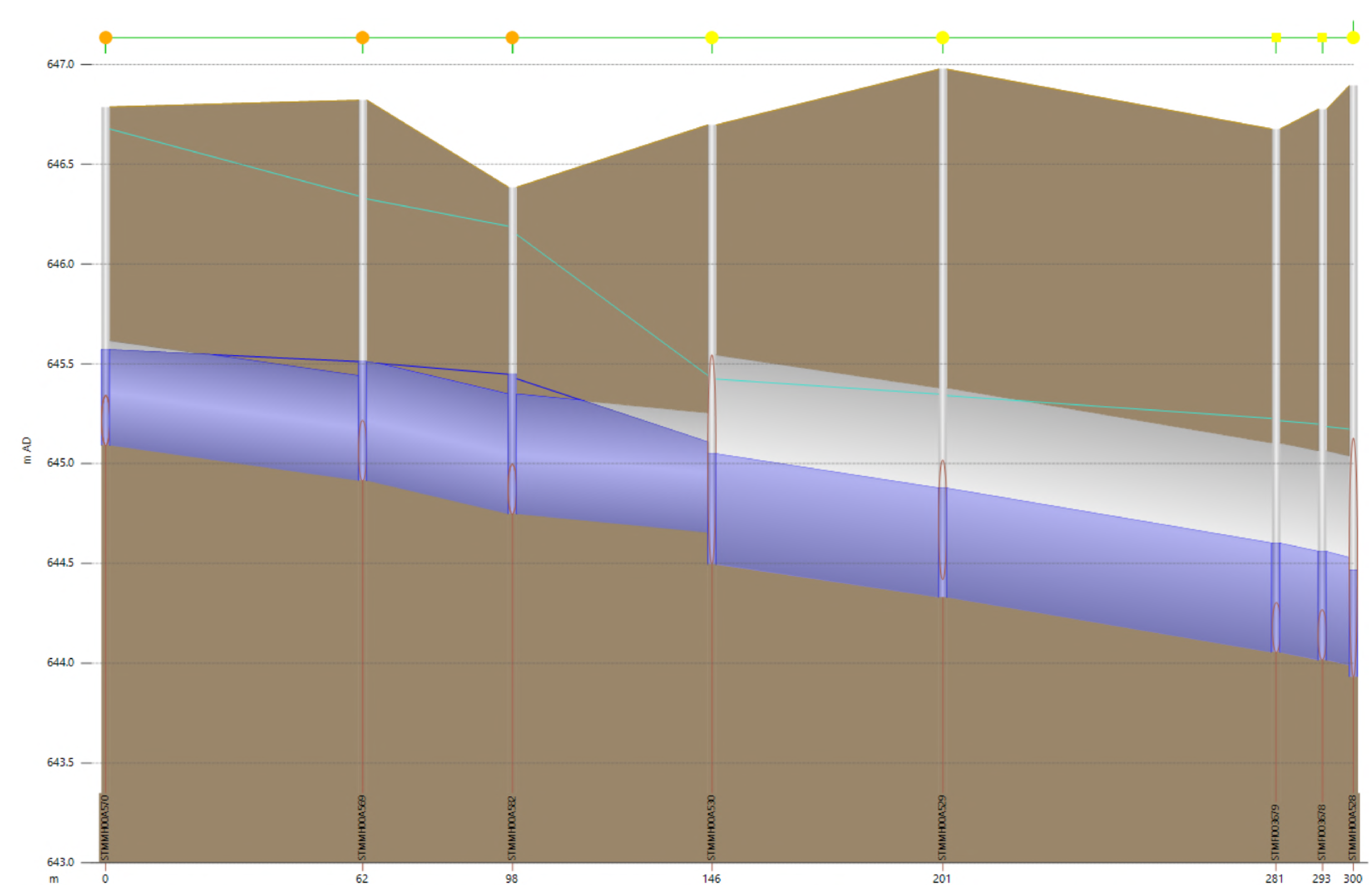

Link	STMMH00A570.1	STMMH00A569.1	STMMH00A582.1	STMMH00A530.1	STMMH00A529.1	-	-
r.pfc (m3/s)	0.230	0.418	0.271	1.489	1.603	1.603	-
DS flow (m3/s)	0.22036	0.27936	0.47541	0.81503	0.84966	0.87394	-

Legend

- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation

FIGURE APPENDIX A.8
EXISTING CONDITIONS - HGL PROFILE 7
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

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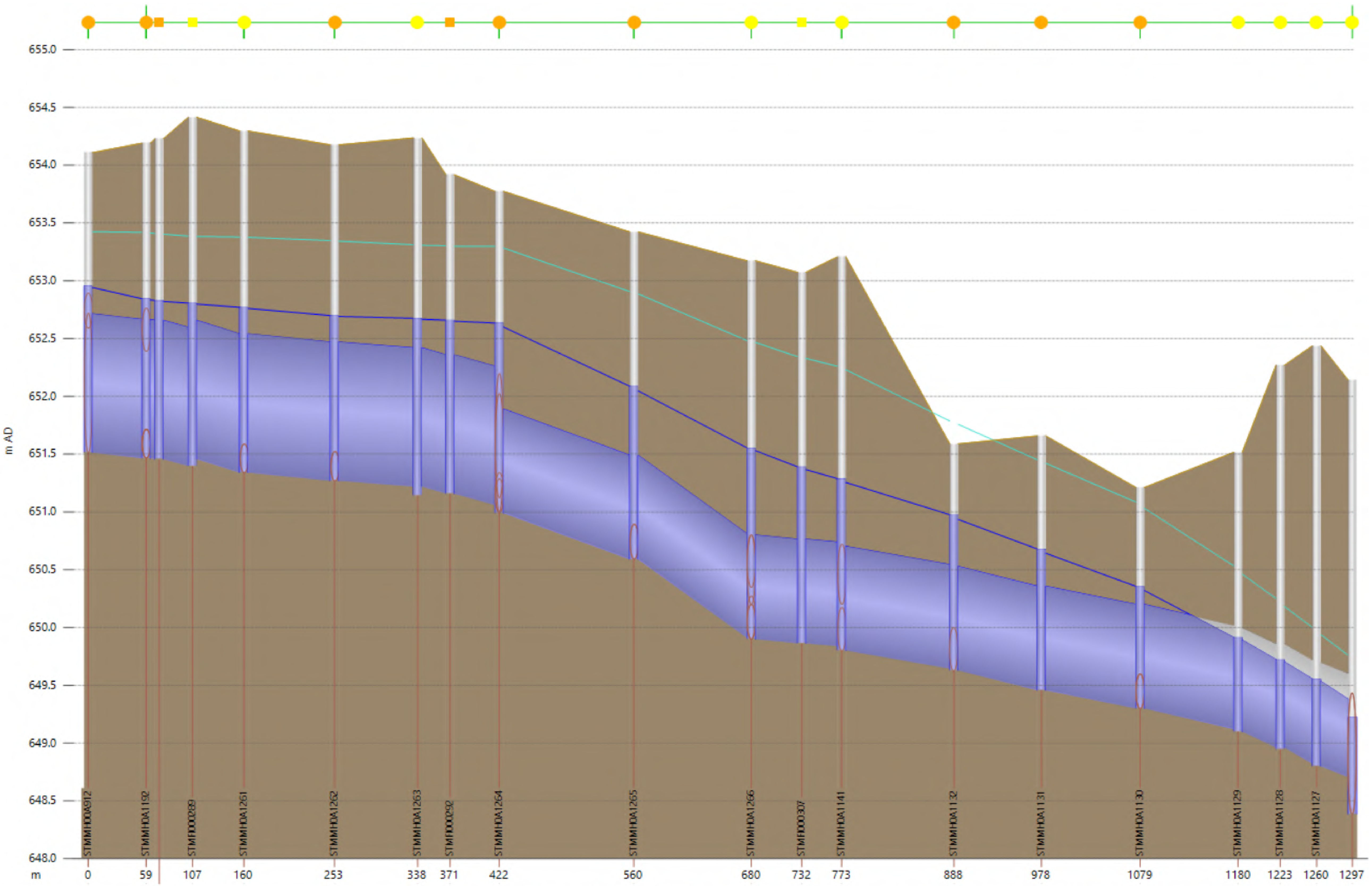

Link		-	-	-	-	-	-	-	-	STMMH0A1264.2	STMMH0A1265.1	-	-	STMMH0A1141.1	-	STMMH0A1131.1	STMMH0A1130.1	-	-	-	
r.pfc (m3/s)		1.120	-	1.638	1.836	1.070	0.944	1.682	1.720	0.974	1.360	0.478	0.529	0.790	0.936	0.843	0.906	1.207	1.320	1.088	
DS flow (m3/s)		1.52528	-	-	1.44219	1.38793	1.36556	-	1.25514	1.17219	1.18423	0.95158	-	1.05016	1.12899	1.12922	1.30218	-	-	-	

Legend

100 Yr 4 Hr Chicago Storm HGL

5 Yr 4 Hr Chicago Storm HGL

Ground Elevation

FIGURE APPENDIX A.9
EXISTING CONDITIONS - HGL PROFILE 8
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

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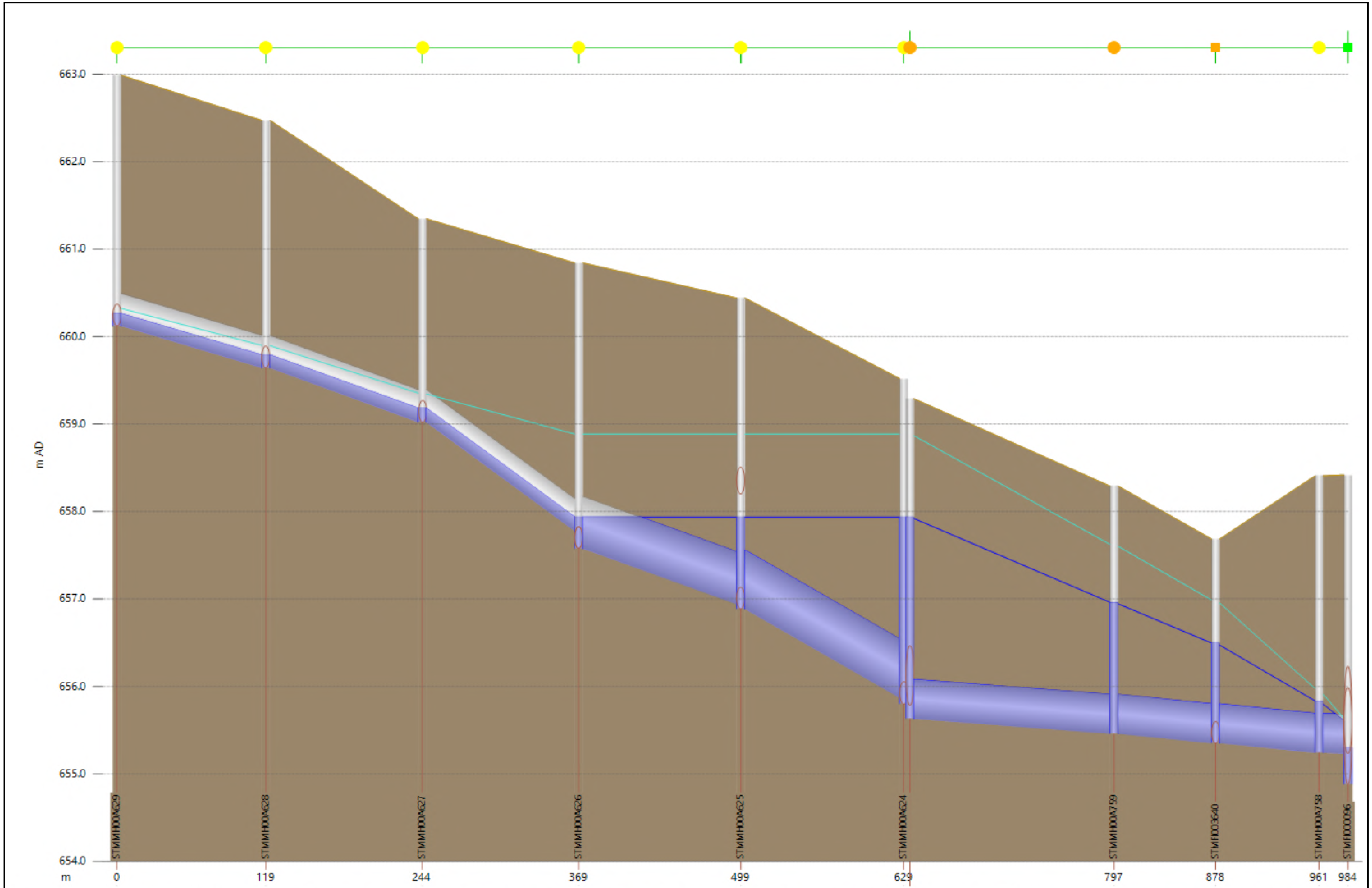
Credits:World Imagery: Vermilion River County, Maxar



Link	STMMH00A629.1	STMMH00A628.1	STMMH00A627.1	STMMH00A626.1	STMMH00A625.1	STMMH00A760.1	STMMH00A759.1	STMFI003640.1	-
r.pfc (m3/s)	0.111	0.124	0.175	0.430	0.743	0.109	0.123	0.123	-
DS flow (m3/s)	0.03322	0.04014	0.06601	-0.09179	-0.35412	0.27113	0.26357	0.29305	-

Legend

- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation

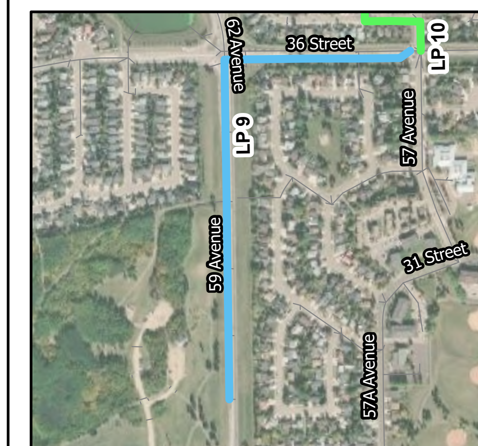


FIGURE APPENDIX A.10
EXISTING CONDITIONS - HGL PROFILE 9
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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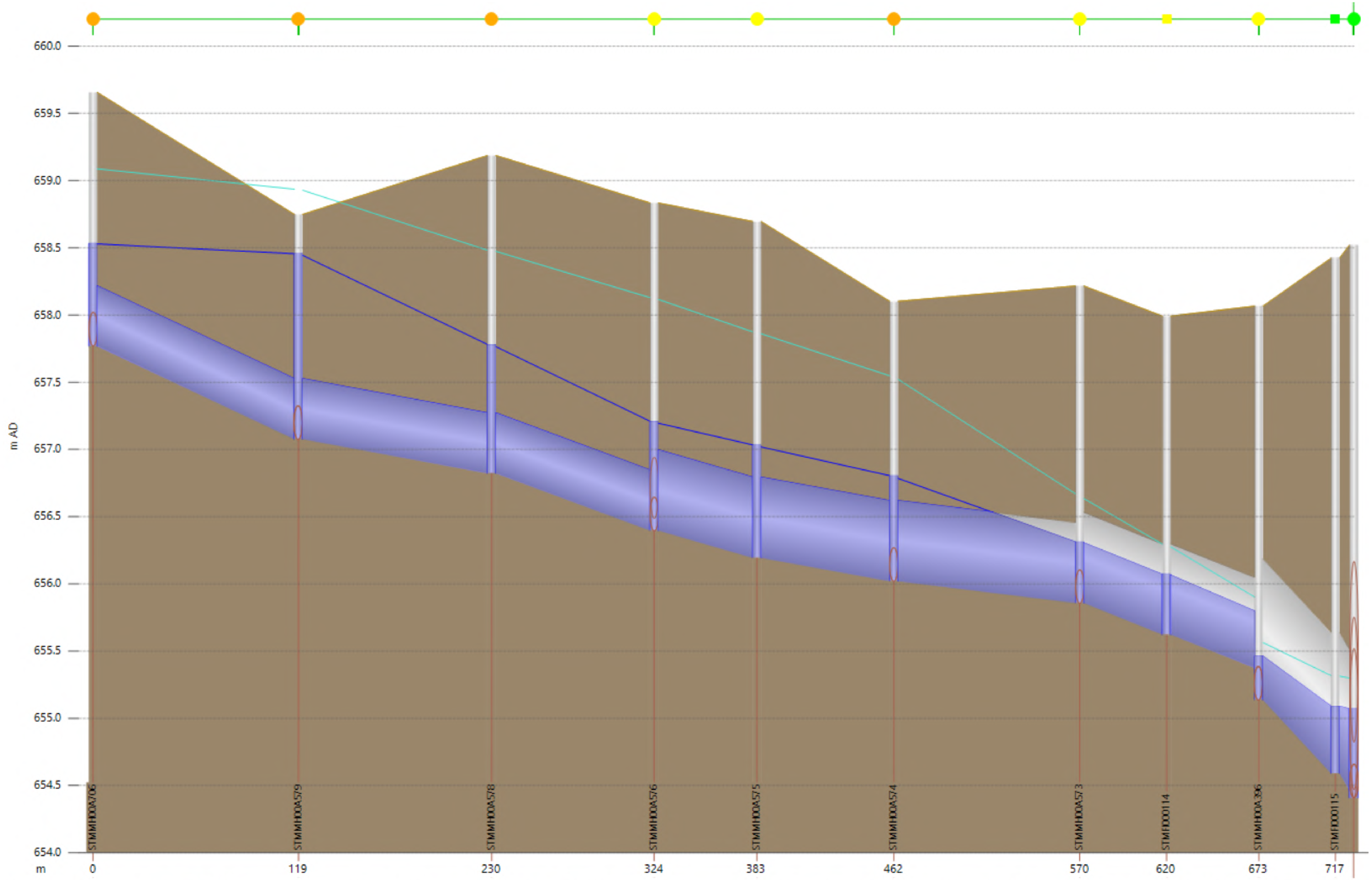

Link		STMMH00A706.1	STMMH00A579.1	STMMH00A578.1	STMMH00A576.1	STMMH00A575.1	STMMH00A574.1	-	STMFI000114.1	-	-
r.pfc (m3/s)		0.218	0.136	0.192	0.359	0.288	0.239	0.576	0.575	3.039	-
DS flow (m3/s)		0.07932	0.23001	0.22770	0.31746	0.31781	0.39076	0.44436	0.44392	0.54264	-

Legend
- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation

FIGURE APPENDIX A.11
EXISTING CONDITIONS - HGL PROFILE 10
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL
LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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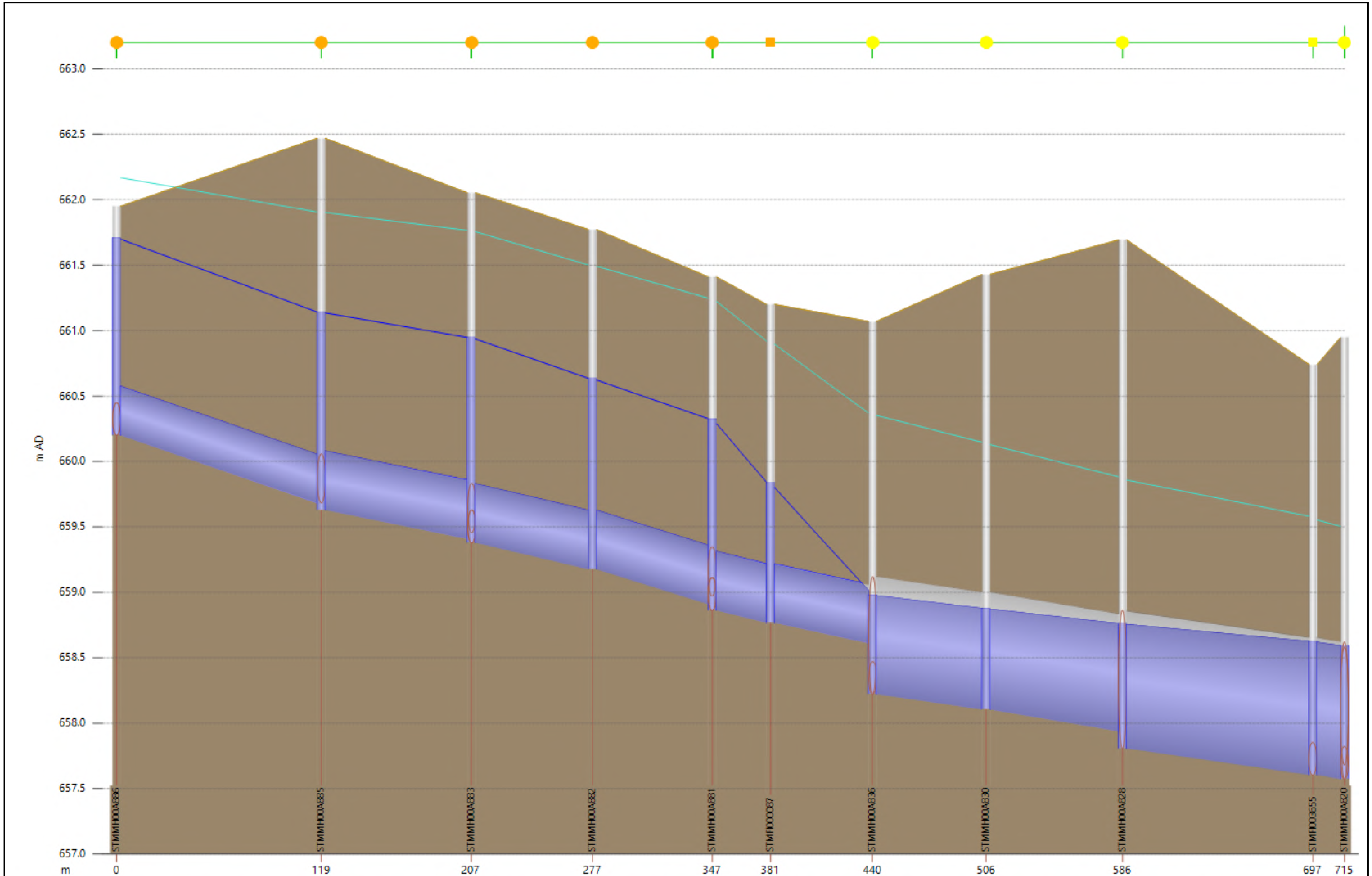

Link		STMMH00A886.1	STMMH00A885.1	STMMH00A883.1	STMMH00A882.1	-	STMFI000087.1	STMMH00A836.1	STMMH00A830.1	STMMH00A828.1	-	
r.pfc (m3/s)		0.137	0.169	0.181	0.208	0.178	0.173	0.765	0.827	1.167	1.167	
DS flow (m3/s)		0.14365	0.15726	0.21903	0.21998	0.38286	0.38287	0.73170	0.69520	0.97033	-	

Legend

100 Yr 4 Hr Chicago Storm HGL

5 Yr 4 Hr Chicago Storm HGL

Ground Elevation

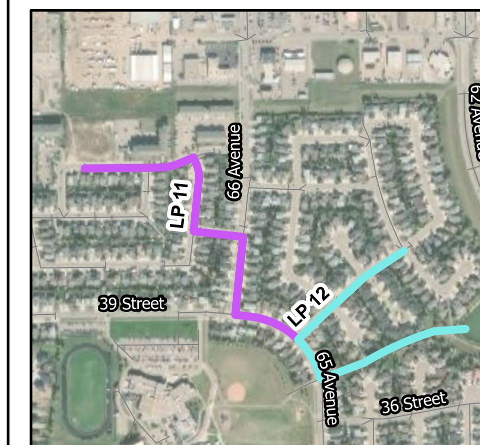

FIGURE APPENDIX A.12
EXISTING CONDITIONS - HGL PROFILE 11
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

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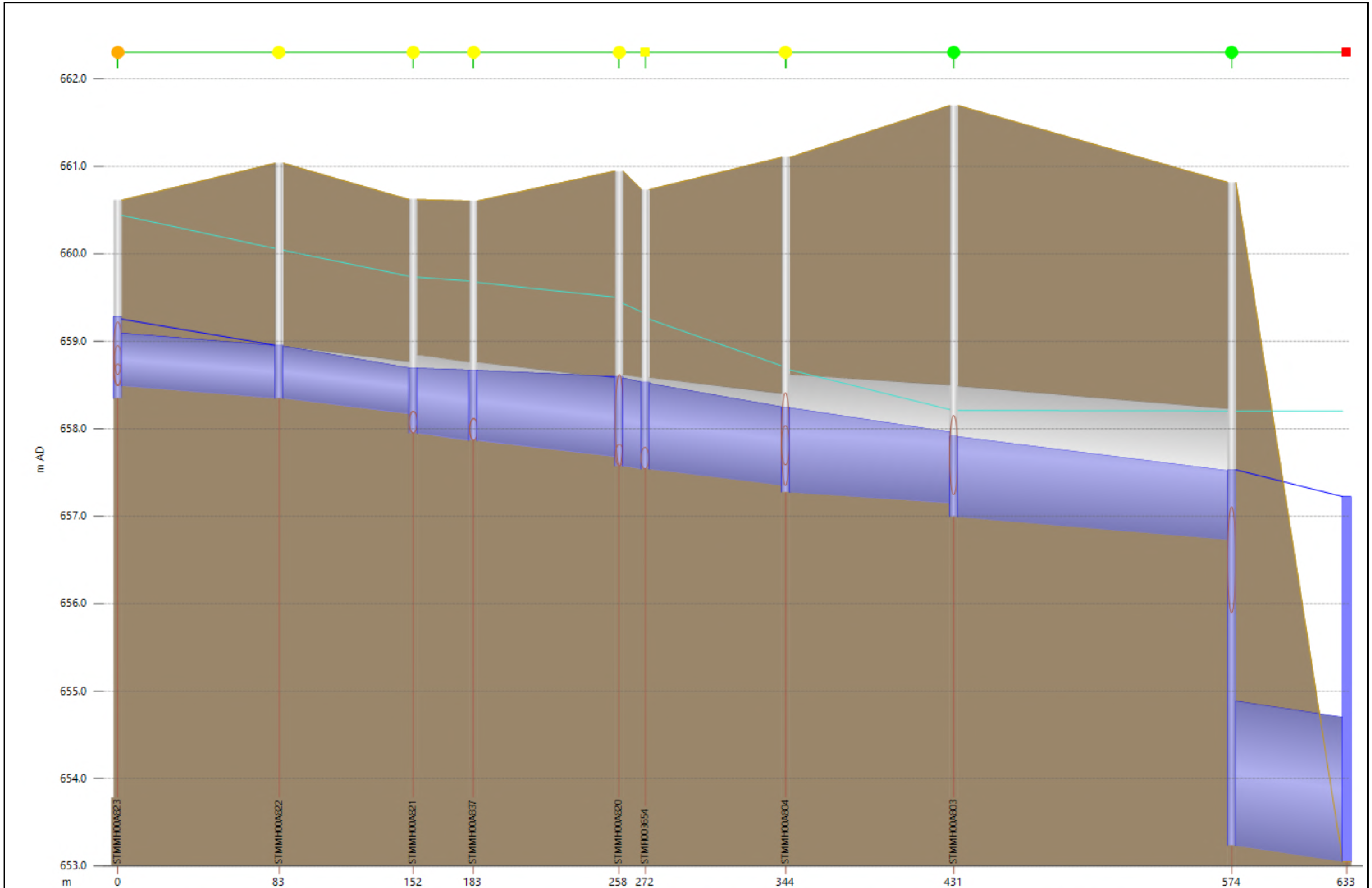

Link	STMMH00A823.2	STMMH00A822.1	-	STMMH00A837.1	-	STMFI003654.1	STMMH00A804.1	STMMH00A803.1	STMMH00A802.1
r.pfc (m3/s)	0.300	0.369	0.943	0.899	-	1.378	2.020	3.002	5.092
DS flow (m3/s)	0.44780	0.44542	0.55363	0.59839	-	1.56805	2.29288	-6.16903	-13.82943

Legend

- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation

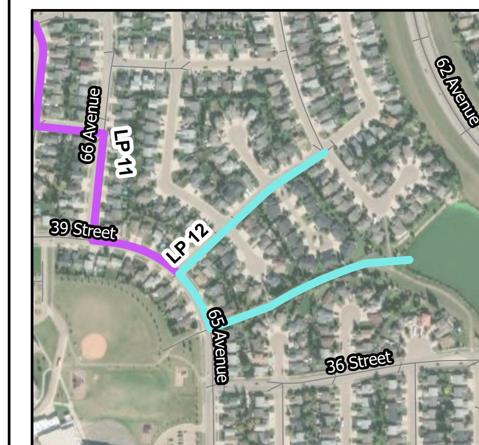

FIGURE APPENDIX A.13
EXISTING CONDITIONS - HGL PROFILE 12
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

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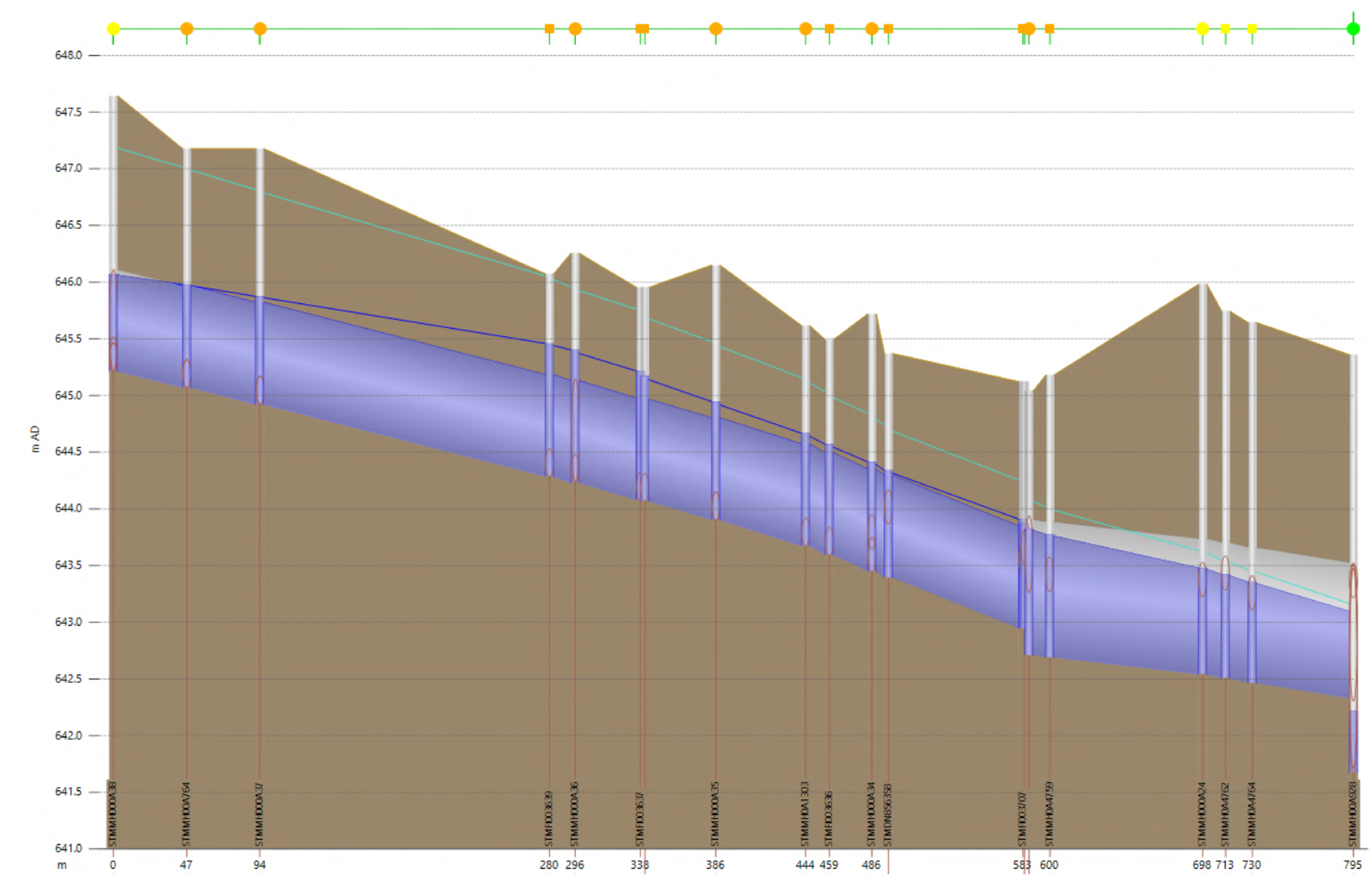

Link	-	-	STMMH000A37.1	-	-	-	-	-	-	-	STMDN856358.1	-	STMMH0A4759.1	-	-	STMMH0A4764.1
r.pfc (m3/s)	1.005	1.018	1.059	-	1.089	1.089	1.145	-	1.306	-	1.306	-	1.522	-	-	1.774
DS flow (m3/s)	0.81880	0.86805	0.86099	-	1.15931	1.20519	1.22014	-	-	-	1.27330	-	1.92139	-	-	1.93210

Legend

- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation

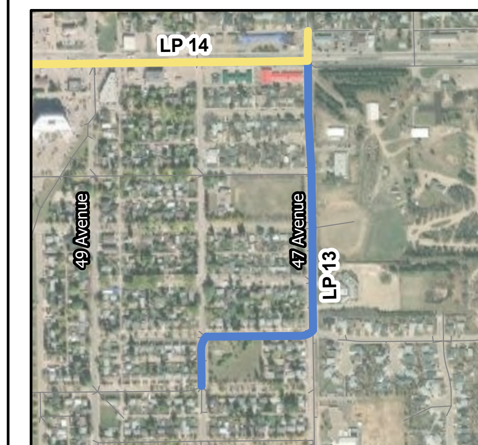

FIGURE APPENDIX A.14
EXISTING CONDITIONS - HGL PROFILE 13
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL LLOYDMINSTER

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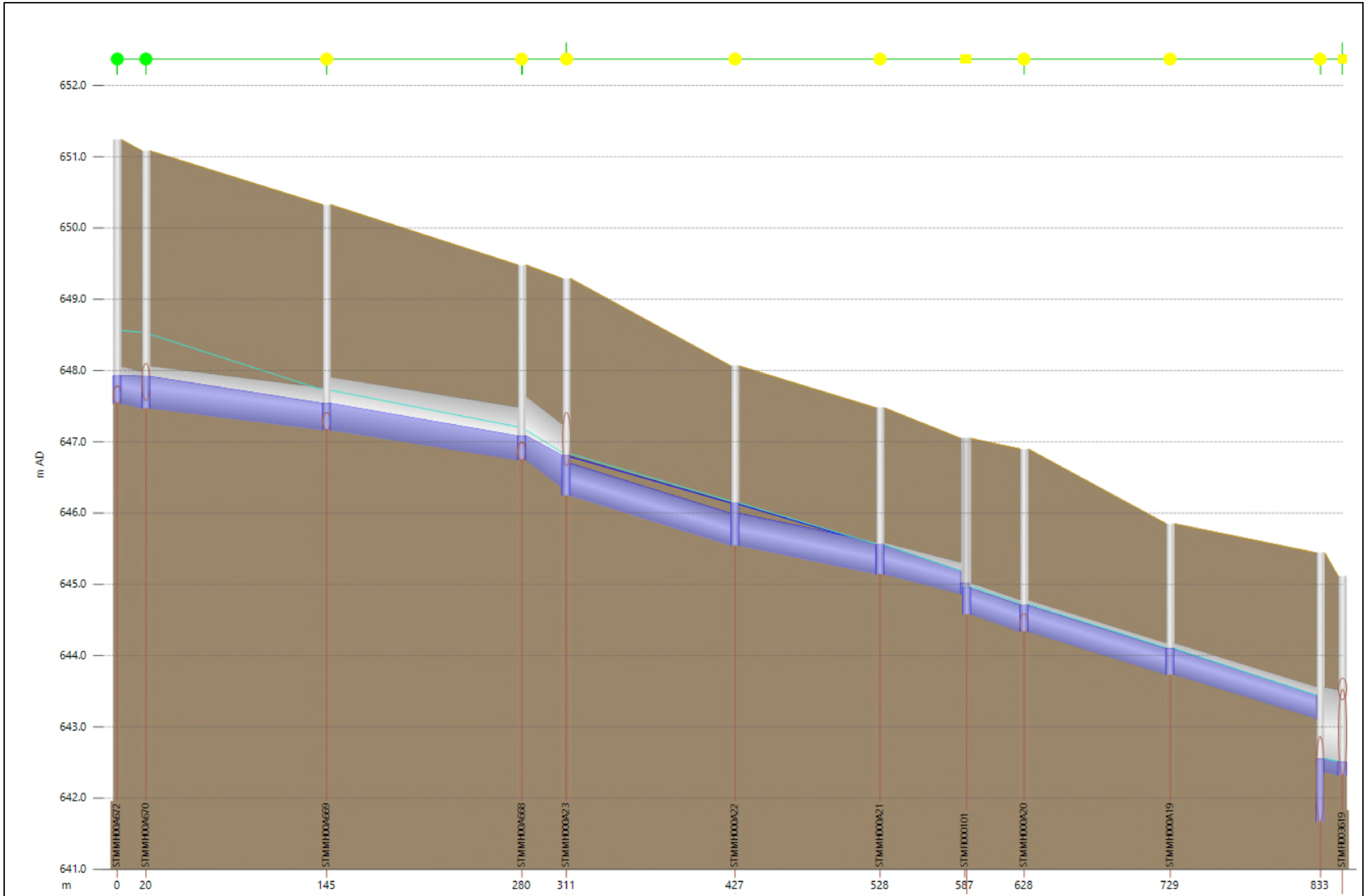


Link		-	STMMH00A670.1	STMMH00A669.1	-	STMMH000A23.1	STMMH000A22.1	-	-	STMMH000A20.1	STMMH000A19.1	-
r.pfc (m3/s)		-	0.303	0.622	2.041	0.221	0.180	0.196	0.222	0.220	0.220	-
DS flow (m3/s)		-	0.28005	0.30724	0.53693	0.21700	0.21134	0.21131	0.21104	0.21195	0.21193	-

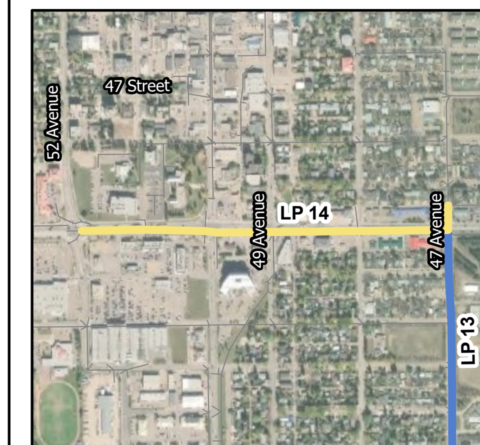
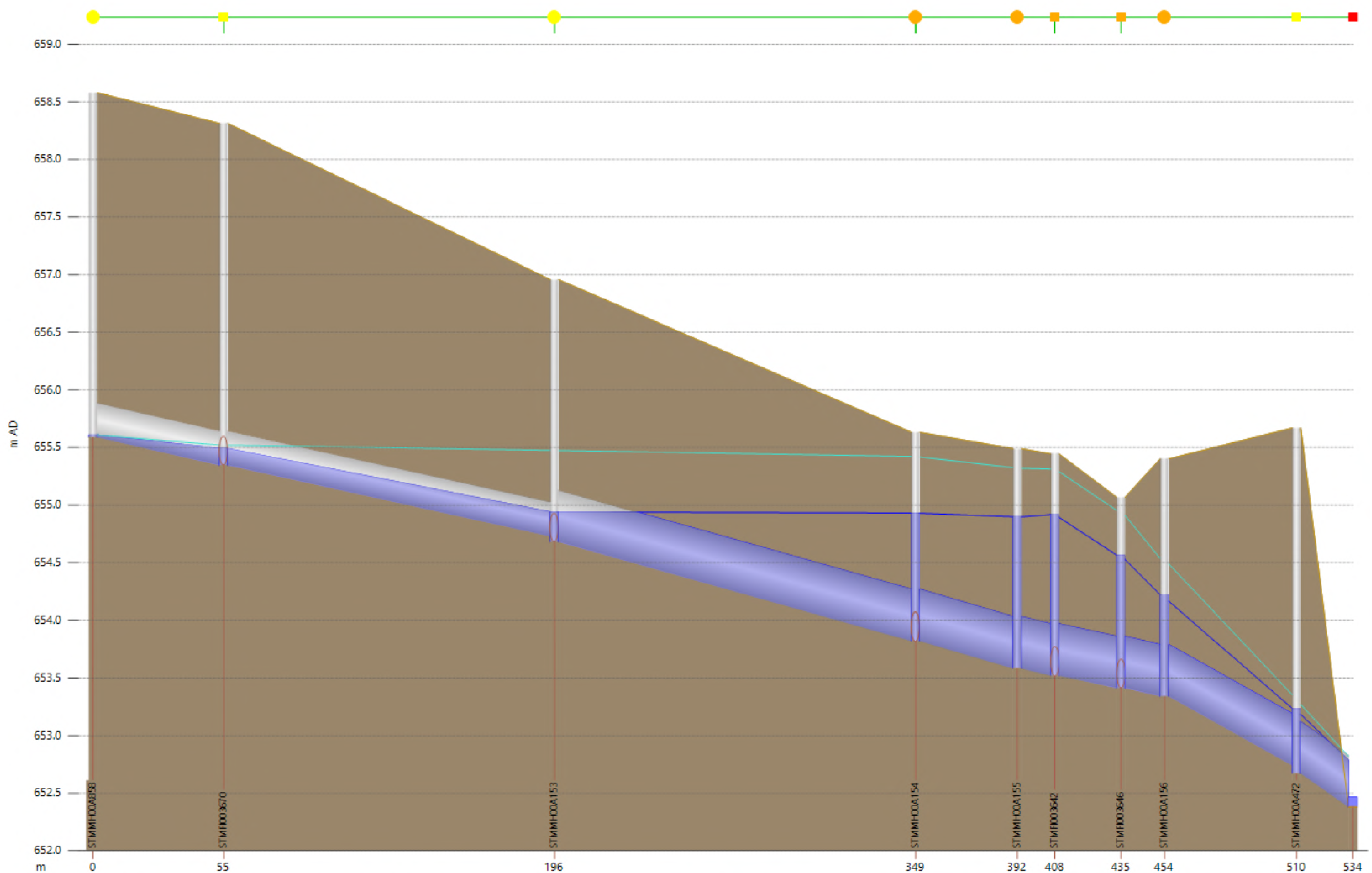


FIGURE APPENDIX A.15
EXISTING CONDITIONS - HGL PROFILE 14
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL
LLOYDMINSTER



Link		STMMH00A858.1	STMFI003670.1	STMMH00A153.1	STMMH00A154.1	-	-	-	STMMH00A156.1	-	
r.pfc (m3/s)		0.064	0.064	0.214	0.212	0.178	0.178	0.178	0.295	0.315	
DS flow (m3/s)		0.00389	0.02972	0.05460	0.11968	-	0.33176	-	0.36162	0.36118	

