TOWN OF CALMAR

Stormwater Master Plan Update

FINAL REPORT

October 2025

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.

7909 51 Avenue NW, Edmonton AB T6E 5L9, T: 780.438.9000 F: 780.438.3700

October 1, 2025
Our Reference: 16898

Town of Calmar
4901 – 50 Avenue
Calmar, AB TOC 0V0

Attention: **Sylvain Losier**, M.ATDR, MCIP, RPP, Chief Administrative Officer
cc. **Graydon Nielson**, Acting Director, Infrastructure and Growth

Dear Sylvain:

Reference: Stormwater Master Plan Update

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

The key objective of the Stormwater Master Plan Update is to assess the Town of Calmar's current stormwater management and drainage infrastructure capacity and the future needs for development areas.

The Stormwater Master Plan Update will provide the Town of Calmar 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 Town of Calmar. Should you have any questions or concerns, please do not hesitate to contact the undersigned at 780.438.9000.

Sincerely,
ISL Engineering and Land Services Ltd.

Ahmed Al-Musawi, P.Eng.
Project Engineer, Community Development

Corporate Authorization

This document entitled "Stormwater Master Plan Update" has been prepared by ISL Engineering and Land Services Ltd. (ISL) for the use of the Town of Calmar. 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.

Sarah Barbosa, P.Eng., ENV SP
Utilities Lead

Josephine Lalonde-Bester, E.I.T.
Utilities Support

Ahmed Al-Musawi, P.Eng.
Project Manager

Executive Summary

The Town of Calmar (the Town) retained ISL Engineering and Land Services Ltd. (ISL) to complete an update to its Stormwater Master Plan (SWMP). This study reviewed the existing stormwater system and assessed its capacity to convey current and future stormwater flows effectively. A robust 1D-2D hydrodynamic InfoWorks ICM model was developed to support this comprehensive assessment, informing the updated SWMP.

Report Summary

- **Purpose and scope:** The SWMP provides a detailed assessment of Calmar's existing stormwater infrastructure, evaluates system performance under current and future conditions, and outlines a strategy for managing stormwater aligned with anticipated growth to 2045.
- **Study area:** The study area covers approximately 420 ha within Calmar, located about 40 km southwest of Edmonton, generally draining northwest to Conjuring Creek. The area includes existing residential, commercial, industrial, and public service lands, as well as lands planned for future development.
- **Design criteria and level of service:** The assessment was guided by the Town's Design and Construction Standards. Minor systems were evaluated using a 1:5-year, 4-hour Modified Chicago design storm, and major systems using a 1:100-year, 4-hour Modified Chicago and 24-hour Huff storm events. System performance was measured by freeboard (HGL vs. ground) and peak flow relative to pipe capacity, while major system performance was evaluated through overland flood depths and velocities.
- **Existing stormwater system and hydraulic model:** Calmar's storm system comprises roughly 17 km of storm sewers ranging from 150 mm to 2400 mm in diameter. The new hydraulic model integrates the 1D sewer network with a 2D overland mesh derived from LiDAR, accounting for surface roughness and infiltration across different land uses.
- **Existing system assessment:** The model identified capacity constraints in both minor and major systems. Under the 1:5-year storm, local surcharge was observed in areas such as Westview and Southbridge. Under the 1:100-year storm, surface ponding exceeding 0.4 m was noted in areas including Westview Drive, Corgi Park, Woodland Park, and the Calmar Mobile Home Park.
- **Proposed existing system upgrades:** Targeted upgrades were developed to address capacity deficiencies, including local sewer upsizing and additional catchbasins. A risk assessment matrix was applied to prioritize upgrades based on factors such as historical flooding, proximity to critical infrastructure, and expected flood alleviation.
- **Future system assessment and concept:** A future servicing concept was created to support growth outlined in the Town's Municipal Development Plan. This includes four new stormwater management facilities (SWMFs) sized to maintain post-development flows at or below pre-development rates, with capacity checks performed on key trunk sewers to ensure future system integration.

SWMP Conclusions

Key conclusions from this study include:

- Calmar's existing storm system faces localized capacity constraints that increase flood risks under major storm events.
- The updated hydraulic model and risk-based prioritization support a phased approach to existing system upgrades.
- The proposed future SWMFs will be essential to service new development areas, manage runoff volumes, and protect downstream watercourses, such as Conjuring Creek.
- Green Infrastructure measures (e.g., bioretention, bioswales, rainwater harvesting) are recommended to enhance stormwater quality, promote infiltration, and reduce peak flows.
- Erosion and sediment control remains a critical requirement during construction to prevent downstream impacts.

SWMP Recommendations

Recommendations arising from this SWMP include:

- Advance high-priority existing system upgrades, particularly in Corgi Park / 51 Street and at the 48A Avenue / 49 Street intersection, to address known flooding concerns.
- Phase lower-priority upgrades according to the risk assessment and monitor these areas to confirm timing and need.
- Integrate the four proposed SWMFs and associated infrastructure into future subdivision planning and approvals, ensuring design aligns with this master plan.
- Encourage developers to incorporate Green Infrastructure and source control practices to improve stormwater quality and reduce runoff volumes.
- Enforce erosion and sediment control measures on all projects to maintain watershed health.
- Regularly update the Town's GIS and hydraulic model to reflect completed works and maintain an accurate stormwater asset inventory.
- Review and refresh the SWMP after significant growth periods or at least every five years, to incorporate new data, infrastructure, and community needs.
- Maintain and update GIS records.

Class "D" cost estimates for the proposed existing system upgrades total approximately **$12.2 million**, and for future storm servicing, approximately **$3.7 million**, inclusive of engineering and contingencies.

Table of Contents

TABLES

FIGURES

ACRONYMS

Acronym	Description
AEPA	Alberta Environment and Protected Areas
ASP	Area Structure Plan
BMP	Best Management Practices
CBOD	Carbonaceous Biochemical Oxygen Demand
CONC	Concrete
CSP	Corrugated Steel Pipe
GIS	Geographic Information System
HGL	Hydraulic Grade Line
HWL	High Water Level
IDF	Intensity-Duration-Frequency
ISL	ISL Engineering and Land Services Ltd.
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
SWMF	Stormwater Management Facility
SWMP	Stormwater Master Plan
Town	Town of Calmar
TSS	Total Suspended Solids
1D	One-Dimensional
2D	Two-Dimensional

UNITS

Unit	Description
mm	Millimetres
m	Metres
m^2	Square Metres
m^3	Cubic Metres
L/s/ha	Litres per Second per Hectare
mm/hr	Millimetres per Hour
ha	Hectares
m/s	Metres per Second
%	Percent
$	Dollars

1.0 Introduction

1.1 Authorization

The Town of Calmar (Town) retained ISL Engineering and Land Services Ltd. (ISL) to complete a review of its existing stormwater drainage system and assess its capacity to convey the current and future growth stormwater volumes effectively. A review and assessment of the capacity of the stormwater drainage system was conducted to generate an updated Stormwater Master Plan (SWMP).

1.2 Background

The original SWMP was completed in 2006 (ISL, 2006). Since then, there has been continued development in the Town and some capital improvements to the stormwater infrastructure. To support growth and infrastructure performance in the Town, there is a need to update the previous master plans to reflect the current system conditions, assess the limitations of the existing system, and develop a capital improvement plan to accommodate future growth.

The updated SWMP will help the Town assess the implications of servicing new developments by understanding each area’s servicing approach and constraints. By completing a comprehensive review of the available background data and stormwater drainage system hydraulic model, maintain consistent approaches to issues, and using sound engineering principles, while all the time protecting the natural and human environment, the updated SWMP will guide effective infrastructure improvement and expansion. The updated SWMP will also examine the capacity of the stormwater drainage 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 objectives of the Stormwater Master Plan Update include the following:

- Review current land use and population.
- Review future land use and projected future population.
- Collect the Town’s staff and residents concerns and items that may be improved.
- Public engagement to receive feedback from residents and communicate the master plan update’s objectives and preliminary results.
- Create a new hydraulic model with the current system configuration and hydraulic loadings.
- Assess existing stormwater drainage system capacity and identify constraints.
- Review and recommendation options for servicing of short-term and long-term development objectives for the Town.
- Develop a future servicing concept.
- Prepare Class “D” cost estimates for the future servicing concept.

2.0 Study Area

2.1 Location

The Town of Calmar is situated along Highway 39, approximately 40 km southwest of Edmonton, and covers approximately 420 ha of land. The Town is relatively flat with the ground gently sloping towards the northwest toward Conjuring Creek. The topography of the study area is shown in **Figure 2.1**.

2.2 Existing Land Use

The Town's Land Use Bylaw (Calmar, 2024) divides Calmar into different land use districts, as illustrated in **Figure 2.2**. 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 Town was classified more broadly by several unique development types, including residential, commercial, industrial, and public service. Land use type influences stormwater runoff coefficients/imperviousness ratios and roughness coefficients; therefore, obtaining an appropriate classification was vital to achieving an accurate representation of stormwater runoff volumes and rates. This will be explained further in Section 5.2.2 – Major System (2D) Model Development.

2.3 Planned Future Land Use

The future land use concept outlined in the Town's Municipal Development Plan (MDP) (Calmar, 2019) is illustrated in **Figure 2.3**.

There are five Area Structure Plans (ASP), including:

- Highway 39 Industrial Park (2016) - approximately 46 ha in the northeast
- Enberg Estates (1994) – approximately 39 hectares in the northeast
- Hawks Landing residential development (2005) - approximately 29 ha in the northwest
- Southbridge residential development (2017) – approximately 21 ha in the southwest
- Thomas Creek residential development (2017) – approximately 63 ha in the southwest

The 2045 development horizon was considered in this assessment to align with the Transportation Master Plan. A series of land use assumptions were made for the 2045 horizon with assistance from Town staff. These assumptions are illustrated in **Figure 2.4** and summarized below by land use.

Residential Development

By 2045, it is assumed that 373 new low density residential lots will be subdivided in Calmar, broken down as follows:

- 65 lots in the Thomas Creek ASP
- Remaining 82 lots in the Southbridge ASP
- 226 lots in the Hawks Landing ASP

For multi-unit residential development, it is anticipated that 108 medium density residential units will be developed:

- Remaining 8 units in the Southbridge ASP
- 100 units in the Hawks Landing ASP

Commercial Development

By 2045, approximately 8.54 ha of commercial land is expected to be developed, including:

- 0.89 ha site on the south side of Highway 39 east of Westview Drive
- 2.95 ha strip on the south side of Highway 39 between 47 Street and 45 Street
- 4.70 ha strip on the north side of Highway 39 between 47 Street and 45 Street

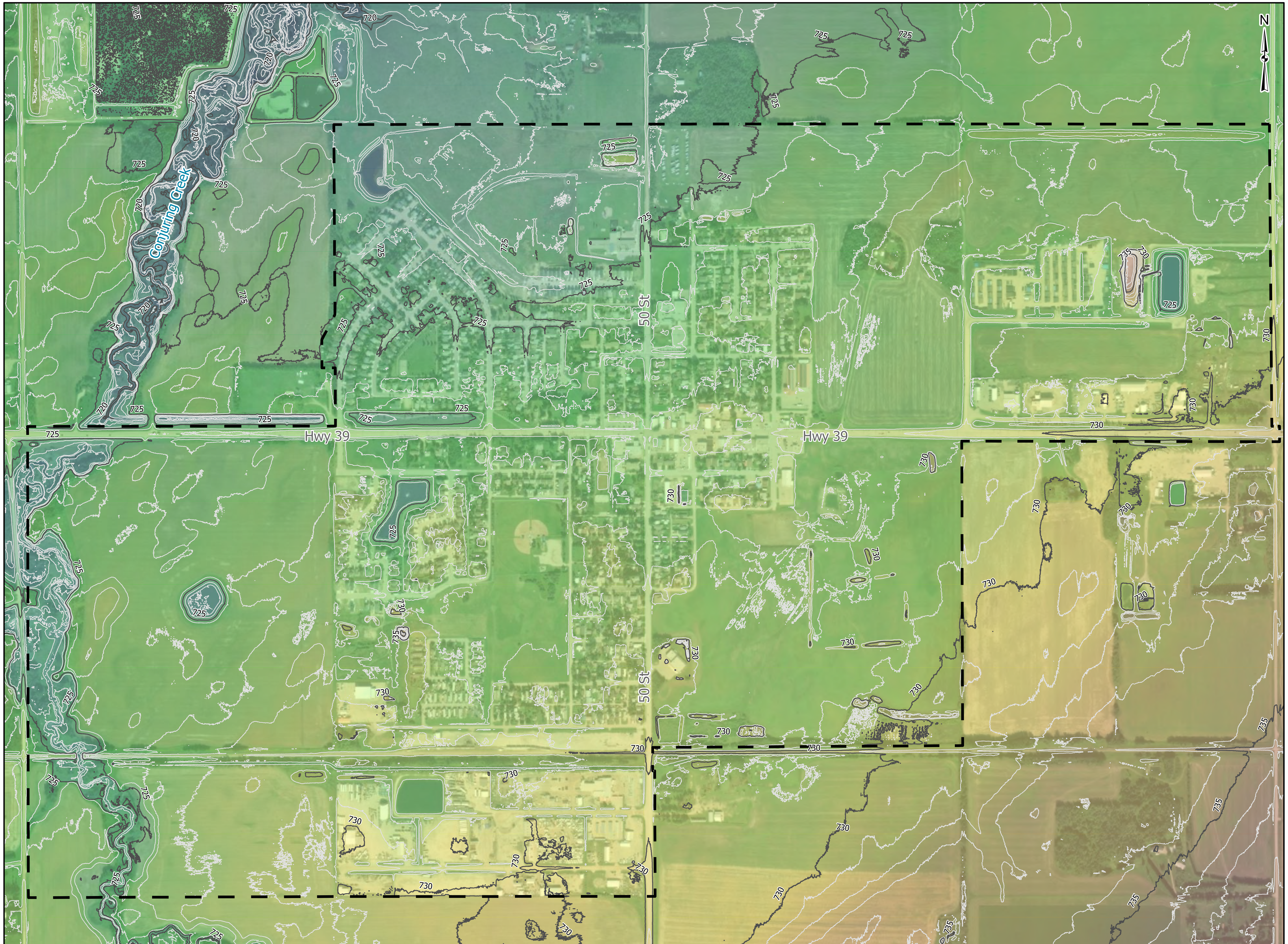
Industrial Development

By 2045, around 58.08 ha of industrial land is projected to be developed, including:

- 16.14 ha site at the western terminus of 42 Avenue in southwest Calmar
- 41.94 ha in the southeast corner of Calmar, south of Highway 39 and east of Highway 795

Beyond 2045, around 8.93 ha of industrial land is projected to be developed, including:

- A 7.65 ha strip and a 1.28 ha site, both east of 45 Street in the southern portion of the Highway 39 Industrial Park



LEGEND

Town Boundary

Minor Contour - 1m

Major Contour - 5m

Elevation (m)

747.765

682.615

TITLE

TOPOGRAPHY

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES

- Topographic Map:Maxar

PROJECTION

NAD 1983 CSRS 3TM 114

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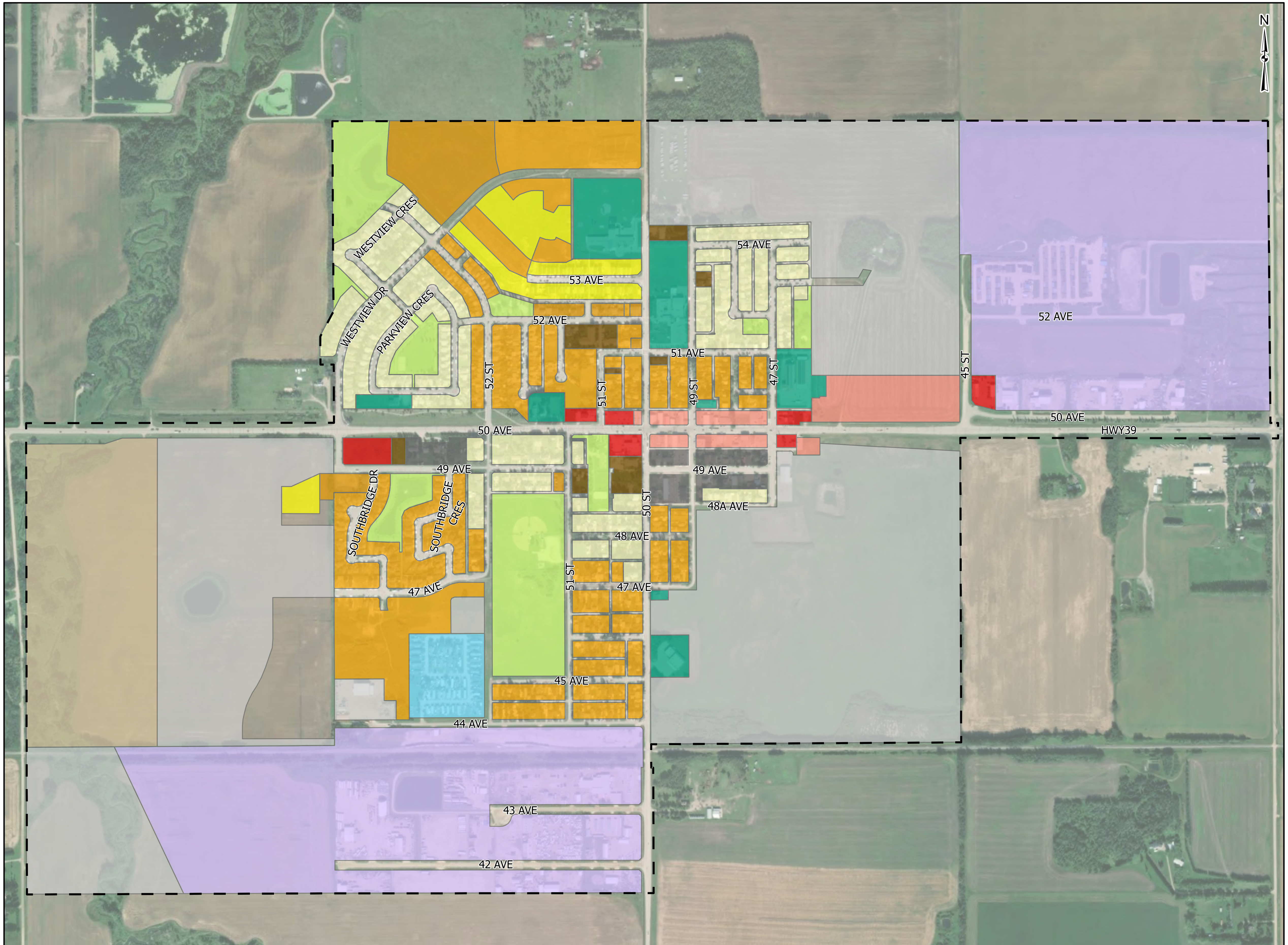
1:10,000 KM

FIGURE	2.1
DATE	7/11/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 2.1_Topography



LEGEND

Town Boundary

Land Use

- R1 Residential (Single Detached)
- R1B Residential (Small Lot, Single Detached)
- R2 Residential (Narrow Lot)
- R3 Residential (Medium Density)
- R4 Residential (Higher Density)
- RCE Residential (Country Estate)
- RMHP Residential (Manufactured Home Park)
- C1 Commercial (Central)
- C2 Commercial (Highway)
- M1 Industrial
- P Parks and Recreation
- US Urban Services
- DC Direct Control
- UR Urban Reserve

TITLE
LAND USE BYLAW

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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FIGURE	2.2
DATE	7/4/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

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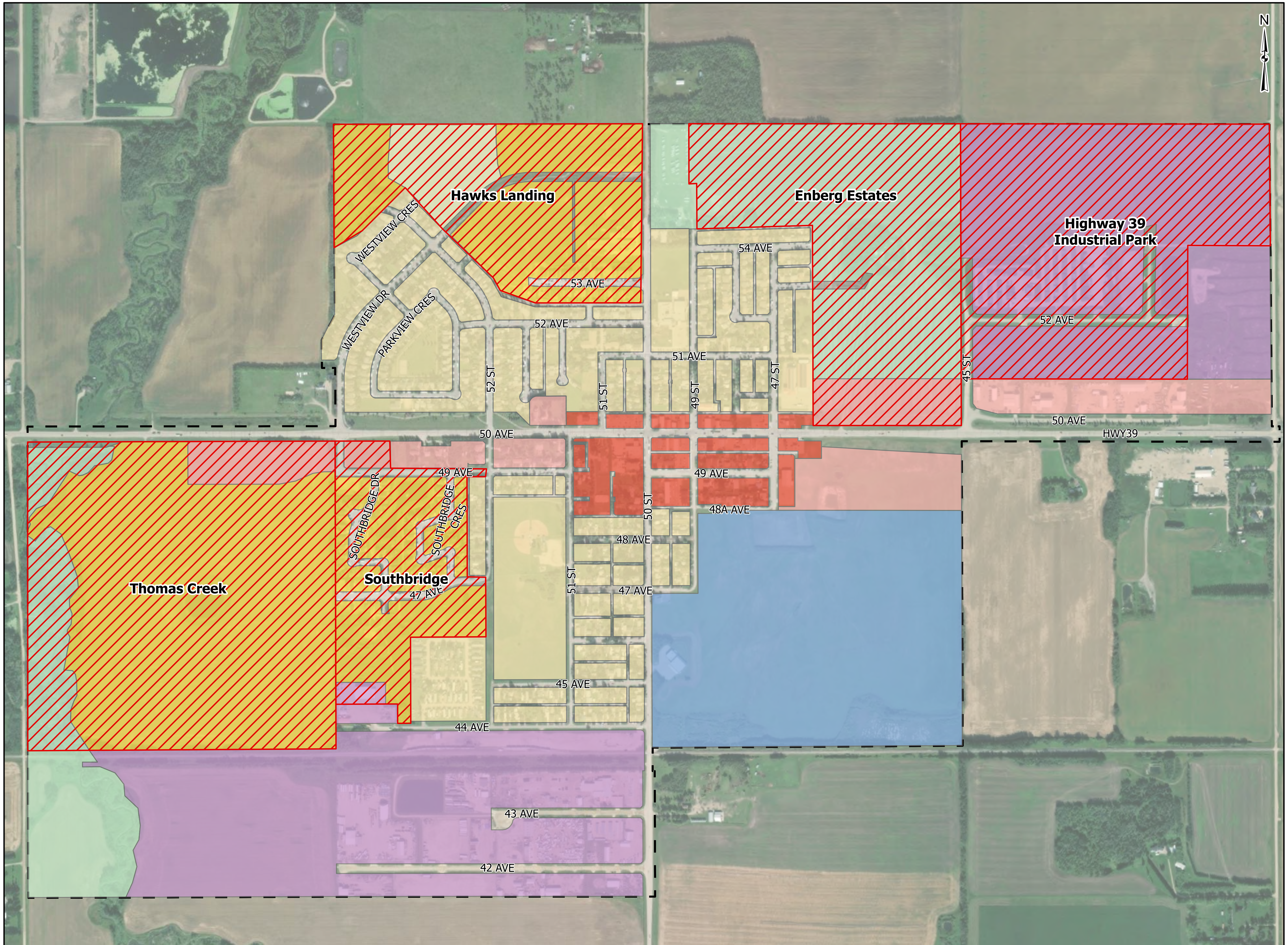

TITLE

FUTURE LAND USE CONCEPT
MUNICIPAL DEVELOPMENT PLAN

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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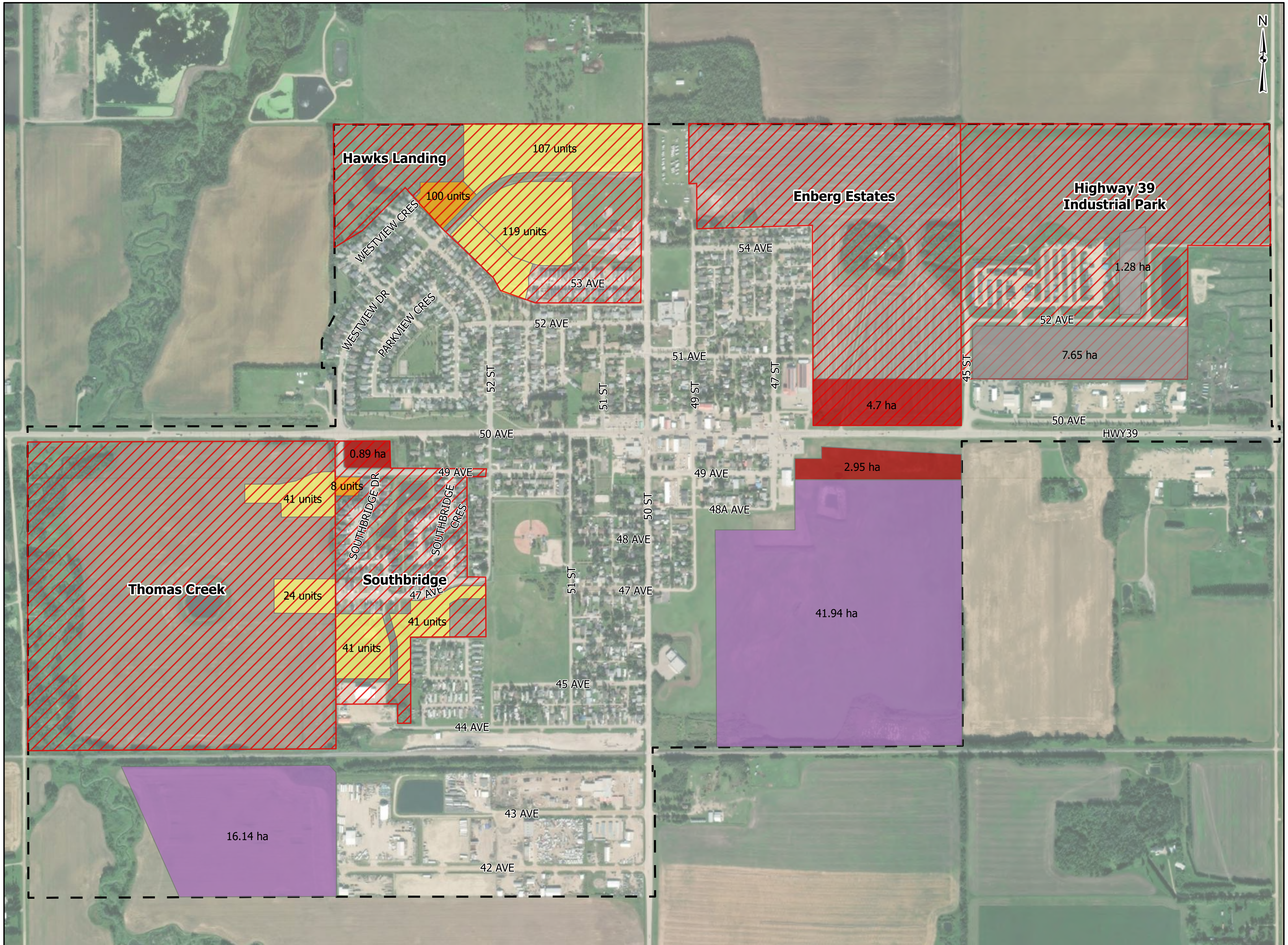
FIGURE	2.3
DATE	7/4/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 2.3 Future Land Use (MDP)



LEGEND

- Town Boundary
- Area Structure Plan (ASP)

Anticipated Land Use

- Future Commercial
- Future Industrial
- Future Low Density Residential
- Future Medium Density Residential

Anticipated Land Use (Post 20-Year Horizon)

- Future Industrial

TITLE

FUTURE LAND USE ASSUMPTIONS

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES

- Topographic Map:Maxar

PROJECTION

NAD 1983 CSRS 3TM 114

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1:10,000 KM

FIGURE	2.4
DATE	9/12/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

3.0 Design Criteria

The design criteria used to assess the Town's stormwater drainage system were derived from Calmar's Design and Construction Standards (Calmar, 2020). The design criteria selected were then used for input into the InfoWorks ICM model to design and assess the stormwater system.

3.1 Pre-Development Runoff Release 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 town. Doing so helps minimize the impact of increased runoff due to future developments on the environment.

ISL recommends the Town use a maximum allowable runoff release rate of 4.5 L/s/ha, which is in alignment with the rate used in the previous SWMP.

The 4.5 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 stormwater drainage 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 Town of Calmar Design and Construction Standards (Calmar, 2020), which stipulates minor stormwater systems are to be designed and assessed under the 1:5-year return period rainfall event and major stormwater systems are to be designed and assessed under the 1:100-year return period rainfall event. Rainfall Intensity-Duration-Frequency (IDF) parameters from the City of Edmonton were used for this assessment and are summarized in **Tables 3.1 and 3.2**, with the 1:5 year and 1:100 year IDF parameters highlighted.

Table 3.1: City of Edmonton 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	66	**89**	108.6	138	162.2	**188.4**
10-minute	48.2	**66.7**	82.6	106.2	125.3	**147.2**
60-minute	16	**23.1**	28.9	37.7	45.3	**54.7**
1440-minute	24	**1.6**	2.4	2.9	3.7	**4.6**

Table 3.2: City of Edmonton IDF Parameters

Parameter	1:2 Year	1:5 Year	1:10 Year	1:25 Year	1:50 Year	1:100 Year
a	337	**498.1**	665.2	909.9	1027.7	**1200.5**
b	-0.732	**-0.735**	-0.748	-0.757	-0.733	**-0.735**
c	4.3	**5.4**	6.3	7.1	7	**7.5**

For minor stormwater 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. For stormwater management facility assessment, the 1:100-year 24-hour Huff distribution design storm was used. Hyetographs of the design storms are illustrated below in **Figures 3.1** and **3.2**.

