Town of Stony Plain

Stormwater Master Plan 2018

Final Report

Date: April 15, 2019
Prepared for: The Town of Stony Plain
Prepared by: Sameng Inc.
Project No: 1310

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April 15, 2019 File: 1310

Town of Stony Plain
4905 – 51 Avenue
Stony Plain, AB T7Z 1Y1

Attention: Greg Zirk, P. Eng.
Director of Engineering and Operations

Re: Stony Plain Stormwater Master Plan 2018
Final Report

Dear Mr. Zirk,

We are pleased to submit the enclosed final project report entitled Stony Plain Stormwater Master Plan 2018. On behalf of the project team at Sameng Inc., I would like to thank you and the Town of Stony Plain for the opportunity to work on this project. It has been a pleasure working with you and Mr. John Illingworth.

Should you have any questions or require additional assistance with this report's contents, please contact me at 780-482-2557.

Sincerely,

David Yue, P. Eng
Project Manager

Executive Summary

PROJECT OBJECTIVES

Sameng was retained by the Town of Stony Plain in July 2018 to undertake a Storm Drainage Master Plan. The main objectives of this Master Plan are to provide a comprehensive review of the Town's existing drainage design standards, a thorough inventory of the Town's drainage system, the development of a comprehensive computer model of the drainage system, examine issues with the existing drainage system and identify upgrades to mitigate these issues, and develop an effective long-term drainage plan to allow future development to proceed.

REVIEW OF MUNICIPAL DEVELOPMENT STANDARDS

The current Town of Stony Plain's servicing standards are mostly in conformance with Provincial guidelines for stormwater drainage design, as well as other Alberta municipalities. Some recommendations to these standards are made. Of note, it is recommended that the Town's standards include rainfall intensity duration and frequency (IDF) curves and artificial rainfall events for multiple events for sizing and analysis of the drainage infrastructure. Secondly, it is recommended that the stormwater management facilities sections be more descriptive and that standards for inlet/outlet structures and control devices be added. Furthermore, it is recommended that the design standards include a section that specifically discusses design criterion of water quality control objectives.

EXISTING DRAINAGE SYSTEM INVENTORY

A thorough inventory and review of the existing drainage system was completed. It consists of storm sewer pipes and ditches through most of the developed portions of the Town. These generally outlet into the four watercourses, which are named as Heritage Creek, Whispering Waters Creek, Stony Creek, and Atim Creek.

The Town's storm drainage system consists of about:

- 62 km of storm pipes:
- 59% are 450mm in diameter or less, 1% are 1200mm in diameter or larger, the largest pipe is a 1600mm pipe;
- The pipe age information is not specifically tracked in the Town's current storm infrastructure database.
- About 32% of the pipes are made of PVC, 22% of concrete, and 26% of pipe has unknown material.
- 6 km of catchbasin leads;

- 653 manholes, 63 catchbasin manholes and 881 catchbasins;
- 63 storm outfalls with 7 of them discharge directly into Heritage Creek, 22 in the Whispering Waters Creek, 20 in Stony Creek, and 12 in Atim Creek, and 1 in the unnamed channel system northwest of the Town.
- 30 stormwater management facilities.

As this master plan has helped to provide a complete inventory of the storm infrastructure, it is recommended that the Town further improve this infrastructure's asset inventory and condition rating. This asset management system should then be continuously updated for the purposes of identifying re-investment requirements.

COMPUTER HYDRAULIC MODEL DEVELOPMENT

For this storm drainage master plan, a comprehensive dual-drainage computer model was developed to better understand the drainage system performance under extreme rainfall events, and to properly identify flood risk areas. To do this, the Town's drainage infrastructure was combined into a single Mike Urban hydraulic model. The model also includes a major drainage system component, including roads and other major drainage paths.

EXISTING DRAINAGE SYSTEM ASSESSMENT

The existing drainage system of the Town of Stony Plain was evaluated (via the computer hydraulic model) under the City of Edmonton's 5-year 4-hour Chicago distribution rainfall event, the 100-year 4-hour Chicago distribution rainfall event and the 100-year 24-hour Chicago distribution rainfall event. Simulation result figures, showing the performance of the sewer and overland drainage systems, were produced, including surface ponding depth maps.

Overall, Stony Plain's drainage system show a good level of performance with positive drainage towards the four well defined creeks that traverse through the Town. These four creeks serve the purpose of providing suitable points of drainage outlet with easy access throughout the land. This allows development to occur with relatively independent drainage watersheds. This smaller watershed per outfall provides a benefit in that the systems are relatively independent of each other and deficiencies are generally isolated to a specific area.

The project's computer model does show a few areas having drainage deficiencies. The most at-risk areas are (in no particular order):

1. Area A: Boulder Blvd. and Granite Dr.
2. Area B: Egerland Pl. and 47 St.
3. Area C: 44 Ave. between St Andrews St. and St Andrews Dr.

4. Area D: 40 Ave. east of 50 St.
5. Area E: 41 Ave. and 43 St.
6. Area F: 46 St. between 54 Ave. and 55 Ave.
7. Area G: Golf Course Rd. N and Crystal Dr.

These seven areas are primarily at risk of flooding due to a poor major drainage system (i.e. overland drainage). In other words, during an intense downpour, the storm sewer pipes are flowing at their maximum capacity and excess rainfall runoff is trapped on the ground surface until the sewer system regains capacity. Flooding in these areas is generally only of concern for rainfall events larger than the 1:5-year event.

During a 5-year design rainfall event, an estimated 33% of the storm pipes will flow surcharged, and about 72% of the storm sewer system will be surcharged to within 1 meter of the ground surface. These are quite significant surcharges percentages considering that the storm sewer system should have been designed to accommodate a 5 year rainfall event. The negating factor is that the Town's major drainage system (ditches and streets) have positive grading which provides the necessary relieve of the pipe flows into the four main creeks. Thus, avoiding wide spread surface flooding during these intense storms.

All 30 of the Towns stormwater management facilities have been examined in order to quantify their performance. Out of these 30, six are projected to overflow during the 100-year, 24-hour design storm event. These being Pond #4 (Westerra), Pond #5 (Westerra), Pond #10 (Umbach). Pond #21 (Merdian height), Pond #26 (Legend trail) and Pond #27 (Graybriar). The simulated water levels are higher than the spillway. The water spills in a safe manner and does not cause flooding to properties.

IMPROVEMENT CONCEPT PLANS FOR EXISTING DRAINAGE SYSTEM

Drainage improvements were conceptualized for the seven areas of the Town that are considered at risk of flooding during the 100-year event. The improvement concepts have a design goal of 100-year level of flood protection. The individual improvements are detailed within the report. This includes road/ground regrading, large diameter pipes, large capacity catchbasins, increase ditch capacity, increased culvert capacity, and more. However, for each specific flood risk areas, detailed investigation should be conducted to obtain the most cost-effective approach for flooding control.

It may be preferred to implement some drainage upgrades to at-least enhance the level of flood protection for each of these areas. This would require additional site-specific studies to further investigate the drainage issues and refine the improvement proposals. For example, it may be possible to achieve a 25-year level of flood protection for all these areas for less than 50% of the cost of achieving a 100-year level of flood protection. A prioritization plan could then be developed with the related benefits quantified.

STORM DRAINAGE MASTER PLAN FOR FUTURE DEVELOPMENT AREAS

A Storm Drainage Master Plan for future development areas was developed at a master plan level. At this level, the designated outlets for future development have been identified for all lands within the corporate boundary of the Town of Stony Plain. The approximate locations and size of stormwater retention facilities are also provided as a guide for the developer. Individual watershed studies will need to done for each specific development to refine the design and configuration of the storm infrastructure. To this end, the stormwater master plan continues to build on the strength of the Town's drainage system which is to create the "right" sized watersheds that have positive overland drainage towards the four major creeks under the post development condition. To this end, the preservation of overland drainage for each planned catchment area will be important in the successful implementation of the master plan. Most stormwater management facilities conceptualized for the master plan are "wet pond" types. Given the heightened importance for wetland preservation and to achieve an acceptable balance with land that are dedicated to stormwater retention requirements, it is recommended that the Town, with the support of the development industry, undertake an environmental review of the environmentally important areas of the developable lands. Once these areas have been identified, the stormwater master plan can be reviewed and optimized to achieve both the preservation of natural features as well as serving the purpose of stormwater management. This would make more land available for development while preserving important wetland features.

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PROFESSIONAL SEAL

April 15, 2019
David Yue, P.Eng.

April 15, 2019
Maxime Belanger, M.Sc., P.Eng.

Yu Qian, Ph.D., E.I.T.

Sameng Inc. – APEGA Permit to Practice P2863

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Acknowledgements

We wish to thank those who contributed time and knowledge to the development of this study including, but not limited to, the following:

TOWN OF STONY PLAIN

- John Illingworth, C.E.T.
- Greg Zirk, P. Eng.

SAMENG INC.

- David Yue, P.Eng.
- Maxime Bélanger, M.Sc., P.Eng.
- Nathan Forsyth, P.Eng.
- Yu Qian, Ph.D., E.I.T.
- Brandon Rivet, C.E.T.
- Jared Nicholas, C.E.T.
- Aeyeun Cho, C.E.T.

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1.0 Introduction

1.1 Project Overview

Sameng Inc. (Sameng) was retained by the Town of Stony Plain (Town) to review and update its Storm Drainage Master Plan. The last such update was completed in 2008, and included recommendations that would improve the hydraulic capacity of key areas with noted capacity deficiencies.

Since 2008, the population of Stony Plain has gradually increased, adding new neighbourhoods and increasing the expected storm flows due to increased imperviousness in previously undeveloped areas, along with the ever-increasing effects of climate change. With these increased storm flows, it is important to update infrastructure plans to coordinate new development, budget for necessary infrastructure upgrades, and avoid potential conflicts. An effective and current master plan will guide engineers and policy makers in continuing to provide the level of service that is expected in Alberta municipalities, and will help to provide conditions conducive to further development within the Town.

1.2 Project Location

Stony Plain is a Town in central Alberta, Canada, in the heart of the Alberta Capital Region. It is located approximately 17 km west of Edmonton at the intersection of Highway 16A and Highway 779 at Latitude 53.54 N and Longitude 114.00 W. The Town is approximately 35.6 km² in size and has a population of 17,189 people according to the 2016 census.

The general topography of the Town has the highest land in the southwest and falls from southwest to northeast. The lowest elevations are found in the northeast portion of the Town's boundaries. The original Stormwater Master Plan was completed in 2008. Since that time, the Alberta Capital Region has experienced steady growth and development with ever increasing economic activity. Likewise, the Town of Stony Plain has experienced significant growth over the ensuing 10 years and has noticeably higher stormwater flows from previously undeveloped land.

There are 4 main watercourses which run through the core of the Town. Each watercourse conveys stormwater from south of the Town, in Parkland County, through the Town, and eventually exits the Town to the northeast, flowing back into Parkland County into Atim Creek and eventually into Big Lake. Stormwater flows from Big Lake then flow into the Sturgeon River, for which post-development stormwater flows are strictly regulated to a maximum unit discharge rate of 2.5 L/s/ha.

A location plan is shown in Figure 1-1. A map showing the current Town neighbourhoods and important areas is shown in Figure 1-2. Figure 1-3 shows the area structure plans, outline plans and area redevelopment plans in effect in the Town which are listed in Section 2.3.

1.3 Land Use Plan

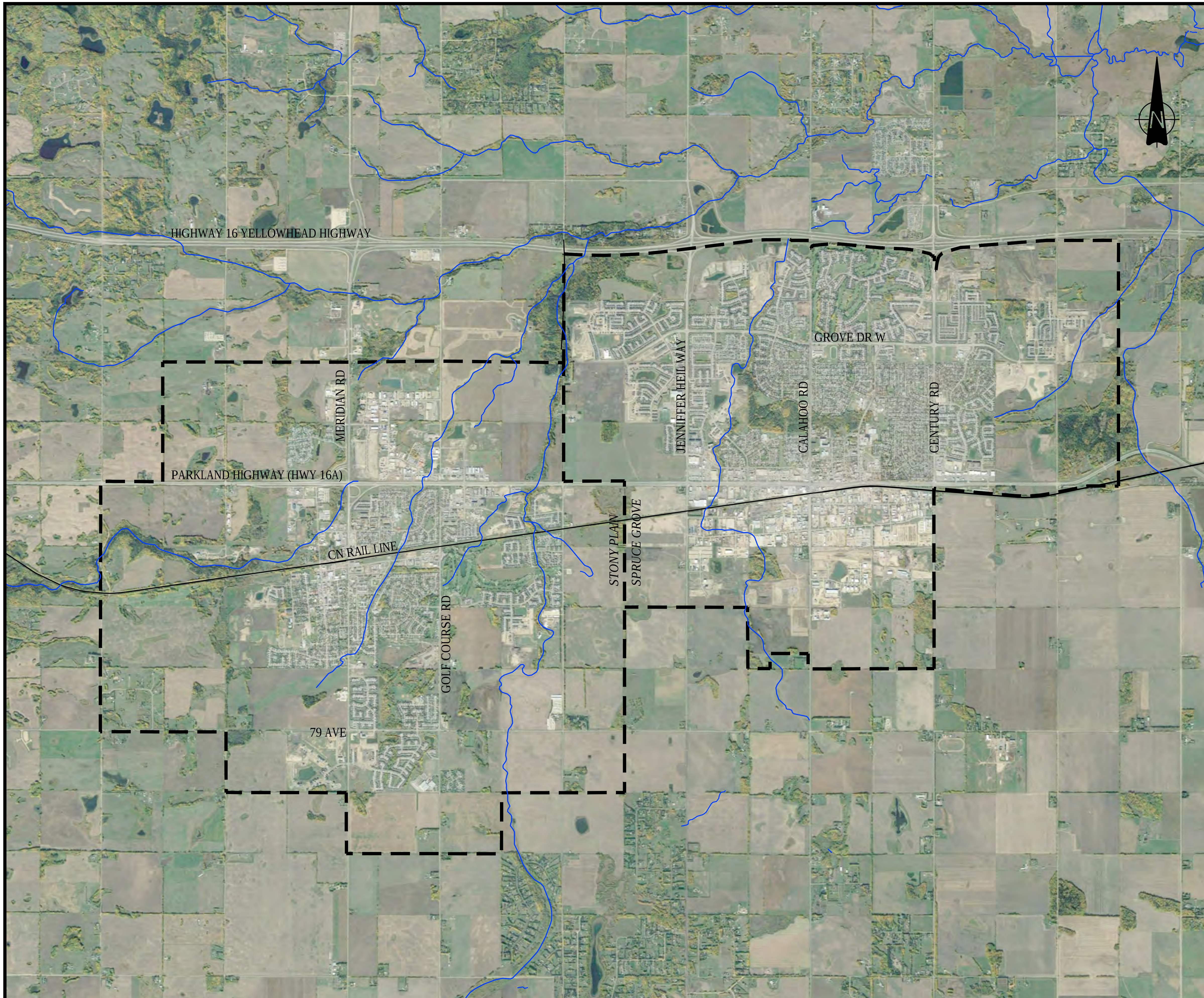
Figure 1-4 shows a simplified version of the current land use plan in the Town. Figure 1-5 shows the Future Land Use Plan according to the Town's Municipal Development Plan.

- **Existing Development (Figure 1-4):** Most of the Town is residential with some small commercial and public service/institution nodes scattered all around. The main industrial areas are north of Highway 16A.
- **Future Development Areas (Figure 1-5):** The MDP suggests that future commercial/industrial developments will focus along the northeast of the Town. Residential areas will mostly extend from the existing residential areas to the east and west of the Town and will cover a large portion of land to the northwest of the Town.

1.4 Project Objectives

The main objectives of this project are to develop an Update to the 2008 Stormwater Master Plan through the following tasks:

- Review Municipal Standards for storm infrastructure design and recommend changes that reflect current operating conditions, level of service and various regulations.
- Accurately model the existing system using a dual-drainage computer model that is compatible with the Town's existing system. Analyze capacity and efficiency of existing stormwater management infrastructure and assess its ability to mitigate flood risks to the Town and communities downstream of the Town.
- Assess the effectiveness of existing infrastructure bearing in mind the impacts of climate change.
- Document all deficiencies identified through the stormwater system model analysis and climate change impact assessment.
- Develop system improvement recommendations that minimize issues of the existing system, facilitate growth, and improve the system's environmental sustainability.
- Develop a prioritized strategy of cost-effective improvements to the existing stormwater management system.
- Provide a review of current funding available for stormwater system improvements funding options.
- Develop a priority list of potential capital projects, including cost estimates and a schedule of implementation for short, medium and long-term timelines.
- Present highlights of the Master Plan to Town Staff and Town Council.



LEGEND:

- MUNICIPAL BOUNDARY
- EXISTING WATERCOURSE
- CN RAIL LINE

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TOWN OF STONY PLAIN

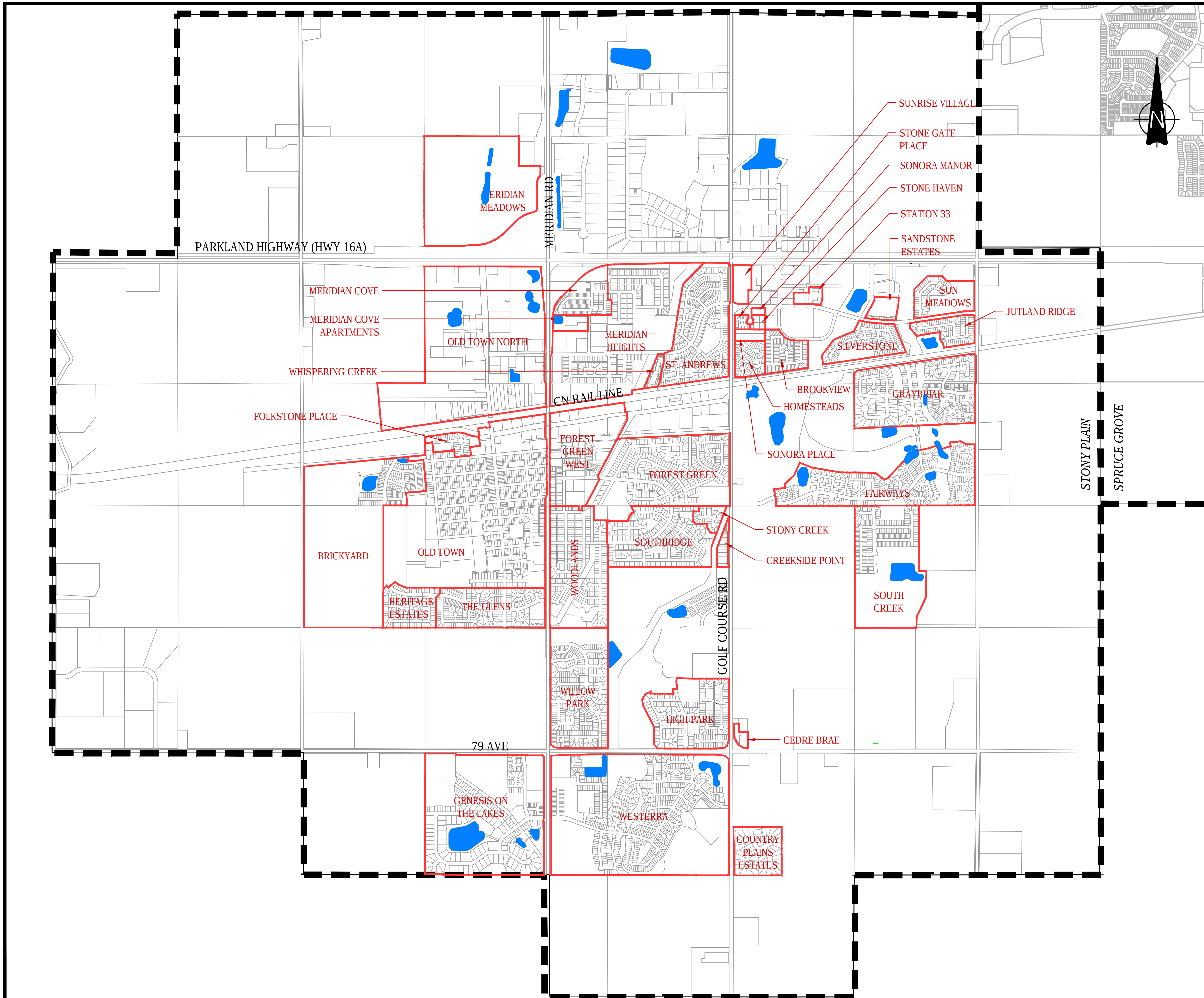
Project:

Stormwater Master Plan

Title:

Stony Plain and Spruce Grove Overview

Scale:	Figure:
1:50,000 (0 500 1000)	1.1



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TOWN OF STONY PLAIN

Project:

Stormwater Master Plan

Title:

Neighbourhoods and Important Areas

Scale: 1:25,000

0 250 500

Figure: 1.2

LEGEND:

- AREA STRUCTURE PLAN
- OUTLINE PLAN
- FIFTH MERIDIAN AREA STRUCTURE PLAN (PARKLAND COUNTY
- MUNICIPAL BOUNDARY
- EXISTING STORMWATER MANAGEMENT FACILITY

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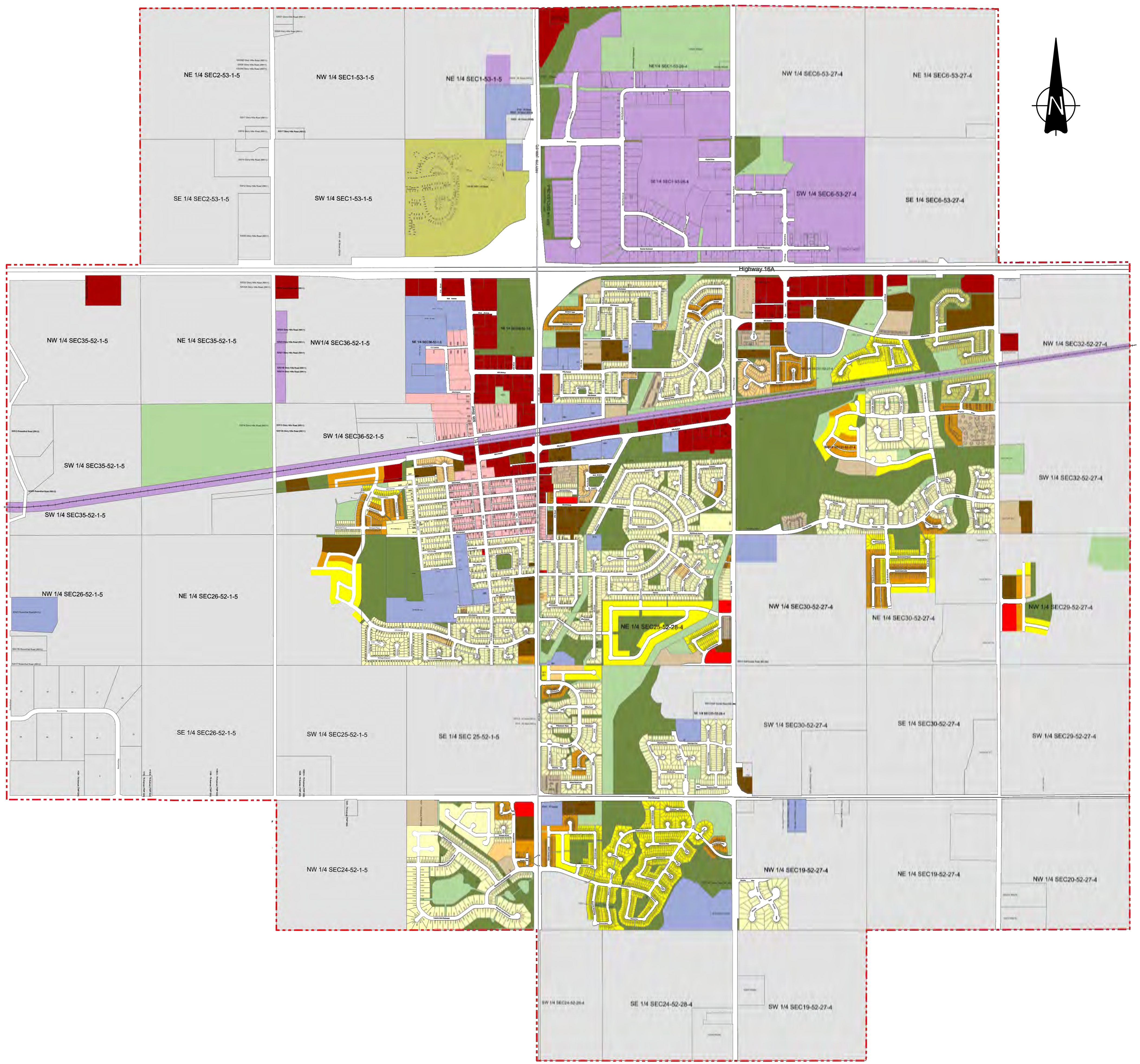
Project:

Stormwater Master Plan

Title:

Area Structure Plan

Scale:	Figure:
1:25,000	1.3



LEGEND:

LAND USE BYLAW DISTRICTS

Residential Districts

- R1 – Large Lot Detached Dwelling Residential District
- R2 – Detached Dwelling Residential District
- R3 – Manufactured Home Residential District
- R4 – Mixed Form Residential District
- R5 – Small Lot Mixed-Form Residential District
- R6 – Comprehensively Planned Residential District
- R7 – Multi-Unit Building Residential District
- R8 – High Density Residential District

Employment Districts

- C1 – Local Commercial District
- C2 – General Commercial District
- C3 – Central Mixed Use District
- M1 – Business Industrial District

Other Land Use Districts

- P1 – Parks District
- P2 – Community Services District
- P3 – Utility District
- FD – Future Development District

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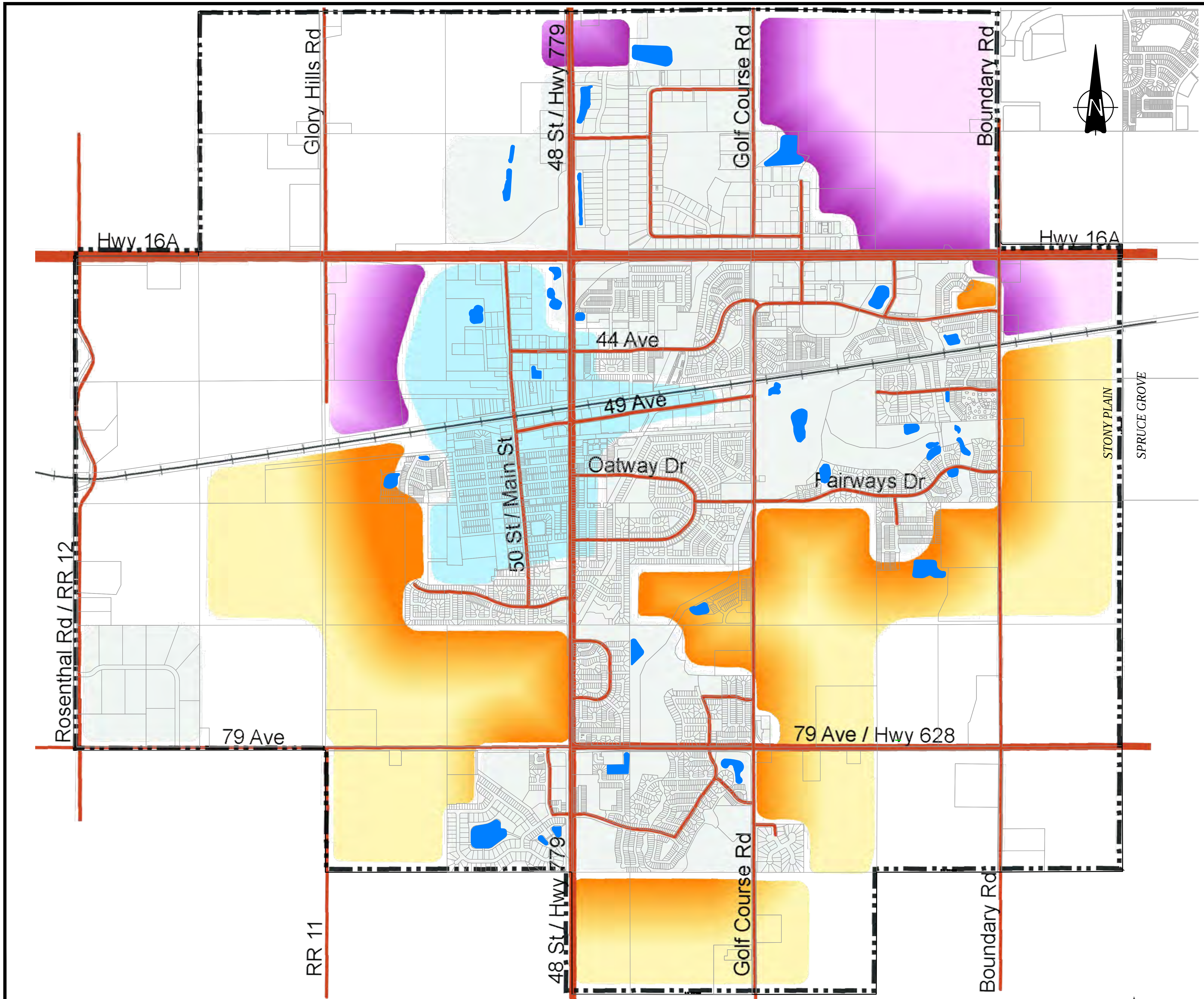
Project:

Stormwater Master Plan

Title:

Current Land Use

Scale:	Figure:
1:25,000	1.4



LEGEND:

- EXISTING DEVELOPMENT
- NEW RESIDENTIAL DEVELOPMENT
- NEW EMPLOYMENT LANDS
- INTENSIFICATION AREA
- EXISTING STORMWATER MANAGEMENT FACILITY

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TOWN OF STONY PLAIN

Project:

Stormwater Master Plan

Title:

Future Land Use

Scale:	Figure:
1:25,000	1.5

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2.0 Data Collection and Review

2.1 Overview

Several documents and information were reviewed through the course of this project. The following are some of the most relevant information that was collected/reviewed/used (in parts or entirely) for purposes of developing this storm drainage master plan.