Legend

- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation

FIGURE APPENDIX A.16
EXISTING CONDITIONS - HGL PROFILE 15
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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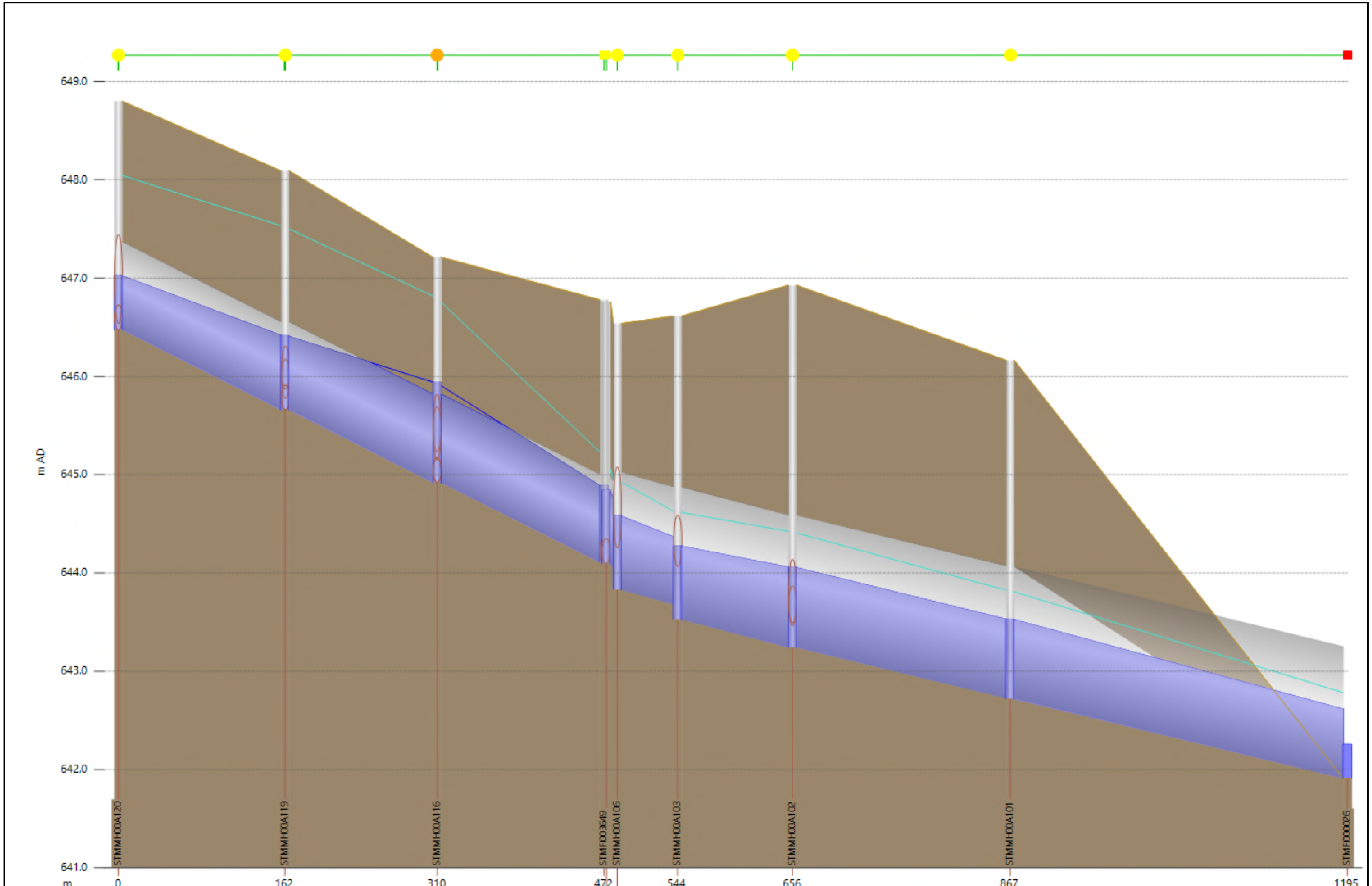

Link		STMMH00A120.1	STMMH00A119.1	STMMH00A116.1	-	-	STMMH00A103.1	STMMH00A102.1	STMMH00A101.1	
r.pfc (m3/s)		1.283	1.281	1.280	-	1.969	2.699	2.632	2.650	
DS flow (m3/s)		0.85977	1.02301	1.42403	-	1.56841	1.51035	1.77228	1.76945	

Legend

- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation

FIGURE APPENDIX A.17
EXISTING CONDITIONS - HGL PROFILE 16
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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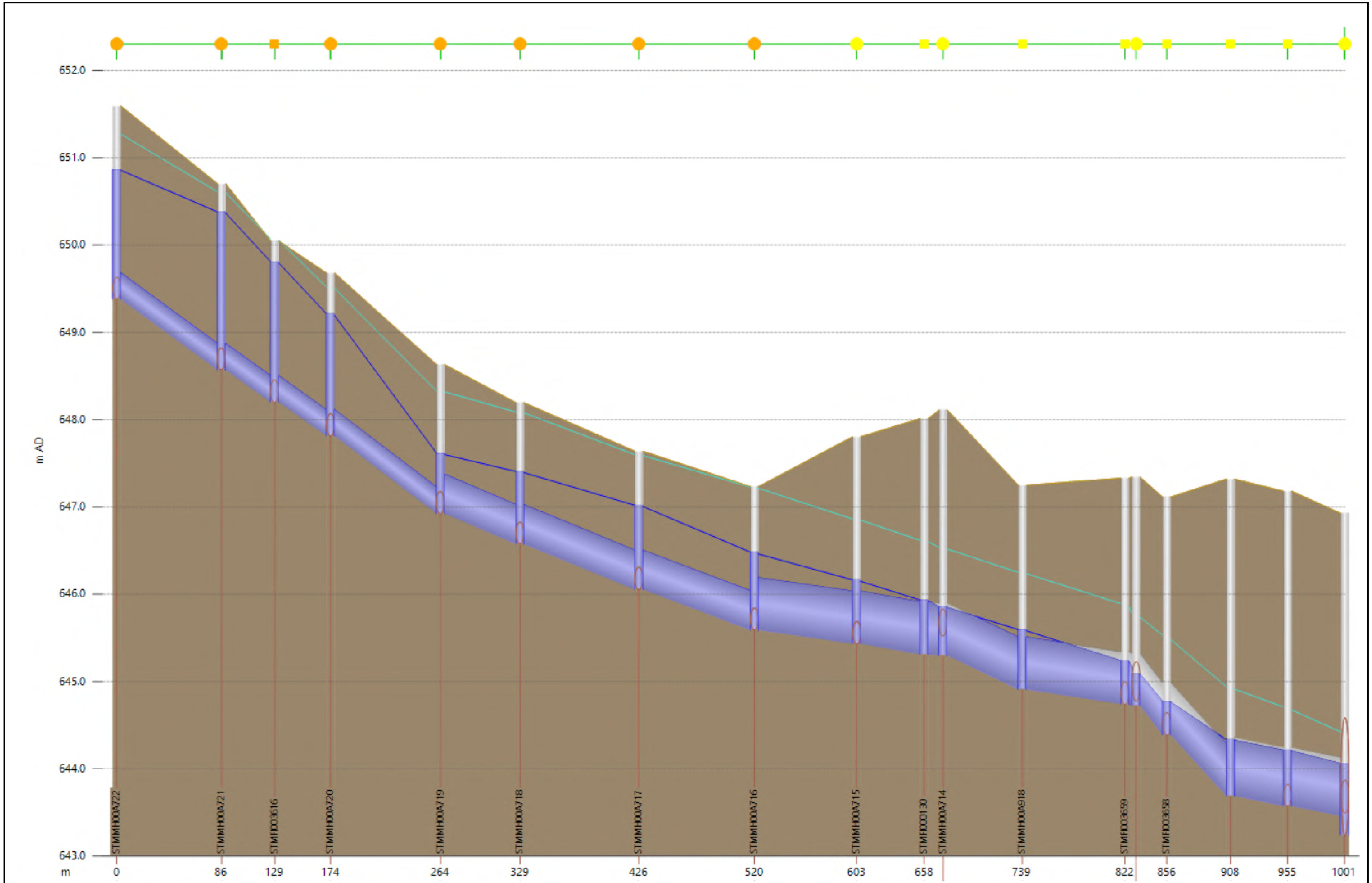

Link		STMMH00A722.1	-	-	STMMH00A720.1	-	STMMH00A718.1	STMMH00A717.1	STMMH00A716.1	-	-	-	STMMH00A918.1	-	-	-	-	-	
r.pfc (m3/s)		0.094	0.089	0.089	0.096	0.210	0.209	0.200	0.265	0.290	-	0.478	0.274	-	0.712	0.712	0.418	0.418	
DS flow (m3/s)		0.07427	0.11342	0.10976	0.12975	0.15478	0.17680	0.21104	0.36781	0.38584	-	0.37846	0.37976	-	-	0.45948	0.45887	0.51264	

FIGURE APPENDIX A.18
EXISTING CONDITIONS - HGL PROFILE 17
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL
LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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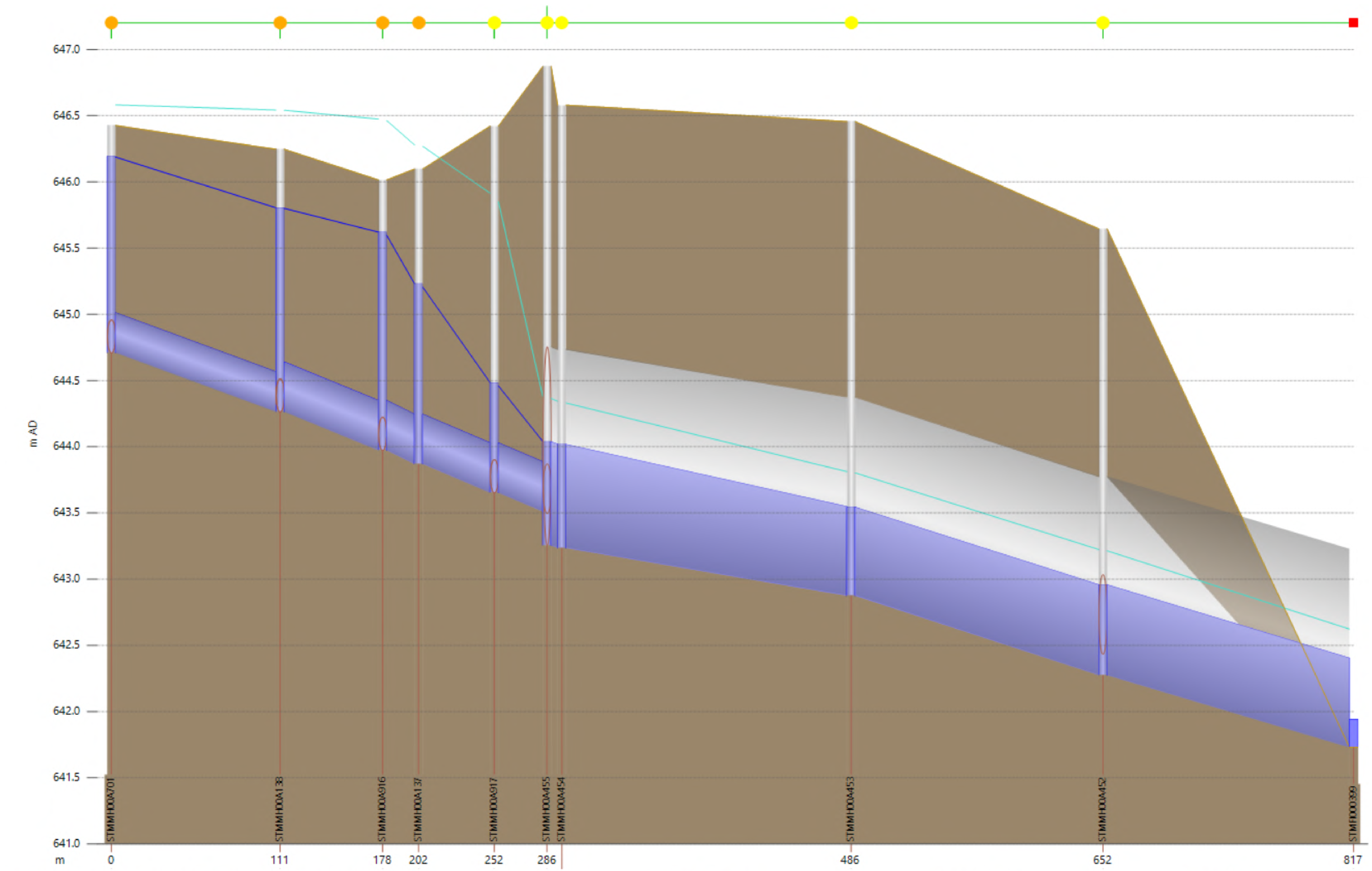
Legend

- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation



Link		STMMH00A701.1	STMMH00A138.1	-	-	-	-	STMMH00A454.1	STMMH00A453.1	STMMH00A452.1
r.pfc (m3/s)		0.061	0.115	0.116	0.116	0.112	-	3.076	4.255	4.065
DS flow (m3/s)		0.05717	0.09107	-	0.21721	0.21741	-	1.70815	1.70712	1.70643

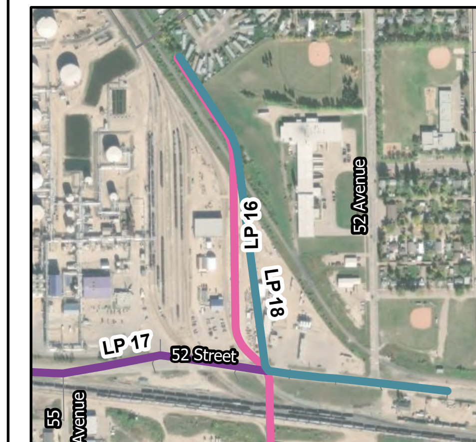


FIGURE APPENDIX A.19
EXISTING CONDITIONS - HGL PROFILE 18
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

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Credits:World Imagery: Vermilion River County, Maxar

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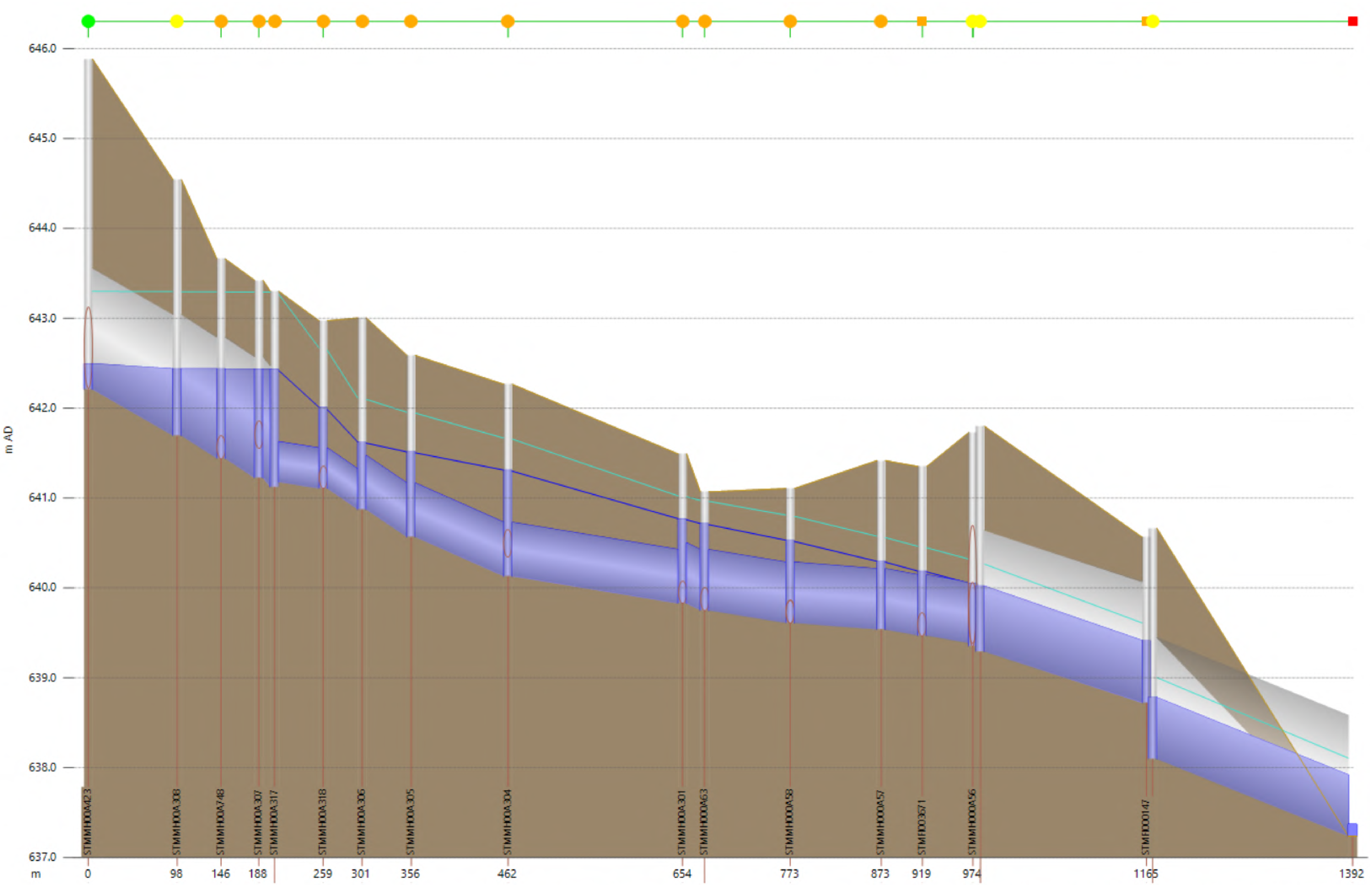


Link		-	-	-	-	-	-	-	STMMH00A305.1	STMMH00A304.1	-	-	-	-	-		STMMH000A54.1		STMMH00A647.1	
r.pfc (m3/s)		3.873	3.866	3.863	-	0.103	0.211	0.463	0.393	0.244	-	0.324	0.227	0.324	0.324		2.984		3.337	
DS flow (m3/s)		0.29121	-	-	-	0.26823	-	0.26243	0.26259	0.32651	-	0.37154	0.40562	-	0.41011		1.68795		1.68287	

Legend

- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation

FIGURE APPENDIX A.20
EXISTING CONDITIONS - HGL PROFILE 19
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

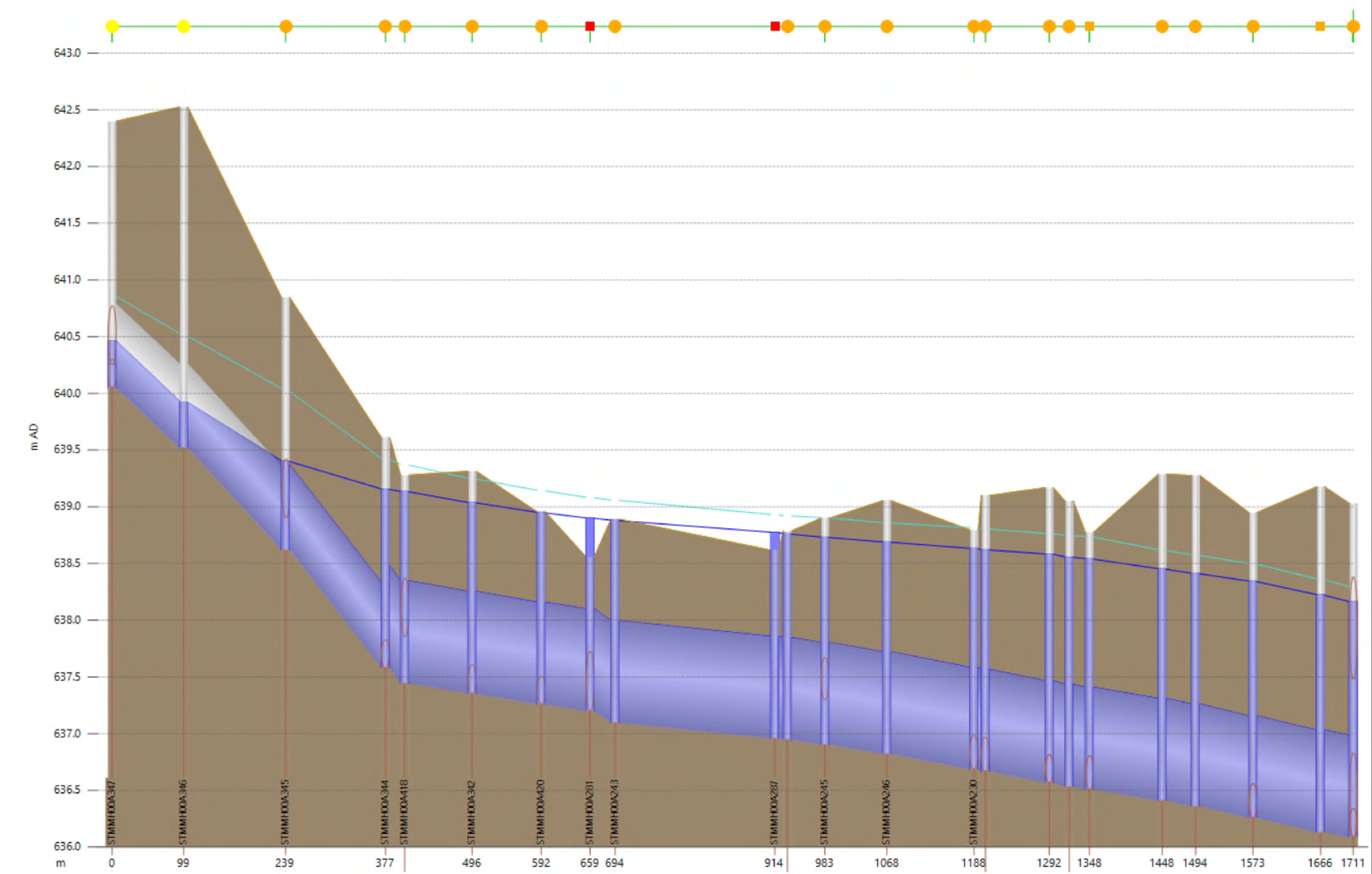
Credits:World Imagery: Vermilion River County, Maxar

Date: 2024-09-13 Document: C:\Users\lche\Desktop\L.Che\Projects\28310 Lloydminster Stormwater Master Plan\30_Technical\GIS\28310_Lloydminster SWMP Appendix\28310_Lloydminster SWMP Appendix.aprx

Integrated Expertise. Locally Delivered.

Legend

- 100 Yr 4 Hr Chicago Storm HGL
- 5 Yr 4 Hr Chicago Storm HGL
- Ground Elevation



Link		-	STMMH00A346.1	STMMH00A345.1	-	-	-	-	-	STMMH00A243.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
r.pfc (m3/s)		0.815	0.891	0.967	-	0.573	0.574	0.531	-	0.453	-	0.522	0.561	0.613	-	0.611	-	-	0.565	0.591	0.660	0.662	0.573		
DS flow (m3/s)		0.47400	0.47337	0.47791	-	0.61285	0.57145	0.48624	-	0.42037	-	-	0.50012	0.43420	-	0.46609	-	-	0.52113	-	0.52390	0.61631	-		

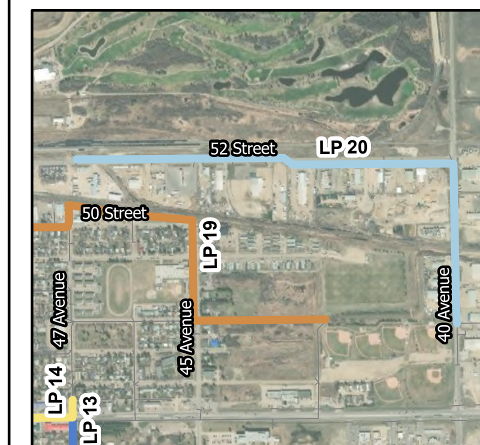


FIGURE APPENDIX A.21
EXISTING CONDITIONS - HGL PROFILE 20
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

Integrated Expertise. Locally Delivered.

APPENDIX
CCTV Inspection Reports

B

Pipe Graphic Report of PSR 2661 for ISL

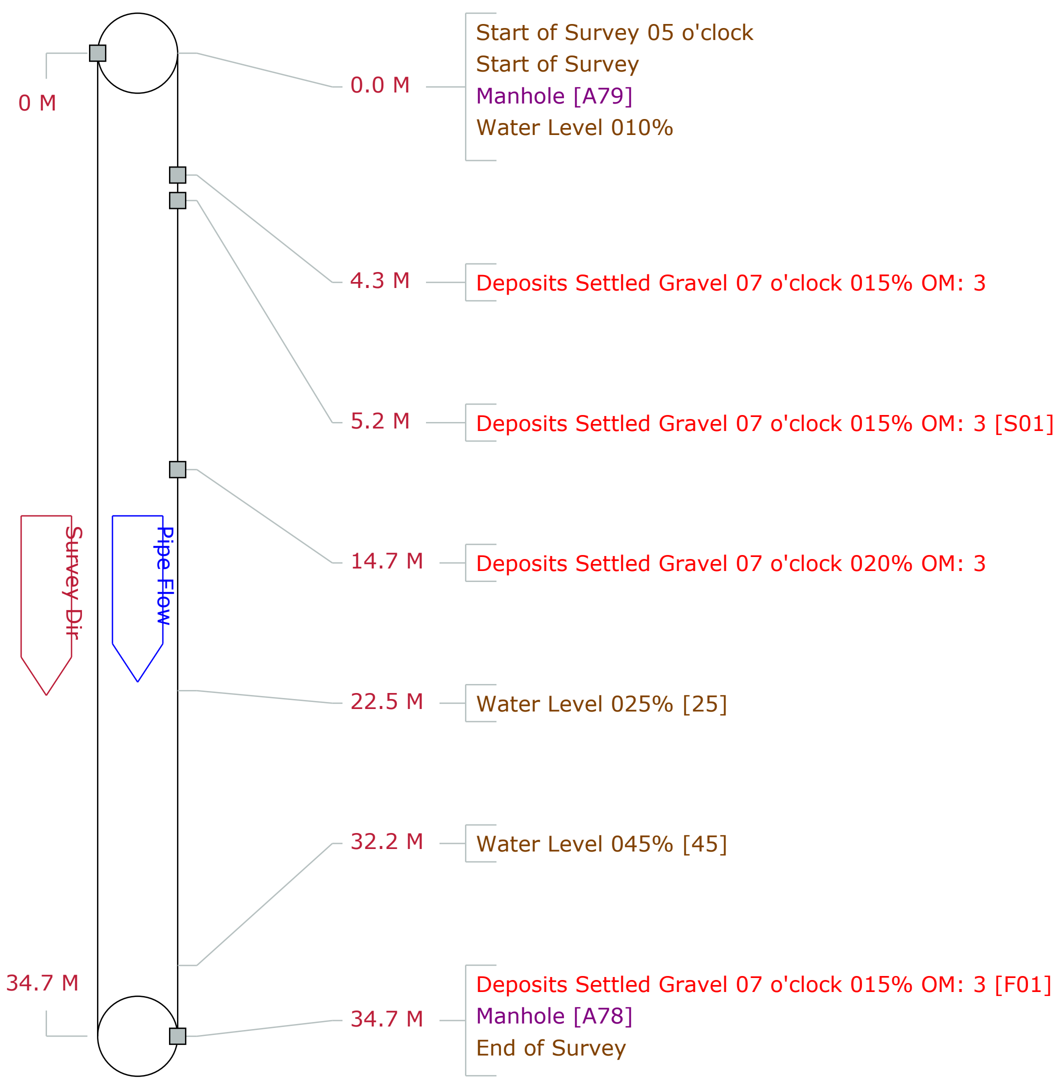
Setup 1 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-13 **Time** 11:29 **Street** 42nd Street
City Lloydminster **Further location details**

Up A79 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A78 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Downstream **Flow control** **Media No**
Shape Circular **Height** 600 **Width** **mm** **Preclean** J **Date Cleaned** 2023-06-13
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** 34.7 **M** **Length Surveyed** 34.70 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Dry
Purpose **Cat**

Additional info
Location
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**

Structural O & M Constructional
Miscellaneous Hydraulic



McGills Industrial Services Inc.
Phone:306-664-2220

Tabular Report of PSR 2661 for ISL

Setup 1	**Surveyor** Ben Cooper	**Certificate #** U-315-06023838	**System Owner**
Drainage	**Survey Customer** ISL		
P/O #	**Date** 2023-06-13	**Time** 11:29	**Street** 42nd Street
City Lloydminster	**Further location details**		
Up A79	**Rim to invert**	**Grade to invert**	**Rim to grade** M
Down A78	**Rim to invert**	**Grade to invert**	**Rim to grade** M
Use Stormwater	**Direction** Down	**Flow control**	**Media No**
Shape Circular	**Height** 600 **Width** mm	**Preclean** J	**Date Cleaned** 2023-06-13
Material Concrete Pipe (non-reinforced)	**Joint length** M	**Total length** 34.7 M	**Length Surveyed** 34.7 M
Lining	**Year laid**	**Year rehabilitated**	**Weather** Dry
Purpose	**Cat**		**Pressure**
Additional info		Structural	O & M / Constructional / Miscellaneous
Location			
Project Lloydminster Phase 2-Storm		**Work Order**	
Northing	**Easting**	**Elevation**	
Coordinate System		**GPS Accuracy**	

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey					05			
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A79
0.0			MWL	Water Level			10					
4.3			DSGV	Deposits Settled Gravel			15		07			
5.2		S01	DSGV	Deposits Settled Gravel			15		07			
14.7			DSGV	Deposits Settled Gravel			20		07			
22.5			MWL	Water Level			25					25
32.2			MWL	Water Level			45					45
34.7		F01	DSGV	Deposits Settled Gravel			15		07			
34.7			AMH	Manhole								A78
34.7			FH	End of Survey								

34.7 **M** **Total Length Surveyed**

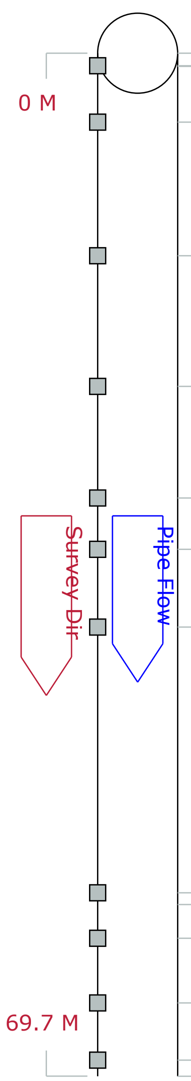
Scores

Structural:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0
O&M:	**Pipe Rating** 66	**Pipe Ratings Index** 3	**Peak** 6	**Mean Pipe** 1.9

Pipe Graphic Report of PSR 1642 for ISL

Setup	2	**Surveyor**	Ben Cooper	**Certificate #**	U-315-06023838	**System Owner**	
Drainage		**Survey Customer**	ISL				
P/O #		**Date**	2023-06-13	**Time**	12:35	**Street**	42nd Street
City	Lloydminster	**Further location details**					
Up	A78	**Rim to invert**		**Grade to invert**		**Rim to grade**	M
Down	A77	**Rim to invert**		**Grade to invert**		**Rim to grade**	M
Use	Stormwater	**Direction**	Downstream	**Flow control**		**Media No**	
Shape	Circular	**Height**	600	**Width**	mm	**Preclean**	J
						Date Cleaned	2023-06-13
Material	Concrete Pipe (non-reinforced)	**Joint length**	M	**Total length**	142.2 M	**Length Surveyed**	142.20 M
Lining		**Year laid**		**Year rehabilitated**		**Weather**	Dry
Purpose		**Cat**					
Additional info							
Location							
Project	Lloydminster Phase 2-Storm			**Work Order**			
Northing		**Easting**		**Elevation**			
Coordinate System				**GPS Accuracy**			

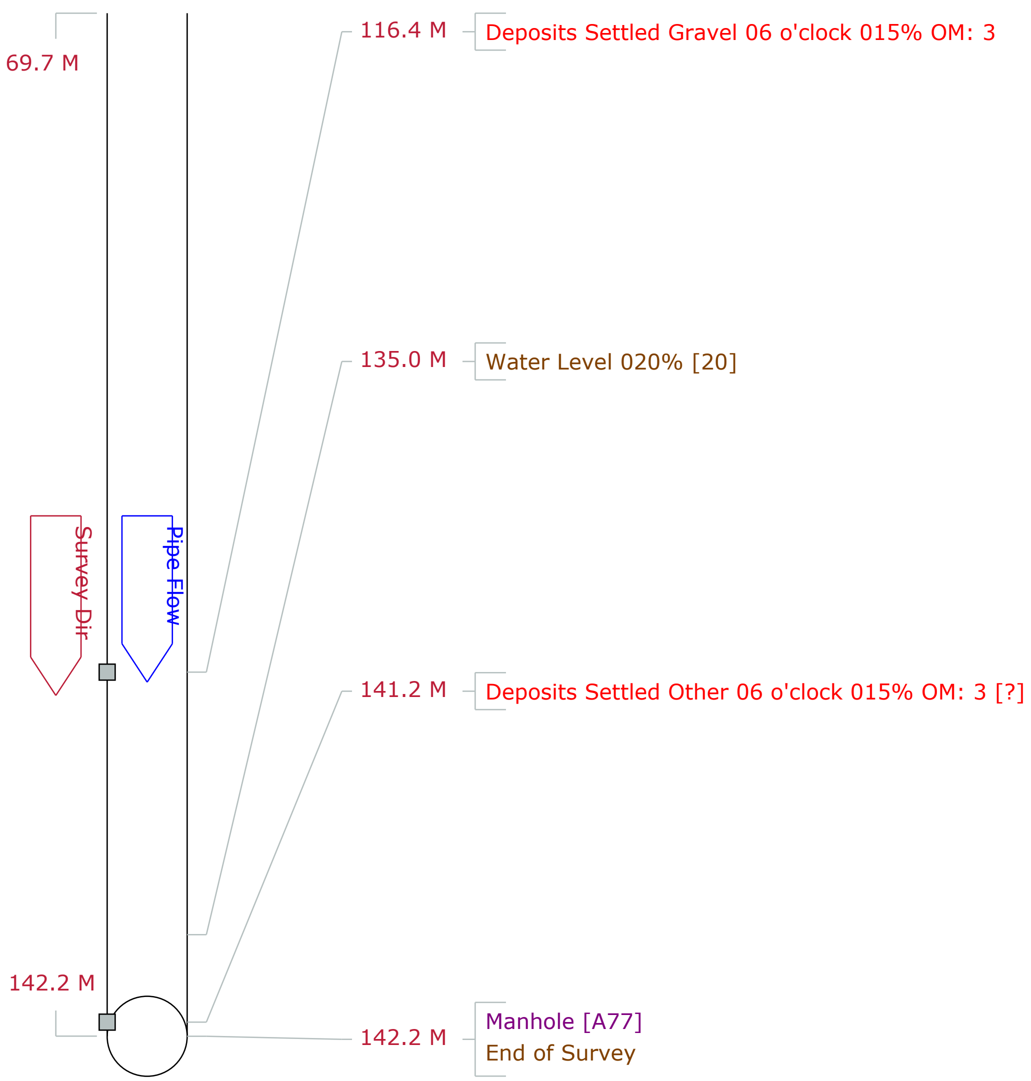
Structural | O & M | Constructional | Miscellaneous | Hydraulic



- 0.0 M
- 0.9 M — Start of Survey 05 o'clock
- 0.9 M — Start of Survey; Manhole [A78]; Water Level 015% [15]
- 4.7 M — Deposits Settled Other 06 o'clock 030% OM: 4 [Heavy debris]
- 13.8 M — Deposits Settled Other 06 o'clock 025% OM: 4 [Heavy Debris]
- 22.7 M — Deposits Settled Gravel 03 o'clock 010% OM: 2
- 30.3 M — Deposits Settled Gravel 06 o'clock 025% OM: 4
- 33.8 M — Deposits Settled Gravel 06 o'clock 030% OM: 4
- 39.1 M — Deposits Settled Gravel 06 o'clock 020% OM: 3
- 57.2 M — Deposits Settled Other 06 o'clock 040% OM: 5 [Heavy debris]
- 58.0 M — General Observation [Unmapped manhole]
- 60.3 M — Deposits Settled Gravel 06 o'clock 025% OM: 4
- 64.7 M — Deposits Settled Other 06 o'clock 025% OM: 4 [Heavy Debris]
- 68.6 M — Deposits Settled Gravel 06 o'clock 020% OM: 3
- 69.7 M — General Observation [Unmapped manhole]

Pipe Graphic Report of PSR 1642 for ISL

Setup 2	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #		**Date** 2023-06-13	**Time** 12:35		**Street** 42nd Street		
City Lloydminster		**Further location details**					
Up A78		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A77		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Downstream		**Flow control**		**Media No**	
Shape Circular		**Height** 600	**Width**	**mm**	**Preclean** J	**Date Cleaned** 2023-06-13	
Material Concrete Pipe (non-reinforced)			**Joint length**	**M**	**Total length** 142.2 **M**	**Length Surveyed** 142.20 **M**	
Lining			**Year laid**		**Year rehabilitated**	**Weather** Dry	
Purpose			**Cat**				
Additional info					Structural	O & M	Constructional
Location					Miscellaneous	Hydraulic	
Project Lloydminster Phase 2-Storm					**Work Order**		
Northing			**Easting**		**Elevation**		
Coordinate System					**GPS Accuracy**		



McGills Industrial Services Inc.
Phone:306-664-2220

Tabular Report of PSR 1642 for ISL

Setup 2 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-13 **Time** 12:35 **Street** 42nd Street
City Lloydminster **Further location details**

Up A78 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A77 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Down **Flow control** **Media No**
Shape Circular **Height** 600 **Width** **mm** **Preclean** J **Date Cleaned** 2023-06-13
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** 142.2 **M** **Length Surveyed** 142.2 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Dry
Purpose **Cat** **Pressure**

Additional info Structural O & M Constructional Miscellaneous
Location
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.9			ST	Start of Survey					05			
0.9			ST	Start of Survey								
0.9			AMH	Manhole								A78
0.9			MWL	Water Level			15					15
4.7			DSZ	Deposits Settled Other			30		06			Heavy debris
13.8			DSZ	Deposits Settled Other			25		06			Heavy Debris
22.7			DSGV	Deposits Settled Gravel			10		03			
30.3			DSGV	Deposits Settled Gravel			25		06			
33.8			DSGV	Deposits Settled Gravel			30		06			
39.1			DSGV	Deposits Settled Gravel			20		06			
57.2			DSZ	Deposits Settled Other			40		06			Heavy debris
58.0			MGO	General Observation								Unmapped manhole
60.3			DSGV	Deposits Settled Gravel			25		06			
64.7			DSZ	Deposits Settled Other			25		06			Heavy Debris
68.6			DSGV	Deposits Settled Gravel			20		06			
69.7			MGO	General Observation								Unmapped manhole
116.4			DSGV	Deposits Settled Gravel			15		06			
135.0			MWL	Water Level			20					20
141.2			DSZ	Deposits Settled Other			15		06			?
142.2			AMH	Manhole								A77
142.2			FH	End of Survey								

142.2 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0
O&M:	**Pipe Rating** 43	**Pipe Ratings Index** 3.6	**Peak** 5	**Mean Pipe** 0.3

Pipe Graphic Report of PSR 1097 **for** ISL

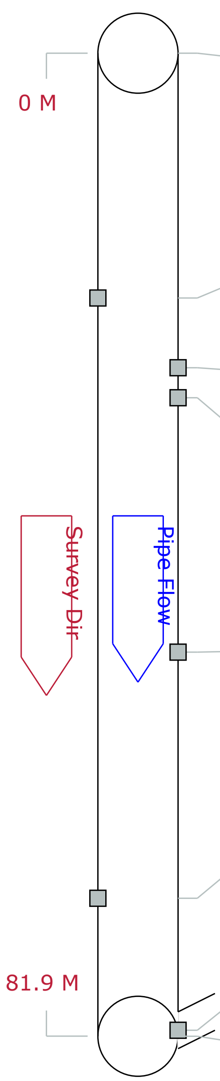
Setup 3 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-13 **Time** 14:49 **Street** 42nd Street
City Lloydminster **Further location details**

Up A76 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A33 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Downstream **Flow control** **Media No**
Shape Circular **Height** 600 **Width** **mm** **Preclean** J **Date Cleaned** 2023-06-13
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** **M** **Length Surveyed** 81.90 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Dry
Purpose **Cat**

Additional info
Location
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**

Structural | O & M | Constructional | Miscellaneous | Hydraulic



0.0 M — Start of Survey; Manhole [A76]; Water Level 010%

20.4 M — Deposits Settled Gravel 06 o'clock 015% OM: 3

26.2 M — Obstacle Intruding Thru Wall 11 o'clock 005% OM: 2

28.7 M — Deposits Settled Gravel 08 o'clock 015% OM: 3

49.9 M — Obstacle Rocks 08 o'clock 020% OM: 3

70.4 M — Deposits Settled Gravel 06 o'clock 015% OM: 3

81.4 M — Tap Break-in Defective 8 09 o'clock OM: 3

81.9 M — Abandoned Survey [TBD]

Tabular Report of PSR 1097 for ISL

Setup 3	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #	**Date** 2023-06-13		**Time** 14:49	**Street** 42nd Street			
City Lloydminster		**Further location details**					
Up A76		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A33		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Down		**Flow control**		**Media No**	
Shape Circular		**Height** 600 **Width**		**mm** **Preclean** J		**Date Cleaned** 2023-06-13	
Material Concrete Pipe (non-reinforced)		**Joint length**	**M**	**Total length**	**M**	**Length Surveyed** 81.9	**M**
Lining		**Year laid**		**Year rehabilitated**		**Weather** Dry	
Purpose			**Cat**			**Pressure**	
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous			
Project Lloydminster Phase 2-Storm					**Work Order**		
Northing			**Easting**		**Elevation**		
Coordinate System					**GPS Accuracy**		