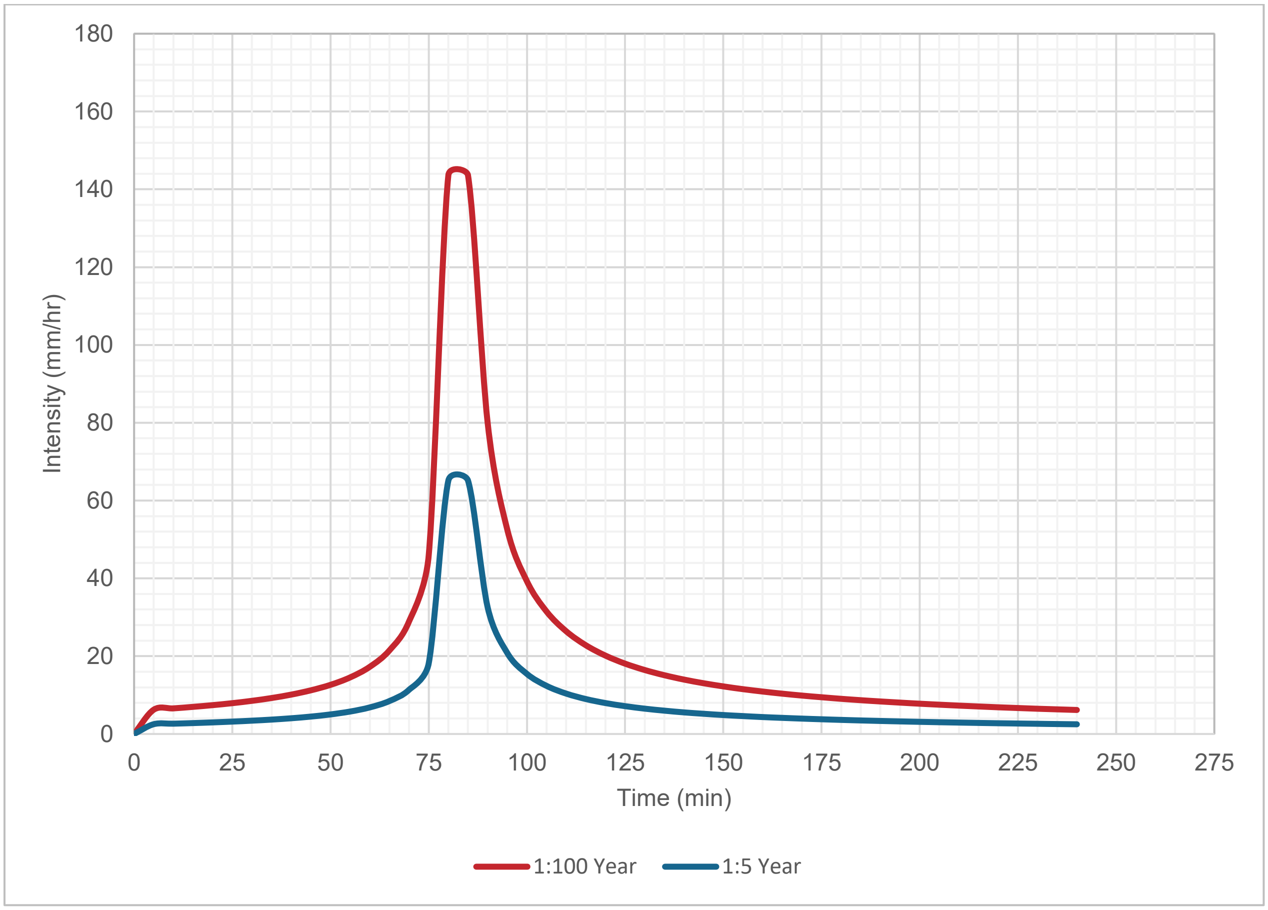


Figure 3.1: 4-Hour Modified Chicago Distribution Design Storms

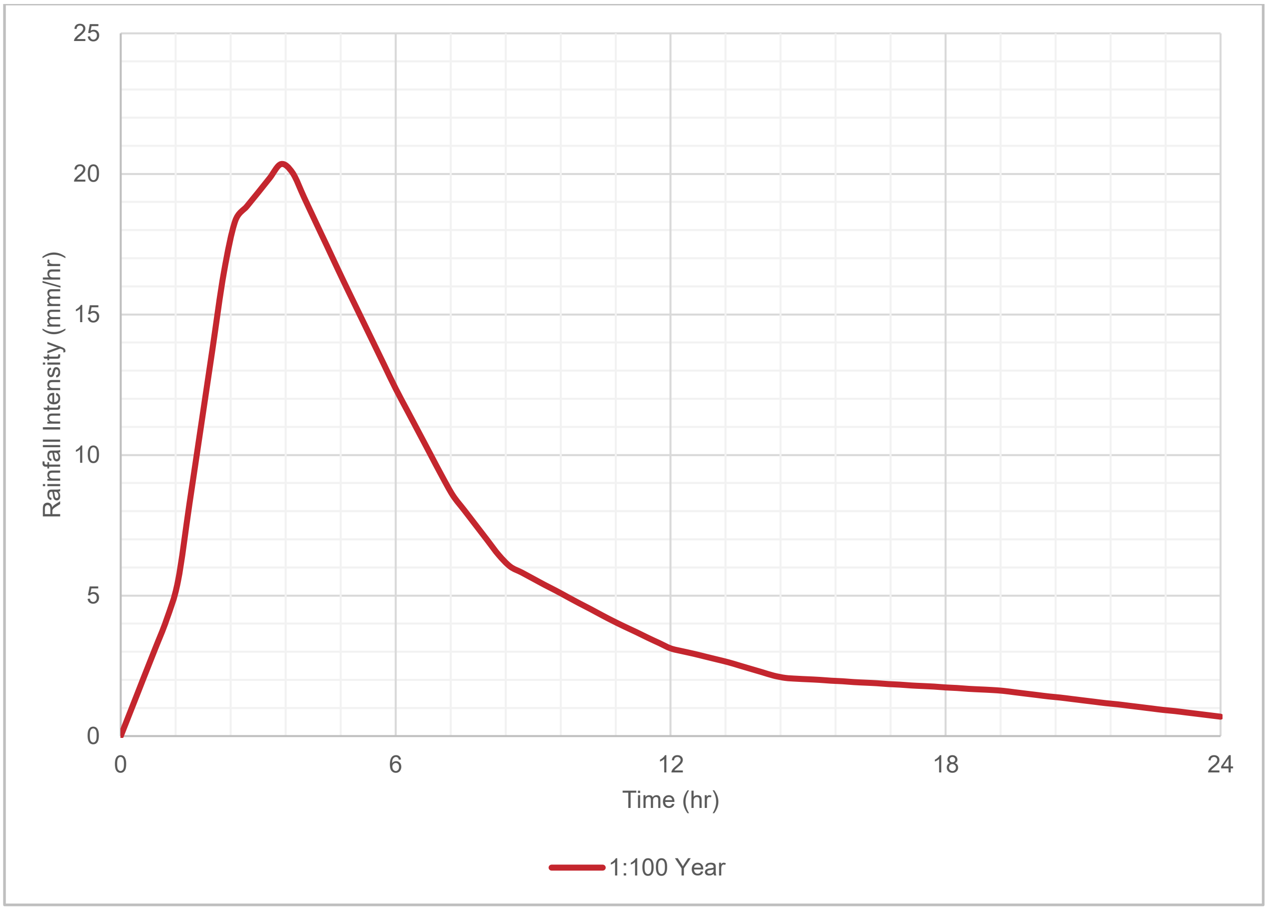


Figure 3.2: 24-Hour Huff Distribution Design Storm

3.3 Assessment Criteria

The performance of the stormwater 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 performance of the existing minor stormwater 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 stormwater system must remain at least 1.5 m based on the minimum depth of cover identified in the Town of Calmar Design and Construction 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 pipe capacity represents the ratio of peak flow to the sewer's design capacity. This metric can also be used to assess the available spare capacity during peak flow events. It is calculated by dividing the modelled peak flow by the corresponding sewer capacity. A ratio greater than one indicates that the sewer is operating beyond its capacity, suggesting a potential need for upgrades—particularly when the over-capacity segment is long enough to cause surcharging in the upstream section.

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 2D Assessments

To present and evaluate the major stormwater system, 2D assessment model files were reviewed, and results data was extracted for both depth and velocity at the maxima for the 1:5-year and 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. The requirements are depicted in **Figure 3.3**. 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.

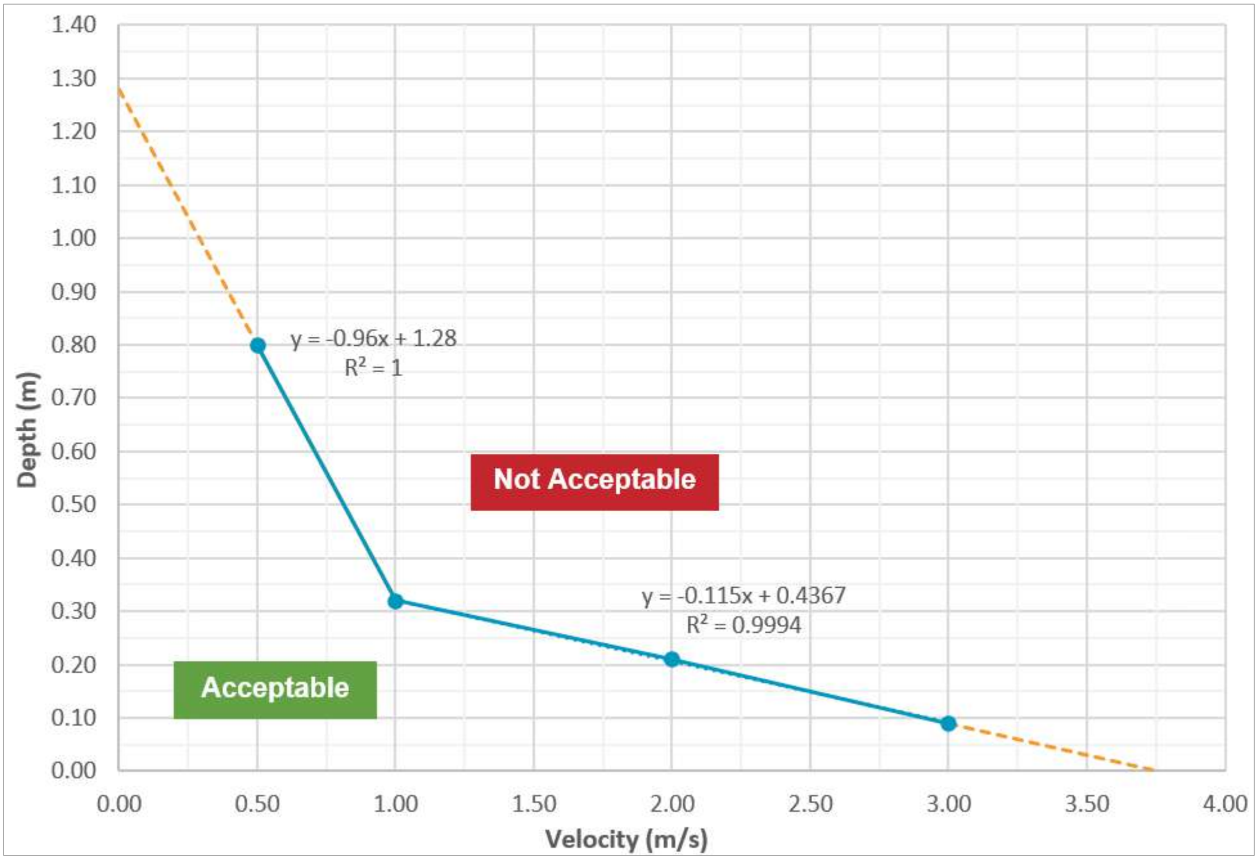


Figure 3.3: Permissible Depths for Submerged Objects

3.3.4 Future Stormwater Management Facilities (SWMF) Design Criteria

In determining future development requirements, the same infiltration surface parameters as specified in **Table 5.6** (as follows) 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 Design, Section 2.2.4 - Major System in the Town of Calmar Design and Construction Standards.

- Ponds shall be sized to store runoff from the 1:100-year, 24-hour Huff storm event, with a maximum 2.0 m rise from the active storage bottom to the high water level (HWL).
- Ponds shall have a minimum depth of 2.5 m at the normal water level (NWL).
- Submerged inlets/oulets shall be designed such that tops are a minimum of 1.0 m below NWL.
- Side slopes above NWL shall have a maximum slope of 7:1.
- Side slopes below NWL shall have a maximum slope of 3:1.

4.0 Existing Stormwater System

4.1 Stormwater Drainage System

An overview of the Town's drainage system is illustrated in **Figure 4.1**. Calmar is currently serviced by approximately 10 km of stormwater sewers. The storm sewer network primarily consists of polyvinyl chloride (PVC) pipes in newer developments and clay tile pipes in older areas of town. Details regarding pipe diameters, materials, and installation periods are provided in **Figures 4.2, 4.3,** and **4.4**, and are summarized in **Tables 4.1** to **4.3**. Culverts were excluded from these tables as most of their parameters had to be assumed due to limited data.

The Town is divided into two major stormwater drainage service areas:

- The area north of 50 Avenue is serviced by a trunk sewer running along 52 Avenue and 52 Street, which eventually discharges to Conjuring Creek in the northwest corner of town.
- The area south of 50 Avenue and the Highway 39 Industrial Park are serviced by a trunk sewer running along 50 Avenue, which discharges to a drainage ditch north of 50 Avenue on the west edge of town and ultimately discharges to Conjuring Creek.

There is one lift station in the Highway 39 Industrial Park, which draws down the Highway 39 Pond through a 200 mm forcemain, discharging into the trunk sewer on 50 Avenue. Additionally, the pond in the Calmar Industrial Park at the south end of town is drawn twice a year, once in the spring and once in the fall, using a portable pump. This portable pumping system was excluded from the hydraulic model, as the pond did not reach levels requiring drawdown under any of the modelled scenarios.

Table 4.1: Existing System Diameter Summary

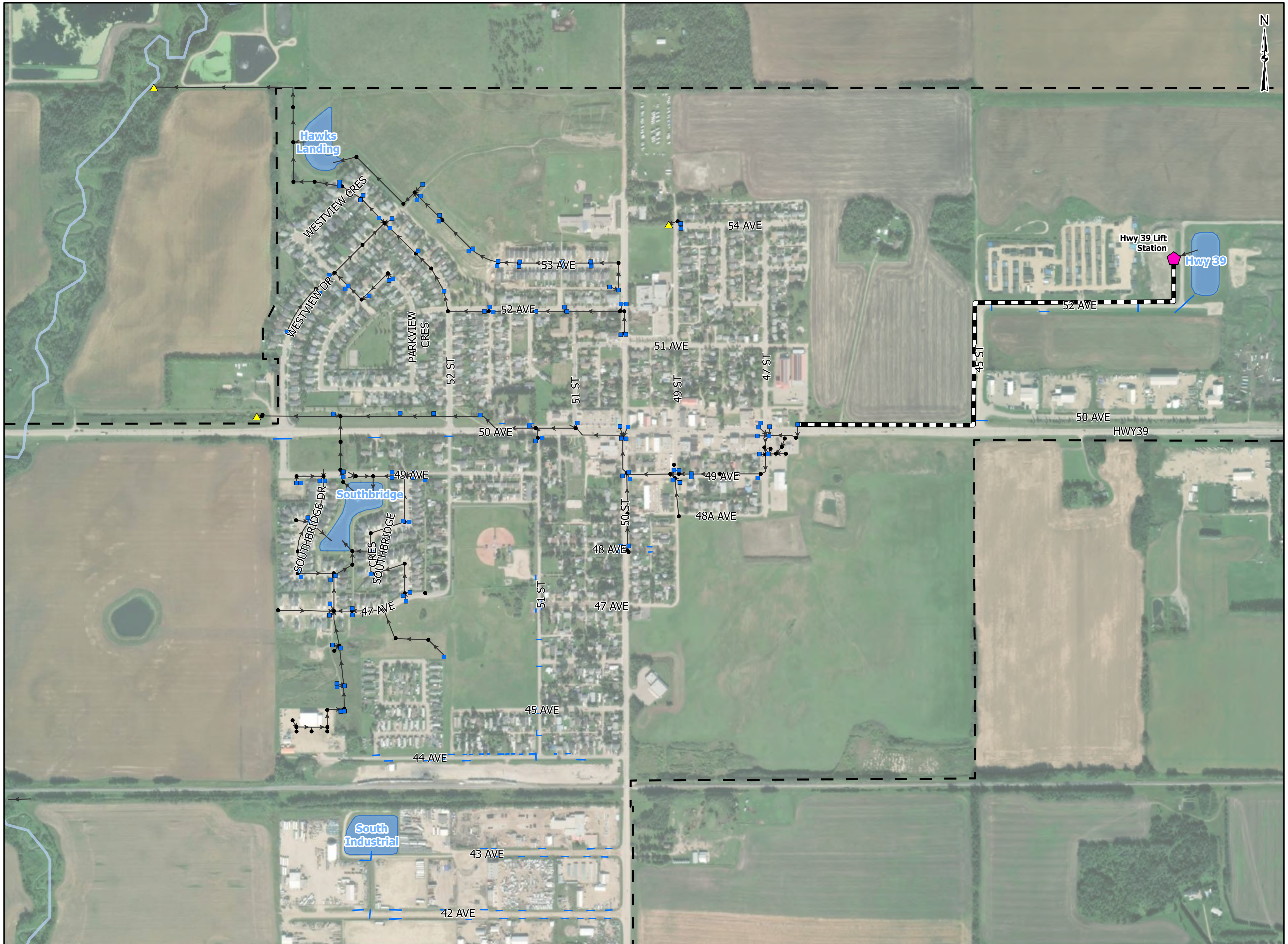
Diameter	Total Length	Percentage of Total
mm	m	%
Gravity Sewers		
150	61	0.68
200	122	1.36
250	1273	14.15
300	1204	13.38
375	864	9.60
450	403	4.48
500	182	2.02
525	68	0.75
600	665	7.40
675	540	6.00
750	1308	14.54
900	103	1.14
1050	795	8.84
1200	16	0.18
1350	865	9.62
2400	527	5.86
Sub-Total	**8,997**	**100.00**
Forcemains		
200	1,266	100
Sub-Total	**1,266**	**100.00**
Total	**10,263**	**-**

Table 4.2: Existing System Material Summary

Material	Total Length	Percentage of Total
	m	%
Gravity Sewers		
Concrete (CONC)	104	80.82
Polyvinyl Chloride (PVC)	1,622	1.15
Unknown (UNKN)	7,272	18.02
Sub-Total	**8,997**	**100.00**
Forcemains		
High Density Polyethylene (HDPE)	1,266	100.00
Sub-Total	**1,266**	**100.00**
Total	**10,263**	**-**

Table 4.3: Existing System Installation Period Summary

Installation Period	Total Length	Percentage of Total
	m	%
Gravity Sewers		
1950-1959	1,289	14.32
1960-1969	48	0.53
1970-1979	809	8.99
1980-1989	1,110	12.34
1990-1999	0	-
2000-2009	3,508	38.99
Unknown	2,234	24.83
Sub-Total	**8,997**	**100.00**
Forcemains		
1950-1959	1,266	100.00
Sub-Total	**1,266**	**100.00**
Total	**10,263**	**-**



LEGEND
- Manhole
- Catch Basin
- Outfall
- Stormwater Lift Station
- Conjuring Creek
- Gravity Main
- Culvert
- Forcemain
- SWMF
- Town Boundary

TITLE
DRAINAGE OVERVIEW

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

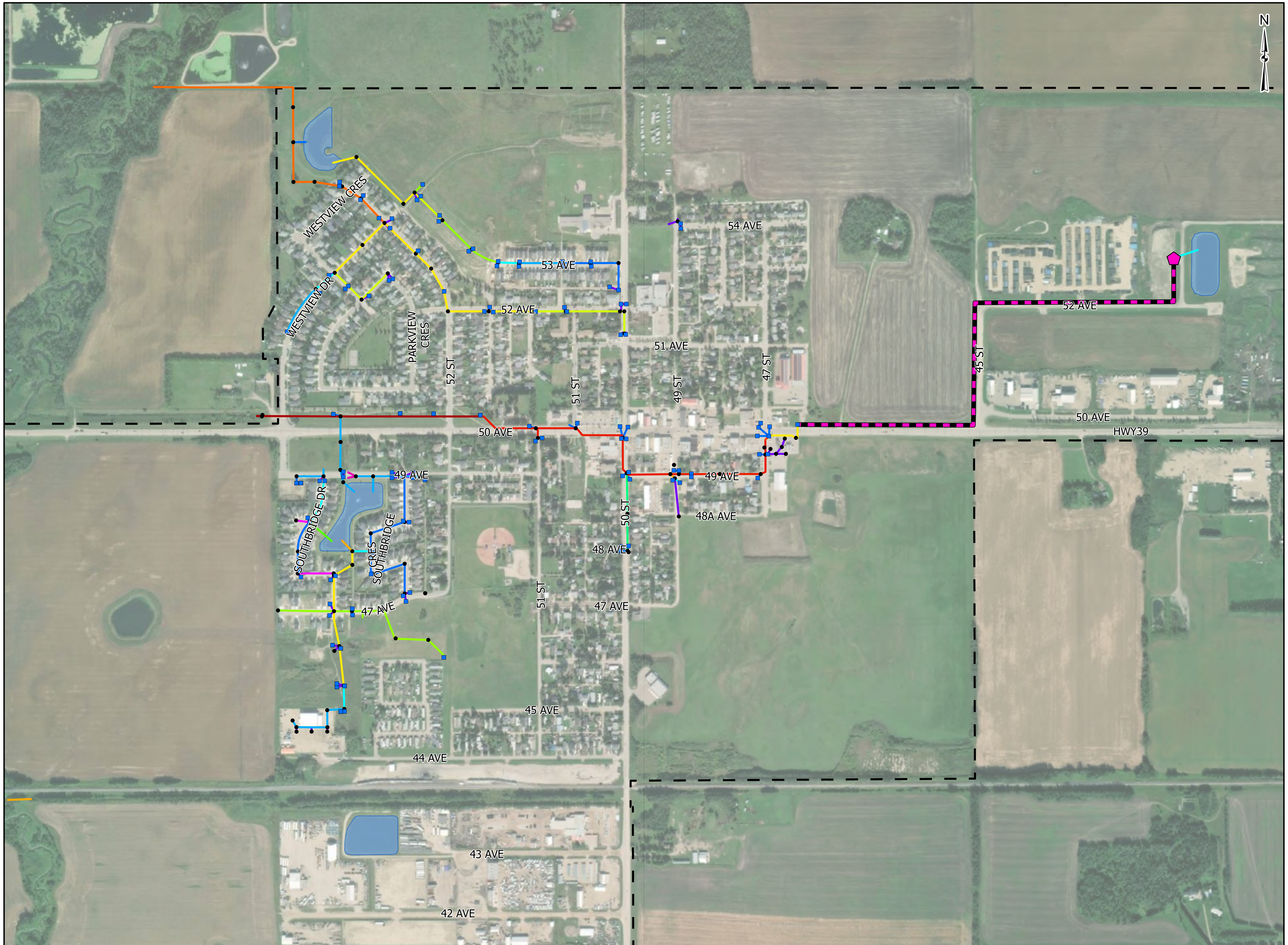
DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

0 0.1 0.2
1:9,000 KM

FIGURE	4.1
DATE	8/14/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 4.1_Drainage Overview



LEGEND

- Manhole
- Catch Basin Manhole
- Stormwater Lift Station
- SWMF
- Town Boundary

Gravity Main Diameter

- 150 mm
- 200 mm
- 250 mm
- 300 mm
- 375 mm
- 450 mm
- 500 mm
- 525 mm
- 600 mm
- 675 mm
- 750 mm
- 900 mm
- 1050 mm
- 1200 mm
- 1350 mm
- 2400 mm

Forcemain Diameter

- 200 mm

TITLE

STORMWATER PIPE DIAMETER

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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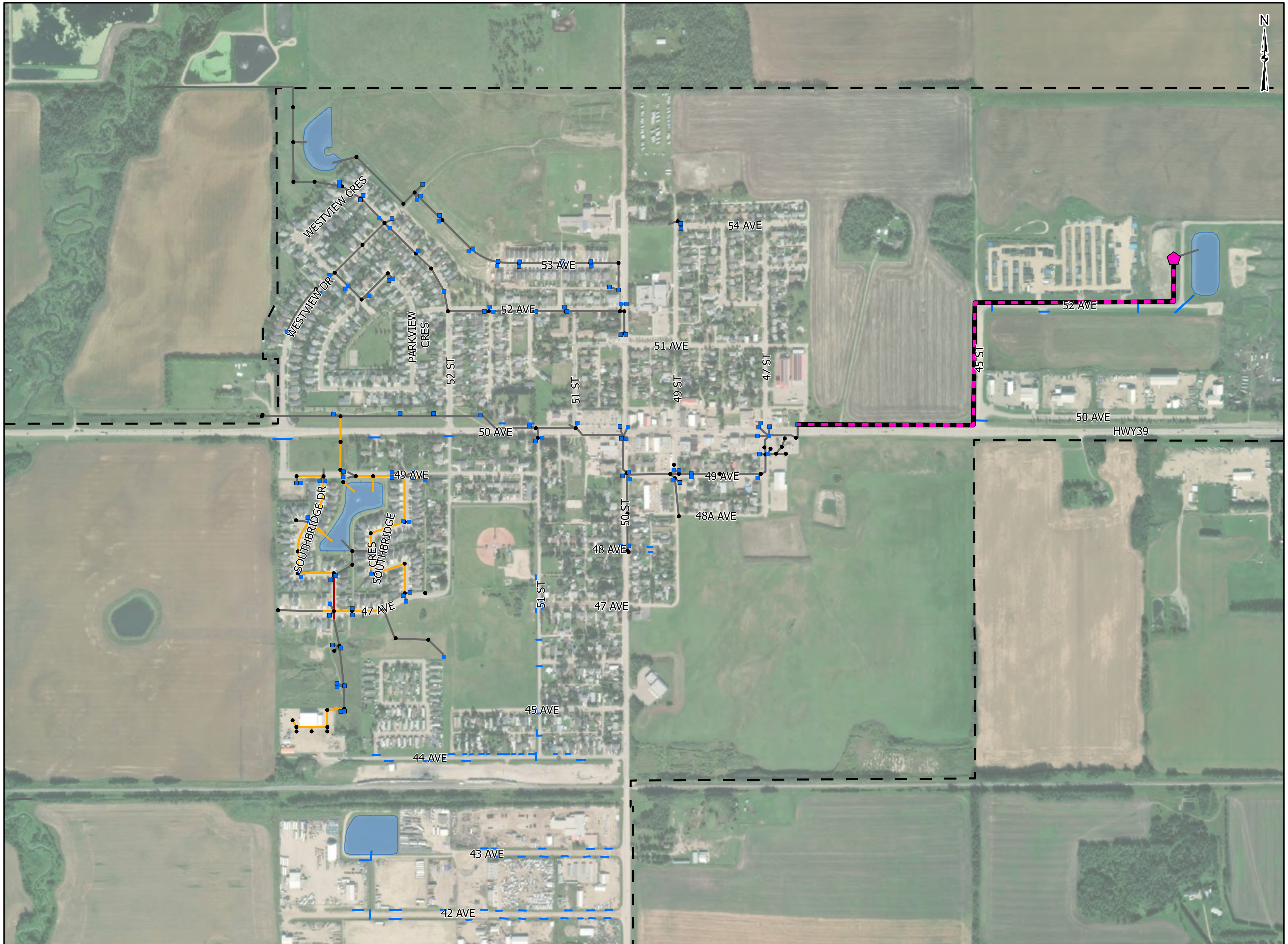
1:9,000 KM

ISL

FIGURE	4.2
DATE	8/14/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 4.2_Pipe Diameter



LEGEND

- Manhole
- Catch Basin Manhole
- Stormwater Lift Station
- Stormwater Pond
- Town Boundary

Gravity Main Material

- CONC
- CSP
- PVC
- UNKN

Forcemain Material

- HDPE

TITLE
STORMWATER PIPE MATERIAL

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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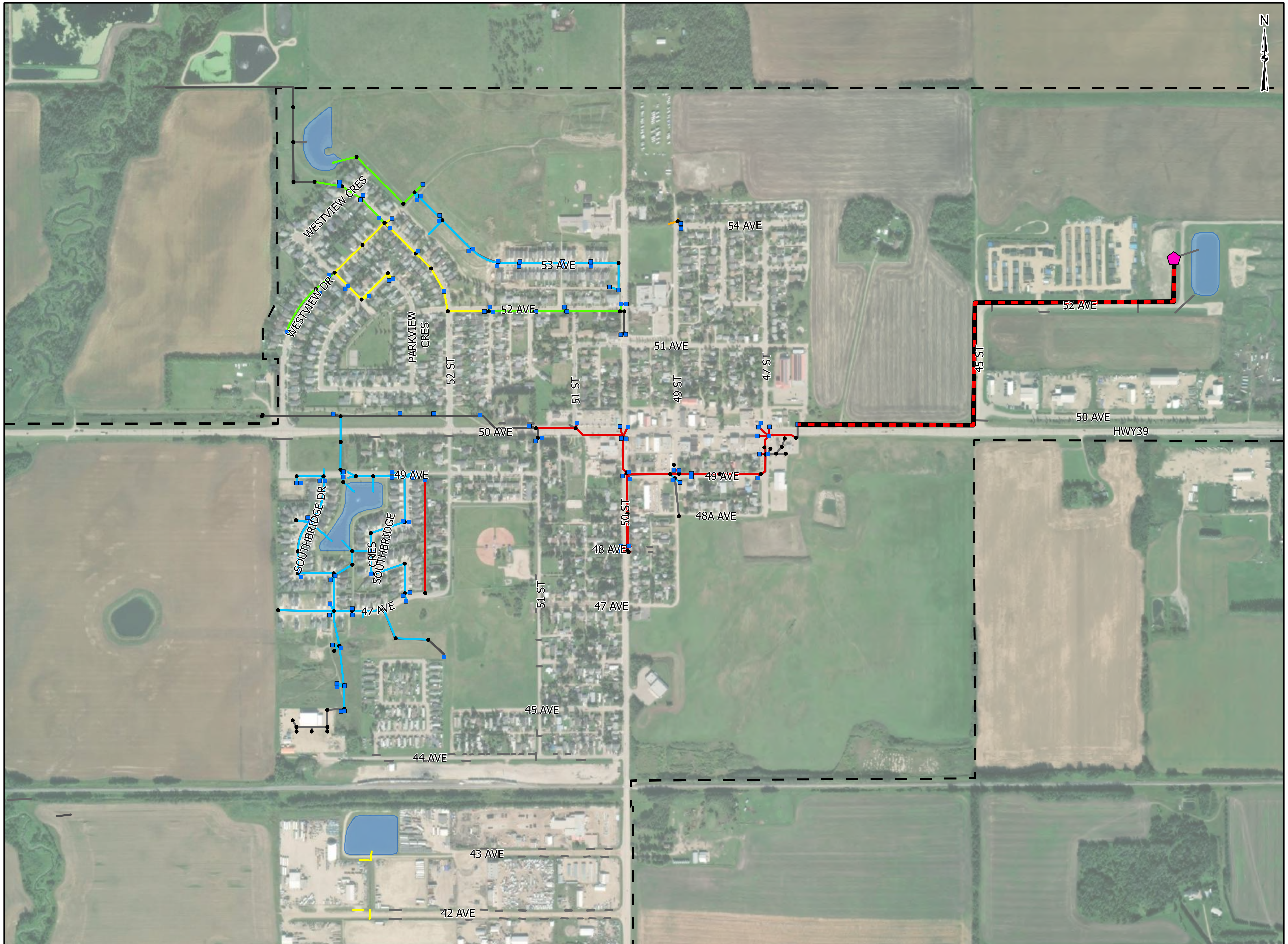
FIGURE	4.3
DATE	8/14/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester



LEGEND

- Manhole
- Catch Basin Manhole
- Stormwater Lift Station
- Stormwater Pond
- Town Boundary

Gravity Main Installation Period

- 1950-1959
- 1960-1969
- 1970-1979
- 1980-1989
- 2000-2009
- Unknown

Forcemain Installation Period

- 1950-1959

TITLE
STORMWATER PIPE INSTALLATION PERIOD

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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FIGURE	4.4
DATE	9/29/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

ISL

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 4.4_Pipe Installation Year

5.0 Hydraulic Model Development

5.1 Computer Model

The computer model used to assess the Town's stormwater system was InfoWorks ICM, which was selected for its advanced 2D modelling capabilities. The Calmar model is a 1D-2D integrated stormwater model which refers to how the minor and major systems have been modelled. The storm sewer network is represented by a 1-dimensional (1D) network of links that connect manhole to manhole, and catchbasin to manhole. The overland major drainage system is modelled using a "2D mesh" network created by the LiDAR surface. Thus, water can travel in two dimensions across the surface, governed by the shape of the surface. Catchbasin and manhole locations are connection points between the 2D overland model and the 1D pipe network. The inlet rate from the 2D mesh into the 1D sewer network has been modelled as a stage-discharge curve, thus providing inlet controls in direct relation to actual site conditions. This means that water exceeding catchbasin inlet capacity will pond on the surface and potentially overflow downstream when the surface sag storage capacity is reached, all as defined by the surface configuration. Catchbasin inlet flows are then impacted by surface water ponding depths as defined by the stage-discharge curves.