2.2 Previous Storm Drainage Studies

Storm Drainage Study (Associated Engineering for Town of Stony Plain, 1976)

Provided an initial review of the four stream courses through Stony Plain, and proposed the following:

- Construction of stormwater ponds upstream of the Town boundary on Streamcourses 1, 2, and 3 to control the runoff from the agricultural areas upstream of the Town,
- Drainage parkways with a 30 m base width on Streamcourses 1, 2, and 3 to control runoff from the Town to a rate of 15 cfs/mi^2 (1.6 L/s/ha) in the 1:25 year storm,
- Channel regrading in Stream course 4, with storage of runoff from proposed development areas in the Highway ditch,
- Replacement of several culverts.

Storm Drainage Study (Associated Engineering for Town of Stony Plain, 1979)

Associated Engineering updated the previous study to investigate the flood conditions within the Town in more detail. The study included updated flood hydrology provided by Alberta Environment and backwater modelling using HEC-2 to generate water surface profiles under existing and upgraded conditions.

The study concluded that large areas of the Town were at risk of flooding due to runoff from upstream of the Town. The primary constraint was the existing culvert capacities at various locations, especially under the CNR in Streamcourse 1, and the restricted channel capacities along Streamcourses 2 and 3.

The study recommended re-grading of Streamcourses 1-3 and upgrading of culverts. Streamcourses 3 has subsequently been rebuilt and new culverts installed at Golf Course Road.

The study also recommended that flows from the basin upstream of the Town be controlled.

East Sanitary and Streamcourse 3 Channel Improvements (1983)

A major upgrade of Streamcourse 3 was completed in 1982, including:

- 1,830 m of storm drainage channel improvements (34,000 m^3 excavation) from 79 Avenue to CNR,
- Installation of culverts at 79 Avenue (1,600 mm diameter) and Golf Course Road (1,600 mm and 600 mm diameter),
- Installation of 10 culverts into Streamcourse 3 (300-600 mm diameter).

Deep Utility Study (Associated Engineering, 1997)

In 1997, Associated Engineering conducted an assessment of the Town's water and sanitary sewer systems. This assessment did not include the storm drainage system and, consequently, an overall assessment has not been completed since the 1979 drainage study.

South Business Park Stormwater Management Plan (Associated Engineering, 2002)

In March 2002, Associated Engineering completed the stormwater management plan for the South Business Park which investigated the flood conditions in Atim Creek and the stormwater management options for the South Business Park. The study concluded that existing lots along Atim Creek were at risk of flooding due to the restricted capacity of the culvert under the CNR.

The study recommended the following:

- that the CNR culvert be upgraded (subsequently done),
- that the Highway 16A culvert be upgraded to prevent overtopping of the highway in the 1:100 year flood (has not been done),
- a program of monitoring and assessment to confirm these findings (not done).

Big Lake Drainage Study (Associated Engineering, 2004)

Associated Engineering completed the Big Lake Basin drainage study in 2004, which examined the drainage issues of the basin and recommended that the runoff from all new developments be controlled to a maximum rate of 2.5 L/s/ha. It was also recommended that the region's municipalities continue to explore opportunities for regional stormwater management facilities to control runoff from existing development areas such as the older portions of Stony Plain.

Flood Risk Study (Sameng)

Sameng conducted the floodplain mapping for the primary drainage courses in the basin, including Atim Creek. Preliminary results indicate that the 1:100 year flood levels may be near the elevation of the roadway at Highway 16A, as indicated in the South Business Park study in 2002. Channel upgrading will be required in Atim Creek south of the existing development.

Services Master Plan Review Storm Drainage Master Plan Review – Stage 1
(Associated Engineering for Town of Stony Plain, January 2008)

- Undertook a review of the Storm Drainage System as part of the Town's Master Plan.
- Reviewed previous recommended updates to Streamcourse 1, 2, 3, and Atim Creek to include the results of the flood plain mapping project.
- Determined conceptual short-term upgrades and related costs to meet the Town's immediate needs.
- Determined conceptual long-term upgrades and related costs to meet the Town's future needs.

2.3 Planning Documents

2.3.1 General

Planning documents including Area Structure Plans (ASP), Area Redevelopment Plans (ARP), the Town's Municipal Development Plan (MDP) provide information related to land use, proposed road alignment and proposed drainage servicing concepts for future development areas. These documents were downloaded from the Town of Stony Plain's website. The study area of these plans is illustrated in Figure 1-3 and listed below.

2.3.2 Municipal Development Plan (MDP) (2013)

The MDP is the primary document that guides the future development and growth of the whole community. The MDP sets the vision on how to accommodate this growth responsibly and serves as an important decision-making tool for Council, administration and all stakeholders.

As a statutory plan under the Alberta Municipal Government Act, the MDP provides direction for Council, administration, developers and builders, property-owners, residents and adjacent municipalities. Furthermore, it abides by the polices and plans established by the Capital Region Board (CRB) to ensure consistency with the long-term regional interests in the CRB Growth Plan.

For municipalities with a population greater than 3,500, an MDP is a mandatory requirement under the MGA and must be adopted by Council through a bylaw and be consistent with provincial Land Use Policies.

An MDP addresses several issues, including: future land use; future development; coordination; transportation; and municipal services.

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2.3.3 Area Structure Plan (ASP)

- Aspen Meadows ASP Bylaw 2357 (March 9, 2009)
- Border ASP Bylaw 2263 (June 26, 2006)
- Border ASP Amendment Bylaw 2579 (September 25, 2017)
- Country Plains Estates ASP Bylaw 2034 (September 8, 1997)
- Deerfield ASP Bylaw 870 (September 26, 2009)
- East Boundary ASP Bylaw 2541 (July 13, 2015)
- Edgeland Park ASP Bylaw 2327 (November 13, 2007)
- Edgeland Park ASP Amendment Bylaw 2540 (July 13, 2015)
- Fairway North ASP Bylaw 2477 (January 28, 2013)
- Genesis on the Lakes ASP Bylaw 2258 (May 8, 2006)
- Genesis on the Lakes ASP Amendment Bylaw 2364 (May 11, 2009)
- Goertz Business Park ASP Bylaw 2315 (August 13, 2008)
- Graybriar ASP Bylaw 2099 (March 27, 2000)
- Graybriar ASP Amendment Bylaw 2198 (April 13, 2004)
- Lake Westerra Estates ASP Bylaw 2185 (May 26, 2003)
- Lake Westerra Estates ASP Amendment Bylaw 2290 (March 12, 2007)
- Meridian Cove ASP Bylaw 2261 (June 12, 2006)
- North Industrial ASP Bylaw 2309 (July 9, 2007)
- Northwest Industrial ASP Bylaw 791 (November 23, 1981)
- Northwest Industrial (Meridian Meadows) ASP Amendment Bylaw 1081 (May 13, 1991)
- Parkland Gateway ASP Bylaw 2542 (August 24, 2015)
- South Business Park ASP Bylaw 1173 (July 18, 1994)
- South Business Park ASP Amendment Bylaw 2058 (July 20, 1998)
- South Business Park ASP Amendment Bylaw 2064 (October 13, 1998)
- South Business Park ASP Amendment Bylaw 2155 (April 8, 2002)
- South Business Park ASP Amendment Bylaw 2209 (June 14, 2004)
- South Business Park ASP Amendment Bylaw 2268 (July 10, 2006)

- South Business Park ASP Amendment Bylaw 2272 (September 25, 2006)
- South Business Park ASP Amendment Bylaw 2455 (May 28, 2012)
- South Business Park (Sun Meadows) ASP Amendment Bylaw 2491 (July 8, 2013)
- South Creek ASP Bylaw 2275 (September 25, 2006)
- Southeast ASP Bylaw 865 (August 8, 1983)
- Southeast (High Park) ASP Amendment Bylaw 991 (October 24, 1988)
- Southeast (High Park) ASP Amendment Bylaw 998 (May 15, 1989)
- Southeast (High Park) ASP Amendment Bylaw 1023 (October 30, 1989)
- Southeast (High Park) ASP Amendment Bylaw 1031 (February 12, 1990)
- Southeast (High Park) ASP Amendment Bylaw 1095 (September 9, 1991)
- Southeast (High Park) ASP Amendment Bylaw 1178 (September 12, 1994)
- Southeast (High Park) ASP Amendment Bylaw 2037 (September 22, 1997)
- Southeast (Sommerville) ASP Amendment Bylaw 2345 (October 14, 2008)
- Southeast (Home Acres) ASP Amendment Bylaw 2399 (June 14, 2010)
- Southeast (Sommerville) ASP Amendment Bylaw 2519 (August 18, 2014)
- The Brickyard at Old Town ASP Bylaw 2521 (October 14, 2014)
- Willow Park ASP Bylaw 2105 (July 10, 2000)
- Willow Park ASP Amendment Bylaw 2125 (April 23, 2001)
- Willow Park ASP Amendment Bylaw 2257 (May 8, 2006)
- Willow Park ASP Amendment Bylaw 2278 (January 8, 2007)
- Willow Park ASP Amendment Bylaw 2350 (September 8, 2008)
- Willow Park ASP Amendment Bylaw 2557 (March 14, 2016)

2.3.4 Area Redevelopment Plan (ARP)

An Area Redevelopment Plan guides the redevelopment of a specific area or neighbourhood. Requirements include the proposed land uses for the redevelopment area and whether a redevelopment levy is to be imposed.

The Town of Stony Plain currently does not have any area redevelopment plans but is embarking on one for Main Street and the land surrounding the downtown core known as Old Town.

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2.4 Drainage System Data

- Sewer pipe layout and information in AutoCAD format and in shape file / GIS format.
- Stormwater Management Facilities Information (i.e. drawings, photos, information sheets).
- Additional information request for select sewer locations provided by Town of Stony Plain
- It is recommended that the Town maintain the inventory developed by this master plan project and to also institute a process of adding new information as developments occur.

2.5 Rainfall and Flow Monitoring Data

- There is currently no flow or rainfall monitoring data from the Town.
- It is recommended that the Town develop a rainfall and flow monitoring program and phase this into its routine operation.

2.6 Historical Flood Records

- There are no formal records kept at this time to document the performance of the storm system during heavy rainfall events.
- It is recommended that the Town implement a process to compile information such as news reports, pictures and videos (e.g. social media) of historical flood events for the purposes of recording flood prone areas and the extent of flooding. It is also recommended for the Town to measure water level in ponds, especially ponds that are identified to overflow during the 100-year design event. This information can be used for future studies to help identify improvements and to prioritize them. This information is also useful to calibrate/validate the computer model.

2.7 Other Collected Data

- Town of Stony Plain – Municipal Development Standards 2006
- Town of Stony Plain – Deep Utility Master Plan 2008
- Various AutoCAD / Shape files, including cadastral
- Recent LiDAR topographical data (dated April 2015 within the Town of Stony Plain)
- Recent aerial photos

2.8 Coordinate System

The Town of Stony Plain currently uses the 10TM coordinate system for all their database information. The 10TM system has become dated. The Alberta Survey Control Monuments (ASCM) do not provide their coordinates in 10TM. It is also challenging to convert a 10TM drawing into other coordinate system as the conversion factors are not straightforward. However, the meridian line between UTM 11N and 12N crosses the Town. Inaccuracies may occur if any of these two zones are used. Therefore, it is recommended that the Town continue to use the 10TM coordinate system.

3.0 Review of Municipal Development Standards

3.1 Overview

This section presents a review of the Town's Storm Drainage System design standards as found in Section 6 of the Town of Stony Plain's Municipal Development Standards. The drainage design standards are summarized in Table 3-1.

The Town's design standards were compared to the current standards for the City of Grande Prairie (2016), City of Edmonton (Volume 3 Drainage, March 2015) and Strathcona County (December 2011); this comparison is included in Table 3-1. Additionally, the information available in the "Province's Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems - Part 5: Stormwater Management Guidelines (2013 and 1999)" is also included in Table 3-1.

3.2 Recommended Changes to Current Design Standards

3.2.1 Section 6.1 – General

The main purpose of this section is to introduce the design standards.

The major and minor system design requirement as well as the target level of service should be included in the General section. The separated sewer system concept should be also be stated.

3.2.2 Section 6.3 – Minor and Major Systems

The concept of minor and major systems

It is recommended to expand this part for a comprehensive definition and the level of service of both minor and major systems. It is also suggested that this part should indicate that pipes downstream of stormwater management facilities need to be upsized by 25%.

3.2.3 Section 6.4.2 – Hydrograph Methods

It is recommended that the town consider adding other reputable software to the list, such as DHI Mike Urban and CHI PCSWMM.

3.2.4 Section 6.4.2 – Coefficient of Runoff

It is suggested that the Town consider the following equation to better define the runoff coefficient where:

$$C = ((0.95 \times \text{Impervious Area}) + 0.10(\text{Total Area} - \text{Impervious Area}))/\text{Total Area}$$

3.2.5 Section 6.6 – Rate of Precipitation

The Town's design guideline suggests that the most updated rainfall curves available for the area of development should be selected for design purposes but the specific parameters are not specified. It is recommended that the Town include the intended IDF curves in the design guidelines. This can be adopted from the City of Edmonton standards.

It is also suggested that the Town include the following design rainfalls for storm sewer designing:

4-hour and 24-hour Chicago distribution

12-hour and 24-hour Huff distribution

3.2.6 Section 6.7 – Site and Lot Grading

It is suggested that the Town specify its design standard. e.g. the min. max. allowable grading, schematic for grading requirements.

3.2.7 Section 6.20 – Pipe, Manhole and Bedding Materials and Specifications

It is suggested that the safety platforms part to be moved to 6.16.

3.2.8 Section 6.21 – Major Systems

It is suggested that the Town state the design storm (i.e. 1:100 year) in the beginning of section 6.21

3.2.9 Section 6.21.1 – Design – Dry Ponds

The Pond Size part can be moved into the Size section

It is suggested that the Town add the depth of pond section. Other design standards indicate that the maximum depth of pond is 1.5 m from invert of outlet pipe.

3.2.10 Section 6.21.2 – Design – Wet Ponds

It is suggested that the Town add the Fluctuation and the Freeboard parts to the design standards. The typical fluctuation is less than 2.0 m in residential areas for 1:100 year storm. The minimum freeboard is usually 0.3 m for a pond equipped with overflow to a suitable watercourse and 0.5 m for a pond without overflow.

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3.2.11 Section 6.21.3 – Design Wetlands

It is recommended that the Town considers expanding the inlet/outlet structure section to contain more quantified descriptions for maximum depth, submerged inlet/outlet, pipe invert elevation, emergency overflow, etc.

It is also recommended that the Town considers adding the following part for a comprehensive design standard on wetlands design:

Forebay, Permanent pool at the outlet, Fencing, Wetland Soil Characteristics, Wetland Vegetation, Upland Vegetation in the Extended Detention Storage Area around the Wetland, Side slopes.

3.2.12 Section 6.22.1 – Drainage Parkways

It is suggested that the Town considers adding the pond depth part to the design standards which is maximum 1.0 m measured from the NWL (City of Grande Prairie, 2018). The Inlets and outlets design should be also considered as well as the access.

3.3 Additional Recommendations to Design Standards

3.3.1 Water Quality Control Facility Design and Monitoring

Water quality control is an important component in the design process of the drainage system. As we are utilizing more linear water drainage corridors and incorporating Environmentally Significant Areas (ESAs) into the future development plans, the water quality control facilities should be considered as an essential element when designing drainage systems.

It is recommended to add a section specifically discussing the design criterion of the water quality control facilities. Sediment removal, oil and grease separation, and other water quality indexes should be considered and quantified.

Design and monitoring requirements should be based on recommendations from watershed studies.

3.3.2 Lot-Level Best Management Practices

Guidelines from Alberta Environment encourages municipalities to promote lot-level best practices for managing runoff. These practices are to reduce the impact of development on runoff rates, prevent pollution of waterways, and manage groundwater levels in urban areas. Current best practices are summarized below. These should be included in the design standards.

- **Reduced Lot Grading –** is intended to reduce runoff volumes and increase travel times. Outside of building envelopes, relatively flat lots will drain more slowly, allowing more runoff to soak into the ground, and reducing the potential travel distance of surface contamination. In flat areas, lot grading of less than 2% should be considered.

- **Surface Ponding and Rooftop Storage –** flat rooftops may be used to store direct runoff, which would reduce the load on stormwater infrastructure. Surface ponding in parking lots and green spaces may also be used to reduce peak flow rates. When these practices are used in private lots, there must be some way to ensure they are maintained in subsequent improvements.
- **On-Lot Infiltration Systems –** infiltration systems may be used to drain small areas without connection to a minor drainage system. Infiltration systems drain primarily through groundwater recharge, and so are limited to places where the risk of contamination is small, and the groundwater table allows for adequate infiltration.
- **Low Impact Development Practices –** there are many documents that thoroughly describe techniques to reduce the impact of urbanization on runoff. It is recommended that the Town select some appropriate practices for implementation consideration and also to encourage these practices in its engineering standard.

Table 3-1: Storm Drainage Design Standards Review.

Parameters	Recommended Changes	Town of Stony Plain, 2006 Municipal Development Standards, Section 6		City of Grande Prairie, 2018 Design Manual, Section 12			City of Edmonton, Dec. 2014 Design and Construction Standards, Volume 3 Drainage Section 12.0, 13.0	Strathcona County, Dec. 2011 Design and Construction Standards, Volume 1, Section 4.4	Alberta Environment and Parks, March 2013 and Jan. 1999 Standards and Guidelines		
6.1. GENERAL											
Storm Sewer Design	Storm sewers shall be designed as a separate system and consider both minor and major drainage.			Storm sewers shall be designed as a separate system and consider both minor and major drainage.			Storm sewers shall be designed as a separate system. New development areas in Edmonton shall be designed using the major/minor system concept.	Storm sewers shall be designed as a separate sewer system.	Storm sewers shall be designed as a separate sewer system. The dual drainage concept (minor and major systems) shall be followed in the design of the collection system.		
6.3. MINOR AND MAJOR SYSTEMS											
Return Period – Minor System	Recommend expanding this part for a comprehensive definition and the level of service of both minor and major system.	1:5 years		1:5 year; 1:5 year + 25% upsize for pipes downstream of stormwater management facilities 1:10 year for high value commercial areas (if required)			1:5 year for area ≤ 30 ha 1:5 year + 25% for area > 30 ha	1:5 year or greater	1:5 year; 1:2 year for several communities faced with limited financial reserves		
Return Period – Major System	Should indicate that pipes downstream of stormwater management facilities need to be upsized by 25%.	1:100 year		1:100 year			1:100 year and historic storm events	1:100 year	1:100 year		
6.4 DESIGN FLOWS											
6.4.1 Rational Formula		<50 ha		<65 ha			<65 ha	<65 ha	Recommended <50 ha		
6.4.2 Hydrograph Methods (Computer modelling requirement)	Considering adding other reputable software to list, such as DHI Mike Urban and CHI PCSWMM	Area ≥50 ha; Designing storage or detention facilities; May be used for areas <50 ha; OTTHYMO or SWMM/XPSWMM model accepted, other models shall be approved prior to sign.		Required where area ≥ 65 ha Required for sizing non-pipe stormwater management facilities (e.g. detention ponds) XP-SWMM preferred, other models may be considered.			Servicing areas larger than 65 ha All stormwater management storage facilities; DHI – Mike Urban and Mike 21 recommended	Areas greater than 65 ha	Any model as long as the engineer can demonstrate that the model is appropriate and accurate as compared to commonly accepted models		
6.5 COEFFICIENT OF RUNOFF											
Runoff Coefficient		1:5 year event		1:5 year	1:10 year	1:100 year	Based on zoning and imperviousness. For return period: - ≤1:10 year, C = (0.95ximp)+0.1(1.0-imp); - >1:10 year and ≤1:25 year, 1.1C; - >1:25 year and ≤1:50 year, 1.2C; - >1:50 year, 1.25C to a max of 0.95	1:5 year value C = ((0.95×Impervious Area)+0.10(Total Area-Impervious Area))/Total Area 1:100 Year - Increase to reflect the impact of antecedent moisture conditions	For return period more than 10 years, increase as follows until to a max of 0.95 1:25 year – add 10% 1:50 year – add 20% 1:100 year - add 25% Typical 1:5 Year coefficients		
Surface		Slope 1:01 to 1:15	Slope 1:15 to 1:50						Minimum	Mean	Maximum
Pavements and Walks		0.95	0.95	Paved Streets 0.90	0.95	0.95	0.95		0.70	0.83	0.95
				Gravel Streets 0.25	0.35	0.65	-				
Roofs		0.95	0.95						0.70	0.83	0.95
Clay Soils											
Sparse Vegetation		0.70	0.55								
Lawns		0.30	0.20								
Weeds and Bush		0.20	0.15								
Dense wood		0.17	0.12								
Sandy Soils											
Sparse Vegetation		0.40	0.30								
Lawns		0.17	0.12								
Weeds and Bush		0.15	0.10								

Parameters	Recommended Changes	Town of Stony Plain, 2006 Municipal Development Standards, Section 6		City of Grande Prairie, 2018 Design Manual, Section 12			City of Edmonton, Dec. 2014 Design and Construction Standards, Volume 3 Drainage Section 12.0, 13.0	Strathcona County, Dec. 2011 Design and Construction Standards, Volume 1, Section 4.4	Alberta Environment and Parks, March 2013 and Jan. 1999 Standards and Guidelines		
Dense Woods		0.13	0.08								
Agricultural		0.10		Undeveloped Land (Farmland) 0.10	0.15	0.20	-		Unimproved – 0.10	0.20	0.30
Low Density Rural Residential		0.15									
High Density Rural Residential		0.25							Suburban – 0.25	0.33	0.40
Schools		0.30									
Colleges		0.75									
Urban Residential		0.45		Residential 0.50	0.50	0.60	Single Family – 0.65	Single Family – 0.40	Single family urban – 0.30	0.40	0.50
Medium Density Residential		0.60		Apartments 0.70	0.70	0.80	Low rise – 0.65 Medium rise – 0.75 High rise – 0.90		Multiple, detached – 0.40	0.50	0.60
High Density Residential		0.95					Row Housing/Multi Family/Low Rise Apt – 0.65	Must be calculated	Multiple, attached – 0.60	0.68	0.75
									Apartment – 0.50	0.60	0.70
Commercial		0.75		Downtown Commercial - 0.85	0.90	0.90	0.90	Must be calculated	0.70	0.83	0.95
				Residential Commercial - 0.70	0.70	0.80			0.50	0.60	0.70
Light Industrial		0.75		0.60	0.70	0.70	0.60	Must be calculated	0.50	0.65	0.80
Asphalt, Concrete, Roof		0.95					0.95				
Lawns, Parks, Playgrounds				0.20	0.25	0.30	Parks, Schools – 0.30	0.15	Parks, Cemeteries – 0.1	0.18	0.25
									Playgrounds – 0.20	0.28	0.35
Heavy Industrial							0.50		0.60	0.75	0.90
Medium Industrial, Industrial Business							0.90				
Railroad yards									0.20	0.28	0.35
Imperviousness	It is suggested that the Town consider the imperviousness to better estimate the runoff coefficient: C = ((0.95×Impervious Area)+0.10(Total Area-Impervious Area))/Total Area			Minimum Percent Impervious			Typical Range				
Single Family Residential				50%			40% - 60%				
Multi-Family Residential				65%			Row Housing/Multi-Family/Low-Rise Apt. 40% - 90%		Multi-Unit detached 50% Multi-Unit attached 70%		
Medium-Rise Apartment				90%			40% - 90%		Apartment 70%		
High-Rise Apartment							40% - 100%				
Neighbourhood Commercial				80%			40% - 100%		70%		
Downtown/Large Commercial				90%			40% - 100%		90%		
Industrial				70%			Light: 50% - 100% Medium: 40% - 100% Heavy: 40% - 70%		Light: 80% Heavy: 90%		
Public Park				10%			10% - 50%		Parks 7%, Playground 13%		
Predominantly Grassed Areas				10%			10% - 30%		Lawns 0%		
Schools				30%			10% - 50%		50%		
Asphalt, Concrete Rooftop				100%			90% - 100%		Roofs 90%, Paved streets 100%		
6.6 RATE OF PRECIPITATION											
Return period		Minor system – 1:5 year curve Major system – 1:100 year curve									

Parameters	Recommended Changes	Town of Stony Plain, 2006 Municipal Development Standards, Section 6	City of Grande Prairie, 2018 Design Manual, Section 12	City of Edmonton, Dec. 2014 Design and Construction Standards, Volume 3 Drainage Section 12.0, 13.0	Strathcona County, Dec. 2011 Design and Construction Standards, Volume 1, Section 4.4	Alberta Environment and Parks, March 2013 and Jan. 1999 Standards and Guidelines
Inlet time		Inlet Time: Max. 10 minutes	Time of Concentration: Min. 15 minutes for large parklands Min. 10 minutes for all other lands	Inlet Time (Minutes) Imperviousness (%) Catchment Area (A): 30 / 50 / >70 A = 8 ha or less: 8 / 8 / 5 8 ha < A < 40 ha: 9.2 / 9.2 / 6 A = 40 ha or more: 10.4 / 10.4 / 7.25	Inlet Time: Max. 15 minutes for residential areas, shorter inlet times for commercial industrial or high density residential areas required	
Intensity-Density-Frequency (IDF) Curve	It is recommended that the Town provide the Intensity-Density-Frequency (IDF) curve in its design guidelines.		Tabulated IDF rainfall data provided	Tabulated IDF rainfall data provided	Tabulated IDF rainfall data provided	
Synthetic Design Rainfalls/Design Hyetograph	It is recommended that the Town includes the following synthetic rainfall for storm sewer designing: 4 hour and 24 hour Chicago distribution 12 hour and 24 hour Huff distribution		- 4 hour Chicago Hyetograph for mains - 12 hr AES and 24 hour SCS for detention ponds	- 4 hour Chicago distribution hyetographs for conveyance systems - 24 hour Huff distribution hydrograph and historical storms for stormwater management design		
6.7 SITE AND LOT GRADING						
	It is suggested that the Town quantifies its design standard by referencing other design standards eg. the min. max. allowable grading, schematic for grading requirements.	Only mentioned that lot shall be graded to drain to the municipal storm systems. Mentioned that building shall be above the Major System hydraulic grade line for 100 year event plus a minimum of 0.3 m free board.	Section 15, Lot Grading Generally 1.5% min. slope	Generally 1.5% min. slope	Generally 2% to 10%. An initial minimum grade of 10% over a distance of 1.5 m is to be provided around all buildings. Driveway slopes:2% to 8%	Typical grading of 2%
6.8 FOUNDATION DRAINS						
		- No connection to sanitary system, - Depth should match the sanitary sewer service at the property line, - Depth shall be adequate to receive the drain service, - Minimum depth of cover 2.4 m, Min. size and grading, 200 mm and 0.4% for foundation drain sewer; 100 mm and 1% for foundation drain service, - PSM type PVC pipe or Open Profile PVC pipe required.	- Residential, apartments, commercial and industrial buildings shall discharge to grassed or pervious areas. - One and two family dwellings may discharge to the storm sewers system when a service connection has been provided. - Apartment buildings, commercial and industrial areas may discharge to the storm sewers system through an approved service connection.	- Connection of foundation drains (weeping tile) to sanitary sewer systems is no longer permitted. Therefore, for new development areas a specific allowance for foundation drain flow to sanitary sewers is not required. However, the designer is required to account for foundation drain flow when computing sanitary design flows from areas developed prior to 1990 where such connections may be present. - Min. depth of cover 1.5 m for sewer larger than 610 mm. Min. depth of cover 2.0 m for the storm service. - Foundation drain service connections are to be provided to all new detached, semi-detached and duplex residential units. Storm service connections are also to be provided to the same residential units when roof leaders' discharges from one lot will drain to another lot. In addition, storm service connections are to be provided when dictated by geotechnical requirements as identified in	- A sump pump discharge collection service must be provided to the property line of each single family lot or multi-family unit. - Roof leaders or any other stormwater source must not be connected to this system.	Where appropriate, discharge to an infiltration system.