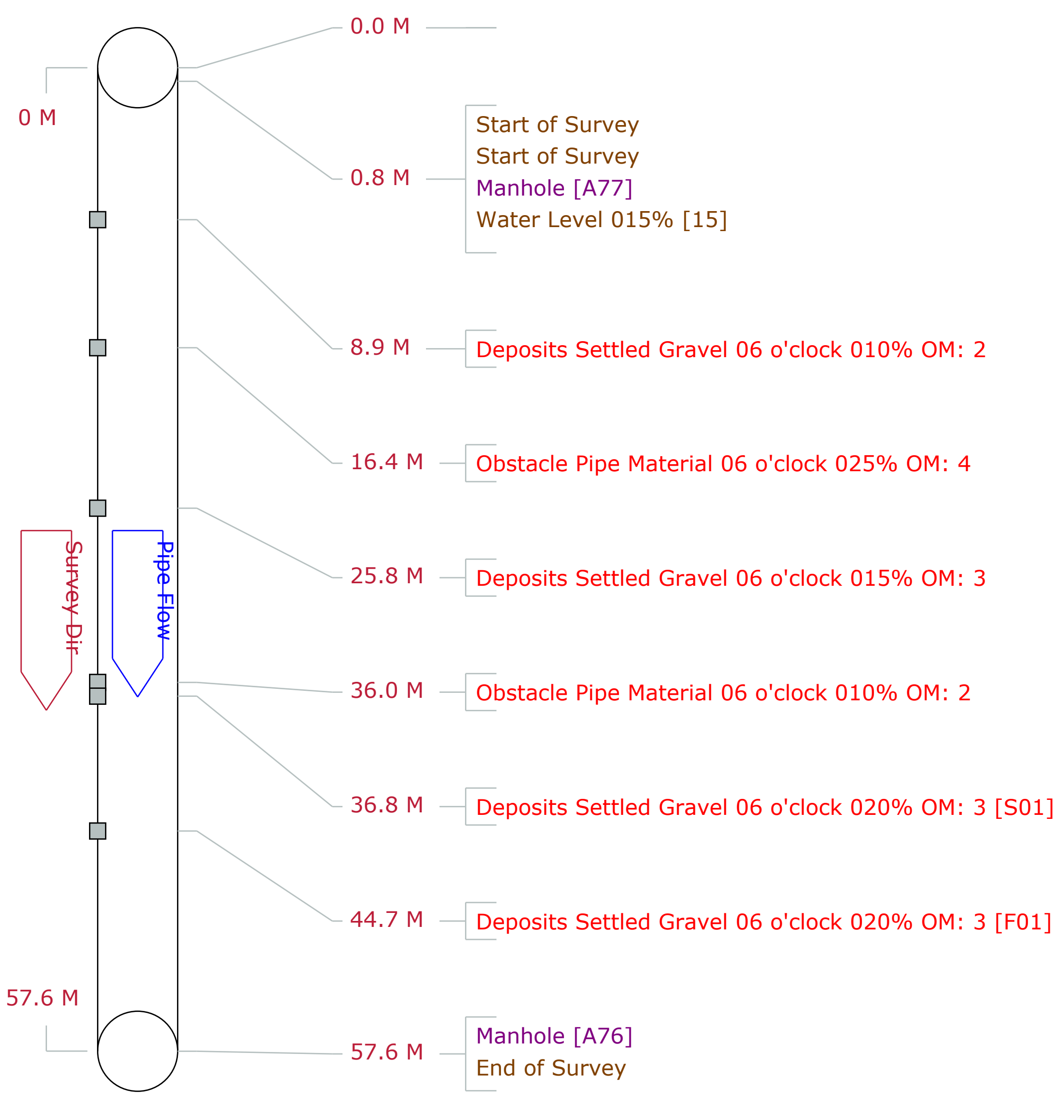
Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A76
0.0			MWL	Water Level			10					
20.4			DSGV	Deposits Settled Gravel			15		06			
26.2			OBI	Obstacle Intruding Thru Wall			5		11			
28.7			DSGV	Deposits Settled Gravel			15		08			
49.9			OBR	Obstacle Rocks			20		08			
70.4			DSGV	Deposits Settled Gravel			15		06			
81.4			TBD	Tap Break-in Defective	8				09			
81.9			MSA	Abandoned Survey								TBD

81.9 **M** **Total Length Surveyed**

Scores					
	Structural:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0
	O&M:	**Pipe Rating** 17	**Pipe Ratings Index** 2.8	**Peak** 3	**Mean Pipe** 0.2

Pipe Graphic Report of PSR 486 **for** ISL

Setup 4	**Surveyor** Ben Cooper	**Certificate #** U-315-06023838	**System Owner**				
Drainage	**Survey Customer** ISL						
P/O #	**Date** 2023-06-13	**Time** 15:18	**Street** 42nd Street				
City Lloydminster	**Further location details**						
Up A77	**Rim to invert**	**Grade to invert**	**Rim to grade**	**M**			
Down A76	**Rim to invert**	**Grade to invert**	**Rim to grade**	**M**			
Use Stormwater	**Direction** Downstream	**Flow control**	**Media No**				
Shape Circular	**Height** 600	**Width**	**mm**	**Preclean** J	**Date Cleaned** 2023-06-13		
Material Concrete Pipe (non-reinforced)	**Joint length**	**M**	**Total length** 57.6	**M**	**Length Surveyed** 57.60	**M**	
Lining	**Year laid**	**Year rehabilitated**	**Weather** Dry				
Purpose	**Cat**						
Additional info	Structural	O & M	Constructional				
Location	Miscellaneous	Hydraulic					
Project Lloydminster Phase 2-Storm	**Work Order**						
Northing	**Easting**	**Elevation**					
Coordinate System	**GPS Accuracy**						



McGills Industrial Services Inc.
Phone:306-664-2220

Tabular Report of PSR 486 for ISL

Setup 4 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-13 **Time** 15:18 **Street** 42nd Street
City Lloydminster **Further location details**

Up A77 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A76 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Down **Flow control** **Media No**
Shape Circular **Height** 600 **Width** **mm** **Preclean** J **Date Cleaned** 2023-06-13
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** 57.6 **M** **Length Surveyed** 57.6 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Dry
Purpose **Cat** **Pressure**

Additional info
Location
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**

Structural O & M Constructional Miscellaneous

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.8			ST	Start of Survey								
0.8			ST	Start of Survey								
0.8			AMH	Manhole								A77
0.8			MWL	Water Level			15					15
8.9			DSGV	Deposits Settled Gravel			10		06			
16.4			OBM	Obstacle Pipe Material			25		06			
25.8			DSGV	Deposits Settled Gravel			15		06			
36.0			OBM	Obstacle Pipe Material			10		06			
36.8		S01	DSGV	Deposits Settled Gravel			20		06			
44.7		F01	DSGV	Deposits Settled Gravel			20		06			
57.6			AMH	Manhole								A76
57.6			FH	End of Survey								

57.6 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0
O&M:	**Pipe Rating** 26	**Pipe Ratings Index** 2.9	**Peak** 4	**Mean Pipe** 0.5

Pipe Graphic Report of PSR 1592 for ISL

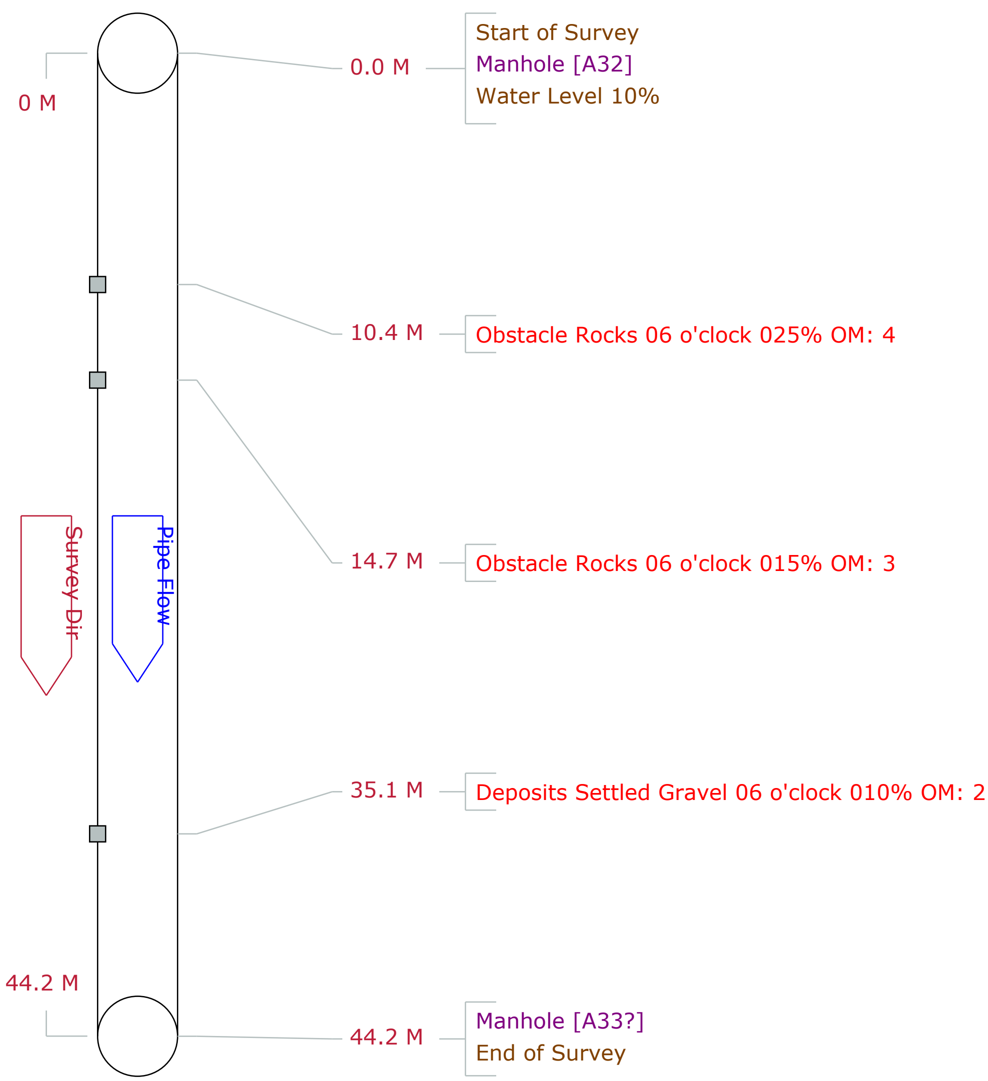
Setup 5 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-13 **Time** 16:22 **Street** 42nd Street
City Lloydminster **Further location details**

Up A32 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A33 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Downstream **Flow control** **Media No**
Shape Circular **Height** 675 **Width** **mm** **Preclean** J **Date Cleaned** 2023-06-13
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** 44.2 **M** **Length Surveyed** 44.20 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Dry
Purpose **Cat**

Additional info
Location
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**

Structural O & M Constructional
Miscellaneous Hydraulic



McGills Industrial Services Inc.
Phone:306-664-2220

Tabular Report of PSR 1592 for ISL

Setup 5	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #		**Date** 2023-06-13	**Time** 16:22	**Street** 42nd Street			
City Lloydminster		**Further location details**					
Up A32		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A33		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Down		**Flow control**		**Media No**	
Shape Circular		**Height** 675 **Width**		**mm**	**Preclean** J	**Date Cleaned** 2023-06-13	
Material Concrete Pipe (non-reinforced)		**Joint length**	**M**	**Total length** 44.2 **M**		**Length Surveyed** 44.2	**M**
Lining		**Year laid**		**Year rehabilitated**		**Weather** Dry	
Purpose		**Cat**				**Pressure**	
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous			
Project Lloydminster Phase 2-Storm				**Work Order**			
Northing		**Easting**		**Elevation**			
Coordinate System				**GPS Accuracy**			

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A32
0.0			MWL	Water Level			10					
10.4			OBR	Obstacle Rocks			25		06			
14.7			OBR	Obstacle Rocks			15		06			
35.1			DSGV	Deposits Settled Gravel			10		06			
44.2			AMH	Manhole								A33?
44.2			FH	End of Survey								

44.2 **M** **Total Length Surveyed**

Scores					
	Structural:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0
	O&M:	**Pipe Rating** 9	**Pipe Ratings Index** 3	**Peak** 4	**Mean Pipe** 0.2

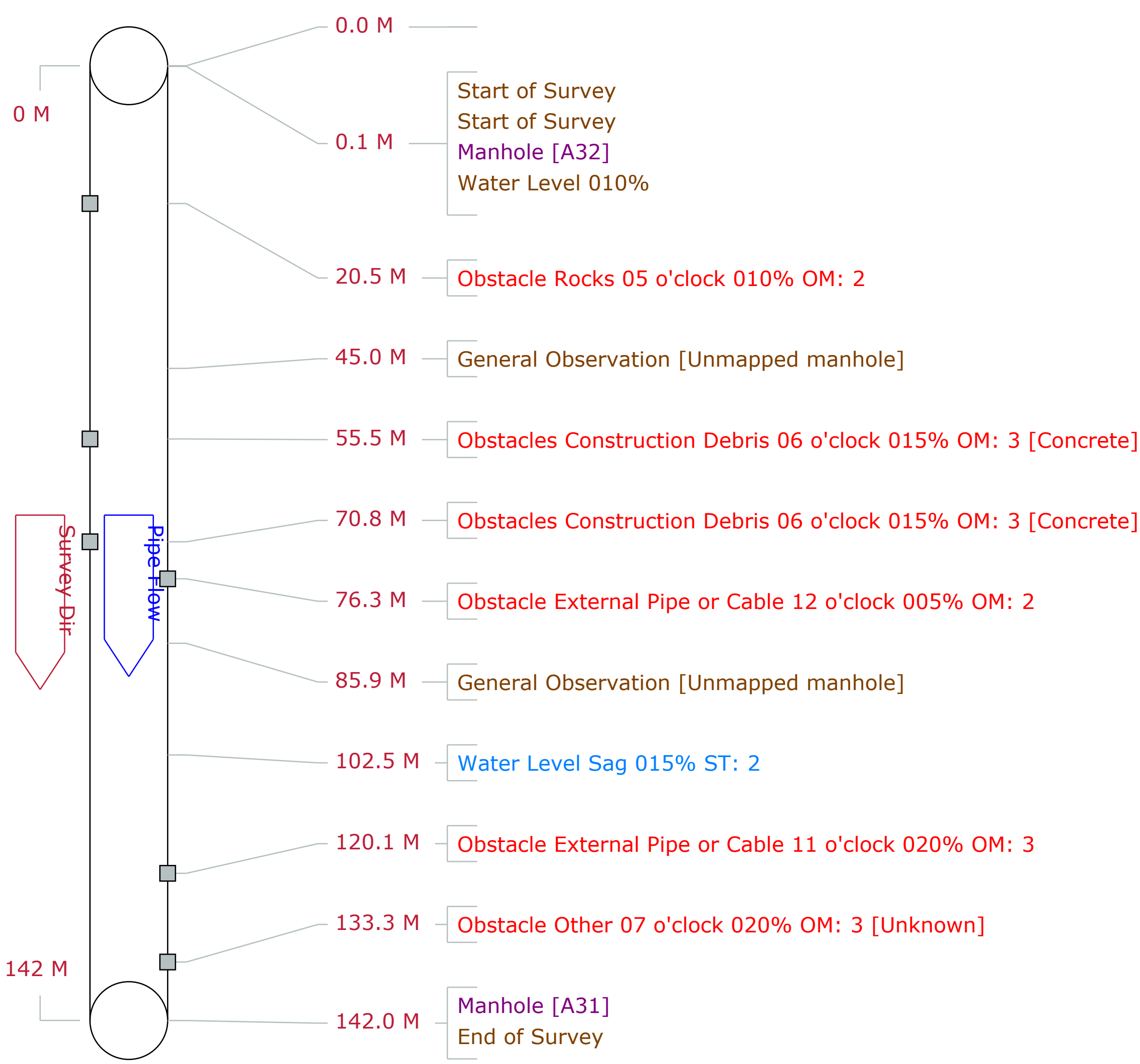
Pipe Graphic Report of PSR 2718 for ISL

Setup 6 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-13 **Time** 17:23 **Street** 42nd Street
City Lloydminster **Further location details**

Up A32 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A31 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Downstream **Flow control** **Media No**
Shape Circular **Height** 675 **Width** **mm** **Preclean** J **Date Cleaned** 2023-06-13
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** 142.0 **M** **Length Surveyed** 142.00 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Dry
Purpose **Cat**

Additional info
Location
Structural O & M Constructional Miscellaneous Hydraulic
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**



Tabular Report of PSR 2718 for ISL

Setup 6	**Surveyor** Ben Cooper	**Certificate #** U-315-06023838	**System Owner**
Drainage	**Survey Customer** ISL		
P/O #	**Date** 2023-06-13	**Time** 17:23	**Street** 42nd Street
City Lloydminster	**Further location details**		
Up A32	**Rim to invert**	**Grade to invert**	**Rim to grade** M
Down A31	**Rim to invert**	**Grade to invert**	**Rim to grade** M
Use Stormwater	**Direction** Down	**Flow control**	**Media No**
Shape Circular	**Height** 675 **Width** mm	**Preclean** J	**Date Cleaned** 2023-06-13
Material Concrete Pipe (non-reinforced)	**Joint length** M	**Total length** 142.0 **M**	**Length Surveyed** 142.0 **M**
Lining	**Year laid**	**Year rehabilitated**	**Weather** Dry
Purpose	**Cat**		**Pressure**
Additional info		Structural / O & M / Constructional / Miscellaneous	
Location			
Project Lloydminster Phase 2-Storm		**Work Order**	
Northing	**Easting**	**Elevation**	
Coordinate System		**GPS Accuracy**	

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.1			ST	Start of Survey								
0.1			ST	Start of Survey								
0.1			AMH	Manhole								A32
0.1			MWL	Water Level			10					
20.5			OBR	Obstacle Rocks			10		05			
45.0			MGO	General Observation								Unmapped manhole
55.5			OBN	Obstacles Construction Debris			15		06			Concrete
70.8			OBN	Obstacles Construction Debris			15		06			Concrete
76.3			OBP	Obstacle External Pipe or Cable			5		12			
85.9			MGO	General Observation								Unmapped manhole
102.5			MWLS	Water Level Sag			15					
120.1			OBP	Obstacle External Pipe or Cable			20		11			
133.3			OBZ	Obstacle Other			20		07			Unknown
142.0			AMH	Manhole								A31
142.0			FH	End of Survey								

142.0 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 2	**Pipe Ratings Index** 2	**Peak** 2	**Mean Pipe** 0
O&M:	**Pipe Rating** 16	**Pipe Ratings Index** 2.7	**Peak** 3	**Mean Pipe** 0.1

Pipe Graphic Report of PSR 4168 **for** ISL

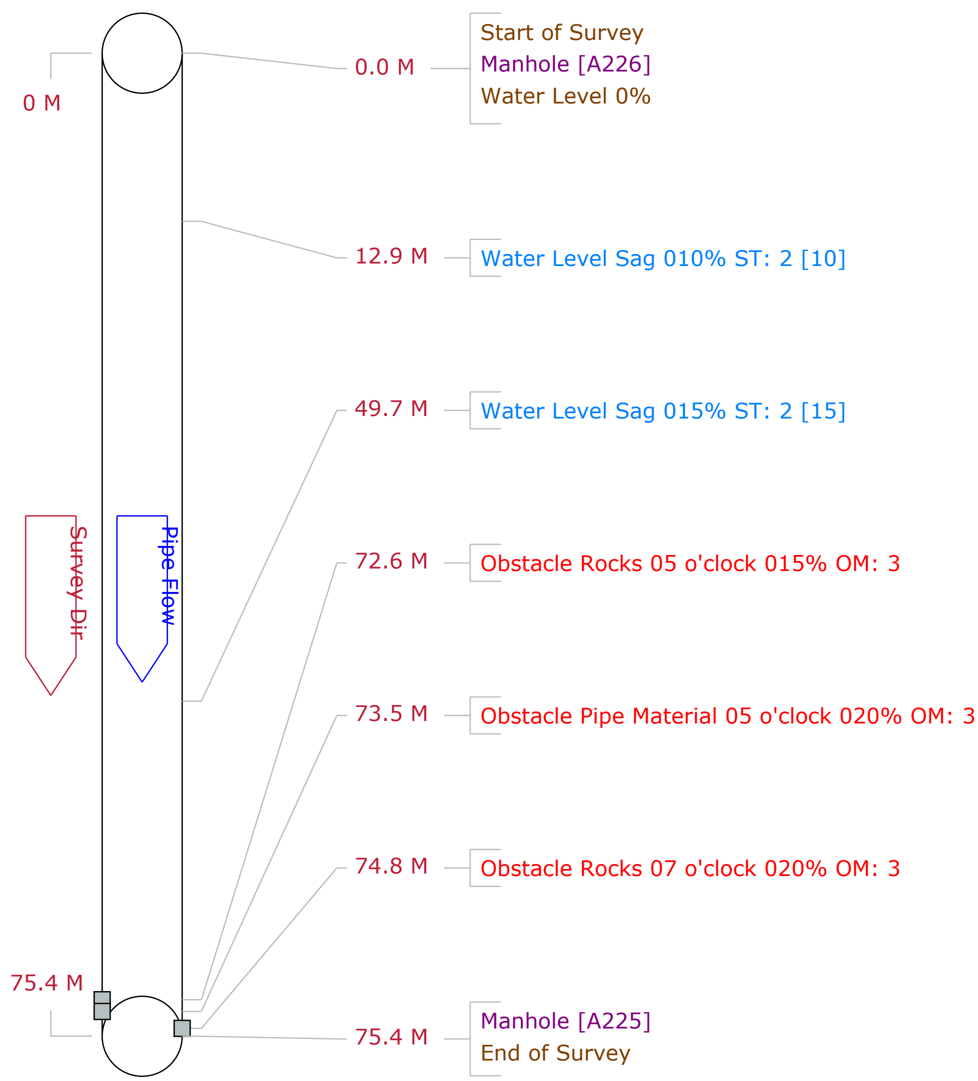
Setup 7 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-22 **Time** 10:44 **Street** 52nd Ave
City Lloydminster **Further location details**

Up A226 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A225 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Downstream **Flow control** **Media No**
Shape Circular **Height** 525 **Width** **mm** **Preclean** J **Date Cleaned** 2023-06-15
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** 75.4 **M** **Length Surveyed** 75.40 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Dry
Purpose **Cat**

Additional info
Location
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**

Structural O & M Constructional
Miscellaneous Hydraulic



Tabular Report of PSR 4168 for ISL

Setup 7 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-22 **Time** 10:44 **Street** 52nd Ave
City Lloydminster **Further location details**

Up A226 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A225 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Down **Flow control** **Media No**
Shape Circular **Height** 525 **Width** **mm** **Preclean** J **Date Cleaned** 2023-06-15
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** 75.4 **M** **Length Surveyed** 75.4 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Dry
Purpose **Cat** **Pressure**

Additional info
Location
Structural O & M Constructional Miscellaneous
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A226
0.0			MWL	Water Level			0					
12.9			MWLS	Water Level Sag			10					10
49.7			MWLS	Water Level Sag			15					15
72.6			OBR	Obstacle Rocks			15		05			
73.5			OBM	Obstacle Pipe Material			20		05			
74.8			OBR	Obstacle Rocks			20		07			
75.4			AMH	Manhole								A225
75.4			FH	End of Survey								

75.4 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 4	**Pipe Ratings Index** 2	**Peak** 2	**Mean Pipe** 0.1
O&M:	**Pipe Rating** 9	**Pipe Ratings Index** 3	**Peak** 3	**Mean Pipe** 0.1

Pipe Graphic Report of PSR 4948 for ISL

Setup 8 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-22 **Time** 11:08 **Street** 52nd Ave
City Lloydminster **Further location details**

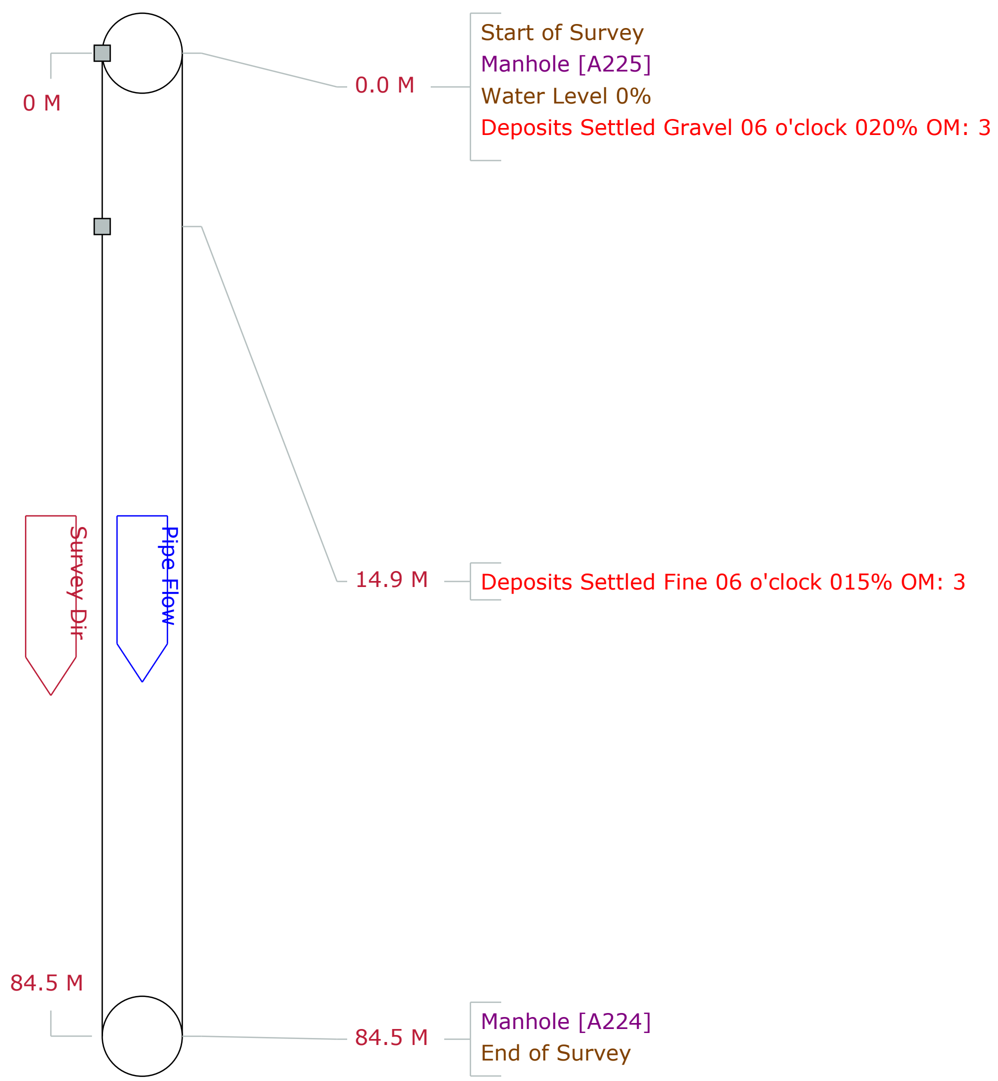
Up A225 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A224 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Downstream **Flow control** **Media No**
Shape Circular **Height** 675 **Width** **mm** **Preclean** J **Date Cleaned** 2023-06-15
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** 84.5 **M** **Length Surveyed** 84.50 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Dry
Purpose **Cat**

Additional info
Location
Project Lloydminster Phase 2-Storm

Structural O & M Constructional
Miscellaneous Hydraulic

Work Order
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**



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Tabular Report of PSR 4948 for ISL

Setup 8	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #		**Date** 2023-06-22	**Time** 11:08	**Street** 52nd Ave			
City Lloydminster		**Further location details**					
Up A225		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A224		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Down		**Flow control**		**Media No**	
Shape Circular		**Height** 675 **Width**		**mm**	**Preclean** J	**Date Cleaned** 2023-06-15	
Material Concrete Pipe (non-reinforced)		**Joint length**	**M**	**Total length** 84.5 **M**		**Length Surveyed** 84.5	**M**
Lining		**Year laid**		**Year rehabilitated**		**Weather** Dry	
Purpose			**Cat**			**Pressure**	
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous			
Project Lloydminster Phase 2-Storm					**Work Order**		
Northing			**Easting**		**Elevation**		
Coordinate System				**GPS Accuracy**			

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A225
0.0			MWL	Water Level			0					
0.0			DSGV	Deposits Settled Gravel			20		06			
14.9			DSF	Deposits Settled Fine			15		06			
84.5			AMH	Manhole								A224
84.5			FH	End of Survey								

84.5 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0
O&M:	**Pipe Rating** 6	**Pipe Ratings Index** 3	**Peak** 3	**Mean Pipe** 0.1

Pipe Graphic Report of PSR 2875 **for** ISL

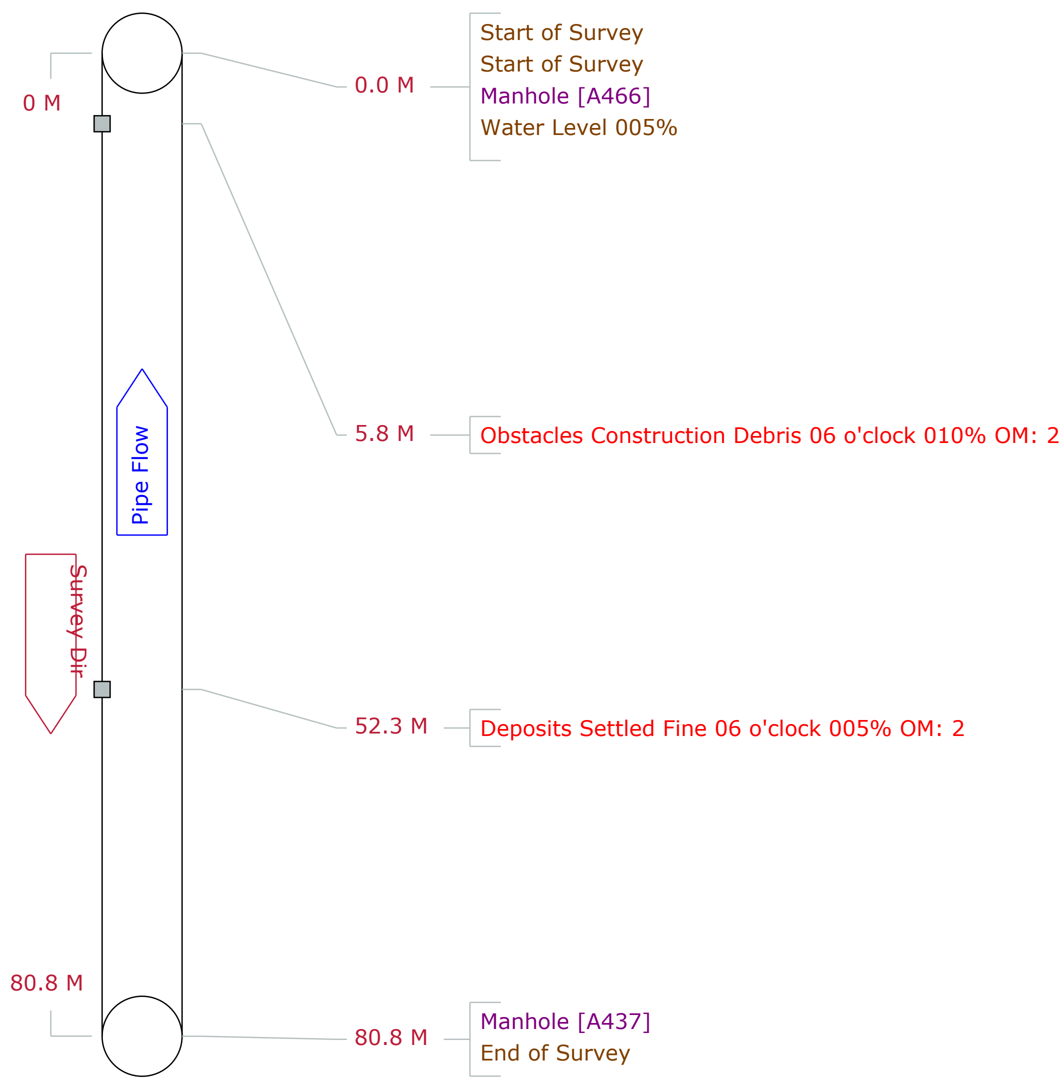
Setup 9 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-22 **Time** 12:33 **Street** 54th Ave
City Lloydminster **Further location details**

Up A437 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A466 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Upstream **Flow control** **Media No**
Shape Circular **Height** 1200 **Width** **mm** **Preclean** J **Date Cleaned** 2023-06-15
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** 80.8 **M** **Length Surveyed** 80.80 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Dry
Purpose **Cat**

Additional info
Location
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**

Structural O & M Constructional
Miscellaneous Hydraulic



Tabular Report of PSR 2875 for ISL

Setup 9 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-22 **Time** 12:33 **Street** 54th Ave
City Lloydminster **Further location details**

Up A437 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A466 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Up **Flow control** **Media No**
Shape Circular **Height** 1200 **Width** **mm** **Preclean** J **Date Cleaned** 2023-06-15
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** 80.8 **M** **Length Surveyed** 80.8 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Dry
Purpose **Cat** **Pressure**

Additional info
Location
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**

Structural O & M Constructional Miscellaneous

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A466
0.0			MWL	Water Level			5					
5.8			OBN	Obstacles Construction Debris			10		06			
52.3			DSF	Deposits Settled Fine			5		06			
80.8			AMH	Manhole								A437
80.8			FH	End of Survey								

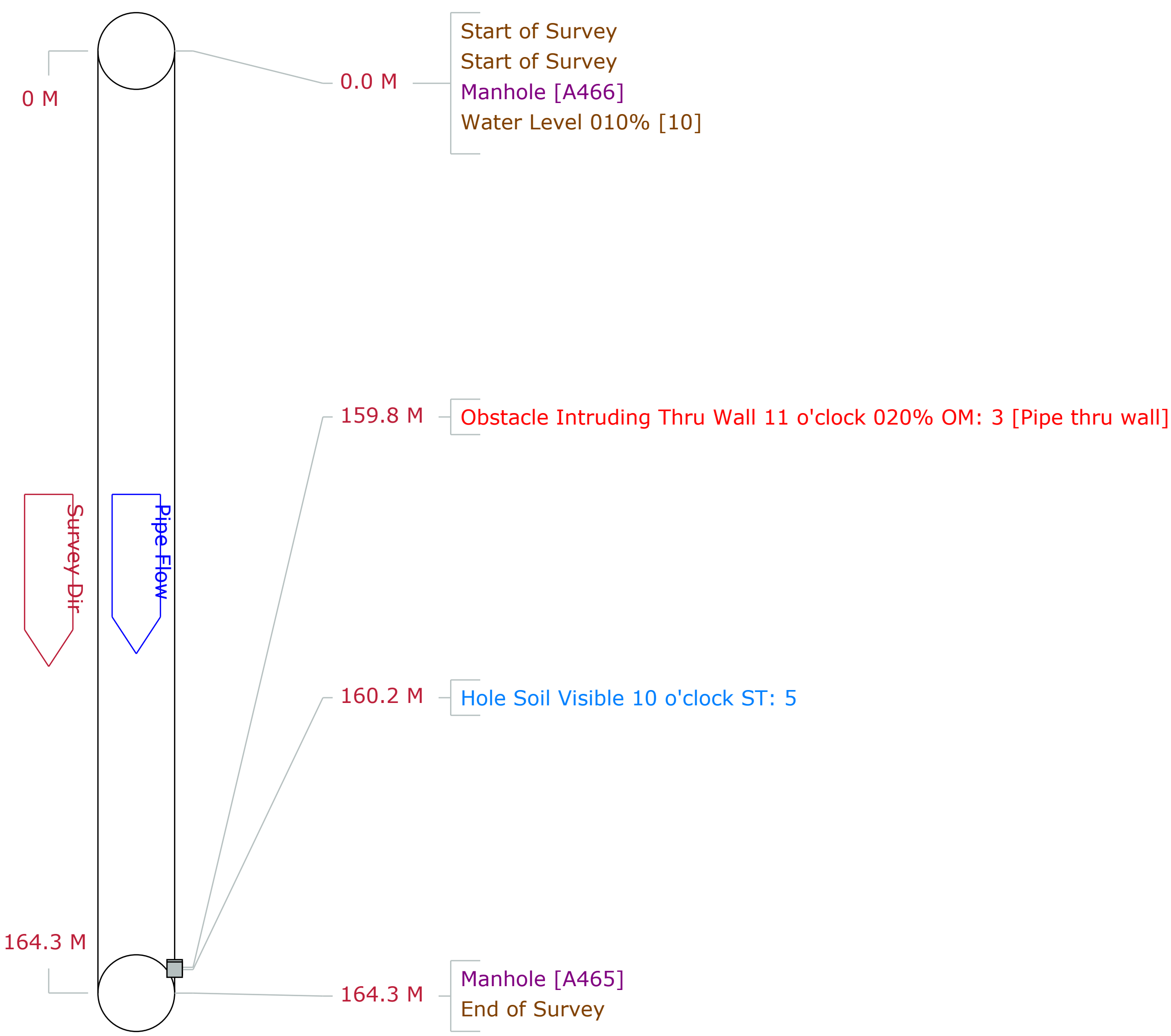
80.8 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0
O&M:	**Pipe Rating** 4	**Pipe Ratings Index** 2	**Peak** 2	**Mean Pipe** 0

Pipe Graphic Report of PSR 4882 **for** ISL

Setup 10	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #	**Date** 2023-06-22		**Time** 13:14	**Street** 54th Ave			
City Lloydminster		**Further location details**					
Up A466		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A465		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Downstream		**Flow control**		**Media No**	
Shape Circular		**Height** 1200 **Width**		**mm**	**Preclean** J	**Date Cleaned** 2023-06-15	
Material Concrete Pipe (non-reinforced)		**Joint length**	**M**	**Total length** 164.3 **M**		**Length Surveyed** 164.30 **M**	
Lining		**Year laid**		**Year rehabilitated**		**Weather** Dry	
Purpose			**Cat**				
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous	Hydraulic		
Project Lloydminster Phase 2-Storm				**Work Order**			
Northing		**Easting**		**Elevation**			
Coordinate System				**GPS Accuracy**			



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Tabular Report of PSR 4882 for ISL

Setup	10	**Surveyor**	Ben Cooper	**Certificate #**	U-315-06023838	**System Owner**	
Drainage		**Survey Customer**	ISL				
P/O #		**Date**	2023-06-22	**Time**	13:14	**Street**	54th Ave
City	Lloydminster	**Further location details**					
Up	A466	**Rim to invert**		**Grade to invert**		**Rim to grade**	M
Down	A465	**Rim to invert**		**Grade to invert**		**Rim to grade**	M
Use	Stormwater	**Direction**	Down	**Flow control**		**Media No**	
Shape	Circular	**Height**	1200 **Width** mm	**Preclean**	J	**Date Cleaned**	2023-06-15
Material	Concrete Pipe (non-reinforced)	**Joint length**	M	**Total length**	164.3 M	**Length Surveyed**	164.3 M
Lining		**Year laid**		**Year rehabilitated**		**Weather**	Dry
Purpose		**Cat**				**Pressure**	
Additional info							
Location							
Project	Lloydminster Phase 2-Storm					**Work Order**	
Northing		**Easting**				**Elevation**	
Coordinate System				**GPS Accuracy**			

Structural O & M Constructional Miscellaneous

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A466
0.0			MWL	Water Level			10					10
159.8			OBI	Obstacle Intruding Thru Wall			20		11			Pipe thru wall
160.2			HSV	Hole Soil Visible					10			
164.3			AMH	Manhole								A465
164.3			FH	End of Survey								

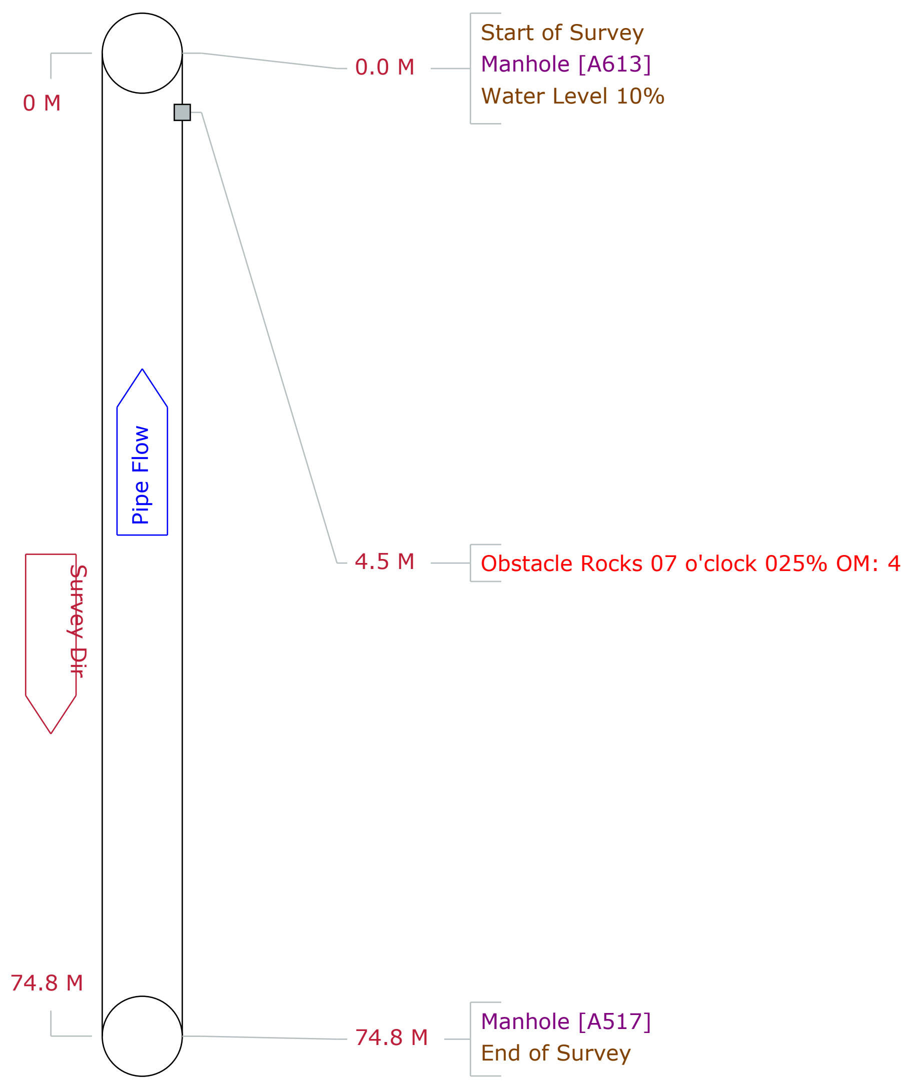
164.3 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 5	**Pipe Ratings Index** 5	**Peak** 5	**Mean Pipe** 0
O&M:	**Pipe Rating** 3	**Pipe Ratings Index** 3	**Peak** 3	**Mean Pipe** 0

Pipe Graphic Report of PSR 4632 for ISL

Setup 11	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #		**Date** 2023-06-22	**Time** 15:19		**Street** 27th Street		
City Lloydminster		**Further location details**					
Up A517		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A613		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Upstream		**Flow control**		**Media No**	
Shape Circular		**Height** 1350 **Width**		**mm**	**Preclean** J	**Date Cleaned** 2023-06-16	
Material Concrete Pipe (non-reinforced)		**Joint length**	**M**	**Total length** 74.8 **M**		**Length Surveyed** 74.80	**M**
Lining		**Year laid**		**Year rehabilitated**		**Weather** Dry	
Purpose			**Cat**				
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous	Hydraulic		
Project Lloydminster Phase 2-Storm					**Work Order**		
Northing		**Easting**			**Elevation**		
Coordinate System				**GPS Accuracy**			