The 2D model has parameters built in for the overland roughness and infiltration parameters. The surface was discretized into different ground types where each ground type was assigned representative overland parameters. The 2D mesh was also modelled to include buildings to ensure that overland drainage would flow around buildings and not through them.

The stormwater model was constructed using LiDAR information and the stormwater GIS database. There were data gaps identified in the GIS database which were then filled using a combination of record drawings, design reports, and engineering assumptions when needed.

5.2 Model Set-Up

5.2.1 Minor System (1D) Model Development

The pipe network data was first processed in ArcGIS to combine pipe segments with matching diameters and materials in order 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 this project was to ensure proper connectivity of the system, and review elevations, diameters, and slopes to determine if the inputted data appeared accurate. This process was completed by producing longitudinal profiles (LPs) of every pipe network in the town. 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 were flagged using the user-defined flagged listed in **Table 5.1**.

Table 5.1: User-Defined Flags

Flag	Description
CB	Inferred based on minimum 1.5 m pipe cover
I	Inferred from neighbouring pipes
I2	Inferred from minimum slope
I3	Inferred from minimum catchbasin lead diameter
MESH	Inferred from mesh elevation
RD	From record drawings
UPG	Existing system upgrade

Missing information and pipe assumptions included:

- Missing invert information was taken from neighbouring pipes if possible.
- Missing upstream invert information with no known inverts further upstream was calculated based on the Towns's minimum design slope for each pipe size, as stipulated in **Table 5.2**.
- Culvert inverts were extracted from mesh element elevations in the model.
- Missing catchbasin lead inverts were set to achieve a minimum cover of 1.5 m below ground level, ensuring a minimum 2% slope is met, as outlined in the Calmar Design and Construction Standards.
- Manning's coefficient was set to 0.013 for mains and 0.023 for culverts.
- Missing pipe diameters were assigned based on neighbouring pipes.

Table 5.2: Minimum Design Slopes for Sewers

Nominal Pipe Diameter	Minimum Design Slope
mm	%
200	0.40
250	0.28
300	0.22
375 and larger	0.15

Catchbasin rim elevations were extracted from mesh element elevations in the model, to ensure proper connectivity between the 1D and 2D system. Many of the manholes were missing sump elevation data, in which case the lowest connected pipe invert was assumed as the manhole sump elevation. Catchbasins were assigned a chamber plan area of 0.6 m^2, while manholes were assigned areas based on incoming pipe sizes, as stipulated in **Table 5.3**.

Table 5.3: Assumed Manhole Size based on Connecting Pipe Diameter

Manhole Area	For Pipe Sized Up To
m^2	mm
1.131	900
1.767	1,050
2.835	1,500
4.524	1,800
6.158	2,100

5.2.2 Major System (2D) Model Development

The major stormwater system consists of all overland drainage infrastructure listed above. In Calmar, 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

The 2D Zone represents the town 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.

Mesh 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), polygons 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 **Table 5.4**.

Table 5.4: Mesh Zone Parameters per Land Use Type

Land Use	Maximum Triangle Area	Minimum Triangle Area
	m^2	m^2
Single Family Residential	25	5
Multi Family Residential	25	5
Urban Services	25	5
Industrial	25	5
Commercial	25	5
Parks & Recreation	50	10
Roads	5	1
Ponds	5	1

Mesh Level Zone

Buildings were incorporated into the 2D model using Mesh Level Zones. To achieve this, a polygon shapefile was manually created using aerial imagery to accurately delineate building footprints. Within these polygons, the mesh elevation was raised by 3 m to represent the height of the structures. This approach ensured that buildings were effectively elevated on the LiDAR surface, preventing runoff from entering them while allowing rainfall to land on rooftops and naturally drain away.

Mesh Level Zones were also 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.

Roughness Zone

The Roughness Zone allows various Manning's roughness coefficients (i.e., n-values) for different parts of the mesh. 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. Roughness coefficients for each land use type were derived by selecting a few representative polygons per land use, and calculating a weighted average based on grass versus pavement cover. The roughness coefficients applied in the model are summarized in **Table 5.5**.

Table 5.5: Roughness Zone Parameters per Land Use Type

Land Use	Roughness Coefficient
Single Family Residential	0.0239
Multi Family Residential	0.0215
Urban Services	0.0219
Industrial	0.0177
Commercial	0.0163
Parks & Recreation	0.0300
Roads	0.0160
Ponds	0.0425

Infiltration Zone

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 for each zoning classification are summarized in **Table 5.6**. These parameters were mostly based on the fixed runoff coefficients specified in Calmar's Design and Construction Standards (2020), except for roads, ponds, and parks which were based on typical industry standards.

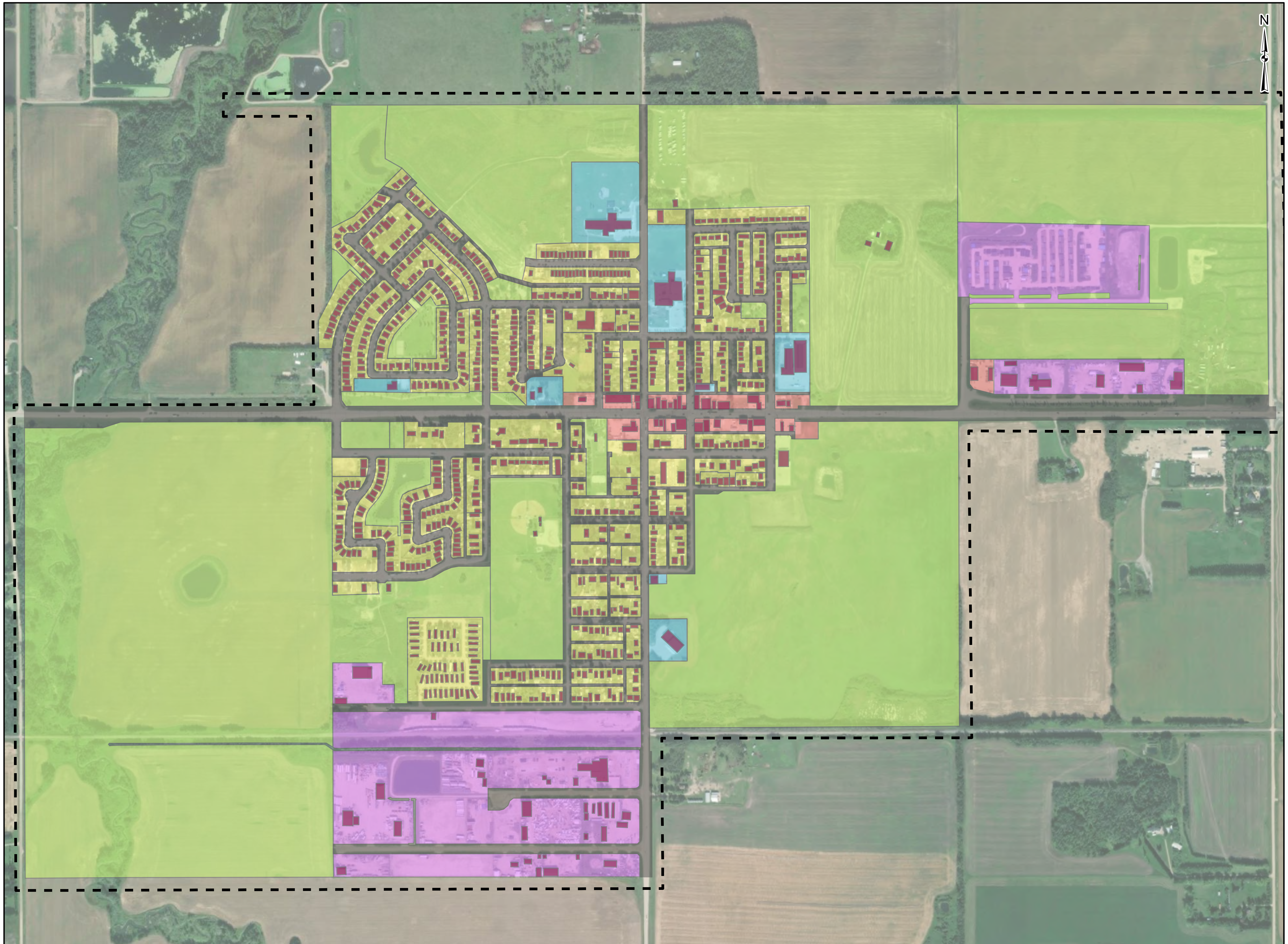
Table 5.6: Infiltration Zone Parameters per Zoning Classification

Zoning Classification	Infiltration Type	Fixed Runoff Coefficient (C)	Horton Initial	Horton Limiting	Horton Decay	Horton Recovery
			mm/hr	mm/hr	1/hour	1/hour
Single Family Residential	Fixed	0.5	-	-	-	-
Multi Family Residential	Fixed	0.65	-	-	-	-
Urban Services	Fixed	0.65	-	-	-	-
Industrial	Fixed	0.5	-	-	-	-
Commercial	Fixed	0.9	-	-	-	-
Parks & Recreation	Horton	-	75	2.5	4.14	0.006
Roads and Ponds	Fixed	0.95	-	-	-	-

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 generally maintained; 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 5.1**.

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.

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. A model schematic, including the generated mesh surface and all minor system infrastructure, is shown in **Figure 5.2**.



LEGEND

2D Zone Boundary

Buildings

Land Use Type

Commercial

Industrial

Residential

Open Space

Public Services

Roads

TITLE

2D MODEL LAND USE SURFACES

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES

- Topographic Map:Maxar

PROJECTION

NAD 1983 CSRS 3TM 114

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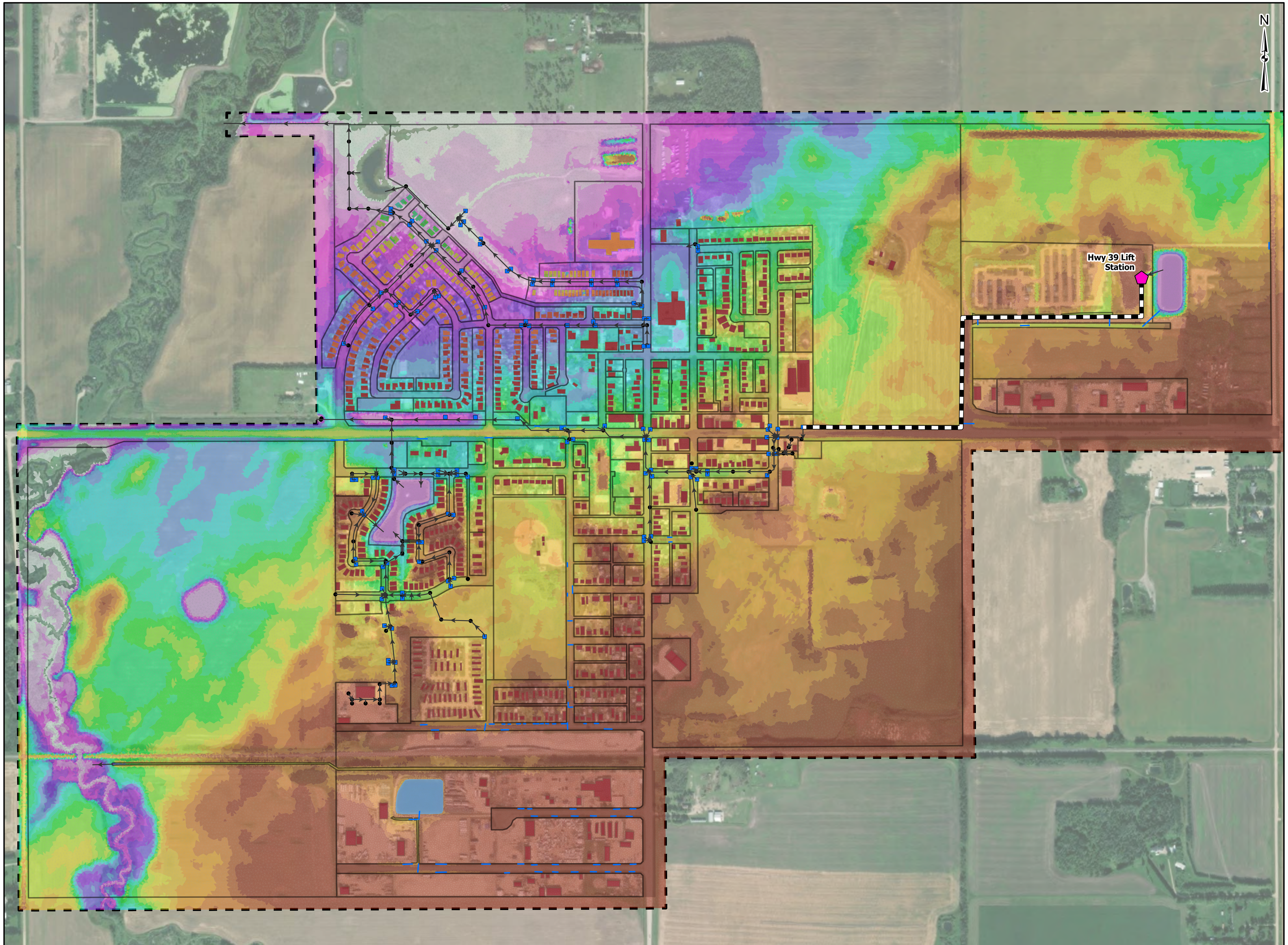
FIGURE	5.1
DATE	7/11/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester



LEGEND

- Manhole
- Catchbasin
- Lift Station
- Gravity Main
- Culvert
- Forcemain
- Mesh Zone Boundary
- 2D Zone Boundary

Mesh Elements

Elevation (m)

- 722.286 - 722.969
- 722.970 - 723.632
- 723.633 - 724.131
- 724.132 - 724.549
- 724.550 - 724.924
- 724.925 - 725.248
- 725.249 - 725.573
- 725.574 - 725.915
- 725.916 - 726.234
- 726.235 - 726.527
- 726.528 - 726.761
- 726.762 - 726.943
- 726.944 - 727.140
- 727.141 - 727.337
- 727.338 - 727.538
- 727.539 - 727.769
- 727.770 - 728.067
- 728.068 - 728.409
- 728.410 - 728.726
- 728.727 - 738.000

TITLE
MODEL SCHEMATIC

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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1:10,000 KM

FIGURE	5.2
DATE	8/14/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

ISL

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 5.2_Model Schematic

6.0 Existing System Assessment

The existing system was assessed using the design criteria stipulated in Section 3.0. Simulation results for each of the design events are summarized in Sections 6.1 and 6.2. The proposed upgrades to the existing system are listed in Section 6.3. Section 6.4 summarizes the risk assessment and prioritization of upgrades. Lastly, cost estimates for the proposed upgrades are provided in Section 6.5.

6.1 1:5 Year Event Result Summary

The results for the existing system under the 1:5-year, 4-hour Chicago (Modified) distribution design storm are shown on **Figure 6.1**. A summary of the results is discussed below and labelled on **Figure 6.1**:

- **Westview Neighbourhood** – Sewer surcharging along 52 Street, 52 Avenue, and Westview Drive causing minor flooding in roadway. This is further exacerbated by surcharging of the downstream trunk leading to the outfall in the northwest corner of town.
- **Southbridge Neighbourhood** – Sewer surcharging along Southbridge Crescent and 49 Avenue. These two areas are less of a concern as they do not result in any surface flooding in the 1:5 Year event, but should be kept in mind for the 1:100 Year event.
- **Downtown** – Sewer surcharging along 50 Street. This is less of a concern in the 1:5 Year storm event as it does not result in any surface flooding, but should be kept in mind for the 1:100 Year event.

6.2 1:100 Year Event Result Summary

The results for the existing system under the 1:100-year, 4-hour Chicago distribution design storm are shown on **Figure 6.2**. Based on the depth/velocity criteria described in Section 3.3.3, the maximum velocities and depths were compared to determine if they exceeded the criteria and the results are shown on **Figure 6.3**. 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. This means that any comparison between the maximum depth and maximum velocity values will be conservative and will slightly overestimate the areas that may exceed the guidelines.

In addition to the concerns listed above in Section 6.1, a summary of the 100-year results is discussed below and labelled on **Figure 6.2**:

- **Westview Neighbourhood** – Ponding on Westview Drive, Parkview Crescent, 52 Street, 52 Avenue, and 50 Street is exceeding 0.4 m. There is sewer surcharging downstream of all these areas, leading to the outfall in the northwest corner of town.
- **Corgi Park / 51 Street** – Flagged by the Town as an area of concern. Ponding in the north end of Corgi Park is exceeding a 0.5 m depth, which extends into private property. Ponding in the center of Corgi Park is spilling into the west ditch of 51 Street, causing ponding exceeding a 0.4 m depth. Ponding in the east ditch of 51 Street is exceeding a 0.4 m depth. It was also noticed in Google Street View that the culvert in the east ditch of 51 Street crossing 47 Avenue is exposed through the pavement and should be flagged for rehabilitation.
- **Woodland Park** – Ponding in the northeast corner is exceeding a 0.5 m depth.
- **49 Avenue** – Ponding in roadway is exceeding a 0.4 m depth.
- **48 Avenue** – Ponding in ditches exceeding 0.5 m depth.

- **48A Avenue and 49 Street** – Flagged by the Town as an area of concern. Ponding in the southeast corner exceeding 0.4 m depth in model.
- **Calmar Mobile Home Park** – Ponding in the northeast corner is exceeding 0.5 m depth but remains contained in the ditch; no upgrades proposed. This area should be monitored in the future and upgraded if conditions worsen.
- **NE Quadrant** – Although the northeast quadrant was identified by the Town as an area of concern, the model did not show significant flooding. This could be due to LiDAR limitations—such as missing localized low points or flooding driven by seasonal snowmelt not represented in the model. At the level of detail used in this master plan, upgrades were not included, as further investigation is needed to confirm the cause and determine appropriate mitigation measures. Localized storm sewers could be implemented in conjunction with future projects in this area.

SWMF Capacity Assessment

The 1:100-year, 24-hour Huff distribution design storm was used to assess the capacity of the four stormwater management facilities (SWMF). The results for this design storm are shown on **Figure 6.4** and the estimated peak water levels in the SWMFs are summarized in **Table 6.1**. There were no capacity issues identified for the Hwy 39 and South Industrials Ponds. The modelled peak elevations for the Hawk's Landing and Southbridge Ponds are above HWL but remain below the freeboard elevations.

It is important to note that Horton infiltration parameters were applied to the open space areas in the model. This conservative assumption regarding ground infiltration likely results in higher estimated runoff volumes. Consequently, the simulated peak pond elevations should be considered conservative estimates.

Table 6.1: Existing SWMF Model Results – 100-Year, 24-Hour Event

Facility ID	Freeboard Elevation	HWL	NWL	Peak Elevation 1:100 Yr 24Hr Huff	Comments
	m		m	m	
Hawk's Landing	722.00[1]	720.83	719.83	721.642	No overflow but only 0.4 m freeboard estimated
Hwy 39	726.30	726.00	724.02	725.673	No capacity issues
Southbridge	725.80[1]	725.00	723.5	725.231	No overflow but only 0.6 m freeboard estimated
South Industrial	727.50	726.90	725.55	726.407	No capacity issues

[1] Freeboard elevation estimated from record drawings.

6.3 Proposed Upgrades for the Existing Stormwater System

Based on the model results, ISL developed a list of recommended upgrades to improve the system's capacity and rectify areas of concern noted in Sections 6.1 and 6.2. Recommended upgrades are illustrated in **Figure 6.5** and summarized in **Table 6.2**. Longitudinal profiles of the sewers flagged for upgrades are provided in **Appendix A**. These profiles illustrate the hydraulic grade line (HGL) for both the existing and the upgraded systems under the 1:5-year and 1:100-year design storm scenarios. A key map for the longitudinal profiles is provided on **Figure 6.6**.

The results for the 1:5-year 4-hour and the 1:100-year 4-hour Chicago (Modified) distribution design storms with the proposed upgrades implemented are shown on **Figure 6.7** and **Figure 6.8**, respectively. It should be noted that additional analysis would be required to adequately model the proposed SWMF in Corgi Park, so the SWMF was not included in this assessment. Longitudinal profiles illustrating HGL comparisons between the existing and with the proposed upgrades scenarios are presented in **Appendix A**.

It is highly recommended that the existing stormwater 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 catchbasin inlet grate type. Therefore, confirming the existing system configuration is crucial to avoid completing unnecessary upgrades. Further, it is recommended that the Town 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 Town 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.

Surcharged catchbasin leads throughout the town 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 catchbasin leads. Therefore, it would be more prudent to monitor the catchbasin leads, and if capacity constraints are evident, upgrading options can then be developed at that time.

Where multiple new catchbasins are proposed within a single area, an alternative option is to install twin catchbasins or super catchbasins in place of separate individual units. This can be further evaluated during preliminary design.

52 Street / 52 Avenue Trunk Upgrades (Westview Neighbourhood)

Upgrade #2 targets reducing pipe surcharging in the 52 Street / 52 Avenue trunk sewer during the 1:5-year event, which is linked to surface flooding in the roadway during the 1:100-year event. The upgrades can be implemented in phases, starting with partial improvements on the downstream end to address some flooding issues, with further upgrades considered if needed. The proposed upgrades eliminate surcharging in the trunk for the 1:5-year event but do not substantially decrease surface flooding in the adjacent roadways in the 1:100-year event. The Town confirmed they are willing to accept the modelled level of surface flooding under the 1:100-year event, as there have been no historical concerns or significant issues in this area. Road or ditch improvements could also be considered to enhance emergency overland drainage paths. The Town may monitor this area during lower return period events, and if significant flooding occurs, reassess the need for more substantial upgrades.

Corgi Park Upgrades

There is a localized low point in the center of Corgi Park, just south of the baseball diamonds, which collects surface runoff from approximately 20 ha to the south. Two potential approaches have been identified for managing drainage in this area:

- **Stormwater Management Facility (SWMF):**
  Construct a SWMF with an estimated storage capacity of approximately 2,800 m^3, based on model results from the 1:100-year, 24-hour Chicago (Modified) distribution design storm. The facility would be designed with a 450 mm outlet pipe, limiting the maximum release rate to 4.5 L/s/ha, and discharging to the proposed 51 Street storm main. Further review of the downstream system capacity would be required during detailed design.
- **Regrading and Surface Drainage Diversion:**
  Re-grade the park to eliminate the low point and redirect surface drainage. However, these options may present significant challenges to both the downstream piped system and the overland drainage network, and would therefore require further investigation in a future study.

Environmental investigations have identified areas of contamination in the southern portion of Corgi Park, primarily due to historical oil and gas activities (Matrix Solutions Inc., 2021). The extent of contamination is shown in **Exhibit 6.1** below. All future redevelopment and stormwater infrastructure planning in Corgi Park should consider these environmental constraints to minimize risk and ensure regulatory compliance.

Exhibit 6.1: Contaminated Area (Matrix Solutions Inc., 2021)

Table 6.2: Existing System Upgrade Recommendations

Upgrade No.	LP No.	Description	Recommended Upgrades
EX UPG #1	LP 1	Corgi Park and 51 Street drainage improvements	• Install 152 m of 1050 mm sewer on 51 Street between 50 Avenue and 48A Avenue. • Install 242 m of 750 mm sewer on 51 Street from 48A Avenue to 47 Avenue. • Install 246 m of 525 mm sewer on 51 Street from 47 Avenue to 45 Avenue. • Upgrade 140 m of existing 1350 mm trunk sewer to 2400 mm on 50 Avenue. • Construct a SWMF in Corgi Park with a capacity of 2800 m^3. • Install 60 m of 450 mm outlet pipe for the Corgi SWMF. • Install two Type K-7 catchbasins with 250 mm leads at the west end of 48 Avenue, 47 Avenue, 46 Avenue, and 45 Avenue. • Install 19 m of 400 mm inlet pipe at the downstream end of the W-E ditch of Corgi Park, and 12 m of 300 mm inlet pipe at the downstream end of the S-N ditch. • *Note: Based on available GIS data, the discharge point of these existing ditches is unclear. This upgrade assumes no existing infrastructure is present and therefore introduces new conveyance to the sewer.* • Install 16 m of 400 mm inlet pipe to convey flow from the east ditch of 51 Street to the new 51 Street sewer. • Install 11 m of 400 mm culvert across the alley between 47 Avenue and 48 Avenue.
EX UPG #2A	LP 2	Westview Neighbourhood local drainage improvements	• Upgrade 550 m of existing 1050 mm trunk sewer to 1350 mm. • *Note: This trunk discharges directly to Conjuring Creek and will likely require provincial approval due to increased release rates, which could raise the risk of erosion and downstream flooding. A downstream creek channel capacity and erosion study is recommended. An alternative solution could be to store this additional flow in the Hawk's Landing pond, which would likely require a pond upgrade.*
EX UPG #2B	LP 2	Westview Neighbourhood local drainage improvements	• Upgrade 256 m of existing sewer on 52 Street from 750 mm to 900 mm. • Upgrade 191 m of existing sewer on 52 Avenue from 750 mm to 900 mm.
EX UPG #2C	LP 2	Westview Neighbourhood local drainage improvements	• Upgrade 211 m of existing sewer on 52 Avenue from 675 mm to 900 mm. • Install two Type F-51 (with side inlet) catchbasins with 300 mm leads at ponding locations on 50 Street.
EX UPG #2D	LP 3	Westview Neighbourhood local drainage improvements	• Upgrade 122 m of existing sewer on Westview Drive from 375 mm to 450 mm. • Upgrade 60 m of existing sewer on Westview Drive from 450 mm to 525 mm.

Upgrade No.	LP No.	Description	Recommended Upgrades

EX UPG #3	LP 4	48 Avenue local drainage improvements	• Upgrade 28 m of culvert in south ditch of 48 Avenue between 49 Street and 50 Street from 300 mm to 400 mm.
			  ◦ *Note: This culvert does not appear in current records. Culvert size and length was estimated based on Google Street View.*
			• Upgrade 37 m of culverts in north ditch of 48 Avenue between 49 Street and 50 Street from 300 mm to 600 mm.
			  ◦ *Note: These culverts do not appear in current records. Culvert size and length were estimated based on Google Street View.*
			• Install 600 mm inlet pipe at downstream end of north ditch and 400 mm inlet pipe in south ditch.
			• Upgrade 304 m of existing sewer on 50 Street from 500 mm to 900 mm.

EX UPG #4	LP 5	48A Avenue and 49 Street intersection drainage improvements	• Install 150 m of 900 mm inlet pipe in the south east corner of the intersection to intercept flow from field and remove existing catchbasin. • Upgrade 150 m of existing sewer on 49 Street from 250 mm to 525 mm. ◦ *Note: Based on the available GIS data, this sewer does not exist in the current records. For modeling purposes, this sewer was manually added as a catchbasin lead to represent a connection from the catchbasin in the northwest corner of the field to the sewer on 49 Avenue. The sewer size and slope were estimated using the minimum design criteria for catchbasin leads as outlined in the Calmar Design and Construction Standards.* • Upgrade 24 m of existing sewer on 49 Street from 900 mm to 1050 mm.
EX UPG #5	-	Woodland Park drainage improvements	• Install four Type 8 catchbasins in the northeast corner of park and connect to 50 Avenue trunk with 250 mm catchbasin leads.

EX UPG #6	-	50 Avenue south ditch improvement	• Improve 180 m of south ditch along 50 Avenue between 51 Street and 52 Street.
			  ◦ *Note: To model this upgrade, the ground level of the ditch was lowered by 0.2 m.*
			• Upgrade 19 m of culvert across 52 Street and driveway from 300 mm to 400 mm.
			  ◦ *Note: This culvert does not appear in current records. Culvert size and length were estimated based on Google Street View.*
			• Install 22 m of 400 mm inlet pipe in low point of ditch and connect to 50 Avenue trunk sewer.

EX UPG #7	-	49 Avenue local drainage improvement	• Install four Type K-7 catchbasins on 49 Avenue, two on each side of street, between 47 Street and 49 Street and connect to 49 Avenue sewer with 250 mm catchbasin leads.

6.4 Risk Assessment and Existing System Upgrade Prioritization

To better aid the Town in prioritizing the proposed 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. The risk assessment criteria and scoring matrix are presented in **Table 6.3**.

Table 6.3: 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	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.3	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.4	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.5	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 6.4**.

Table 6.4: Existing System Upgrade Risk Assessment – Criteria Ranking

Risk Criteria - Pairwise Comparison						Count	Weighting	Criteria Ranking		
	C.1	C.2	C.3	C.4	C.5			Rank	ID	Description
C.1	C.1	C.1	C.1	C.1	C.1	5	33.3%	1	C.1	Historical Flooding
C.2		C.2	C.2	C.2	C.2	4	26.7%	2	C.2	Proximity to Critical Infrastructure and Buildings
C.3			C.3	C.3	C.3	3	20.0%	3	C.3	Surface Flooding Alleviation
C.4				C.4	C.4	2	13.3%	4	C.4	Peak HGL Reduction
C.5					C.5	1	6.7%	5	C.5	Road Condition Upgrade Potential
				Total		15	100.0%			

Each proposed upgrade was then assigned a score based on anecdotal information, model results, and pipe improvement and roadway condition. The prioritization results of the risk assessment are summarized in **Table 6.5** with detailed assessment and scoring calculations provided in **Appendix B**. Note that Upgrades #2A, #2B, and #2C are sequential (e.g., #2A must be completed before #2B).