Parameters	Recommended Changes	Town of Stony Plain, 2006 Municipal Development Standards, Section 6	City of Grande Prairie, 2018 Design Manual, Section 12	City of Edmonton, Dec. 2014 Design and Construction Standards, Volume 3 Drainage Section 12.0, 13.0	Strathcona County, Dec. 2011 Design and Construction Standards, Volume 1, Section 4.4	Alberta Environment and Parks, March 2013 and Jan. 1999 Standards and Guidelines
				the Hydrogeotechnical Impact Assessment or Slope Stability Evaluations for top-of bank locations.		
6.9 ROOF DRAINAGE						
		- Roof drainage from one-family and two-family dwellings shall be discharged to the ground and dispersed via splash pads at the downspouts. The point of discharge shall be a minimum 1.5 m away from the building (including downspout extensions) to ensure water flows away from it. - Roof drainage from apartment buildings residential/commercial/industrial areas may discharge to the storm sewer where the new and existing systems are designed to accommodate the direct discharge and only if approved by the Town.	- Residential, apartments, commercial and industrial buildings discharge to grassed or pervious areas. - Apartment buildings, commercial areas and industrial areas may discharge to the City's storm sewer system through an approved storm service connection	Where storm sewer service connections are not provided to each lot or downspouts are not to be connected to a storm service, provisions to carry and discharge roof drain flows away from the building foundation and to control erosion are required.	- Roof leaders must discharge to a landscaped area wherever possible. - Commercial sites may be connected to a storm service if this is not practical.	-Roof leaders to discharge to surface ponding areas where possible. - Rooftop storage for commercial, industrial, and institutional buildings
6.10 FLOW CAPACITIES						
6.10.1 Storm Sewers and Open Channels		Mannings formula $Q = (AR^{0.667}S^{0.5})/n$	Manning's formula n = 0.013 for concrete and plastic pipes	Manning's formula	Manning's formula with n = 0.013	Manning's formula
Roughness coefficient						
PVC pipe		0.013		All smooth-wall pipe 0.013		
Smooth walled concrete pipe		0.015				
Corrugated still pipe (unpaved)		0.024		0.024		
Corrugated steel pipe (invert paved)		0.020		0.020		
Gravel lined channels		0.020		All paved CSP: 0.013		
Concrete or asphalt lined channels		0.015				
Natural streams and grassed channels		0.05				
6.10.2 Culverts		Use the inlet control and outlet control methods referred to in: 1. The Handbook of Steel Drainage and Highway Construction Products, by the American Iron and Steel Institute 2. The Handbook of Concrete Culvert Pipe Hydraulic by the Portland Cement Association.	Culvert and bridge design should consider backwater effects over a range of flows. The design of a hydraulic structure requires assessment of both its nominal design "capacity" and its performance during the 1-in-100-year event.	- The Engineer may require submission of hydraulic design calculations to identify design flow conditions and inlet head requirements for culverts. The need for energy dissipation and erosion control measures is to be considered for each design. When hydraulic considerations or minimal cover do not govern, the minimum culvert size shall be 400 mm, to allow for reliability and ease of maintenance. - Culverts are to be constructed with approved sewer material when they will be permanent structures. End treatment and traffic protection are to be suitable for the location under consideration. All temporary crossings shall have culverts installed prior to road construction whenever feasible and are to be extended sufficiently to prevent end blockage. Refer to the Construction Specifications for typical end treatment. - The discharge flow characteristics of culverts shall be analyzed and appropriate measures taken to avoid	- Min. size 600 mm for road crossing. Min. size 400 mm for access. Additional sections for culvert design. Min. wall thickness of 1.6 mm for 400 mm diameter and 2.0 mm for larger diameter culverts. - All culverts to be buried a ¼ of the diameter below ditch invert. Culverts are to have 3:1 sloped end treatments. Culverts of ≤ 600 mm require rip-rap erosion control.	

Parameters	Recommended Changes	Town of Stony Plain, 2006 Municipal Development Standards, Section 6	City of Grande Prairie, 2018 Design Manual, Section 12	City of Edmonton, Dec. 2014 Design and Construction Standards, Volume 3 Drainage Section 12.0, 13.0		Strathcona County, Dec. 2011 Design and Construction Standards, Volume 1, Section 4.4	Alberta Environment and Parks, March 2013 and Jan. 1999 Standards and Guidelines
				erosion. For outlets of large culverts, the requirements of Storm Sewer Outfall Structures, shall apply, in respect of erosion control and safety.			
6.11 PIPE LOCATION							
Minimum separation		- Min. separation of storm sewer from water mains: • 3.0 m horizontally • 0.5 m vertically above or below water pipe and in separate trench if 3.0 m horizontal separation is not possible - Minimum separation of storm sewer from sanitary sewer: 3.0 m horizontally.	- Min. horizontal separation: From water mains, 2.5 m center/center for pipes ≤ 300 mm, 2.2 m from outside walls for pipes >300 mm - Min. vertical separation: 500 mm from water mains from outside walls, 500 mm from sanitary sewers from outside walls	Min. horizontal separation: 2.4 m center/center between parallel sewers, 250 mm between sewers in common trench		- Min. horizontal separation: 2.5 m from water mains, 1.8 m from gas lines - Min. vertical separation: Normally water mains cross above sewers, 0.5 m from water main crown to sewer invert	
6.12 MINIMUM DEPTH OF COVER							
		Storm sewers in road: 2.1 m to obvert, Culverts across roads: 1.0 m to obvert, Catch basin leads at the catch basin: 1.8 m to obvert, Landscaped areas: 2.5 m to obvert	1.5 m from finished surface grade to top of pipe	2.0 m for pipe <610 mm, 1.5 m for pipe ≥610 mm, when not achieved, provide adequate insulation		1.5 m to top of pipe	1.2 m to pipe crown
6.13 MINIMUM PIPE DIAMETER							
		Storm sewers: 300 mm Culvert crossing roads: 500 mm Catch basin leads: 300 mm Foundation drain sewers: 200 mm Foundation drain services: 100 mm	300 mm in general, 200 mm – Residential lot service main with grade ≥ 0.4%	300 mm – Storm sewers 250 mm – Catchbasin leads 200 mm – Foundation drain sewer		300 mm, 150 mm – Sump pump collection system	300 mm
6.14 MINIMUM VELOCITY AND GRADE							
		Mean velocity of 0.9 m/s, no less than 0.6 m/s	0.6 m/s	0.6 m/s		0.6 m/s	0.6 m/s when flowing in full
Pipe size (mm)		Min. grade (%)	Min. grade (%)	Straight (%)	Curve (%)	Min. slopes increase 50% on all curves	Based on 0.6 m/s velocity for pipe flowing at least half full Consider increasing grade fro curves
200		0.4 (foundation drain sewer only)	0.4	0.4 (foundation drain sewer)		N/A	N/A
250		0.25 (foundation drain sewer only)		0.28 (foundation drain sewer)		N/A	N/A
300		0.22	0.22	0.22	0.25	0.22	0.194
375		0.15	0.15	0.15	0.18	0.15	0.145
450		0.15	0.12	0.12	0.15	0.15	0.114
525		0.15	0.1	0.10	0.13	0.15	0.092
600 and larger		0.15	0.1	0.10	0.10	0.15	0.077 for 600 mm to 0.010 for 2820 mm
6.15 CURVED SEWERS							
		Minimum grade shall be 50% greater than the aforementioned grades. Maximum joint deflection shall be as recommended by the pipe manufacturer. Curved sewers shall be aligned parallel to the road centreline.	- Only to follow curved ROW; - Radius ≥ 90 m or manufacturer's minimum recommended radius, whichever is larger; - Manholes shall be located at the beginning and end of the curve; - Manholes shall be located at intervals ≤90 m along the curve; - Parallel to property line; - Minimum grade 50% greater than the minimum grade required for straight runs.			Run parallel to curb or street centreline	Only allowed for pipes ≥ 1.0 m
6.16 MANHOLES							

Parameters	Recommended Changes	Town of Stony Plain, 2006 Municipal Development Standards, Section 6	City of Grande Prairie, 2018 Design Manual, Section 12	City of Edmonton, Dec. 2014 Design and Construction Standards, Volume 3 Drainage Section 12.0, 13.0	Strathcona County, Dec. 2011 Design and Construction Standards, Volume 1, Section 4.4	Alberta Environment and Parks, March 2013 and Jan. 1999 Standards and Guidelines
Upstream/downstream pipe		- Generally, the crown of the downstream pipe shall not be higher than that of the upstream pipe. However, the 0.8 depth point of both pipes may be placed at the same elevation. - A smooth transition shall be provided between the inverts of incoming sewers and the outlet sewer and extreme changes in elevation at manholes should be avoided wherever feasible.				< 600mm, 0.8 depth point of both sewers should be matched; ≥ 600mm, drop manhole should be used
Minimum drop		Minimum drop in invert levels across manholes to account for energy loss: • straight runs and deflections up to 45° - 30 mm drop minimum • deflection 45° to 90° - 60 mm drop minimum Deflections greater than 90° shall be accommodated using two (2) or more manholes.	- 30 mm, - 60 mm at change in direction, - Consider minor losses - inlet pipe > 525 mm & bend > 45° or velocity > 1.5 m/s	For sewers ≤ 600 mm: - 30 mm for deflections < 45°, - 60 mm for deflections of 45° to 90°, Detailed analysis for large sewers, high velocities or complex/unusual junctions	12 mm, 50 mm at change in direction	
Drop manholes		Where drops greater than 1.0 m cannot be avoided, a specifically designed drop manhole will be required to address the hydraulic requirements of the change of elevation. Considerations include: • The pipe shall be of sufficient size so that it does not surcharge. • A smooth vertical curve shall be formed between the inlet pipe and the drop shaft with no breaks in grade, projections, or edges. • The drop shaft diameter shall be equal to or greater in size than that of the largest inlet pipe. For multiple connections, a larger drop shaft shall be supplied. • Air vents shall be provided. • The cover shall be able to withstand pressures from air discharge and surcharging. • The outlet shall provide a hydraulic jump basin to dissipate energy, to convert the flow to subcritical velocity, and to allow for air release.	≤ 1.0 m - ensure free outflow and low backwater conditions will exist in the downstream sewer, > 1.0 m - specifically designed drop manhole may be required			
Dropshafts		Baffled vertical drop shafts are generally not permitted due to potential maintenance and access problems. Vortex type drop shafts are preferred. Proposals to use vortex type drop shafts must be supported by the appropriate design calculations and approved by the Manager of Engineering.				
6.17 MANHOLE SPACING						
		- Max. 120 m for sewer ≤900 mm - Max. 150 m for sewer >900 mm - For curved sewers: Max. 90 m for sewer ≤1200 m and 120 m for sewer > 1200 mm	- 120 m, - 90m on curved sewer, with MH at beginning and end of curve.	- 150 m - < 1200 mm, - 500 m - 1200 mm to 1650 mm, - 800 m - ≥ 1800 mm	150 m	- 120 m - ≤ 375 mm, - 150 m - 450 mm to 750 mm - Greater spacing allowed for > 750 mm
6.18 CATCH BASINS						
Maximum space		120 m, Max. distance to first catch basin: 150 m				

Parameters	Recommended Changes	Town of Stony Plain, 2006 Municipal Development Standards, Section 6	City of Grande Prairie, 2018 Design Manual, Section 12	City of Edmonton, Dec. 2014 Design and Construction Standards, Volume 3 Drainage Section 12.0, 13.0	Strathcona County, Dec. 2011 Design and Construction Standards, Volume 1, Section 4.4	Alberta Environment and Parks, March 2013 and Jan. 1999 Standards and Guidelines
Sump		500 mm				
Catch basin leads	It is suggested that the Town include the maximum length of the CB leads.	- Min. slope 2.0%, - Min. cover 1.8 m from design finish grade to pipe obvert, - Directly discharge into stormwater manholes, - Catch basin for CB lead ≤ 18 m, - Catch basin MH for CB lead >18 m	- Min. diameter: 300 mm - Min. slope: 2.0% - Min. cover: 1.20 m from the finished road surface to the top of pipe, - Max. length: 30 m, - Hydraulic gradient: Match the obvert of the senior pipe	- Min. diameter: 250 mm, - Min. slope: 1.0%, - Min. cover: 2.0 m, - Max. length: 30 m	- Min. diameter: 250 mm, 300 mm for F51 CB, - Min. slope: 1.0%, - Min. cover: 1.5 m, - Max. length: 30 m	Min. diameter: 250 mm,
6.19 CULVERTS AND DRAINAGE (RURAL)						
Ditch grade		- Min. grade: 0.5%, - Ditch shall be protected for grade greater than 2.0%				
Ditch bottom		- Min. bottom width: 1.5 m, - Min. sloping away from the roadway: 5.0%				
Culvert size		- roadway cross culvert: 500 mm - residential approach culvert: 400 mm - industrial approach culvert: 500 mm				
Culvert material		Corrugated steel pipe Min. wall thickness 1.6 mm				
Culvert depth of cover		Min. 500 mm or half the culvert diameter whichever is greater				
Riprap		Riprap material shall consist of rock ranging in size from 150 mm to 350 mm with 50% of the rock material being larger than 200 mm.				
Geotextile Fabric		Non-woven fabric with a minimum tensile strength of 1300 N				
6.20 PIPE, MANHOLE AND BEDDING MATERIALS AND SPECIFICATIONS						
6.20.1 Pipe materials		Material; Range (mm); Specifications				
Accepted pipe materials		Reinforced Concrete; 300 and up; CAN/CSA A257 Class 3 min.				
		PVC; 200 to 400 mm; ASTM D3034 Min. Class DR35				
		Open Profile (PVC); 400 to 900 mm; CSA-B182.4, 320 kPa pipe				
		Corrugated Steel Culverts; 400 and up; Stiffness ASSHO-M-36				
6.20.2 Manholes						
Cement		Sulphate resistant Type 50				
MH sections		Precast reinforced concrete conforming to ASTM C478 and CSA A257.4				
MH steps		Aluminum forged of 6061-76 alloy, min. tensile strength 200 MPa				
Joints		Sealed with rubber gaskets conforming to ASTM C443, grouted inside and outside with non-shrink grout				
Frame and cover		Cast iron Class 20 ASTM A48				
Pre-benched MH bases		Shall be used wherever possible				
Tee riser manholes		CSA 257.2/ASTM C76 (pipe components) and CSA A257.4/ASTM C76 (manhole riser				

Parameters	Recommended Changes	Town of Stony Plain, 2006 Municipal Development Standards, Section 6	City of Grande Prairie, 2018 Design Manual, Section 12	City of Edmonton, Dec. 2014 Design and Construction Standards, Volume 3 Drainage Section 12.0, 13.0	Strathcona County, Dec. 2011 Design and Construction Standards, Volume 1, Section 4.4	Alberta Environment and Parks, March 2013 and Jan. 1999 Standards and Guidelines
		component)				
Perched MHs		Required on mains ≥ 600 mm				
Safety platforms	Move this part to 6.16	Aluminium, depth greater than 6.0 m.	> 6.5 m in depth		> 5.0 m depth	
6.20.3 Bedding Material		Class B sand bedding				
6.20.4 Outfall Structures						
Exit velocity		- Hydraulic analysis required, - Final velocity < 1.5 m/s	≤ 1 m/s and may be further limited depending on site specific soil and flow conditions	≤ 1 m/s and may be further limited depending on site specific soil and flow conditions		
Erosion control		Required downstream of the outfall	- Where necessary to prevent erosion - Hydraulic analysis required at all outfalls	Erosion control measures are to be provided at and downstream of the outfall to prevent erosion in the downstream channel.	Use where necessary to prevent erosion	
Grates		- Lockable grates, - Guardrails and/or fences where required for safety	Grate with vertical bars ≤150mm to prevent entry	- Lockable grate with vertical bars spaced ≤ 150 mm. - Guardrails or fences along headwalls and wingwalls.	Grates shall be provided to restrict access	
Aesthetics		Shall be considered	- Should be as safe and attractive as is reasonably possible. - Cosmetic treatment or concealment to be considered. - Concrete surface treatment recommended.	- Should be as safe and attractive as is reasonably possible. - Cosmetic treatment or concealment is to be considered. - Concrete surface treatment is recommended.		
6.21 MAJOR SYSTEMS	It is recommended that the Town mention the design return period (1:100 year) in the beginning of section 6.21					
6.21.1 Design – Dry Ponds						
Size		Sized to store storm run-off in excess of the pre-development flows				
Sideslopes		No steeper than 5:1	Max 5H:1V within public property	Max 7H:1V within private property, Max 5H:1V within public property		4H:1V
Bottom grade		-Graded to have positive drainage to the outlet, -Min. bottom slope 2%	Min 1%, greater where feasible, ≥ 2% for lateral slopes, French drains may be required	Min 0.7%, ≥ 1.0% where feasible, ≥ 1.0% for lateral slopes, French drains may be required		1% minimum
Surface		Topsoilded and seeded except for the low flow channel	- Landscaping plans to be submitted with engineering drawings, - Min requirement - establish grass cover	- Landscaping plans to be submitted with engineering drawings, - Min requirement - establish grass cover		
Inlet/outlet structures		Permanently fixed grate to prevent unauthorized entry	- Require safety grate with Max clear spacing of 150 mm, - Grated outlet's hydraulic capacity ≥ 200% design flow, - Flow velocity ≤ 1.0 m/s, - Fencing/guardrails for headwalls & wingwalls, - Inlet & outlet to be separated, - Emergency overflow to overland route where possible	- Require safety grate with Max clear spacing of 150 mm, - Grate outlet's hydraulic capacity ≥ 200% design flow, - Flow velocity ≤ 1.0 m/s, - Fencing/guardrails for headwalls & wingwalls, - Inlet & outlet to be separated		
Out flow pipe		- Sized for flow 25% greater than max. designed flow, - Water release controlled by orifice or other means				

Parameters	Recommended Changes	Town of Stony Plain, 2006 Municipal Development Standards, Section 6	City of Grande Prairie, 2018 Design Manual, Section 12	City of Edmonton, Dec. 2014 Design and Construction Standards, Volume 3 Drainage Section 12.0, 13.0	Strathcona County, Dec. 2011 Design and Construction Standards, Volume 1, Section 4.4	Alberta Environment and Parks, March 2013 and Jan. 1999 Standards and Guidelines
		- Increased flow rate in an emergency				
Pond size	This part can be moved to the Size section.	Sized to store 1:100 year storm event plus adequate free board for maximum historical event				
Emergency drainage		An emergency overland drainage swale shall be provided from the downstream end of the pond to the receiving stream with capacity to transport storm runoff should a downstream malfunction occur.				
Landscaped/rip-rapped channel		Accommodate 1:5 year event and low flow condition				
Public usage		Dry ponds shall be designed as an amenity to the development with passive park features and links to pedestrian walkways for use by the public.				
Depth of pond	Mention the maximum depth of the dry pond		Max. 1.5 m from invert of outlet pipe	Max 3.0 m from invert of outlet pipe		Typically 1.0 to 1.5m, 0.6m freeboard
6.21.2 Design – Wet Ponds						
Surface area		Min. 2 hectares, needs approval for area < 2 hectares	2 ha at NWL			
Pond size		- Sized to store 1:100 year storm event plus adequate freeboard for maximum historical event. - Max. water depth fluctuation of 1.5 m.				
Pond water turnover rate		Twice per year based on 1:5 year low precipitation rate				
Emergency drainage		An emergency overland drainage swale shall be provided from the downstream end of the pond to the receiving stream with capacity to transport storm runoff should a downstream malfunction occur.				
Pond bottom		Impervious material	- Ground water table < NWL: Bottom and side slopes to be impervious material (permeability coeff ≈ $1x10^{-6}$ cm/s). - Ground water table ≥ NWL: Pond bottom may be pervious material as dictated by geotechnical considerations.	- Ground water table < NWL: Bottom and side slopes to be impervious material (permeability coeff ≈ $1x10^{-6}$ cm/s). - Ground water table ≥ NWL: Pond bottom may be pervious material as dictated by geotechnical considerations.	Impervious material.	
Pond depth		- Min. 2 m NWL, 3 m where practical - Supplementary water supply incorporated to ensure min. water level	2.0 m to 2.5 m			
Dead bay areas		Not permitted	- Narrow/dead bay areas to be avoided. - Locate inlets & outlets to maximize detention time and circulation	- Narrow/dead bay areas to be avoided. - Locate inlets & outlets to maximize detention time and circulation	Stagnant/poorly circulated areas to be eliminated. Semi-annual turnover at average annual precipitation.	
Inlet/outlet structures		Submerged min. 1.2 m below NWL and posted at the surface	- Fully submerged, crown at least 1.0m below NWL - < 25 m of pipe flooded - Invert of inlet at first manhole upstream ≥ NWL - Obvert of inlet at first manhole upstream ≥ 1:5 year Elevation - Inlets & outlets separated to avoid shortcircuiting	- Fully submerged, crown ≥ 1.0m below NWL - Pipe inverts ≥ 100 mm above lake bottom - Invert of inlet at first manhole ≥ NWL - Obvert of inlet at first manhole ≥ 1:5 year Elevation - Inlets & outlets separated to avoid shortcircuiting	- Submerged inlets preferred with minimum 1.0 m below NWL	
Pond elevation		Max. water level below adjacent house basement footings				
Side slope		7:1	7H:1V - HWL to 1.0 m below NWL,			

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			3H:1V - 1.0 m below NWL to bottom			
Normal water elevation		Under 1:5 year storm, the lowest catch basin invert not surcharged				
Shoreline treatment		- 4.5 m wide band of granular material 2.0 m below and 2.5 m above NWL - 50 mm to 150 mm evenly graded - Suitable bank protection if necessary	- Compatible with the adjacent land use - Required from 1.5 m below to 3.0 m horizontally above NWL	Edge treatment required for an increase or decrease from NWL of 0.3 m		
Buffer strip		- Provided between NWL and 1:25 year flood level - Limited to 1 m vertical rise				
Fluctuation	Suggest to contain this part		≤ 2.0 m in residential areas for 1:100 year storm		1.5 m (or otherwise approved by Alberta Env.)	Max active detention storage depth of 1.5 m
Freeboard	Suggest to contain this part		- Minimum 1.0 m, - Municipal Engineer may reduce if Pond surface >2 ha and Fluctuation <1.0 m during 1:100 year event.	Min 0.3 m	0.5 m	0.5 m
Sediment removal provisions	Suggest to contain this part		- Requires sediment removal process during neighbourhood development - Sediment basins at all inlet locations	- Requires sediment removal process during neighbourhood development - Sediment basins at inlet locations		
6.21.3 Design Wetlands						
Size		Approximately 5% of the watershed area	- Minimum drainage area of 5 ha, - Smallest practical drainage area – 20 ha, - Hydrological studies required, - City prefers fewer larger wetlands vs. series of small wetlands, - Sediment controls required during development in the drainage area	- Minimum drainage area of 5 ha, - Smallest practical drainage area - 20 ha, - Hydrological studies required, - City prefers fewer larger wetlands vs. series of small wetlands, - Sediment controls required during development in the drainage area		
Surface area		Approximately 10% of the wetland surface area should be a 1.5 to 2.0 m deep sediment forebay upstream of the wetland area for settleable solids removal.	- Minimum 1 ha at NWL, - typically 3% to 5% of drainage area	- Minimum 1 ha at NWL, - typically 3% to 5% of drainage area		Approx. 5% of watershed area
Water depth		0.3 m with 1 m deep zones for flow redistribution and for fish and submerged or floating aquatic vegetation habitat.	- 0.1 m to 0.6 m, average 0.3 m - Deep water areas (> 2 m) < 25% of surface area, - Water fluctuations > 1 m above NWL should be infrequent	- 0.1 m to 0.6 m, average 0.3 m - Deep water areas (> 2 m) < 25% of surface area, - Water fluctuations > 1 m above NWL should be infrequent		- Average depth 0.3 m - Approx. 10% of surface area 1.5 to 2.0 m deep sediment forebay
Active storage		0.3 to 0.6 m deep				Active storage 0.3 to 0.6 m
Length to wide ratio		As low as 1:1, Increase where required to maximize treatment and to prevent short-circuiting	Minimum of 3 for effective flow path at low flow	Minimum of 3 for effective flow path at low flow		As low as 1:1
Bottom slope		0.5 to 1.0% smooth bottom				
Size		Store 1:100 year storm event				
Inflow/outflow structure	Consider expand this part to contain more quantified descriptions such as max. depth, submerged inlet/outlet etc.	Regulated inflow and outflow structures required	- Inlets are to discharge to a forebay, - Variable water level control required. Control structure capable of maintaining NWL ±0.5m, - Located to avoid short-circuiting, - Max depth 3.0 m, - Submerged, crown ≥1.0m below NWL, - Pipe inverts ≥100 mm above bottom, - Maintenance access to forebay & permanent pool, - Emergency overflow to overland route	- Inlets are to discharge to a forebay, - Variable water level control required. Control structure capable of maintaining NWL ±0.5m, - Located to avoid short-circuiting, - Max depth 3.0 m, - Submerged, crown ≥1.0m below NWL, - Pipe inverts ≥100 mm above bottom, - Maintenance access to forebay & permanent pool, - Emergency overflow to overland route		

Parameters	Recommended Changes	Town of Stony Plain, 2006 Municipal Development Standards, Section 6	City of Grande Prairie, 2018 Design Manual, Section 12	City of Edmonton, Dec. 2014 Design and Construction Standards, Volume 3 Drainage Section 12.0, 13.0	Strathcona County, Dec. 2011 Design and Construction Standards, Volume 1, Section 4.4	Alberta Environment and Parks, March 2013 and Jan. 1999 Standards and Guidelines
			where possible	where possible		
Landscape		Design with the landscape, not against it.				
Edge incorporation		Incorporate as much "edge" as possible and design in conjunction with a buffer and the surrounding land and aquatic systems.				
High flows and sediment loads		Design to protect the wetland from any potential high flows and sediment loads.	Minimum requirements for total suspended solids removal is 85% of particle size 75um or greater	Minimum requirements for total suspended solids removal is 85% of particle size 75um or greater		
Maintenance		Design for self-sustainability and to minimize maintenance.	- Developer required to provide operations and maintenance manual, - 2 Year maintenance & warranty period from Construction Completion Certificate (CCC), - Sediment removal from forebays required prior to Final Acceptance Certificate (FAC), - Sediment removal required when forebay & permanent pool volume reduced by 25%, - Inspection required twice/year during maintenance period. Inspection reports to be submitted when applying for FAC.	- Developer required to provide operations and maintenance manual, - 2 Year maintenance & warranty period from Construction Completion Certificate (CCC), - Sediment removal from forebays required prior to Final Acceptance Certificate (FAC), - Sediment removal required when forebay & permanent pool volume reduced by 25%, - Inspection required twice/year during maintenance period. Inspection reports to be submitted when applying for FAC.		
Forebay	Suggest to contain this part		- Required at each major inlet (>10% total storm inflow) - 2.4 m to 3.0 m deep - Require maintenance access for sediment removal - 7H:1V Side slopes	- Required at each major inlet (>10% total storm inflow) - 2.4 m to 3.0 m deep - Require maintenance access for sediment removal - 7H:1V Side slopes		
Permanent pool at the outlet	Suggest to contain this part		- 2.4 m to 3.0 m depth, - 7H:1V max side slopes along accessible open and deep water	- 2.4 m to 3.0 m depth, - 7H:1V max side slopes along accessible open and deep water		
Fencing	Suggest to contain this part		- Developer to use natural solutions (grading, planting strategies) to provide safety features, - Developer to provide fence at PUL boundary with openings for maintenance and access to trails	- Developer to use natural solutions (grading, planting strategies) to provide safety features, - Developer to provide fence at PUL boundary with openings for maintenance and access to trails		
Wetland Soil Characteristics	Suggest to contain this part		- Deep water areas - low soil permeability 10^{-7} m/s recommended - Vegetative zones - can use recently displaced wetland soils, sterilized topsoil or peat from within drainage basin - 10 cm to 30 cm of soil in vegetative zone. - Planting be done over the 2 years following construction.	- Deep water areas - low soil permeability 10^{-7} m/s recommended - Vegetative zones - can use recently displaced wetland soils, sterilized topsoil or peat from within drainage basin - 10 cm to 30 cm of soil in vegetative zone. - Planting be done over the 2 years following construction.		
Wetland Vegetation	Suggest to contain this part		Plant diverse species within one year after construction;	Plant diverse species within one year after construction;		Transplant from local donor sites
Upland Vegetation in the Extended Detention Storage Area around the Wetland	Suggest to contain this part		Minimum 2 m mow strip required from PUL boundary to NWL	Minimum 2 m mow strip required from PUL boundary to NWL		
Side slopes	Suggest to contain this part		- 5H:1V: or flatter side slopes, terraced slopes acceptable,	- 5H:1V: or flatter side slopes, terraced slopes acceptable,		

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			- 2 m wide marsh bench with 10H:1V slope at NWL, - 7H:1V max side slopes along accessible deep areas, - 2 m wide mow strip, 7H:1V side slope at accessible deep water areas, 5H:1V in other areas	- 2 m wide marsh bench with 10H:1V slope at NWL, - 7H:1V max side slopes along accessible deep areas, - 2 m wide mow strip, 7H:1V side slope at accessible deep water areas, 5H:1V in other areas		
6.21.4 Recreation						
Regulation		Recreational use of the ponds will be regulated by the Town.				
Recreational facilities		Suitable recreation facilities such as bicycle trails, benches, trees, etc. shall be provided for storm water management facilities.				
Recreational activities		Primary recreational activities will not be allowed upon wet ponds. The ponds will be posted, prohibiting primary recreational activities				
6.21.5 Erosion						
New developments		Construction of new developments shall be exercised in a manner such that erosion of the site and sediment discharge via runoff to the receiving stream are minimized. The Developer/Consultant shall be required to submit a formal erosion and sedimentation control plan to the Town.				
Erosion protection		Adequate erosion protection will be required for all natural and man-made water courses within the new development.				
Outfalls		Designed to control local erosion				
6.21.6 Maintenance						
Defects		The Developer shall be responsible for any defects of the works and lands associated with the facility, including adjacent park lands, for the warranty period.				
Operation and maintenance		The Developer shall assume full responsibility with respect to the operation and maintenance of the ponds				
Silting and debris		The Developer will be responsible for silting and debris problems which are caused due to poor erosion control in the development.				
Water quality		The monitoring and maintenance of water quality to eliminate any nuisance factors and to protect against health hazards shall be the responsibility of the Developer during the warranty period.				
6.21.7 Pond boundary control and use						
Return period		All pond and shoreline areas must be sufficient to accommodate the 1:100 year design event and will be retained in public ownership.				
Land protection		Land above the 1:100 year design flood level, when no overflow is provided, shall be protected by a restrictive covenant, registered against the title of the property, indicating that the land is subject to flooding				

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		and that the Owner will not construct any permanent structures susceptible to flood damage.				
Public access		If the provision of public access to the shoreline is being considered, fencing of a uniform type shall be constructed by the Developer along the 100 year event elevation to separate public from private lands.				
Noxious industrial land uses		Noxious industrial land uses are considered as unacceptable adjacent to or upstream of storm ponds.				
Lot dimensions and rare yard depths		Minimum lot dimensions and rear yard depths as measured from the property line shall conform to the requirements of the Town of Stony Plain Land Use Bylaw and Area Structure Plan.				
6.21.8 Site acquisition and financing of construction						
Pond sites acquisition		The acquisition of all pond sites shall occur prior to subdivision approval and at no cost to the Town. In addition, the pond site shall be excluded from all subsequent outline and tentative plans for the purposes of roadway, public utility, density, and potential municipal reserve calculations. The parcel of land acquired shall be designated as a utility lot within a Public Service (PS) District. Partial Municipal Reserve credit may be granted for dry pond land areas above the 1:25 year flood elevation provided suitable amenities are incorporated into the development.				
Design approval		All design and construction of stormwater ponds, interconnecting pipe systems, and outfall lines shall be completed to the Town's approval and paid for by the Developer and such works shall be closely coordinated with the grading and dirt balance of the reminder of the subdivision.				
Costs recover		Where the development utilizes an existing system or the work is undertaken by others, the Town will recover the costs from the Developer through off-site levies or development charges.				
6.21.9 Legal liability and safety						
Supervision		Given that primary water contact (i.e. swimming and wading) will be forbidden, supervision will not be provided.				
Signage		Proper and adequate signage to alert people to the potential hazards (No Swimming – Deep Water, subject to flooding, etc.) shall be provided by the Developer.				
Fencing		Fencing of municipal park areas shall be determined during the detailed design stage and provided by the Developer.				
Lighting		Lighting shall be provided by the Developer at the interface between the pond and the				

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		adjacent land. Additional lighting requirements are to be determined at the detailed design stage.				
6.22 DRAINAGE PARKWAYS AND EROSION CONTROL						
6.22.1 Drainage parkways						
Bottom width		3.0 m bottom sloped to drain to a low flow trickle channel to be installed in the bottom	- 5.0 m Min base width, with low flow channel - 0.5% Min longitudinal slope, 1.0% preferred			
Side slopes		Max. 5H:1V	Max 5H:1V			
Terraced side slopes		When depth exceeds 3 m or for amenities				
Sloped terrace width		3.0 m				
Clearance		1.5 m between top of excavation and property lines				
Landscape		Above the 1:25 year flood elevation shall be landscaped	- Landscaping plans to be submitted with engineering drawings, - Min requirement - establish grass cover			
Depth of ponding	Suggest to contain this part		Max. 1.0 m measured from the NWL			
Inlets and outlets	Suggest to contain this part		- Require safety grate with Max clear spacing of 150 mm, - Grated outlet's hydraulic capacity ≥200% design flow, - Flow velocity ≤1.0 m/s, - Fencing/guardrails for headwalls & wingwalls, - Inlet & outlet to be separated, - Emergency overflow to overland route where possible			
Access	Suggest to contain this part		Min. 5 m setback on one side for walkways/access			
6.22.2 Erosion Control						
		All storm drainage systems, including pipe outlets and other drainage channel outlets or overflows, shall be designed to control erosion that may result from piped or overland stormwater flows and discharge into the storm drainage system.				