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Tabular Report of PSR 4632 for ISL

Setup 11	**Surveyor** Ben Cooper	**Certificate #** U-315-06023838	**System Owner**
Drainage	**Survey Customer** ISL		
P/O #	**Date** 2023-06-22	**Time** 15:19	**Street** 27th Street
City Lloydminster	**Further location details**		
Up A517	**Rim to invert**	**Grade to invert**	**Rim to grade** M
Down A613	**Rim to invert**	**Grade to invert**	**Rim to grade** M
Use Stormwater	**Direction** Up	**Flow control**	**Media No**
Shape Circular	**Height** 1350 **Width** mm	**Preclean** J	**Date Cleaned** 2023-06-16
Material Concrete Pipe (non-reinforced)	**Joint length** M	**Total length** 74.8 M	**Length Surveyed** 74.8 M
Lining	**Year laid**	**Year rehabilitated**	**Weather** Dry
Purpose	**Cat**		**Pressure**
Additional info		Structural	O & M / Constructional / Miscellaneous
Location			
Project Lloydminster Phase 2-Storm		**Work Order**	
Northing	**Easting**	**Elevation**	
Coordinate System		**GPS Accuracy**	

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A613
0.0			MWL	Water Level			10					
4.5			OBR	Obstacle Rocks			25		07			
74.8			AMH	Manhole								A517
74.8			FH	End of Survey								

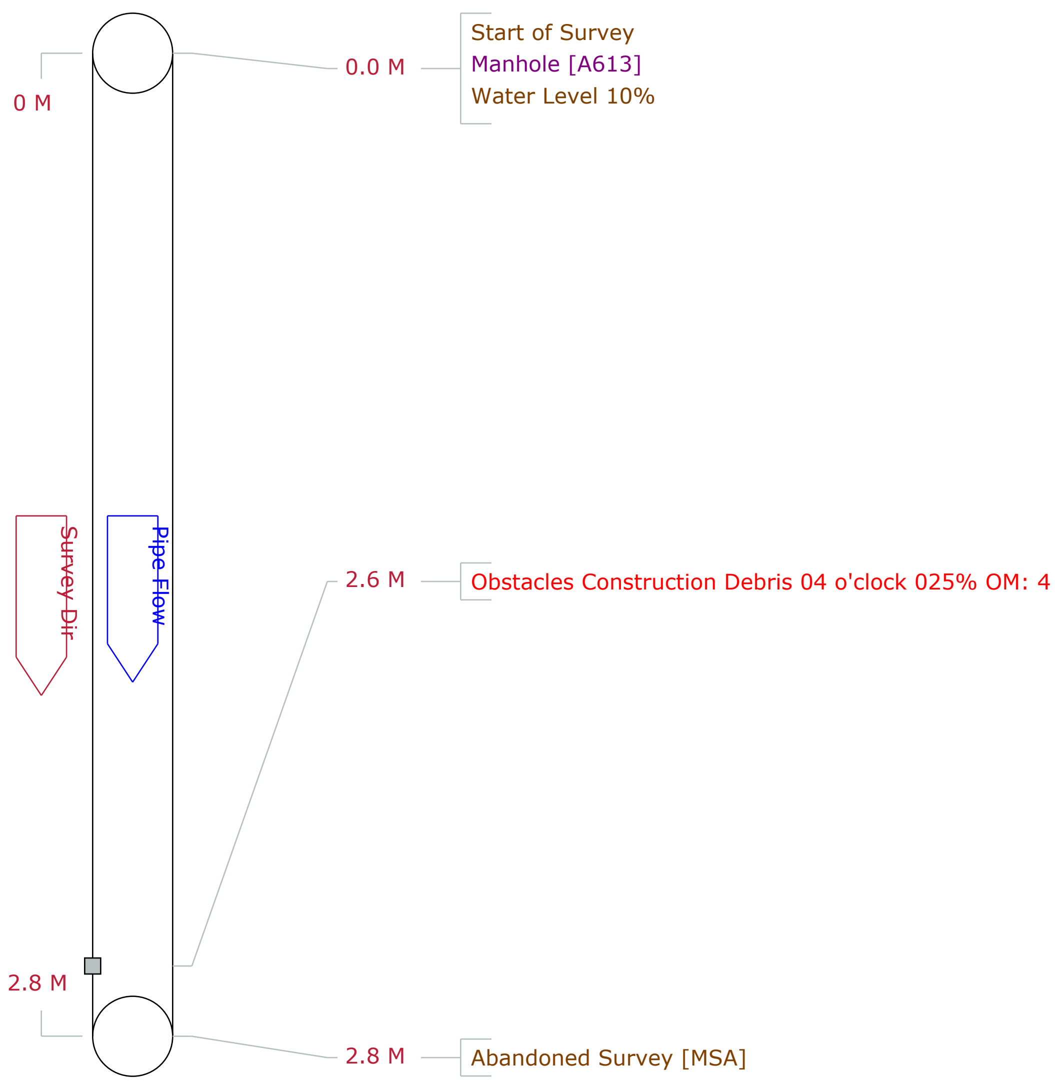
74.8 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0
O&M:	**Pipe Rating** 4	**Pipe Ratings Index** 4	**Peak** 4	**Mean Pipe** 0.1

Pipe Graphic Report of PSR 2296 for ISL

Setup 12	**Surveyor** Ben Cooper	**Certificate #** U-315-06023838	**System Owner**				
Drainage		**Survey Customer** ISL					
P/O #	**Date** 2023-06-22	**Time** 16:24	**Street** 27th Street				
City Lloydminster		**Further location details**					
Up A613		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A241		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Downstream		**Flow control**		**Media No**	
Shape Circular		**Height** 1350	**Width**	**mm**	**Preclean** J	**Date Cleaned** 2023-06-16	
Material Concrete Pipe (non-reinforced)		**Joint length**	**M**	**Total length**	**M**	**Length Surveyed** 02.80	**M**
Lining		**Year laid**		**Year rehabilitated**		**Weather** Dry	
Purpose			**Cat**				
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous	Hydraulic		
Project Lloydminster Phase 2-Storm					**Work Order**		
Northing		**Easting**			**Elevation**		
Coordinate System				**GPS Accuracy**			



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Phone:306-664-2220

Tabular Report of PSR 2296 for ISL

Setup 12	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #		**Date** 2023-06-22	**Time** 16:24	**Street** 27th Street			
City Lloydminster		**Further location details**					
Up A613		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A241		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Down		**Flow control**		**Media No**	
Shape Circular		**Height** 1350 **Width**		**mm**	**Preclean** J	**Date Cleaned** 2023-06-16	
Material Concrete Pipe (non-reinforced)		**Joint length**	**M**	**Total length**	**M**	**Length Surveyed** 2.8	**M**
Lining		**Year laid**		**Year rehabilitated**		**Weather** Dry	
Purpose			**Cat**			**Pressure**	
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous			
Project Lloydminster Phase 2-Storm					**Work Order**		
Northing			**Easting**		**Elevation**		
Coordinate System				**GPS Accuracy**			

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A613
0.0			MWL	Water Level			10					
2.6			OBN	Obstacles Construction Debris			25		04			
2.8			MSA	Abandoned Survey								MSA

2.8 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0
O&M:	**Pipe Rating** 4	**Pipe Ratings Index** 4	**Peak** 4	**Mean Pipe** 1.4

Pipe Graphic Report of PSR 4466 for ISL

Setup 13	**Surveyor** Ben Cooper	**Certificate #** U-315-06023838	**System Owner**				
Drainage	**Survey Customer** ISL						
P/O #	**Date** 2023-06-22	**Time** 17:12	**Street** 57A Ave				
City Lloydminster	**Further location details**						
Up A786	**Rim to invert**	**Grade to invert**	**Rim to grade** M				
Down A785	**Rim to invert**	**Grade to invert**	**Rim to grade** M				
Use Stormwater	**Direction** Downstream	**Flow control**	**Media No**				
Shape Circular	**Height** 900 **Width** mm	**Preclean** J	**Date Cleaned** 2023-06-16				
Material Concrete Pipe (non-reinforced)	**Joint length** M	**Total length** 99.0 M	**Length Surveyed** 99.00 M				
Lining	**Year laid**	**Year rehabilitated**	**Weather** Dry				
Purpose	**Cat**						

Additional info

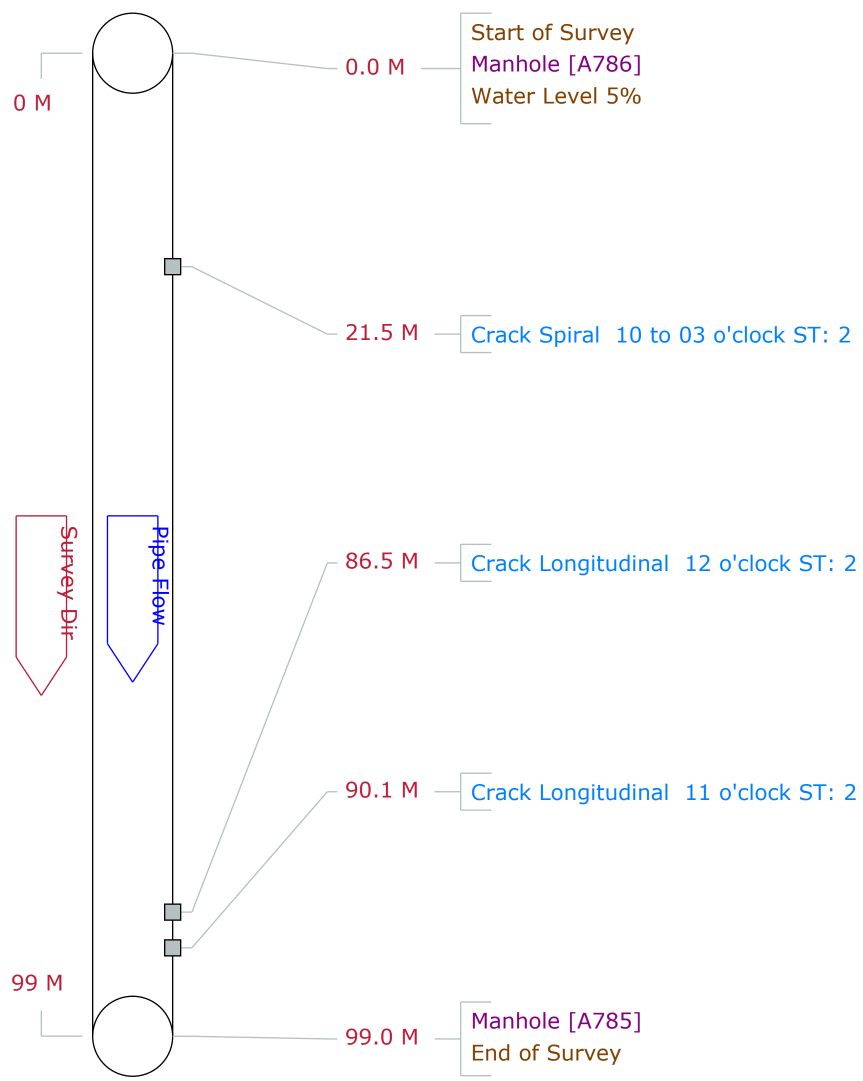
Structural O & M Constructional Miscellaneous Hydraulic

Location

Project Lloydminster Phase 2-Storm **Work Order**

Northing **Easting** **Elevation**

Coordinate System **GPS Accuracy**



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Tabular Report of PSR 4466 for ISL

Setup 13	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #		**Date** 2023-06-22	**Time** 17:12	**Street** 57A Ave			
City Lloydminster		**Further location details**					
Up A786		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A785		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Down		**Flow control**		**Media No**	
Shape Circular		**Height** 900 **Width**		**mm** **Preclean** J		**Date Cleaned** 2023-06-16	
Material Concrete Pipe (non-reinforced)		**Joint length**	**M**	**Total length** 99.0 **M**		**Length Surveyed** 99.0	**M**
Lining		**Year laid**		**Year rehabilitated**		**Weather** Dry	
Purpose		**Cat**				**Pressure**	
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous			
Project Lloydminster Phase 2-Storm				**Work Order**			
Northing		**Easting**		**Elevation**			
Coordinate System				**GPS Accuracy**			

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A786
0.0			MWL	Water Level			5					
21.5			CS	Crack Spiral					10	03		
86.5			CL	Crack Longitudinal					12			
90.1			CL	Crack Longitudinal					11			
99.0			AMH	Manhole								A785
99.0			FH	End of Survey								

99.0 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 6	**Pipe Ratings Index** 2	**Peak** 2	**Mean Pipe** 0.1
O&M:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0

Pipe Graphic Report of PSR 4556 for ISL

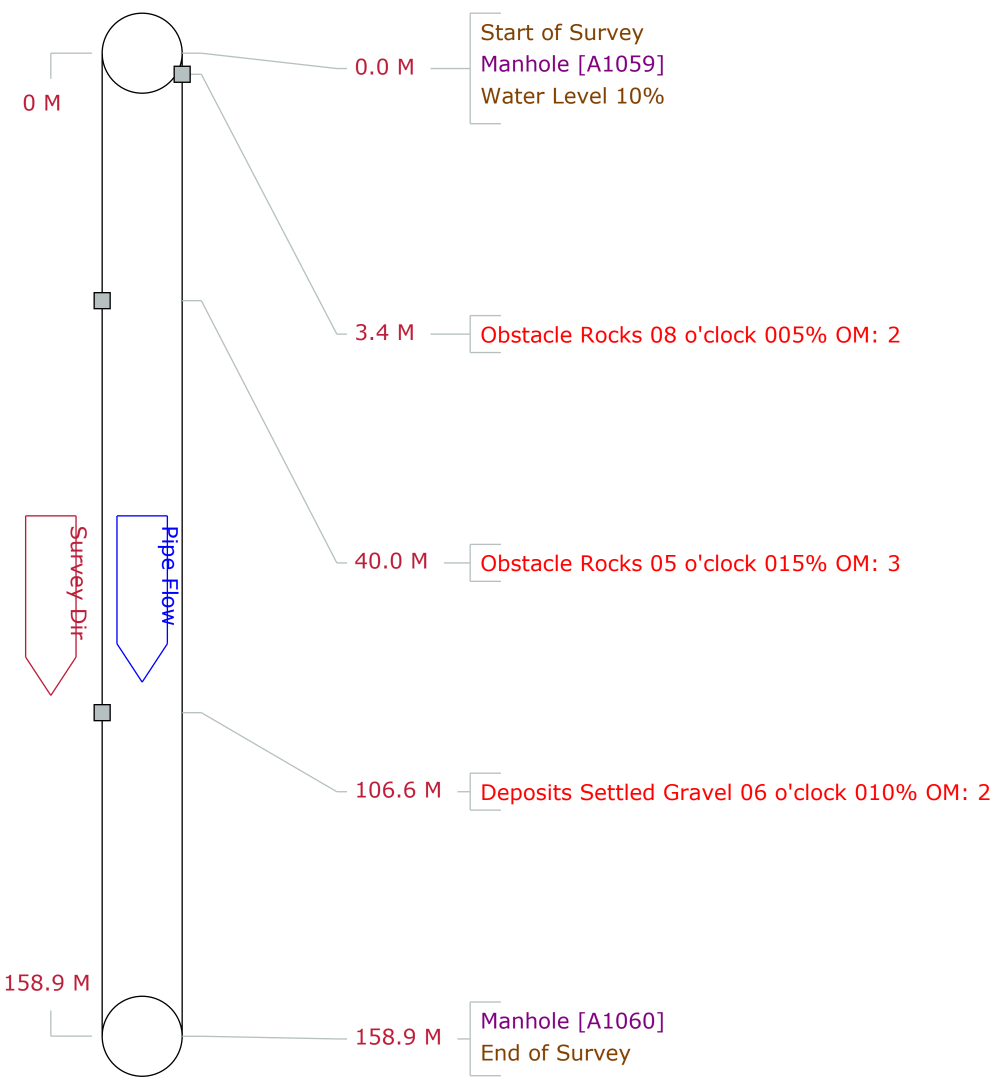
Setup 14 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-23 **Time** 6:40 **Street** 18th Street
City Lloydminster **Further location details**

Up A1059 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A1060 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Downstream **Flow control** **Media No**
Shape Circular **Height** 1200 **Width** **mm** **Preclean** J **Date Cleaned** 2023-06-16
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** 158.9 **M** **Length Surveyed** 158.90 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Dry
Purpose **Cat**

Additional info
Location
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**

Structural O & M Constructional
Miscellaneous Hydraulic



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Phone:306-664-2220

Tabular Report of PSR 4556 **for** **ISL**

Setup 14	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #		**Date** 2023-06-23	**Time** 6:40	**Street** 18th Street			
City Lloydminster		**Further location details**					
Up A1059		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A1060		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Down		**Flow control**		**Media No**	
Shape Circular		**Height** 1200 **Width**	**mm**	**Preclean** J		**Date Cleaned** 2023-06-16	
Material Concrete Pipe (non-reinforced)		**Joint length**	**M**	**Total length** 158.9 **M**		**Length Surveyed** 158.9	**M**
Lining		**Year laid**		**Year rehabilitated**		**Weather** Dry	
Purpose		**Cat**				**Pressure**	
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous			
Project Lloydminster Phase 2-Storm				**Work Order**			
Northing		**Easting**		**Elevation**			
Coordinate System				**GPS Accuracy**			

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A1059
0.0			MWL	Water Level			10					
3.4			OBR	Obstacle Rocks			5		08			
40.0			OBR	Obstacle Rocks			15		05			
106.6			DSGV	Deposits Settled Gravel			10		06			
158.9			AMH	Manhole								A1060
158.9			FH	End of Survey								

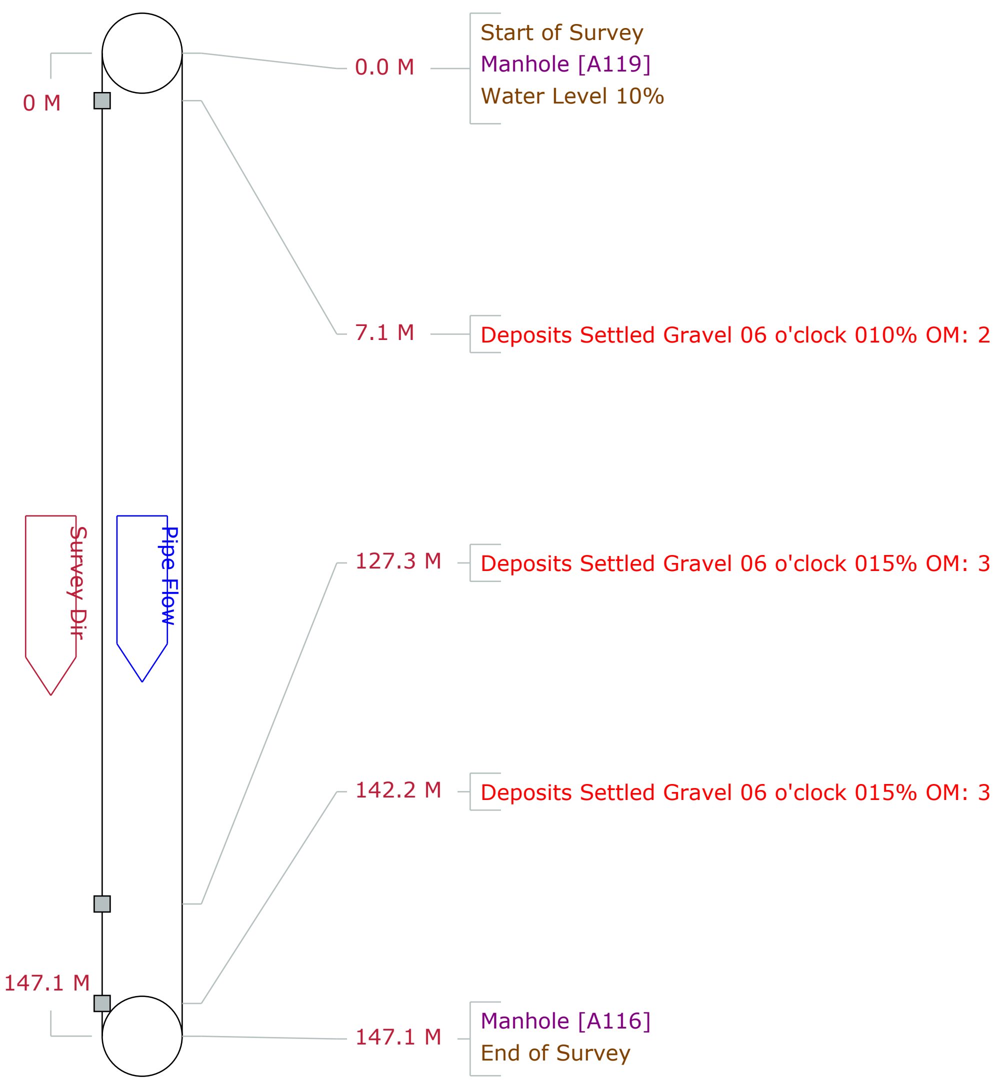
158.9 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0
O&M:	**Pipe Rating** 7	**Pipe Ratings Index** 2.3	**Peak** 3	**Mean Pipe** 0

Pipe Graphic Report of PSR 2017 for ISL

Setup 15	**Surveyor** Ben Cooper	**Certificate #** U-315-06023838	**System Owner**				
Drainage		**Survey Customer** ISL					
P/O #	**Date** 2023-06-23	**Time** 8:36	**Street** 51st Street				
City Lloydminster		**Further location details**					
Up A119		**Rim to invert**	**Grade to invert**	**Rim to grade** M			
Down A116		**Rim to invert**	**Grade to invert**	**Rim to grade** M			
Use Stormwater		**Direction** Downstream	**Flow control**	**Media No**			
Shape Circular		**Height** 900	**Width** mm	**Preclean** J	**Date Cleaned** 2023-06-16		
Material Concrete Pipe (non-reinforced)		**Joint length** M	**Total length** 147.1 M	**Length Surveyed** 147.10 M			
Lining		**Year laid**	**Year rehabilitated**	**Weather** Dry			
Purpose		**Cat**					
Additional info			Structural	O & M	Constructional		
Location			Miscellaneous	Hydraulic			
Project Lloydminster Phase 2-Storm			**Work Order**				
Northing		**Easting**	**Elevation**				
Coordinate System			**GPS Accuracy**				



McGills Industrial Services Inc.
Phone:306-664-2220

Tabular Report of PSR 2017 for ISL

Setup 15	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #		**Date** 2023-06-23	**Time** 8:36	**Street** 51st Street			
City Lloydminster		**Further location details**					
Up A119		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A116		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Down		**Flow control**		**Media No**	
Shape Circular		**Height** 900 **Width**		**mm** **Preclean** J		**Date Cleaned** 2023-06-16	
Material Concrete Pipe (non-reinforced)		**Joint length** **M**		**Total length** 147.1 **M**		**Length Surveyed** 147.1 **M**	
Lining		**Year laid**		**Year rehabilitated**		**Weather** Dry	
Purpose		**Cat**				**Pressure**	
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous			
Project Lloydminster Phase 2-Storm				**Work Order**			
Northing		**Easting**		**Elevation**			
Coordinate System				**GPS Accuracy**			

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A119
0.0			MWL	Water Level			10					
7.1			DSGV	Deposits Settled Gravel			10		06			
127.3			DSGV	Deposits Settled Gravel			15		06			
142.2			DSGV	Deposits Settled Gravel			15		06			
147.1			AMH	Manhole								A116
147.1			FH	End of Survey								

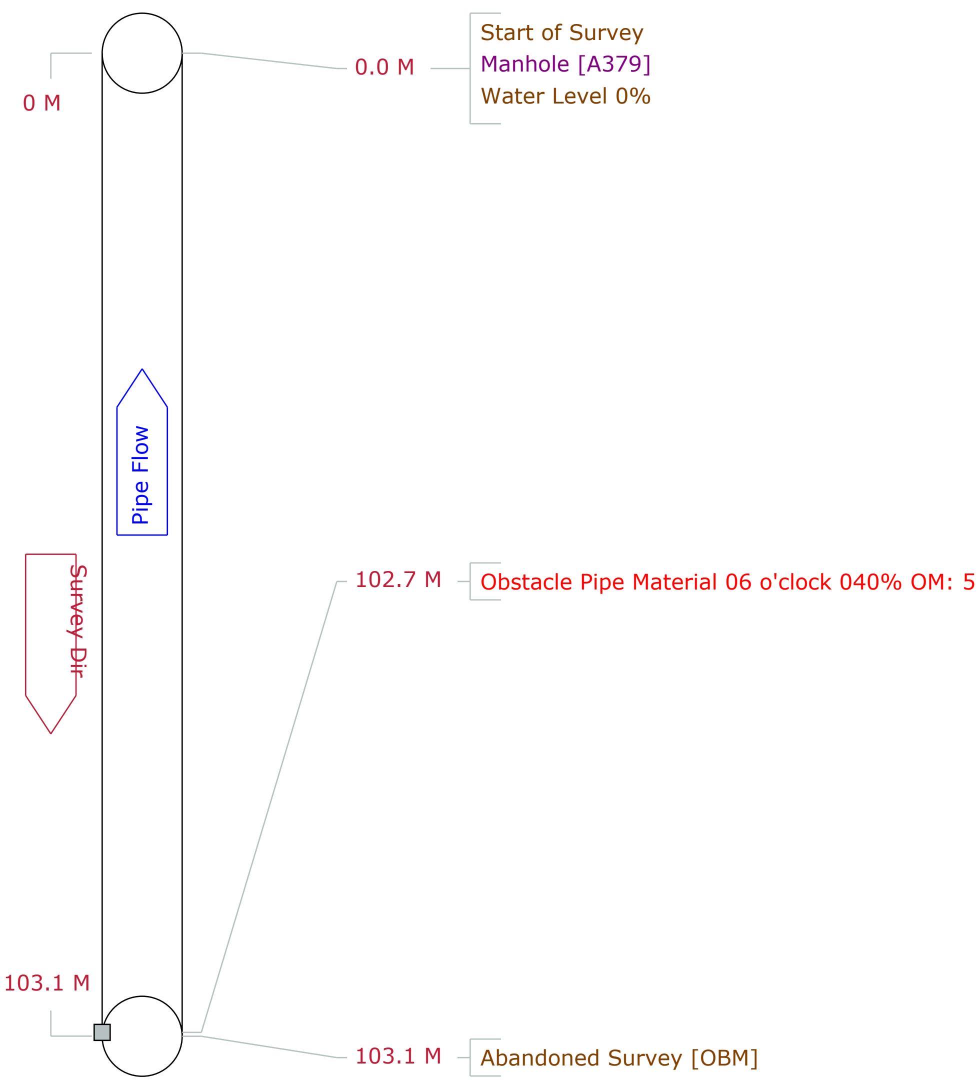
147.1 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0
O&M:	**Pipe Rating** 8	**Pipe Ratings Index** 2.7	**Peak** 3	**Mean Pipe** 0.1

Pipe Graphic Report of PSR 1241 for ISL

Setup 16	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #	**Date** 2023-06-23		**Time** 10:25	**Street** 47th Ave			
City Lloydminster		**Further location details**					
Up A380		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A379		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Upstream		**Flow control**		**Media No**	
Shape Circular		**Height** 750	**Width**	**mm**	**Preclean** J	**Date Cleaned** 2023-06-16	
Material Polyvinyl Chloride			**Joint length**	**M**	**Total length** **M**	**Length Surveyed** 103.10 **M**	
Lining			**Year laid**	**Year rehabilitated**		**Weather** Dry	
Purpose			**Cat**				
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous	Hydraulic		
Project Lloydminster Phase 2-Storm					**Work Order**		
Northing		**Easting**			**Elevation**		
Coordinate System				**GPS Accuracy**			



Tabular Report of PSR 1241 for ISL

Setup 16	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #	**Date** 2023-06-23		**Time** 10:25	**Street** 47th Ave			
City Lloydminster		**Further location details**					
Up A380		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A379		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Up		**Flow control**		**Media No**	
Shape Circular		**Height** 750 **Width**		**mm** **Preclean** J		**Date Cleaned** 2023-06-16	
Material Polyvinyl Chloride		**Joint length** **M**		**Total length** **M**		**Length Surveyed** 103.1 **M**	
Lining		**Year laid**		**Year rehabilitated**		**Weather** Dry	
Purpose			**Cat**			**Pressure**	
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous			
Project Lloydminster Phase 2-Storm				**Work Order**			
Northing			**Easting**	**Elevation**			
Coordinate System				**GPS Accuracy**			

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A379
0.0			MWL	Water Level			0					
102.7			OBM	Obstacle Pipe Material			40		06			
103.1			MSA	Abandoned Survey								OBM

103.1 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0
O&M:	**Pipe Rating** 5	**Pipe Ratings Index** 5	**Peak** 5	**Mean Pipe** 0

Pipe Graphic Report of PSR 1783 for ISL

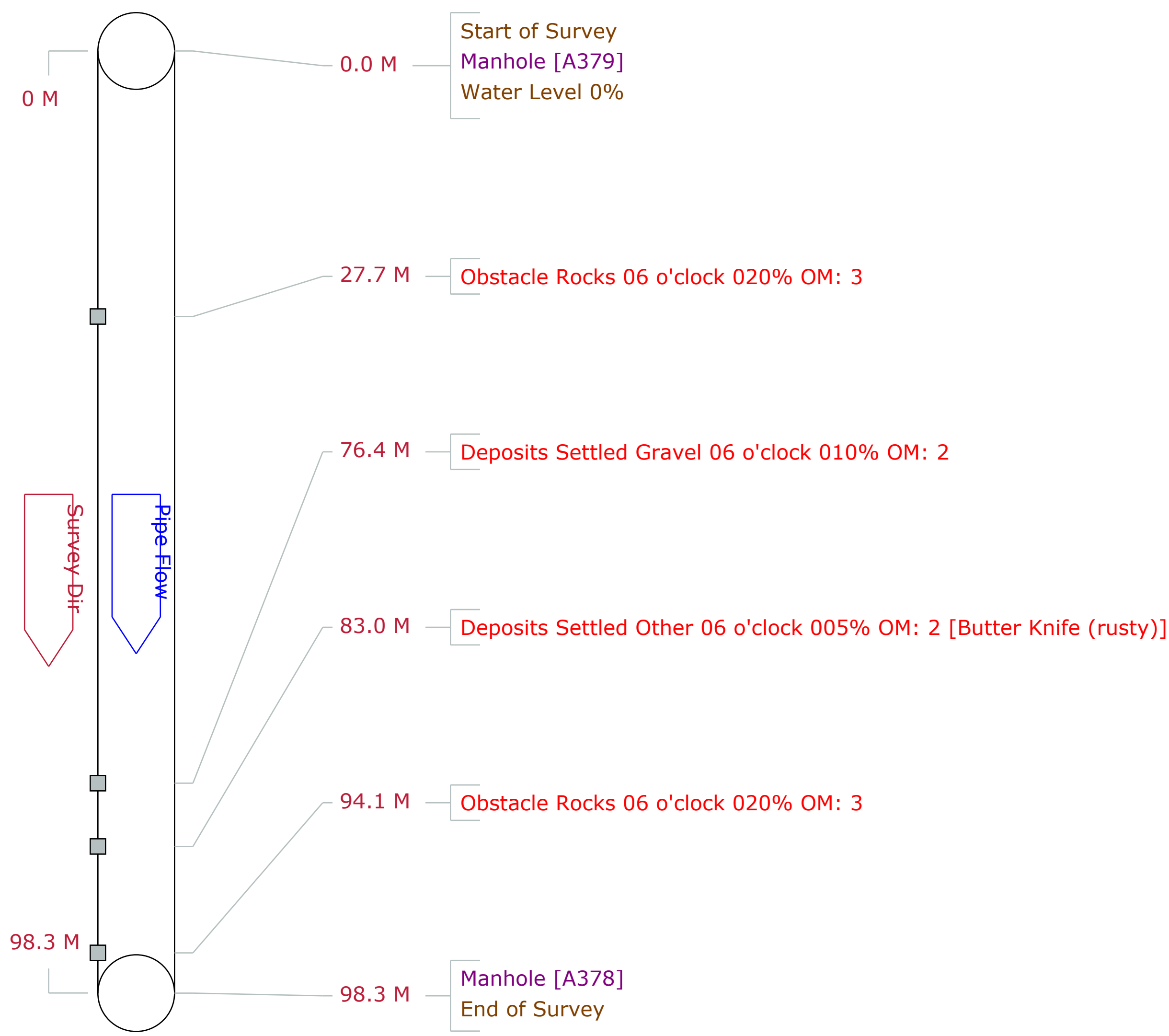
Setup 17 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-23 **Time** 11:07 **Street** 47th Ave
City Lloydminster **Further location details**

Up A379 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A378 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Downstream **Flow control** **Media No**
Shape Circular **Height** 900 **Width** **mm** **Preclean** J **Date Cleaned** 2023-06-16
Material Polyvinyl Chloride **Joint length** **M** **Total length** 98.3 **M** **Length Surveyed** 98.30 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Dry
Purpose **Cat**

Additional info
Location
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**

Structual O & M Constructional
Miscellaneous Hydraulic



McGill's Industrial Services 306-664-2220 mcgills.ca

McGills Industrial Services Inc.
Phone:306-664-2220

Tabular Report of PSR 1783 for ISL

Setup 17	**Surveyor** Ben Cooper	**Certificate #** U-315-06023838	**System Owner**
Drainage	**Survey Customer** ISL		
P/O #	**Date** 2023-06-23	**Time** 11:07	**Street** 47th Ave
City Lloydminster	**Further location details**		
Up A379	**Rim to invert**	**Grade to invert**	**Rim to grade** M
Down A378	**Rim to invert**	**Grade to invert**	**Rim to grade** M
Use Stormwater	**Direction** Down	**Flow control**	**Media No**
Shape Circular	**Height** 900 **Width** mm	**Preclean** J	**Date Cleaned** 2023-06-16
Material Polyvinyl Chloride	**Joint length** M	**Total length** 98.3 M	**Length Surveyed** 98.3 M
Lining	**Year laid**	**Year rehabilitated**	**Weather** Dry
Purpose	**Cat**		**Pressure**
Additional info		Structural / O & M / Constructional / Miscellaneous	
Location			
Project Lloydminster Phase 2-Storm		**Work Order**	
Northing	**Easting**	**Elevation**	
Coordinate System		**GPS Accuracy**	

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A379
0.0			MWL	Water Level			0					
27.7			OBR	Obstacle Rocks			20		06			
76.4			DSGV	Deposits Settled Gravel			10		06			
83.0			DSZ	Deposits Settled Other			5		06			Butter Knife (rusty)
94.1			OBR	Obstacle Rocks			20		06			
98.3			AMH	Manhole								A378
98.3			FH	End of Survey								

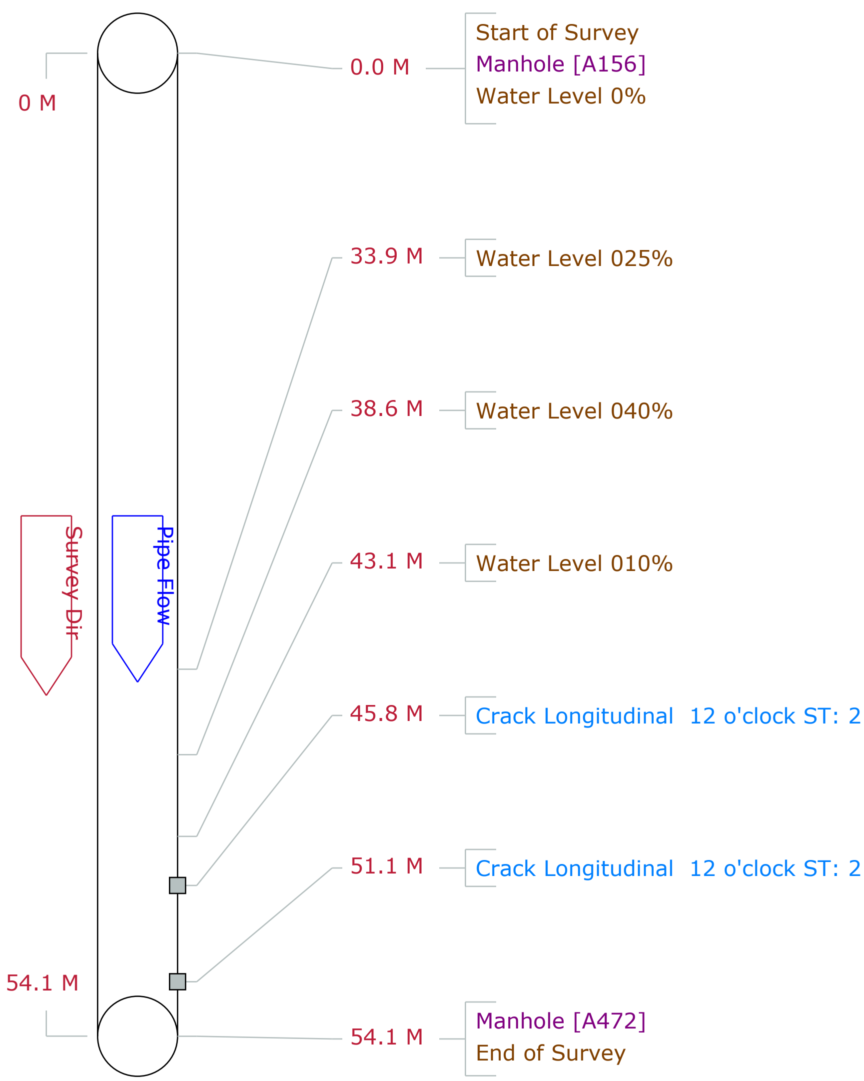
98.3 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0
O&M:	**Pipe Rating** 10	**Pipe Ratings Index** 2.5	**Peak** 3	**Mean Pipe** 0.1

Pipe Graphic Report of PSR 4019 **for** ISL

Setup 18	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #	**Date** 2023-06-23		**Time** 12:48	**Street** 62nd Ave			
City Lloydminster		**Further location details**					
Up A156		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A472		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Downstream		**Flow control**		**Media No**	
Shape Circular		**Height** 450	**Width** mm	**Preclean** Z		**Date Cleaned**	
Material Concrete Pipe (non-reinforced)		**Joint length** M		**Total length** 54.1 M		**Length Surveyed** 54.10 M	
Lining		**Year laid**		**Year rehabilitated**		**Weather** Light Rain	
Purpose		**Cat**					
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous	Hydraulic		
Project Lloydminster Phase 2-Storm				**Work Order**			
Northing		**Easting**		**Elevation**			
Coordinate System				**GPS Accuracy**			



Tabular Report of PSR 4019 for ISL

Setup 18	**Surveyor** Ben Cooper		**Certificate #** U-315-06023838		**System Owner**		
Drainage		**Survey Customer** ISL					
P/O #		**Date** 2023-06-23	**Time** 12:48	**Street** 62nd Ave			
City Lloydminster		**Further location details**					
Up A156		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Down A472		**Rim to invert**		**Grade to invert**		**Rim to grade**	**M**
Use Stormwater		**Direction** Down		**Flow control**		**Media No**	
Shape Circular		**Height** 450 **Width**		**mm** **Preclean** Z		**Date Cleaned**	
Material Concrete Pipe (non-reinforced)		**Joint length**	**M**	**Total length** 54.1 **M**		**Length Surveyed** 54.1	**M**
Lining		**Year laid**		**Year rehabilitated**		**Weather** Light Rain	
Purpose		**Cat**				**Pressure**	
Additional info				Structural	O & M	Constructional	
Location				Miscellaneous			
Project Lloydminster Phase 2-Storm				**Work Order**			
Northing		**Easting**		**Elevation**			
Coordinate System				**GPS Accuracy**			

Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A156
0.0			MWL	Water Level			0					
33.9			MWL	Water Level			25					
38.6			MWL	Water Level			40					
43.1			MWL	Water Level			10					
45.8			CL	Crack Longitudinal					12			
51.1			CL	Crack Longitudinal					12			
54.1			AMH	Manhole								A472
54.1			FH	End of Survey								

54.1 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 4	**Pipe Ratings Index** 2	**Peak** 2	**Mean Pipe** 0.1
O&M:	**Pipe Rating** 0	**Pipe Ratings Index** 0	**Peak** 0	**Mean Pipe** 0

Pipe Graphic Report of PSR 4468 **for** ISL

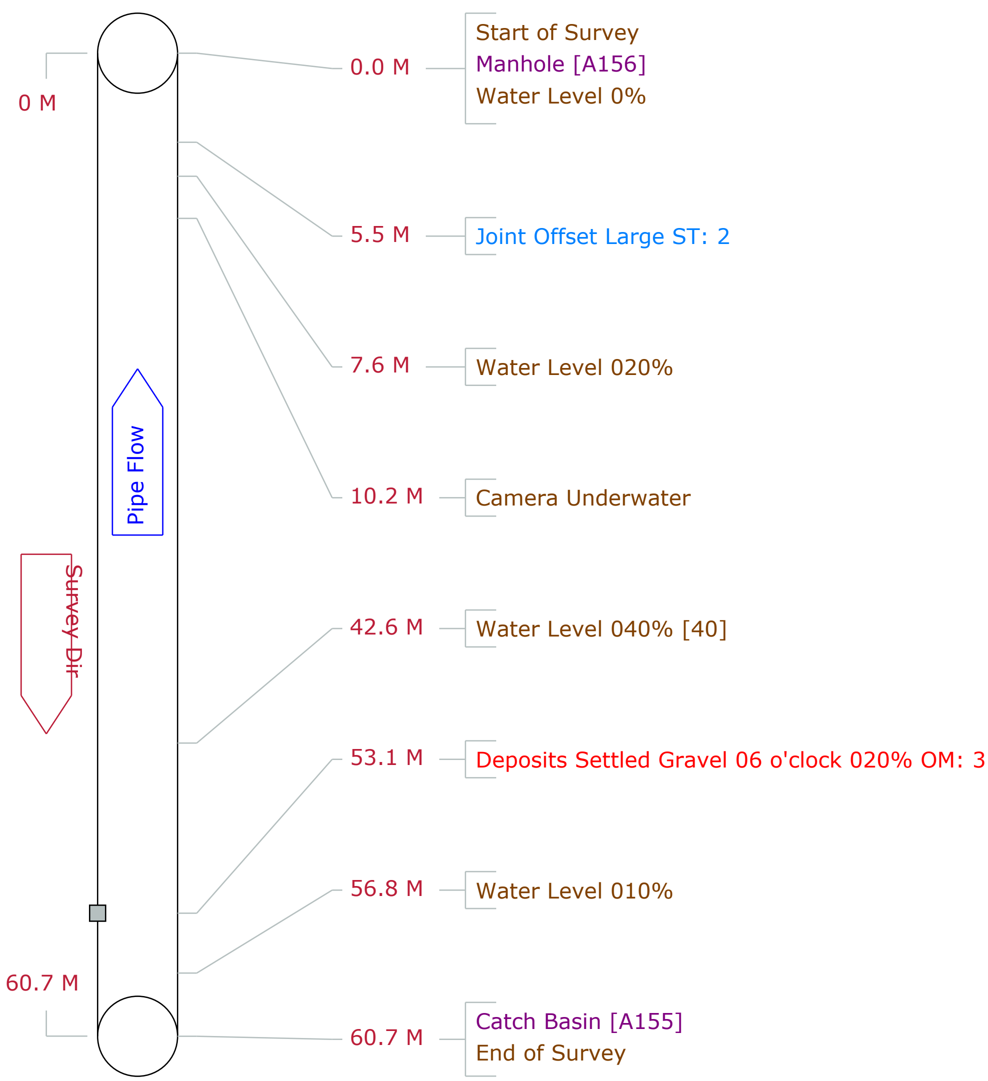
Setup 19 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-23 **Time** 13:18 **Street** 62nd Ave
City Lloydminster **Further location details**