Table 6.5: Existing System Upgrades Risk Assessment Priority Summary

Priority	Upgrade No.	Name	Overall Score
1	EX UPG #1	Corgi Park and 51 Street drainage improvements	3.40
2	EX UPG #4	48A Avenue and 49 Street intersection drainage improvements	3.13
3	EX UPG #6	50 Avenue south ditch improvement	2.20
4	EX UPG #5	Woodland Park drainage improvements	1.67
5	EX UPG #3	48 Avenue local drainage improvements	1.60
6	EX UPG #2D	Westview Neighbourhood local drainage improvements	1.60
7	EX UPG #2A	Westview Neighbourhood local drainage improvements	1.47
8	EX UPG #2B	Westview Neighbourhood local drainage improvements	1.47
9	EX UPG #2C	Westview Neighbourhood local drainage improvements	1.47
10	EX UPG #7	49 Avenue local drainage improvement	1.27

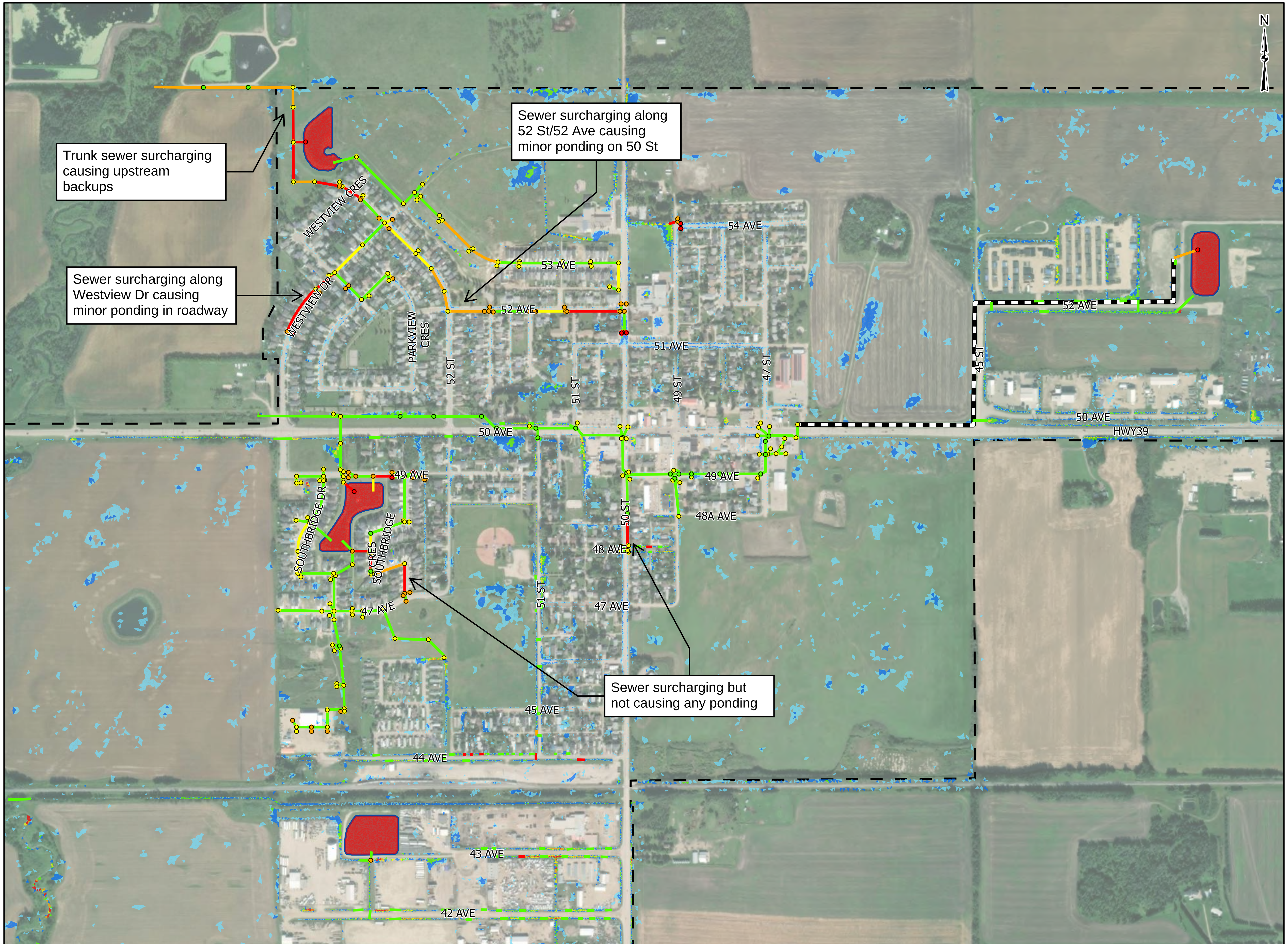
6.5 Cost Estimates

Class ‘D’ cost estimates of the proposed existing system upgrades were developed based on typical representative unit costs from ISL’s past project experience in similar municipalities in Alberta, escalated for 2025 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 upgrades are presented in **Table 6.6**, with the full breakdown available in **Appendix C**. As some of the pipe sizes/locations in the existing system had to be inferred due to missing GIS data, it is recommended that the Town monitors each site and only proceeds with the upgrade if capacity constraints are evident.

Table 6.6: Existing System Upgrades Cost Estimates

Priority	Upgrade ID	Cost	Engineering (15%)	Contingency (30%)	Total
		($)	($)	($)	($)
1	EX UPG #1	$3,111,000	$468,500	$934,000	$4,513,500
7	EX UPG #2A	$1,319,000	$198,000	$396,000	$1,913,000
8	EX UPG #2B	$1,379,000	$207,000	$414,000	$2,000,000
9	EX UPG #2C	$672,000	$101,000	$201,000	$974,000
6	EX UPG #2D	$403,000	$61,000	$121,000	$585,000
5	EX UPG #3	$981,000	$147,000	$295,000	$1,423,000
2	EX UPG #4	$400,000	$60,000	$121,000	$581,000
4	EX UPG #5	$51,000	$8,000	$15,000	$74,000
3	EX UPG #6	$39,000	$5,000	$12,000	$56,000
10	EX UPG #7	$64,000	$9,000	$19,000	$92,000
Total		**$8,419,000**	**$1,264,500**	**$2,528,000**	**$12,211,500**



LEGEND

- Lift Station
- Forcemain
- SWMF
- Town Boundary

Maximum HGL Elevation Relative to Ground

- Less than -3.0 m
- -3.0 m to -1.5 m
- -1.5 m to 0.0 m
- Greater than 0.0 m

Peak Discharge Relative to Pipe Capacity

- Less than 86%
- Between 86% and 100%
- Between 100% and 120%
- Greater than 120%

Maximum Depth (m)

- Less than 0.1m
- 0.1 m to 0.2 m
- 0.2 m to 0.3 m
- 0.3 m to 0.4 m
- 0.4 m to 0.5 m
- Greater than 0.5 m

TITLE
EXISTING SYSTEM RESULTS
5-YR 4-HR CHICAGO (MODIFIED)

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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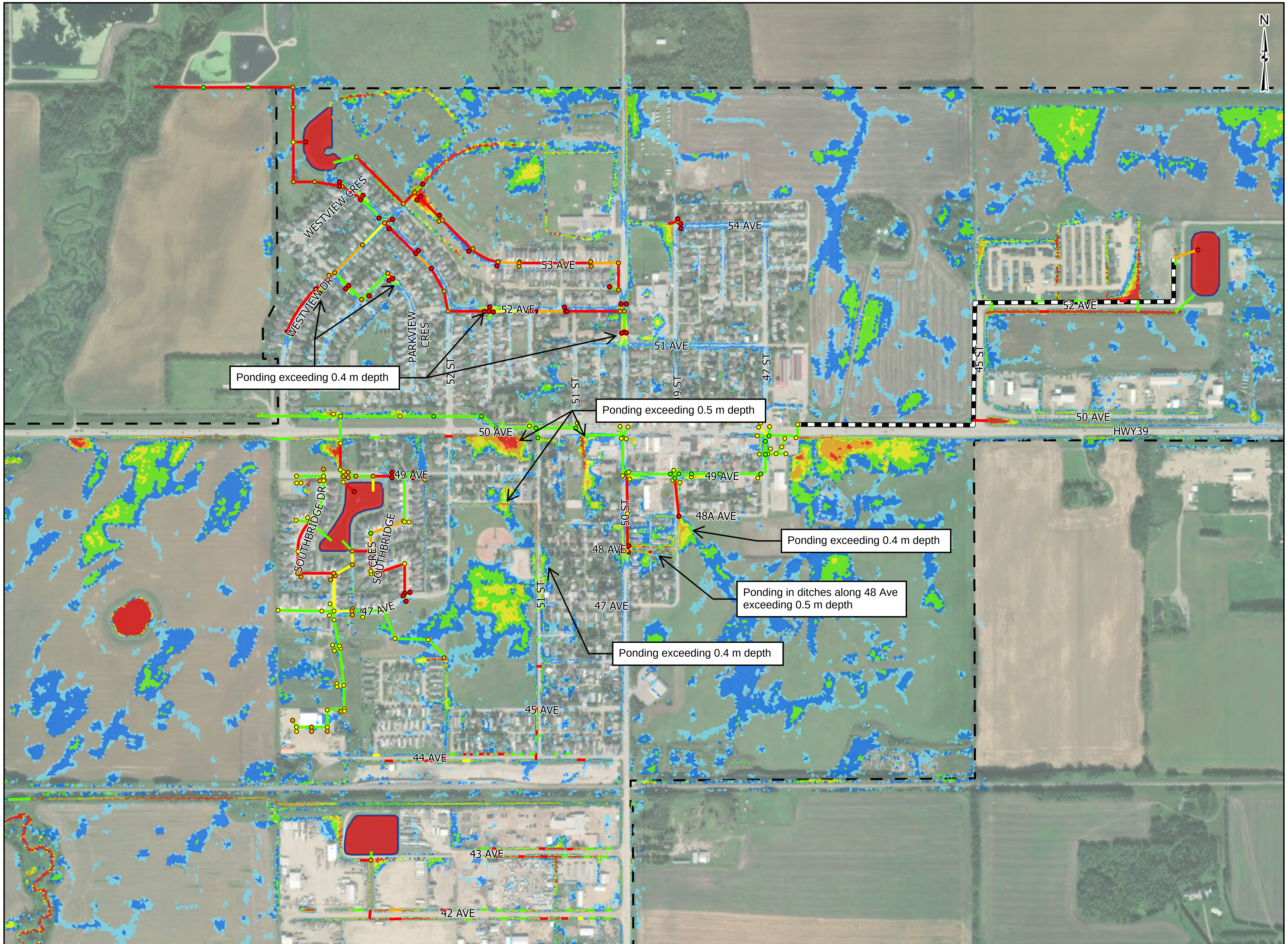
1:9,000 KM

ISL

FIGURE	6.1
DATE	8/14/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 6.1_Existing Results_5yr4Hr



LEGEND

- Lift Station
- Forcemain
- SWMF
- Town Boundary

Maximum HGL Elevation Relative to Ground

- Less than -3.0 m
- -3.0 m to -1.5 m
- -1.5 m to 0.0 m
- Greater than 0.0 m

Peak Discharge Relative to Pipe Capacity

- Less than 86%
- Between 86% and 100%
- Between 100% and 120%
- Greater than 120%

Maximum Depth (m)

- Less than 0.1 m
- 0.1 m to 0.2 m
- 0.2 m to 0.3 m
- 0.3 m to 0.4 m
- 0.4 m to 0.5 m
- Greater than 0.5 m

TITLE

EXISTING SYSTEM RESULTS
100-YR 4-HR CHICAGO (MODIFIED)

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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FIGURE	6.2
DATE	8/14/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

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LEGEND

Town Boundary

SWMF

Exceeds Maximum V/d Guidelines

No

Yes

TITLE

EXISTING SYSTEM RESULTS
100-YR 4-HR CHICAGO (MODIFIED)
MAX OVERLAND DEPTH
AND VELOCITY ASSESSMENT

PROJECT

CALMAR MASTER PLANS UPDATES

CLIENT

TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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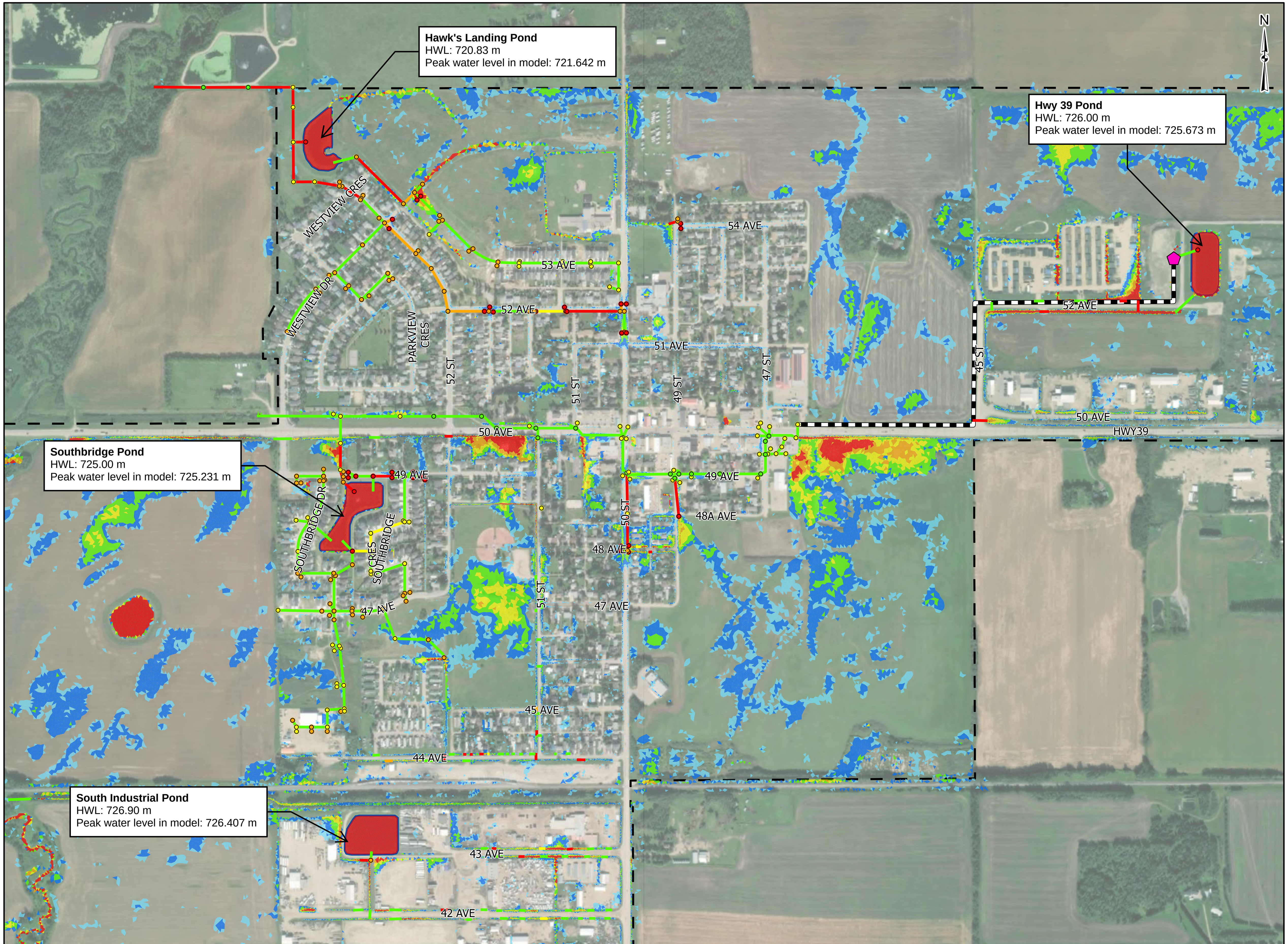
FIGURE	6.3
DATE	7/15/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates.aprx - Figure 6.3_100yr4hr_Max Depth vs Velocity



LEGEND

- Lift Station
- Forcemain
- SWMF
- Town Boundary

Maximum HGL Elevation Relative to Ground

- Less than -3.0 m
- -3.0 m to -1.5 m
- -1.5 m to 0.0 m
- Greater than 0.0 m

Peak Discharge Relative to Pipe Capacity

- Less than 86%
- Between 86% and 100%
- Between 100% and 120%
- Greater than 120%

Maximum Depth (m)

- Less than 0.1 m
- 0.1 m to 0.2 m
- 0.2 m to 0.3 m
- 0.3 m to 0.4 m
- 0.4 m to 0.5 m
- Greater than 0.5 m

TITLE
EXISTING SYSTEM RESULTS
100-YR 24-HR HUFF

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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FIGURE	6.4
DATE	9/11/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

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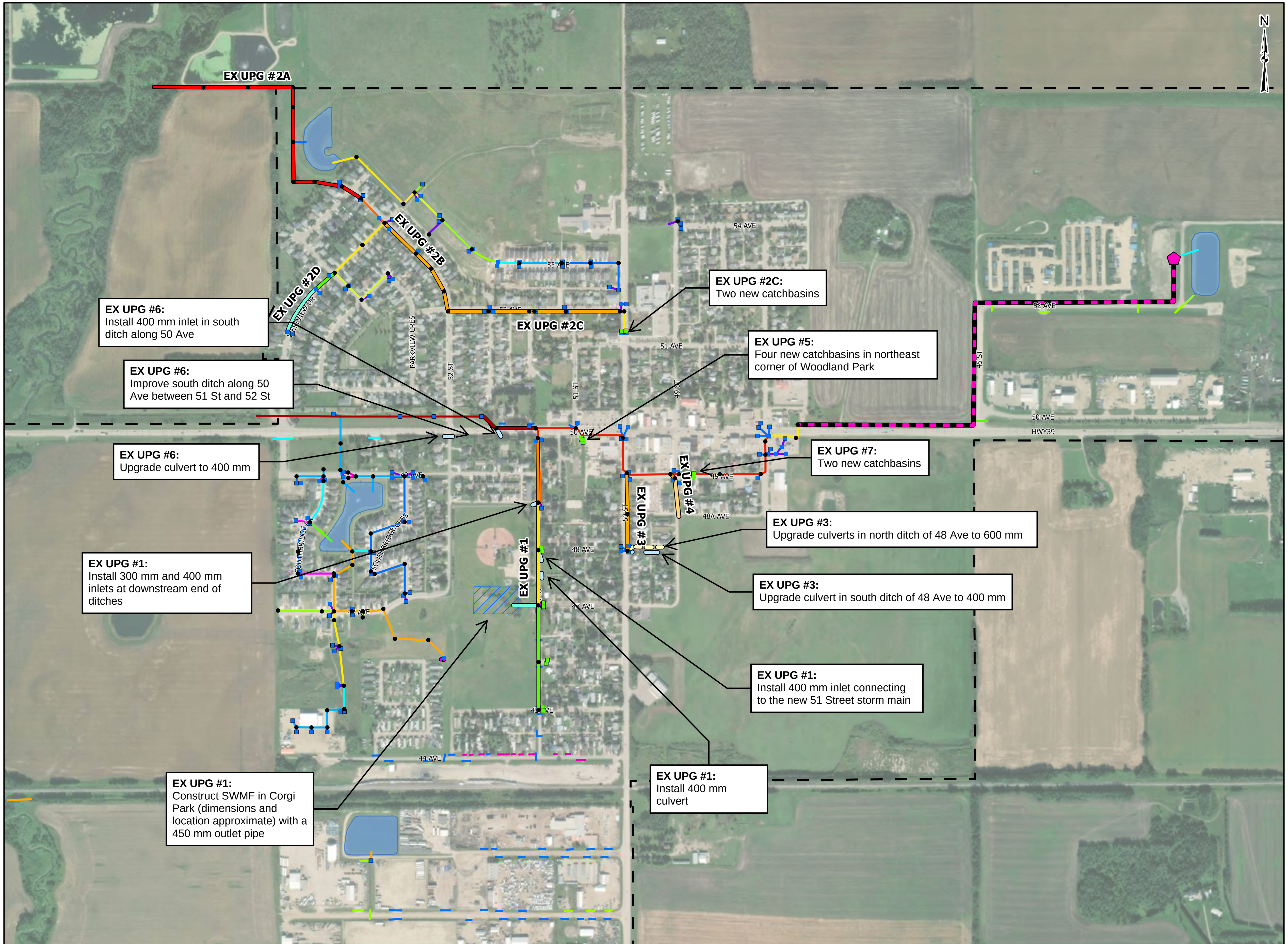

LEGEND

- New Catchbasin
- Existing Catchbasin
- Existing Manhole
- Lift Station
- Existing SWMF
- Proposed SWMF
- Town Boundary

Pipe Upgrade Diameter

- 450 mm
- 525 mm
- 900 mm
- 1350 mm

Existing Pipe Diameter

- 150 mm
- 200 mm
- 250 mm
- 300 mm
- 375 mm
- 450 mm
- 500 mm
- 525 mm
- 600 mm
- 675 mm
- 750 mm
- 900 mm
- 1050 mm
- 1200 mm
- 1350 mm
- 2400 mm

Culvert Upgrade Diameter

- 300 mm
- 400 mm
- 500 mm
- 600 mm
- 900 mm

TITLE

EXISTING SYSTEM PROPOSED UPGRADES

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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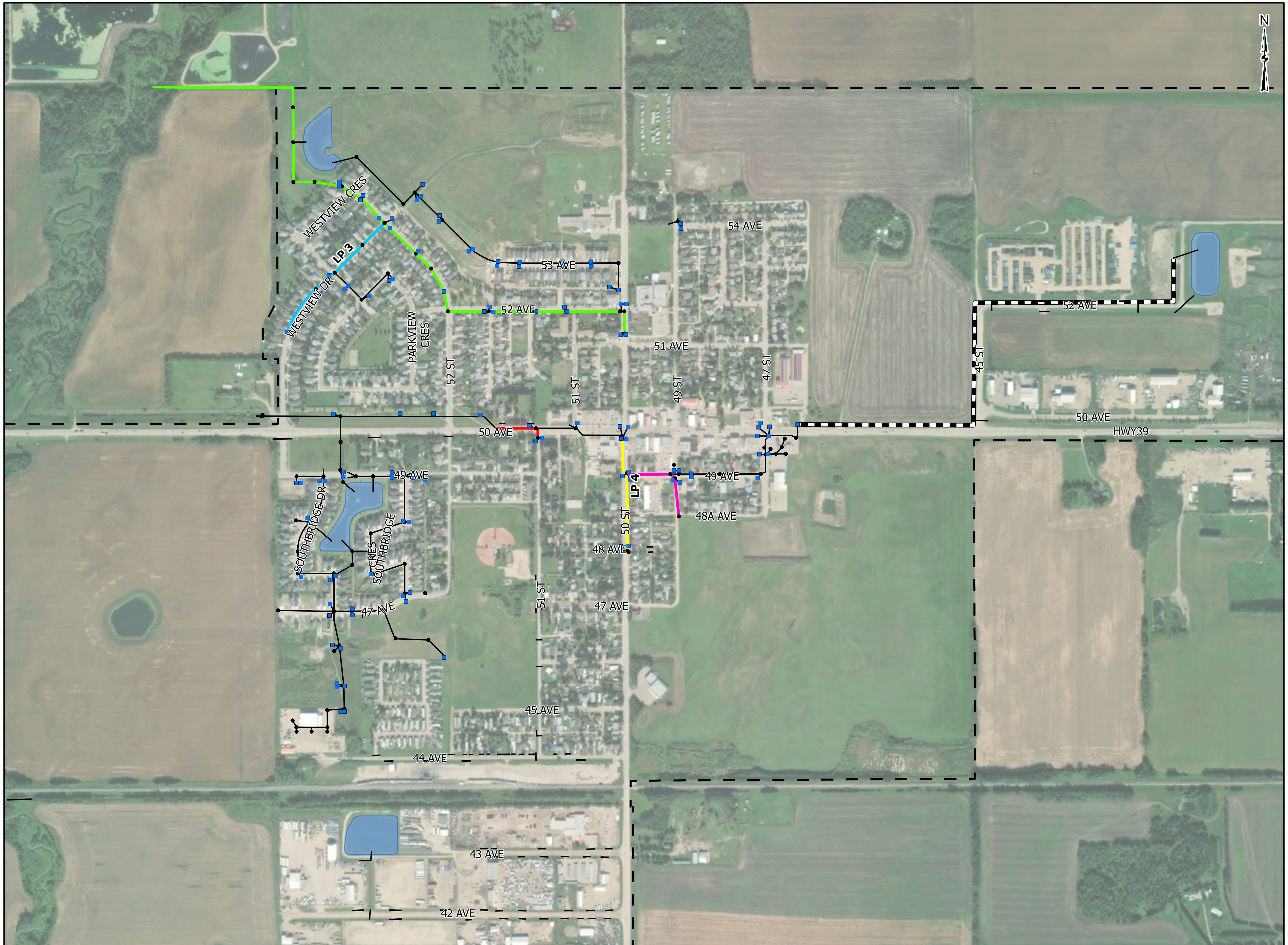
FIGURE	6.5
DATE	9/15/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester



LEGEND

- Manhole
- Catch Basin Manhole
- Lift Station
- Gravity Main
- Forcemain
- LP 1 (EX UPG #1)
- LP 2 (EX UPG #2)
- LP 3 (EX UPG #2)
- LP 4 (EX UPG #3)
- LP 5 (EX UPG #4)
- SWMF
- Town Boundary

TITLE

LONGITUDINAL PROFILE KEY MAP

See Appendix A for profiles

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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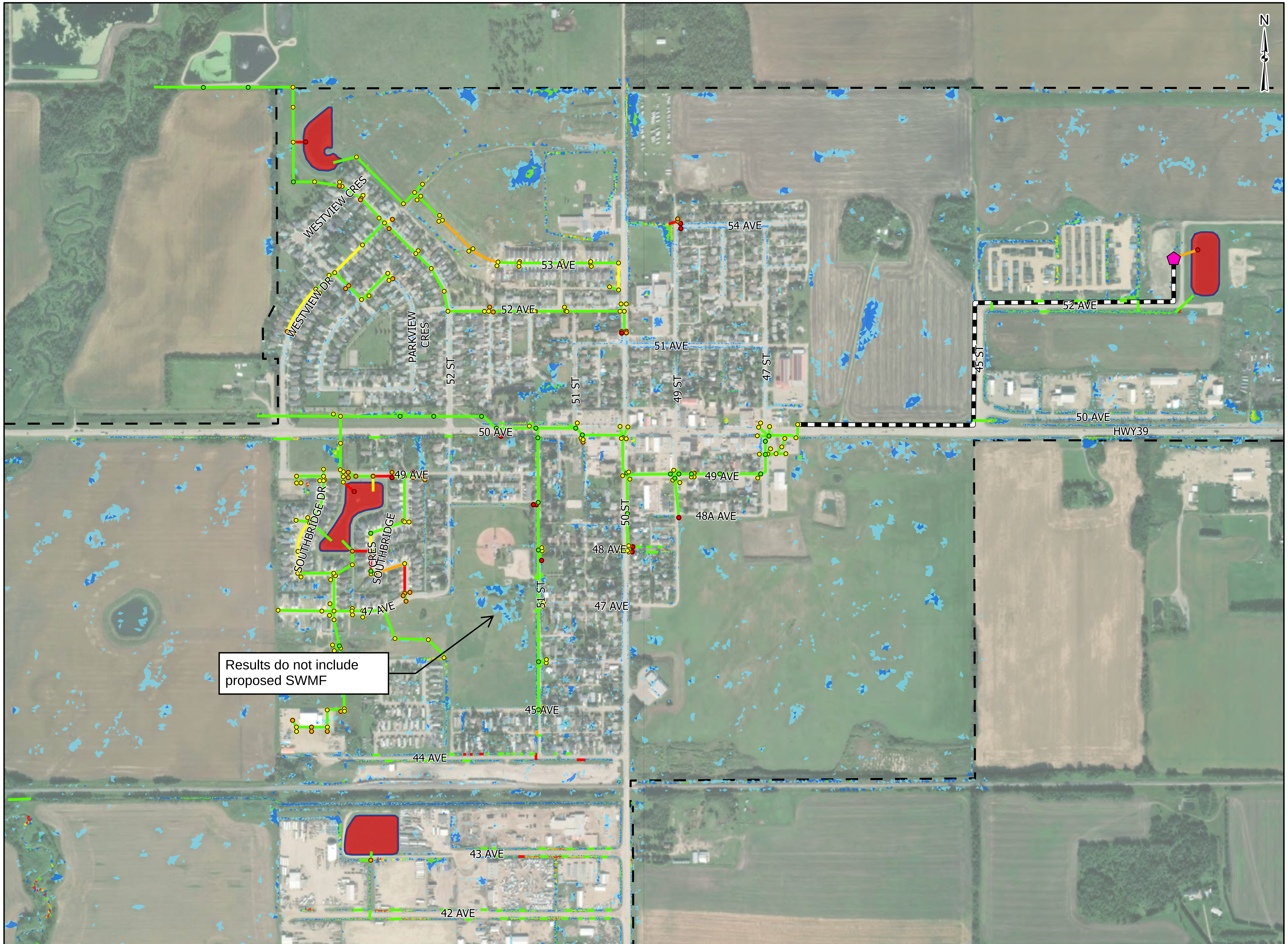
FIGURE	6.6
DATE	8/14/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 6.6_Longitudinal Profile Overview



LEGEND

- Lift Station
- Forcemain
- SWMF
- Town Boundary

Maximum HGL Elevation Relative to Ground

- Less than -3.0 m
- -3.0 m to -1.5 m
- -1.5 m to 0.0 m
- Greater than 0.0 m

Peak Discharge Relative to Pipe Capacity

- Less than 86%
- Between 86% and 100%
- Between 100% and 120%
- Greater than 120%

Maximum Depth (m)

- Less than 0.1m
- 0.1 m to 0.2 m
- 0.2 m to 0.3 m
- 0.3 m to 0.4 m
- 0.4 m to 0.5 m
- Greater than 0.5 m

TITLE

EXISTING SYSTEM WITH UPGRADES 5-YR 4-HR CHICAGO (MODIFIED)