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4.0 Existing Drainage System

4.1 Overview

This section provides a summary of the current drainage infrastructure in the Town of Stony Plain, including an overview of the topography and drainage basins. It should be noted that the current master plan helped to complete the inventory of the Town's storm infrastructure. It would be prudent for the Town to continue to expand this inventory for the benefit of long-term asset management and forecasting of re-investment requirements.

4.2 Topography

The overall topography and major drainage basins near the Town of Stony Plain is illustrated in Figure 4-1 (town area) and Figure 4-2 (around town). Elevations in the Town range from about 734 Above Mean Sea Level (AMSL) at the southwest of the Town to 682m AMSL to the north.

About 95% of the developed areas of the Town is situated within the 734 m and 682 m elevation range. The highest developed areas of the Town are to the south (i.e. Genesis on the Lake, Westerra) with elevations typically ranging between 715 and 707 m. The area north of Hwy 16A is at an elevation of 699 m to 697 m.

4.3 Major Drainage Basins and Drainage Features

4.3.1 Overview

Runoff from the Town of Stony Plain discharges to four major creeks. From west to east, these creeks are named as: Heritage Creek, Whispering Water Creek, Stony Creek, and Atim Creek. The main Town drainage basins, delineated based on surface topography alone, are shown in Figure 4-1.

The major drainage basins are summarized as follows and explained in more details in the next sub-sections:

- The total drainage area served by the four creeks is 21,171 ha. The total drainage area upstream of the town is 12,172 ha. There are 6 major culverts crossing the Highway 16A and CN Rail.
- There is a stream course draining north bond near the east boundary of the Town. This stream course enters the Town's east boundary from Parkland County near the CN rail and exits the Town's northeast boundary at Hwy 16A. This stream course flows into Spruce Grove and become more defined there. The amount of land within the Town boundary that is tributary to this stream course is relatively small. This stream course ultimately drains back into Atim Creek just south of its crossing with Yellowhead Highway which is approximately 3 km north of Highway 16A.

- Most of the town's storm flow discharges into the four creeks flowing through the Town. The runoff of Meridian Meadows drains in the pond located east of the community and then flow north bound via a well-defined stream course.

4.3.2 Heritage Creek

The Heritage Creek is located to the west of the Town. The creek flows into the town's west boundary at Range Rd. 12 between Hwy 16A and the CN Rail. The creek then turns north and crosses Hwy 16A at Rotary Park, then Hwy 779 and flows out of the town north of Umbach Business Park. The Heritage Creek receives the storm discharge of downtown area west of 50 St., north of 54 Ave., Brickyard pond, Freson pond, Hwy 779 at 44 Ave., RJ industrial park wetland, Legend Trail dry, and Umbach business park pond. There are 7 outfalls along this creek.

The plan and profile for this creek in the Town's boundary is shown in Figure 4-4a. The creek is about 5.6 km long within the Town's boundary and the elevation drops from 708.7 m to 693.4 m, resulting an averaged slope of 0.27%. To the west, Spring Lake and Hasse Lake drains into the upstream of this creek. The catchment area of this creek before entering the town is 9346 ha including the tributary joining the creek from the Hasse Lake near the CN Rail and Glory Hills Rd. of which the flow channel in the town's boundary cannot be identified. The catchment area adding to this creek when exiting the town is 1615 ha resulting in a total drainage area of 10961 ha at this point.

4.3.3 Whispering Waters Creek

The Whispering Waters Creek flows through the town in a northeast direction. At upstream reach, this creek flows in a fairly flat region before entering the culvert located at Hwy 779 and St. John Paul II Catholic School. This creek crosses the CN Rail at 49 Ave. and Brown St. after crossing 49 Ave. It then crosses Hwy 16A near the St. Andrews community. To the north, the creek exits the town's boundary north of the Quance Industrial Park pond. The catchment area of this creek before entering the town is 156 ha and the catchment area in the town's boundary before CN Rail is 449 ha, 116 ha between CN Rail and Hwy 16A. The catchment area downstream of Hwy 16A upstream of the town's boundary is 224 ha. The total drainage area of this creek is 945 ha when exiting the town.

The plan and profile of this creek is shown in Figure 4-4b. This creek traverses 4.8 km within the town's boundary and the elevation drops from 706.4 m to 690.0 m which results in an averaged slope of 0.34%. This creek receives storm flows from The Glen, West of Southridge, Woodlands, Forest Green, Downtown area along 52 Ave, 49 Ave. trunk, Saint Andrews, Merdian heights via ditch, and industrial area north of Hwy 16A, south of Wood Ave, east of Boulder Blvd. via ditches and Quance industrial park pond.

4.3.4 Stony Creek

The Stony Creek flows in a northeast direction through the town via the Stony Plain Golf Course. This creek originates in a wetland south of Westerra and east of Genesis on the Lake. The creek flows north and crosses Hwy 628 at Willow Park and then Golf Course Rd. at Fairway Dr. before flowing through the Golf Course. The creek then crosses the CN Rail and then Homesteads, Silverstone, South Business Park crossing 44 Ave. and 28 St., then merges with Atim Creek. The catchment area of this creek before crossing the CN Rail is 1191 ha and the catchment area upstream of the town's boundary is 696 ha. The catchment between CN Rail and Atim Creek is 53.7 ha. There are 11 culverts on this creek and there is one major culvert crossing Hwy 16A.

The plan and profile of this creek is shown in Figure 4-4c. The length of this creek is 4.4 km between Hwy 628 and Atim Creek. The elevation drop is 21 m resulting in an averaged slope of 0.47%. This creek receives the storm flows from Genesis on the Lake pond, Westerra ponds, Country Plains Estates, High Park, Willow Park pond, Golf Course Rd., east of Southridge, west of Fairways, Golf Course, Homesteads, Silverstone, and South Business Park pond.

4.3.5 Atim Creek

The Atim Creek flows through the east part of the town in a northerly direction. After entering the town, the creek flows through undeveloped area and crosses Hwy 628. The creek then flows through South Creek, Fairways, Graybriar and then crosses the CN Rail. The creek continues north through Silverstone and Jutland before crossing Hwy 16A. There are 8 culverts on this creek crossing roadways including two major culverts crossing CN Rail and Hwy 16A. Then the creek enters an undeveloped area zoned business industrial and exits the town. The catchment area upstream of the town's boundary is 838 ha. The catchment area entering the culvert at CN Rail is 1629 ha. The area controlled by the culvert at Hwy 16A is 2926 ha due to the joining of Stony Creek. The catchment area downstream of Hwy 16A before exiting the town's boundary is 118 ha.

The plan and profile of this creek is shown in Figure 4-4d. This creek runs 6.5 km in the town's boundary with an elevation drop of 24 m which results in an averaged slope of 0.37%. This creek receives the storm flows from South Creek pond, Fairways dry ponds, Gray briar, and Jutland pond.

4.4 Major culverts on creeks

There are 40 culverts on the creeks within the town's boundary. These culverts are numbered based on their location and listed in Table 4-1.

The capacity of the culverts through the town is presented as follows: The capacity of a culvert in the town is first calculated using applied hydraulic equations. This capacity is then divided by the cumulative service area in the town minus the capacity of the upstream culverts at the town's boundary. This assumption is based on the fact that the large catchment areas upstream the town are undeveloped, flat and contain many water features. This undeveloped land's drainage is further controlled by the culverts entering the town. This calculation method is aimed at reducing the likelihood of over estimating upstream flows. It is recommended that the Town begin the implementation of rainfall and flow monitoring program to better substantiate this assumption.

In general, the capacity of the creek culverts that form a part of the Town's stormwater conveyance infrastructure ranges from 0.01 L/s/ha at the Heritage Creek crossing the Town's boundary to 11.6 L/s/ha at the Atim Creek crossing the Hwy 16A. Among the 40 culverts, there are 5 culverts that have a capacity less than 2.5 L/s/ha, and they are highlighted in Table 4-1. Two of these culverts are on the Town's boundary (HC-C-10, WWC-C-10) and they control the total inflow into the town. These would be of no concern to the Town at this time. Two of the culverts are north of the Hwy 16A (HC-C-35, WWC-C-100). These culverts are located in the industrial area and should be replaced by culverts with higher capacity. Another culvert with capacity less than 2.5 L/s/ha is located on Stony Creek crossing the CN Rail (SC-C-90). The culvert capacity is 2.16 L/s/ha which is slightly less than the 2.5 L/s/ha limit.

The plan and profile of all the culverts and creeks is shown in Figure 4-4 from a to d. For all the creeks, most of the culverts are inlet control condition. The creeks have an averaged slope of around 0.3%.

Table 4-1: Summary of culverts

Culvert ID	Material	Shape	Size (mm)	Location	Capacity (L/s/ha)
HC-C-10		Circular	300	HC/Range Rd. 12	0.01
HC-C-15	CSP	Circular	900	Brickyard/CN Rail	2.53
HC-C-20	CSP	Circular	1100	HC/50 St.	5.31
HC-C-30	CSP	Circular	1829	HC/Hwy 16A	9.67
HC-C-31	CSP	Circular	1200	HC/Hwy 16A ramp	3.41
HC-C-32	CSP	Circular	1200	HC/Derek Dr.	3.25
HC-C-33	CSP	Circular	1100	HC/Derek Dr.	2.61
HC-C-34	CSP	Circular	1200	HC/Hwy 779	3.25
HC-C-35	CSP	Circular	900	HC/Wood Ave.	1.49
WWC-C-10		Circular	600	WWC/Hwy 628	2.05
WWC-C-20	CSP	Circular	1400	WWC/48 St.	7.07
WWC-C-30	CSP	Circular	1400	WWC/57 Ave.	6.28
WWC-C-40a	CSP	Circular	1400	WWC/55 Ave.	12.90
WWC-C-40b	CSP	Circular	1400	WWC/55 Ave.	
WWC-C-50a	CSP	Circular	1400	WWC/52 Ave.	12.23
WWC-C-50b	CSP	Circular	1500	WWC/52 Ave.	
WWC-C-60a	CSP	Circular	1200	WWC/50 Ave.	4.30
WWC-C-60b	CSP	Circular	1000	WWC/50 Ave.	
WWC-C-70a	CSP	Circular	1500	WWC/49 Ave.	14.35
WWC-C-70b	CSP	Circular	1500	WWC/49 Ave.	
WWC-C-71	CSP	Circular	1800	WWC/CN Rail	8.17
WWC-C-80a	CSP	Circular	1400	WWC/44 Ave.	10.05
WWC-C-80b	CSP	Circular	1500	WWC/44 Ave.	
WWC-C-90	Steel	Circular	1500	WWC/Hwy 16A	3.50
WWC-C-91a	Concrete	Circular	1400	WWC/Boulder Blvd.	6.81
WWC-C-91b	Concrete	Circular	1400	WWC/Boulder	

Culvert ID	Material	Shape	Size (mm)	Location	Capacity (L/s/ha)
				Blvd.	
WWC-C-100	Concrete	Circular	1200	WWC/Golf Course Rd. N	0.75
WWC-C-101a	Concrete	Circular	1000	WWC/Golf Course Rd. N	
WWC-C-101b	Concrete	Circular	900	WWC/Golf Course Rd. N	2.75
WWC-C-101c	Concrete	Circular	1000	WWC/Golf Course Rd. N	
SC-C-20a	CSP	Arc	840x660	SC/Westerra Dr.	
SC-C-20b	CSP	Arc	840x660	SC/Westerra Dr.	5.97
SC-C-20c	CSP	Arc	840x660	SC/Westerra Dr.	
SC-C-30a	CSP	Arc	840x660	SC/Westerra Loop	
SC-C-30b	CSP	Arc	840x660	SC/Westerra Loop	5.85
SC-C-30c	CSP	Arc	840x660	SC/Westerra Loop	
SC-C-31a	CSP	Arc	840x660	SC/Westerra Loop	
SC-C-31b	CSP	Arc	840x660	SC/Westerra Loop	8.36
SC-C-31c	CSP	Arc	840x660	SC/Westerra Loop	
SC-C-40	CSP	Circular	1400	SC/79 Ave.	8.71
SC-C-50	CSP	Circular	1400	SC/unnamed Trial	8.26
SC-C-60	CSP	Circular	900	SC/unnamed Trial	3.73
SC-C-70	CSP	Circular	1500	SC/Golf Course Rd. & Brightbank Ave.	7.03
SC-C-80a	CSP	Circular	900	SC/Golf Parking lot	
SC-C-80b	CSP	Circular	700	SC/Golf Parking lot	3.65
SC-C-80c	CSP	Circular	700*	SC/Golf Parking lot	
SC-C-90a	CSP	Circular	800	SC/CN Rail	2.16
SC-C-90b	CSP	Circular	800	SC/CN Rail	
SC-C-100	Concrete	Circular	1500	SC/44 Ave.	5.11

Culvert ID	Material	Shape	Size (mm)	Location	Capacity (L/s/ha)
SC-C-101	Concrete	Circular	1200	SC/28 St. & 43 Ave.	N/A
AC-C-10		Circular	1500	AC/South of Hwy 628 in farmland	2.63
AC-C-20	CSP	Circular	1700	AC/Hwy 628	21.78
AC-C-50a	CSP	Circular	1500	AC/Fariway Dr.	11.29
AC-C-50b	CSP	Circular	1500	AC/Fariway Dr.	
AC-C-60	CSP	Circular	1100	AC/Graybriar Dr.	3.10
AC-C-70a	CSP	Circular	1100	AC/CN Rail	11.60
AC-C-70b	CSP	Circular	1100	AC/CN Rail	
AC-C-70c	CSP	Circular	1300	AC/CN Rail	
AC-C-80	Concrete	Box	2000	AC/44 Ave.	7.72
AC-C-100	CSP	Circular	2500	AC/Hwy 16A	6.72

Culverts crossing CN Rail
Culverts crossing Hwy 16A
Culverts crossing Town's boundary

HC: Heritage Creek; WWC: Whispering Waters Creek; SC: Stony Creek; AC: Atim Creek

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4.5 Existing Stormwater Conveyance System

4.5.1 General

The Town's storm drainage network is illustrated in Figure 4-5.This network consists of about 62 km of storm pipes of which 6 km are catchbasin leads with the remainder being storm pipes that are connect by manholes. The Town has 653 manholes including 63 catchbasin manholes. There are 881 catchbasins. In addition, there are 63 storm outfalls (Figure 4.6), 40 stormwater management facilities, and 2 pump stations associated with the discharge of several ponds.

As shown in Figure 4-5, most of the developed areas of the Town, with a few exceptions, are serviced by a system of storm sewer pipes and stormwater management facilities.

4.5.2 Drainage Infrastructure Asset Management

4.5.2.1 Overview

The Town has developed a GIS electronic database of various components of its storm drainage infrastructure. This GIS database provided the geographic locations of catch basins, storm pipes and storm manholes. Over the course of preparing this stormwater master plan, additional drainage infrastructure information was collected.

The following summarized the physical data collected of the Town's storm drainage infrastructure. The purpose of this discussion is to document the method of data collection for the various types of information so that the accuracy and completeness of the data inventory can be understood. It is recommended that the Town continue to build on this data inventory for the purpose of establishing the stormwater management system's asset management program.

4.5.2.2 Storm Sewer Pipes

The "stormline" file is a database that includes 1385 storm lines (lines that are not CB leads), 495 catchbasin leads and 331 pipes with no description. This database provides relevant information for each pipe including diameter, length pipe material, abandoned or not, private or not, amongst others. The shape file also has the alignment of the pipe. Furthermore, the upstream/downstream invert elevation is missing in the database and was filled based on survey, assumptions and as-built drawings. The distribution of pipe invert elevation from as-built drawing and from survey is shown in Figure 4-5.

4.5.2.3 Manholes and Catchbasin Manholes

The "Storm_pt" file is a database includes 1921 points of which 653 are identified as manholes, 63 are catchbasin manholes, 881 are catchbasins, and an amount of T, P, and X. These databases provide limited information about the manholes and catchbasins. The shape file also has the location of the infrastructure, but it does not always match with the pipe location. The following are some observations and comments:

4.5.2.4 Drainage Asset Management Recommendations

The following are some key asset management recommendations:

- The Town of Stony Plain can use the current GIS system and update it accordingly. This asset management system should be continuously updated and include a comprehensive inventory of existing drainage asset, their condition, cost of replacement and prioritization, amongst others.
- Other manhole and pipe information that would be useful to include in the database is the year of installation; and most recent year of rehabilitation.

4.5.3 Piped Network

According to the above-mentioned databases, the Town's storm sewer network consists of 62 km of storm pipes ranging in size from 100 mm to 1600 mm in diameter, and 6 km of catchbasin leads typically 250 mm in diameter. Pipe size distribution is summarized and illustrated in Figure 4-5. Majority (59%) of the pipes are 450mm in diameter or less. Less than 4% of the pipes are 1200mm in diameter or larger.

The Town's storm sewer system also consists of an estimated 653 manholes, 63 catchbasin manholes and 881 catchbasins. The sewer system also consists of an estimated 13 orifices used to control the water level and flow rate out of stormwater management facilities.

AGE: There is no information on the age of the pipe from the Town's database.

MATERIAL: The pipe materials is shown in Figure 4-5. About 1/3 of the pipes in the town are PVC pipes. Concrete pipe makes up about 20%. 25% of the pipe material is unknown. The CB leads makes up about 10% of the Town's storm pipes. Culverts make up between 1% - 2% of the storm infrastructure and they are typically SRC, Ultra-Rib or CMP/CSP.

4.5.4 Storm Outfalls

The Town of Stony Plain has an estimated 63 storm outfalls servicing various areas of the Town: 7 into Heritage Creek, 22 in the Whispering Waters Creek, 20 in Stony Creek, 12 in the Atim Creek, and 1 in the unnamed channel system northwest of the Town.

All known outfalls in the Town of Stony Plain are illustrated in Figure 4-6 along with their tributary sewer pipes. A summary of these outfalls is provided in Table 4-2. It should be noted that pipes flowing into stormwater management facilities are not considered outfalls, neither are culverts along major drainage channels. Furthermore, decommissioned outfalls are not included in the table. The information provided in this table and on the figure comes from many sources of information and was not field-verified as part of this study.

The outfall numbering used in this report is newly created based on their location.

Table 4-2: Summary of Storm Sewer Outfalls

Outfall ID	Material	Invert elev. (m)	Diameter (mm)	Data source
HC-O-10	CPP	705.103	420	Survey
HC-O-20	Concrete			
HC-O-30				
HC-O-40	Concrete	700.203	1370	
HC-O-50	Steel	697.850	150	As-built drawing
HC-O-60	Concrete	695.440	300	As-built drawing
HC-O-70	Concrete	689.490	450	As-built drawing
WWC-O-10	Concrete	703.404	900	Survey
WWC-O-15				
WWC-O-20	PVC	703.158	300	Survey
WWC-O-30		702.931	375	
WWC-O-40	CPP	702.255	1000	Survey
WWC-O-45				
WWC-O-50	Concrete	702.086	1200	
WWC-O-60a	Concrete	700.928	750	Survey
WWC-O-60b	Concrete	701.192	1300	Survey
WWC-O-70		700.898	500	Survey
WWC-O-80		700.897	450	Survey
WWC-O-90	Concrete	701.079	520	Survey
WWC-O-100a	Concrete	700.583	1000	Survey
WWC-O-100b	Concrete	700.543	400	Survey
WWC-O-110	PVC	699.699	400	Survey
WWC-O-120a	Concrete	698.832	900	Survey

Outfall ID	Material	Invert elev. (m)	Diameter (mm)	Data source
WWC-O-120b	Concrete	699.341	700	Survey
WWC-O-130	Concrete	697.665	500	Survey
WWC-O-140	Concrete	697.594	800	Survey
WWC-O-150	Concrete	697.222	800	Survey
WWC-O-160		694.707	375	As-built drawing
WWC-O-170				
WWC-O-180				
WWC-O-200		693.120	450	As-built drawing
SC-O-10				
SC-O-20		705.320	450	As-built drawing
SC-O-30	Concrete	704.906	500	Survey
SC-O-40		705.112	1000	Survey
SC-O-50	Concrete	704.210	375	Survey
SC-O-60	Concrete	705.110	900	Survey
SC-O-70		702.719	600	Survey
SC-O-80		702.729	600	Survey
SC-O-90	Concrete	702.499	600	Survey
SC-O-100		702.084	800	Survey
SC-O-101	Concrete	702.287	375	Survey
SC-O-110		701.840	600	As-built drawing
SC-O-120	Concrete	701.579	500	Survey
SC-O-130		702.300	450	As-built drawing
SC-O-140	Concrete	698.840	700	Survey
SC-O-150		697.849	700	Survey

Outfall ID	Material	Invert elev. (m)	Diameter (mm)	Data source
SC-O-155				
SC-O-160		695.000	750	As-built drawing
SC-O-161	Concrete	695.875	600	Survey
SC-O-162	Concrete	695.811	1350	Survey
AC-O-50		702.547	600	As-built drawing
AC-O-60		701.390	450	As-built drawing
AC-O-61				
AC-O-70	Concrete	699.603	570	Survey
AC-O-80		699.650	750	As-built drawing
AC-O-90		698.551	375	As-built drawing
AC-O-100		696.700	300	As-built drawing
AC-O-101		696.750	750	As-built drawing
AC-O-102		697.590	375	As-built drawing
AC-O-103	Concrete	696.983	500	Survey
AC-O-110	Concrete	696.738	750	Survey
AC-O-120	Concrete	695.090	400	Survey
AC-O-130				
MM1	PVC	699.013	600	Survey

HC: Heritage Creek; WWC: Whispering Waters Creek; SC: Stony Creek; AC: Atim Creek

4.5.5 Ditch Network

Portions of the Town's drainage network is composed of ditches, many of which are located along roads. The areas served primarily by ditches and surface drainage are shown in

Figure 4-7. They service most of the undeveloped rural areas as well as a few commercial areas north of Highway 16A.

4.5.6 Major Drainage Channels

In addition to the four watercourses that service large drainage basins, the following channels and ditches are worth mentioning:

- A northeast-flowing channel west of Brickyard going from the wetland west of Range Road 12, chaining several depressions, then passes the Brickyard wet pond and crosses the CN Rail and merges with the Heritage creek. This channel conveys drainage for a large undeveloped and to-be-developed area west in the Town South of the CN Rail. In the process of subdivision review and approvals, the Town should be mindful to preserve an overland drainage route.
- A north flowing channel east of the Town at the boundary between the Town of Stony Plain and the City of Spruce Grove. The management of flow into this water course should be well planned as to avoid infrastructure conflicts between municipalities.

4.5.7 Catchbasins

There is an estimated 63 catchbasin manholes and 881 catchbasins currently installed throughout the Town. The distribution of catchbasins in the Town is illustrated in Figure 4-8.

The newer neighbourhoods generally have more catchbasins than the older areas, and their distribution throughout the neighbourhood is more consistent, generally spaced less than 150 meters apart.

In many of the more mature neighbourhoods, runoff has to flow a long distance, more than 500 meters in some instances, and cross many roads prior to reaching a catchbasin. This layout and large distance between catchbasins would not meet current design standards. This includes neighbourhoods such Heritage Estates, Country Plains Estates, Forest Green, Downtown amongst others. When these neighborhoods undergo rehabilitation, the Town should review the catch basin design and update their spacing to reflect current standards. This practice has the potential to lengthen the life of roadway surface as the increase in the number of catch basins will reduce the amount of water retained on residential streets. This reduces the impact of freeze and thaw cycles of northern Alberta climate.

Current hydraulic analysis and computer modeling results suggest that the Towns street flooding at isolated locations is a result of small pipes restricting the flows, not the lack of catchbasins. To this end, adding catch basis on a neighbourhood wide basis would be for the purpose of improving the level of service during frequent events. It would not necessarily reduce flooding during major rainfall events.

4.5.8 Stormwater Management Facilities (SWMFs)

4.5.8.1 Overview

There are currently 30 stormwater management facilities (SWMFs). Sixteen (16) are wet ponds and wetlands, two (2) dry ponds, and seven (7) flow through ponds Two of the SWMF are under construction. There are also three ponds that collect surface drainage and attenuate the flow. There is no design information for these three flow-through facilities.

A summary of the Town's SWMFs is provided in Table 4-3. The locations of the facilities are illustrated in Figure 4-9. A detailed summary of each facility is included under Table 4-3. For the purpose of this master plan and for future asset reference, unique names have been assigned to each of the Town's SWMF. These names are generally based on the neighbourhood which the pond(s) are located in.