Up A155 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A156 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Upstream **Flow control** **Media No**
Shape Circular **Height** 450 **Width** **mm** **Preclean** Z **Date Cleaned**
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** 60.7 **M** **Length Surveyed** 60.70 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Light Rain
Purpose **Cat**

Additional info
Location
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**

Structural O & M Constructional
Miscellaneous Hydraulic



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Phone:306-664-2220

Tabular Report of PSR 4468 for ISL

Setup 19 **Surveyor** Ben Cooper **Certificate #** U-315-06023838 **System Owner**
Drainage **Survey Customer** ISL
P/O # **Date** 2023-06-23 **Time** 13:18 **Street** 62nd Ave
City Lloydminster **Further location details**

Up A155 **Rim to invert** **Grade to invert** **Rim to grade** **M**
Down A156 **Rim to invert** **Grade to invert** **Rim to grade** **M**

Use Stormwater **Direction** Up **Flow control** **Media No**
Shape Circular **Height** 450 **Width** **mm** **Preclean** Z **Date Cleaned**
Material Concrete Pipe (non-reinforced) **Joint length** **M** **Total length** 60.7 **M** **Length Surveyed** 60.7 **M**
Lining **Year laid** **Year rehabilitated** **Weather** Light Rain
Purpose **Cat** **Pressure**

Additional info
Location
Project Lloydminster Phase 2-Storm **Work Order**
Northing **Easting** **Elevation**
Coordinate System **GPS Accuracy**

Structural O & M Constructional Miscellaneous

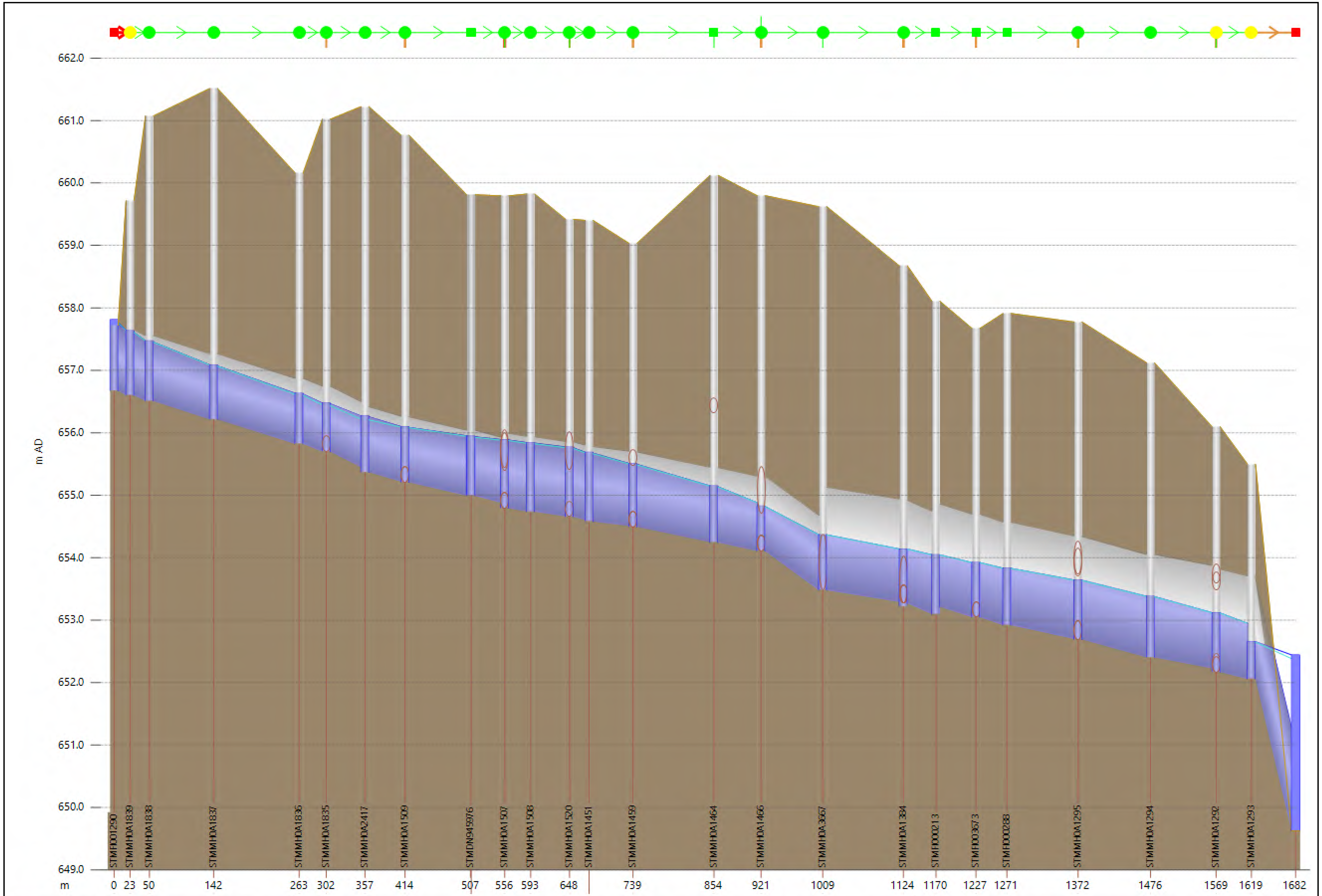
Count	Video	CD	Code		In1	In2	%	Jnt	Fr	To	ImRef	Remarks
0.0			ST	Start of Survey								
0.0			AMH	Manhole								A156
0.0			MWL	Water Level			0					
5.5			JOL	Joint Offset Large								
7.6			MWL	Water Level			20					
10.2			MCU	Camera Underwater								
42.6			MWL	Water Level			40					40
53.1			DSGV	Deposits Settled Gravel			20		06			
56.8			MWL	Water Level			10					
60.7			ACB	Catch Basin								A155
60.7			FH	End of Survey								

60.7 **M** **Total Length Surveyed**

Scores

Structural:	**Pipe Rating** 2	**Pipe Ratings Index** 2	**Peak** 2	**Mean Pipe** 0
O&M:	**Pipe Rating** 7	**Pipe Ratings Index** 3.5	**Peak** 4	**Mean Pipe** 0.1

APPENDIX C
HGL Comparison Between Existing and with Proposed Upgrade Under 1:5 Year Chicago Storm



Link		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
r.pfc (m3/s)		-	-	1.550	1.552	-	1.838	1.403	1.309	1.312	-	1.445	-	1.332	1.800	1.771	3.292	3.709	5.600	4.901	4.901	4.277	4.815	3.949	4.240	17.940
DS flow (m3/s)		-	-	1.73124	1.57356	-	-	-	1.38726	-	-	-	-	1.90934	1.98279	1.97793	1.99884	2.19627	-	-	-	2.38989	2.91308	2.90759	-	-

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

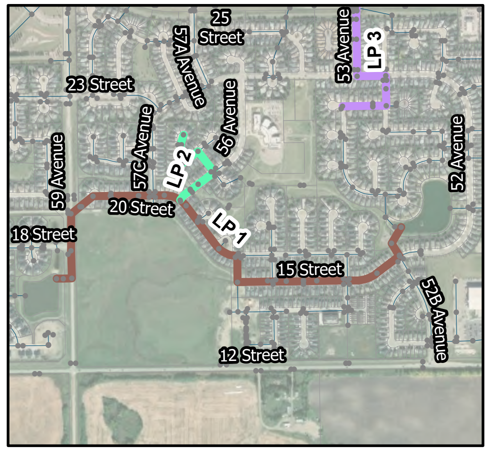


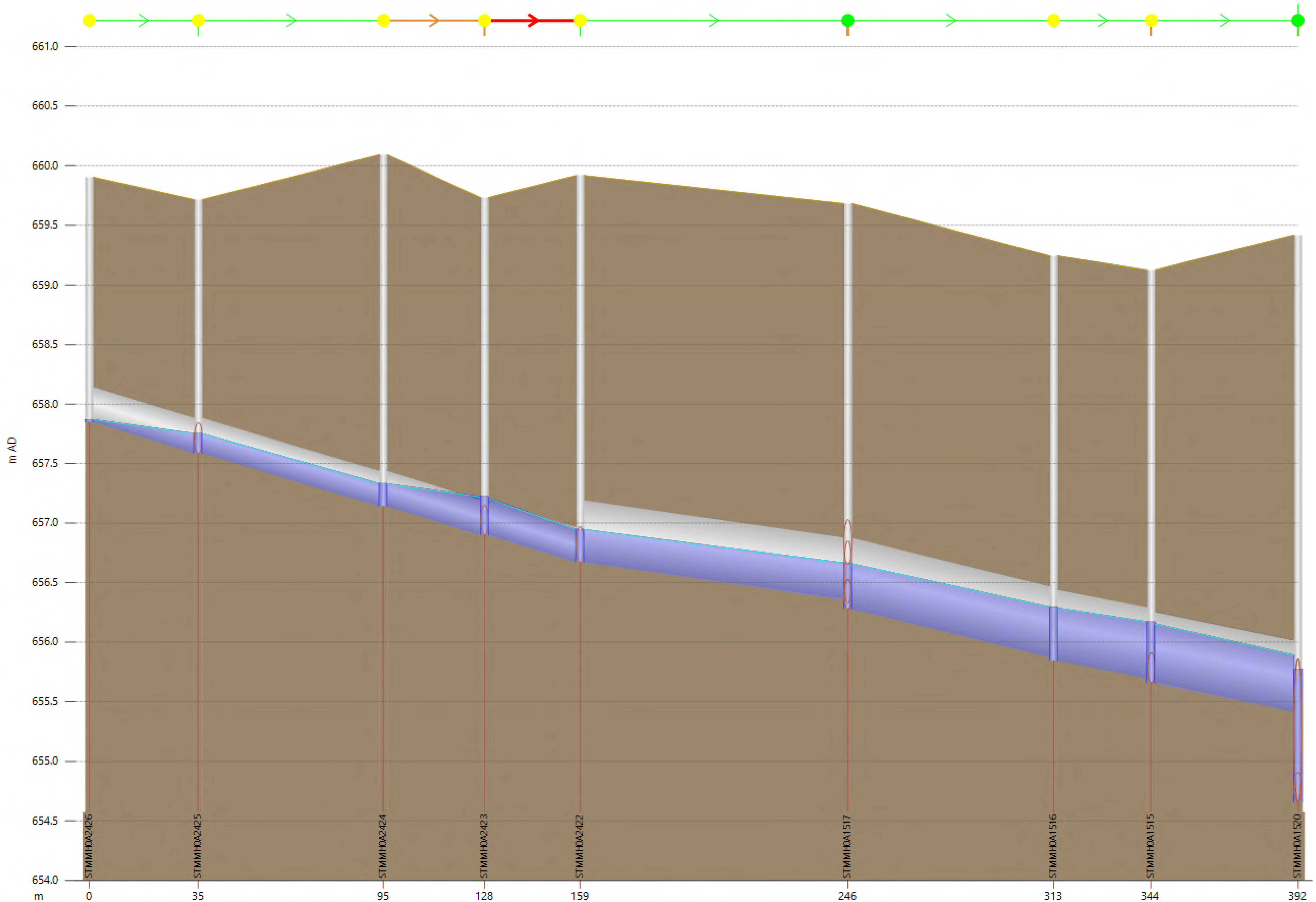
FIGURE APPENDIX C.1
HGL COMPARISON - PROFILE 1
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

Integrated Expertise. Locally Delivered.



Link	STMMH0A2426.1	STMMH0A2425.1	STMMH0A2424.1	STMMH0A2423.1	STMMH0A2422.1	STMMH0A1517.1	STMMH0A1516.1	STMMH0A1515.1
r.pfc (m3/s)	0.098	0.098	0.098	0.098	0.305	0.565	0.495	0.515
DS flow (m3/s)	0.00106	0.05552	0.05589	0.10375	0.16059	0.40031	0.39918	0.52079

Legend

Existing System HGL

Existing with Proposed Upgrades HGL

Ground Elevation

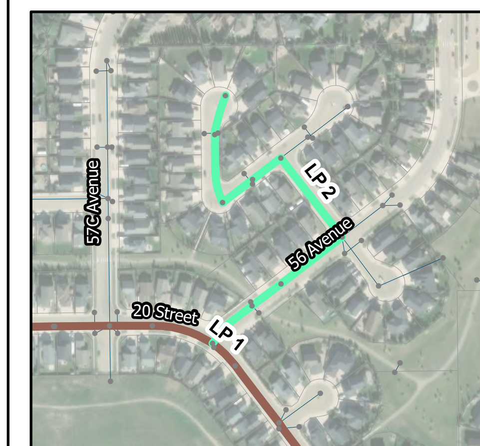


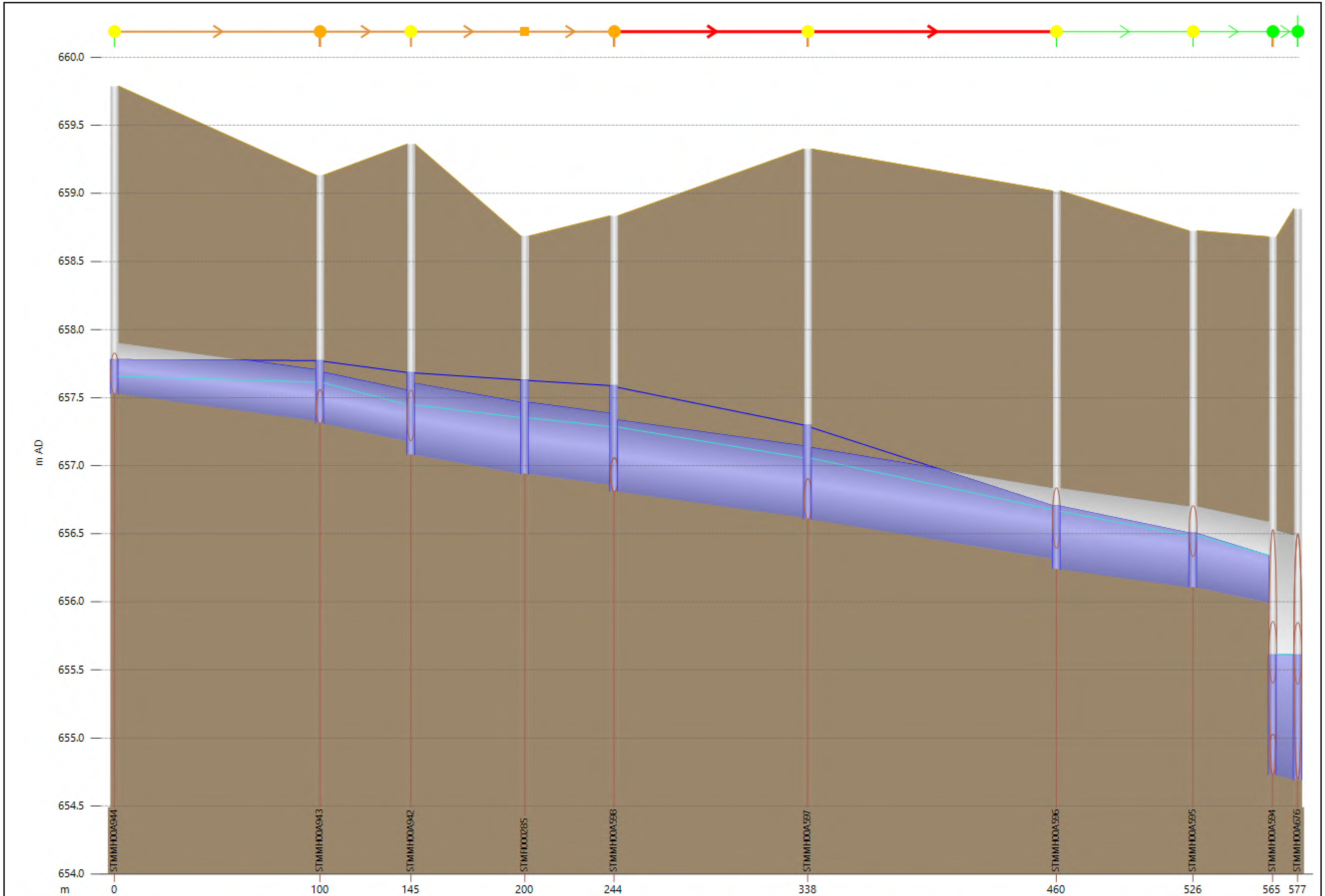
FIGURE APPENDIX C.2
HGL COMPARISON - PROFILE 2
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

Credits:World Imagery: Vermilion River County, Maxar

ISL

LLOYDMINSTER

Integrated Expertise. Locally Delivered.



Link		STMMH00A944.1	STMMH00A943.1	STMMH00A942.1	STMFI000285.1	STMMH00A598.1	STMMH00A597.1	STMMH00A596.1	-	-	
r.pfc (m3/s)		0.093	0.112	0.216	0.185	0.193	0.211	0.275	0.333	-	
DS flow (m3/s)		0.03246	0.10872	0.13181	0.13296	0.23127	0.28450	0.28382	0.28368	-	

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

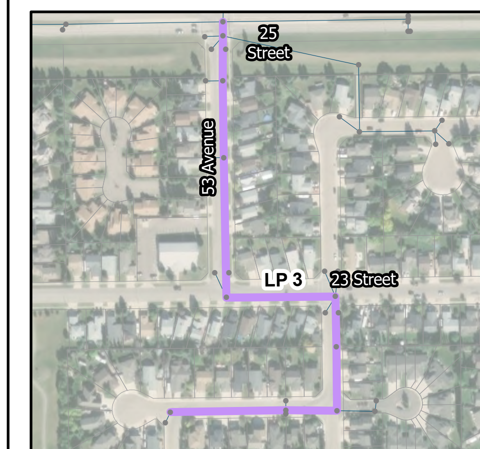


FIGURE APPENDIX C.3
HGL COMPARISON - PROFILE 3
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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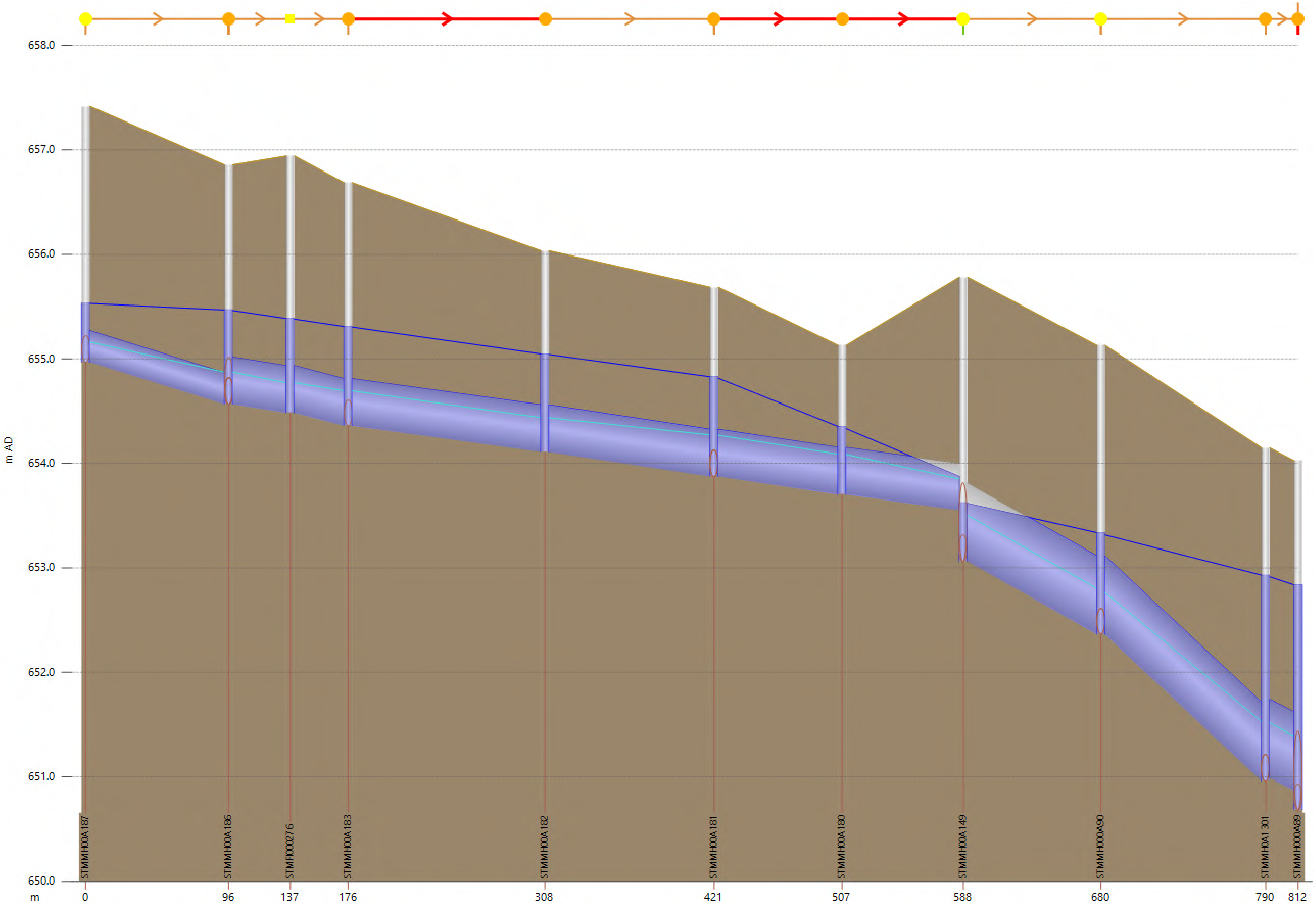

Link		STMMH00A187.1	-	-	STMMH00A183.1	STMMH00A182.1	STMMH00A181.1	STMMH00A180.1	STMMH00A149.1	STMMH000A90.1	-	
r.pfc (m3/s)		0.063	0.127	0.162	0.124	0.130	0.128	0.123	0.971	1.255	0.831	
DS flow (m3/s)		0.04309	0.12397	0.12380	0.12694	0.12912	0.20718	0.20706	0.60161	0.64192	-	

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

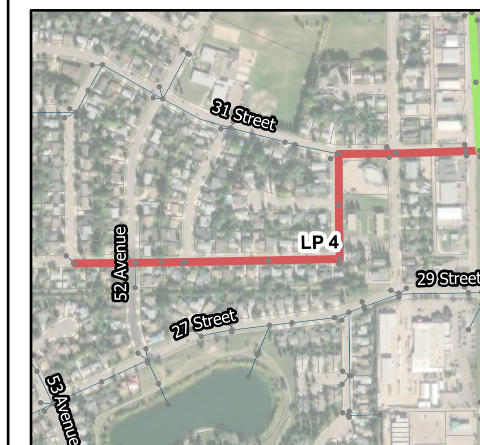

FIGURE APPENDIX C.4
HGL COMPARISON - PROFILE 4
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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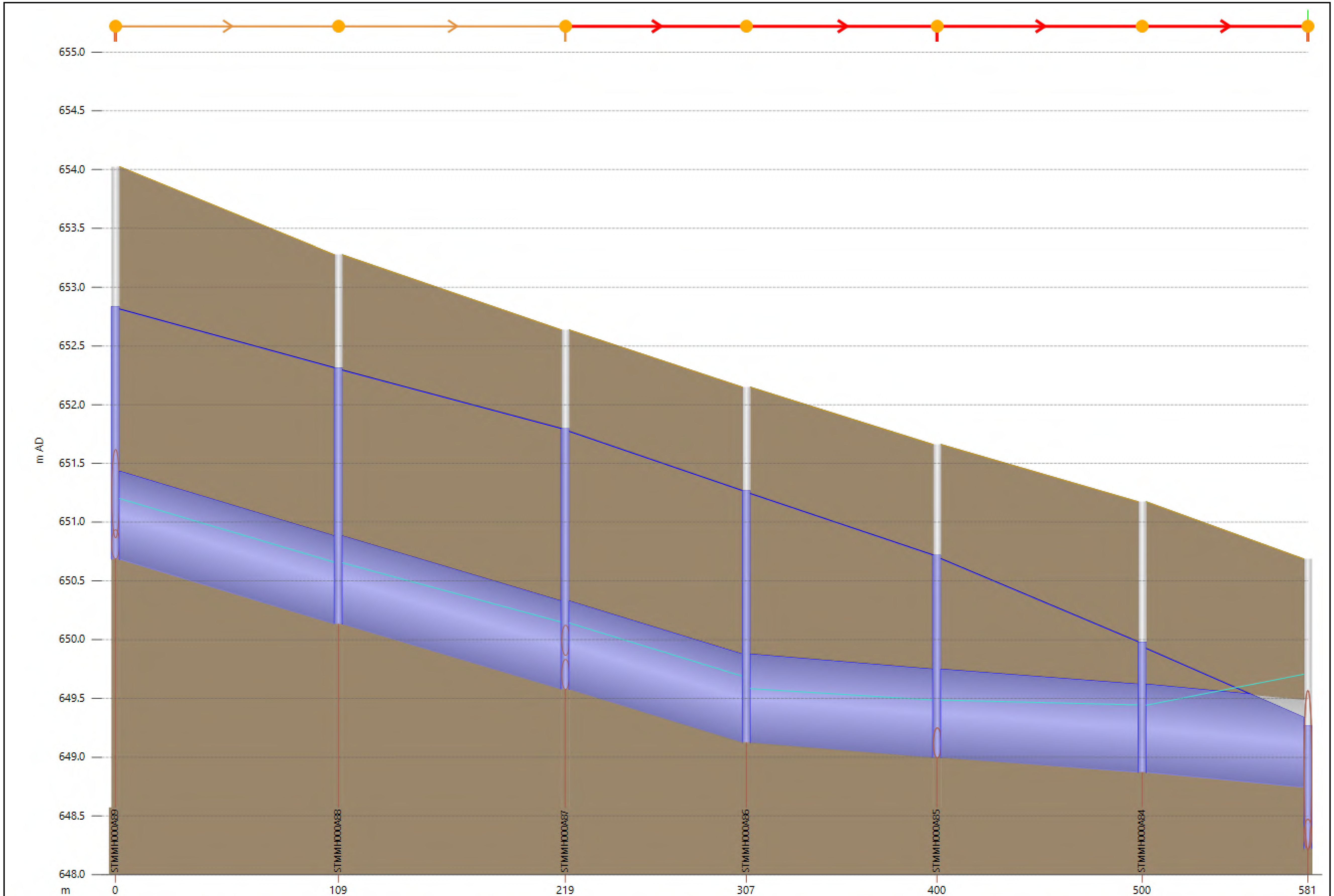

Link		STMMH000A89.1	STMMH000A88.1	STMMH000A87.1	STMMH000A86.1	STMMH000A85.1	STMMH000A84.1	
r.pfc (m3/s)		0.794	0.788	0.797	0.413	0.398	0.444	
DS flow (m3/s)		0.75444	0.76005	0.83625	0.83329	0.92622	0.92601	

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

FIGURE APPENDIX C.5
HGL COMPARISON - PROFILE 5
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

Date: 2024-09-17 Document: C:\Users\lche\Desktop\L.Che\Projects\28310 Lloydminster Stormwater Master Plan\30_Technical\GIS\28310_Lloydminster SWMP Appendix\28310_Lloydminster SWMP Appendix.aprx

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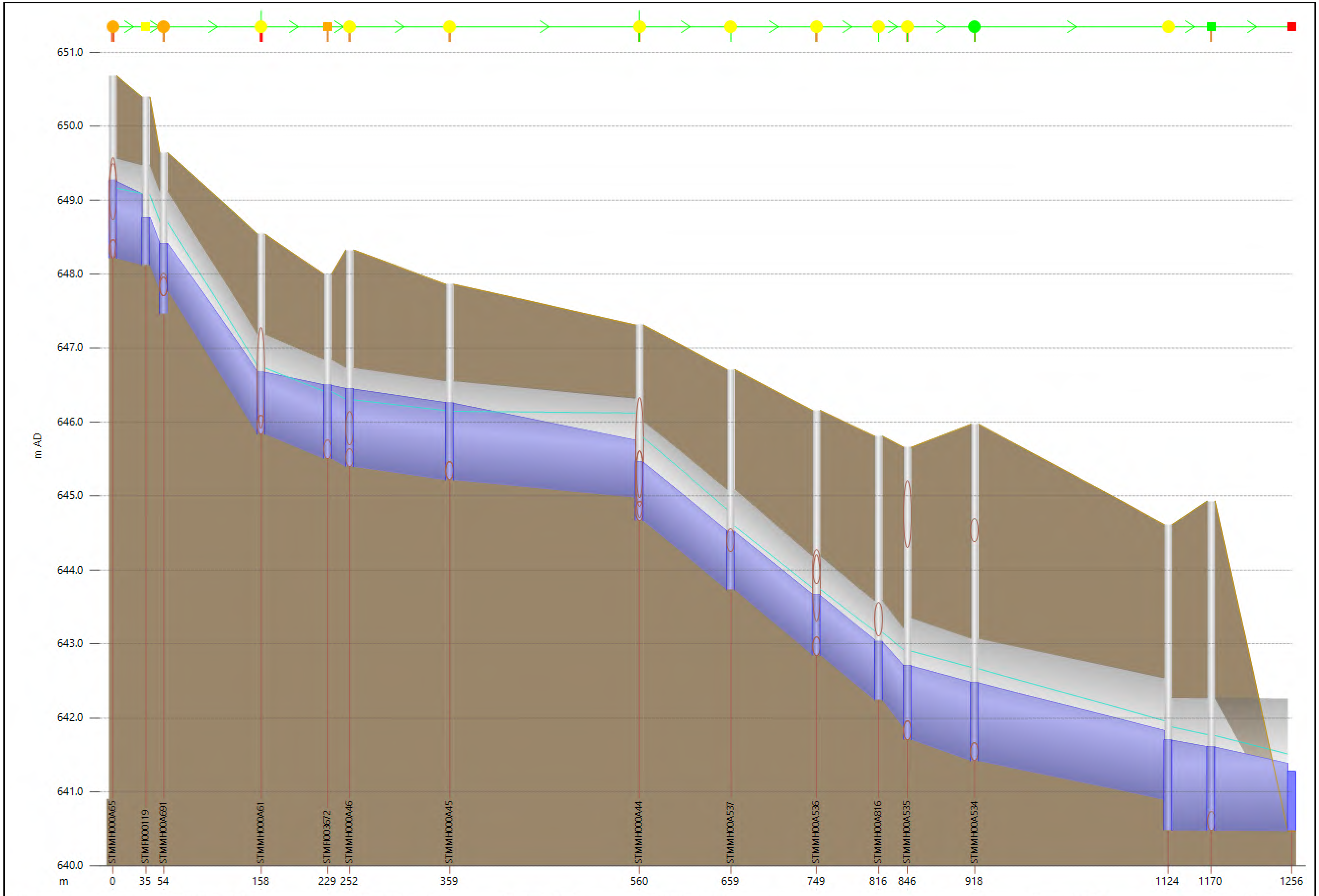

Link		-	-	STMMH00A691.1	-	-	STMMH000A46.1	STMMH000A45.1	STMMH000A44.1	-	-	-	-	STMMH00A534.1	-	STMFI003656.1	
r.pfc (m3/s)		2.704	-	7.295	3.675	-	2.172	1.823	5.192	5.306	5.067	-	5.775	4.633	1.003	1.003	
DS flow (m3/s)		-	-	3.18942	2.00430	-	2.09388	2.09873	3.26620	3.26723	3.37471	-	3.44040	3.46146	3.46235	3.48247	

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

FIGURE APPENDIX C.6
HGL COMPARISON - PROFILE 6
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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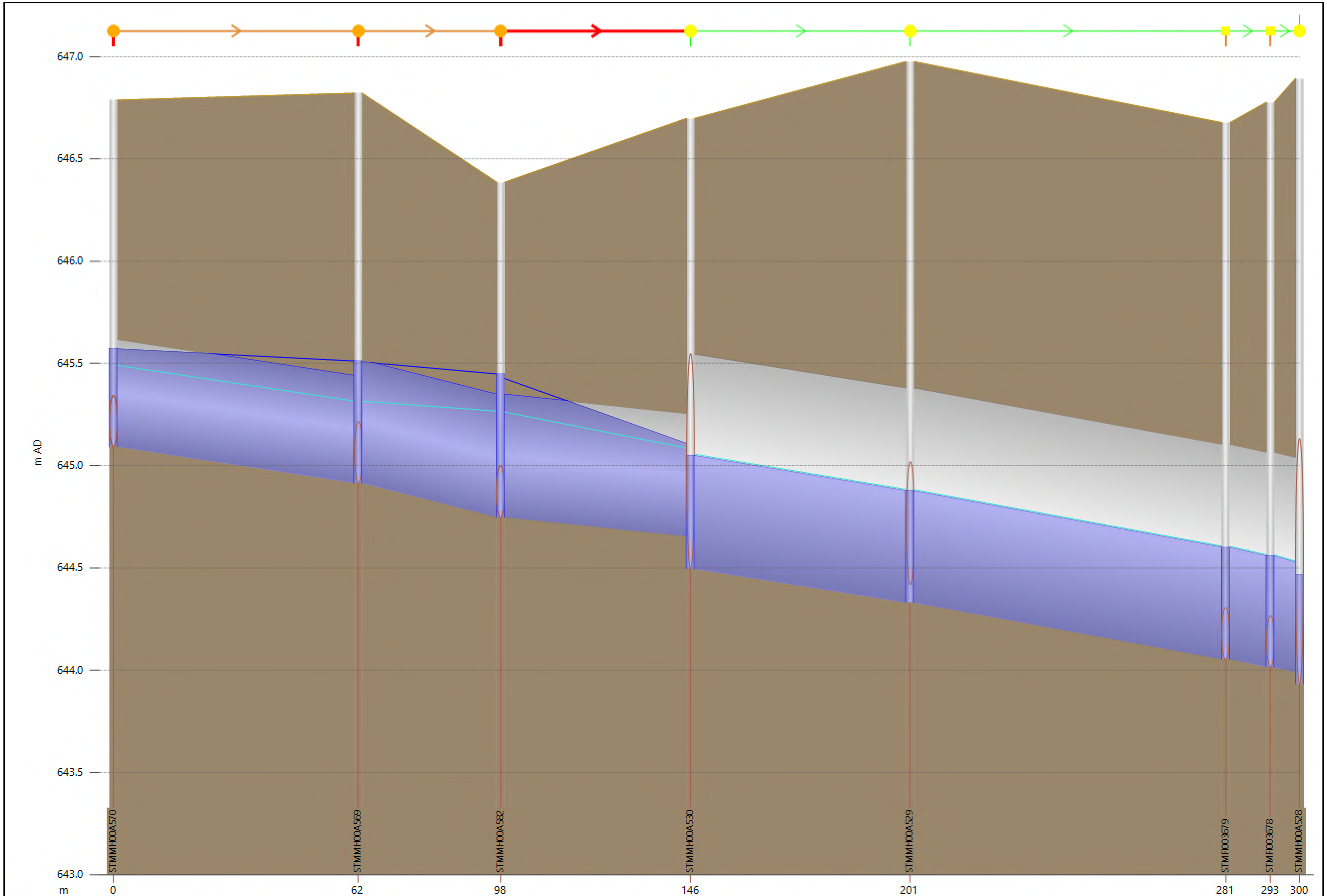

Link		STMMH00A570.1	STMMH00A569.1	STMMH00A582.1	STMMH00A530.1	STMMH00A529.1	-	-	
r.pfc (m3/s)		0.230	0.418	0.271	1.489	1.603	1.603	-	
DS flow (m3/s)		0.22036	0.27936	0.47541	0.81503	0.84966	0.87394	-	

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

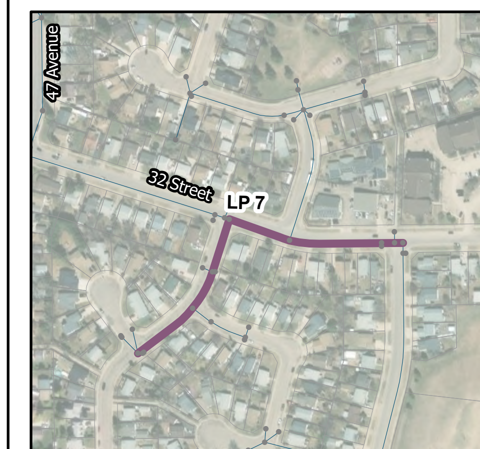

FIGURE APPENDIX C.7
HGL COMPARISON - PROFILE 7
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

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Credits:World Imagery: Vermilion River County, Maxar

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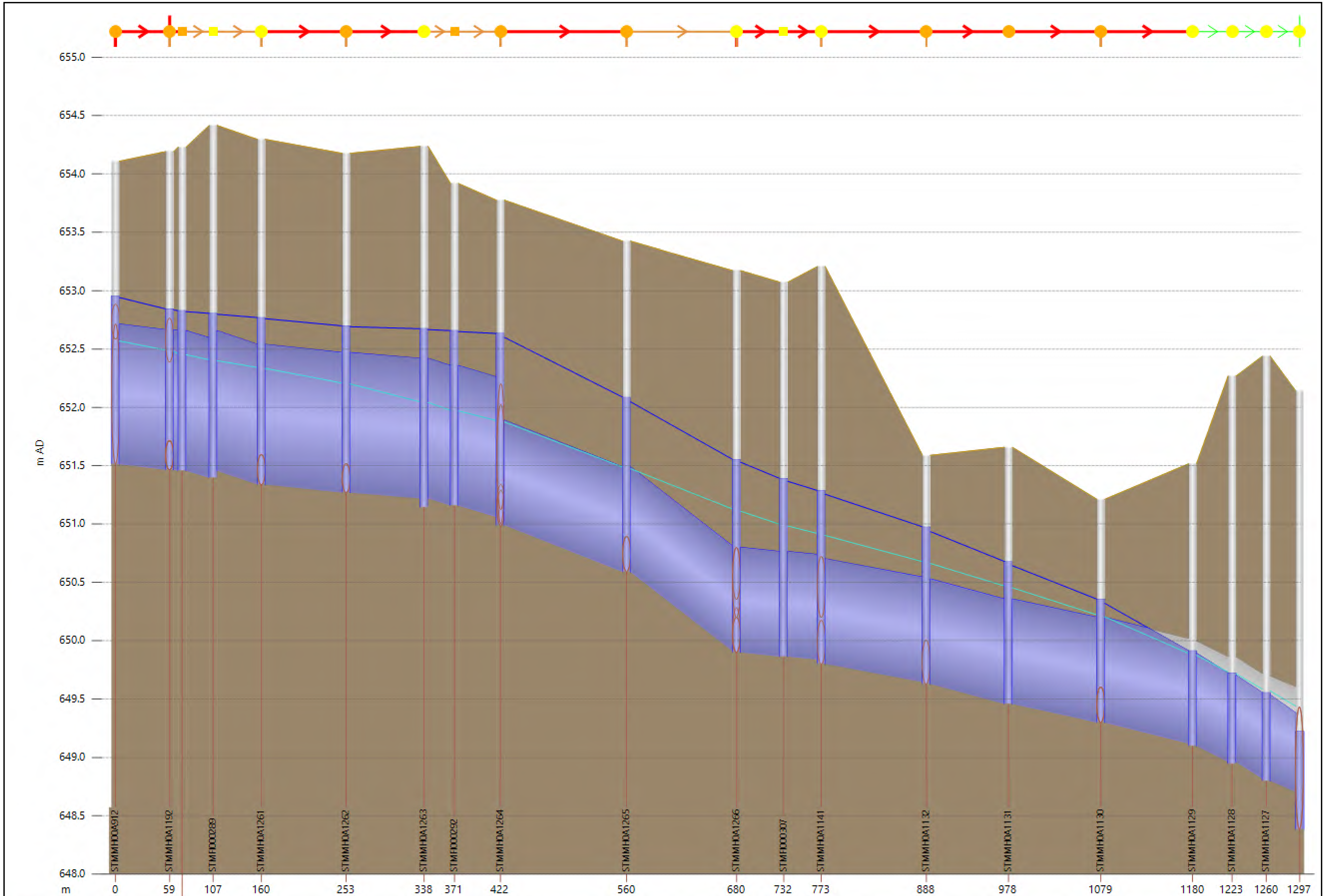

Link		-	-	-	-	-	-	-	-	STMMH0A1264.2	STMMH0A1265.1	-	-	STMMH0A1141.1	-	STMMH0A1131.1	STMMH0A1130.1	-	-	-	
r.pfc (m3/s)		1.120	-	1.638	1.836	1.070	0.944	1.682	1.720	0.974	1.360	0.478	0.529	0.790	0.936	0.843	0.906	1.207	1.320	1.088	
DS flow (m3/s)		1.52528	-	-	1.44219	1.38793	1.36556	-	1.25514	1.17219	1.18423	0.95158	-	1.05016	1.12899	1.12922	1.30218	-	-	-	

FIGURE APPENDIX C.8
HGL COMPARISON - PROFILE 8
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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Credits:World Imagery: Vermilion River County, Maxar