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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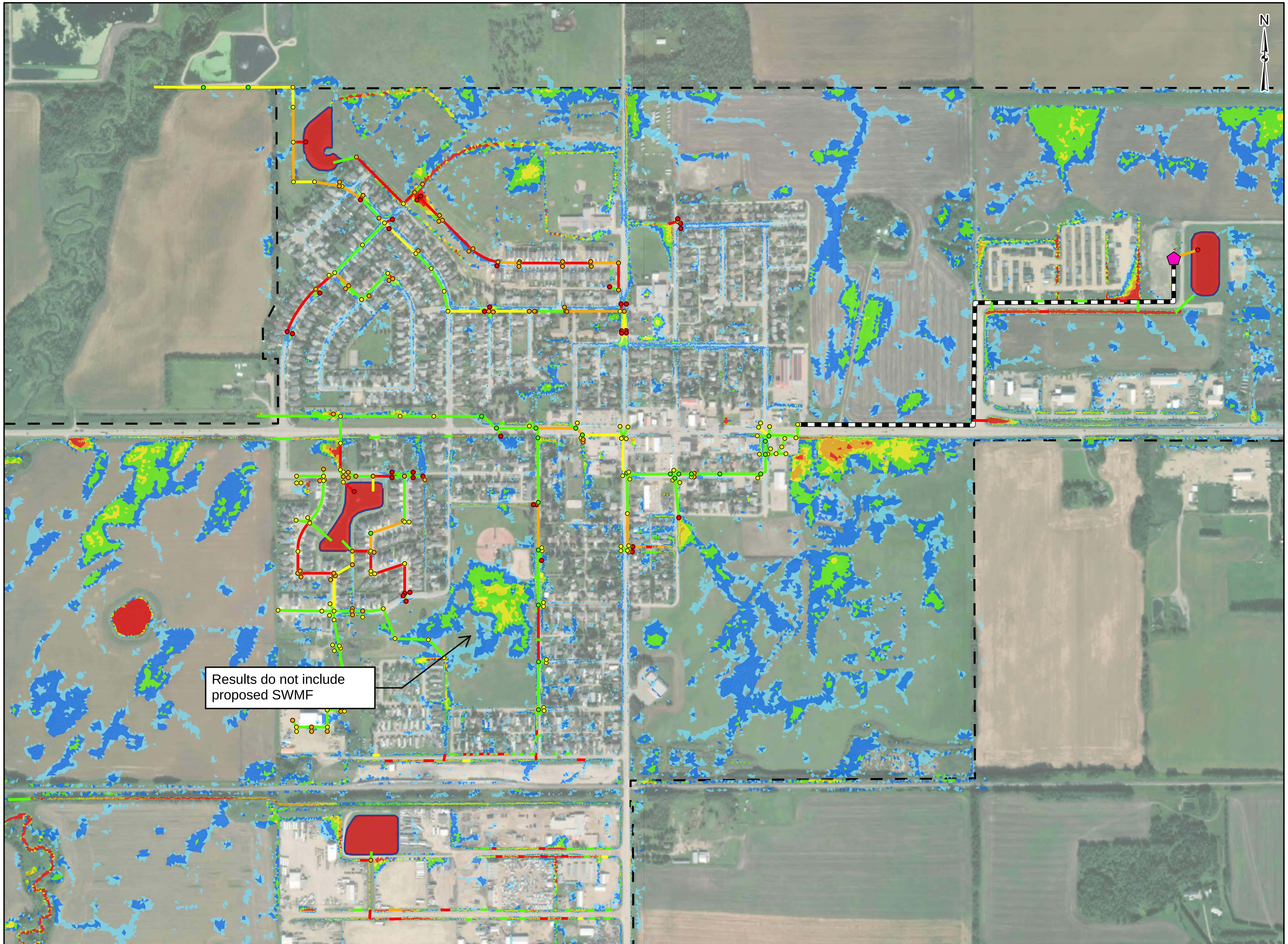
FIGURE	6.7
DATE	9/17/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 6.7_Existing_UPG_5yr4Hr



LEGEND

- Lift Station
- Forcemain
- SWMF
- Town Boundary

Maximum HGL Elevation Relative to Ground

- Less than -3.0 m
- -3.0 m to -1.5 m
- -1.5 m to 0.0 m
- Greater than 0.0 m

Peak Discharge Relative to Pipe Capacity

- Less than 86%
- Between 86% and 100%
- Between 100% and 120%
- Greater than 120%

Maximum Depth (m)

- Less than 0.1 m
- 0.1 m to 0.2 m
- 0.2 m to 0.3 m
- 0.3 m to 0.4 m
- 0.4 m to 0.5 m
- Greater than 0.5 m

TITLE

EXISTING SYSTEM WITH UPGRADES
100-YR 4-HR CHICAGO (MODIFIED)

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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1:9,000 KM

FIGURE	6.8
DATE	9/17/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

ISL

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 6.8_Existing_UPG_100yr4Hr

7.0 Future System Concept and Assessment

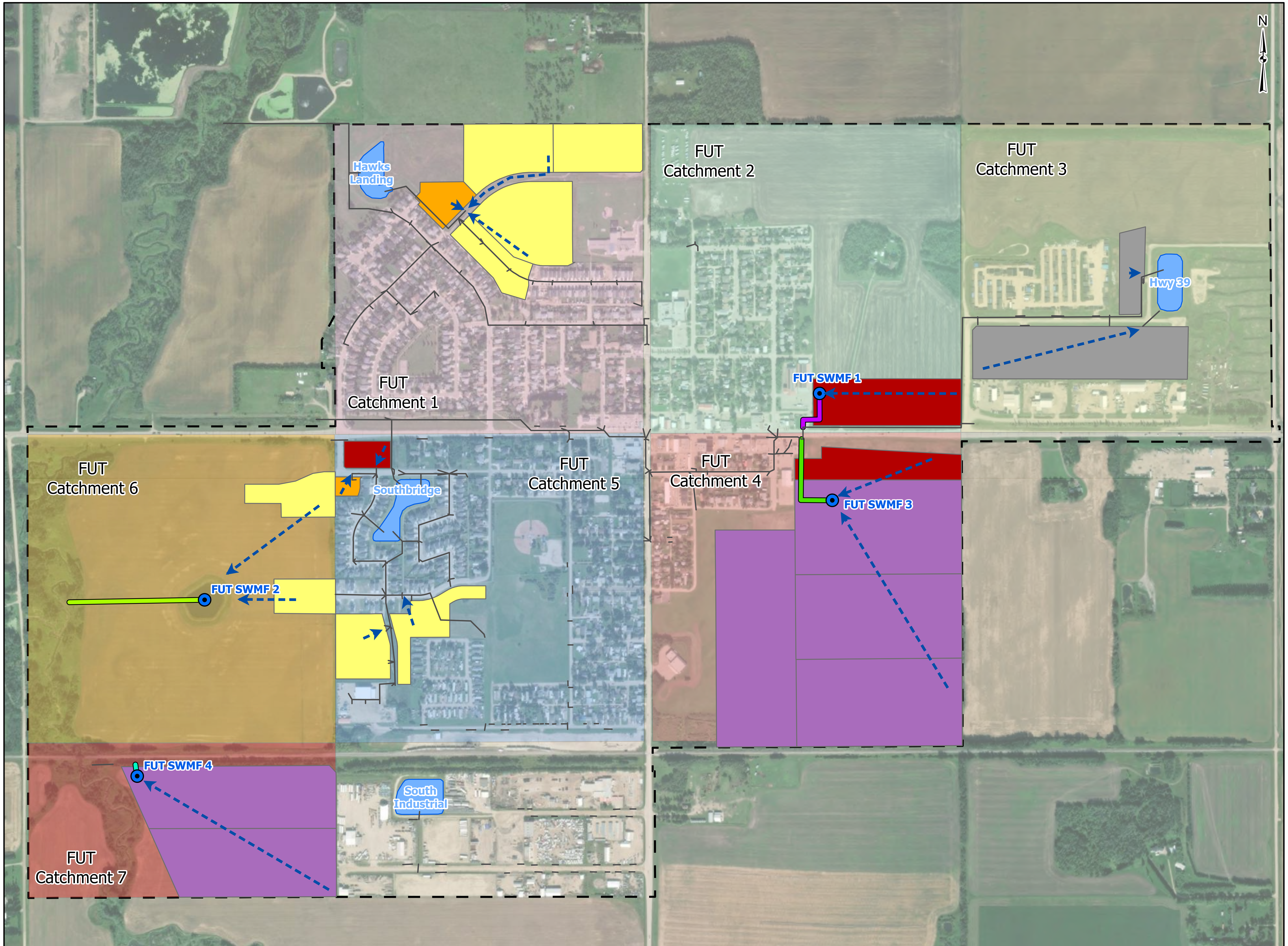
The future growth plan is summarized in Section 2.3 and **Figure 2.4**.

7.1 Future System Concept

To facilitate future developments, major and minor stormwater drainage systems are required to collect and control runoff in these areas. Runoff due to development 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 Alberta Environment and Protected Areas (AEPA) regulations, it is specified that post-development flows released should not exceed pre-development flows.

Future drainage catchments were delineated on a quarter section basis, as shown in **Figure 7.1**. There are four new stormwater management facilities proposed to serve these areas. There 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.

The following section will assess each future catchment in detail.



LEGEND

- Proposed SWMF
- Existing Minor System
- Drainage Direction
- Existing SWMF
- Town Boundary

Proposed Pipe Diameter

- 250 mm
- 450 mm
- 600 mm
- 675 mm

Future Catchments

- FUT Catchment 1
- FUT Catchment 2
- FUT Catchment 3
- FUT Catchment 4
- FUT Catchment 5
- FUT Catchment 6
- FUT Catchment 7

Anticipated Land Use

- Future Commercial
- Future Industrial
- Future Low Density Residential
- Future Medium Density Residential

Anticipated Land Use (Post 20-Year Horizon)

- Future Industrial

TITLE
FUTURE DRAINAGE CONCEPT
MUNICIPAL DEVELOPMENT PLAN

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

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1:10,000 KM

FIGURE	7.1
DATE	9/24/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 7.1_Future Drainage Catchments

7.2 Future System Concept Development and Assessment

7.2.1 Future Catchment 1

This area includes three subcatchments, all of which are part of the Hawk's Landing ASP, as illustrated in **Figure 7.2**. It comprises 12.6 ha of single-family residential development and 1.2 ha of multi-family residential development.

The existing Hawk's Landing Pond was originally sized to accommodate the Phase 1 development only. A spreadsheet analysis was completed to estimate the additional storage requirements for future phases. Based on these calculations, the current pond does not have sufficient capacity and will need to be resized. Refer to **Table 7.1** below for a summary of the findings and **Appendix D** for more details. It should be noted that the modelled runoff volumes are based on Horton infiltration parameters, which yield conservative estimates of surface runoff.

According to the Phase 1 Hawk's Landing as-built drawings, runoff from the future phases will be directed to the sewer on Westview Drive. A spreadsheet-based assessment was carried out to verify whether this existing sewer has adequate capacity to accommodate the future flows. The analysis indicates that the existing sewer capacity is sufficient under the 1:5-yr 4-Hr design storm event. See **Table 7.2** below for the supporting data and **Appendix D** for more details.

Table 7.1: Hawk's Landing Pond Storage Analysis

Subcatchment ID	Catchment Area	Existing Live Storage Within Pond	Existing Runoff Volume under 1:100 Yr 24 Hr Huff	Additional Runoff Volume Post-Development	Additional Storage Needed
	ha	m^3	m^3	m^3	m^3
Subcatchment 1-1	1.2	6,047	14,180	4,100	12,233
Subcatchment 1-2	6.3				
Subcatchment 1-3	6.4				

Table 7.2: Minor System Capacity Assessment – Future Catchment 1

Pipe ID	Existing Sewer Capacity	Peak Flow under Developed Conditions	Capacity Assessment
	m^3/s	m^3/s	
StmMH_0164.1	0.174	0.063	Adequate
StmMH_0165.1	0.451	0.272	Adequate
StmMH_0168.1	0.314	0.268	Adequate
StmMH_0169.1	0.849	0.260	Adequate

7.2.2 Future Catchment 2

This area includes a single 4.7 ha commercial subcatchment, as shown in **Figure 7.3**. It lies within the boundary of the 1994 Enberg Area Structure Plan (ASP), which is no longer in effect. The original ASP proposed two stormwater detention ponds: one in the southwest corner to serve the commercial zone, and a larger pond in the northwest corner to serve the entire ASP area.

As there are currently no plans to develop the broader area, the assessment focused solely on the commercial zone. A new SWMF is proposed at the same location identified in the 1994 ASP. Details on the sizing of the pond, orifice, and outlet pipe are provided in **Appendix D**. The pond is designed to discharge into the 50 Avenue trunk sewer. A capacity assessment of this sewer to accommodate future flows is presented in Section 7.3.

7.2.3 Future Catchment 3

This area contains two industrial subcatchments that are anticipated to develop beyond the 20-year horizon; therefore, no future servicing concept has been prepared at this stage. If development occurs sooner than expected, the master plan will be updated to incorporate the required infrastructure.

7.2.4 Future Catchment 4

This area includes two subcatchments, both of which are part of the Thomas Creek ASP, as illustrated in **Figure 7.4**. It comprises 3.4 ha of single-family residential development. Eventually, a total area of 51.4 ha will be developed in this catchment based on the ASP.

For the purpose of this assessment, a new SWMF was sized to accommodate full build-out conditions. Storage requirements for the interim development of 3.4 ha are provided for reference in **Appendix D**. The pond will discharge directly into Conjuring Creek.

Details on the sizing of the pond, orifice, and outlet pipe are provided in **Appendix D**.

Based on aerial imagery, there appears to be an existing pond at the location of the proposed SWMF. This feature has the potential to be crown-claimed as public land. Constructing a SWMF at this site would require regulatory approvals, including a Water Act approval and an Environmental Protection and Enhancement Act (EPEA) registration.

7.2.5 Future Catchment 5

This area includes four subcatchments, all of which are part of the Southbridge ASP, as illustrated in **Figure 7.5**. It comprises 4.4 ha of single-family residential development, 0.3 ha of multi-family residential development, and 0.9 ha of commercial development. The existing Southbridge Pond was sized to accommodate the entire ASP area, so it should have sufficient capacity. A spreadsheet analysis was completed to verify this. Based on these calculations, the current pond has sufficient capacity. Refer to **Table 7.3** below for a summary of the findings and **Appendix D** for more details. It should be noted that the modelled runoff volumes are based on Horton infiltration parameters, which yield conservative estimates of surface runoff.

The flows from the future developments will pass through the Southbridge minor system before entering the Southbridge Pond. A spreadsheet-based assessment was carried out to verify whether these existing sewers have adequate capacity to accommodate the future flows. The analysis indicates that the existing sewer capacity is sufficient under the 1:5-yr 4-Hr design storm event. See **Table 7.4** below for the supporting data and **Appendix D** for more details.

Table 7.3: Southbridge Pond Storage Analysis

Subcatchment ID	Catchment Area (ha)	Existing Live Storage Within Pond (m^3)	Existing Runoff Volume under 1:100 Yr 24 Hr Huff (m^3)	Additional Runoff Volume Post-Development (m^3)	Additional Storage Needed (m^3)
Subcatchment 5-1	0.89	24,763	16,981	2,100	0
Subcatchment 5-2	0.32				
Subcatchment 5-3	2.3				
Subcatchment 5-4	2.1				

Table 7.4: Minor System Capacity Assessment – Future Catchment 5

Pipe ID	Existing Sewer Capacity (m^3/s)	Peak Flow under Developed Conditions (m^3/s)	Capacity Assessment
StmMH_0102.1	0.106	0.008	Adequate
StmMH_0099.1	0.158	0.049	Adequate
StmMH_0086.1	0.394	0.133	Adequate
StmMH_0021.1	0.431	0.029	Adequate
StmMH_0026.1	0.300	0.026	Adequate
StmMH_0023.1	0.502	0.108	Adequate
StmMH_0079.1	0.545	0.148	Adequate
StmMH_0091.1	0.545	0.148	Adequate
StmMH_0090.1	2.665	0.328	Adequate

7.2.6 Future Catchment 6

This area consists of two subcatchments, as illustrated in **Figure 7.6**, and includes approximately 3.2 ha of commercial development and 41.8 ha of industrial development. There is currently no active ASP governing this area. The site topography generally slopes toward the northwest, where a SWMF is proposed. Details regarding the sizing of the pond, orifice, and outlet pipe are provided in **Appendix D**. The pond is designed to discharge into the 50 Avenue trunk sewer, and a capacity assessment of this sewer to confirm its ability to accommodate future flows is presented in Section 7.3.

Based on discussions with the Town, stormwater re-use is expected to be implemented on this site in the future. In the absence of detailed design information, the allowable release rate has been assumed for calculation purposes. However, the actual release rate could be lower depending on the extent of re-use ultimately achieved.

7.2.7 Future Catchment 7

This area consists of a single subcatchment, as illustrated in **Figure 7.7**, and includes approximately 16.5 ha of industrial development. There is currently no active ASP governing this area. The site topography generally slopes toward Conjuring Creek to the west, where a SWMF is proposed. Details regarding the sizing of the pond, orifice, and outlet pipe are provided in **Appendix D**. The pond is designed to discharge into the ditch to the north.

LEGEND

- Existing Manhole
- Existing Catchbasin
- Minor Contour - 1m
- Drainage Direction
- SWMF
- Town Boundary

Existing Gravity Main Diameter

- 250 mm
- 300 mm
- 375 mm
- 450 mm
- 600 mm
- 675 mm
- 750 mm
- 1050 mm

Anticipated Land Use

- Future Low Density Residential
- Future Medium Density Residential

TITLE

FUTURE DRAINAGE CONCEPT CATCHMENT 1

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES

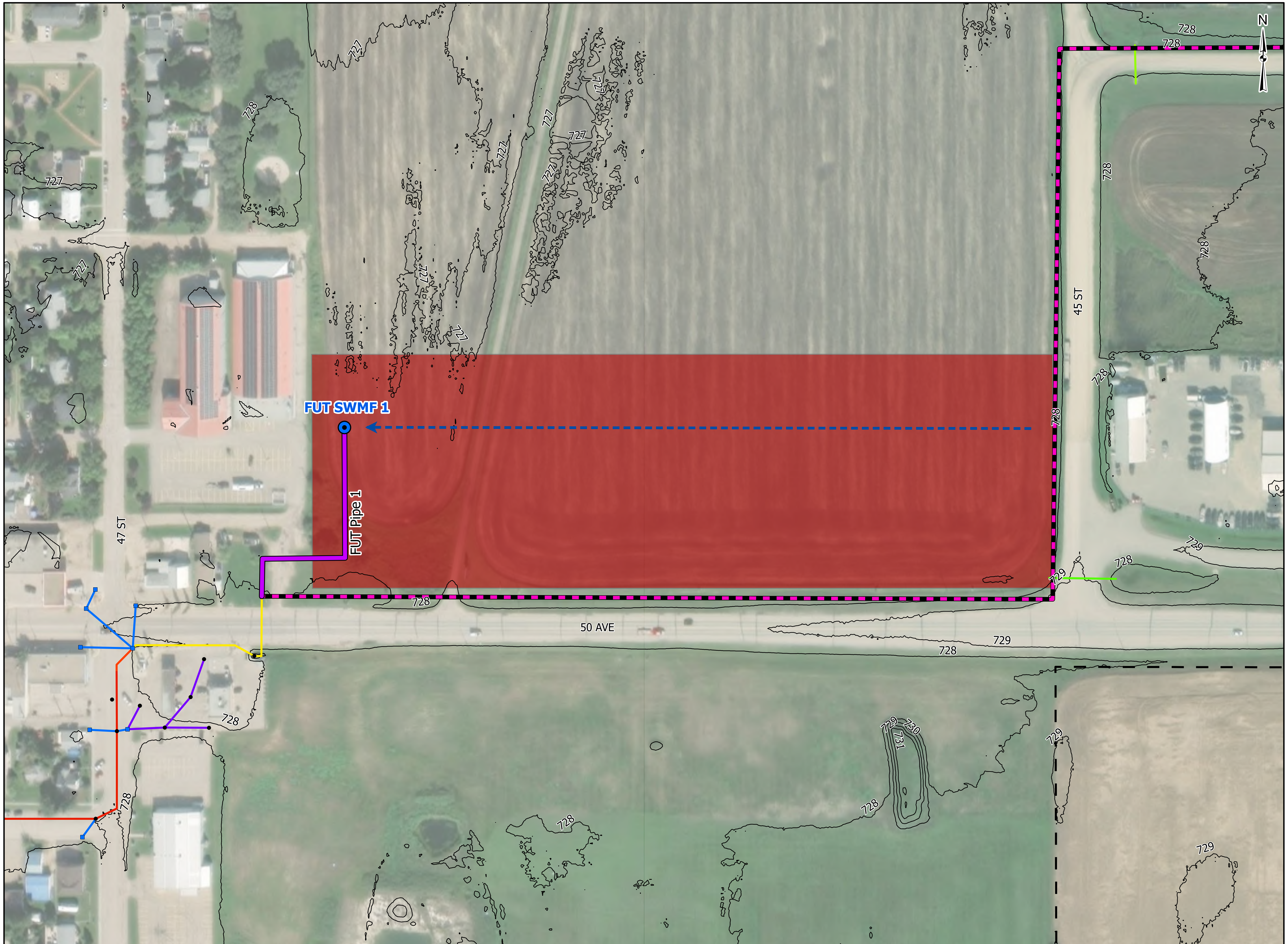
- Topographic Map:Maxar

PROJECTION

NAD 1983 CSRS 3TM 114

0 0.03 0.06
1:2,500 KM

FIGURE	7.2
DATE	7/11/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester



LEGEND

- Existing Manhole
- Existing Catchbasin
- Proposed SWMF
- Minor Contour - 1m
- Drainage Direction
- Town Boundary

Existing Forcemain Diameter

- 200 mm

Existing Gravity Main Diameter

- 200 mm
- 250 mm
- 300 mm
- 525 mm
- 600 mm
- 750 mm
- 1200 mm
- 1350 mm

Anticipated Land Use

- Future Commercial

TITLE

FUTURE DRAINAGE CONCEPT CATCHMENT 2

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

0 0.03 0.05
1:2,000 KM

FIGURE	7.3
DATE	7/11/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 7.3 Future Catchment 2

LEGEND

- Existing Manhole
- Existing Catchbasin
- Proposed SWMF
- Minor Contour - 1m
- Drainage Direction
- Existing SWMF
- Town Boundary

Proposed Pipe Diameter

- 675 mm

Existing Gravity Main Diameter

- 150 mm
- 200 mm
- 250 mm
- 300 mm
- 375 mm
- 450 mm
- 525 mm
- 600 mm
- 750 mm
- 900 mm
- 2400 mm

Anticipated Land Use

- Future Low Density Residential
- Ultimate Build-Out Area

TITLE

FUTURE DRAINAGE CONCEPT CATCHMENT 4

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES

- Topographic Map:Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

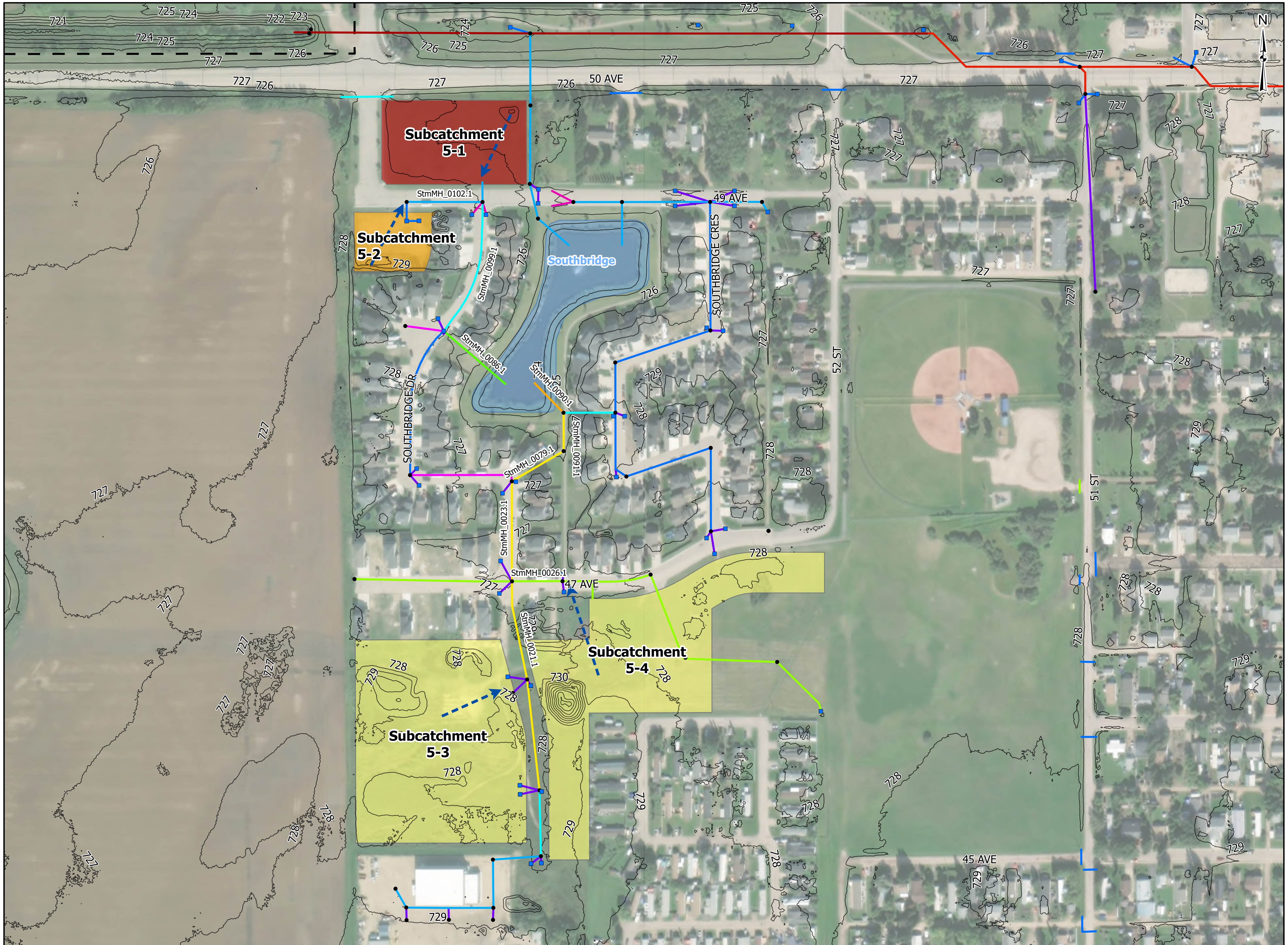
PROJECTION

NAD 1983 CSRS 3TM 114

0 0.05 0.1 KM

1:4,200

FIGURE	7.4
DATE	7/11/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester



LEGEND

- Existing Manhole
- Existing Catchbasin
- Minor Contour - 1m
- Drainage Direction
- Existing SWMF
- Town Boundary

Existing Gravity Main Diameter

- 150 mm
- 200 mm
- 250 mm
- 300 mm
- 375 mm
- 450 mm
- 525 mm
- 600 mm
- 750 mm
- 900 mm
- 1350 mm
- 2400 mm

Anticipated Land Use

- Future Commercial
- Future Low Density Residential
- Future Medium Density Residential

TITLE
FUTURE DRAINAGE CONCEPT CATCHMENT 5

PROJECT
STORMWATER MASTER PLAN UPDATE

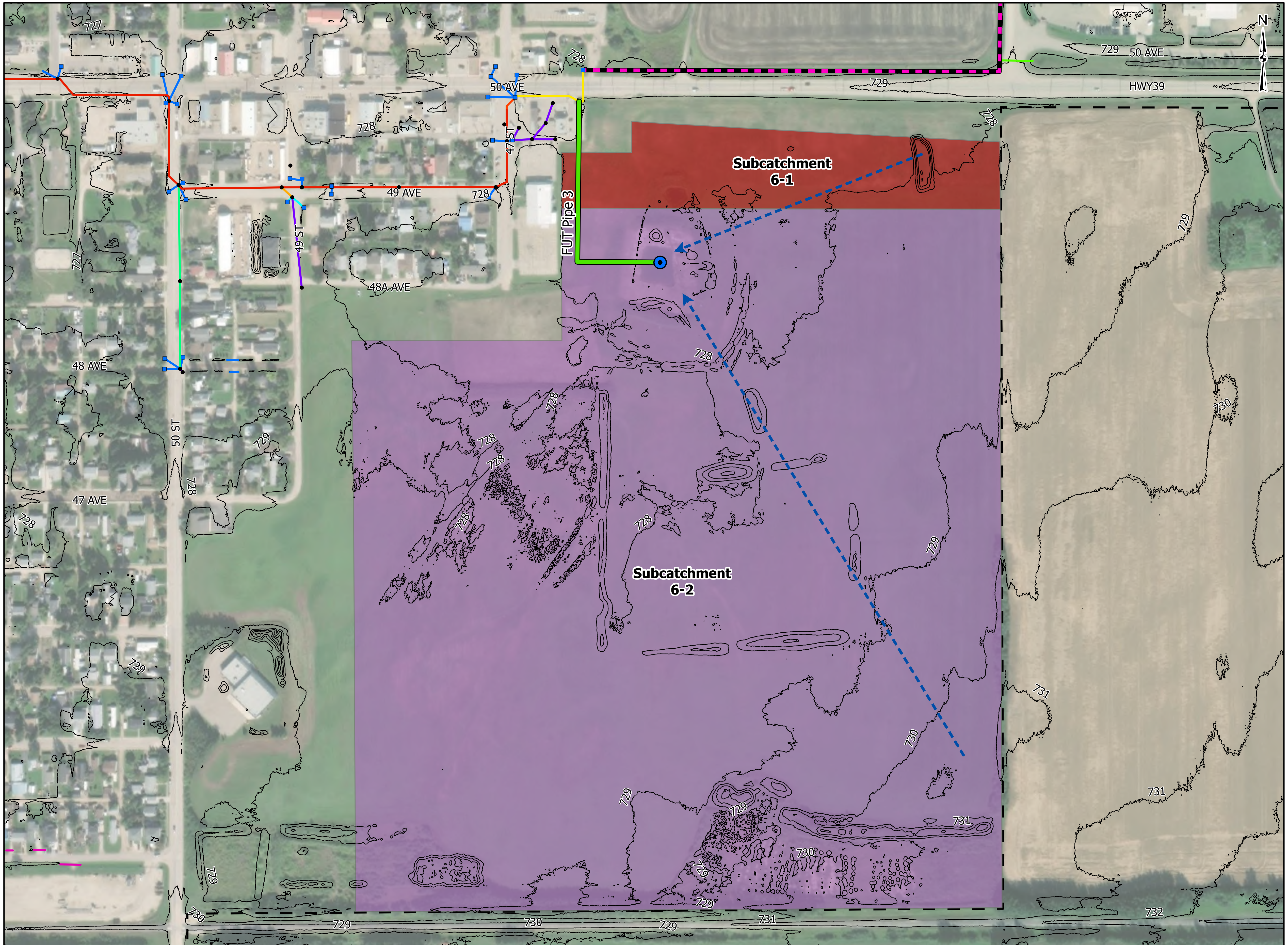
CLIENT
TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

PROJECTION
NAD 1983 CSRS 3TM 114

0 0.04 0.08
1:3,200 KM

FIGURE	7.5
DATE	7/11/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester



LEGEND

- Existing Manhole
- Existing Catchbasin
- Proposed SWMF
- Minor Contour - 1m
- Drainage Direction
- Town Boundary

Proposed Pipe Diameter

- 600 mm

Forcemain Diameter

- 200 mm

Existing Gravity Main Diameter

- 150 mm
- 200 mm
- 250 mm
- 300 mm
- 450 mm
- 500 mm
- 525 mm
- 750 mm
- 900 mm
- 1200 mm
- 1350 mm