Table 4-3: Summary of Stormwater Management Facilities

Pond ID	Name / Location	Type	Type of control
1	Genesis West pond	Wet pond	Pump
2	Genesis East Pond 1	Wet pond	
3	Genesis East Pond 2	Wet pond	
4	Westerra East Pond	Wet pond	Pipe invert
5	Westerra West Pond	Wet pond	Orifice plate
6	Southcreek Pond	Wet pond	Unknown
7	Brickyard Pond	Wet pond	Unknown
8	Industrial Pond 1	Wet pond	Orifice plate
9	Industrial Pond 2	Wet pond	Orifice plate
10	Industrial Pond 3	Wet pond	Orifice plate
11	Jutland Pond	Wet pond	Slide gate
12	South Business Park Pond	Wet pond	Unknown
13	Golfcourse Pond 1	Wet pond	Surface drain
14	Golfcourse Pond 2	Wet pond	Surface drain
15	Fairways Pond 1	Dry pond	Orifice plate
16	Fairways Pond 2	Dry pond	
17	Fairways Pond 3	Flow through pond	Orifice plate
18	Willowpark Pond	Wet pond	Orifice plate
19	Sommerville Pond	In construction	Pump
20	Fairway Pond 4	In construction	Orifice plate
21	Meridian cove dry pond	Flow through pond	Orifice plate
22	Merdian condo dry pond	Flow through pond	Oil grit separator

Pond ID	Name / Location	Type	Type of control
23	Brickyard dry pond	Flow through pond	Orifice plate
24	Golfcourse Pond 3	Flow through pond	Orifice plate
25	RJ Industrial Park Wetland	Wetland	Pump
26	Legend trial dry pond	Flow through pond	Orifice plate
27	Graybriar dry pond	Flow through pond	Outlet pipe invert
28	Rotary Park Pond	No information	Surface drainage
29	Heritage Park Pond	No information	Surface drainage
30	Merdian Meadows Pond	No information	Surface drainage

4.5.8.2 Pond Types

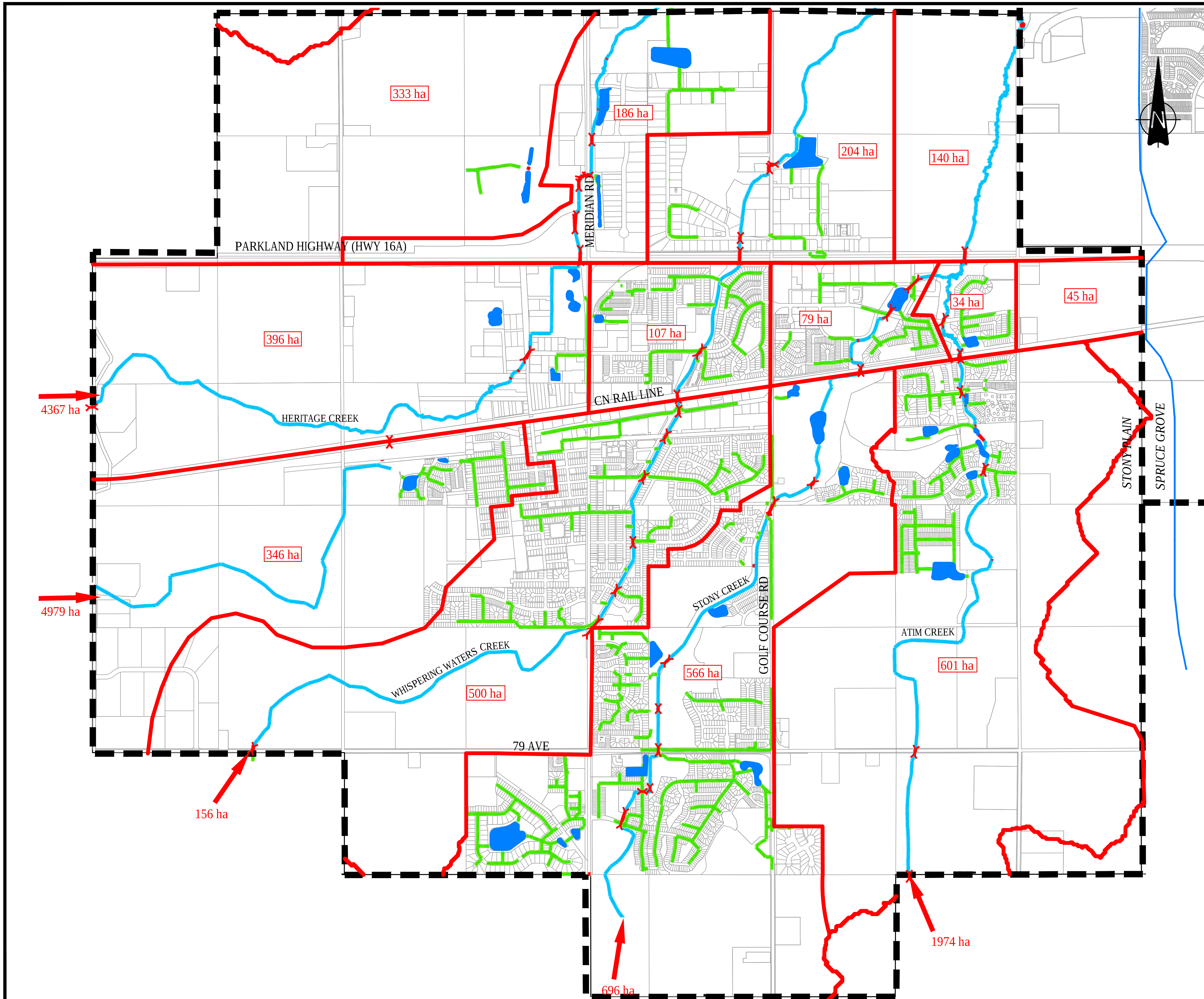
Each pond was categorized into one of the following pond types depending on the system layout and their quality and quantity control capabilities.

- **Wet ponds** and **wetlands** collect runoff through a combination of pipe, ditch and street drainage. Low flows are conveyed into the facility through pond inlets, and higher intensity runoff events would typically drain into the pond via overland conveyance. Consequently, all of the pond's catchment area runoff would go through the facility. Wet ponds offer both quality control and quantity control of stormwater.
- **Dry ponds** were divided in to three different categories:
- **Surge ponds** typically only fill with water when the surrounding sewer system is surcharged, typically for events larger than a 2-year return frequency. They offer very little water quality benefit and their peak flows into the downstream system is buffered by the capacity limitation of the pipe network. There is no other flow rate control for these types of facilities.
    - **Controlled surge ponds:** Similar to surge ponds, controlled surge ponds only fill with water during the larger rainfall events. The difference is that controlled surge ponds have a control structure (e.g. orifice) in the downstream system that controls the peak outflows to the downstream system. Consequently, controlled surge ponds may see some water flowing into and through the pond several times per year, depending on the design intent. They offer very little water quality benefit.
    - **Flow-through ponds:** Similar to wet ponds, flow-through dry ponds have drainage from their tributary catchments flow directly into the SWMF in series with the downstream system. Although the pond is intended to be dry when it is not raining, the facility will be wet frequently based on the weather pattern of northern Alberta. These ponds may provide some water quality benefits however, their primary function is to control peak flows released into the downstream system.

4.5.8.3 Control Structures

- There are many types of control structures used throughout the Town to control flows and water levels of the SWMFs. These are explained for each facility in Appendix A. In general, they fall into the following categories.
- The **normal water level (NWL)** in wet ponds is often controlled by the elevation of the downstream outlet pipe, and in some cases by the elevation of the downstream orifice or weir.
- **Flow rates** are often controlled by an orifice installed in the downstream sewers. In some locations, the flow rate is controlled by the smaller size of the downstream sewers.
- A few SWMFs have **overflow** weir structures inside the storm sewer system, but most of them have surface overflow channels at a specific location along the perimeter of the pond. The overflow weir structures should only be considered an operational redundancy feature and not an emergency overflow provision. This is due to the capacity limitation of the downstream pipe.
- Two SWMFs have a **pump station** to regulate the normal water level and discharges the pond through mechanical means.

It is recommended that the Town establish a design guideline for the control structures of a SWMF. As the number and age of these facilities increase, the routine operations and maintenance of them will place an increasing burden on the town's resources. Functions such as the ability to remove a blocked orifice during a rainfall event; slight manipulation of the pond water level for maintenance or to control vegetation; draw down of the pond's water level without having to install lengthy piping; etc. would allow the Town to more efficiently operate the entire drainage network. Having a design standard would lay the foundation for new developments to incorporate a suitable structure to be designed and build as part of the development. These requirements are becoming more common in the Edmonton region.



LEGEND:

- MUNICIPAL BOUNDARY
- EXISTING WATERCOURSE
- BASIN BOUNDARY
- EXISTING CULVERT
- EXISTING STORM PIPE
- EXISTING STORMWATER MANAGEMENT FACILITY
- 140 ha CATCHMENT AREA (IN TOWN)

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Client:

TOWN OF STONY PLAIN

Project:

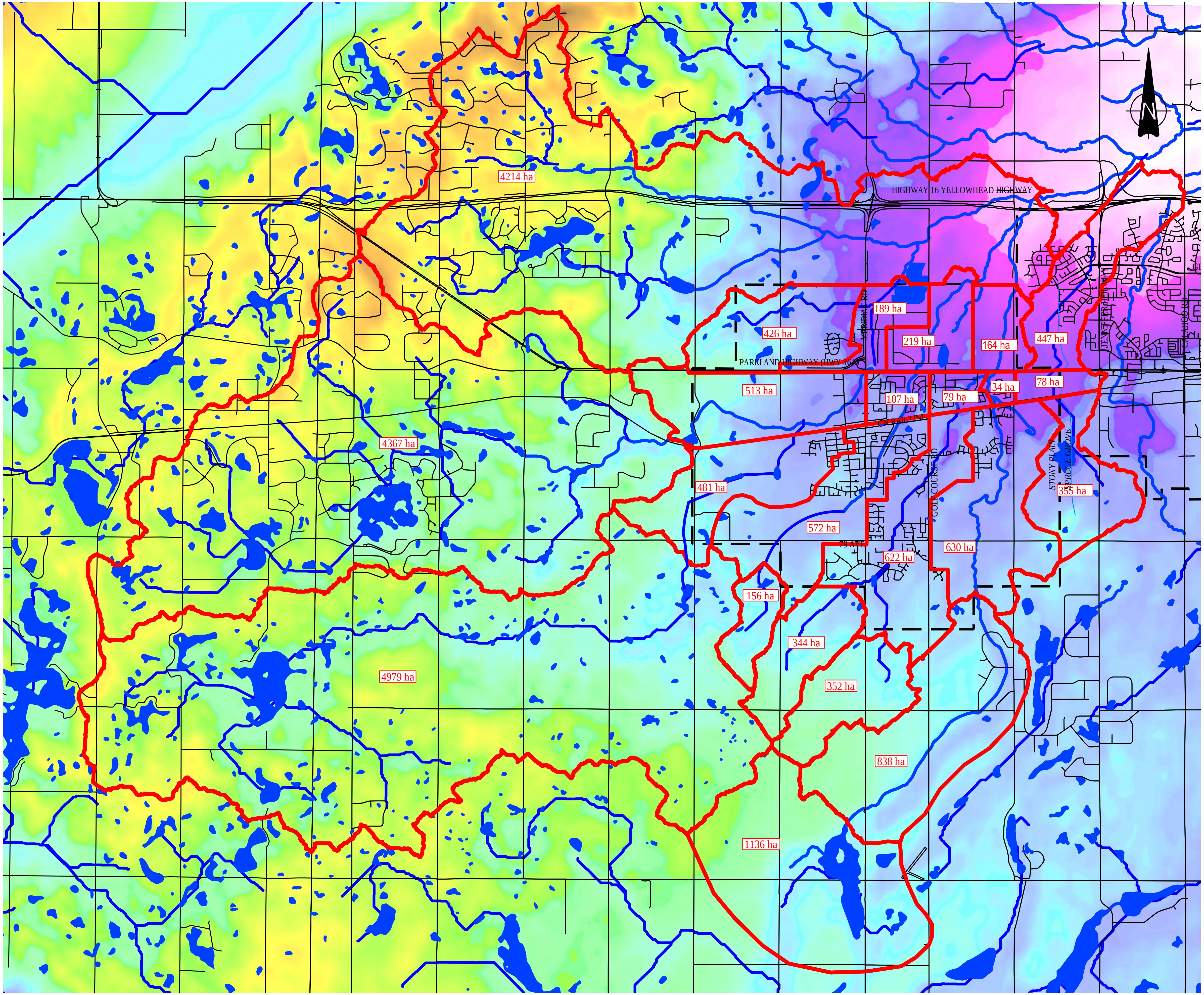
Stormwater Master Plan

Title:

Drainage Basin Delineation
(Town Area)

Scale: 1:25,000

Figure: 4.1



LEGEND:

MUNICIPAL BOUNDARY

EXISTING WATERCOURSE

BASIN BOUNDARY (TOTAL AREA = 21,170 ha)

426 ha CATCHMENT AREA

LiDAR ELEVATION LEGEND

796m

756m

717m

677m

638m

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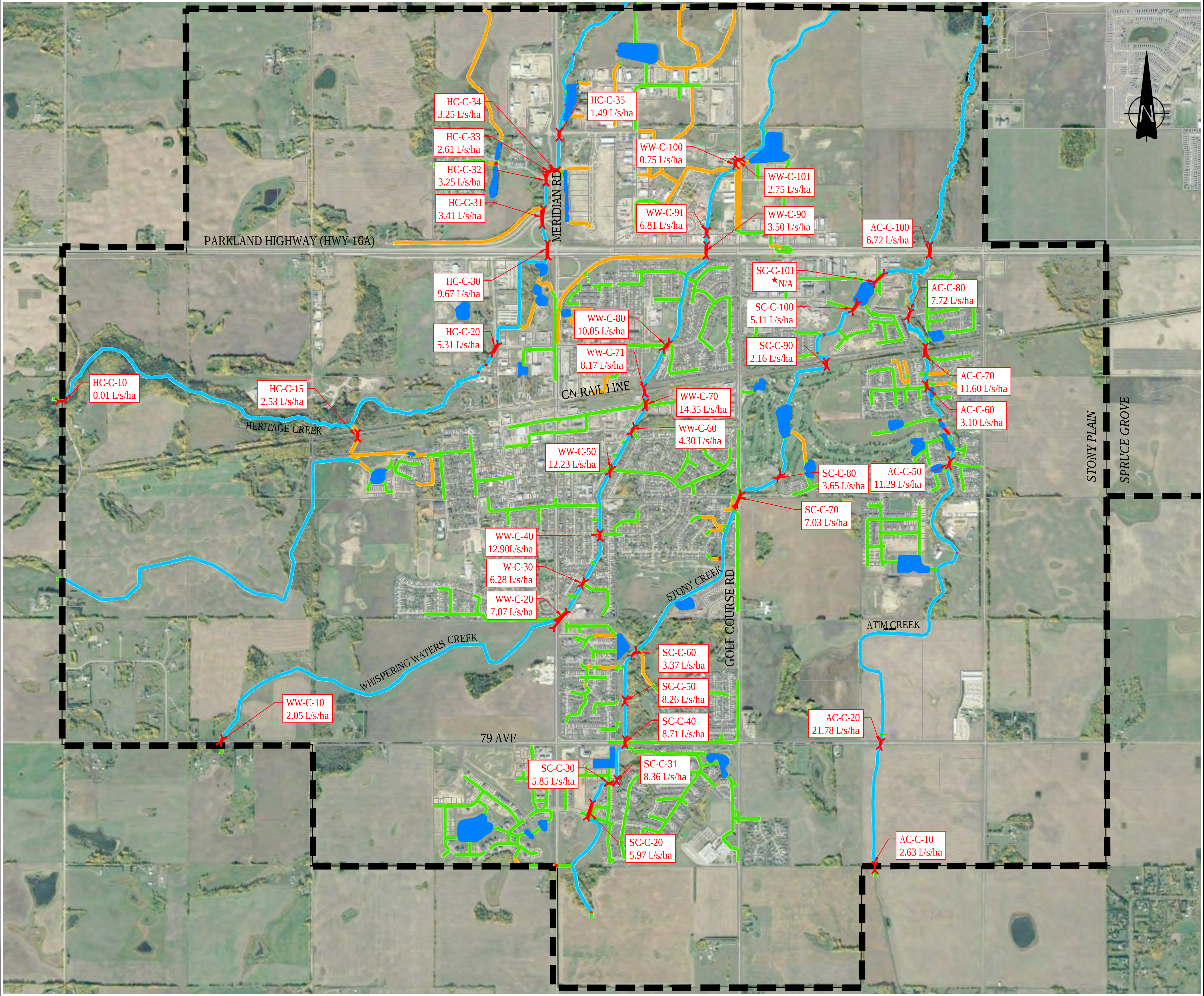
Project:

Stormwater Master Plan

Title:

Drainage Basin Delineation
(Around Town)

Scale:	Figure:
N.T.S.	4.2



LEGEND:

- MUNICIPAL BOUNDARY
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY
- EXISTING DITCH
- EXISTING STORM PIPE
- EXISTING CULVERT

★CONTROL STRUCTURE IN CULVERT

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TOWN OF STONY PLAIN

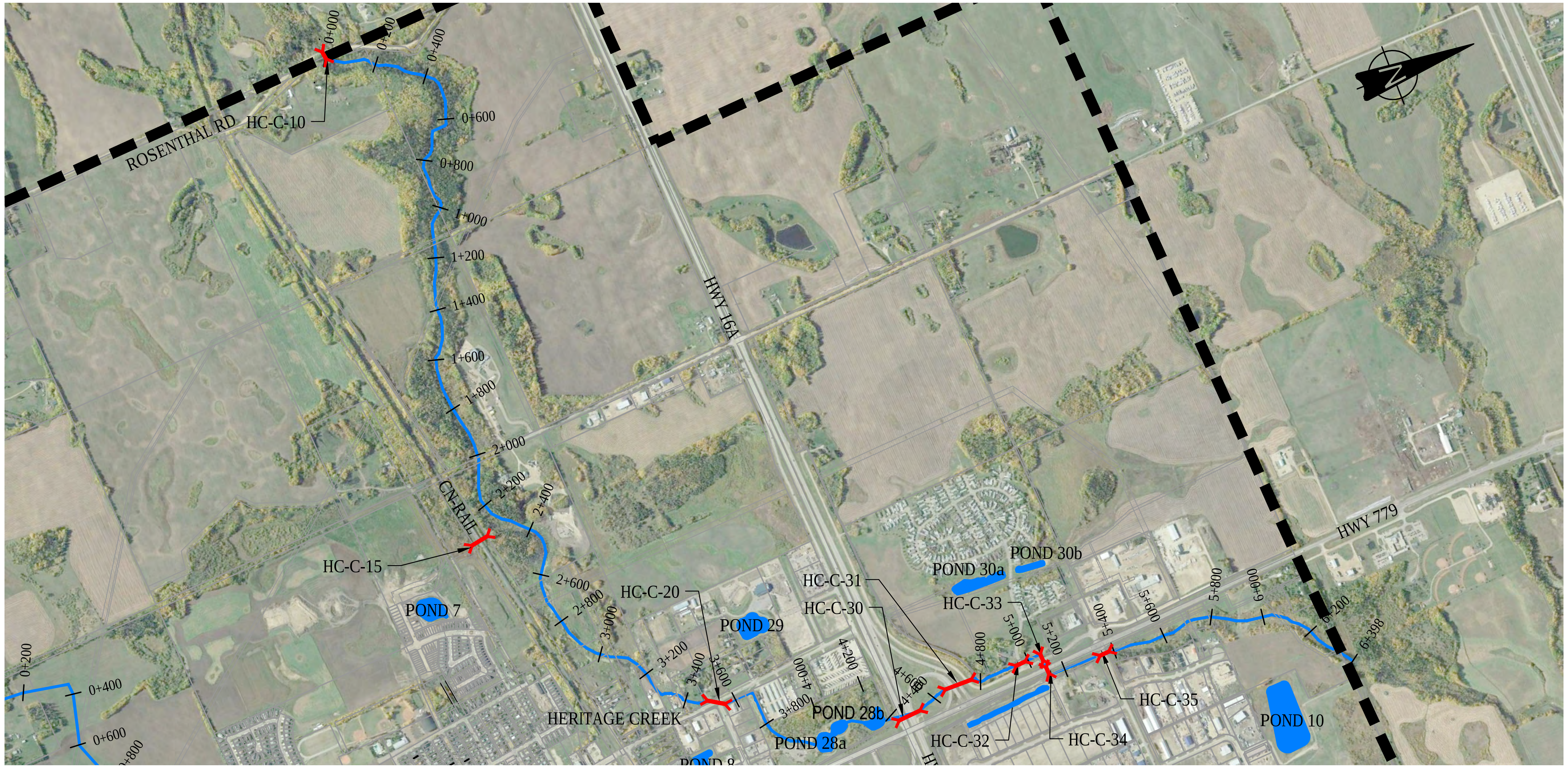
Project:

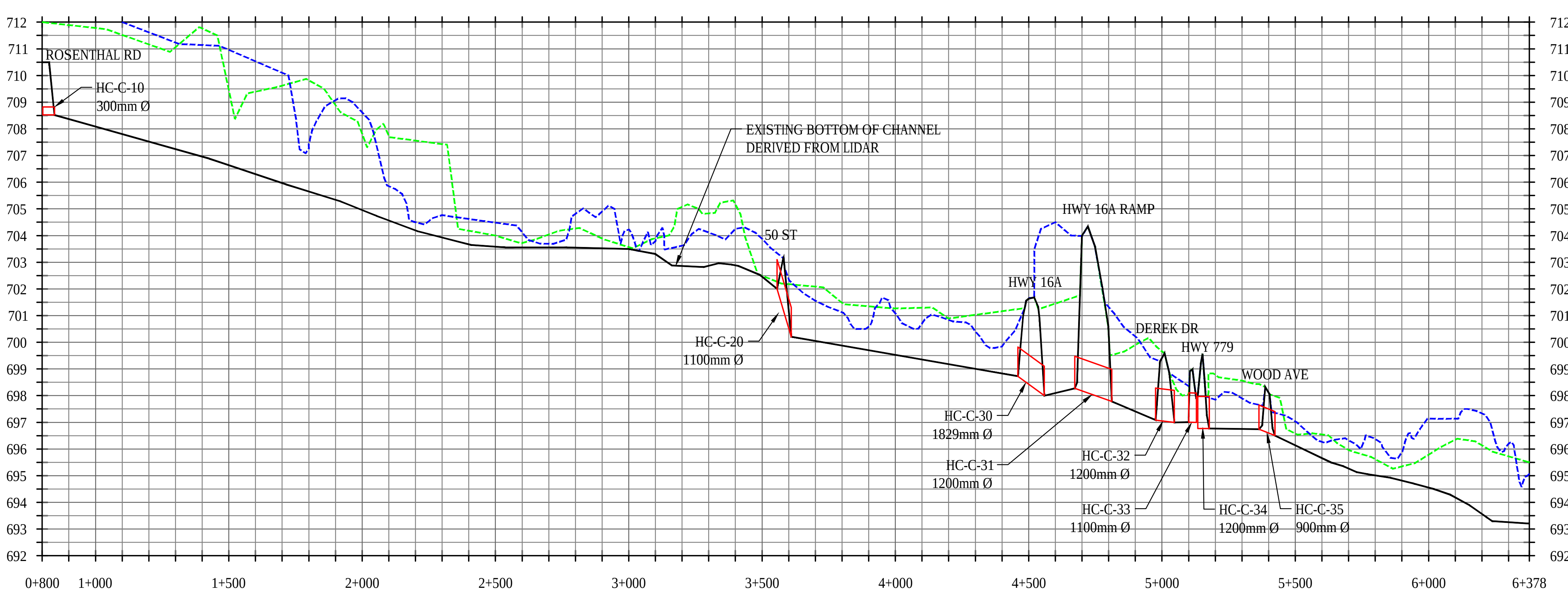
Stormwater Master Plan

Title:

Existing Culverts

Scale:	Figure:
1:25,000	4.3





LEGEND:

- MUNICIPAL BOUNDARY
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY
- EXISTING CULVERT
- CHANNEL BANK (LEFT)
- CHANNEL BANK (RIGHT)

Culverts ID	Catchment area in town(ha)	Capacity (L/s/ha)
HC-C-10	0	0.01
HC-C-15	347	2.53
HC-C-20	272	5.31
HC-C-30	516	9.67
HC-C-31	524	3.41
HC-C-32	549	3.25
HC-C-33	549	2.61
HC-C-34	549	3.25
HC-C-35	582	1.49
Culverts crossing CN Rail		
Culverts crossing Hwy 16A		
Culverts crossing Town's boundary		

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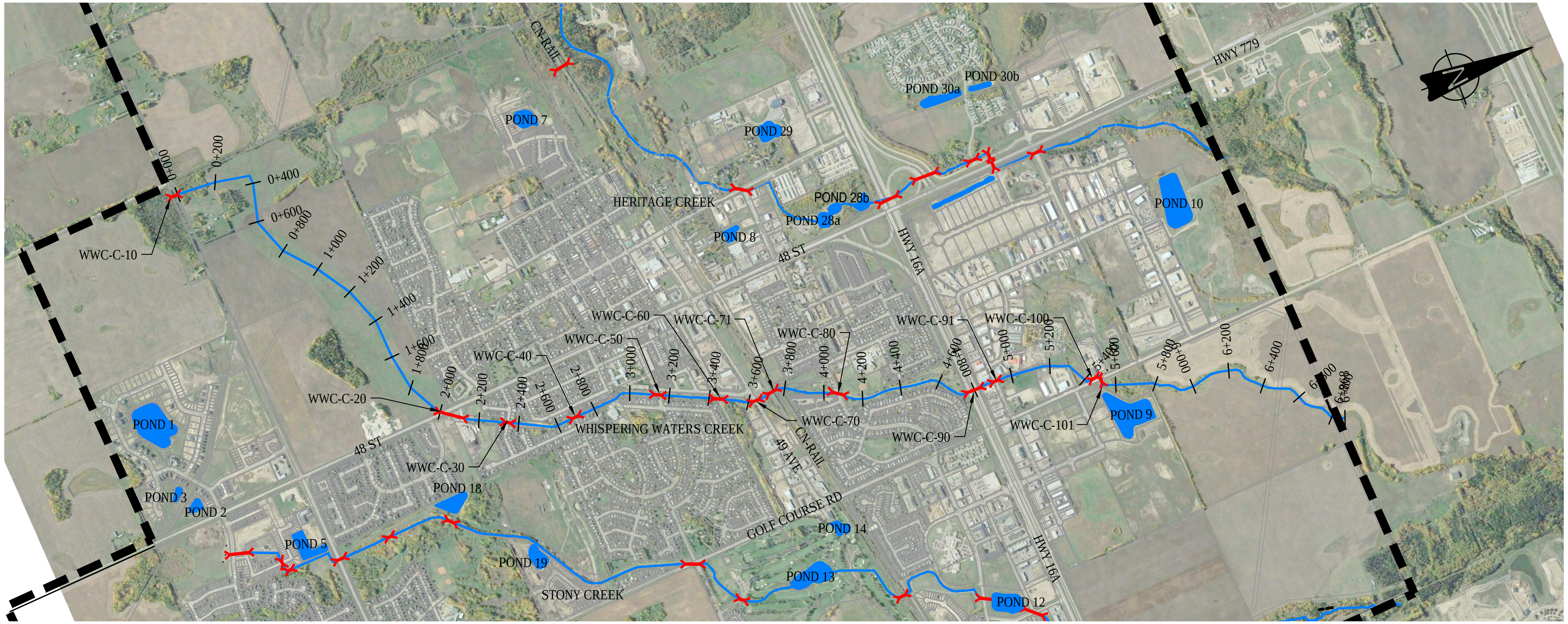
Project: Stormwater Master Plan

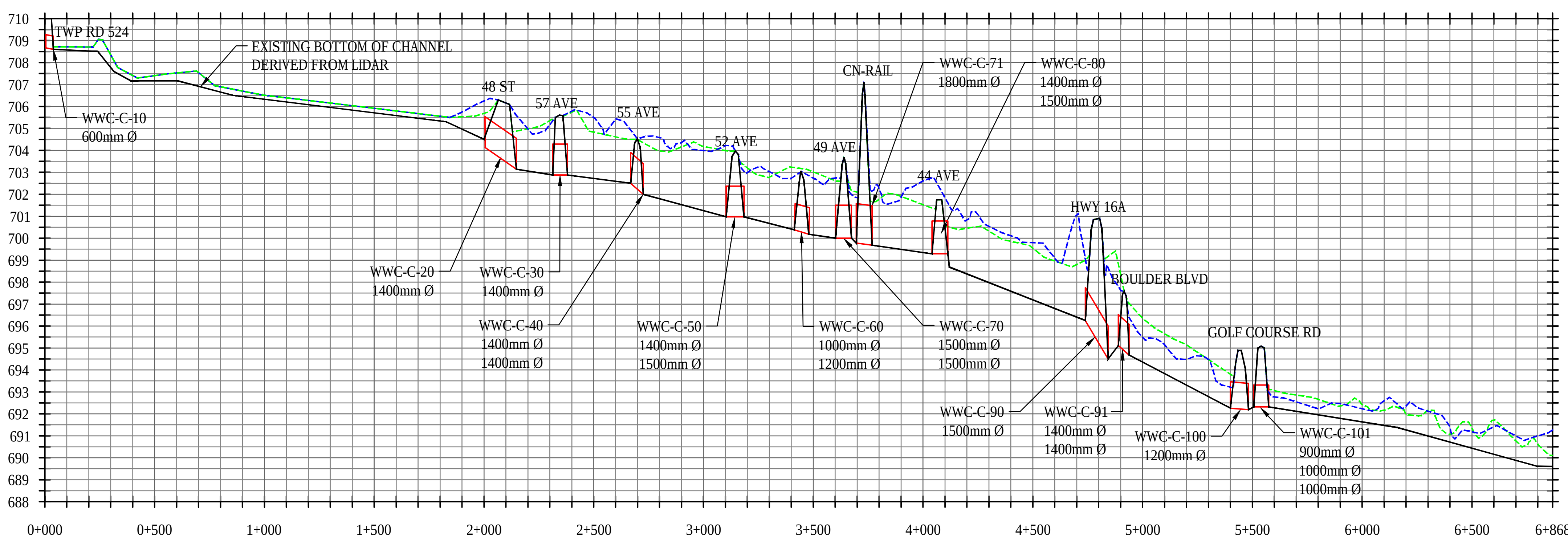
Title: Heritage Creek Plan and Profile

Scale: 1:20,000

0 250 500

Figure: 4.4a





LEGEND:

- MUNICIPAL BOUNDARY
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY
- EXISTING CULVERT
- CHANNEL BANK (LEFT)
- CHANNEL BANK (RIGHT)

Culverts ID	Catchment area in town(ha)	Capacity (L/s/ha)
WWC-C-10	0	2.05
WWC-C-20	285	7.07
WWC-C-30	336	6.28
WWC-C-40a	348	12.90
WWC-C-40b	348	
WWC-C-50a	406	12.23
WWC-C-50b		
WWC-C-60a	456	4.30
WWC-C-60b		
WWC-C-70a	469	14.35
WWC-C-70b		
WWC-C-71	469	8.17
WWC-C-80a	479	10.05
WWC-C-80b		
WWC-C-90	577	3.50
WWC-C-91a	587	6.81
WWC-C-91b		
WWC-C-100	642	0.75
WWC-C-101a	642	2.75
WWC-C-101b		
WWC-C-101c		
Culverts crossing CN Rail		
Culverts crossing Hwy 16A		
Culverts crossing Town's boundary		