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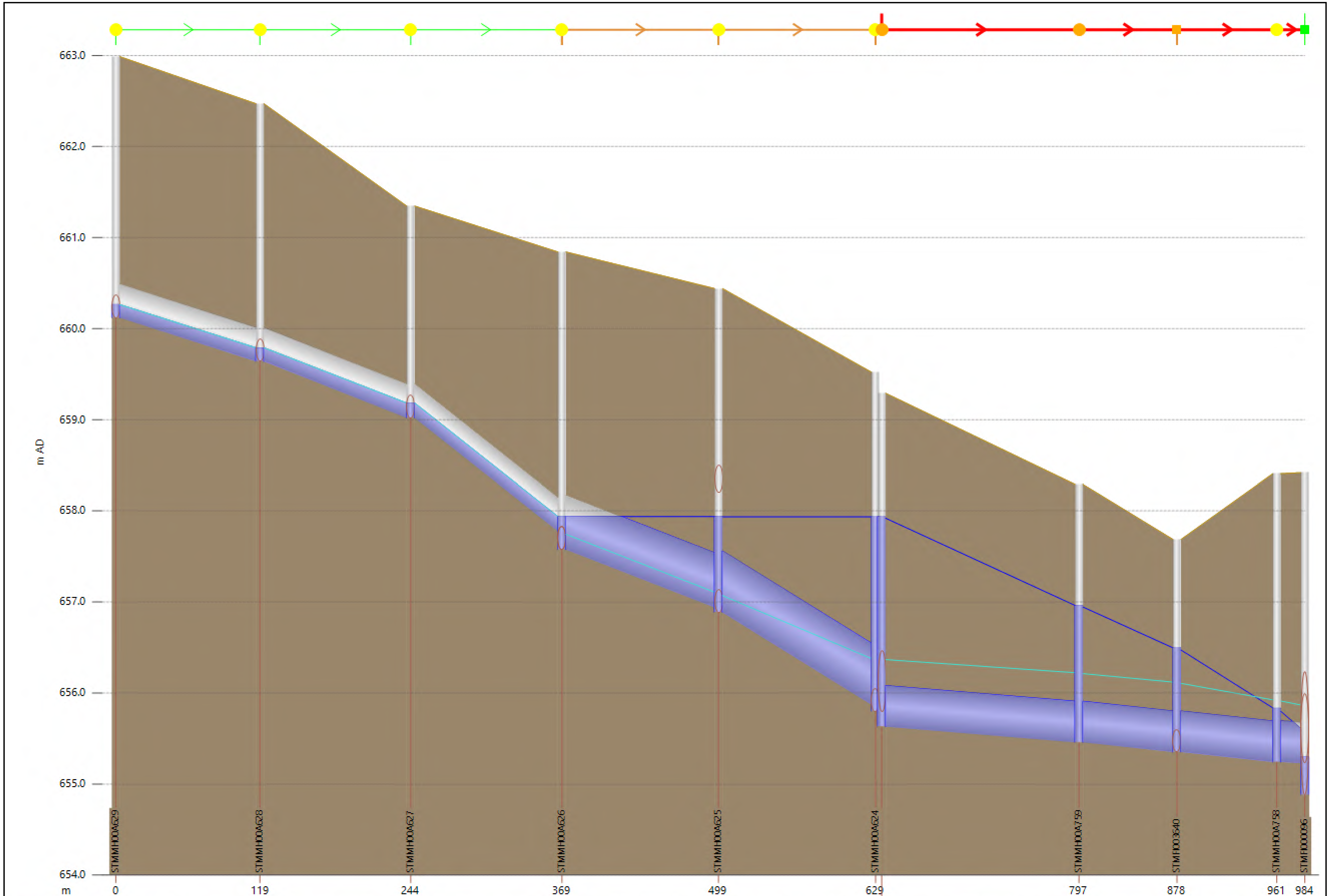

Link	STMMH00A629.1	STMMH00A628.1	STMMH00A627.1	STMMH00A626.1	STMMH00A625.1		STMMH00A760.1	STMMH00A759.1	STMFI003640.1	-	
r.pfc (m3/s)	0.111	0.124	0.175	0.430	0.743		0.109	0.123	0.123	-	
DS flow (m3/s)	0.03322	0.04014	0.06601	-0.09179	-0.35412		0.27113	0.26357	0.29305	-	

Legend
- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

FIGURE APPENDIX C.9
HGL COMPARISON - PROFILE 9
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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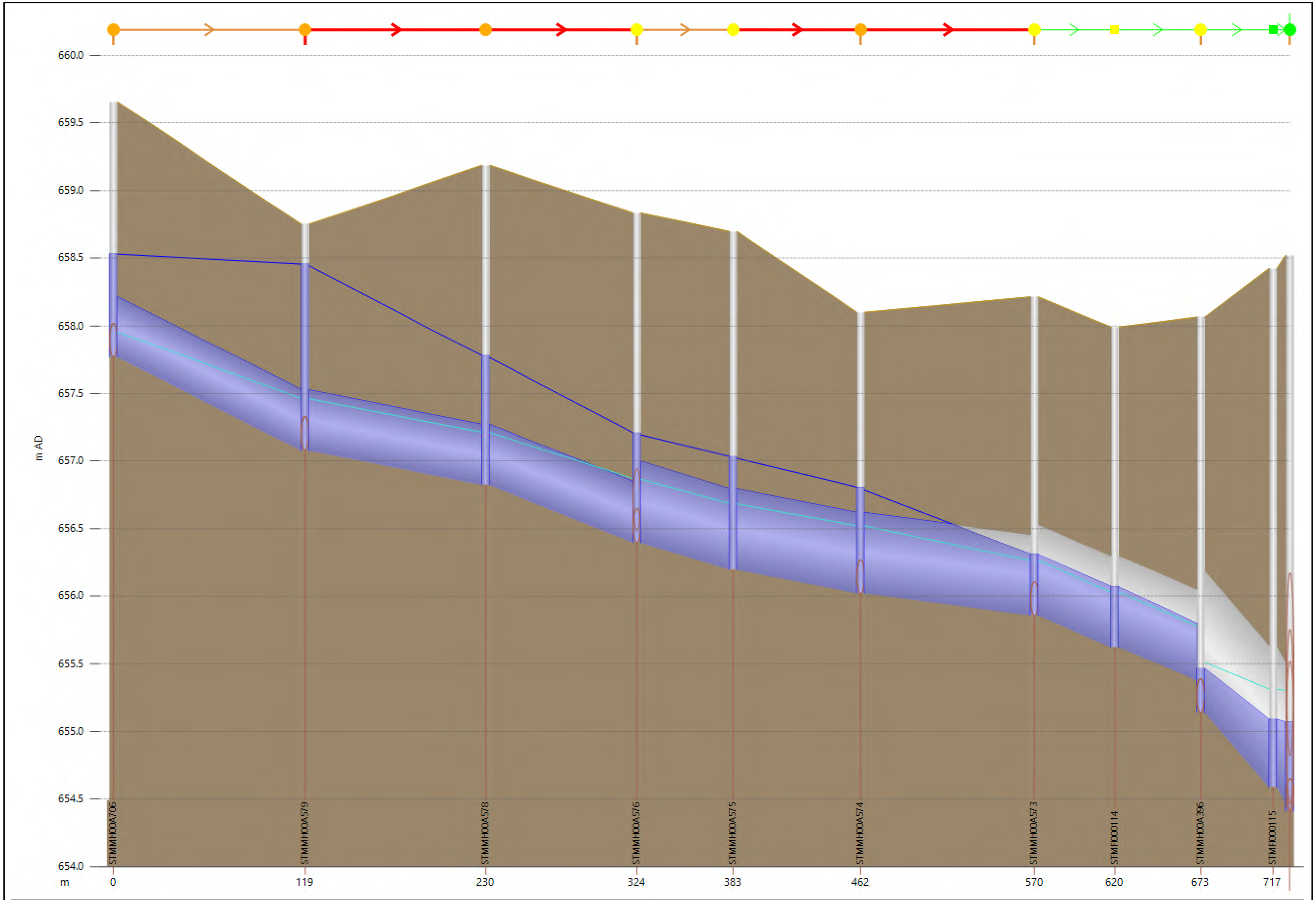

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r.pfc (m3/s)		0.218	0.136	0.192	0.359	0.288	0.239	0.576	0.575	3.039	-
DS flow (m3/s)		0.07932	0.23001	0.22770	0.31746	0.31781	0.39076	0.44436	0.44392	0.54264	-

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

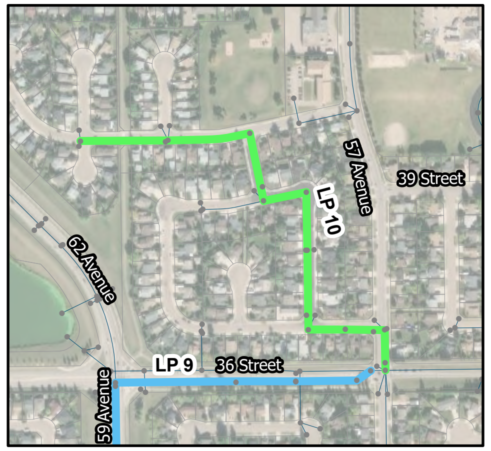

FIGURE APPENDIX C.10
HGL COMPARISON - PROFILE 10
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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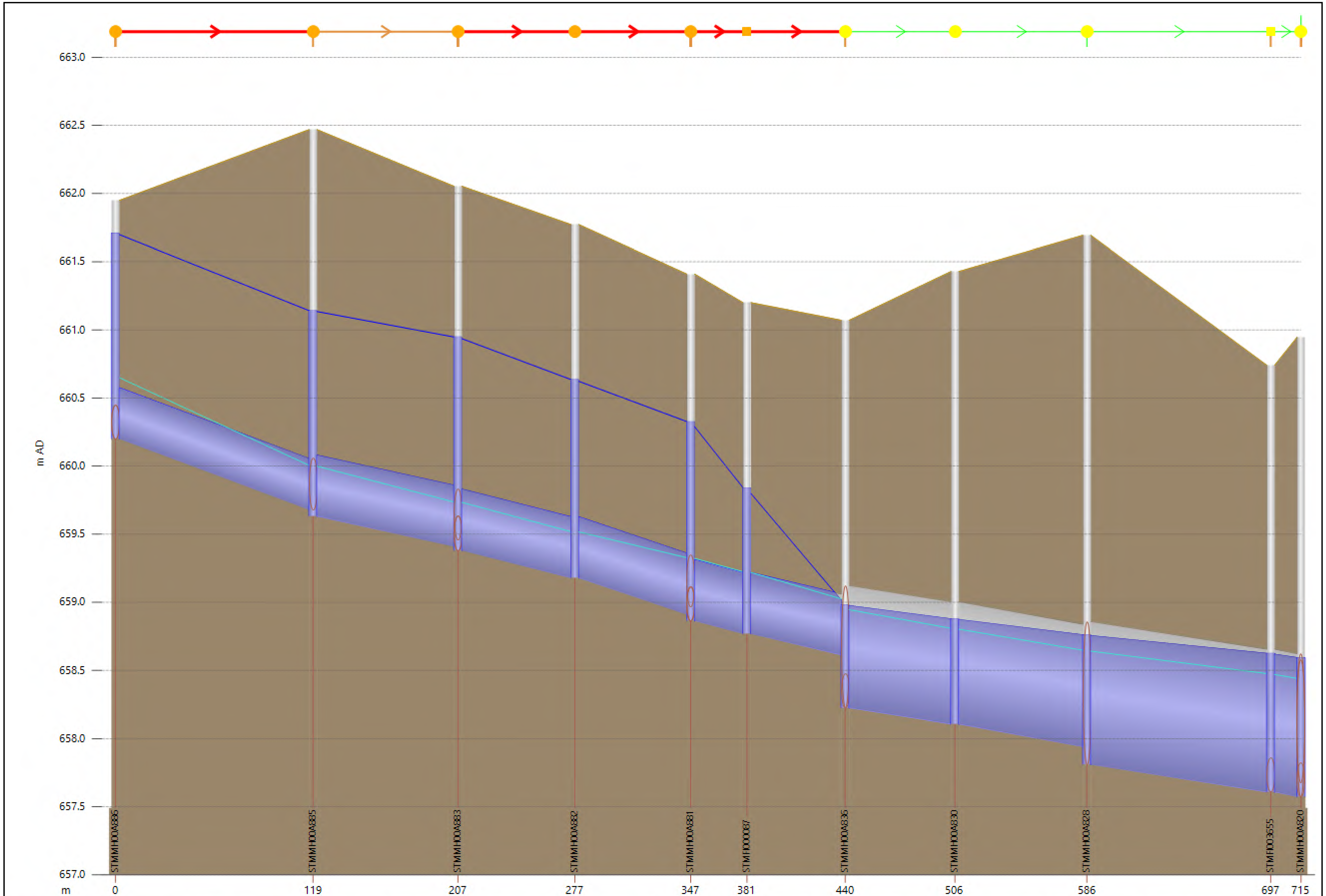

Link	STMMH00A886.1	STMMH00A885.1	STMMH00A883.1	STMMH00A882.1	-	STMFI000087.1	STMMH00A836.1	STMMH00A830.1	STMMH00A828.1	-
r.pfc (m3/s)	0.137	0.169	0.181	0.208	0.178	0.173	0.765	0.827	1.167	1.167
DS flow (m3/s)	0.14365	0.15726	0.21903	0.21998	0.38286	0.38287	0.73170	0.69520	0.97033	-

Legend

Existing System HGL

Existing with Proposed Upgrades HGL

Ground Elevation

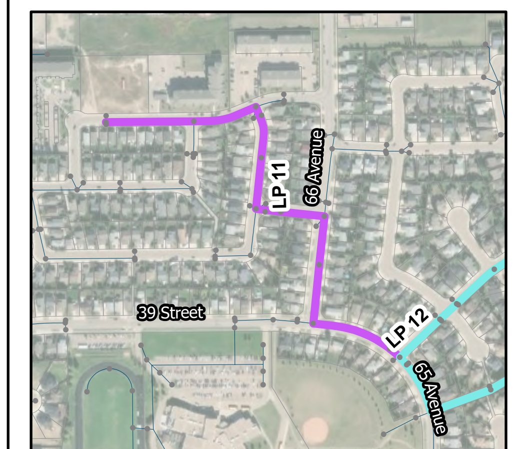

FIGURE APPENDIX C.11
HGL COMPARISON - PROFILE 11
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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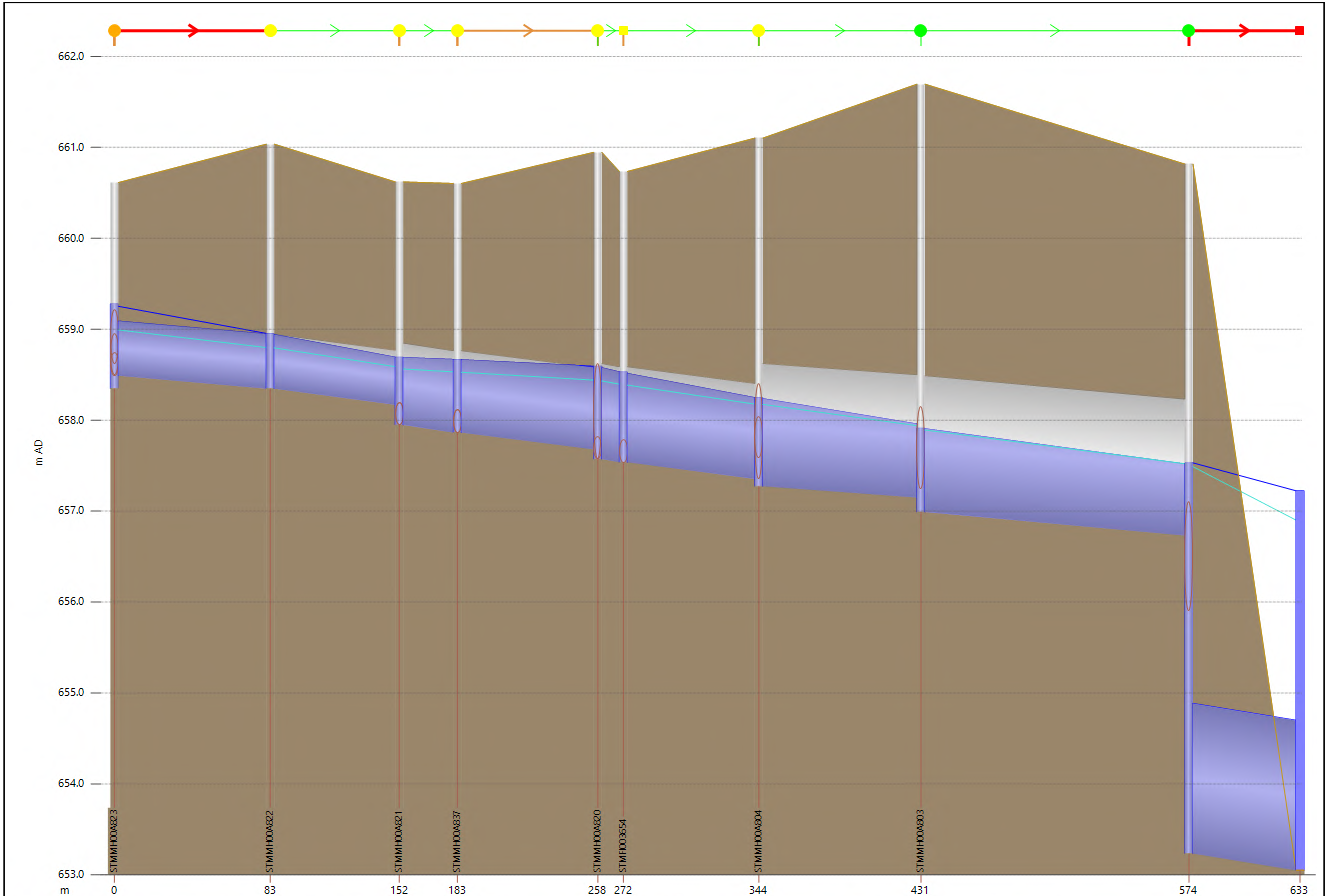

Link		STMMH00A823.2	STMMH00A822.1	-	STMMH00A837.1	-	STMFI003654.1	STMMH00A804.1	STMMH00A803.1	STMMH00A802.1	
r.pfc (m3/s)		0.300	0.369	0.943	0.899	-	1.378	2.020	3.002	5.092	
DS flow (m3/s)		0.44780	0.44542	0.55363	0.59839	-	1.56805	2.29288	-6.16903	-13.82943	

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

FIGURE APPENDIX C.12
HGL COMPARISON - PROFILE 12
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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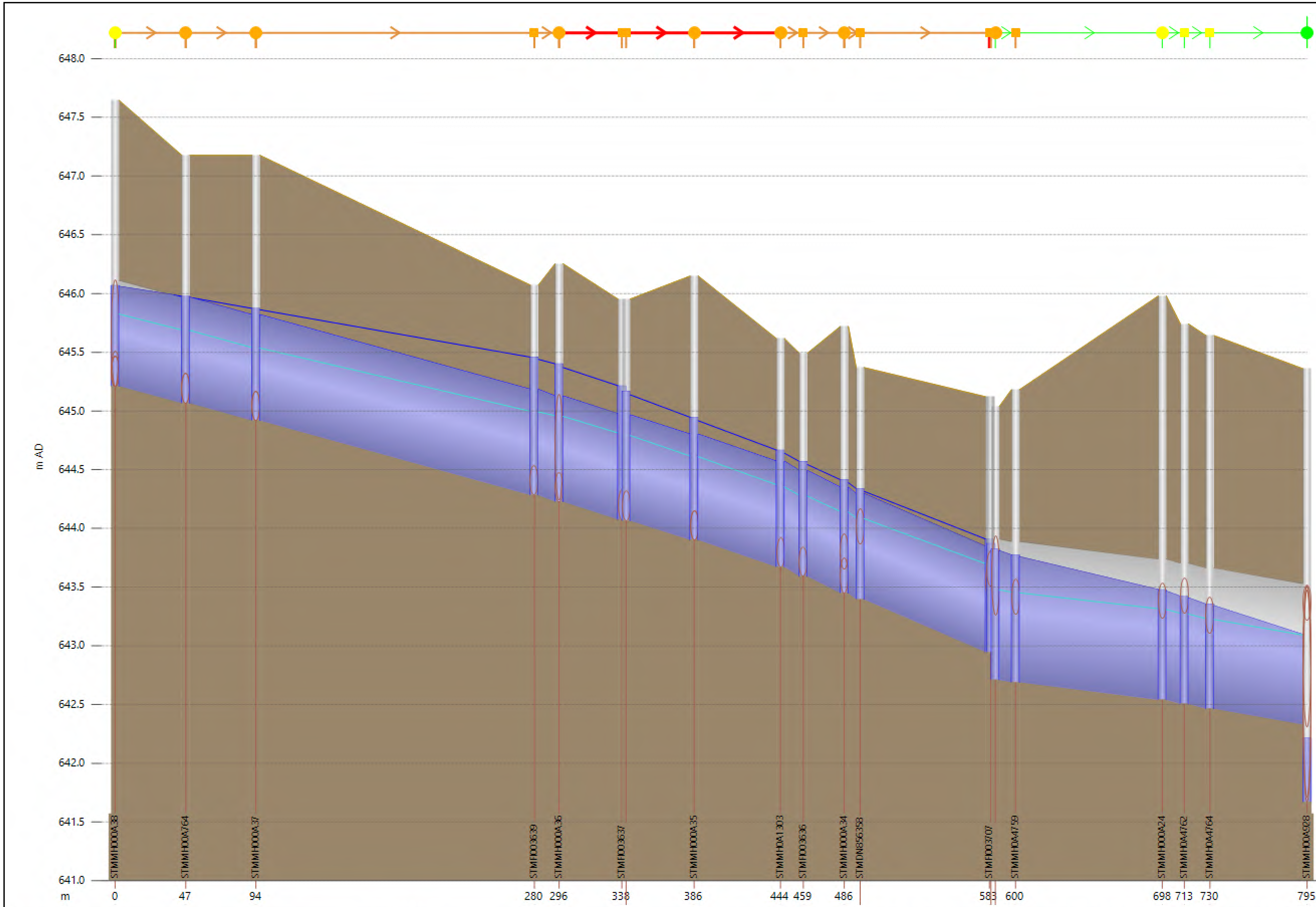

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r.pfc (m3/s)		1.005	1.018	1.059	-	1.089	1.089	1.145	-	1.306	-	1.306	-	1.522	-	-	1.774	
DS flow (m3/s)		0.81880	0.86805	0.86099	-	1.15931	1.20519	1.22014	-	-	-	1.27330	-	1.92139	-	-	1.93210	

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

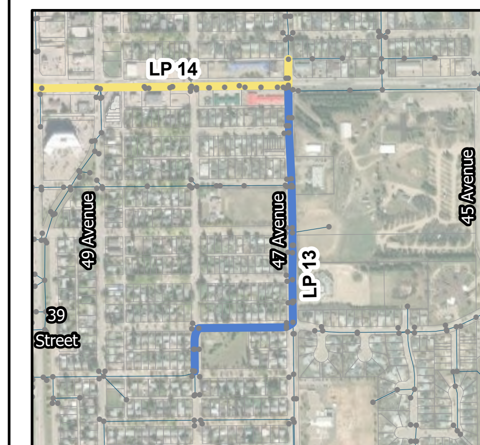
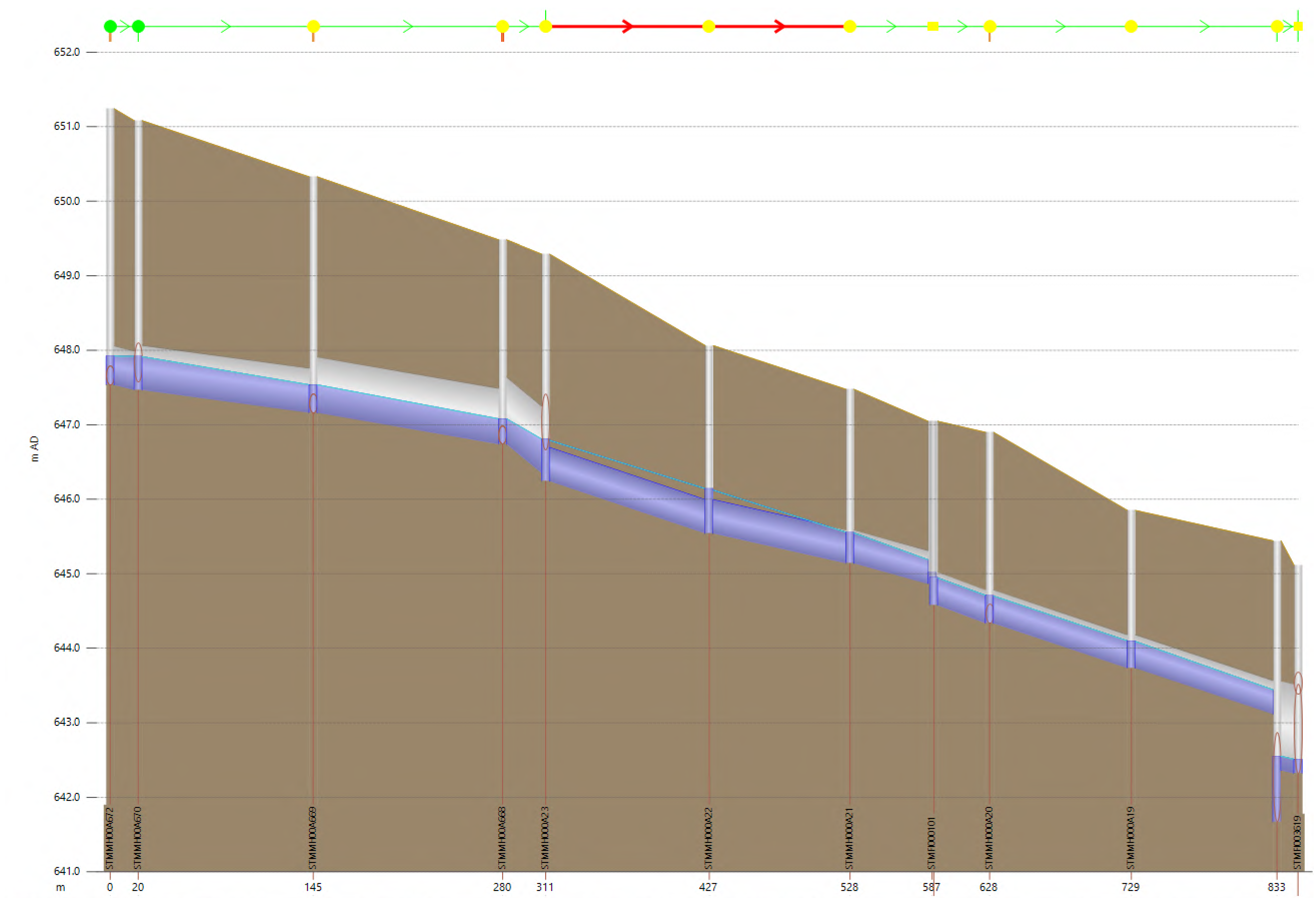


FIGURE APPENDIX C.13
HGL COMPARISON - PROFILE 13
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar



Link		-	STMMH00A670.1	STMMH00A669.1	-	STMMH000A23.1	STMMH000A22.1	-	-	STMMH000A20.1	STMMH000A19.1	-	
r.pfc (m3/s)		-	0.303	0.622	2.041	0.221	0.180	0.196	0.222	0.220	0.220	-	
DS flow (m3/s)		-	0.28005	0.30724	0.53693	0.21700	0.21134	0.21131	0.21104	0.21195	0.21193	-	

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

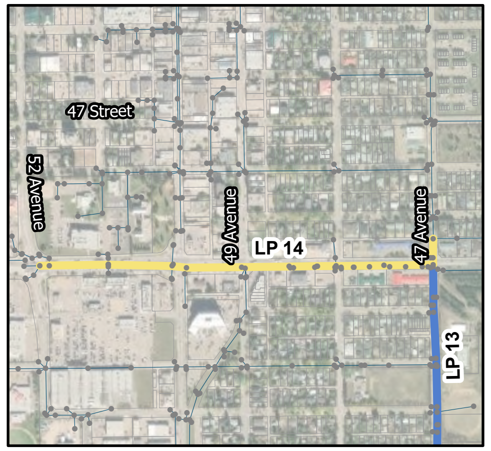


FIGURE APPENDIX C.14
HGL COMPARISON - PROFILE 14
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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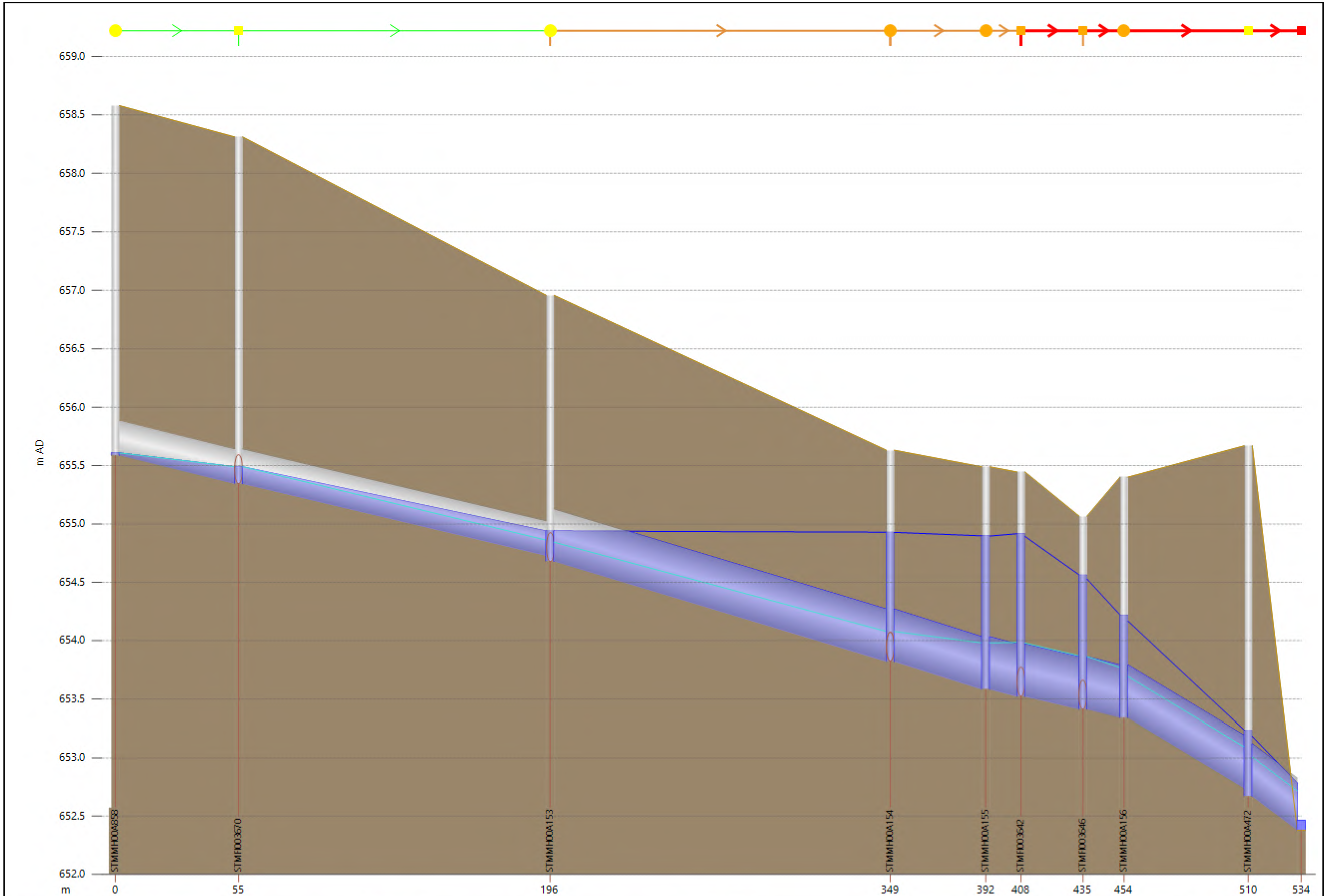

Link	STMMH00A858.1	STMFI003670.1	STMMH00A153.1	STMMH00A154.1	-	-	-	STMMH00A156.1	-
r.pfc (m3/s)	0.064	0.064	0.214	0.212	0.178	0.178	0.178	0.295	0.315
DS flow (m3/s)	0.00389	0.02972	0.05460	0.11968	-	0.33176	-	0.36162	0.36118

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

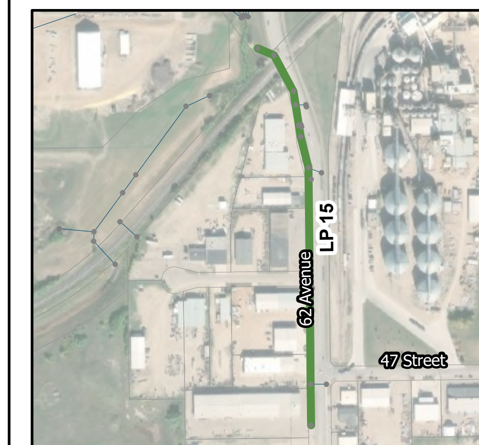

FIGURE APPENDIX C.15
HGL COMPARISON - PROFILE 15
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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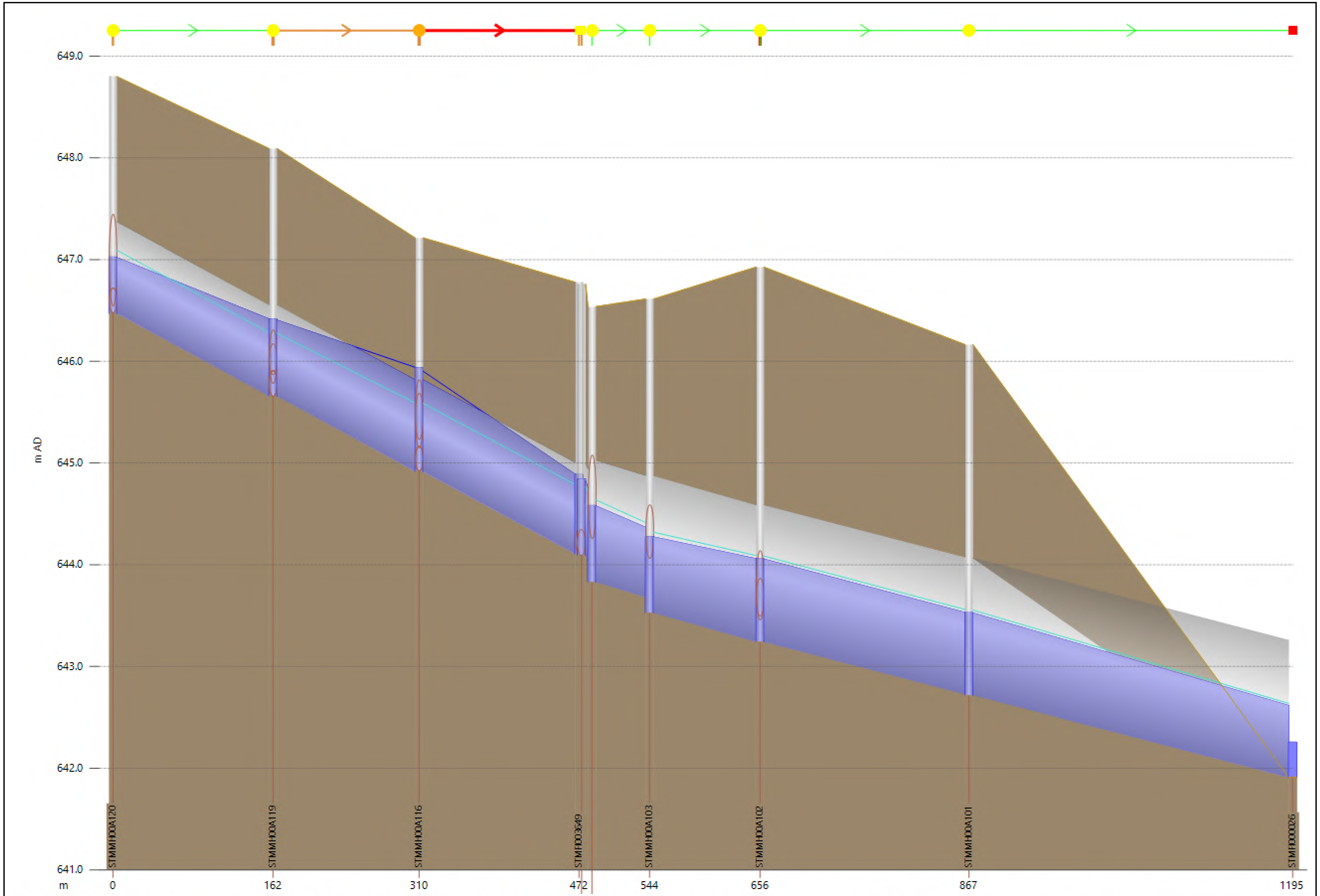

Link		STMMH00A120.1	STMMH00A119.1	STMMH00A116.1	-	-	STMMH00A103.1	STMMH00A102.1	STMMH00A101.1	
r.pfc (m3/s)		1.283	1.281	1.280	-	1.969	2.699	2.632	2.650	
DS flow (m3/s)		0.85977	1.02301	1.42403	-	1.56841	1.51035	1.77228	1.76945	

Legend

Existing System HGL

Existing with Proposed Upgrades HGL

Ground Elevation

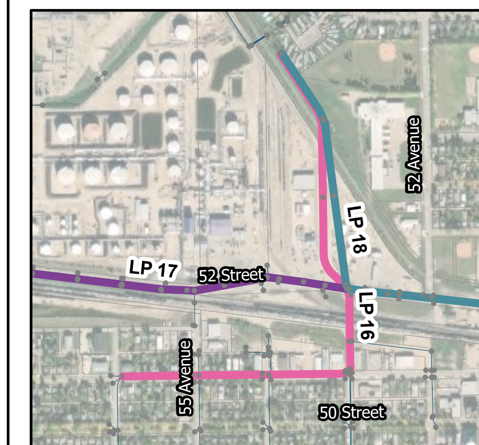

FIGURE APPENDIX C.16
HGL COMPARISON - PROFILE 16
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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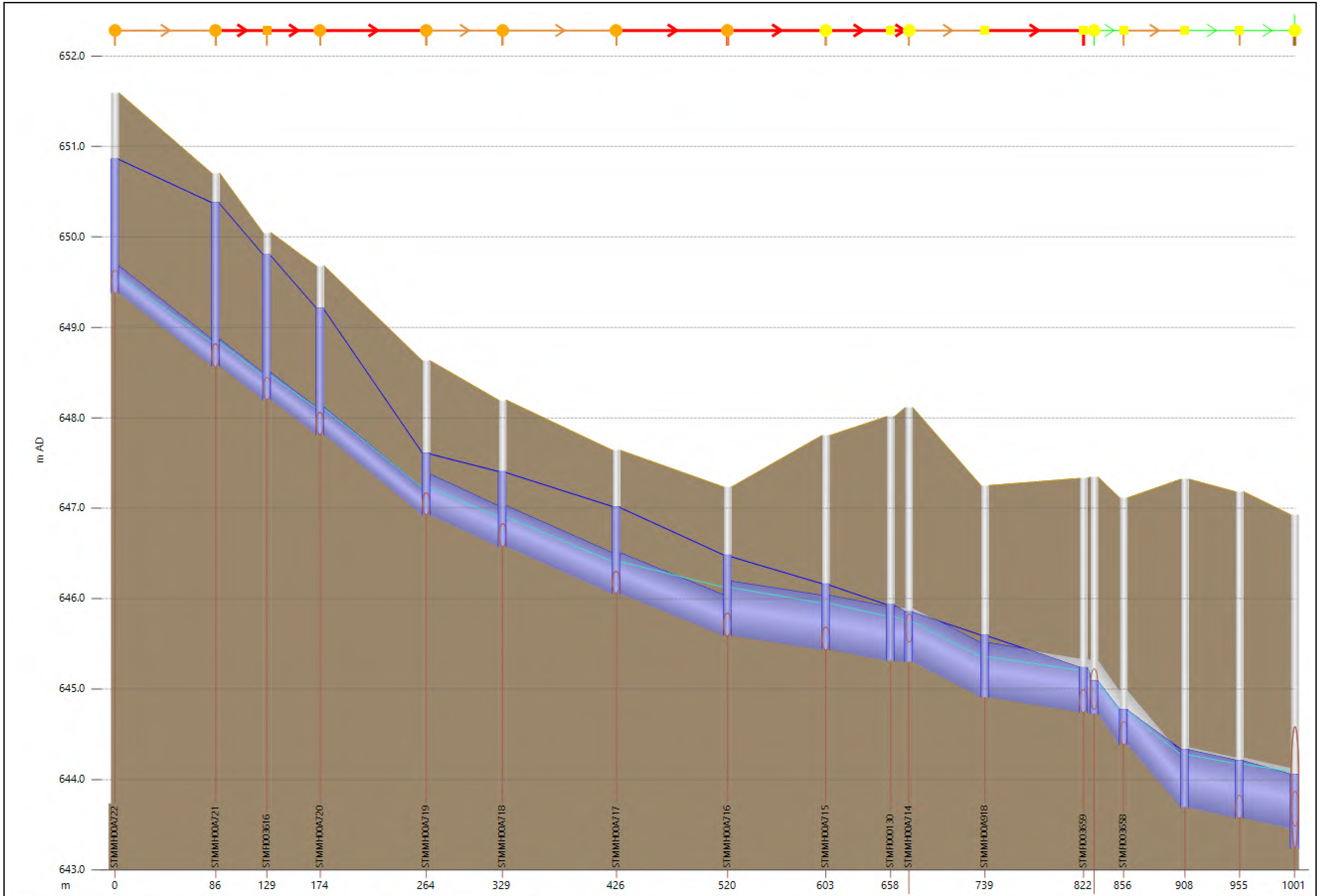

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r.pfc (m3/s)		0.094	0.089	0.089	0.096	0.210	0.209	0.200	0.265	0.290	-	0.478	0.274	-	0.712	0.712	0.418	0.418	
DS flow (m3/s)		0.07427	0.11342	0.10976	0.12975	0.15478	0.17680	0.21104	0.36781	0.38584	-	0.37846	0.37976	-	-	0.45948	0.45887	0.51264	

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

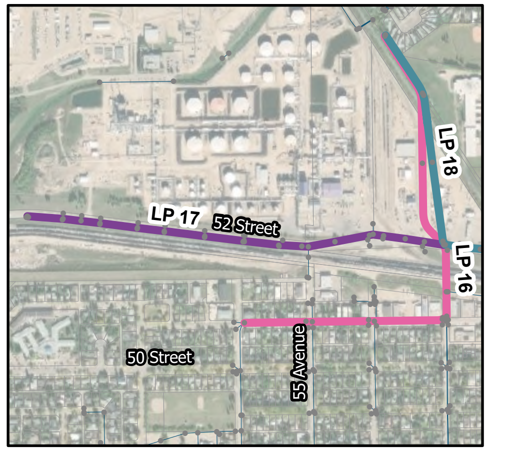

FIGURE APPENDIX C.17
HGL COMPARISON - PROFILE 17
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