Anticipated Land Use

- Future Commercial
- Future Industrial

TITLE

FUTURE DRAINAGE CONCEPT CATCHMENT 6

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES

- Topographic Map:Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

PROJECTION

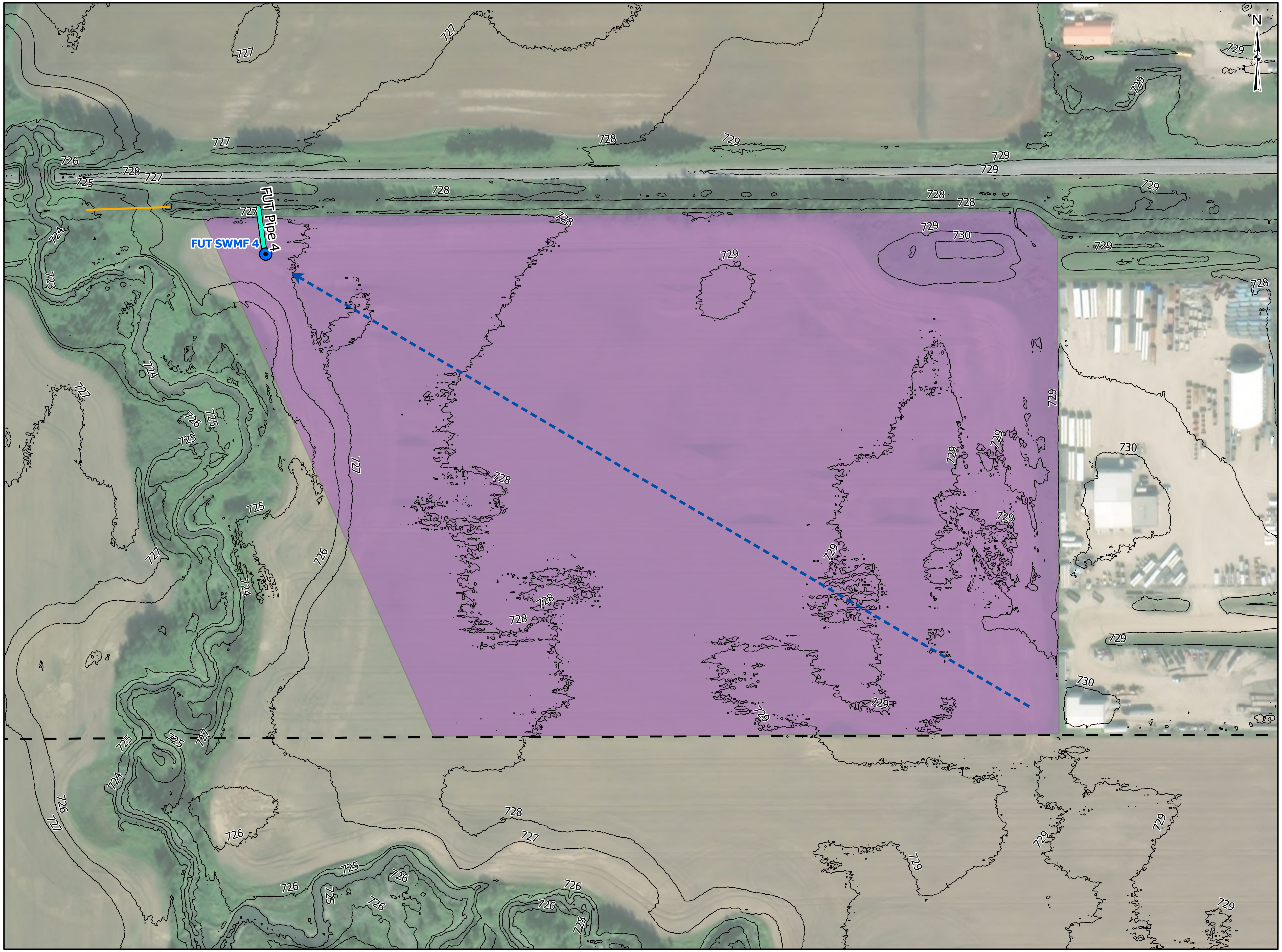
NAD 1983 CSRS 3TM 114

0 0.05 0.1 KM

1:3,800

FIGURE	7.6
DATE	7/11/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 7.7_Future Catchment 6



LEGEND

- Proposed SWMF
- Minor Contour - 1m
- Drainage Direction
- Town Boundary

Proposed Pipe Diameter

- 450 mm

Existing Culvert Diameter

- 900 mm

Anticipated Land Use

- Future Commercial
- Future Industrial
- Future Low Density Residential
- Future Medium Density Residential

TITLE

FUTURE DRAINAGE CONCEPT CATCHMENT 7

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Maxar

PROJECTION
NAD 1983 CSRS 3TM 114

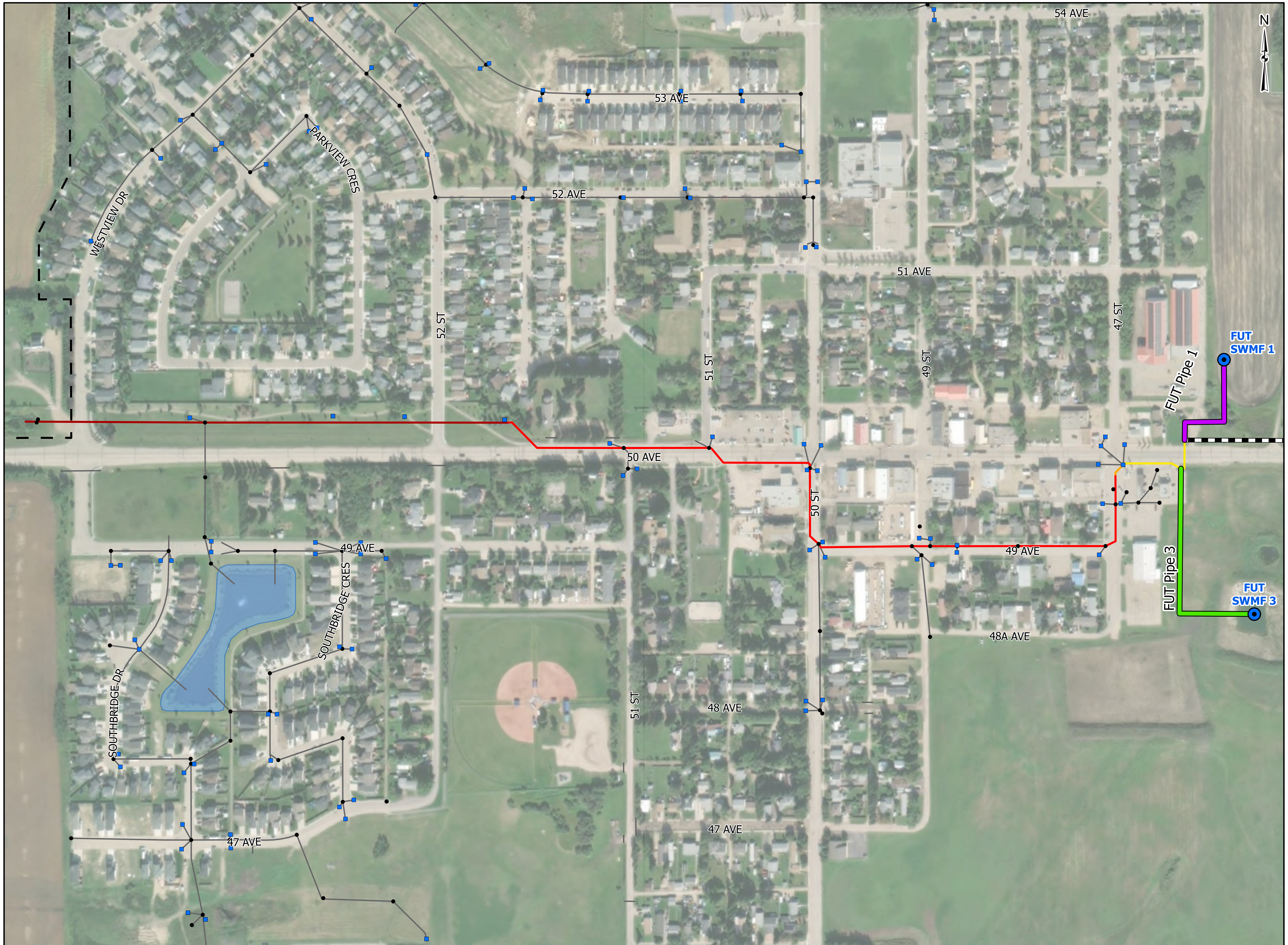
0 0.03 0.06
1:2,500 KM

FIGURE	7.7
DATE	7/11/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 7.8 Future Catchment 7

7.3 50 Avenue Trunk Future Capacity Assessment

Based on the future system concept proposed above, two of the proposed SWMFs will discharge into the 50 Avenue trunk sewer. The capacity of the existing trunk sewer was assessed under the 1:5-year 4-hour Chicago (Modified) design storm with the peak flows from the proposed ponds outlets. No capacity issues were identified. The existing pipe diameters of this trunk are illustrated in **Figure 7.8** and the results of the capacity assessment are shown in **Figure 7.9**.



LEGEND

- Manhole
- Catchbasin
- Proposed SWMF
- SWMF
- Town Boundary
- Gravity Main
- Forcemain

Proposed Pipe Diameter

- 250 mm
- 600 mm

50 Ave Trunk Diameter

- 750
- 1200
- 1350
- 2400

TITLE

50 AVE TRUNK FUTURE CAPACITY ASSESSMENT PIPE DIAMETER

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES

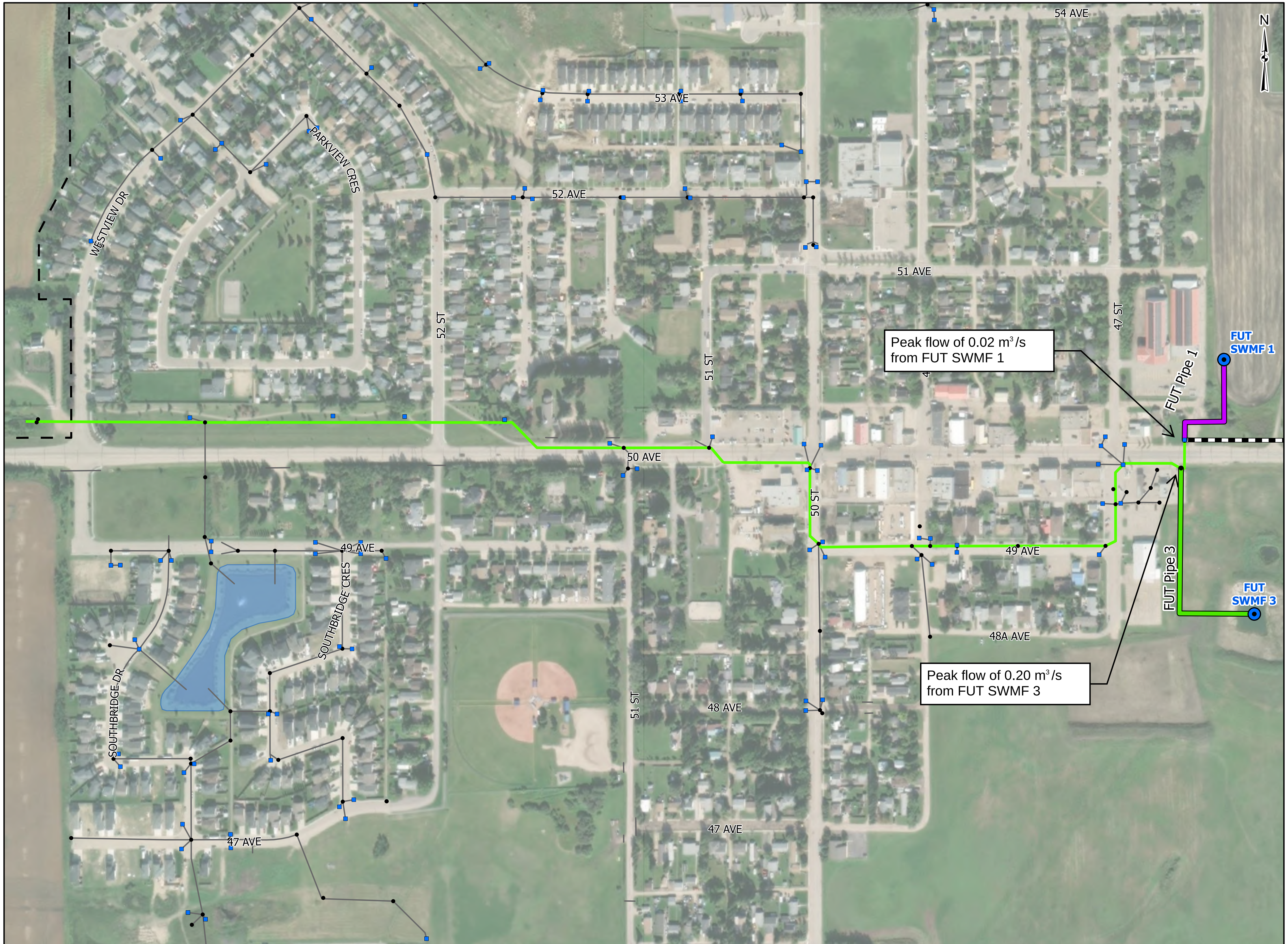
- Topographic Map:Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

PROJECTION

NAD 1983 CSRS 3TM 114

0 0.05 0.1
1:4,200 KM

FIGURE	7.8
DATE	7/8/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester



LEGEND

- Proposed SWMF
- Manhole
- Catch Basin Manhole
- Gravity Main
- Forcemain
- SWMF
- Town Boundary

Proposed Pipe Diameter

- 250 mm
- 600 mm

Peak Discharge Relative to Pipe Capacity

- Less than 86%
- Between 86% and 100%
- Between 100% and 120%
- Greater than 120%

TITLE

50 AVE TRUNK FUTURE CAPACITY ASSESSMENT
5-YR 4-HR CHICAGO (MODIFIED)
PLUS FUTURE FLOWS

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

DATA SOURCES
- Topographic Map:Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

PROJECTION
NAD 1983 CSRS 3TM 114

0 0.05 0.1
1:4,200 KM

FIGURE	7.9
DATE	8/14/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

ISL

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure 7.10_50 Ave Trunk Future Assessment

7.4 Recommendations

Apart from the recommended existing system upgrades specified in Section 6.3, upgrades to the stormwater system 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 Green Infrastructure

To reduce the overall runoff produced by developments, and to improve water quality within the local and regional watershed, Green Infrastructure (formerly known as low impact development or LID) may be integrated into the stormwater design. Green Infrastructure 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 Green Infrastructure into 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 SWMF size. Additionally, Green Infrastructure implementation can provide reductions in the total loadings to the receiving water course. As such, Green Infrastructure would support the development in adhering to the recommendation to reduce total suspended solids (TSS), carbonaceous biochemical oxygen demand (CBOD), nitrogen, and phosphorus, and thus promote the overall health of the Conjuring Creek basin.

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 Town 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 7.5**.

Table 7.5: 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. Local geology may limit the effectiveness of this option if a low-permeable soil underlays the added topsoil. 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
Bioretention Areas	Bioretention areas consist 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

Water quality improvements begin with filtration of particulates as runoff flows over the surface of the Green Infrastructure 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 2-year, or 5-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 Green Infrastructure installations where performance of the Green Infrastructure 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 7.11**, the monitored performance of the Green Infrastructure systems reduces peak flows up to 60 – 80%.

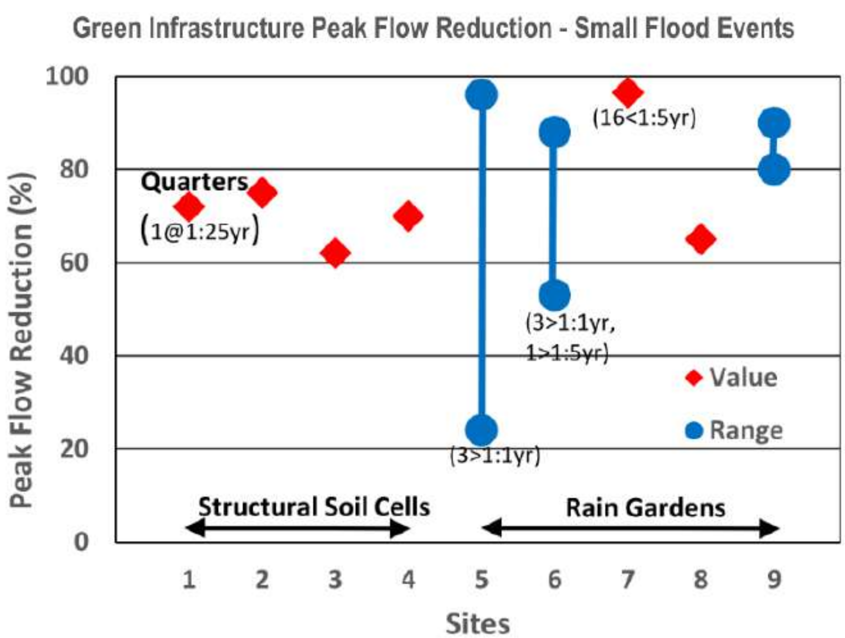


Figure 7.11: Monitored Peak Flow Reductions

Table 7.6 outlines the Green Infrastructure peak flow reduction expectation and performance for various flood events. It is observed that the monitored performance of Green Infrastructure installations generally meet the theoretical peak flow reductions.

Table 7.6: Green Infrastructure Peak Flow Reduction Expectations

Event Size	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 (2-year, 5-year)	Moderate (>80% reduction)	60 – 90% (majority)
Large flood event (25-year, 100-year)	Minimal (<50% reduction)	N/A

More recently, EPCOR hosted the EPCOR Design Standards Modernization Workshop for municipalities and select consultants in the Edmonton region in 2023. The purpose of this workshop was to get feedback regarding planned changes to short-term and long-term design standard revisions. EPCOR's long-term objective is to promote the installation of "Green Hectares" which is defined as a volume of runoff managed by Green Infrastructure spread evenly over an area of 15 mm of depth. In other words, approximately 150 m^3 of Green Infrastructure storage will equate to one Green Hectare based on a common rainfall event of approximately 15 mm (which is less than a 2-year, 4-hour Chicago design storm).

7.6 Erosion and Sediment Control

The Calmar Design and Construction Standards require an Erosion and Sedimentation Control (E&SC) Plan during both construction and all maintenance periods. These guidelines are intended to limit soil disturbance, provide construction details for managing E&SC measures, locations of erosion and sediment control measures being implemented, etc. All phases of development require a detailed E&SC plan detailing the downstream erosion impacts caused by the proposed stormwater discharge and detail how these impacts are being mitigated.

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, thus 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 E&SC practices are not implemented, it can lead to the transport of sediment and other contaminants thus 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
- Affects 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. Potential options to mitigate negative impacts of erosion are outlined below.

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
  - 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 and 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 7.7**, with the detailed cost breakdown provided in **Appendix E**. Separate reviews should be prepared to support each subdivision application/development permit to ensure compliance with the overarching SWMP.

Table 7.7: Class D Cost Estimates for Proposed Future System

Item	Cost[1,2]	Engineering (15%)	Contingency (30%)	Total[3]
	($)	($)	($)	($)
FUT SWMF 1	$310,000	$47,000	$94,000	$451,000
FUT SWMF 2	$1,137,000	$170,000	$342,000	$1,649,000
FUT SWMF 3	$820,000	$124,000	$246,000	$1,190,000
FUT SWMF 4	$305,000	$47,000	$92,000	$444,000
Total	**$2,572,000**	**$388,000**	**$774,000**	**$3,734,000**

[1] Costs include excavation, topsoil and sod, landscaping, outlet control structure, and installation of outlet pipe.
[2] Costs herein are comparable to other municipalities. Costs are representative of 2025 dollars.
[3] The total cost has been rounded up to the nearest $10,000.

7.7.2 Typical Source Control Implementation Costs

Typical construction unit costs for Green Infrastructure practices are tabulated in **Table 7.8** 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 7.8: 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

8.0 Conclusions and Recommendations

8.1 Conclusion

This updated Stormwater Master Plan for the Town of Calmar provides a comprehensive review of the existing stormwater infrastructure, evaluates system capacity under current and future conditions, and outlines a strategic approach to managing stormwater aligned with projected growth to 2045. The assessment identified several system constraints under both minor (1:5-year) and major (1:100-year) storm events, highlighting critical areas prone to surcharge and surface ponding. Through the development of an enhanced hydraulic model, detailed risk assessment, and engagement with Town priorities, the Plan offers a well-founded roadmap for sustaining service levels, minimizing flood risk, and protecting downstream watercourses.

8.2 Recommendations

- **Implement Priority Existing System Upgrades.** Proceed with the high-priority upgrades identified, notably at Corgi Park and 51 Street, and the 48A Avenue and 49 Street intersection, to alleviate historical flooding issues. Confirm system assumptions through targeted field investigations prior to construction to validate pipe sizes, inverts, and connections.
- **Phase Remaining Upgrades Based on Risk Scores.** Stage remaining upgrades according to the risk prioritization matrix developed. Monitor medium- and lower-priority sites to validate the timing and necessity of interventions.
- **Plan and Construct New SWMFs.** Incorporate the four proposed stormwater management facilities (SWMFs) into future subdivision and infrastructure planning, ensuring they are properly sized to control post-development flows to pre-development rates.
- **Adopt Green Infrastructure Practices.** Encourage developers to integrate source control measures (such as bioretention areas, bioswales, and rainwater harvesting) to improve water quality, reduce runoff volume, and potentially decrease SWMF sizing requirements.
- **Ensure Erosion and Sediment Control.** Enforce erosion and sediment control plans during construction phases to protect downstream waterbodies and maintain compliance with provincial guidelines.
- **Coordinate with Road and Utility Projects.** Where feasible, align stormwater upgrades with other capital projects (such as road rehabilitation) to optimize construction efforts and reduce costs.
- **Update the Stormwater Master Plan Periodically.** Review and update the SWMP after significant period of growth or every five years to update the hydrodynamic model and analysis with any capital upgrades completed by the Town, and the most up-to-date growth plans.
- **Maintain and Update GIS Records.** Continuously update the Town's GIS records to reflect field-verified data and any new infrastructure, ensuring the accuracy of the stormwater asset inventory for future modelling and planning.

9.0 References

Town of Calmar Design and Construction Standards, 2020.

Town of Calmar Land Use Bylaw, 2024.

Town of Calmar Municipal Development Plan, 2019.

Highway 39 Industrial Park ASP, ISL Engineering and Land Services Ltd., 2016.

Enberg Estates ASP, W.J. Francl Consulting Ltd., 1994.

Hawk’s Landing ASP, Challenger Engineering, 2005.

Southbridge ASP, Select Engineering Consultants Ltd., 2017.

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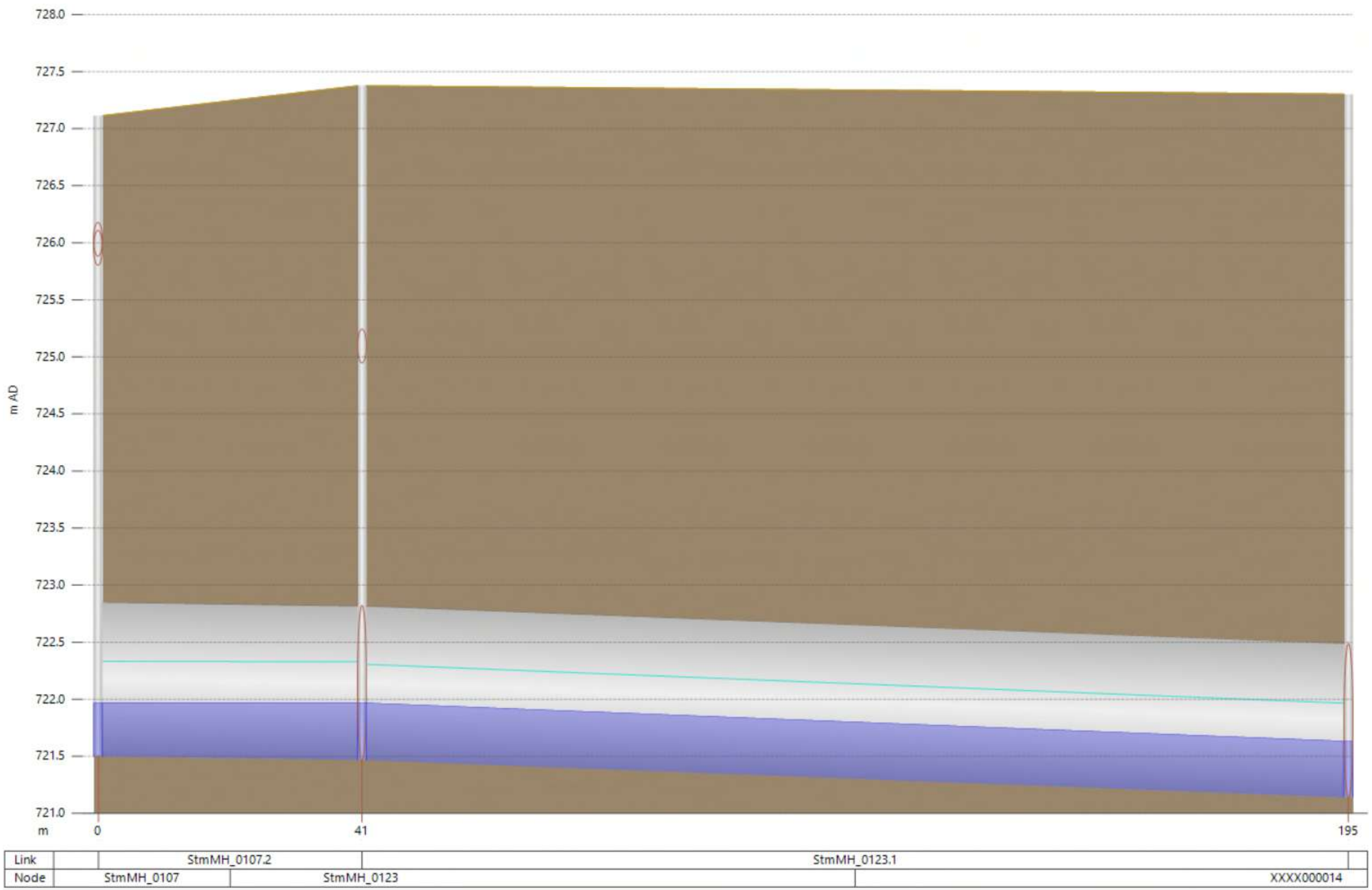
Calmar Stormwater Master Plan, ISL Engineering and Land Services Ltd., 2006.

Stormwater Management Guidelines for the Province of Alberta, 1999.

Risk Management Plan for Former Calmar 09-25 Battery, Matrix Solutions Inc., 2021.

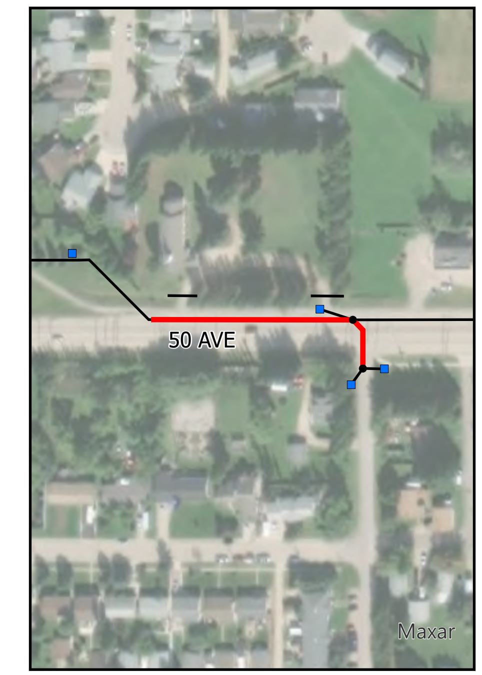
APPENDIX
Longitudinal Profiles

A



LEGEND

- HGL under 1:5-yr 4-Hr Event
- HGL under 1:100-yr 4-Hr Event
- Ground Level



TITLE
LP 1
EXISTING SYSTEM

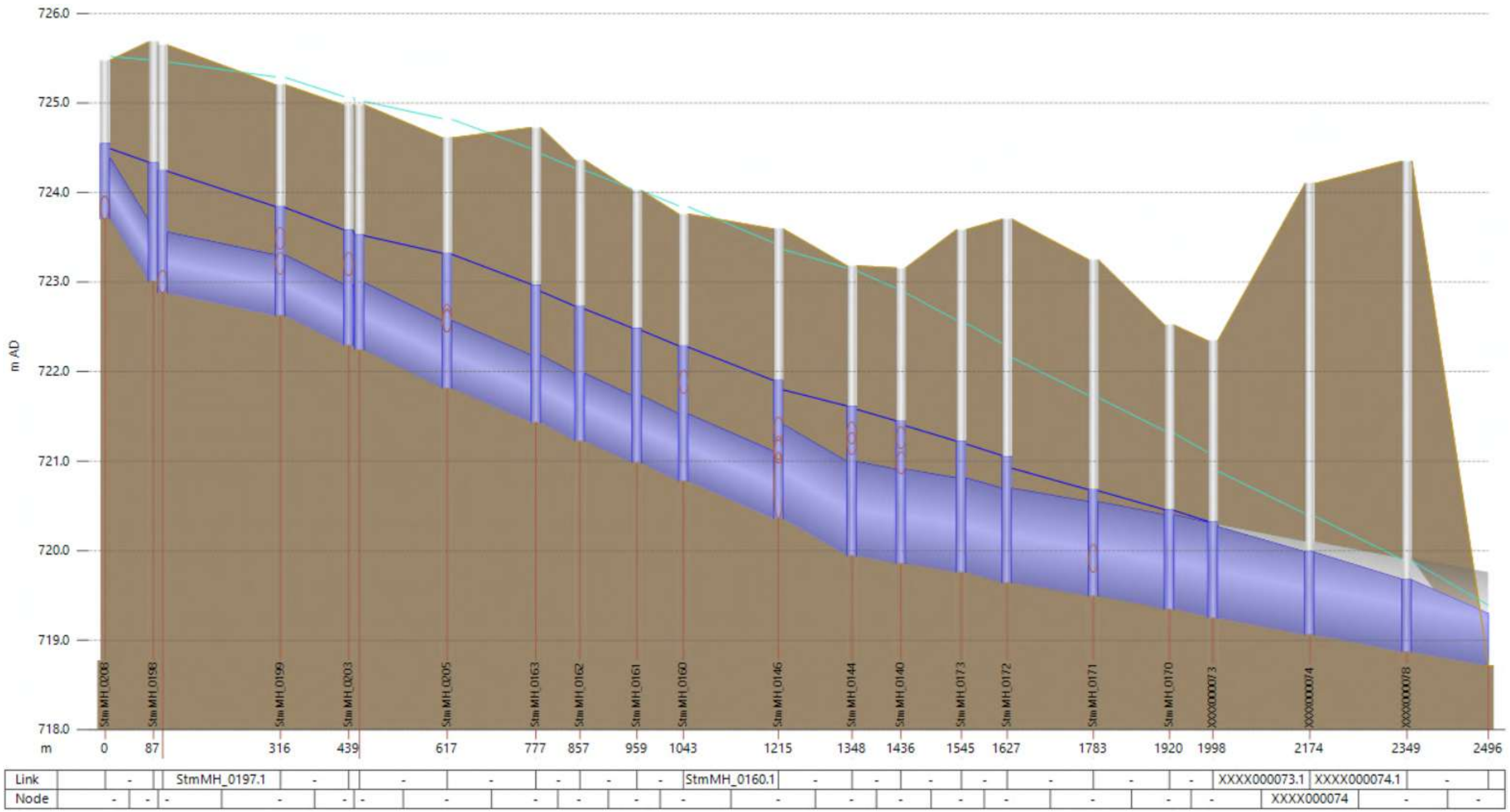
PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