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TOWN OF STONY PLAIN

Project:

Stormwater Master Plan

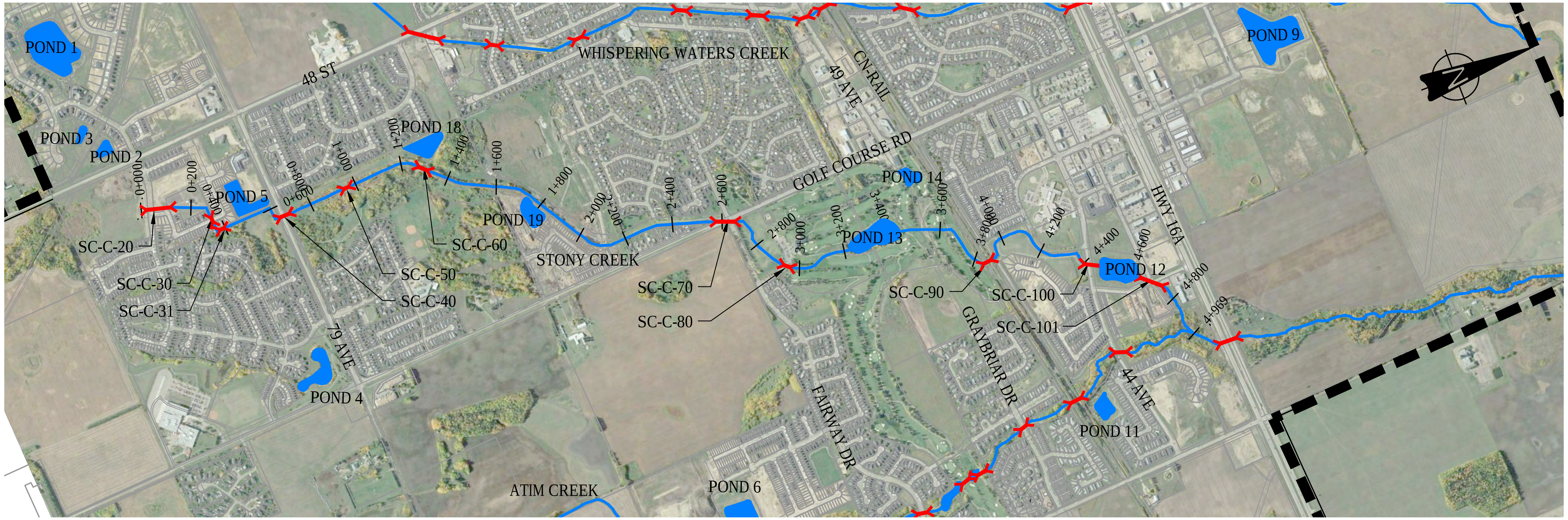
Title:

Whispering Waters Creek Plan and Profile

Scale: 1:20,000

0 250 500

Figure: 4.4b

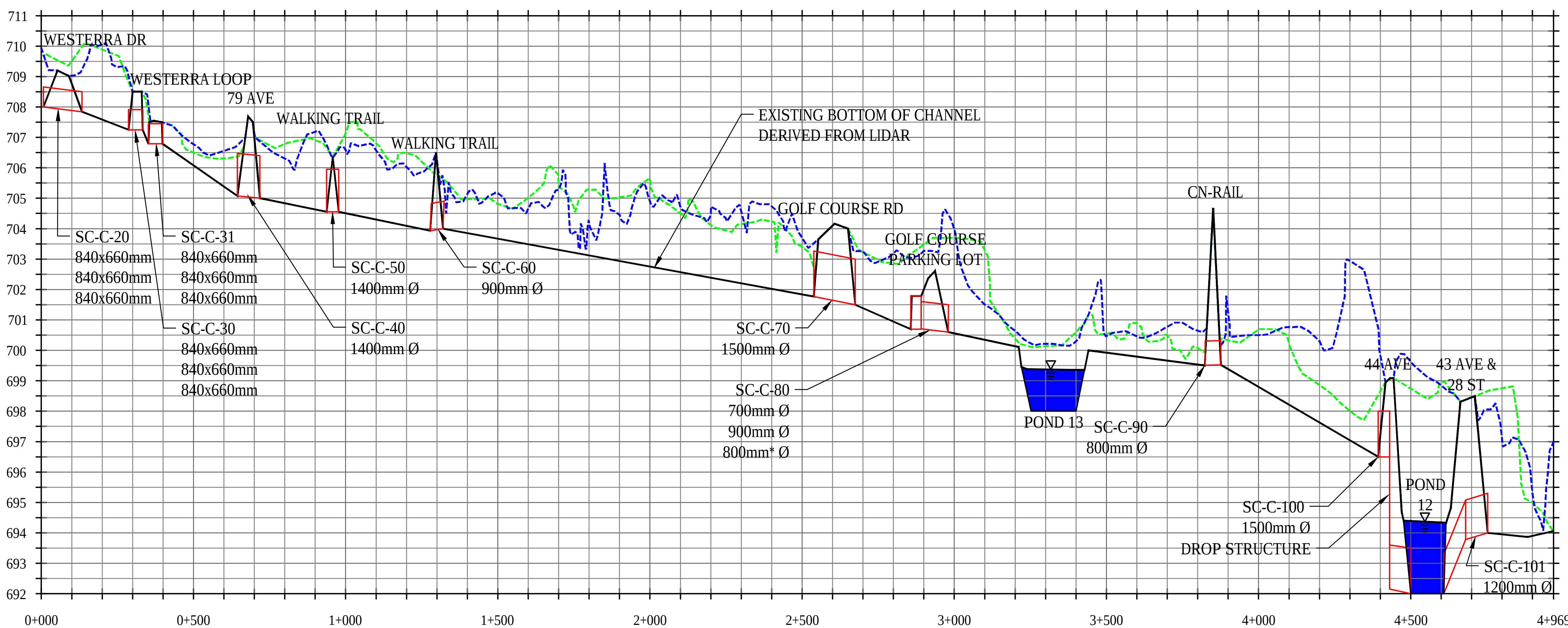


LEGEND:

- MUNICIPAL BOUNDARY
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY
- EXISTING CULVERT
- CHANNEL BANK (LEFT)
- CHANNEL BANK (RIGHT)

Culverts ID	Catchment area in town(ha)	Capacity (L/s/ha)
SC-C-20a		
SC-C-20b	196	5.97
SC-C-20c		
SC-C-30a		
SC-C-30b	199	5.85
SC-C-30c		
SC-C-31a		
SC-C-31b	199	8.36
SC-C-31c		
SC-C-40	293	8.71
SC-C-50	308	8.26
SC-C-60	346	3.73
SC-C-70	444	7.03
SC-C-80a		
SC-C-80b	481	3.65
SC-C-80c		
SC-C-90a	558	2.16
SC-C-90b		
SC-C-100	606	5.11
SC-C-101	637	N/A
Culverts crossing CN Rail		
Culverts crossing Hwy 16A		
Culverts crossing Town's boundary		

**Control Structure in Culvert
*Assumed Culvert Diameter



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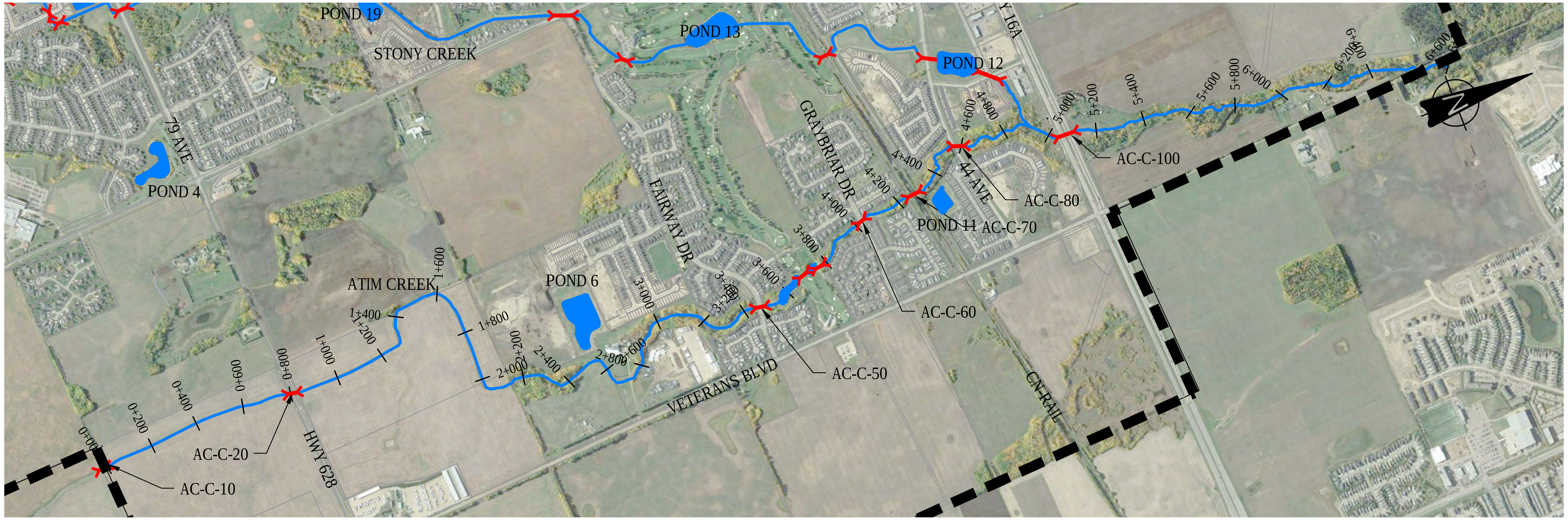
Project:
Stormwater Master Plan

Title:
Stony Creek Plan and Profile

Scale: 1:20,000 (0 250 500)

Figure: 4.4c



LEGEND:

MUNICIPAL BOUNDARY

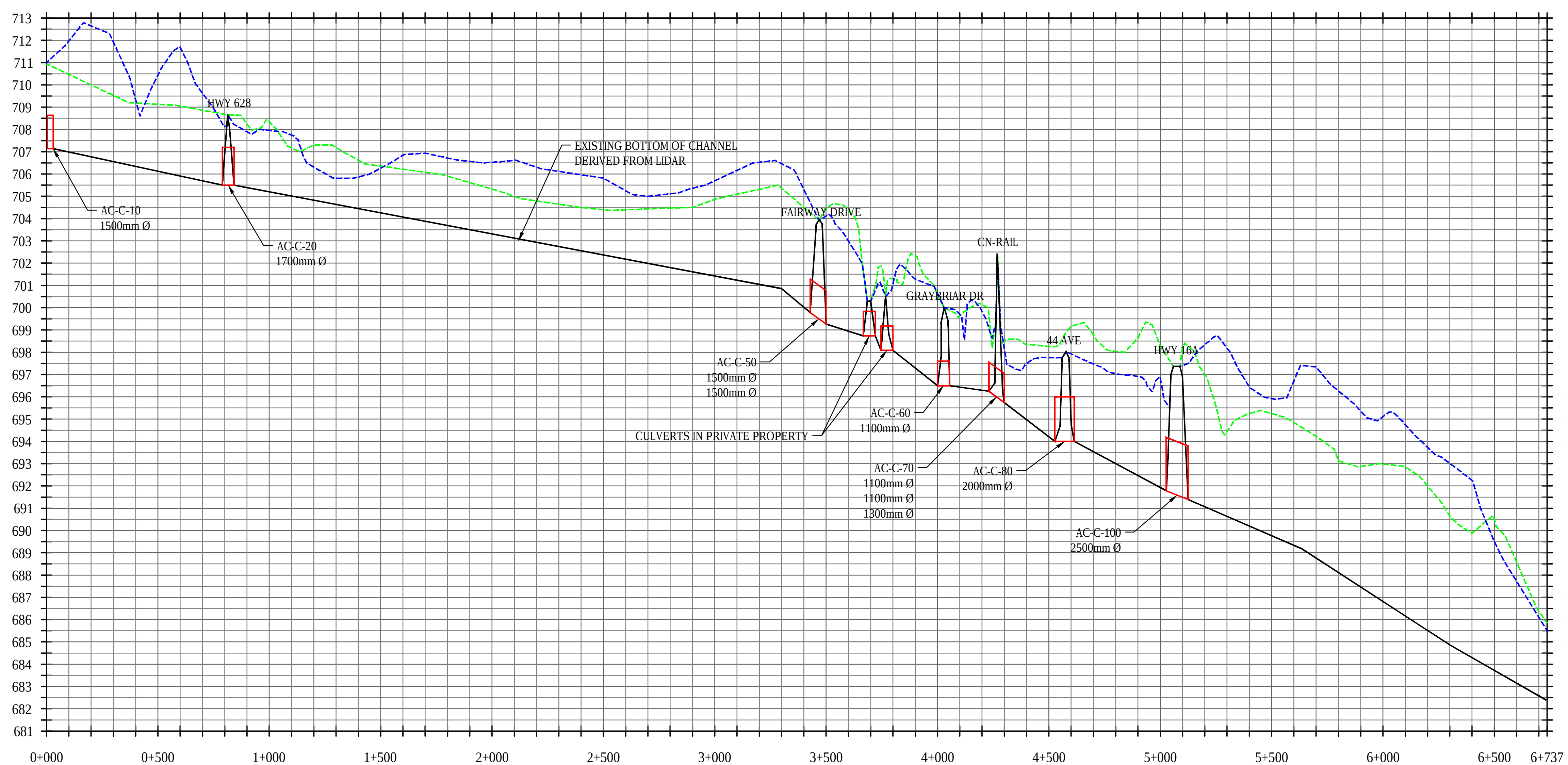
EXISTING WATERCOURSE

EXISTING STORMWATER MANAGEMENT FACILITY

EXISTING CULVERT

CHANNEL BANK (LEFT)

CHANNEL BANK (RIGHT)



Culverts ID	Catchment area in town(ha)	Capacity (L/s/ha)
AC-C-10	0	2.63
AC-C-20	172	21.78
AC-C-50a	460	11.29
AC-C-50b		
AC-C-60	480	3.10
AC-C-70a	576	11.60
AC-C-70b		
AC-C-70c		
AC-C-80	599	7.72
AC-C-100	1247	6.72
Culverts crossing CN Rail		
Culverts crossing Hwy 16A		
Culverts crossing Town's boundary		

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Project:

Stormwater Master Plan

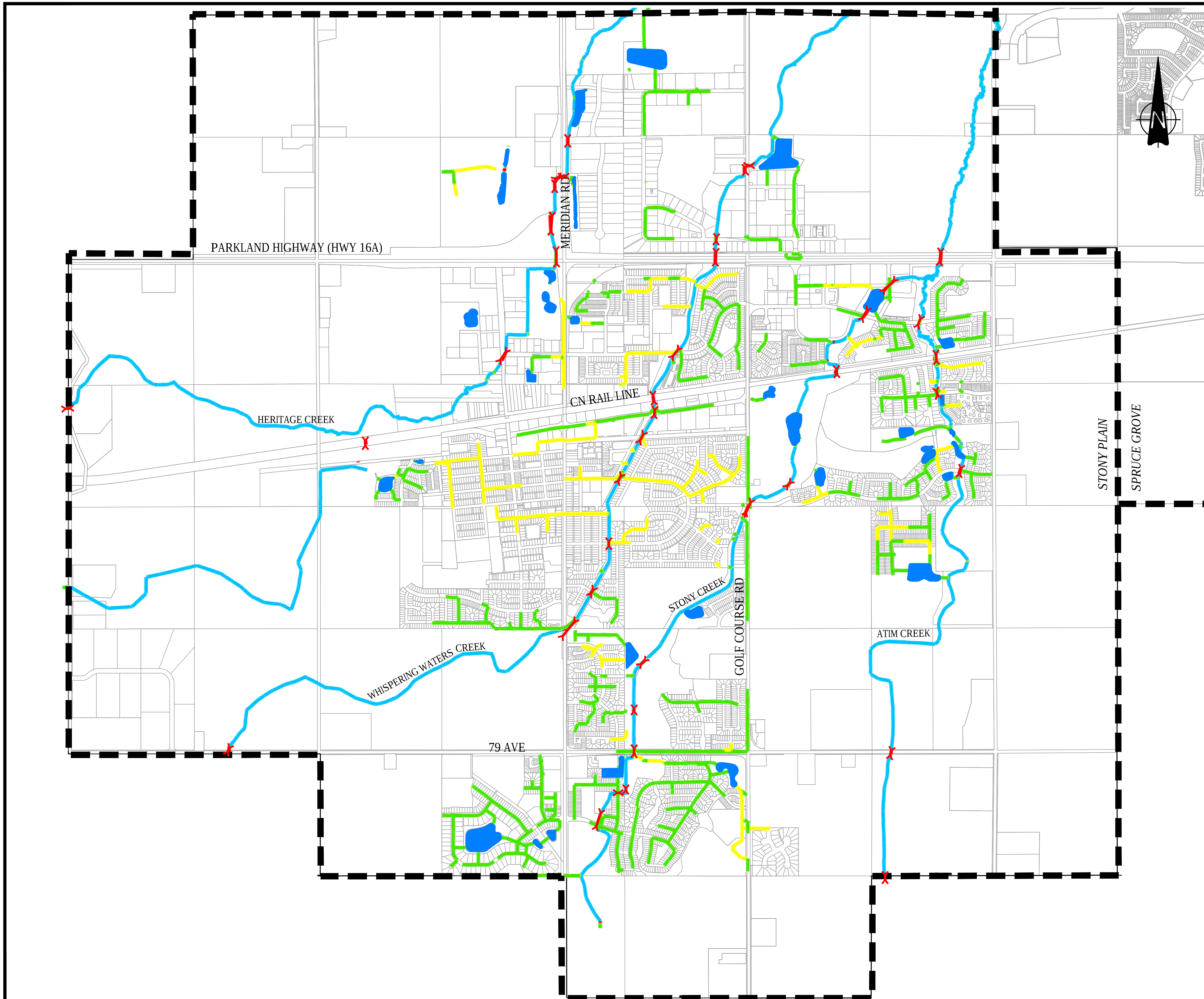
Title:

Atim Creek Plan and Profile

Scale: 1:20,000

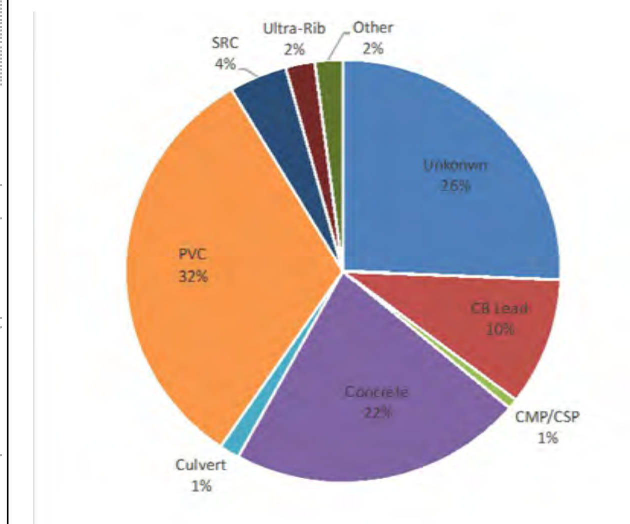
0 250 500

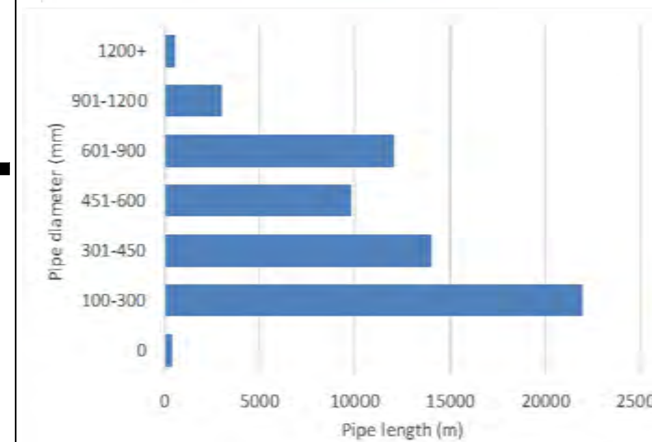
Figure: 4.4d



LEGEND:

- MUNICIPAL BOUNDARY
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY
- EXISTING STORM PIPE (FROM AS-BUILT)
- EXISTING STORM PIPE (FROM SURVEY)
- EXISTING CULVERT





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Client:

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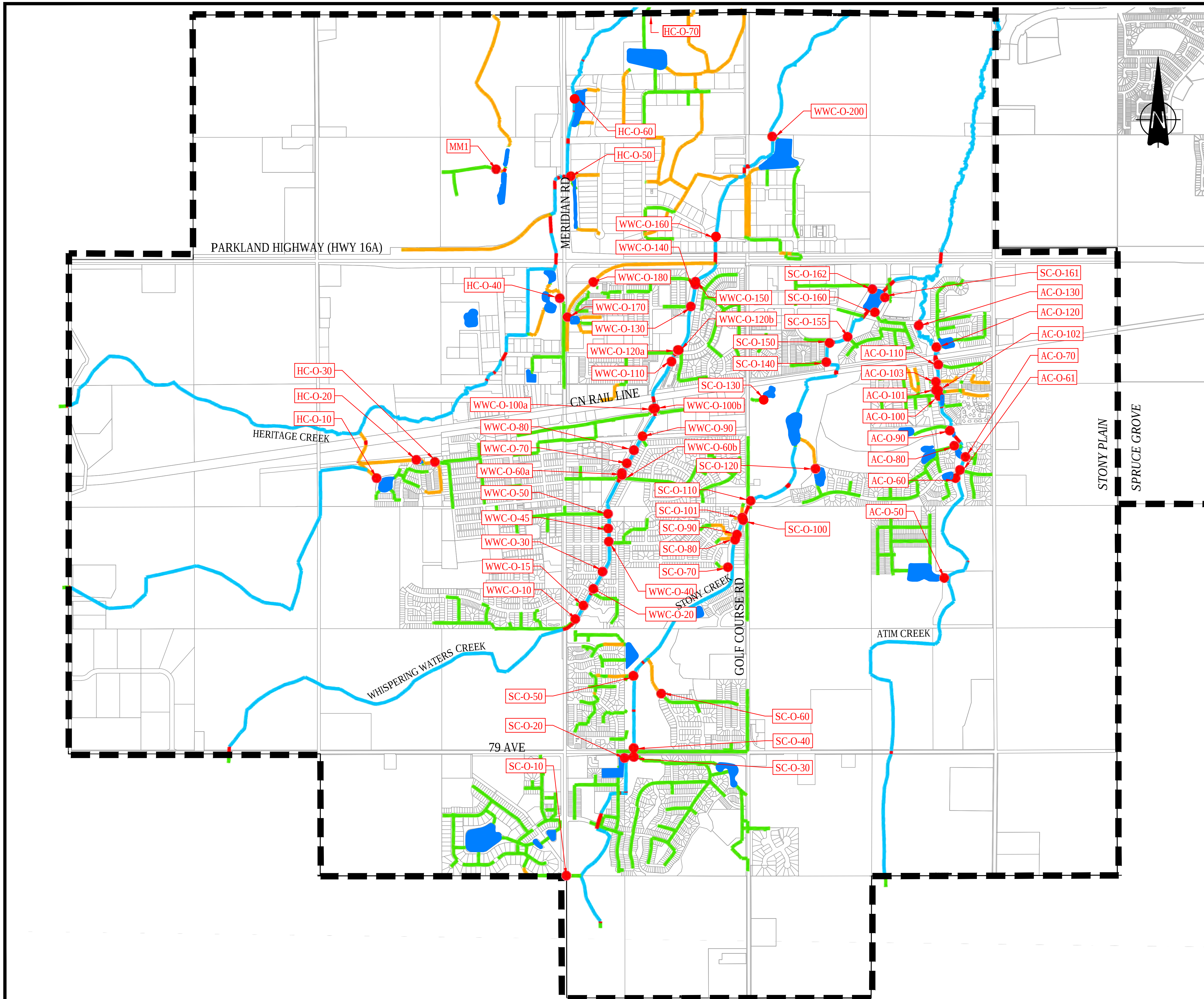
Project:

Stormwater Master Plan

Title:

Existing Drainage Network

Scale:	Figure:
1:25,000	4.5



LEGEND:

- MUNICIPAL BOUNDARY
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY
- EXISTING DITCH
- EXISTING STORM PIPE
- EXISTING OUTFALL

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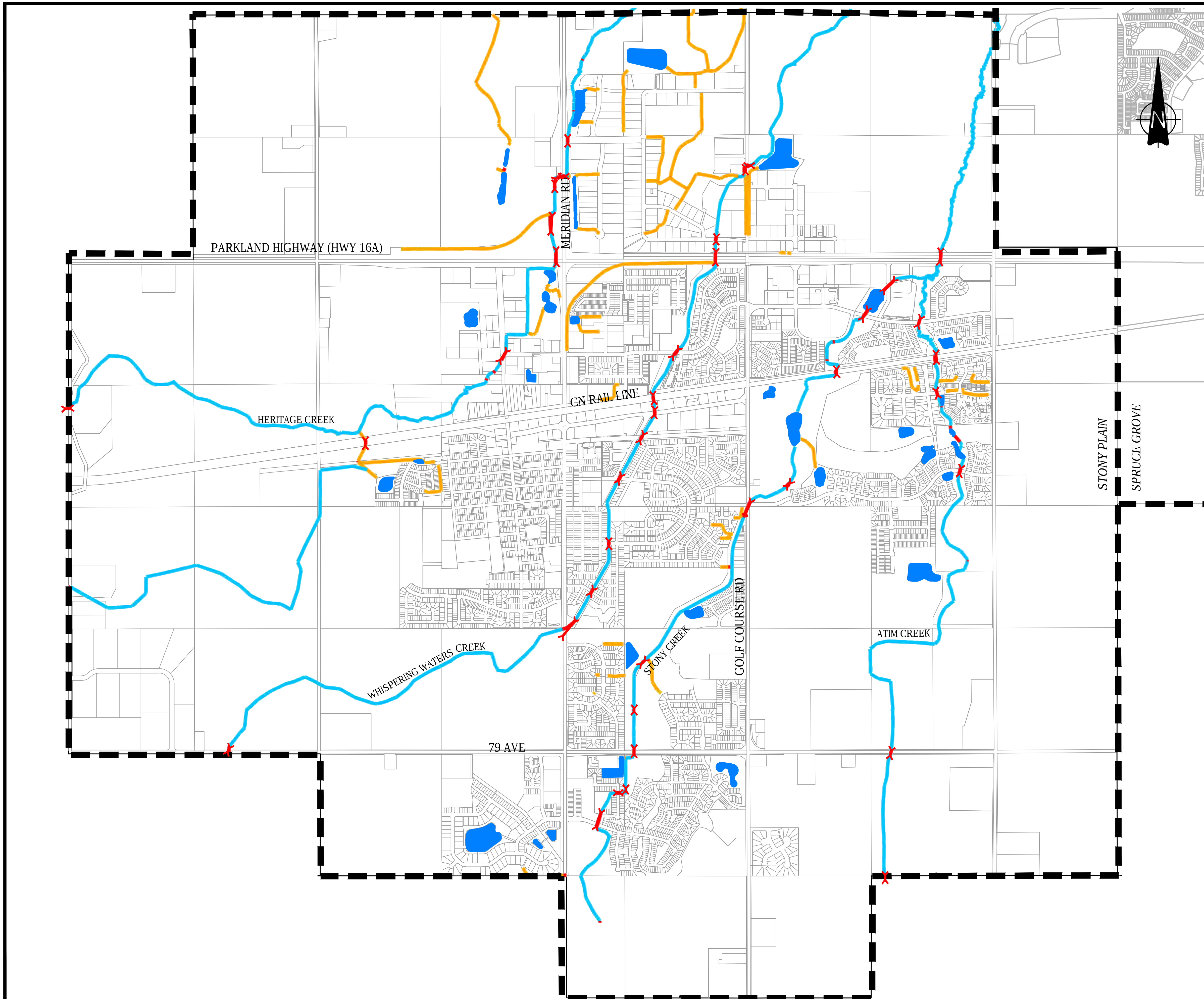
Project:

Stormwater Master Plan

Title:

Existing Outfalls

Scale:	Figure:
1:25,000	4.6



LEGEND:

- MUNICIPAL BOUNDARY
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY
- EXISTING DITCH
- EXISTING CULVERT

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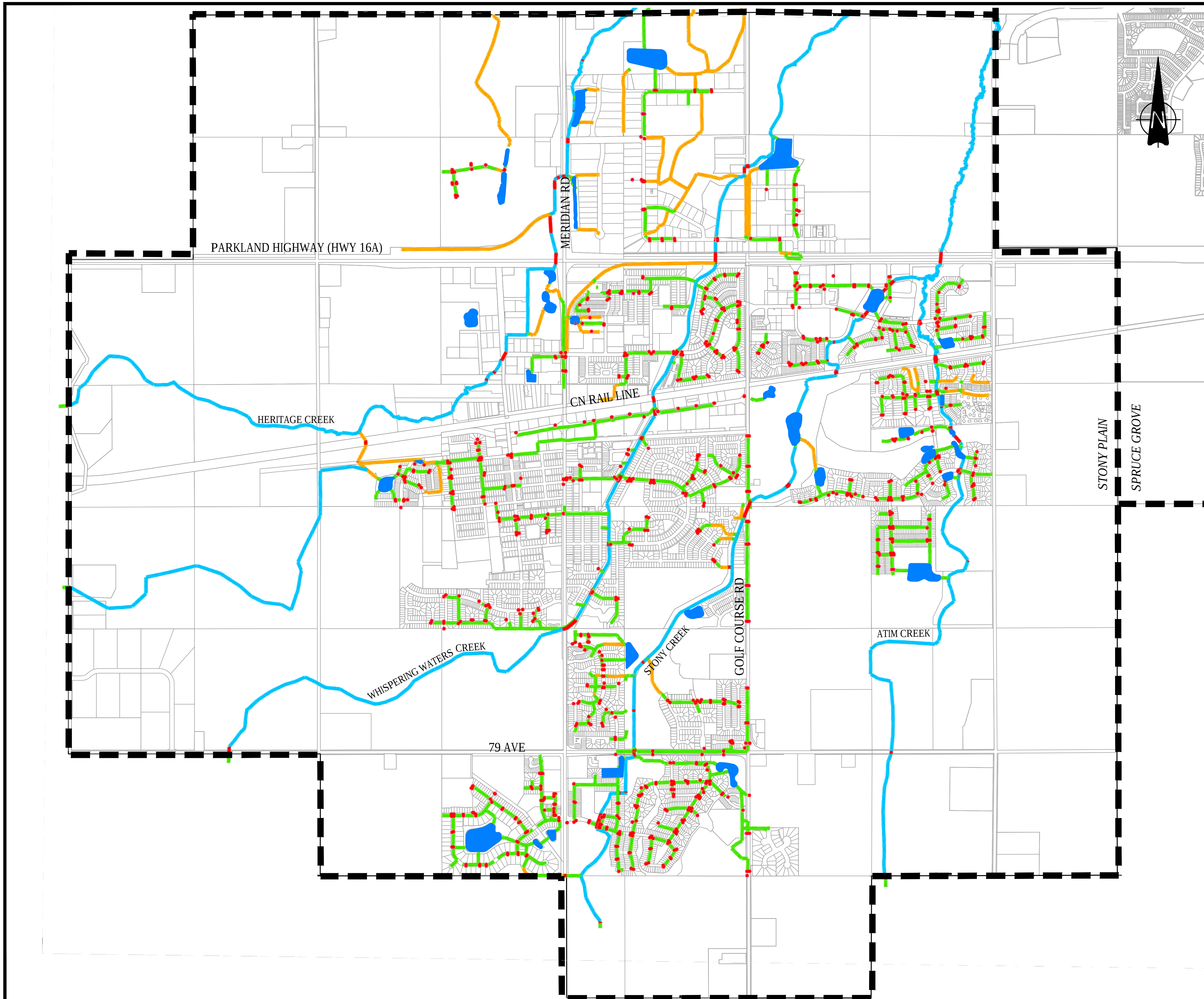
Project:

Stormwater Master Plan

Title:

Ditch Drainage

Scale:	Figure:
1:25,000	4.7



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Client:

TOWN OF STONY PLAIN

Project:

Stormwater Master Plan

Title:

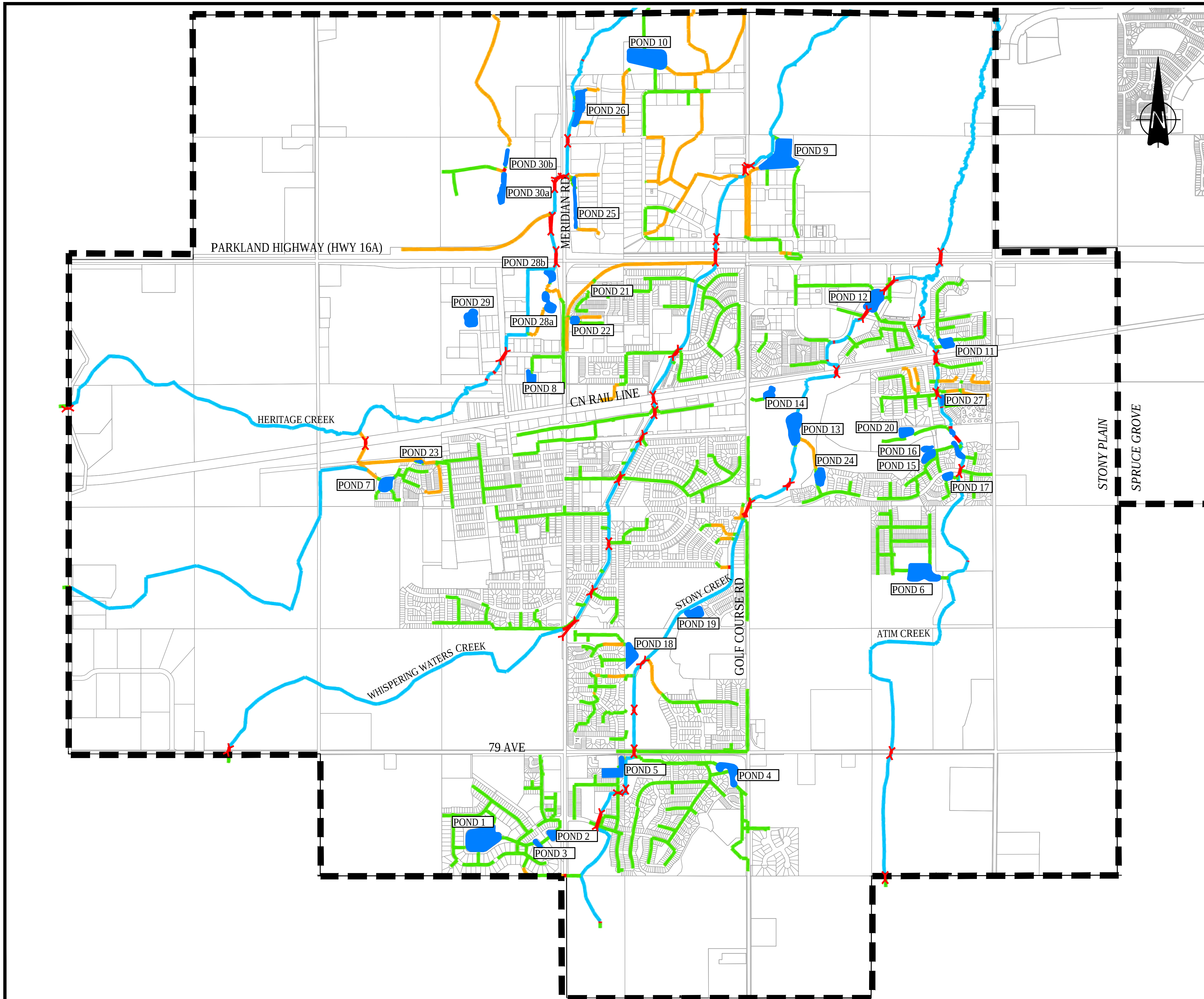
Catchbasin Distribution

Scale:

1:25,000

Figure:

4.8



LEGEND:

- MUNICIPAL BOUNDARY
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY
- EXISTING DITCH
- EXISTING CULVERT
- EXISTING STORM PIPE

Pond ID	Name / Location	Type
1	Genesis West pond	Wet pond
2	Genesis Eest Pond 1	Wet pond
3	Genesis Eest Pond 2	Wet pond
4	Westerra East Pond	Wet pond
5	Westerra West Pond	Wet pond
6	Southcreek Pond	Wet pond
7	Brickyard Pond	Wet pond
8	Industrial Pond 1	Wet pond
9	Industrial Pond 2	Wet pond
10	Industrial Pond 3	Wet pond
11	Jutland Pond	Wet pond
12	South Business Park Pond	Wet pond
13	Golfcourse Pond 1	Wet pond
14	Golfcourse Pond 2	Wet pond
15	Fairways Pond 1	Dry pond
16	Fairways Pond 2	Dry pond
17	Fairways Pond 3	Flow through pond
18	Willowpark Pond	Wet pond
19	Sommerville Pond	In construction
20	Fairway Pond 4	In construction
21	Meridian cove dry pond	Flow through pond
22	Merdian condo dry pond	Flow through pond
23	Brickyard dry pond	Flow through pond
24	Golfcourse Pond 3	Flow through pond
25	RJ Industrial Park Wetland	Wetland
26	Legend trial dry pond	Flow through pond
27	Graybriar dry pond	Flow through pond
28	Rotary Park Pond	No information
29	Hertiage Park Pond	No information
30	Merdian Meadows Pond	No information

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Client:

TOWN OF STONY PLAIN

Project:

Stormwater Master Plan

Title:

Existing Stormwater Management Facilities

Scale:	Figure:
1:25,000	4.9

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5.0 Computer Hydraulic Model Development

5.1 Computer Modeling Overview

Using the drainage infrastructure inventory created for this storm drainage master plan, an integrated major and minor system hydraulic model was created under a single Mike Urban model. The minor system network comprises of storm pipes, manholes, outfalls, drainage channels, stormwater management facilities and their related discharge control devices. The major drainage system network includes roads and other major drainage paths. The hydraulic interactions between the minor system and the major system were fully-integrated. For example, the rainfall runoff is generated by the catchments delineated on a block by block basis. This flow is generated by the catchment using the specific characteristics such as percent imperviousness and catchment size. The runoff water is then introduced to the major drainage segment and from there, the flow would be routed through the roadway and enter the sewer system at the catchbasin locations. If the storm pipe's capacity has been exceeded, the model would calculate its level of surcharge. Should a sewer's capacity be exceeded to a point where the surcharging reaches the roadway elevation, the flow will then be routed through the roadway. In this way, the total drainage picture of the system is represented dynamically by the model.

The resulting computer model provides a good representation of the existing major and minor drainage system interactions, and the modeling results provide a good understanding of the surface flows, surface ponding locations and depths, as well as drainage system constraints. We trust that the model provides accurate and realistic hydraulic results for this planning level of study. For future design phases, this model could be updated to include more details.

This comprehensive dual-drainage hydraulic model was used to evaluate the performance of the existing drainage system under many rainfall events. The results are presented in Section 6.0. It was also used to develop improvement recommendations to the existing drainage system, explained in Section 7.0.

The following summarizes how the various component of the model were constructed.

5.2 Selection of Computer Model Software

A variety of computer modeling software are marketed as being able to complete dual-drainage and/or 2D modeling of stormwater systems. The following summarized some well-known software.

- XPSWMM by Innovyze is a fully dynamic hydraulic and hydrologic modelling software that combines 1D calculations for upstream to downstream flow with 2D overland flow calculations. Its use over the last 25 years, as well as its UK Environment Agency benchmark testing and U.S. FEMA approval, has made it one of the most stable and well-used simulation software programs in the world. (http://www.innovyze.com/products/xpswmm/)

- PCSWMM by CHI is an advanced modeling software for stormwater, wastewater, watershed and water distribution systems. Their software is marketed as being able to help improve new water supply, drainage and green infrastructure design, floodplain delineation, sewer overflow mitigation, water quality and integrated catchment analysis, 1D-2D modeling and more. (https://www.pcswmm.com/)
- MIKE URBAN by DHI is an urban water modelling software that covers all water networks in the town, including water distribution systems, storm water drainage systems, and sewer collection in separate and combined systems. (https://www.mikepoweredbydhi.com/products/mike-urban)
- SWMHYMO by J.F. Sabourin and Associates Inc. is a complex hydrologic model used for the simulation and management of stormwater runoff in either small or large rural and urban area. Using easily acquired watershed or sewershed information, SWMHYMO processes rainfall records to simulate the transformation of rainfall into surface runoff. Computed hydrographs can be routed through pipes, channels or stormwater control ponds and reservoirs. In urban area, the effective capture rates of catch basins and the effects of storage in street low points can also be simulated. (www.jfsa.com/hydrologic-modelling-swmhymo.php)

For this project, it was decided to use DHI's Mike Urban (Release 2017 SP1). The main reasons for using Mike Urban is that Sameng is experienced with its interface, capabilities and limitations, it is known to be stable and we are able to check the accuracy of its results efficiently. Although another software may have generated similar results, the risks of potentially constructing a dual-drainage model that was unstable and produced erroneous results would be detrimental to the project. The Mike Urban database can be exported to SWMM format and vice versa.

The use of Mike Urban for this project proved successful. The model is stable. Although Mike Urban was used for this project, developers should not be mandated to use Mike Urban to model their drainage systems. Instead, alternative software may be used to analyze their specific development or issues.

5.3 Network Model

5.3.1 Minor Drainage System

The sewer/piped system was constructed by importing all elements from the Town's geodatabase, and then completing the network by adding missing pipes and manholes, missing/incorrect information (e.g. diameter, invert, length, etc.), and by inferring how data gaps would be filled (e.g. record drawings, previous models, discussions with Town, assumed/estimated, etc.). The network model does not include abandoned or removed sewer elements, and it does not include individual catchbasins and catchbasin leads (these were omitted to keep the model simple, although they could be added in a future revision or for detailed design projects). Some pipes/manholes on private properties were included if the information was available. Most of the key culverts are included in the model, but majority of the local property access culverts were purposely excluded.

The resulting minor drainage network, including stormwater management facilities, is illustrated in Figure 5-1.

5.3.2 Major Drainage System

A major drainage 'surface' layer was constructed to provide a 2-D representation of the overland drainage system using a 1-D software. This requires manual definition of flow paths and inputting these flow paths and overflow elevations in the model. This includes roadways, ditches, swales, and overflow locations. The alleys were not included in the major drainage model unless they served an important flow function.

The resulting major drainage network is illustrated in Figure 5-2.

5.3.3 Major – Minor System Integration

The major drainage system nodes were connected to the storm sewer system's manholes (or catchbasin manholes) where catchbasins are physically connected/located using 'orifice' elements that approximate flows between the surface and the receiving manhole. The orifices were sized as to not significantly overestimate or underestimate actual catchbasin capacities, while keeping the model simple.

5.3.4 Stormwater Management Facilities and Control Structures

All known stormwater management facilities and their control structure (i.e. orifice and/or weir) were included in the model.

The storm sewer system is connected to stormwater management facilities through their inlet and outlet pipes.

Major drainage connections to the ponds, including pond overflows and major drainage inflows, were also modeled.

5.4 Runoff Model

Storm catchments were created for the entire Town. Drainage basins were delineated based on the proximity of the surface node. This model includes a total of about 2,191 catchment areas throughout the Town, with a median size of 0.40 ha. The flow length and slope of each catchment area was calculated from the LiDAR data.

To calculate the runoff generation, the Kinematic Wave method was used with typical Horton Infiltration parameters. These parameters are summarized in Table 5-1 below.

Table 5-1: Kinematic Wave Parameters (Horton Parameters) for Storm Catchments

	Impervious Component	Pervious Component
	Flat	Medium
Initial Losses		
Wetting	0.050 mm	0.050 mm
Storage	0.625 mm	2.5 mm
Horton's Infiltration Capacity		
Maximum		75.6 mm/hr
Minimum		7.56 mm/hr
Horton's Exponent		
Wet Condition		5.4 /hr
Dry Condition		0.036 /hr
Manning's Number		
Manning's Number	59 (n = 0.017)	33 (n = 0.03)

The following Table 5-2 demonstrates the approximate runoff coefficient of storm catchments of various imperviousness and for various rainfall events. As shown in the table, the runoff coefficient of areas with low imperviousness (e.g. 10%) varies significantly depending on the rainfall event. For high intensity rainfalls, most of the rainfall is converted to runoff as the pervious soil cannot absorb all the water. For areas with already large imperviousness values (e.g. 90%), the runoff coefficient does not vary greatly.

Table 5-2: Approximate Runoff Coefficient for Catchment Areas of Various Imperviousness

Imperviousness	Runoff Coefficient			
	5-year 4-hour Chicago Dist.	100-year 4-hour Chicago Dist.	5-year 24-hour Chicago Dist.	100-year 24-hour Chicago Dist.
10% (Park)	0.20	0.47	0.23	0.38
50% (Single-Family Residential)	0.55	0.70	0.57	0.65

90% (Commercial)	0.89	0.93	0.90	0.92
Total Rainfall Depth	31.31 mm	58.67 mm	52.47 mm	97.51 mm

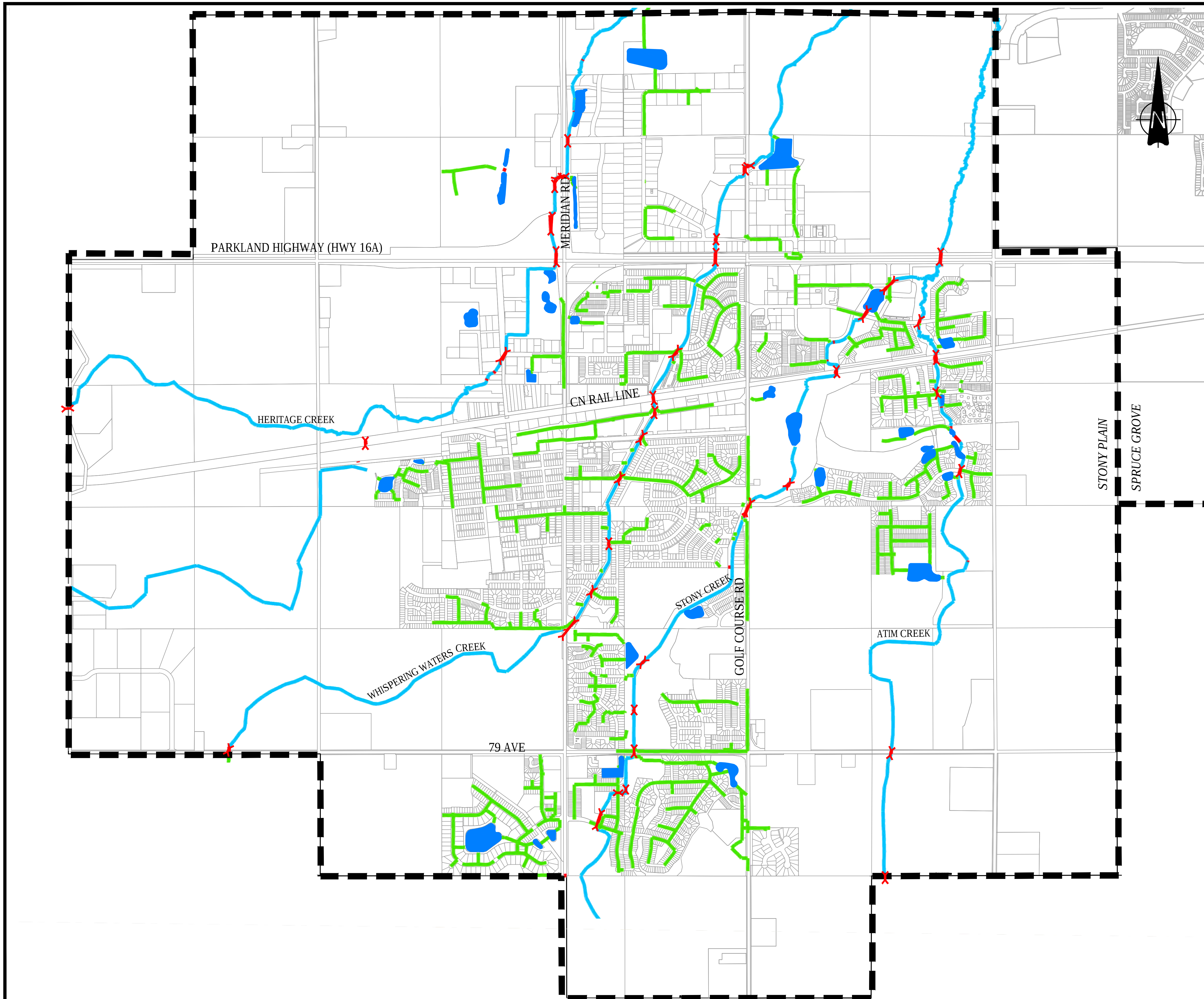
5.5 Summary of Physical Model Elements

The final model contains:

- Nodes: 4455 (about 828 belong to the sewer system and culverts, the others represent the major drainage system, drainage channels and stormwater management facilities.
- Links: 4718 (about 936 belong to the sewer system and culverts, the others represent the major drainage system, drainage channels and stormwater management facilities.
- Orifices: 410 (13 are control structure orifices, the others represent catchbasin connections)
- Catchments: 2,191

5.6 Model Calibration and Validation

Due to a lack of the actual measured flow rate in storm sewer systems and a lack of rainfall monitoring data, we are not able to compare the model result with the monitoring data. Nevertheless, the model was finely tuned to reflect the performance of the storm water system based on experience and checking the hydraulic behaviour of specific locations.



LEGEND:

- MUNICIPAL BOUNDARY
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY
- EXISTING STORM PIPE
- EXISTING CULVERT

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TOWN OF STONY PLAIN

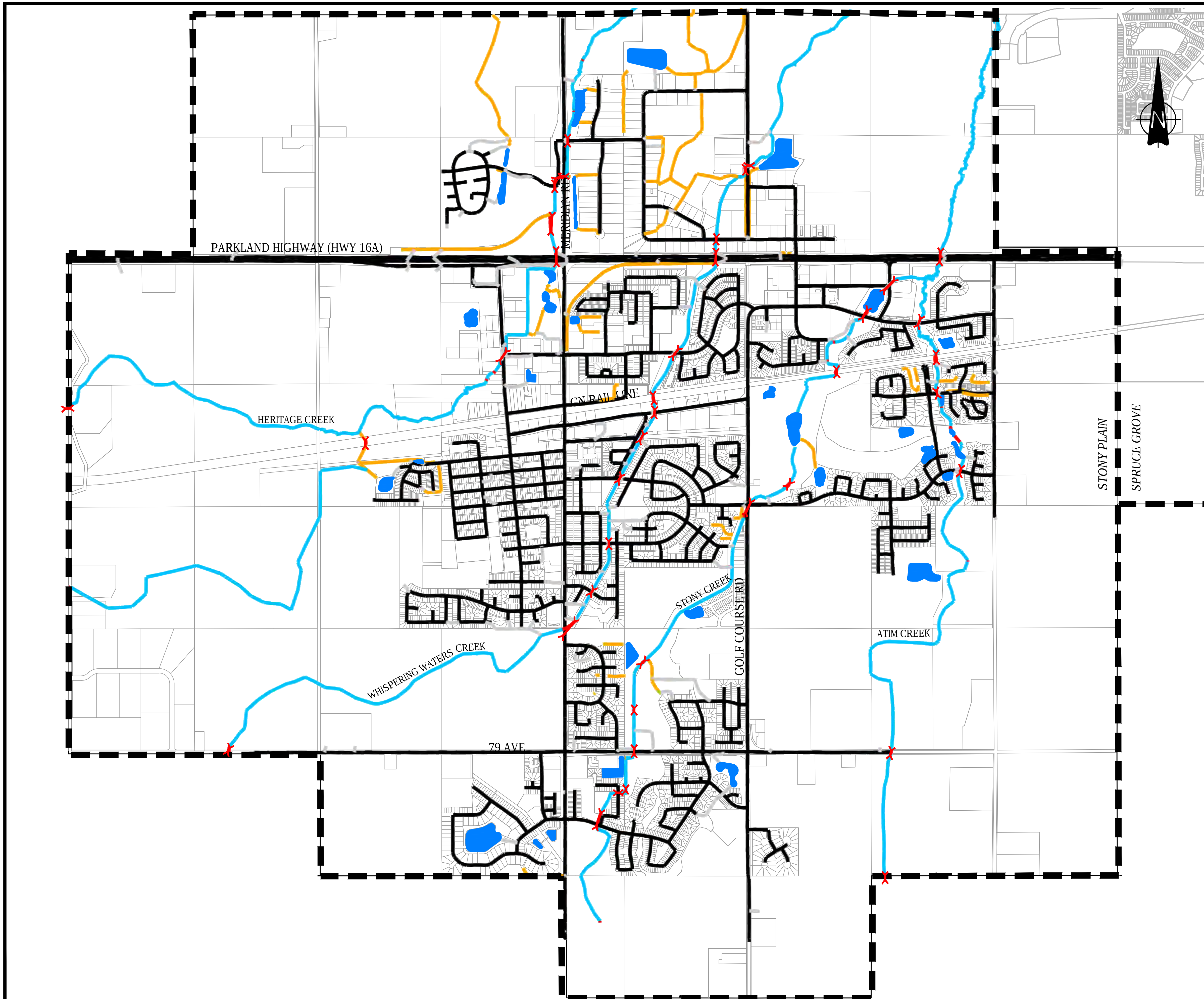
Project:

Stormwater Master Plan

Title:

Model Minor Drainage Network

Scale:	Figure:
1:25,000	5.1



LEGEND:

- MUNICIPAL BOUNDARY
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY
- EXISTING DITCH
- EXISTING CULVERT
- ROADWAY
- OVERFLOW

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Client:

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Project: Stormwater Master Plan

Title: Model Major Drainage Network

Scale: 1:25,000

Figure: 5.2

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6.0 Existing Drainage System Assessment

6.1 Simulation Results

6.1.1 Overview of Simulation Result Figures

The existing drainage system of the Town of Stony Plain was evaluated under various design rainfall events, using the computer model as explained in Section 5.0. Simulation results for the 5-year 4-hour Chicago distribution rainfall event, the 100-year 4-hour Chicago distribution rainfall event and the 100-year 24-hour Chicago distribution rainfall event are included in this section.

6.1.2 Minor Drainage System

For the storm sewer system, the simulation results show the theoretical loading of the pipes (Q_{peak}/Q_{cap}) as well as the surcharge depth in each pipe (identified at the manholes). From these results, it is possible to identify which sewer pipes are flowing beyond their pipe full capacity ($Q_{peak}/Q_{cap} > 1.0$), and how surcharged the pipes are.

6.1.3 Major Drainage System

For the major drainage system, the simulation results show the ponding depth and extents along the main drainage paths, as well as the peak flow rate on the ground surface.

6.2 Flood Risk Assessment

Table 6-1: Flood Risk Quantification Table

Flood Risk Category	Flood Risk Description
High Flood Risk	**Many properties are at risk of flooding during a 100-year (or smaller) rainfall event.** A high flood risk was attributed to areas where flooding of many vehicles, properties and residences/buildings is expected during the 100-year rainfall event, based on a thorough review of the 2D ponding maps. These are often areas with a poor major drainage system, depressions with large ponding depths, and/or poor private lot grading.
Medium Flood Risk	**Properties may be at risk of flooding during a 100-year (or smaller) rainfall event.** A medium flood risk was attributed to areas where there is potential for some vehicles, properties and residences/buildings to be flooded, and/or for which the flooding may pose safety concerns. This includes all areas: - Adjacent to a depression with ponding depths exceeding 50cm. - Adjacent to a depression with ponding depths exceeding 35cm AND for which the ponding appears to overflow onto private properties.
Low/No Flood Risk	**Few properties are at risk of flooding during a 100-year rainfall event. Any flood risk would be very localized.** A low/no flood risk was attributed to areas that were not classified as being medium or high risk. Generally, these areas: - Are well-graded with a good major drainage system. - Are not adjacent to a large/deep ponding area (less than 35cm ponding depth).
Large Private Property Hatch Additional computer modeling is needed to confirm flood risk on large private properties; the computer modeling focused on public roads and residential areas. These are typically associated to large commercial and industrial sites with their own internal drainage system and catchbasins.	**Undeveloped Land Hatch** The area is currently undeveloped and flood risks could not be assigned.

6.3 Simulation Result Description

6.3.1 5-year 4-hour Chicago Distribution Rainfall Event

Simulation results for the 5-year 4-hour design rainfall event are presented in Figure 6-1 (sewer surcharge), Figure 6-2 (theoretical loading in pipe), Figure 6-3 (surface ponding and extents) and Figure 6-4(surface flow).

MINOR DRAINAGE SYSTEM RESULTS

The Town of Stony Plain's current design standard is for the storm sewer system to convey the 5-year rainfall event peak flows within pipefull flow which is typical of most Alberta municipalities.

Figure 6-1 shows that several storm sewers in the Town will surcharge during the 5-year event. About 493 manholes (60%) will be surcharged to 1.0m below ground or less, and more than 130 manholes (15%) will be surcharged to grade.

Figure 6-2 shows that several pipes will see flows exceeding their pipefull capacity, which correlates with the widespread surcharge experienced in the sewer system. About 16 km of pipe (33%) will see peak flows exceed their pipefull capacity, and close to 2 km of pipe (4%) will flow at more than twice their capacity.

There are limited areas with sewer capacity issues during the 5-year event. It should be noted that upgrading pipes with a large theoretical loading (Qp/Qc) may reduce surcharge in the system, but the solution is often more complex. The focus should be on ensuring that the areas do not flood and that major drainage flows can be conveyed safely.

MAJOR DRAINAGE SYSTEM RESULTS

Figure 6-3 shows that surface ponding during the 5-year event is not of concern for most areas of the Town; with ponding depths at street depressions rarely exceeding 35cm (only 2 locations of the model's surface road nodes have more than 35cm of ponding).

Figure 6-4 shows that surface flows rates during a 5-year event are generally quite small on most roadways, as the sewer system captures most of the runoff. About 2% of the roads will see surface flows exceed 500 L/s, no road will experience flows larger than 2,000 L/s.

FLOOD RISK AREAS

Areas at higher flood risks due to excessive surface ponding during the 5-year 4-hour design event are:

1- **Boulder Blvd.:** Major drainage overflows towards the many depressions, especially on southwest corner of Boulder Blvd. The area has a poor major drainage system.

2- **Egerland Pl. and 47 St.:** Lack of sewer capacity in the area with significant major drainage flows pooling at large surface depressions. Major drainage system is not able to relieve the trapped flow.

All stormwater management facilities appear capable of storing the flows from the 5-year 4-hour design rainfall event without exceeding their capacity.