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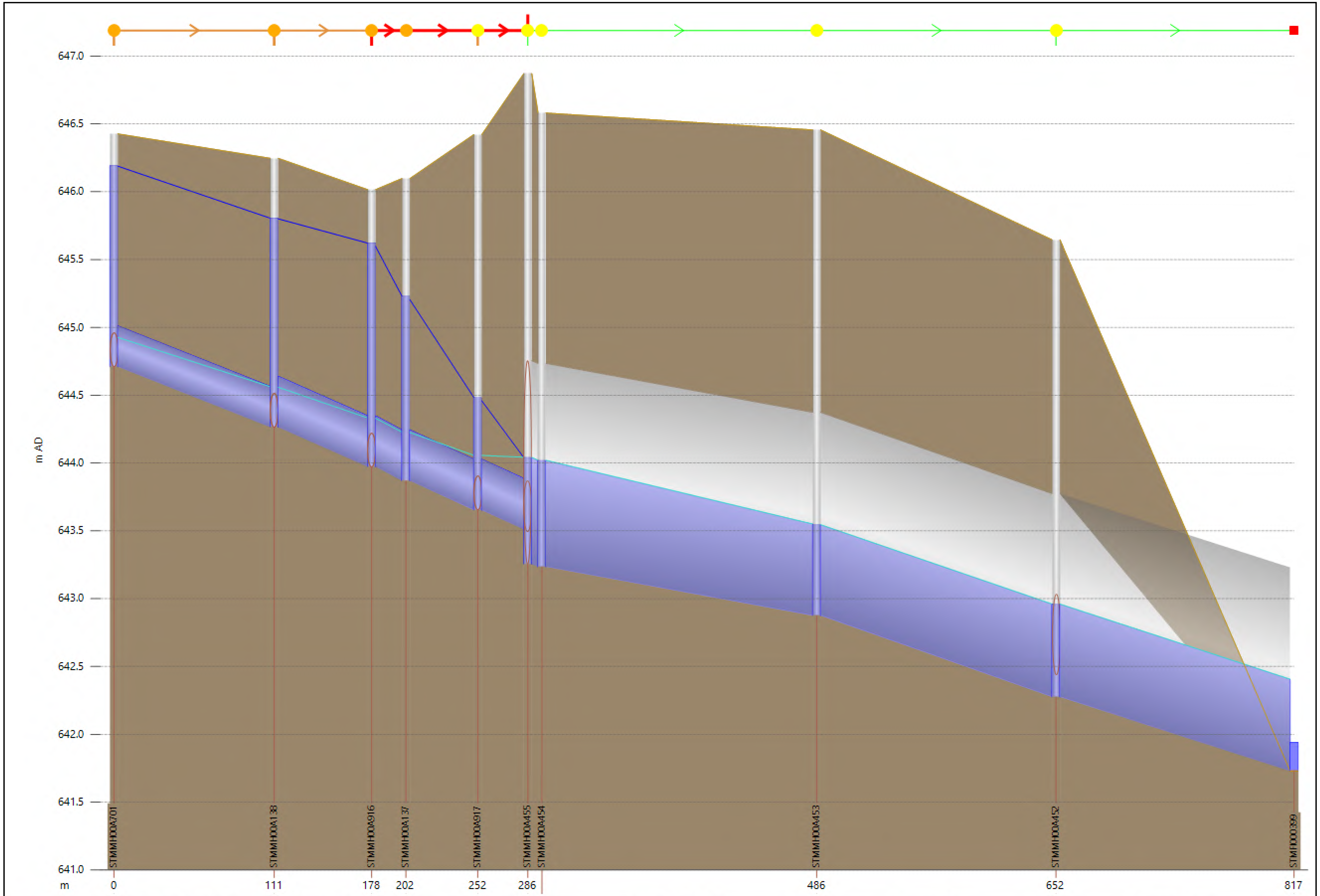

Link		STMMH00A701.1	STMMH00A138.1	-	-	-	-	STMMH00A454.1	STMMH00A453.1	STMMH00A452.1	
r.pfc (m3/s)		0.061	0.115	0.116	0.116	0.112	-	3.076	4.255	4.065	
DS flow (m3/s)		0.05717	0.09107	-	0.21721	0.21741	-	1.70815	1.70712	1.70643	

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

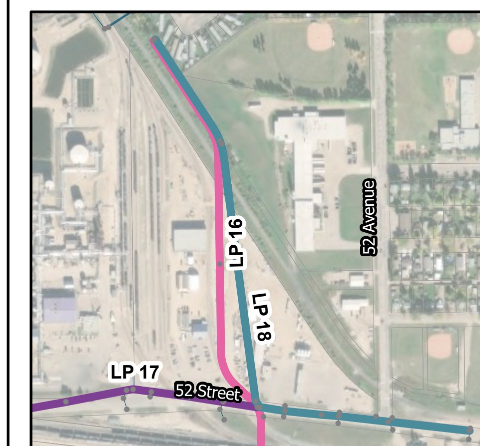

FIGURE APPENDIX C.18
HGL COMPARISON - PROFILE 18
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL
LLOYDMINSTER

Credits:World Imagery: Vermilion River County, Maxar

Date: 2024-09-17 Document: C:\Users\lche\Desktop\L.Che\Projects\28310 Lloydminster Stormwater Master Plan\30_Technical\GIS\28310_Lloydminster SWMP Appendix\28310_Lloydminster SWMP Appendix.aprx

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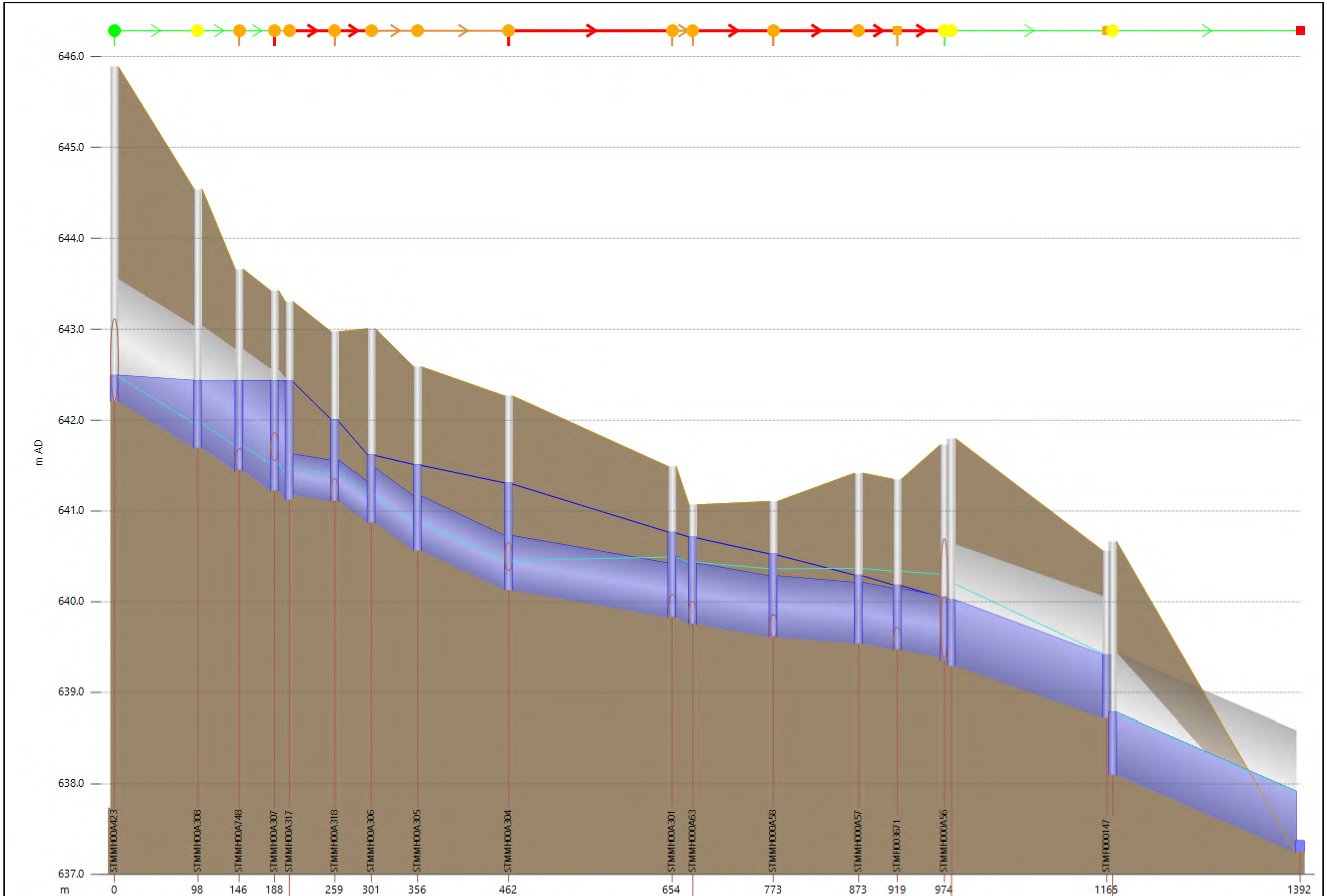


Link		-	-	-	-	-	-	-	STMMH00A305.1	STMMH00A304.1	-	-	-	-	-		STMMH000A54.1		STMMH00A647.1	
r.pfc (m3/s)		3.873	3.866	3.863	-	0.103	0.211	0.463	0.393	0.244	-	0.324	0.227	0.324	0.324		2.984		3.337	
DS flow (m3/s)		0.29121	-	-	-	0.26823	-	0.26243	0.26259	0.32651	-	0.37154	0.40562	-	0.41011		1.68795		1.68287	

Legend

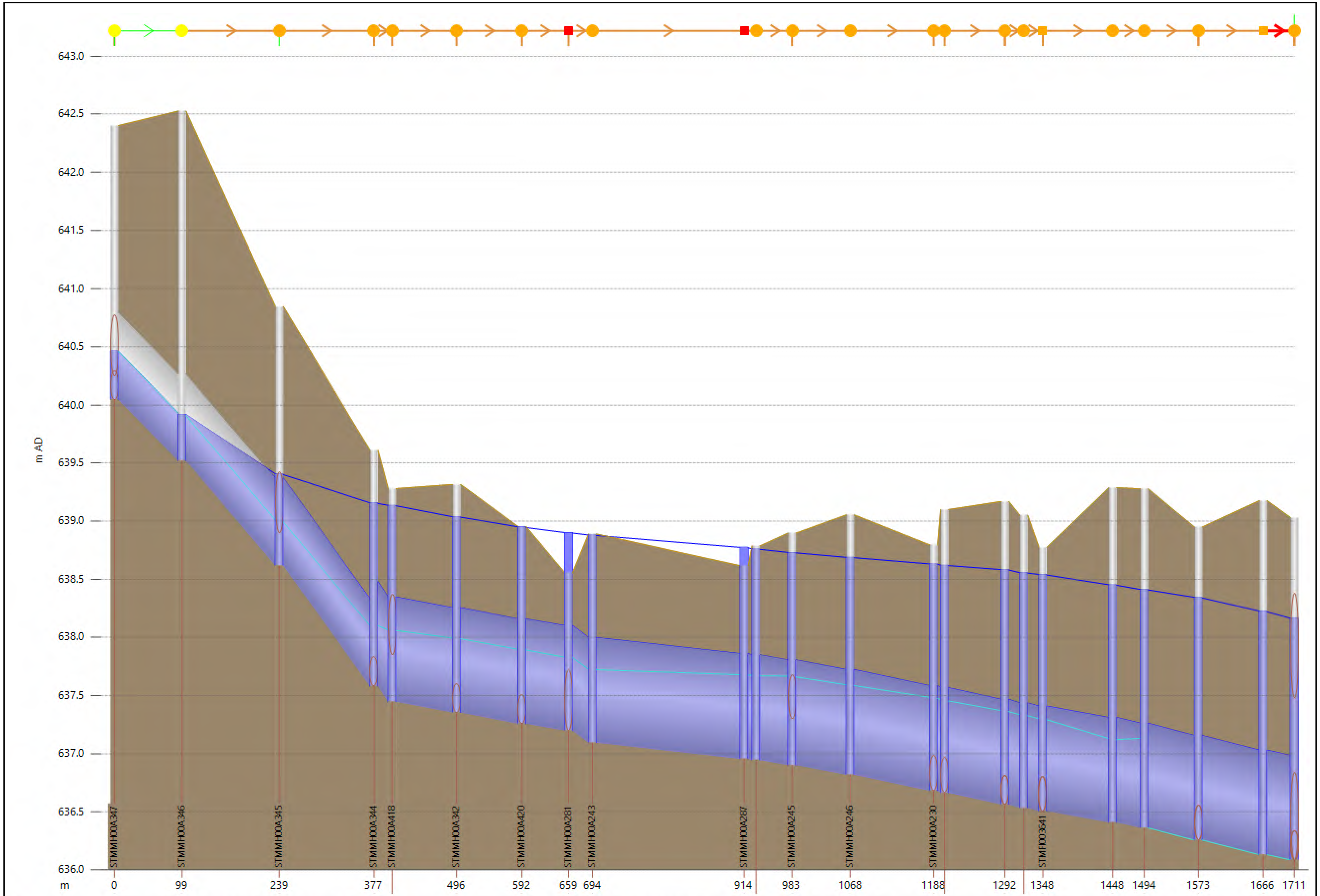
- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

FIGURE APPENDIX C.19
HGL COMPARISON - PROFILE 19
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

ISL

LLOYDMINSTER

Date: 2024-09-17 Document: C:\Users\lche\Desktop\L.Che\Projects\28310 Lloydminster Stormwater Master Plan\30_Technical\GIS\28310_Lloydminster SWMP Appendix\28310_Lloydminster SWMP Appendix.aprx



Link		-	STMMH00A346.1	STMMH00A345.1	-	-	-	-	-	STMMH00A243.1	-	-	-	-	-	-	-	-	-	-	-	-	-	
r.pfc (m3/s)		0.815	0.891	0.967	-	0.573	0.574	0.531	-	0.453	-	0.522	0.561	0.613	-	0.611	-	-	0.565	0.591	0.660	0.662	0.573	
DS flow (m3/s)		0.47400	0.47337	0.47791	-	0.61285	0.57145	0.48624	-	0.42037	-	-	0.50012	0.43420	-	0.46609	-	-	0.52113	-	0.52390	0.61631	-	

Legend

- Existing System HGL
- Existing with Proposed Upgrades HGL
- Ground Elevation

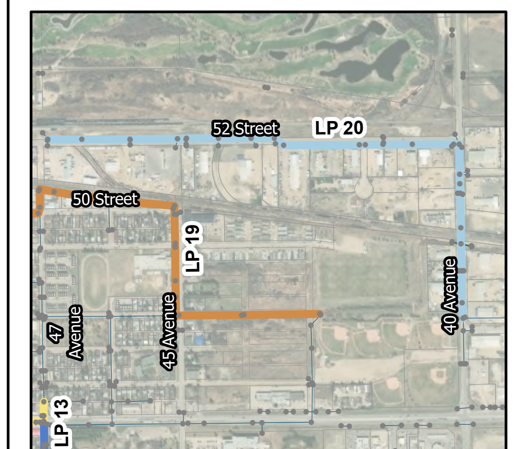


FIGURE APPENDIX C.20
HGL COMPARISON - PROFILE 20
1:5 YEAR 4-HOUR CHICAGO DESIGN STORM
CITY OF LLOYDMINSTER
STORMWATER MASTER PLAN

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Date: 2024-09-17 Document: C:\Users\lche\Desktop\L.Che\Projects\28310 Lloydminster Stormwater Master Plan\30_Technical\GIS\28310_Lloydminster SWMP Appendix\28310_Lloydminster SWMP Appendix.aprx

APPENDIX D
Risk Assessment Matrix and Scoring

Table D.1: Existing System Proposed Upgrades Risk Assessment Scores

Priority	Upgrade No.	Location	Name	Category	Length	Category Weighted Score						Combined Weighted Score
						Historical Flooding	Surface Flooding Alleviation	Peak HGL Reduction	Proximity to Critical Structures/Buildings	Generalized Pipe Condition	Road Condition Upgrade Potential	
1	EX UPG #12	50 Ave @ 31 St to 36 St @ 46 Ave	50 Avenue and 36 Street Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	1,319	1.43	0.24	0.95	0.71	0.38	0.14	3.86
2	EX UPG #4	From 50 St @ 47 Ave to east of 47 St via 45 Ave	45 Avenue and 47 Street Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	1,187	1.43	0.24	0.95	0.71	0.38	0.10	3.81
3	EX UPG #6	42 St @ 67 Ave to 40 St @ 66 Ave	67 Avenue and 40 Street Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	233	1.43	0.24	0.95	0.57	0.19	0.14	3.52
4	EX UPG #2	52 St between 59 Ave and 50 Ave	52 Street Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	1,287	1.43	0.24	0.95	0.43	0.38	0.10	3.52
5	EX UPG #22	47 Ave at Barr Cresent	47 Avenue Catch Basin Upgrade	Surface Flooding Under 100-Yr Event	0	1.43	0.71	0.19	0.57	0.38	0.14	3.43
6	EX UPG #18	Intersection of 52 Ave and 41 St	52 Avenue/41 Street Catch Basin Upgrade	Surface Flooding Under 100-Yr Event	0	1.43	0.71	0.19	0.57	0.38	0.10	3.38
7	EX UPG #1	62 Ave between 48 St and 52 St	62 Avenue Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	185	1.43	0.24	0.76	0.43	0.38	0.14	3.38
8	EX UPG #11	47 Ave between 39 St and 44 St	39 Street and 47 Avenue Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	502	1.43	0.24	0.38	0.71	0.24	0.19	3.19
9	EX UPG #3	51 St between 55 Ave and 53 Ave	51 Street Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	323	1.43	0.24	0.38	0.57	0.38	0.19	3.19
10	EX UPG #16	18 St @ 47a Ave to east of 25 St @ 47 Ave	46 Avenue Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	875	1.43	0.24	0.57	0.57	0.19	0.10	3.10
11	EX UPG #19	50 Avenue at 38 Street to 47 Avenue at 39 Street	38 Street Storm Sewer Upgrade	Surface Flooding Under 100-Yr Event	657	1.43	0.24	0.19	0.57	0.38	0.14	2.95
12	EX UPG #23	Intersection of 45 Ave and 29 St	45 Avenue/29 Street Catch Basin Upgrade	Surface Flooding Under 100-Yr Event	0	0.00	1.19	0.19	0.57	0.38	0.10	2.43
13	EX UPG #21	Intersection of 35 St and 54 Ave	54 Avenue Storm Sewer Upgrade	Surface Flooding Under 100-Yr Event	75	0.00	0.95	0.19	0.57	0.38	0.19	2.29
14	EX UPG #10	59 Ave @ 36 St to 36 St @ 57 Ave	36 Street Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	350	0.00	0.24	0.95	0.57	0.29	0.14	2.19
15	EX UPG #5	52 St to 40 Ave	52 Street and 40 Avenue Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	1,309	0.00	0.24	0.95	0.43	0.38	0.14	2.14
16	EX UPG #13	46 Ave between 31 St and 32 St	46 Avenue/31 Street Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	137	0.00	0.24	0.76	0.57	0.38	0.19	2.14
17	EX UPG #9	40 St @ 58 Ave Close to 57 Ave @ 37 St via 57a Ave	57A Avenue Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	553	0.00	0.24	0.76	0.57	0.38	0.10	2.05
18	EX UPG #20	36 St between 59 Ave and 57 Ave	36 Street Catch Basin Upgrade	Surface Flooding Under 100-Yr Event	0	0.00	0.95	0.19	0.43	0.33	0.14	2.05
19	EX UPG #26	49 Ave south of 18 St	49 Avenue Storm Sewer Upgrade	Surface Flooding Under 100-Yr Event	299	0.00	0.71	0.19	0.57	0.38	0.14	2.00
20	EX UPG #14	52 Ave @ 29 St to 31 St @ 51a Ave	29 Street and 51A Avenue Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	492	0.00	0.24	0.57	0.57	0.38	0.14	1.90
21	EX UPG #25	Intersection of 26 St and 57a Ave	26 Street/57A Avenue Storm Sewer Upgrade	Surface Flooding Under 100-Yr Event	136	0.00	0.48	0.19	0.71	0.38	0.05	1.81
22	EX UPG #17	44 St and 45 St @ 56 Ave	56 Avenue between 44 Street and 50 Street Storm Sewer Upgrade	Surface Flooding Under 100-Yr Event	691	0.00	0.48	0.19	0.57	0.38	0.14	1.76
23	EX UPG #24	Intersection of 27 St and 54 Ave	27 Street/54 Avenue Catch Basin Upgrade	Surface Flooding Under 100-Yr Event	0	0.00	0.48	0.19	0.57	0.38	0.10	1.71
24	EX UPG #27	60 St @ 53 Ave	60 Street/53 Avenue Catch Basin Upgrade	Surface Flooding Under 100-Yr Event	0	0.00	0.71	0.19	0.29	0.38	0.10	1.67
25	EX UPG #15	23 St @ 52b Ave to 25 St @ 53 Ave	53 Avenue at 23 Street Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	322	0.00	0.24	0.38	0.57	0.38	0.05	1.62
26	EX UPG #7	39 St between 63a Ave and 65 Ave	39 Street Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	152	0.00	0.24	0.38	0.57	0.29	0.14	1.62
26	EX UPG #8	65 Ave from 39 St to Lake L	65 Avenue to Lake L Storm Sewer Upgrade	Inadequate Pipe Capacity Under 5-Yr Event	316	0.00	0.24	0.38	0.57	0.29	0.14	1.62

Table D.2: Existing System Proposed Upgrades Risk Assessment Parameter Summary

Upgrade No.	Location	Category	Historical Flooding	Surface Flooding Alleviation (m)	Peak HGL Reduction (m)	Proximity to Critical Structure/Building	Generalized Pipe Condition	Road Condition
EX UPG #1	62 Ave between 48 St and 52 St	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	0.00	0.92	Arterial and collector roadway	Poor	Average
EX UPG #2	52 St between 59 Ave and 50 Ave	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	0.00	1.54	Arterial and collector roadway	Poor	Good
EX UPG #3	51 St between 55 Ave and 53 Ave	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	0.00	0.35	Residential neighbourhood and non-essential commerical establishment	Poor	Poor
EX UPG #4	From 50 St @ 47 Ave to east of 47 St via 45 Ave	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	0.00	1.29	Close to schools, hospitals, and essential and emergency services	Poor	Good
EX UPG #5	52 St to 40 Ave	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0.00	1.49	Arterial and collector roadway	Poor	Average
EX UPG #6	42 St @ 67 Ave to 40 St @ 66 Ave	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	0.00	1.14	Residential neighbourhood and non-essential commerical establishment	Good	Average
EX UPG #7	39 St between 63a Ave and 65 Ave	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0.00	0.28	Residential neighbourhood and non-essential commerical establishment	Fair	Average
EX UPG #8	65 Ave from 39 St to Lake L	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0.00	0.28	Residential neighbourhood and non-essential commerical establishment	Fair	Average
EX UPG #9	40 St @ 58 Ave Close to 57 Ave @ 37 St via 57a Ave	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0.00	0.99	Residential neighbourhood and non-essential commerical establishment	Poor	Good
EX UPG #10	59 Ave @ 36 St to 36 St @ 57 Ave	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0.00	1.56	Residential neighbourhood and non-essential commerical establishment	Fair	Average
EX UPG #11	47 Ave between 39 St and 44 St	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	0.00	0.46	Close to schools, hospitals, and essential and emergency services	Excellent/Poor	Poor
EX UPG #12	50 Ave @ 31 St to 36 St @ 46 Ave	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	0.00	1.68	Close to schools, hospitals, and essential and emergency services	Poor	Average
EX UPG #13	46 Ave between 31 St and 32 St	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0.00	0.88	Residential neighbourhood and non-essential commerical establishment	Poor	Poor
EX UPG #14	52 Ave @ 29 St to 31 St @ 51a Ave	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0.00	0.61	Residential neighbourhood and non-essential commerical establishment	Poor	Average
EX UPG #15	23 St @ 52b Ave to 25 St @ 53 Ave	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0.00	0.30	Residential neighbourhood and non-essential commerical establishment	Poor	Excellent
EX UPG #16	18 St @ 47a Ave to east of 25 St @ 47 Ave	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	0.00	0.75	Residential neighbourhood and non-essential commerical establishment	Good	Good
EX UPG #17	44 St and 45 St @ 56 Ave	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0.07	0.00	Residential neighbourhood and non-essential commerical establishment	Poor	Average
EX UPG #18	Intersection of 52 Ave and 41 St	Surface Flooding Under 100-Yr Event	Historical Flooding Issues Observed	0.12	0.00	Residential neighbourhood and non-essential commerical establishment	Poor	Good
EX UPG #19	50 Avenue at 38 Street to 47 Avenue at 39 Street	Surface Flooding Under 100-Yr Event	Historical Flooding Issues Observed	0.04	0.00	Residential neighbourhood and non-essential commerical establishment	Poor	Average
EX UPG #20	36 St between 59 Ave and 57 Ave	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0.25	0.00	Arterial and collector roadway	Fair/Poor	Average
EX UPG #21	Intersection of 35 St and 54 Ave	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0.23	0.00	Residential neighbourhood and non-essential commerical establishment	Poor	Poor
EX UPG #22	47 Ave at Barr Cresent	Surface Flooding Under 100-Yr Event	Historical Flooding Issues Observed	0.13	0.00	Residential neighbourhood and non-essential commerical establishment	Poor	Average
EX UPG #23	Intersection of 45 Ave and 29 St	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0.34	0.00	Residential neighbourhood and non-essential commerical establishment	Poor	Good
EX UPG #24	Intersection of 27 St and 54 Ave	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0.05	0.00	Residential neighbourhood and non-essential commerical establishment	Poor	Good
EX UPG #25	Intersection of 26 St and 57a Ave	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0.05	0.00	Close to schools, hospitals, and essential and emergency services	Poor	Excellent
EX UPG #26	49 Ave south of 18 St	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0.18	0.00	Residential neighbourhood and non-essential commerical establishment	Poor	Average
EX UPG #27	60 St @ 53 Ave	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0.16	0.00	Parking lot of commerical/industrial/warehouse	Poor	Good

Table D.3: Existing System Proposed Upgrades Risk Assessment - Historical Flooding

Upgrade No.	Category	Historical Flooding Instance	Raw Score	Weighted Score
EX UPG #1	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	5	1.43
EX UPG #2	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	5	1.43
EX UPG #3	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	5	1.43
EX UPG #4	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	5	1.43
EX UPG #5	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #6	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	5	1.43
EX UPG #7	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #8	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #9	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #10	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #11	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	5	1.43
EX UPG #12	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	5	1.43
EX UPG #13	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #14	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #15	Inadequate Pipe Capacity Under 5-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #16	Inadequate Pipe Capacity Under 5-Yr Event	Historical Flooding Issues Observed	5	1.43
EX UPG #17	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #18	Surface Flooding Under 100-Yr Event	Historical Flooding Issues Observed	5	1.43
EX UPG #19	Surface Flooding Under 100-Yr Event	Historical Flooding Issues Observed	5	1.43
EX UPG #20	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #21	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #22	Surface Flooding Under 100-Yr Event	Historical Flooding Issues Observed	5	1.43
EX UPG #23	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #24	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #25	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #26	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0	0.00
EX UPG #27	Surface Flooding Under 100-Yr Event	No Historical Flooding Issues	0	0.00

Table D.4: Existing System Proposed Upgrades Risk Assessment - Surface Flooding Reduction

Upgrade No.	Category	Peak Flooding Depth Reduction	Raw Score	Weighted Score
		m		
EX UPG #1	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #2	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #3	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #4	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #5	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #6	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #7	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #8	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #9	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #10	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #11	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #12	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #13	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #14	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #15	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #16	Inadequate Pipe Capacity Under 5-Yr Event	0	1	0.24
EX UPG #17	Surface Flooding Under 100-Yr Event	0.07	2	0.48
EX UPG #18	Surface Flooding Under 100-Yr Event	0.12	3	0.71
EX UPG #19	Surface Flooding Under 100-Yr Event	0.04	1	0.24
EX UPG #20	Surface Flooding Under 100-Yr Event	0.25	4	0.95
EX UPG #21	Surface Flooding Under 100-Yr Event	0.23	4	0.95
EX UPG #22	Surface Flooding Under 100-Yr Event	0.13	3	0.71
EX UPG #23	Surface Flooding Under 100-Yr Event	0.34	5	1.19
EX UPG #24	Surface Flooding Under 100-Yr Event	0.05	2	0.48
EX UPG #25	Surface Flooding Under 100-Yr Event	0.05	2	0.48
EX UPG #26	Surface Flooding Under 100-Yr Event	0.18	3	0.71
EX UPG #27	Surface Flooding Under 100-Yr Event	0.16	3	0.71

Table D.5: Existing System Proposed Upgrades Risk Assessment - HGL Reduction

Upgrade No.	Category	Peak HGL Reduction (m)	Raw Score	Weighted Score
EX UPG #1	Inadequate Pipe Capacity Under 5-Yr Event	0.92	4	0.76
EX UPG #2	Inadequate Pipe Capacity Under 5-Yr Event	1.54	5	0.95
EX UPG #3	Inadequate Pipe Capacity Under 5-Yr Event	0.35	2	0.38
EX UPG #4	Inadequate Pipe Capacity Under 5-Yr Event	1.29	5	0.95
EX UPG #5	Inadequate Pipe Capacity Under 5-Yr Event	1.49	5	0.95
EX UPG #6	Inadequate Pipe Capacity Under 5-Yr Event	1.14	5	0.95
EX UPG #7	Inadequate Pipe Capacity Under 5-Yr Event	0.28	2	0.38
EX UPG #8	Inadequate Pipe Capacity Under 5-Yr Event	0.28	2	0.38
EX UPG #9	Inadequate Pipe Capacity Under 5-Yr Event	0.99	4	0.76
EX UPG #10	Inadequate Pipe Capacity Under 5-Yr Event	1.56	5	0.95
EX UPG #11	Inadequate Pipe Capacity Under 5-Yr Event	0.46	2	0.38
EX UPG #12	Inadequate Pipe Capacity Under 5-Yr Event	1.68	5	0.95
EX UPG #13	Inadequate Pipe Capacity Under 5-Yr Event	0.88	4	0.76
EX UPG #14	Inadequate Pipe Capacity Under 5-Yr Event	0.61	3	0.57
EX UPG #15	Inadequate Pipe Capacity Under 5-Yr Event	0.30	2	0.38
EX UPG #16	Inadequate Pipe Capacity Under 5-Yr Event	0.75	3	0.57
EX UPG #17	Surface Flooding Under 100-Yr Event	0	1	0.19
EX UPG #18	Surface Flooding Under 100-Yr Event	0	1	0.19
EX UPG #19	Surface Flooding Under 100-Yr Event	0	1	0.19
EX UPG #20	Surface Flooding Under 100-Yr Event	0	1	0.19
EX UPG #21	Surface Flooding Under 100-Yr Event	0	1	0.19
EX UPG #22	Surface Flooding Under 100-Yr Event	0	1	0.19
EX UPG #23	Surface Flooding Under 100-Yr Event	0	1	0.19
EX UPG #24	Surface Flooding Under 100-Yr Event	0	1	0.19
EX UPG #25	Surface Flooding Under 100-Yr Event	0	1	0.19
EX UPG #26	Surface Flooding Under 100-Yr Event	0	1	0.19
EX UPG #27	Surface Flooding Under 100-Yr Event	0	1	0.19

Table D.6: Existing System Proposed Upgrades Risk Assessment - Proximity to Critical Structure and Buildings

Upgrade No.	Category	Proximity to Critical Structure or Buildings	Raw Score	Weighted Score
EX UPG #1	Inadequate Pipe Capacity Under 5-Yr Event	Arterial and collector roadway	3	0.43
EX UPG #2	Inadequate Pipe Capacity Under 5-Yr Event	Arterial and collector roadway	3	0.43
EX UPG #3	Inadequate Pipe Capacity Under 5-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #4	Inadequate Pipe Capacity Under 5-Yr Event	Close to schools, hospitals, and essential and emergency services	5	0.71
EX UPG #5	Inadequate Pipe Capacity Under 5-Yr Event	Arterial and collector roadway	3	0.43
EX UPG #6	Inadequate Pipe Capacity Under 5-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #7	Inadequate Pipe Capacity Under 5-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #8	Inadequate Pipe Capacity Under 5-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #9	Inadequate Pipe Capacity Under 5-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #10	Inadequate Pipe Capacity Under 5-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #11	Inadequate Pipe Capacity Under 5-Yr Event	Close to schools, hospitals, and essential and emergency services	5	0.71
EX UPG #12	Inadequate Pipe Capacity Under 5-Yr Event	Close to schools, hospitals, and essential and emergency services	5	0.71
EX UPG #13	Inadequate Pipe Capacity Under 5-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #14	Inadequate Pipe Capacity Under 5-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #15	Inadequate Pipe Capacity Under 5-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #16	Inadequate Pipe Capacity Under 5-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #17	Surface Flooding Under 100-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #18	Surface Flooding Under 100-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #19	Surface Flooding Under 100-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #20	Surface Flooding Under 100-Yr Event	Arterial and collector roadway	3	0.43
EX UPG #21	Surface Flooding Under 100-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #22	Surface Flooding Under 100-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #23	Surface Flooding Under 100-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #24	Surface Flooding Under 100-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #25	Surface Flooding Under 100-Yr Event	Close to schools, hospitals, and essential and emergency services	5	0.71
EX UPG #26	Surface Flooding Under 100-Yr Event	Residential neighbourhood and non-essential commerical establishment	4	0.57
EX UPG #27	Surface Flooding Under 100-Yr Event	Parking lot of commerical/industrial/warehouse	2	0.29

Table D.7: Existing System Proposed Upgrades Risk Assessment - Generalized Pipe Condition

Upgrade No.	Category	Generalized Pipe Condition	Raw Score	Weighted Score
EX UPG #1	Inadequate Pipe Capacity Under 5-Yr Event	Poor	4	0.38
EX UPG #2	Inadequate Pipe Capacity Under 5-Yr Event	Poor	4	0.38
EX UPG #3	Inadequate Pipe Capacity Under 5-Yr Event	Poor	4	0.38
EX UPG #4	Inadequate Pipe Capacity Under 5-Yr Event	Poor	4	0.38
EX UPG #5	Inadequate Pipe Capacity Under 5-Yr Event	Poor	4	0.38
EX UPG #6	Inadequate Pipe Capacity Under 5-Yr Event	Good	2	0.19
EX UPG #7	Inadequate Pipe Capacity Under 5-Yr Event	Fair	3	0.29
EX UPG #8	Inadequate Pipe Capacity Under 5-Yr Event	Fair	3	0.29
EX UPG #9	Inadequate Pipe Capacity Under 5-Yr Event	Poor	4	0.38
EX UPG #10	Inadequate Pipe Capacity Under 5-Yr Event	Fair	3	0.29
EX UPG #11	Inadequate Pipe Capacity Under 5-Yr Event	Excellent/Poor	2.5	0.24
EX UPG #12	Inadequate Pipe Capacity Under 5-Yr Event	Poor	4	0.38
EX UPG #13	Inadequate Pipe Capacity Under 5-Yr Event	Poor	4	0.38
EX UPG #14	Inadequate Pipe Capacity Under 5-Yr Event	Poor	4	0.38
EX UPG #15	Inadequate Pipe Capacity Under 5-Yr Event	Poor	4	0.38
EX UPG #16	Inadequate Pipe Capacity Under 5-Yr Event	Good	2	0.19
EX UPG #17	Surface Flooding Under 100-Yr Event	Poor	4	0.38
EX UPG #18	Surface Flooding Under 100-Yr Event	Poor	4	0.38
EX UPG #19	Surface Flooding Under 100-Yr Event	Poor	4	0.38
EX UPG #20	Surface Flooding Under 100-Yr Event	Fair/Poor	3.5	0.33
EX UPG #21	Surface Flooding Under 100-Yr Event	Poor	4	0.38
EX UPG #22	Surface Flooding Under 100-Yr Event	Poor	4	0.38
EX UPG #23	Surface Flooding Under 100-Yr Event	Poor	4	0.38
EX UPG #24	Surface Flooding Under 100-Yr Event	Poor	4	0.38
EX UPG #25	Surface Flooding Under 100-Yr Event	Poor	4	0.38
EX UPG #26	Surface Flooding Under 100-Yr Event	Poor	4	0.38
EX UPG #27	Surface Flooding Under 100-Yr Event	Poor	4	0.38

Table D.8: Existing System Proposed Upgrades Risk Assessment - Road Condition Upgrade Potential

Upgrade No.	Category	Imagery Year	Road Condition	Raw Score	Weighted Score
EX UPG #1	Inadequate Pipe Capacity Under 5-Yr Event	2024	Average	3	0.14
EX UPG #2	Inadequate Pipe Capacity Under 5-Yr Event	2024	Good	2	0.10
EX UPG #3	Inadequate Pipe Capacity Under 5-Yr Event	2024	Poor	4	0.19
EX UPG #4	Inadequate Pipe Capacity Under 5-Yr Event	2024	Good	2	0.10
EX UPG #5	Inadequate Pipe Capacity Under 5-Yr Event	2024	Average	3	0.14
EX UPG #6	Inadequate Pipe Capacity Under 5-Yr Event	2024	Average	3	0.14
EX UPG #7	Inadequate Pipe Capacity Under 5-Yr Event	2024	Average	3	0.14
EX UPG #8	Inadequate Pipe Capacity Under 5-Yr Event	2024	Average	3	0.14
EX UPG #9	Inadequate Pipe Capacity Under 5-Yr Event	2024	Good	2	0.10
EX UPG #10	Inadequate Pipe Capacity Under 5-Yr Event	2024	Average	3	0.14
EX UPG #11	Inadequate Pipe Capacity Under 5-Yr Event	2019	Poor	4	0.19
EX UPG #12	Inadequate Pipe Capacity Under 5-Yr Event	2024	Average	3	0.14
EX UPG #13	Inadequate Pipe Capacity Under 5-Yr Event	2024	Poor	4	0.19
EX UPG #14	Inadequate Pipe Capacity Under 5-Yr Event	2024	Average	3	0.14
EX UPG #15	Inadequate Pipe Capacity Under 5-Yr Event	2024	Excellent	1	0.05
EX UPG #16	Inadequate Pipe Capacity Under 5-Yr Event	2024	Good	2	0.10
EX UPG #17	Surface Flooding Under 100-Yr Event	2019	Average	3	0.14
EX UPG #18	Surface Flooding Under 100-Yr Event	2012	Good	2	0.10
EX UPG #19	Surface Flooding Under 100-Yr Event	2024	Average	3	0.14
EX UPG #20	Surface Flooding Under 100-Yr Event	2024	Average	3	0.14
EX UPG #21	Surface Flooding Under 100-Yr Event	2024	Poor	4	0.19
EX UPG #22	Surface Flooding Under 100-Yr Event	2018	Average	3	0.14
EX UPG #23	Surface Flooding Under 100-Yr Event	2024	Good	2	0.10
EX UPG #24	Surface Flooding Under 100-Yr Event	2024	Good	2	0.10
EX UPG #25	Surface Flooding Under 100-Yr Event	2024	Excellent	1	0.05
EX UPG #26	Surface Flooding Under 100-Yr Event	2024	Average	3	0.14
EX UPG #27	Surface Flooding Under 100-Yr Event	2024	Good	2	0.10

APPENDIX E
Existing System Upgrade Cost Estimates

Appendix E - Class D Cost Estimates - Existing System Upgrade Recommendations

Project: City of Lloydminster SWMP
Client: City of Lloydminster
Project #: 28310
Date: 2024-09-18