ISL

FIGURE	A.1
DATE	8/14/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure X_LP1_Existing

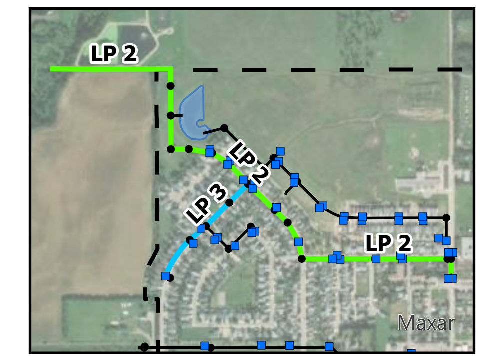


LEGEND

HGL under 1:5-yr 4-Hr Event

HGL under 1:100-yr 4-Hr Event

Ground Level



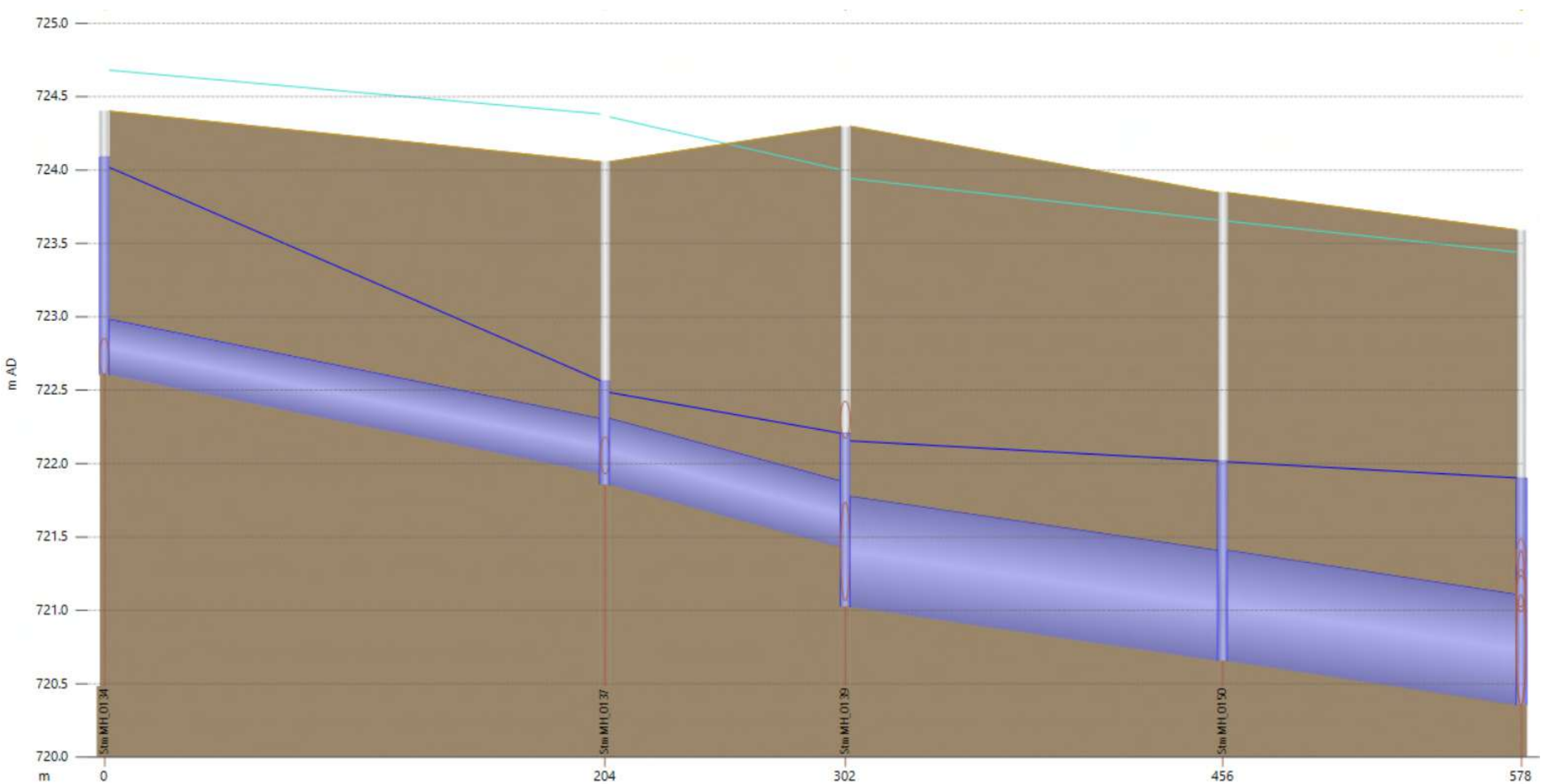
TITLE
LP 2
EXISTING SYSTEM

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

FIGURE	A.2
DATE	7/2/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure X_LP2_Existing



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LEGEND

- HGL under 1:5-yr 4-Hr Event
- HGL under 1:100-yr 4-Hr Event
- Ground Level

TITLE
LP 3
EXISTING SYSTEM

PROJECT
STORMWATER MASTER PLAN UPDATE

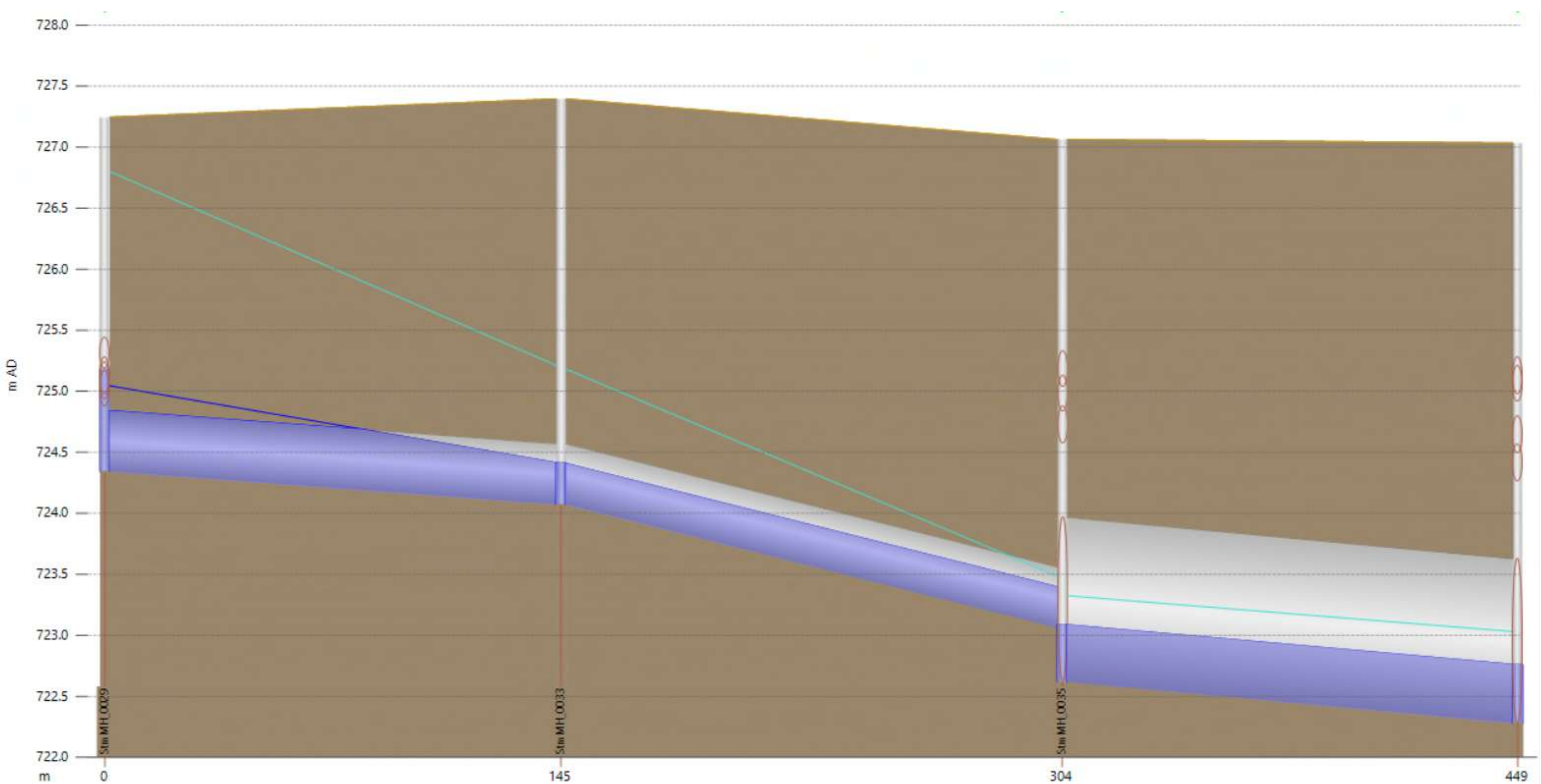
CLIENT
TOWN OF CALMAR

ISL

FIGURE	A.3
DATE	7/2/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

LEGEND

- HGL under 1:5-yr 4-Hr Event
- HGL under 1:100-yr 4-Hr Event
- Ground Level



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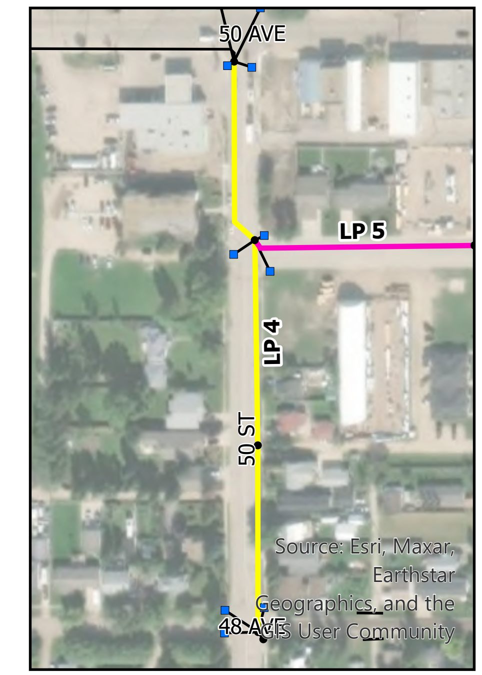
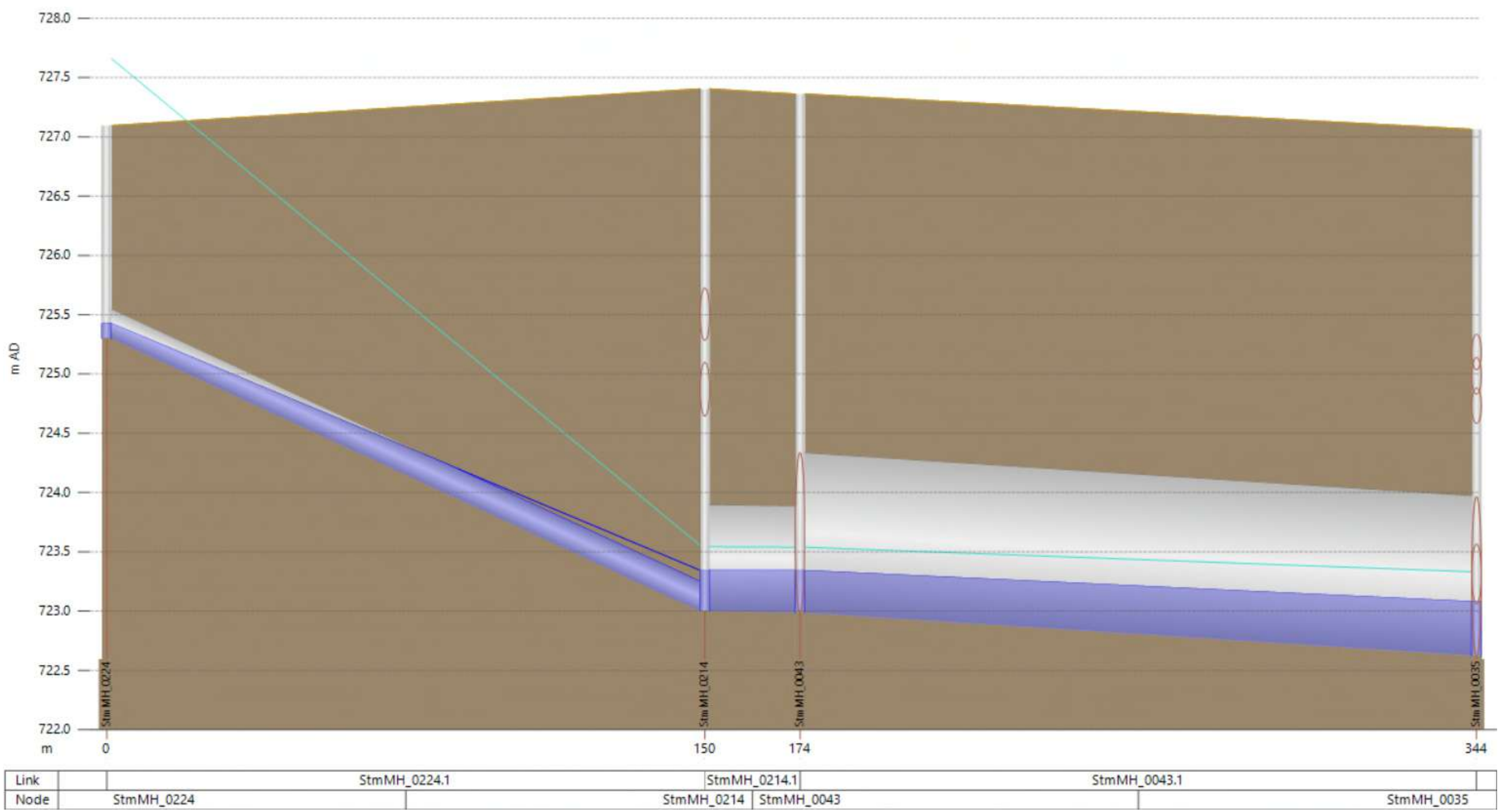


TITLE
LP 4
EXISTING SYSTEM

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

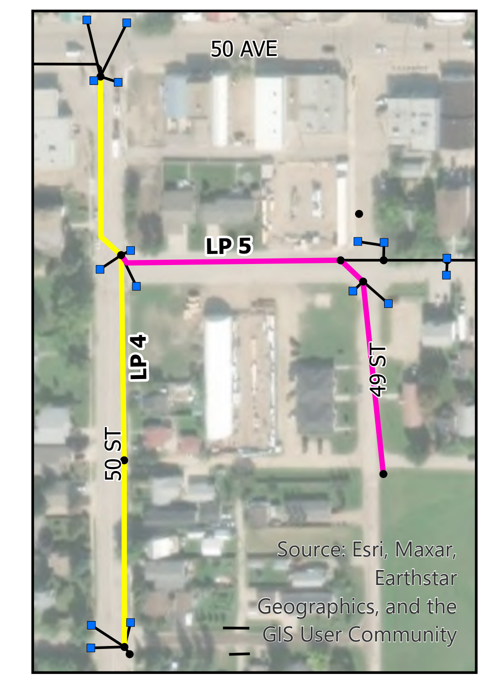
FIGURE	A.4
DATE	7/2/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester



LEGEND

- HGL under 1:5-yr 4-Hr Event
- HGL under 1:100-yr 4-Hr Event
- Ground Level

Note: No GIS data provided for link StmMH_0224.1. Pipe size and inverts are inferred.



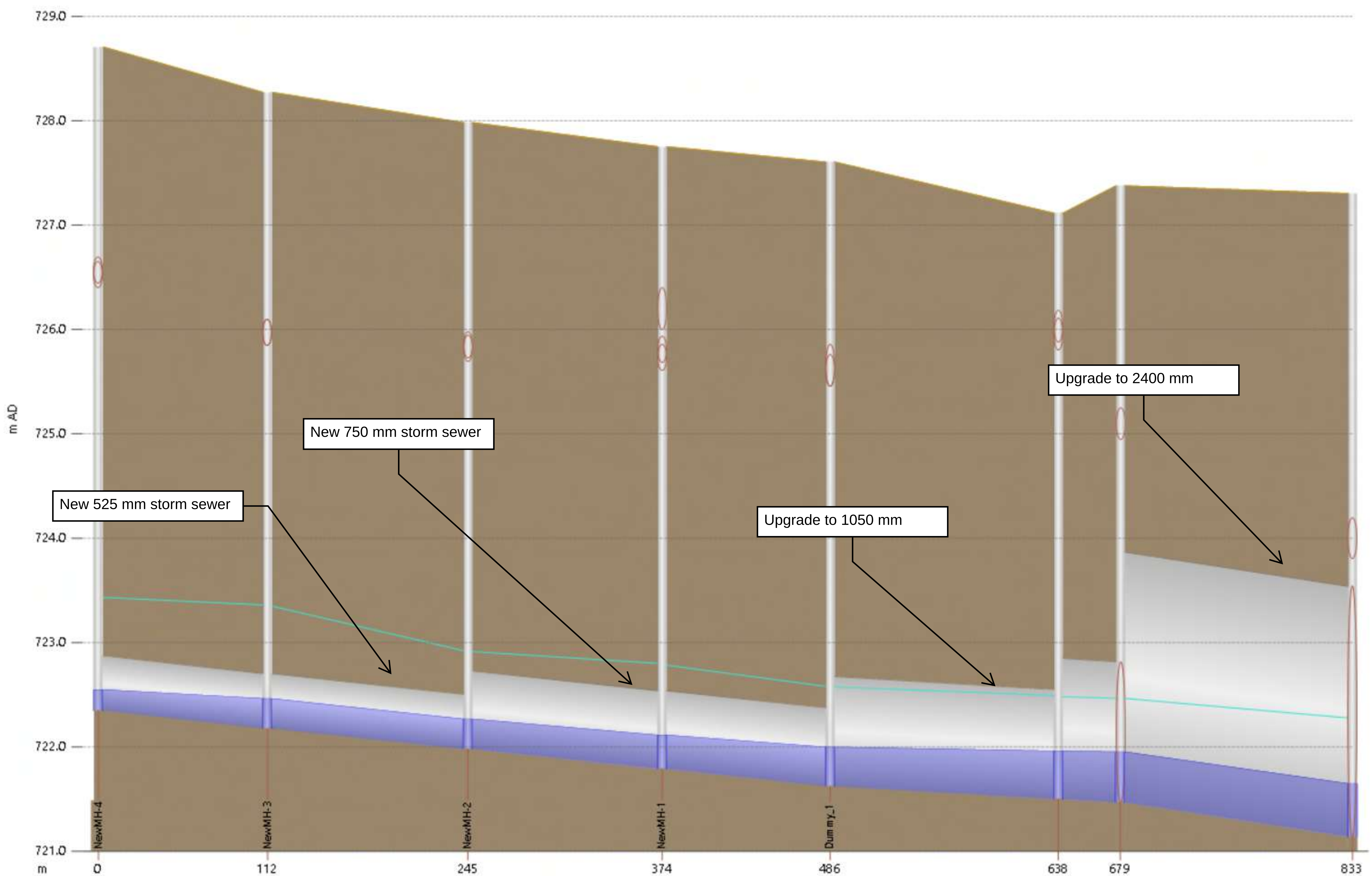
TITLE
LP 5
EXISTING SYSTEM

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

ISL

FIGURE	A.5
DATE	7/15/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester



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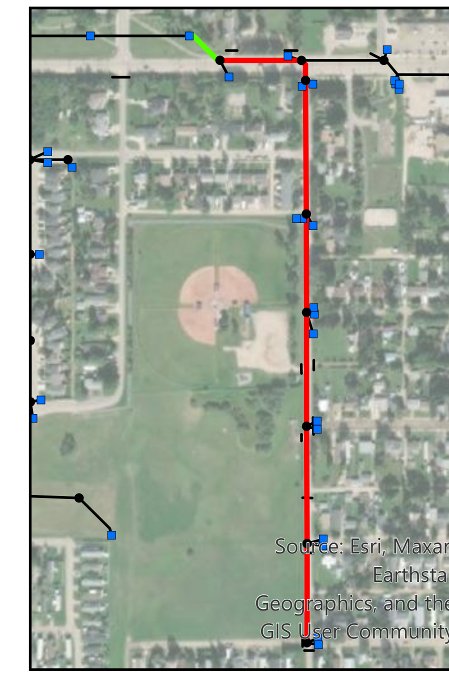
LEGEND

- HGL under 1:5-yr 4-Hr Event
- HGL under 1:100-yr 4-Hr Event
- Ground Level



TITLE
LP 1
EXISTING SYSTEM WITH UPGRADES

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

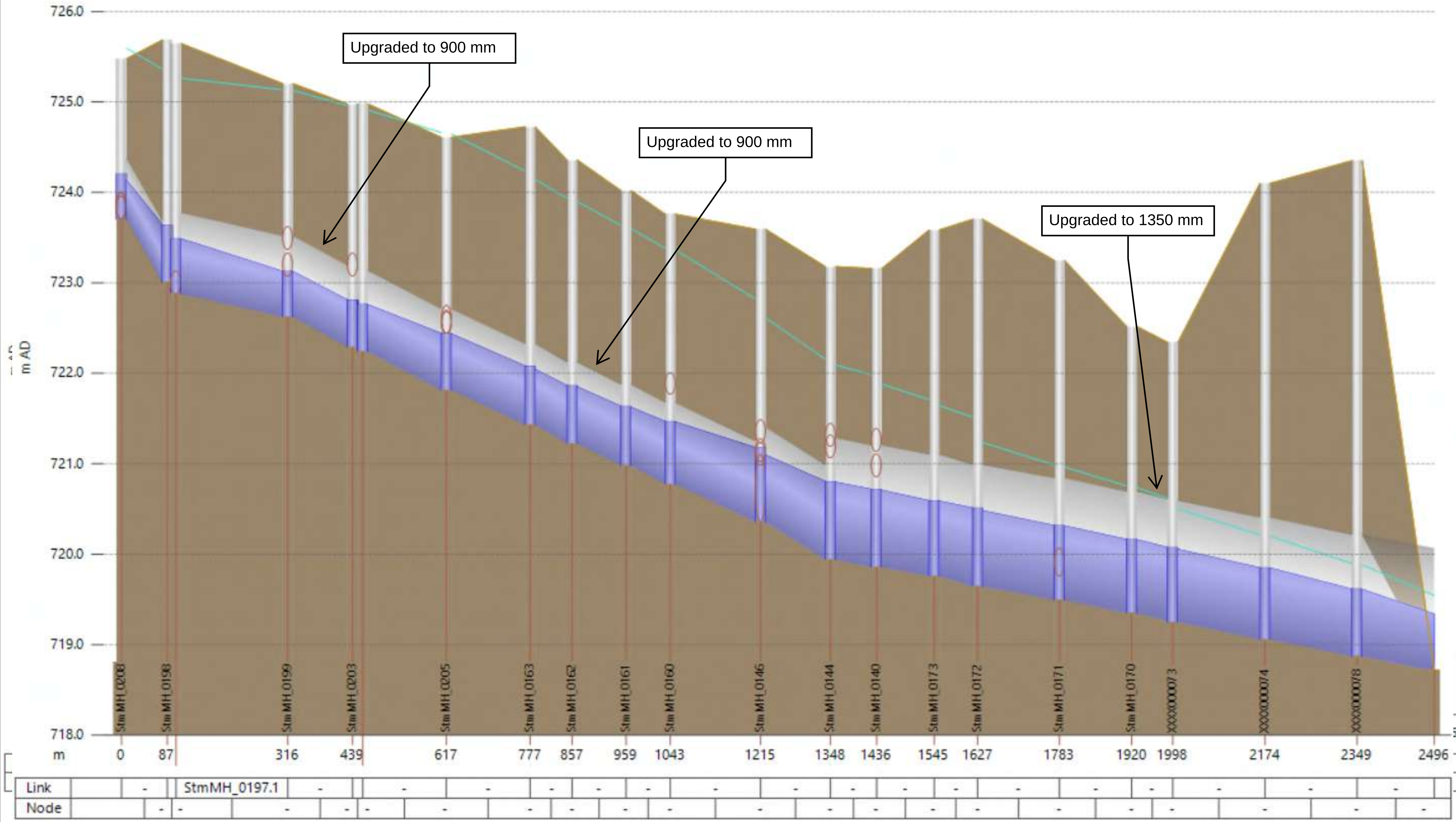
ISL

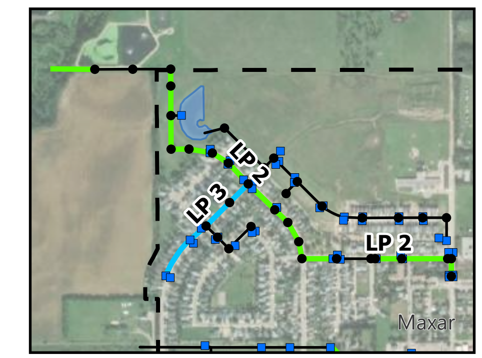
FIGURE	A.6
DATE	8/26/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure X_LP1_Upgrades

LEGEND

- HGL under 1:5-yr 4-Hr Event
- HGL under 1:100-yr 4-Hr Event
- Ground Level





TITLE
LP 2
EXISTING SYSTEM WITH UPGRADES

PROJECT
STORMWATER MASTER PLAN UPDATE

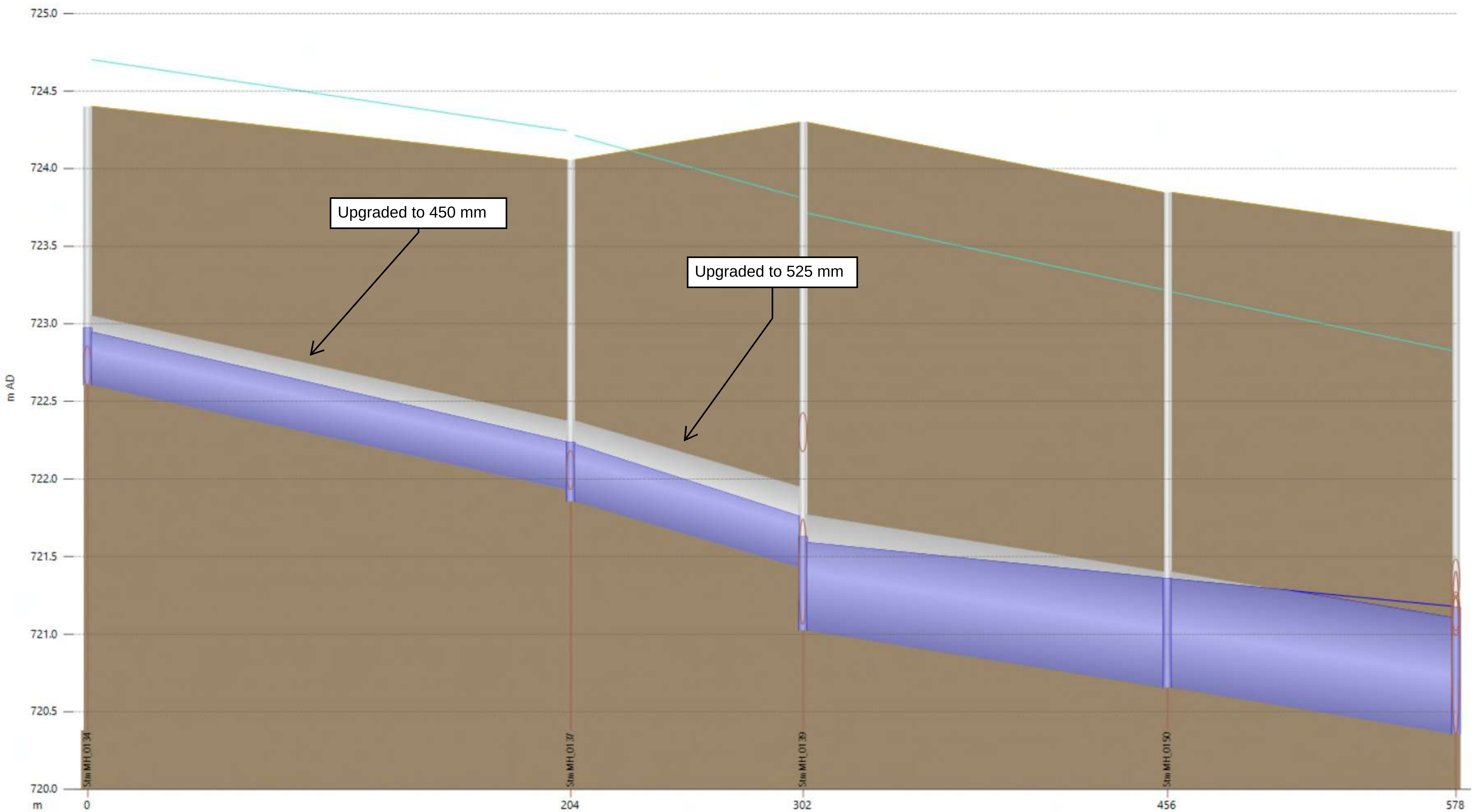
CLIENT
TOWN OF CALMAR

ISL

FIGURE	A.7
DATE	9/15/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

LEGEND

HGL under 1:5-yr 4-Hr Event
HGL under 1:100-yr 4-Hr Event
Ground Level



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TITLE
LP 3
EXISTING SYSTEM WITH UPGRADES