Engineering: 15%
Contingency: 30%

Table E.1 - Existing System Upgrade Recommendation Cost Estimates

Item	Description	Unit Rate ($/unit)	Unit	Quantity (unit)	Cost ($)	Engineering ($)	Contingency ($)	Total ($)
EX UPG #1								
1.1	Excavation, backfill, and supply and installation of 525 mm gravity sewer	1,263	m	43	$ 54,000	$ 8,000	$ 16,000	$ 78,000
1.2	Excavation, backfill, and supply and installation of 675 mm gravity sewer	675	m	142	$ 96,000	$ 14,000	$ 29,000	$ 139,000
1.3	Pavement Rehabilitation	1,030	m	185	$ 191,000	$ 29,000	$ 57,000	$ 277,000
1.4	Supply and install 1200 mm dia. manhole (4m) x 4	2,148	v.m.	16	$ 34,000	$ 5,000	$ 10,000	$ 49,000
				Upgrade #1 Subtotal	**$ 375,000**	**$ 56,000**	**$ 112,000**	**$ 543,000**
EX UPG #2								
2.1	Excavation, backfill, and supply and installation of 375 mm gravity sewer	850	m	442	$ 376,000	$ 56,000	$ 113,000	$ 545,000
2.2	Excavation, backfill, and supply and installation of 525 mm gravity sewer	1,137	m	162	$ 184,000	$ 28,000	$ 55,000	$ 267,000
2.3	Excavation, backfill, and supply and installation of 600 mm gravity sewer	1,221	m	202	$ 247,000	$ 37,000	$ 74,000	$ 358,000
2.4	Excavation, backfill, and supply and installation of 750 mm gravity sewer	1,549	m	481	$ 745,000	$ 112,000	$ 224,000	$ 1,081,000
2.5	Pavement Rehabilitation	1,030	m	1,287	$ 1,326,000	$ 199,000	$ 398,000	$ 1,923,000
2.6	Supply and install 1200 mm dia. manhole (4m) x 8	2,148	v.m.	32	$ 69,000	$ 10,000	$ 21,000	$ 100,000
2.7	Supply and install 1500 mm dia. manhole (4m) x 4	4,230	v.m.	16	$ 68,000	$ 10,000	$ 20,000	$ 98,000
				Upgrade #2 Subtotal	**$ 3,015,000**	**$ 452,000**	**$ 905,000**	**$ 4,372,000**
EX UPG #3								
3.1	Excavation, backfill, and supply and installation of 1050 mm gravity sewer	2,190	m	148	$ 324,000	$ 49,000	$ 97,000	$ 470,000
3.2	Excavation, backfill, and supply and installation of 1200 mm gravity sewer	2,334	m	175	$ 408,000	$ 61,000	$ 122,000	$ 591,000
3.3	Pavement Rehabilitation	1,030	m	323	$ 333,000	$ 50,000	$ 100,000	$ 483,000
3.4	Supply and install 1800 mm dia. manhole (4m) x 2	5,411	v.m.	8	$ 43,000	$ 6,000	$ 13,000	$ 62,000
3.5	Supply and install 2100 mm dia. manhole (4m) x 3	7,856	v.m.	12	$ 94,000	$ 14,000	$ 28,000	$ 136,000
				Upgrade #3 Subtotal	**$ 1,202,000**	**$ 180,000**	**$ 360,000**	**$ 1,742,000**
EX UPG #4								
4.1	Excavation, backfill, and supply and installation of 1350 mm gravity sewer	2,550	m	769	$ 1,961,000	$ 294,000	$ 588,000	$ 2,843,000
4.2	Excavation, backfill, and supply and installation of 1500 mm gravity sewer	2,801	m	418	$ 1,171,000	$ 176,000	$ 351,000	$ 1,698,000
4.3	Pavement Rehabilitation	1,030	m	1,187	$ 1,223,000	$ 183,000	$ 367,000	$ 1,773,000
4.4	Supply and install 2100 mm dia. manhole (4m) x 6	7,856	v.m.	24	$ 189,000	$ 28,000	$ 57,000	$ 274,000
4.5	Supply and install 2400 mm dia. manhole (4m) x 3	11,517	v.m.	12	$ 138,000	$ 21,000	$ 41,000	$ 200,000
				Upgrade #4 Subtotal	**$ 4,682,000**	**$ 702,000**	**$ 1,404,000**	**$ 6,788,000**
EX UPG #5								
5.1	Excavation, backfill, and supply and installation of 900 mm gravity sewer	1,948	m	474	$ 922,000	$ 138,000	$ 277,000	$ 1,337,000
5.2	Excavation, backfill, and supply and installation of 1050 mm gravity sewer	2,190	m	835	$ 1,829,000	$ 274,000	$ 549,000	$ 2,652,000
5.3	Pavement Rehabilitation	1,030	m	1,309	$ 1,348,000	$ 202,000	$ 404,000	$ 1,954,000
5.4	Supply and install 1500 mm dia. manhole (4m) x 10	4,230	v.m.	40	$ 169,000	$ 25,000	$ 51,000	$ 245,000
5.5	Supply and install 1800 mm dia. manhole (4m) x 2	5,411	v.m.	8	$ 43,000	$ 6,000	$ 13,000	$ 62,000
				Upgrade #5 Subtotal	**$ 4,311,000**	**$ 645,000**	**$ 1,294,000**	**$ 6,250,000**
EX UPG #6								
6.1	Excavation, backfill, and supply and installation of 600 mm gravity sewer	1,221	m	140	$ 171,000	$ 26,000	$ 51,000	$ 248,000
6.2	Excavation, backfill, and supply and installation of 675 mm gravity sewer	1,275	m	93	$ 119,000	$ 18,000	$ 36,000	$ 173,000
6.3	Pavement Rehabilitation	1,030	m	233	$ 240,000	$ 36,000	$ 72,000	$ 348,000
6.4	Supply and install 1200 mm dia. manhole (4m) x 2	2,148	v.m.	8	$ 17,000	$ 3,000	$ 5,000	$ 25,000
6.5	Supply and install 1500 mm dia. manhole (4m) x 2	4,230	v.m.	8	$ 34,000	$ 5,000	$ 10,000	$ 49,000
				Upgrade #6 Subtotal	**$ 581,000**	**$ 88,000**	**$ 174,000**	**$ 843,000**
EX UPG #7								
7.1	Excavation, backfill, and supply and installation of 750 mm gravity sewer	1,549	m	152	$ 235,000	$ 35,000	$ 71,000	$ 341,000
7.2	Pavement Rehabilitation	1,030	m	152	$ 157,000	$ 24,000	$ 47,000	$ 228,000
7.3	Supply and install 1500 mm dia. manhole (4m) x 3	4,230	v.m.	12	$ 51,000	$ 8,000	$ 15,000	$ 74,000
				Upgrade #7 Subtotal	**$ 443,000**	**$ 67,000**	**$ 133,000**	**$ 643,000**
EX UPG #8								
8.1	Excavation, backfill, and supply and installation of 1200 mm gravity sewer	2,334	m	86	$ 201,000	$ 30,000	$ 60,000	$ 291,000
8.2	Excavation, backfill, and supply and installation of 1650 mm gravity sewer	3,500	m	230	$ 805,000	$ 121,000	$ 242,000	$ 1,168,000
8.3	Pavement Rehabilitation	1,030	m	316	$ 325,000	$ 49,000	$ 98,000	$ 472,000
8.4	Supply and install 2100 mm dia. manhole (4m) x 2	7,856	v.m.	8	$ 63,000	$ 9,000	$ 19,000	$ 91,000
8.5	Supply and install 3000 mm dia. manhole (4m) x 3	15,000	v.m.	12	$ 180,000	$ 27,000	$ 54,000	$ 261,000
				Upgrade #8 Subtotal	**$ 1,574,000**	**$ 236,000**	**$ 473,000**	**$ 2,283,000**
EX UPG #9								
9.1	Excavation, backfill, and supply and installation of 675 mm gravity sewer	1,275	m	264	$ 337,000	$ 51,000	$ 101,000	$ 489,000
9.2	Excavation, backfill, and supply and installation of 750 mm gravity sewer	1,549	m	79	$ 122,000	$ 18,000	$ 37,000	$ 177,000
9.3	Excavation, backfill, and supply and installation of 900 mm gravity sewer	1,948	m	210	$ 409,000	$ 61,000	$ 123,000	$ 593,000
9.4	Pavement Rehabilitation	1,030	m	553	$ 570,000	$ 86,000	$ 171,000	$ 827,000
9.5	Supply and install 1500 mm dia. manhole (4m) x 3	4,230	v.m.	12	$ 51,000	$ 8,000	$ 15,000	$ 74,000
9.6	Supply and install 1800 mm dia. manhole (4m) x 3	5,411	v.m.	12	$ 65,000	$ 10,000	$ 20,000	$ 95,000
				Upgrade #9 Subtotal	**$ 1,554,000**	**$ 234,000**	**$ 467,000**	**$ 2,255,000**
EX UPG #10								
10.1	Excavation, backfill, and supply and installation of 900 mm gravity sewer	1,948	m	350	$ 682,000	$ 102,000	$ 205,000	$ 989,000
10.2	Pavement Rehabilitation	1,030	m	350	$ 361,000	$ 54,000	$ 108,000	$ 523,000
10.3	Supply and install 1800 mm dia. manhole (4m) x 3	5,411	v.m.	12	$ 65,000	$ 10,000	$ 20,000	$ 95,000
				Upgrade #10 Subtotal	**$ 1,108,000**	**$ 166,000**	**$ 333,000**	**$ 1,607,000**
EX UPG #11								
11.1	Excavation, backfill, and supply and installation of 1200 mm gravity sewer	2,334	m	290	$ 677,000	$ 102,000	$ 203,000	$ 982,000
11.2	Excavation, backfill, and supply and installation of 1350 mm gravity sewer	2,550	m	212	$ 541,000	$ 81,000	$ 162,000	$ 784,000
11.3	Pavement Rehabilitation	1,030	m	502	$ 517,000	$ 78,000	$ 155,000	$ 750,000
11.4	Supply and install 2100 mm dia. manhole (4m) x 6	7,856	v.m.	24	$ 189,000	$ 28,000	$ 57,000	$ 274,000
				Upgrade #11 Subtotal	**$ 1,924,000**	**$ 289,000**	**$ 577,000**	**$ 2,790,000**
EX UPG #12								
12.1	Excavation, backfill, and supply and installation of 900 mm gravity sewer	1,948	m	199	$ 388,000	$ 58,000	$ 116,000	$ 562,000
12.2	Excavation, backfill, and supply and installation of 1050 mm gravity sewer	2,190	m	274	$ 600,000	$ 90,000	$ 180,000	$ 870,000
12.3	Excavation, backfill, and supply and installation of 1500 mm gravity sewer	2,801	m	846	$ 2,370,000	$ 356,000	$ 711,000	$ 3,437,000
12.4	Pavement Rehabilitation	1,030	m	1,319	$ 1,359,000	$ 204,000	$ 408,000	$ 1,971,000
12.5	Supply and install 1800 mm dia. manhole (4m) x 6	5,411	v.m.	24	$ 130,000	$ 20,000	$ 39,000	$ 189,000
12.6	Supply and install 2400 mm dia. manhole (4m) x 7	11,517	v.m.	28	$ 322,000	$ 48,000	$ 97,000	$ 467,000
				Upgrade #12 Subtotal	**$ 5,169,000**	**$ 776,000**	**$ 1,551,000**	**$ 7,496,000**
EX UPG #13								
13.1	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	53	$ 51,000	$ 8,000	$ 15,000	$ 74,000
13.2	Excavation, backfill, and supply and installation of 750 mm gravity sewer	1,549	m	84	$ 130,000	$ 20,000	$ 39,000	$ 189,000
13.3	Pavement Rehabilitation	1,030	m	137	$ 141,000	$ 21,000	$ 42,000	$ 204,000
13.4	Supply and install 1200 mm dia. manhole (4m) x 2	2,148	v.m.	8	$ 17,000	$ 3,000	$ 5,000	$ 25,000
13.5	Supply and install 1500 mm dia. manhole (4m) x 2	4,230	v.m.	8	$ 34,000	$ 5,000	$ 10,000	$ 49,000
				Upgrade #13 Subtotal	**$ 373,000**	**$ 57,000**	**$ 111,000**	**$ 541,000**
EX UPG #14								
14.1	Excavation, backfill, and supply and installation of 525 mm gravity sewer	1,137	m	325	$ 369,000	$ 55,000	$ 111,000	$ 535,000
14.2	Excavation, backfill, and supply and installation of 600 mm gravity sewer	1,221	m	167	$ 204,000	$ 31,000	$ 61,000	$ 296,000
14.3	Pavement Rehabilitation	1,030	m	492	$ 507,000	$ 76,000	$ 152,000	$ 735,000
14.4	Supply and install 1200 mm dia. manhole (4m) x 4	2,148	v.m.	16	$ 34,000	$ 5,000	$ 10,000	$ 49,000
				Upgrade #14 Subtotal	**$ 1,114,000**	**$ 167,000**	**$ 334,000**	**$ 1,615,000**
EX UPG #15								
15.1	Excavation, backfill, and supply and installation of 600 mm gravity sewer	1,221	m	95	$ 116,000	$ 17,000	$ 35,000	$ 168,000

15.2	Excavation, backfill, and supply and installation of 675 mm gravity sewer	1,275	m	121	$ 154,000	$ 23,000	$ 46,000	$ 223,000
15.3	Excavation, backfill, and supply and installation of 750 mm gravity sewer	1,549	m	106	$ 164,000	$ 25,000	$ 49,000	$ 238,000
15.4	Pavement Rehabilitation	1,030	m	322	$ 332,000	$ 50,000	$ 100,000	$ 482,000
15.5	Supply and install 1200 mm dia. manhole (4m) x 3	2,148	v.m.	12	$ 26,000	$ 4,000	$ 8,000	$ 38,000
15.6	Supply and install 1500 mm dia. manhole (4m) x 2	4,230	v.m.	8	$ 34,000	$ 5,000	$ 10,000	$ 49,000
				Upgrade #15 Subtotal	**$ 826,000**	**$ 124,000**	**$ 248,000**	**$ 1,198,000**
EX UPG #16								
16.1	Excavation, backfill, and supply and installation of 1050 mm gravity sewer	2,190	m	875	$ 1,916,000	$ 287,000	$ 575,000	$ 2,778,000
16.2	Pavement Rehabilitation	1,030	m	875	$ 901,000	$ 135,000	$ 270,000	$ 1,306,000
16.3	Supply and install 1800 mm dia. manhole (4m) x 7	5,411	v.m.	28	$ 152,000	$ 23,000	$ 46,000	$ 221,000
				Upgrade #16 Subtotal	**$ 2,969,000**	**$ 445,000**	**$ 891,000**	**$ 4,305,000**
EX UPG #17								
17.1	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	66	$ 63,000	$ 9,000	$ 19,000	$ 91,000
17.2	Excavation, backfill, and supply and installation of 600 mm gravity sewer	1,221	m	125	$ 153,000	$ 23,000	$ 46,000	$ 222,000
17.3	Excavation, backfill, and supply and installation of 900 mm gravity sewer	1,948	m	500	$ 974,000	$ 146,000	$ 292,000	$ 1,412,000
17.4	Pavement Rehabilitation	1,030	m	691	$ 712,000	$ 107,000	$ 214,000	$ 1,033,000
17.5	Supply and install 1200 mm dia. manhole (4m) x 4	2,148	v.m.	16	$ 34,000	$ 5,000	$ 10,000	$ 49,000
17.6	Supply and install 1800 mm dia. manhole (4m) x 4	5,411	v.m.	16	$ 87,000	$ 13,000	$ 26,000	$ 126,000
17.7	Removal existing catch basin, and supply and install type TK-7 frame and cover	6,765	ea	2	$ 14,000	$ 2,000	$ 4,000	$ 20,000
				Upgrade #17 Subtotal	**$ 2,037,000**	**$ 305,000**	**$ 611,000**	**$ 2,953,000**
EX UPG #18								
18.1	Removal existing catch basin, and supply and install type TK-7 frame and cover	6,765	ea	3	$ 20,000	$ 3,000	$ 6,000	$ 29,000
				Upgrade #18 Subtotal	**$ 20,000**	**$ 3,000**	**$ 6,000**	**$ 29,000**
EX UPG #19								
19.1	Excavation, backfill, and supply and installation of 1050 mm gravity sewer	2,190	m	202	$ 442,000	$ 66,000	$ 133,000	$ 641,000
19.2	Excavation, backfill, and supply and installation of 1050 mm gravity sewer	2,190	m	455	$ 996,000	$ 149,000	$ 299,000	$ 1,444,000
19.3	Pavement Rehabilitation	1,030	m	657	$ 677,000	$ 102,000	$ 203,000	$ 982,000
19.4	Supply and install 1800 mm dia. manhole (4m) x 6	5,411	v.m.	24	$ 130,000	$ 20,000	$ 39,000	$ 189,000
				Upgrade #19 Subtotal	**$ 2,245,000**	**$ 337,000**	**$ 674,000**	**$ 3,256,000**
EX UPG #20								
20.1	Removal existing catch basin, and supply and install type TF-51 frame and cover	6,665	ea	2	$ 13,000	$ 2,000	$ 4,000	$ 19,000
				Upgrade #20 Subtotal	**$ 13,000**	**$ 2,000**	**$ 4,000**	**$ 19,000**
EX UPG #21								
21.1	Excavation, backfill, and supply and installation of 1050 mm gravity sewer	2,190	m	75	$ 164,000	$ 25,000	$ 49,000	$ 238,000
21.2	Pavement Rehabilitation	1,030	m	75	$ 77,000	$ 12,000	$ 23,000	$ 112,000
21.3	Supply and install 1800 mm dia. manhole (4m) x 2	5,411	v.m.	8	$ 43,000	$ 6,000	$ 13,000	$ 62,000
21.4	Removal existing catch basin, and supply and install type TF-51 frame and cover	6,665	ea	4	$ 27,000	$ 4,000	$ 8,000	$ 39,000
				Upgrade #21 Subtotal	**$ 311,000**	**$ 47,000**	**$ 93,000**	**$ 451,000**
EX UPG #22								
22.2	Removal existing catch basin, and supply and install type TF-51 frame and cover	6,665	ea	4	$ 27,000	$ 4,000	$ 8,000	$ 39,000
				Upgrade #22 Subtotal	**$ 27,000**	**$ 4,000**	**$ 8,000**	**$ 39,000**
EX UPG #23								
23.1	Removal existing catch basin, and supply and install type TK-7 frame and cover	6,765	ea	3	$ 20,000	$ 3,000	$ 6,000	$ 29,000
				Upgrade #23 Subtotal	**$ 20,000**	**$ 3,000**	**$ 6,000**	**$ 29,000**
EX UPG #24								
24.1	Removal existing catch basin, and supply and install type TF-51 frame and cover	6,665	ea	3	$ 20,000	$ 3,000	$ 6,000	$ 29,000
				Upgrade #24 Subtotal	**$ 20,000**	**$ 3,000**	**$ 6,000**	**$ 29,000**
EX UPG #25								
25.1	Excavation, backfill, and supply and installation of 900 mm gravity sewer	1,948	m	136	$ 265,000	$ 40,000	$ 80,000	$ 385,000
25.2	Pavement Rehabilitation	1,030	m	136	$ 140,000	$ 21,000	$ 42,000	$ 203,000
25.3	Supply and install 1800 mm dia. manhole (4m) x 2	4,230	v.m.	8	$ 34,000	$ 5,000	$ 10,000	$ 49,000
25.4	Supply and install type TF-51 frame and cover	6,665	ea	2	$ 13,000	$ 2,000	$ 4,000	$ 19,000
				Upgrade #25 Subtotal	**$ 452,000**	**$ 68,000**	**$ 136,000**	**$ 656,000**
EX UPG #26								
26.1	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	89	$ 85,000	$ 13,000	$ 26,000	$ 124,000
26.2	Excavation, backfill, and supply and installation of 750 mm gravity sewer	1,549	m	210	$ 325,000	$ 49,000	$ 98,000	$ 472,000
26.3	Pavement Rehabilitation	1,030	m	299	$ 308,000	$ 46,000	$ 92,000	$ 446,000
26.4	Supply and install 1200 mm dia. manhole (4m) x 2	2,148	v.m.	8	$ 17,000	$ 3,000	$ 5,000	$ 25,000
26.5	Supply and install 1500 mm dia. manhole (4m) x 3	4,230	v.m.	12	$ 51,000	$ 8,000	$ 15,000	$ 74,000
26.6	Removal existing catch basin, and supply and install type TF-51 frame and cover	6,665	ea	4	$ 27,000	$ 4,000	$ 8,000	$ 39,000
				Upgrade #26 Subtotal	**$ 813,000**	**$ 123,000**	**$ 244,000**	**$ 1,180,000**
EX UPG #27								
27.1	Removal existing catch basin, and supply and install type TF-51 frame and cover	6,665	ea	5	$ 33,000	$ 5,000	$ 10,000	$ 48,000
				Upgrade #27 Subtotal	**$ 33,000**	**$ 5,000**	**$ 10,000**	**$ 48,000**
				Total	**$ 37,211,000**	**$ 5,584,000**	**$ 11,165,000**	**$ 53,960,000**

APPENDIX F
Future System Cost Estimates

Appendix F - Class D Cost Estimates - Proposed Future Servicing System

Project: City of Lloydminster SWMP
Client: City of Lloydminster
Project #: 28310
Date: 2024-07-18

Engineering: 15%
Contingency: 30%

Table F.1 - Proposed Future SWMF Cost Estimates

Item	Description	Unit Rate ($/unit)	Unit	Quantity (unit)	Cost ($)	Engineering ($)	Contingency ($)	Total ($)
FUT_SWMF_1								
1.1	Excavation	7	m^3	51,100	$ 358,000	$ 54,000	$ 107,000	$ 519,000
1.2	Topsoil and Sod	12	m^2	16,200	$ 194,000	$ 29,000	$ 58,000	$ 281,000
1.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
1.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_1 Subtotal				**$ 702,000**	**$ 106,000**	**$ 210,000**	**$ 1,018,000**
FUT_SWMF_2								
2.1	Excavation	7	m^3	109,300	$ 765,000	$ 115,000	$ 230,000	$ 1,110,000
2.2	Topsoil and Sod	12	m^2	31,700	$ 380,000	$ 57,000	$ 114,000	$ 551,000
2.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
2.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_2 Subtotal				**$ 1,295,000**	**$ 195,000**	**$ 389,000**	**$ 1,879,000**
FUT_SWMF_3								
3.1	Excavation	7	m^3	98,900	$ 692,000	$ 104,000	$ 208,000	$ 1,004,000
3.2	Topsoil and Sod	12	m^2	29,000	$ 348,000	$ 52,000	$ 104,000	$ 504,000
3.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
3.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_3 Subtotal				**$ 1,190,000**	**$ 179,000**	**$ 357,000**	**$ 1,726,000**
FUT_SWMF_4								
4.1	Excavation	7	m^3	94,100	$ 659,000	$ 99,000	$ 198,000	$ 956,000
4.2	Topsoil and Sod	12	m^2	27,700	$ 332,000	$ 50,000	$ 100,000	$ 482,000
4.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
4.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_4 Subtotal				**$ 1,141,000**	**$ 172,000**	**$ 343,000**	**$ 1,656,000**
FUT_SWMF_5								
5.1	Excavation	7	m^3	98,500	$ 690,000	$ 104,000	$ 207,000	$ 1,001,000
5.2	Topsoil and Sod	12	m^2	28,900	$ 347,000	$ 52,000	$ 104,000	$ 503,000
5.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
5.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_5 Subtotal				**$ 1,187,000**	**$ 179,000**	**$ 356,000**	**$ 1,722,000**
FUT_SWMF_6								
6.1	Excavation	7	m^3	97,600	$ 683,000	$ 102,000	$ 205,000	$ 990,000
6.2	Topsoil and Sod	12	m^2	28,700	$ 344,000	$ 52,000	$ 103,000	$ 499,000
6.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
6.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_6 Subtotal				**$ 1,177,000**	**$ 177,000**	**$ 353,000**	**$ 1,707,000**
FUT_SWMF_7								
7.1	Excavation	7	m^3	102,400	$ 717,000	$ 108,000	$ 215,000	$ 1,040,000
7.2	Topsoil and Sod	12	m^2	29,900	$ 359,000	$ 54,000	$ 108,000	$ 521,000
7.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
7.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_7 Subtotal				**$ 1,226,000**	**$ 185,000**	**$ 368,000**	**$ 1,779,000**
FUT_SWMF_8								
8.1	Excavation	7	m^3	27,300	$ 191,000	$ 29,000	$ 57,000	$ 277,000
8.2	Topsoil and Sod	12	m^2	9,500	$ 114,000	$ 17,000	$ 34,000	$ 165,000
8.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
8.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_8 Subtotal				**$ 455,000**	**$ 69,000**	**$ 136,000**	**$ 660,000**
FUT_SWMF_9								
9.1	Excavation	7	m^3	103,600	$ 725,000	$ 109,000	$ 218,000	$ 1,052,000
9.2	Topsoil and Sod	12	m^2	30,200	$ 362,000	$ 54,000	$ 109,000	$ 525,000
9.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
9.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_9 Subtotal				**$ 1,237,000**	**$ 186,000**	**$ 372,000**	**$ 1,795,000**
FUT_SWMF_10								
10.1	Excavation	7	m^3	96,600	$ 676,000	$ 101,000	$ 203,000	$ 980,000
10.2	Topsoil and Sod	12	m^2	28,400	$ 341,000	$ 51,000	$ 102,000	$ 494,000
10.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
10.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_10 Subtotal				**$ 1,167,000**	**$ 175,000**	**$ 350,000**	**$ 1,692,000**
FUT_SWMF_11								
11.1	Excavation	7	m^3	91,600	$ 641,000	$ 96,000	$ 192,000	$ 929,000
11.2	Topsoil and Sod	12	m^2	27,100	$ 325,000	$ 49,000	$ 98,000	$ 472,000
11.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
11.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_11 Subtotal				**$ 1,116,000**	**$ 168,000**	**$ 335,000**	**$ 1,619,000**
FUT_SWMF_12								
12.1	Excavation	7	m^3	16,800	$ 118,000	$ 18,000	$ 35,000	$ 171,000
12.2	Topsoil and Sod	12	m^2	6,400	$ 77,000	$ 12,000	$ 23,000	$ 112,000
12.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
12.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_12 Subtotal				**$ 345,000**	**$ 53,000**	**$ 103,000**	**$ 501,000**
FUT_SWMF_13								
13.1	Excavation	7	m^3	121,600	$ 851,000	$ 128,000	$ 255,000	$ 1,234,000
13.2	Topsoil and Sod	12	m^2	34,900	$ 419,000	$ 63,000	$ 126,000	$ 608,000
13.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
13.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_13 Subtotal				**$ 1,420,000**	**$ 214,000**	**$ 426,000**	**$ 2,060,000**
FUT_SWMF_14								
14.1	Excavation	7	m^3	89,200	$ 624,000	$ 94,000	$ 187,000	$ 905,000
14.2	Topsoil and Sod	12	m^2	26,400	$ 317,000	$ 48,000	$ 95,000	$ 460,000
14.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
14.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_14 Subtotal				**$ 1,091,000**	**$ 165,000**	**$ 327,000**	**$ 1,583,000**
FUT_SWMF_15								
15.1	Excavation	7	m^3	96,100	$ 673,000	$ 101,000	$ 202,000	$ 976,000
15.2	Topsoil and Sod	12	m^2	28,200	$ 338,000	$ 51,000	$ 101,000	$ 490,000
15.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
15.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
	FUT_SWMF_15 Subtotal				**$ 1,161,000**	**$ 175,000**	**$ 348,000**	**$ 1,684,000**
FUT_SWMF_16								

16.1	Excavation	7	m^3	65,500	$ 459,000	$ 69,000	$ 138,000	$ 666,000
16.2	Topsoil and Sod	12	m^2	20,100	$ 241,000	$ 36,000	$ 72,000	$ 349,000
16.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
16.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_16 Subtotal			$ 850,000	$ 128,000	$ 255,000	$ 1,233,000
FUT_SWMF_17								
17.1	Excavation	7	m^3	89,600	$ 627,000	$ 94,000	$ 188,000	$ 909,000
17.2	Topsoil and Sod	12	m^2	26,500	$ 318,000	$ 48,000	$ 95,000	$ 461,000
17.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
17.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_17 Subtotal			$ 1,095,000	$ 165,000	$ 328,000	$ 1,588,000
FUT_SWMF_18								
18.1	Excavation	7	m^3	106,400	$ 745,000	$ 112,000	$ 224,000	$ 1,081,000
18.2	Topsoil and Sod	12	m^2	31,000	$ 372,000	$ 56,000	$ 112,000	$ 540,000
18.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
18.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_18 Subtotal			$ 1,267,000	$ 191,000	$ 381,000	$ 1,839,000
FUT_SWMF_19								
19.1	Excavation	7	m^3	62,400	$ 437,000	$ 66,000	$ 131,000	$ 634,000
19.2	Topsoil and Sod	12	m^2	19,300	$ 232,000	$ 35,000	$ 70,000	$ 337,000
19.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
19.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_19 Subtotal			$ 819,000	$ 124,000	$ 246,000	$ 1,189,000
FUT_SWMF_20								
20.1	Excavation	7	m^3	53,400	$ 374,000	$ 56,000	$ 112,000	$ 542,000
20.2	Topsoil and Sod	12	m^2	16,900	$ 203,000	$ 30,000	$ 61,000	$ 294,000
20.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
20.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_20 Subtotal			$ 727,000	$ 109,000	$ 218,000	$ 1,054,000
FUT_SWMF_21								
21.1	Excavation	7	m^3	54,400	$ 381,000	$ 57,000	$ 114,000	$ 552,000
21.2	Topsoil and Sod	12	m^2	17,200	$ 206,000	$ 31,000	$ 62,000	$ 299,000
21.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
21.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_21 Subtotal			$ 737,000	$ 111,000	$ 221,000	$ 1,069,000
FUT_SWMF_22								
22.1	Excavation	7	m^3	51,100	$ 358,000	$ 54,000	$ 107,000	$ 519,000
22.2	Topsoil and Sod	12	m^2	16,200	$ 194,000	$ 29,000	$ 58,000	$ 281,000
22.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
22.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_22 Subtotal			$ 702,000	$ 106,000	$ 210,000	$ 1,018,000
FUT_SWMF_23								
23.1	Excavation	7	m^3	14,300	$ 100,000	$ 15,000	$ 30,000	$ 145,000
23.2	Topsoil and Sod	12	m^2	5,700	$ 68,000	$ 10,000	$ 20,000	$ 98,000
23.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
23.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_23 Subtotal			$ 318,000	$ 48,000	$ 95,000	$ 461,000
FUT_SWMF_24								
24.1	Excavation	7	m^3	67,000	$ 469,000	$ 70,000	$ 141,000	$ 680,000
24.2	Topsoil and Sod	12	m^2	20,500	$ 246,000	$ 37,000	$ 74,000	$ 357,000
24.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
24.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_24 Subtotal			$ 865,000	$ 130,000	$ 260,000	$ 1,255,000
FUT_SWMF_25								
25.1	Excavation	7	m^3	54,200	$ 379,000	$ 57,000	$ 114,000	$ 550,000
25.2	Topsoil and Sod	12	m^2	17,100	$ 205,000	$ 31,000	$ 62,000	$ 298,000
25.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
25.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_25 Subtotal			$ 734,000	$ 111,000	$ 221,000	$ 1,066,000
FUT_SWMF_26								
26.1	Excavation	7	m^3	85,900	$ 601,000	$ 90,000	$ 180,000	$ 871,000
26.2	Topsoil and Sod	12	m^2	25,500	$ 306,000	$ 46,000	$ 92,000	$ 444,000
26.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
26.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_26 Subtotal			$ 1,057,000	$ 159,000	$ 317,000	$ 1,533,000
FUT_SWMF_27								
27.1	Excavation	7	m^3	56,300	$ 394,000	$ 59,000	$ 118,000	$ 571,000
27.2	Topsoil and Sod	12	m^2	17,700	$ 212,000	$ 32,000	$ 64,000	$ 308,000
27.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
27.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_27 Subtotal			$ 756,000	$ 114,000	$ 227,000	$ 1,097,000
FUT_SWMF_28								
28.1	Excavation	7	m^3	54,000	$ 378,000	$ 57,000	$ 113,000	$ 548,000
28.2	Topsoil and Sod	12	m^2	17,000	$ 204,000	$ 31,000	$ 61,000	$ 296,000
28.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
28.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_28 Subtotal			$ 732,000	$ 111,000	$ 219,000	$ 1,062,000
FUT_SWMF_29								
29.1	Excavation	7	m^3	52,300	$ 366,000	$ 55,000	$ 110,000	$ 531,000
29.2	Topsoil and Sod	12	m^2	16,600	$ 199,000	$ 30,000	$ 60,000	$ 289,000
29.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
29.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_29 Subtotal			$ 715,000	$ 108,000	$ 215,000	$ 1,038,000
FUT_SWMF_30								
30.1	Excavation	7	m^3	52,300	$ 366,000	$ 55,000	$ 110,000	$ 531,000
30.2	Topsoil and Sod	12	m^2	16,500	$ 198,000	$ 30,000	$ 59,000	$ 287,000
30.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
30.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_30 Subtotal			$ 714,000	$ 108,000	$ 214,000	$ 1,036,000
FUT_SWMF_31								
31.1	Excavation	7	m^3	61,400	$ 430,000	$ 65,000	$ 129,000	$ 624,000
31.2	Topsoil and Sod	12	m^2	19,000	$ 228,000	$ 34,000	$ 68,000	$ 330,000
31.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
31.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_31 Subtotal			$ 808,000	$ 122,000	$ 242,000	$ 1,172,000
FUT_SWMF_32								
32.1	Excavation	7	m^3	80,200	$ 561,000	$ 84,000	$ 168,000	$ 813,000
32.2	Topsoil and Sod	12	m^2	24,100	$ 289,000	$ 43,000	$ 87,000	$ 419,000
32.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
32.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_32 Subtotal			$ 1,000,000	$ 150,000	$ 300,000	$ 1,450,000
FUT_SWMF_33								
33.1	Excavation	7	m^3	50,200	$ 351,000	$ 53,000	$ 105,000	$ 509,000
33.2	Topsoil and Sod	12	m^2	16,000	$ 192,000	$ 29,000	$ 58,000	$ 279,000
33.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
33.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_33 Subtotal			$ 693,000	$ 105,000	$ 208,000	$ 1,006,000
FUT_SWMF_34								
34.1	Excavation	7	m^3	50,100	$ 351,000	$ 53,000	$ 105,000	$ 509,000

34.2	Topsoil and Sod	12	m^2	16,000	$ 192,000	$ 29,000	$ 58,000	$ 279,000
34.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
34.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_34 Subtotal			**$ 693,000**	**$ 105,000**	**$ 208,000**	**$ 1,006,000**
FUT_SWMF_35								
35.1	Excavation	7	m^3	49,900	$ 349,000	$ 52,000	$ 105,000	$ 506,000
35.2	Topsoil and Sod	12	m^2	15,900	$ 191,000	$ 29,000	$ 57,000	$ 277,000
35.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
35.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_35 Subtotal			**$ 690,000**	**$ 104,000**	**$ 207,000**	**$ 1,001,000**
FUT_SWMF_36								
36.1	Excavation	7	m^3	50,100	$ 351,000	$ 53,000	$ 105,000	$ 509,000
36.2	Topsoil and Sod	12	m^2	15,900	$ 191,000	$ 29,000	$ 57,000	$ 277,000
36.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
36.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_36 Subtotal			**$ 692,000**	**$ 105,000**	**$ 207,000**	**$ 1,004,000**
FUT_SWMF_37								
37.1	Excavation	7	m^3	60,000	$ 420,000	$ 63,000	$ 126,000	$ 609,000
37.2	Topsoil and Sod	12	m^2	18,700	$ 224,000	$ 34,000	$ 67,000	$ 325,000
37.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
37.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_37 Subtotal			**$ 794,000**	**$ 120,000**	**$ 238,000**	**$ 1,152,000**
FUT_SWMF_38								
38.1	Excavation	7	m^3	87,200	$ 610,000	$ 92,000	$ 183,000	$ 885,000
38.2	Topsoil and Sod	12	m^2	25,900	$ 311,000	$ 47,000	$ 93,000	$ 451,000
38.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
38.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_38 Subtotal			**$ 1,071,000**	**$ 162,000**	**$ 321,000**	**$ 1,554,000**
FUT_SWMF_39								
39.1	Excavation	7	m^3	53,200	$ 372,000	$ 56,000	$ 112,000	$ 540,000
39.2	Topsoil and Sod	12	m^2	16,800	$ 202,000	$ 30,000	$ 61,000	$ 293,000
39.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
39.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_39 Subtotal			**$ 724,000**	**$ 109,000**	**$ 218,000**	**$ 1,051,000**
FUT_SWMF_40								
40.1	Excavation	7	m^3	50,200	$ 351,000	$ 53,000	$ 105,000	$ 509,000
40.2	Topsoil and Sod	12	m^2	16,000	$ 192,000	$ 29,000	$ 58,000	$ 279,000
40.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
40.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_40 Subtotal			**$ 693,000**	**$ 105,000**	**$ 208,000**	**$ 1,006,000**
FUT_SWMF_41								
41.1	Excavation	7	m^3	25,600	$ 179,000	$ 27,000	$ 54,000	$ 260,000
41.2	Topsoil and Sod	12	m^2	9,000	$ 108,000	$ 16,000	$ 32,000	$ 156,000
41.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
41.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_41 Subtotal			**$ 437,000**	**$ 66,000**	**$ 131,000**	**$ 634,000**
FUT_SWMF_42								
42.1	Excavation	7	m^3	19,100	$ 134,000	$ 20,000	$ 40,000	$ 194,000
42.2	Topsoil and Sod	12	m^2	7,100	$ 85,000	$ 13,000	$ 26,000	$ 124,000
42.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
42.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_42 Subtotal			**$ 369,000**	**$ 56,000**	**$ 111,000**	**$ 536,000**
FUT_SWMF_43								
43.1	Excavation	7	m^3	52,200	$ 365,000	$ 55,000	$ 110,000	$ 530,000
43.2	Topsoil and Sod	12	m^2	16,600	$ 199,000	$ 30,000	$ 60,000	$ 289,000
43.3	Landscaping	50,000	L.S.	1	$ 50,000	$ 8,000	$ 15,000	$ 73,000
43.4	Outlet Control Structure	100,000	L.S.	1	$ 100,000	$ 15,000	$ 30,000	$ 145,000
		FUT_SWMF_43 Subtotal			**$ 714,000**	**$ 108,000**	**$ 215,000**	**$ 1,037,000**
				Total	**$ 37,376,000**	**$ 5,638,000**	**$ 11,214,000**	**$ 54,228,000**

Appendix F - Class D Cost Estimates - Proposed Future Servicing System

Project: City of Lloydminster SWMP
Client: City of Lloydminster
Project #: 28310
Date: 2024-07-18

Engineering: 15%
Contingency: 30%

Table F.2 - Proposed Future Sewer Cost Estimates

Item	Description	Unit Rate	Unit	Quantity	Cost	Engineering	Contingency	Total
		($/unit)		(unit)	($)	($)	($)	($)
FUT_STM_1	Excavation, backfill, and supply and installation of 300 mm gravity sewer	695	m	325	$ 226,000	$ 34,000	$ 68,000	$ 328,000
FUT_STM_2	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	800	$ 768,000	$ 115,000	$ 230,000	$ 1,113,000
FUT_STM_3	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	80	$ 77,000	$ 12,000	$ 23,000	$ 112,000
FUT_STM_4	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	255	$ 245,000	$ 37,000	$ 74,000	$ 356,000
FUT_STM_5	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	166	$ 159,000	$ 24,000	$ 48,000	$ 231,000
FUT_STM_6	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	40	$ 38,000	$ 6,000	$ 11,000	$ 55,000
FUT_STM_7	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	920	$ 883,000	$ 132,000	$ 265,000	$ 1,280,000
FUT_STM_8	Excavation, backfill, and supply and installation of 250 mm gravity sewer	580	m	590	$ 342,000	$ 51,000	$ 103,000	$ 496,000
FUT_STM_9	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	80	$ 77,000	$ 12,000	$ 23,000	$ 112,000
FUT_STM_10	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	420	$ 403,000	$ 60,000	$ 121,000	$ 584,000
FUT_STM_11	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	10	$ 10,000	$ 2,000	$ 3,000	$ 15,000
FUT_STM_12	Excavation, backfill, and supply and installation of 200 mm gravity sewer	500	m	20	$ 10,000	$ 2,000	$ 3,000	$ 15,000
FUT_STM_13	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	122	$ 117,000	$ 18,000	$ 35,000	$ 170,000
FUT_STM_14	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	20	$ 19,000	$ 3,000	$ 6,000	$ 28,000
FUT_STM_15	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	180	$ 173,000	$ 26,000	$ 52,000	$ 251,000
FUT_STM_16	Excavation, backfill, and supply and installation of 375 mm gravity sewer	850	m	78	$ 66,000	$ 10,000	$ 20,000	$ 96,000
FUT_STM_17	Excavation, backfill, and supply and installation of 375 mm gravity sewer	850	m	90	$ 77,000	$ 12,000	$ 23,000	$ 112,000
FUT_STM_18	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	57	$ 55,000	$ 8,000	$ 17,000	$ 80,000
FUT_STM_19	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	278	$ 267,000	$ 40,000	$ 80,000	$ 387,000
FUT_STM_20	Excavation, backfill, and supply and installation of 375 mm gravity sewer	850	m	78	$ 66,000	$ 10,000	$ 20,000	$ 96,000
FUT_STM_21	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	143	$ 137,000	$ 21,000	$ 41,000	$ 199,000
FUT_STM_22	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	158	$ 152,000	$ 23,000	$ 46,000	$ 221,000
FUT_STM_23	Excavation, backfill, and supply and installation of 250 mm gravity sewer	580	m	73	$ 42,000	$ 6,000	$ 13,000	$ 61,000
FUT_STM_24	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	330	$ 317,000	$ 48,000	$ 95,000	$ 460,000
FUT_STM_25	Excavation, backfill, and supply and installation of 375 mm gravity sewer	850	m	135	$ 115,000	$ 17,000	$ 35,000	$ 167,000
FUT_STM_26	Excavation, backfill, and supply and installation of 525 mm gravity sewer	1,137	m	520	$ 591,000	$ 89,000	$ 177,000	$ 857,000
FUT_STM_27	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	115	$ 110,000	$ 17,000	$ 33,000	$ 160,000
FUT_STM_28	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	230	$ 221,000	$ 33,000	$ 66,000	$ 320,000
FUT_STM_29	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	185	$ 178,000	$ 27,000	$ 53,000	$ 258,000
FUT_STM_30	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	58	$ 56,000	$ 8,000	$ 17,000	$ 81,000
FUT_STM_31	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	222	$ 213,000	$ 32,000	$ 64,000	$ 309,000
FUT_STM_32	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	40	$ 38,000	$ 6,000	$ 11,000	$ 55,000
FUT_STM_33	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	50	$ 48,000	$ 7,000	$ 14,000	$ 69,000
FUT_STM_34	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	94	$ 90,000	$ 14,000	$ 27,000	$ 131,000
FUT_STM_35	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	110	$ 106,000	$ 16,000	$ 32,000	$ 154,000
FUT_STM_36	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	480	$ 461,000	$ 69,000	$ 138,000	$ 668,000
FUT_STM_37	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	780	$ 749,000	$ 112,000	$ 225,000	$ 1,086,000
FUT_STM_38	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	180	$ 173,000	$ 26,000	$ 52,000	$ 251,000
FUT_STM_39	Excavation, backfill, and supply and installation of 300 mm gravity sewer	695	m	40	$ 28,000	$ 4,000	$ 8,000	$ 40,000
FUT_STM_40	Excavation, backfill, and supply and installation of 450 mm gravity sewer	960	m	750	$ 720,000	$ 108,000	$ 216,000	$ 1,044,000
FUT_STM_41	Excavation, backfill, and supply and installation of 250 mm gravity sewer	580	m	62	$ 36,000	$ 5,000	$ 11,000	$ 52,000
FUT_STM_42	Excavation, backfill, and supply and installation of 300 mm gravity sewer	695	m	95	$ 66,000	$ 10,000	$ 20,000	$ 96,000
FUT_STM_43	Excavation, backfill, and supply and installation of 300 mm gravity sewer	695	m	50	$ 35,000	$ 5,000	$ 11,000	$ 51,000
FUT_STM_44	Excavation, backfill, and supply and installation of 600 mm gravity sewer	1,221	m	1,077	$ 1,315,000	$ 197,000	$ 395,000	$ 1,907,000
FUT_STM_45	Excavation, backfill, and supply and installation of 600 mm gravity sewer	1,221	m	195	$ 238,000	$ 36,000	$ 71,000	$ 345,000
FUT_STM_46	Excavation, backfill, and supply and installation of 600 mm gravity sewer	1,221	m	570	$ 696,000	$ 104,000	$ 209,000	$ 1,009,000
FUT_STM_47	Excavation, backfill, and supply and installation of 750 mm gravity sewer	1,549	m	820	$ 1,270,000	$ 191,000	$ 381,000	$ 1,842,000
FUT_STM_48	Excavation, backfill, and supply and installation of 900 mm gravity sewer	1,948	m	800	$ 1,558,000	$ 234,000	$ 467,000	$ 2,259,000
FUT_STM_49	Excavation, backfill, and supply and installation of 1050 mm gravity sewer	2,190	m	820	$ 1,796,000	$ 269,000	$ 539,000	$ 2,604,000
FUT_STM_50	Excavation, backfill, and supply and installation of 1200 mm gravity sewer	2,334	m	800	$ 1,867,000	$ 280,000	$ 560,000	$ 2,707,000
FUT_STM_51	Excavation, backfill, and supply and installation of 1200 mm gravity sewer	2,334	m	830	$ 1,937,000	$ 291,000	$ 581,000	$ 2,809,000
FUT_STM_52	Excavation, backfill, and supply and installation of 300 mm gravity sewer	695	m	814	$ 566,000	$ 85,000	$ 170,000	$ 821,000
FUT_STM_53	Excavation, backfill, and supply and installation of 525 mm gravity sewer	1,137	m	1,570	$ 1,784,000	$ 268,000	$ 535,000	$ 2,587,000
FUT_STM_54	Excavation, backfill, and supply and installation of 675 mm gravity sewer	1,275	m	96	$ 122,000	$ 18,000	$ 37,000	$ 177,000
FUT_STM_55	Excavation, backfill, and supply and installation of 600 mm gravity sewer	1,221	m	860	$ 1,050,000	$ 158,000	$ 315,000	$ 1,523,000
FUT_STM_56	Excavation, backfill, and supply and installation of 750 mm gravity sewer	1,549	m	820	$ 1,270,000	$ 191,000	$ 381,000	$ 1,842,000
FUT_STM_57	Excavation, backfill, and supply and installation of 900 mm gravity sewer	1,948	m	720	$ 1,402,000	$ 210,000	$ 421,000	$ 2,033,000
FUT_STM_58	Excavation, backfill, and supply and installation of 900 mm gravity sewer	1,948	m	360	$ 701,000	$ 105,000	$ 210,000	$ 1,016,000
				Total	$ 26,332,000	$ 3,954,000	$ 7,902,000	$ 38,188,000