PROJECT
STORMWATER MASTER PLAN UPDATE

CLIENT
TOWN OF CALMAR

ISL

FIGURE	A.8
DATE	9/17/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

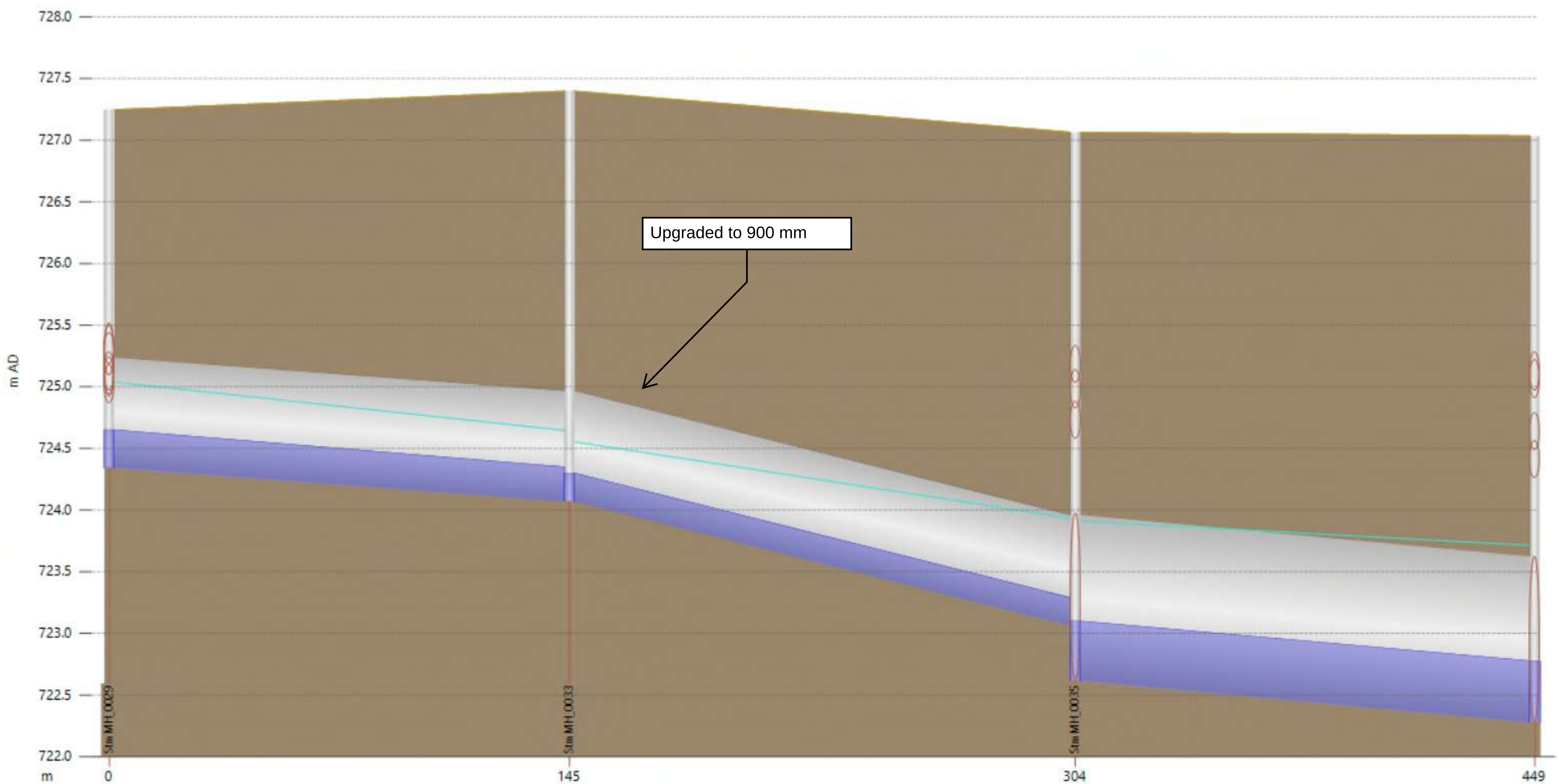
Document: Y:\Projects\16898_Calmar_Master_Plans_Updates\251_Figures\16898_Calmar_MP_Updates\16898_Calmar_MP_Updates.aprx - Figure X_LP3_Upgrades

LEGEND

HGL under 1:5-yr 4-Hr Event

HGL under 1:100-yr 4-Hr Event

Ground Level



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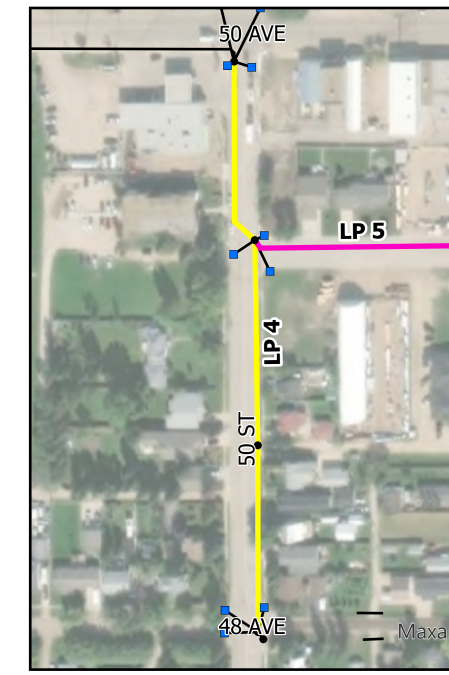


TITLE

LP 4

EXISTING SYSTEM WITH UPGRADES

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

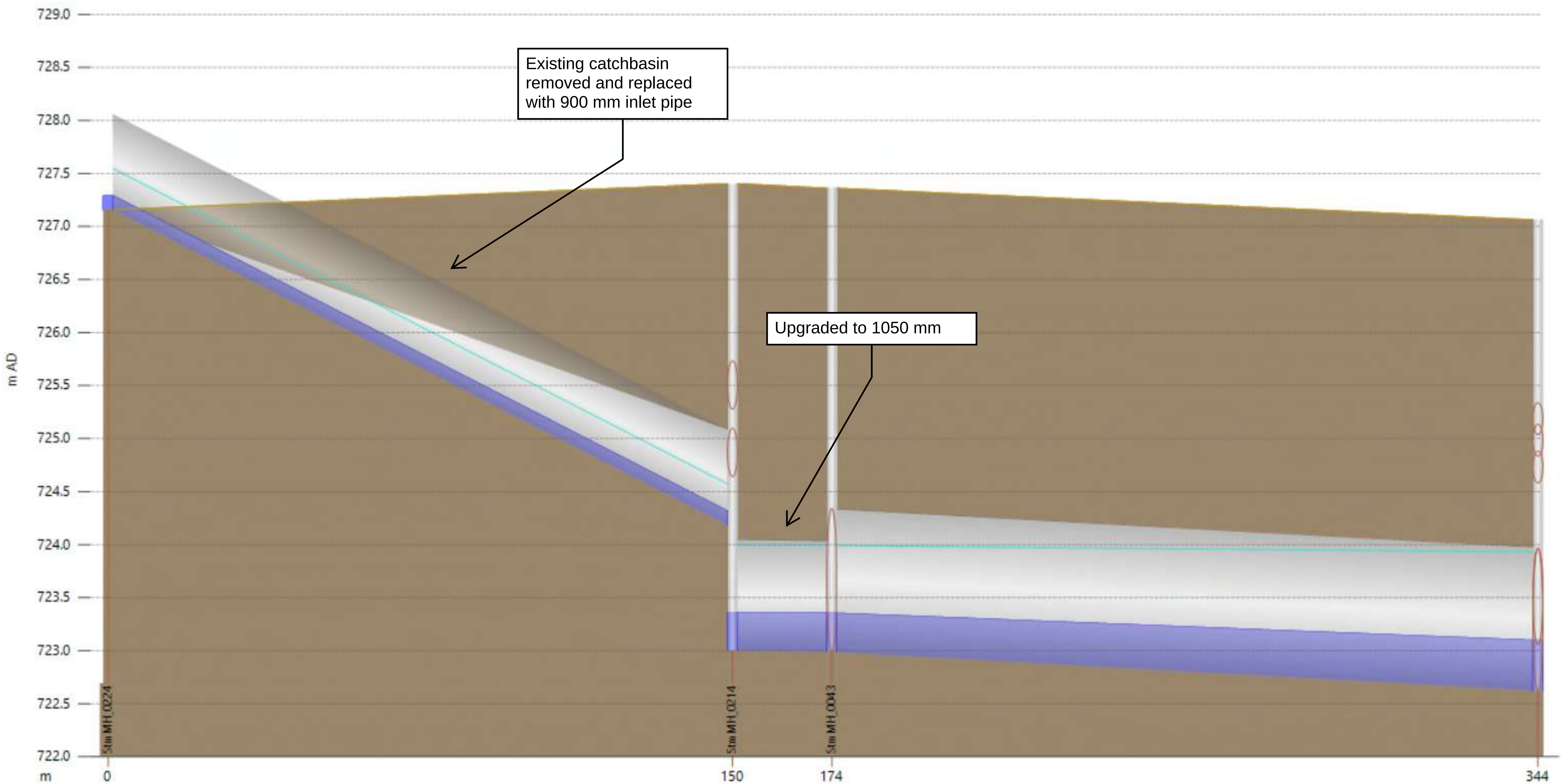
FIGURE	A.9
DATE	7/15/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

LEGEND

HGL under 1:5-yr 4-Hr Event

HGL under 1:100-yr 4-Hr Event

Ground Level



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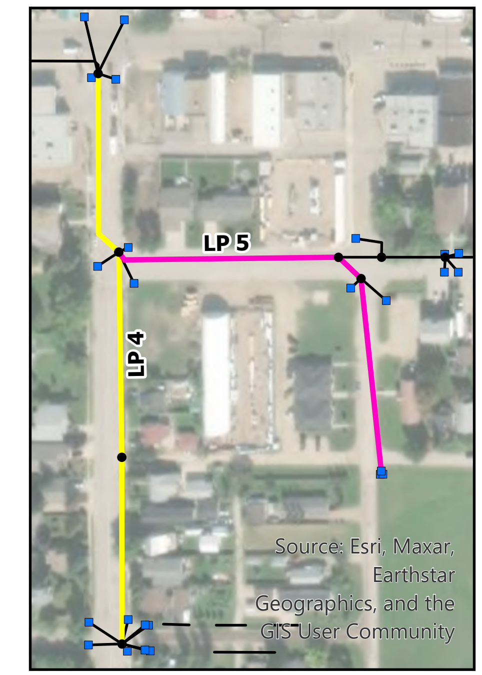

TITLE

LP 5

EXISTING SYSTEM WITH UPGRADES

PROJECT

STORMWATER MASTER PLAN UPDATE

CLIENT

TOWN OF CALMAR

FIGURE	A.10
DATE	7/15/2025
PROJECT NO.	16898
AUTHOR	jlalonde-bester

APPENDIX
Risk Assessment

B

Appendix B Risk Assessment

Table B.1: Existing System Upgrades Risk Assessment Parameter Summary

Upgrade No.	Description	Category Weighted Score					Combined Weighted Score
		Historical Flooding	Proximity to Critical Structures/Buildings	Surface Flooding Alleviation	Peak HGL Reduction	Road Condition Upgrade Potential	
EX UPG 1	Corgi Park and 51 Street drainage improvements	1.67	1.07	0.60	0.00	0.07	3.40
EX UPG #2A	Westview Neighbourhood local drainage improvements	0.00	0.53	0.20	0.53	0.20	1.47
EX UPG #2B	Westview Neighbourhood local drainage improvements	0.00	0.53	0.20	0.53	0.20	1.47
EX UPG #2C	Westview Neighbourhood local drainage improvements	0.00	0.53	0.20	0.53	0.20	1.47
EX UPG #2D	Westview Neighbourhood local drainage improvements	0.00	0.53	0.20	0.67	0.20	1.60
EX UPG 3	48 Avenue local drainage improvements	0.00	1.07	0.40	0.13	0.00	1.60
EX UPG 4	48A Avenue and 49 Street intersection drainage improvements	1.67	0.27	0.60	0.40	0.20	3.13
EX UPG 5	Woodland Park drainage improvements	0.00	0.53	1.00	0.00	0.13	1.67
EX UPG 6	50 Avenue south ditch improvement	0.00	1.07	1.00	0.00	0.13	2.20
EX UPG 7	49 Avenue local drainage improvement	0.00	0.53	0.60	0.00	0.13	1.27

Table B.2: Existing System Upgrades Risk Assessment Parameter Summary

Upgrade No.	Description	Historical Flooding	Surface Flooding Alleviation	Peak HGL Reduction	Proximity to Critical Structure/Building	Road Condition
			m	m		
EX UPG #1	Corgi Park and 51 Street drainage improvements	Historical Flooding Issues Observed	0.09	0.19	Flooding onto private property	Excellent
EX UPG #2A	Westview Neighbourhood local drainage improvements	No Historical Flooding Issues	0.02	0.75	Flooding on roadway	Average
EX UPG #2B	Westview Neighbourhood local drainage improvements	No Historical Flooding Issues	0.01	0.34	Flooding on roadway	Average
EX UPG #2C	Westview Neighbourhood local drainage improvements	No Historical Flooding Issues	0.01	0.21	Flooding on roadway	Average
EX UPG #2D	Westview Neighbourhood local drainage improvements	No Historical Flooding Issues	0.03	1.11	Flooding on roadway	Average
EX UPG #3	48 Avenue local drainage improvements	No Historical Flooding Issues	0.05	0.24	Flooding onto private property	N/A
EX UPG #4	48A Avenue and 49 Street intersection drainage improvements	Historical Flooding Issues Observed	0.17	0.44	Flooding in open field	Average
EX UPG #5	Woodland Park drainage improvements	No Historical Flooding Issues	0.34	N/A	Flooding in parking lot of commercial/industrial/ warehouse	Good
EX UPG #6	50 Avenue south ditch improvement	No Historical Flooding Issues	0.33	N/A	Flooding onto private property	Good
EX UPG #7	49 Avenue local drainage improvement	No Historical Flooding Issues	0.18	N/A	Flooding on roadway	Good

Table B.3: Existing System Upgrades Risk Assessment – Historical Flooding

Upgrade No.	Historical Flooding Instance	Raw Score	Weighted Score
EX UPG #1	Historical Flooding Issues Observed	5	1.67
EX UPG #2A	No Historical Flooding Issues	0	0.00
EX UPG #2B	No Historical Flooding Issues	0	0.00
EX UPG #2C	No Historical Flooding Issues	0	0.00
EX UPG #2D	No Historical Flooding Issues	0	0.00
EX UPG #3	No Historical Flooding Issues	0	0.00
EX UPG #4	Historical Flooding Issues Observed	5	1.67
EX UPG #5	No Historical Flooding Issues	0	0.00
EX UPG #6	No Historical Flooding Issues	0	0.00
EX UPG #7	No Historical Flooding Issues	0	0.00

Table B.4: Existing System Upgrades Risk Assessment – Proximity to Critical Infrastructure

Upgrade No.	Proximity to Critical Structure or Buildings	Raw Score	Weighted Score
EX UPG #1	Flooding onto private property	4	1.07
EX UPG #2A	Flooding on roadway	2	0.53
EX UPG #2B	Flooding on roadway	2	0.53
EX UPG #2C	Flooding on roadway	2	0.53
EX UPG #2D	Flooding on roadway	2	0.53
EX UPG #3	Flooding onto private property	4	1.07
EX UPG #4	Flooding in open field	1	0.27
EX UPG #5	Flooding in parking lot of commercial/industrial/warehouse	2	0.53
EX UPG #6	Flooding onto private property	4	1.07
EX UPG #7	Flooding on roadway	2	0.53

Table B.5: Existing System Upgrades Risk Assessment – Surface Flooding Alleviation

Upgrade No.	Peak Flooding Depth Reduction	Raw Score	Weighted Score
	m		
EX UPG #1	0.136	3	0.60
EX UPG #2A	0.020	1	0.20
EX UPG #2B	0.010	1	0.20
EX UPG #2C	0.010	1	0.20
EX UPG #2D	0.032	1	0.20
EX UPG #3	0.052	2	0.40
EX UPG #4	0.171	3	0.60
EX UPG #5	0.343	5	1.00
EX UPG #6	0.331	5	1.00
EX UPG #7	0.183	3	0.60

Table B.6: Existing System Upgrades Risk Assessment – HGL Reduction

Upgrade No.	Peak HGL Reduction	Raw Score	Weighted Score
	m		
EX UPG #1	N/A	0	0.00
EX UPG #2A	0.75	4	0.53
EX UPG #2B	0.34	4	0.53
EX UPG #2C	0.21	4	0.53
EX UPG #2D	1.11	5	0.67
EX UPG #3	0.24	1	0.13
EX UPG #4	0.44	3	0.40
EX UPG #5	N/A	0	0.00
EX UPG #6	N/A	0	0.00
EX UPG #7	N/A	0	0.00

Table B.7: Existing System Upgrades Risk Assessment - Road Condition Upgrade Potential

Upgrade No.	Imagery Year	Road Condition	Raw Score	Weighted Score
EX UPG #1	2023	Excellent	1	0.07
EX UPG #2A	2023	Average	3	0.20
EX UPG #2B	2023	Average	3	0.20
EX UPG #2C	2023	Average	3	0.20
EX UPG #2D	2023	Average	3	0.20
EX UPG #3	2023	N/A	0	0.00
EX UPG #4	2023	Average	3	0.20
EX UPG #5	2023	Good	2	0.13
EX UPG #6	2023	Good	2	0.13
EX UPG #7	2023	Good	2	0.13

APPENDIX C
Existing System Upgrade Cost Estimates

Appendix C Existing System Upgrade Cost Estimates

Table C.1: Existing System Capacity Upgrades 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 2400 mm gravity sewer, including existing pipe removal	5,079	m	140	$711,000	$107,000	$213,000	$1,031,000
1.2	Excavation, backfill, and supply and installation of 1050 mm gravity sewer	2,228	m	152	$339,000	$51,000	$102,000	$492,000
1.3	Excavation, backfill, and supply and installation of 750 mm gravity sewer	1,611	m	242	$390,000	$59,000	$117,000	$566,000
1.4	Excavation, backfill, and supply and installation of 525 mm gravity sewer	1,221	m	246	$300,000	$45,000	$90,000	$435,000
1.5	Supply and installation of 1500 mm dia. manhole (6m) x5	4,304	v.m.	30	$129,000	$19,000	$39,000	$187,000
1.6	Excavation	10	m^3	2,800	$28,000	$4,000	$8,000	$40,000
1.7	Topsoil and sod	15	m^2	3,800	$57,000	$9,000	$17,000	$83,000
1.8	Landscaping	50,000	L.S.	1	$50,000	$8,000	$15,000	$73,000
1.9	Outlet control structure	100,000	L.S.	1	$100,000	$15,000	$30,000	$145,000
1.10	Installation of approximately 60 m of 450 mm outlet pipe	60	m	977	$59,000	$9,000	$18,000	$86,000
1.11	Excavation, backfill, and supply and installation of 300 mm culvert	400	m	7	$3,000	$500	$1,000	$4,500
1.12	Excavation, backfill, and supply and installation of 400 mm culvert	400	m	49	$20,000	$3,000	$6,000	$29,000
1.13	Installation of catchbasin with K-7 frame and cover	6,883	ea	8	$55,000	$8,000	$17,000	$80,000
1.14	Excavation, backfill, and supply and installation of 250 mm catchbasin lead	677	m	124	$84,000	$13,000	$25,000	$122,000
1.15	Pavement rehabilitation	1,048	m	750	$786,000	$118,000	$236,000	$1,140,000
				Upgrade #1 Subtotal	**$3,111,000**	**$468,500**	**$934,000**	**$4,513,500**
EX UPG #2A								
2A.1	Excavation, backfill, and supply and installation of 1350 mm gravity sewer	1,934	m	550	$1,064,000	$160,000	$319,000	$1,543,000
2A.2	Supply and installation of 1900 mm dia. manhole (5m) x2	5,505	v.m.	10	$55,000	$8,000	$17,000	$80,000
2A.3	Supply and installation of 1900 mm dia. manhole (3m) x7	5,505	v.m.	21	$116,000	$17,000	$35,000	$168,000
2A.4	Pavement rehabilitation	1,048	m	80	$84,000	$13,000	$25,000	$122,000
				Upgrade #2A Subtotal	**$1,319,000**	**$198,000**	**$396,000**	**$1,913,000**
EX UPG #2B								
2B.1	Excavation, backfill, and supply and installation of 900 mm gravity sewer	1,934	m	447	$865,000	$130,000	$260,000	$1,255,000
2B.2	Supply and installation of 1200 mm dia. manhole (3m) x6	2,185	v.m.	21	$46,000	$7,000	$14,000	$67,000
2B.3	Pavement rehabilitation	1,048	m	447	$468,000	$70,000	$140,000	$678,000
				Upgrade #2B Subtotal	**$1,379,000**	**$207,000**	**$414,000**	**$2,000,000**
EX UPG #2C								
2C.1	Excavation, backfill, and supply and installation of 900 mm gravity sewer	1,934	m	211	$408,000	$61,000	$122,000	$591,000
2C.2	Supply and installation of 1200 mm dia. manhole (3m) x3	2,185	v.m.	6	$13,000	$2,000	$4,000	$19,000
2C.3	Pavement rehabilitation	1,048	m	216	$226,000	$34,000	$68,000	$328,000
2C.4	Installation of catchbasin with F-51 frame and cover	6,781	ea	2	$14,000	$2,000	$4,000	$20,000
2C.5	Excavation, backfill, and supply and installation of 300 mm catchbasin lead	809	m	13	$11,000	$2,000	$3,000	$16,000
				Upgrade #2C Subtotal	**$672,000**	**$101,000**	**$201,000**	**$974,000**

Item	Description	Unit Rate ($/unit)	Unit	Quantity (unit)	Cost ($)	Engineering ($)	Contingency ($)	Total ($)
EX UPG #2D								
2D.1	Excavation, backfill, and supply and installation of 450 mm gravity sewer	977	m	122	$119,000	$18,000	$36,000	$173,000
2D.2	Excavation, backfill, and supply and installation of 525 mm gravity sewer	1,221	m	60	$73,000	$11,000	$22,000	$106,000
2D.3	Supply and installation of 1200 mm dia. manhole (3m) x3	2,185	v.m.	9	$20,000	$3,000	$6,000	$29,000
2D.4	Pavement rehabilitation	1,048	m	182	$191,000	$29,000	$57,000	$277,000
				Upgrade #2D Subtotal	**$403,000**	**$61,000**	**$121,000**	**$585,000**
EX UPG #3								
3.1	Excavation, backfill, and supply and installation of 900 mm gravity sewer	1,934	m	304	$588,000	$88,000	$176,000	$852,000
3.2	Supply and installation of 1200 mm dia. manhole (4m) x3	2,185	v.m.	12	$26,000	$4,000	$8,000	$38,000
3.3	Excavation, backfill, and supply and installation of 400 mm culvert	400	m	40	$16,000	$2,000	$5,000	$23,000
3.4	Excavation, backfill, and supply and installation of 600 mm culvert	606	m	52	$32,000	$5,000	$10,000	$47,000
3.5	Pavement rehabilitation	1,048	m	304	$319,000	$48,000	$96,000	$463,000
				Upgrade #3 Subtotal	**$981,000**	**$147,000**	**$295,000**	**$1,423,000**
EX UPG #4								
4.1	Excavation, backfill, and supply and installation of 900 mm culvert	1,097	m	150	$165,000	$25,000	$50,000	$240,000
4.2	Excavation, backfill, and supply and installation of 1050 mm gravity sewer	2,228	m	24	$53,000	$8,000	$16,000	$77,000
4.3	Pavement rehabilitation	1,048	m	174	$182,000	$27,000	$55,000	$264,000
				Upgrade #4 Subtotal	**$400,000**	**$60,000**	**$121,000**	**$581,000**
EX UPG #5								
5.1	Installation of catchbasin with Type 8 frame and cover	6,781	ea	4	$27,000	$4,000	$8,000	$39,000
5.2	Excavation, backfill, and supply and installation of 250 mm catchbasin lead	677	m	35	$24,000	$4,000	$7,000	$35,000
				Upgrade #5 Subtotal	**$51,000**	**$8,000**	**$15,000**	**$74,000**
EX UPG #6								
6.1	Ditch improvement	14	m^3	136	$2,000	$0	$1,000	$3,000
6.2	Excavation, backfill, and supply and installation of 400 mm culvert	400	m	41	$16,000	$2,000	$5,000	$23,000
6.3	Pavement rehabilitation	1,048	m	20	$21,000	$3,000	$6,000	$30,000
				Upgrade #6 Subtotal	**$39,000**	**$5,000**	**$12,000**	**$56,000**
EX UPG #7								
7.1	Installation of catchbasin with K-7 frame and cover	6,883	ea	4	$28,000	$4,000	$8,000	$40,000
7.2	Excavation, backfill, and supply and installation of 250 mm catchbasin lead	677	m	30	$20,000	$3,000	$6,000	$29,000
7.3	Pavement rehabilitation	1,048	m	15	$16,000	$2,000	$5,000	$23,000
				Upgrade #7 Subtotal	**$64,000**	**$9,000**	**$19,000**	**$92,000**
				Total	**$8,419,000**	**$1,264,500**	**$2,528,000**	**$12,211,500**

[1] Costs herein are comparable to other municipalities. Costs are representative of 2025 dollars.
[2] The total cost has been rounded up to the nearest $10,000.

APPENDIX
Future System Concept Assessment and Development

D

Appendix D Future System Concept Development and Assessment

D.1 Existing System Analysis with Future Flows

Table D.1: Existing Stormwater Management Facility Storage Analysis

SWMF ID	Subcatchment ID	Catchment Area (ha)	Runoff Coefficient Pre-Development (C)	Runoff Coefficient Post-Development (C)	Runoff Volume Pre-Development (m^3)	Runoff Volume Post-Development (m^3)	Existing Live Storage Within Pond (m^3)	Existing Runoff Volume under 1:100 Yr 24 Hr Huff (m^3)	Additional Run-off Volume Post-Development (m^3)	Additional Storage Required (m^3)
Hawk's Landing	Subcatchment 1-1	1.2	0.30	0.65	500	1,100	6,047	14,180	4,100	12,233
	Subcatchment 1-2	6.3	0.30	0.50	2,600	4,400				
	Subcatchment 1-3	6.4	0.30	0.50	2,700	4,400				
Hwy 39	Subcatchment 3-1	1.28	0.30	0.50	500	900	16,596	14,870	2,500	774
	Subcatchment 3-2	7.65	0.30	0.50	3,200	5,300				
Southbridge	Subcatchment 5-1	0.89	0.30	0.90	400	1,100	24,763	16,981	2,100	0
	Subcatchment 5-2	0.32	0.30	0.65	100	300				
	Subcatchment 5-3	2.3	0.30	0.50	1,000	1,600				
	Subcatchment 5-4	2.1	0.30	0.50	900	1,500				

Table D.2: Existing Minor System Capacity Assessment with Future Flows

Catchment ID	Pipe ID	Existing Diameter (mm)	Peak Q under 1:5yr 4Hr	Existing Capacity (m^3/s)	Peak Q developed (m^3/s)	Capacity Assessment
FUT Catchment 1	StmMH_0164.1	600	0.002	0.174	0.063	Adequate
	StmMH_0165.1	750	0.212	0.451	0.272	Adequate
	StmMH_0168.1	750	0.207	0.314	0.268	Adequate
	StmMH_0169.1	750	0.200	0.849	0.260	Adequate
FUT Catchment 5	StmMH_0102.1	375	0.002	0.106	0.008	Adequate
	StmMH_0099.1	450	0.024	0.158	0.049	Adequate
	StmMH_0086.1	525	0.108	0.394	0.133	Adequate
	StmMH_0021.1	750	0.006	0.431	0.029	Adequate
	StmMH_0026.1	600	0.107	0.300	0.026	Adequate
	StmMH_0023.1	750	0.107	0.502	0.108	Adequate
	StmMH_0079.1	750	0.148	0.545	0.148	Adequate
	StmMH_0091.1	750	0.148	0.545	0.148	Adequate
	StmMH_0090.1	900	0.328	2.665	0.328	Adequate

D.2 Future System Concept

Table D.3: Proposed Stormwater Management Facility Design Parameters

ID	Area	Runoff Coefficient	Maximum Flow Release Rate	Runoff Storage Required 1:100 Yr 24 Hr Huff[1]
	ha		L/s	m^3
FUT Catchment 2	4.7	0.90	21.2	3,600
FUT Catchment 4 (Ultimate Build-Out)	51.4	0.58	231.2	24,100
FUT Catchment 4 (Interim)[2]	3.4	0.50	15.3	2,300
FUT Catchment 6	44.9	0.53	202.1	17,100
FUT Catchment 7	16.5	0.50	74.3	5,000

[1] Required storage volume is calculated based on the design rainfall intensity and rounded to the nearest hundred cubic metres.
[2] Interim stage includes the two low density residential parcels identified in the MDP. These numbers are only provided for reference, as the pond was sized for ultimate build-out based on the Thomas Creek ASP.

Table D.4: Proposed Stormwater Management Facility Design Summary

SWMF ID	Bottom		NWL		HWL		Top		Permanent Pond 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	722.2	200	724.7	1,200	726.7	2,600	727.0	2,900	1,200	3,600	4,500	9,300	6.17%
FUT SWMF 2	720.3	6,200	722.8	10,200	724.8	14,100	725.1	14,700	15,500	24,100	28,400	68,000	2.86%
FUT SWMF 3	722.9	3,800	725.4	7,000	727.4	10,300	727.7	10,800	10,000	17,100	20,200	47,300	2.41%
FUT SWMF 4	722.0	400	724.5	1,700	726.5	3,500	726.8	3,800	1,800	5,000	6,100	12,900	2.30%

Table D.5: Proposed Stormwater Management Facility Orifice and Outlet Pipe Sizing

SWMF ID	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	21.2	85	102 (4)	24.6	250	31.5	6.9
FUT SWMF 2	231.2	280	302 (12)	268.8	675	325.6	56.7
FUT SWMF 3	202.1	262	302 (12)	234.9	600	237.8	2.9
FUT SWMF 4	74.3	159	202 (8)	86.3	450	110.4	24.1

[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 Town's Design and Construction Standards and a Manning's n of 0.013.

APPENDIX E
Future System Cost Estimates

Appendix E Future System Cost Estimates

Table E.1: Future System Cost Estimates

Item	Description	Unit Rate ($/unit)	Unit	Quantity (unit)	Cost ($)	Engineering ($)	Contingency ($)	Total ($)
FUT SWMF 1								
1.1	Excavation	7	m^3	9,300	$65,000	$10,000	$20,000	$95,000
1.2	Topsoil and sod	12	m^2	2,900	$35,000	$5,000	$11,000	$51,000
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
1.5	Installation of approximately 130 m of 250 mm outlet pipe	460	m	130	$60,000	$9,000	$18,000	$87,000
				FUT SWMF 1 Subtotal	**$310,000**	**$47,000**	**$94,000**	**$451,000**
FUT SWMF 2								
2.1	Excavation	7	m^3	68,000	$476,000	$71,000	$143,000	$690,000
2.2	Topsoil and sod	12	m^2	14,700	$176,000	$26,000	$53,000	$255,000
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
2.5	Installation of approximately 350 m of 675 mm outlet pipe	957	m	350	$335,000	$50,000	$101,000	$486,000
				FUT SWMF 2 Subtotal	**$1,137,000**	**$170,000**	**$342,000**	**$1,649,000**
FUT SWMF 3								
3.1	Excavation	7	m^3	47,300	$331,000	$50,000	$99,000	$480,000
3.2	Topsoil and sod	12	m^2	10,800	$130,000	$20,000	$39,000	$189,000
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
3.5	Installation of approximately 240 m of 600 mm outlet pipe	870	m	240	$209,000	$31,000	$63,000	$303,000
				FUT SWMF 3 Subtotal	**$820,000**	**$124,000**	**$246,000**	**$1,190,000**
FUT SWMF 4								
4.1	Excavation	7	m^3	12,900	$90,000	$14,000	$27,000	$131,000
4.2	Topsoil and sod	12	m^2	3,800	$46,000	$7,000	$14,000	$67,000
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
4.5	Installation of approximately 30 m of 450 mm outlet pipe	635	m	30	$19,000	$3,000	$6,000	$28,000
				FUT SWMF 4 Subtotal	**$305,000**	**$47,000**	**$92,000**	**$444,000**
				Total	**$2,572,000**	**$388,000**	**$774,000**	**$3,734,000**

[1] Costs herein are comparable to other municipalities. Costs are representative of 2025 dollars.
[2] The total cost has been rounded up to the nearest $10,000.