6.3.2 100-year 4-hour Chicago Distribution Rainfall Event

Simulation results for the 100-year 4-hour design rainfall event are presented in Figure 6-5 (sewer surcharge), Figure 6-6 (theoretical loading in pipe), Figure 6-7 (surface ponding and extents) and Figure 6-8 (surface flow).

MINOR DRAINAGE SYSTEM RESULTS

Sewer pipes during an intense 100-year 4-hour event are expected to be flowing full and be surcharged to grade in most locations, as shown in Figure 6-5. About 393 manholes (47%) will be surcharged to 1.0m below ground or less, and more than 300 manholes (40%) will be surcharged to grade.

Figure 6-6 shows that several pipes will see flows exceed their pipefull capacity, which correlates with the widespread surcharge experienced in the sewer system. About 24 km of pipe (50%) will see peak flows exceed their pipefull capacity, and close to 5 km of pipe (10%) will flow at more than twice their capacity.

MAJOR DRAINAGE SYSTEM RESULTS

Figure 6-7 shows that surface ponding during the 100-year event is mainly in old neighbourhoods, but some areas, especially local depressions with poor major drainage routes, are at higher risk of flooding. Ponding depths exceeded 35cm at 67 surface road nodes (5% of the entire model road nodes).

Figure 6-8 shows that surface flows have become significant on many roads, as the sewer pipes cannot convey these large runoff flows. About 92% of the roads will see surface flows exceed 500 L/s, with nearly 2% of them experiencing flows greater than 2,000 L/s.

FLOOD RISK AREAS

Areas at flood risk due to excessive surface ponding during the 5-year 4-hour design event will continue to be at risk. For these locations, the flood risks during the 100-year event are significantly greater. Additional areas of flood risk during the 100-year event are listed below:

1- **44 Ave. between St Andrews St. and St Andrews Dr.:** Water level increases in the creek raises the water level in the sewer pipe and therefore cause ponding on road.

2- **49 Ave. east of 50 St.**: Lack of sewer capacity in the area with significant major drainage flows pooling at large surface depressions with inadequate major drainage overflow.

3- **41 Ave. and 43 St.**: Lack of sewer capacity in the area with significant major drainage flows pooling at large surface depressions with inadequate major drainage overflow.

4- **46 St. between 54 Ave. and 55 Ave.**: Lack of sewer capacity and insufficient catchbasin capacity.

5- **Golf Course Rd. N and Crystal Dr.**: Lack of culvert capacity at WWC-C-100.

Most stormwater management facilities appear capable of storing the flows from the 100-year 4-hour design rainfall event without exceeding their capacity, with the exception of Pond #4 (Westerra) of which the water does not spill to private properties.

For Pond #21 (Merdian height), Pond #26 (Legend trail) and Pond #27 (Graybriar), the simulated water level is higher than the spillway elevation.

6.3.3 100-year 24-hour Chicago Distribution Rainfall Event

Simulation results for the 100-year 24-hour design rainfall event are presented in Figure 6-9 (sewer surcharge), Figure 6-10 (theoretical loading in pipe), Figure 6-11 (surface ponding and extents) and Figure 6-12 (surface flow). The 100-year 24-hour event is designed to test the capability of storage devices that have restricted outflow rates. In this regard, the conveyance system would be expected to perform better during this rainfall condition while the stormwater management facilities would be stressed to a greater extent.

MINOR DRAINAGE SYSTEM RESULTS

Sewer pipes during an intense 100-year 24-hour event are expected to be flowing full and be surcharged to grade in most locations, as shown in Figure 6-9. About 700 manholes (86%) will be surcharged to 1.0m below ground or less, and 53 manholes (6%) will be surcharged to grade.

Figure 6-10 shows that several pipes will see flows exceeding their pipefull capacity during this event, which is expected. About 5 km of pipe (14%) will see peak flows exceed their pipefull capacity, and close to 1.3 km of pipe (3%) will flow at more than twice their capacity.

MAJOR DRAINAGE SYSTEM RESULTS

Figure 6-11 shows that surface ponding during the 100-year 24 hr. event is not of concern for most areas, with ponding depths at street depressions rarely exceeding 35cm (only 1 node of the model's surface road nodes have more than 35cm of ponding).

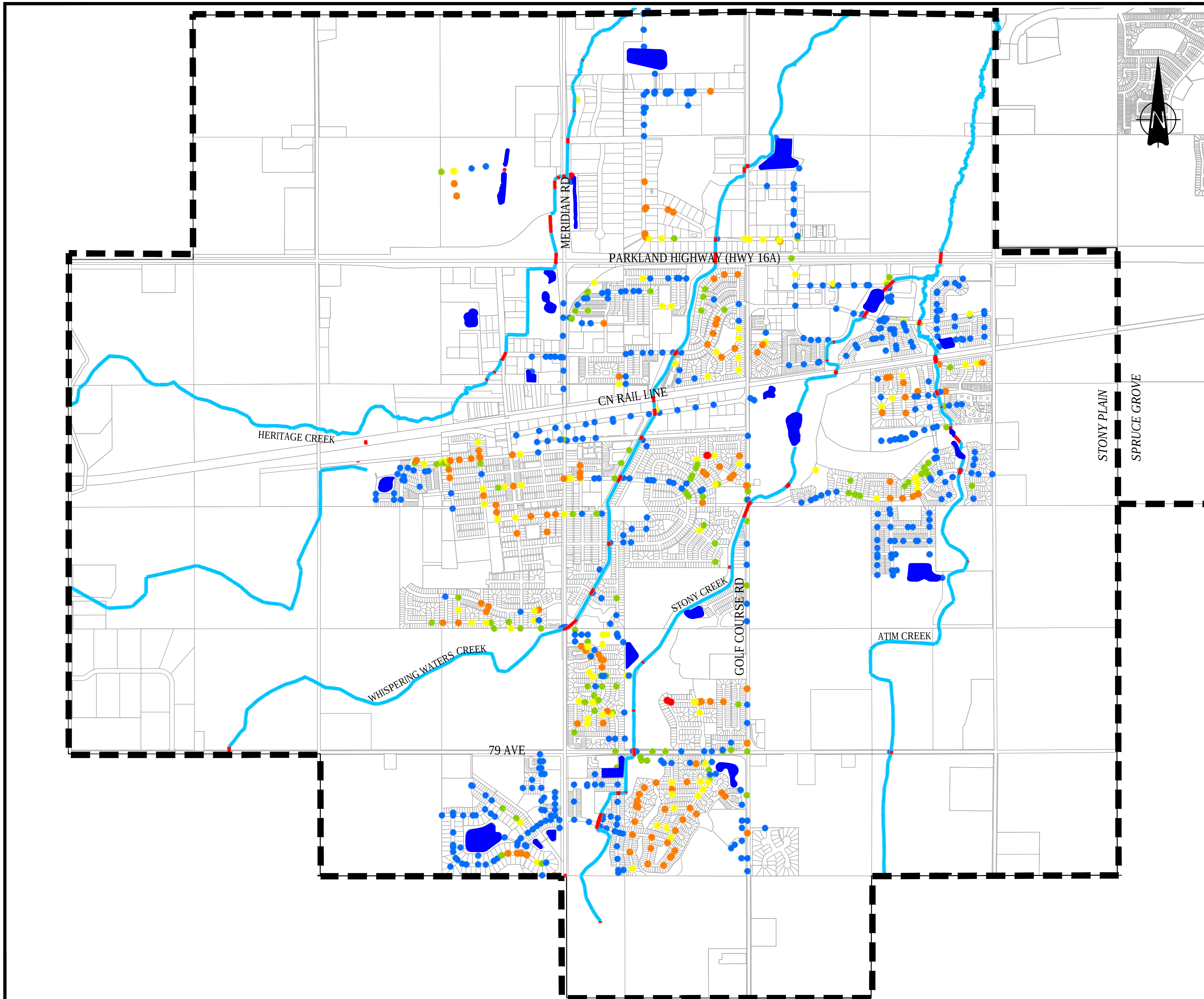
Figure 6-12 shows that surface flows are not significant on many roads. About 1% of the roads will see surface flows exceed 500 L/s, with no roads experiencing flows larger than 2,000 L/s.

FLOOD RISK AREAS

Areas at high flood risks due to excessive surface ponding during the 100-year 24-hour design event are almost identical as the ones at risk during the 100-year 4-hour event.

Water levels in the ponds during the 100-year 24-hour event are generally higher than during the 100-year 4-hour event. Most stormwater management facilities appear capable of storing the flows from the 100-year 24-hour design rainfall event without exceeding their capacity, with the exception of the following ponds: Pond #4 (Westerra) without spilling to private properties.

For Pond #5 (Westerra), Pond #10 (Umbach), Pond #21 (Merdian height), Pond #26 (Legend trail), Pond #27 (Graybriar), the simulated water level is higher than the spillway.



LEGEND

CITY BOUNDARY

PROPERTY LINE

EXISTING WATERCOURSE

EXISTING STORMWATER MANAGEMENT FACILITY

SURCHARGE DEPTH

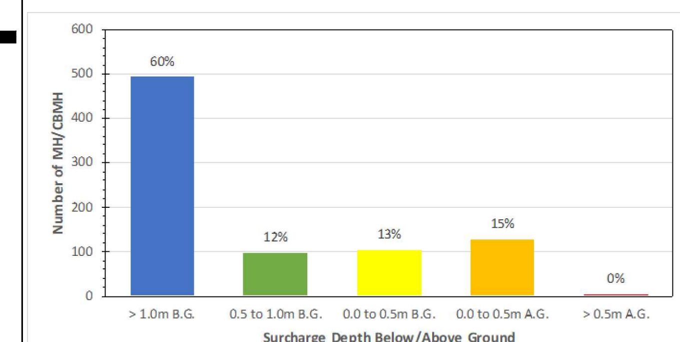
≥ 1.0m BELOW GROUND

0.5 TO 1.0m BELOW GROUND

0.0 TO 0.5m BELOW GROUND

0.0 TO 0.5m ABOVE GROUND

> 0.5m ABOVE GROUND



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Client:

TOWN OF STONY PLAIN

Project:

Stormwater Master Plan

Title:

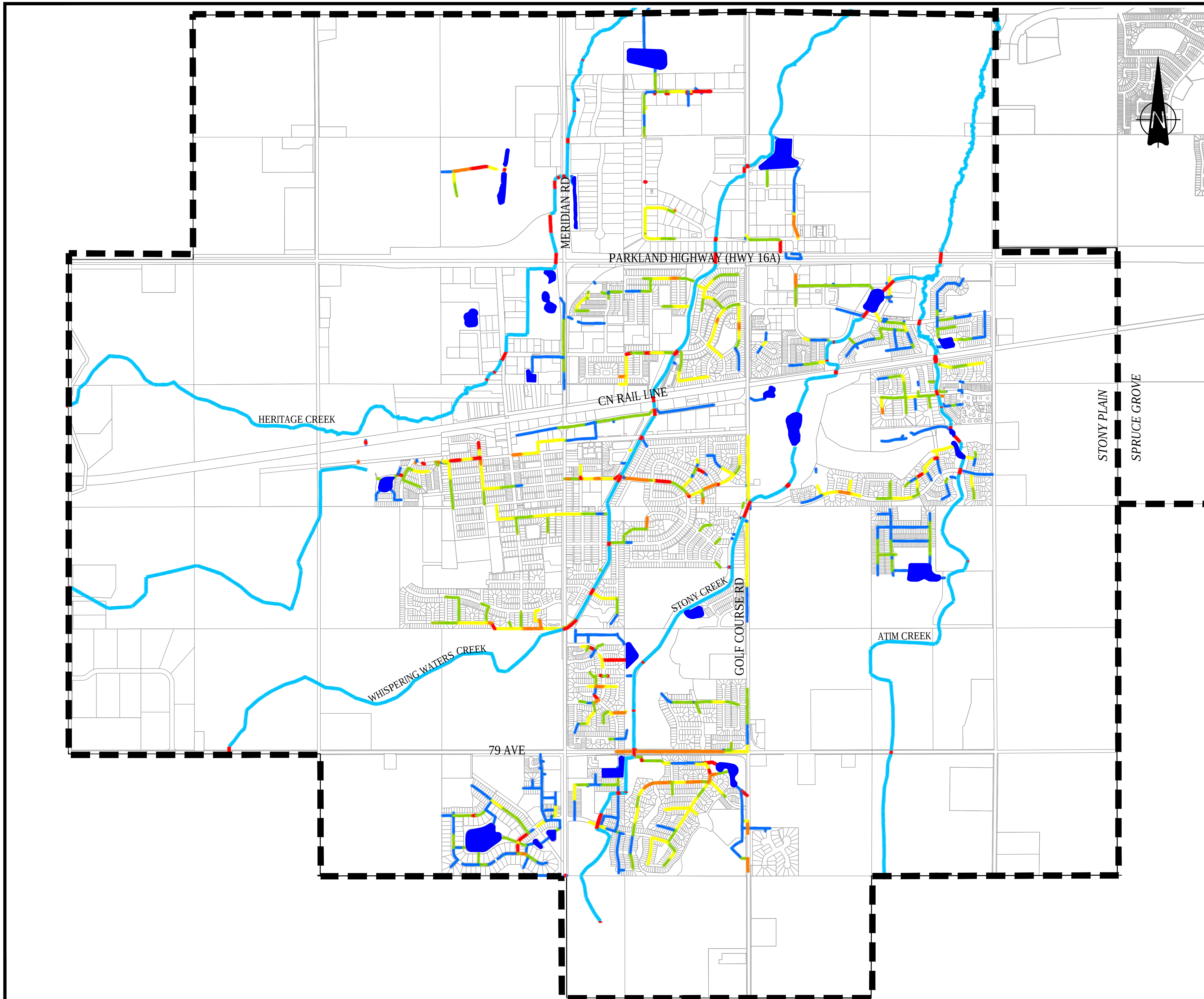
Simulation Results - Existing System
1:5-year 4-hour Event - Sewer Surcharge

Scale:

1:25,000

Figure:

6.1

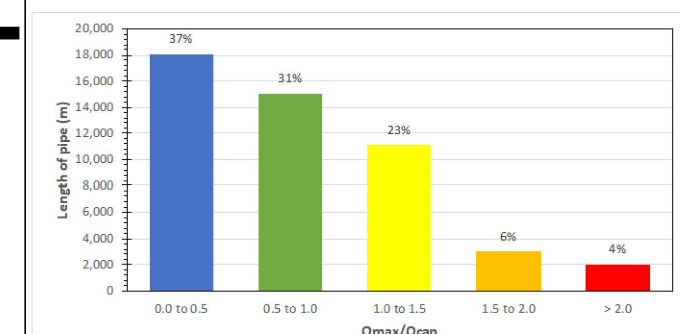


LEGEND

- CITY BOUNDARY
- PROPERTY LINE
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY

THEORETICAL LOADING Qp / Qc

- ≤ 0.5
- 0.51 - 1.0
- 1.01 - 1.5
- 1.51 - 2.0
- > 2.0



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Project:

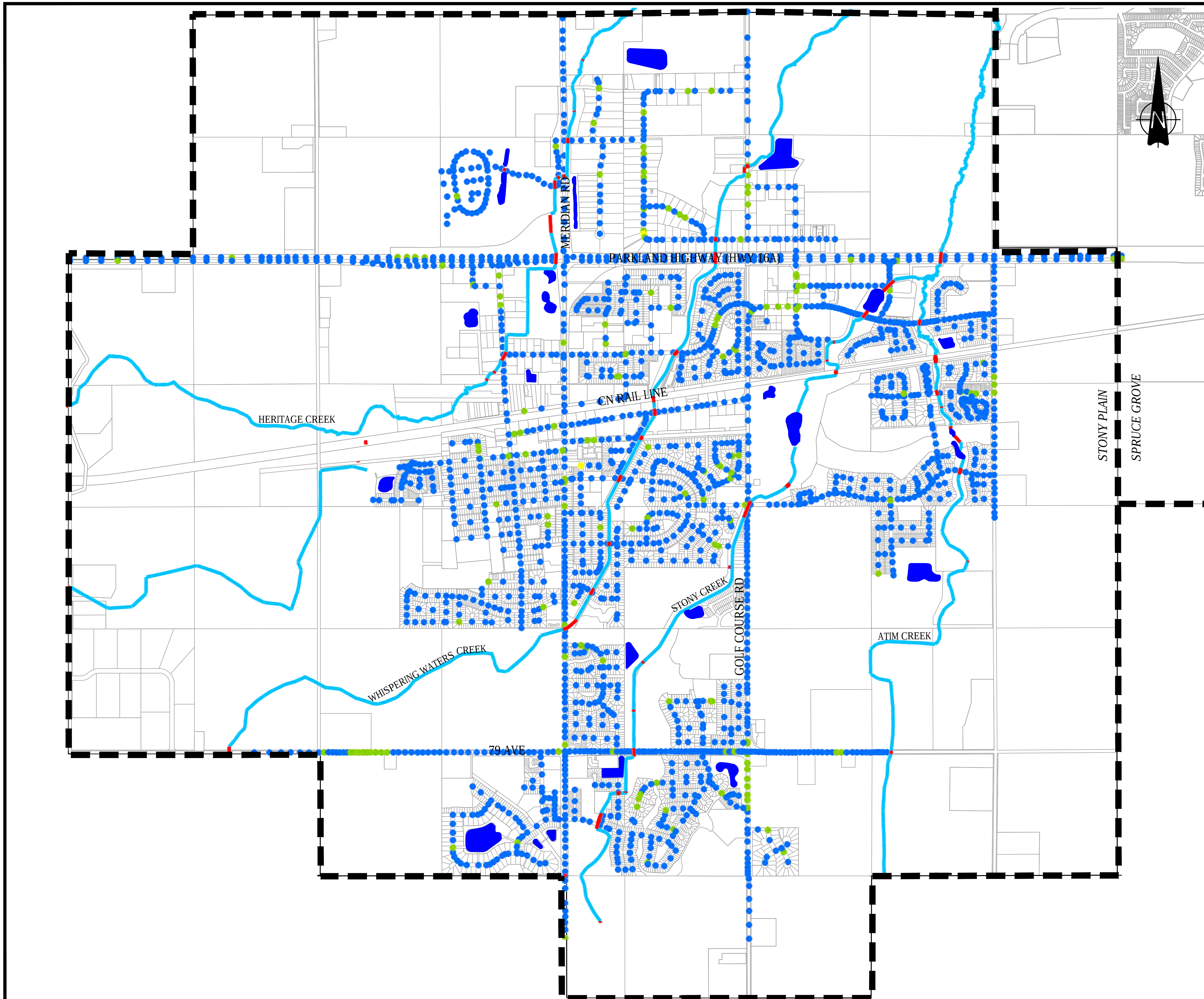
Stormwater Master Plan

Title:

Simulation Results - Existing System
1:5-year 4-hour Event - Theoretical Loading in Pipe

Scale: 1:25,000

Figure: 6.2

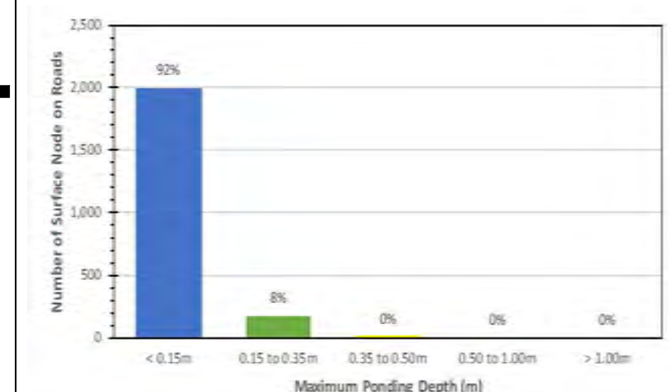


LEGEND

- CITY BOUNDARY
- PROPERTY LINE
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY

SURFACE PONDING DEPTH

- <0.15m
- 0.16m - 0.35m
- 0.36m - 0.50m
- 0.51m - 1.00m
- >1.00m



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Client:

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Project:

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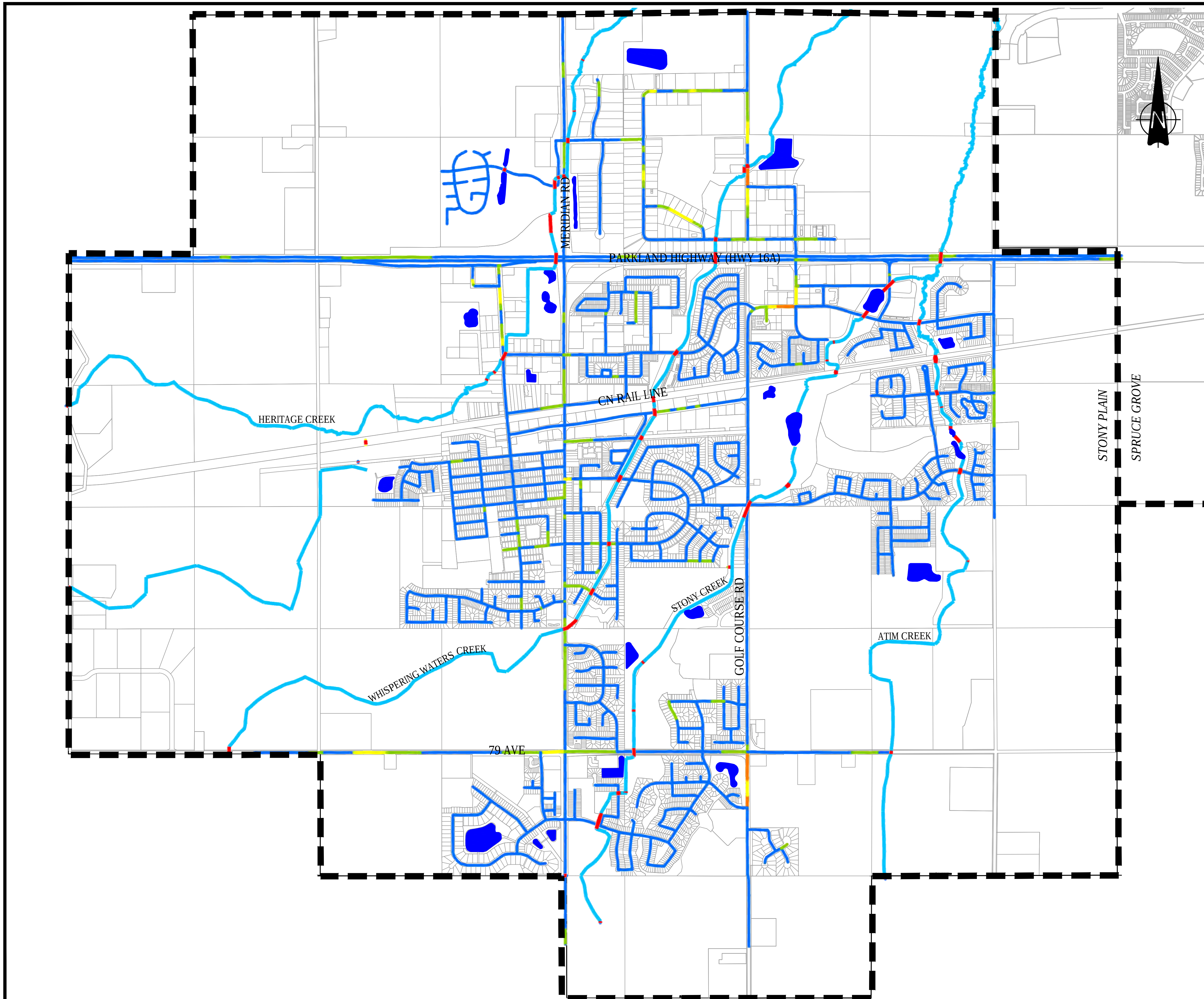
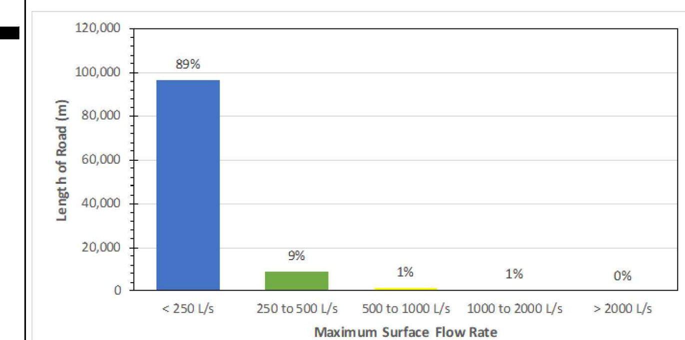
Title:

Simulation Results - Existing System
1:5-year 4-hour Event - Surface Ponding

Scale: 1:25,000

Figure: 6.3





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Client:

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Project:

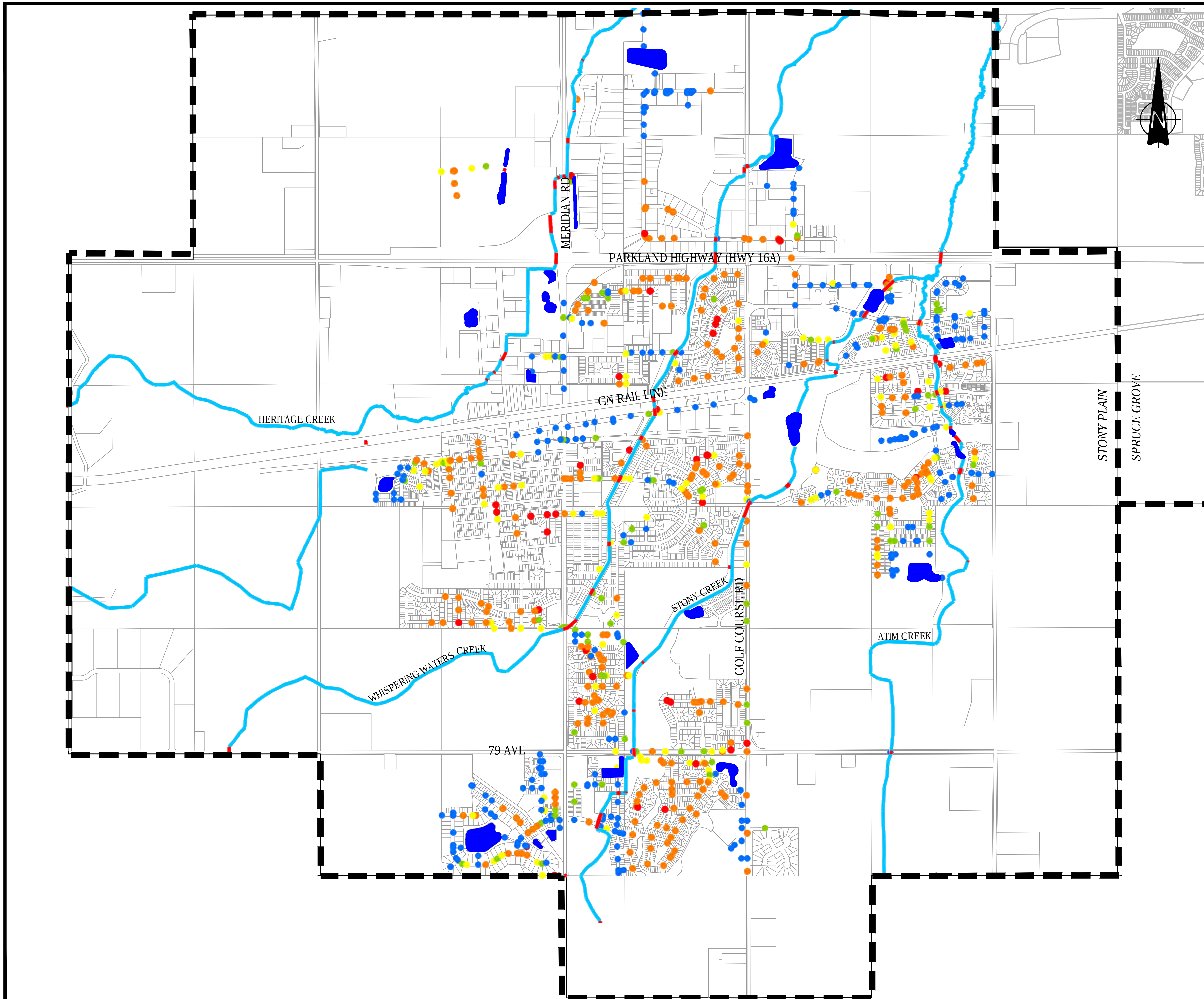
Stormwater Master Plan

Title:

Simulation Results - Existing System
1:5-year 4-hour Event - Peak Surface Flow Rate

Scale: 1:25,000

Figure: 6.4

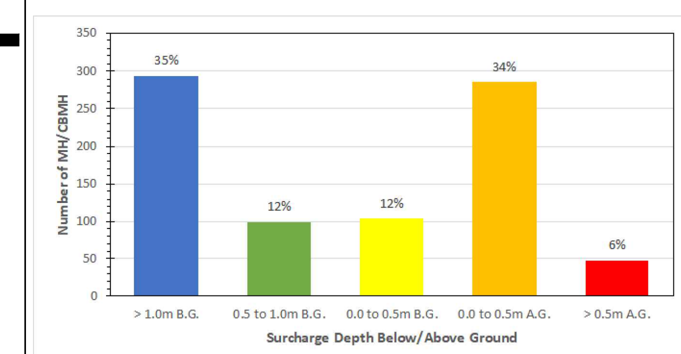


LEGEND

- CITY BOUNDARY
- PROPERTY LINE
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY

SURCHARGE DEPTH

- ≥ 1.0m BELOW GROUND
- 0.5 TO 1.0m BELOW GROUND
- 0.0 TO 0.5m BELOW GROUND
- 0.0 TO 0.5m ABOVE GROUND
- > 0.5m ABOVE GROUND



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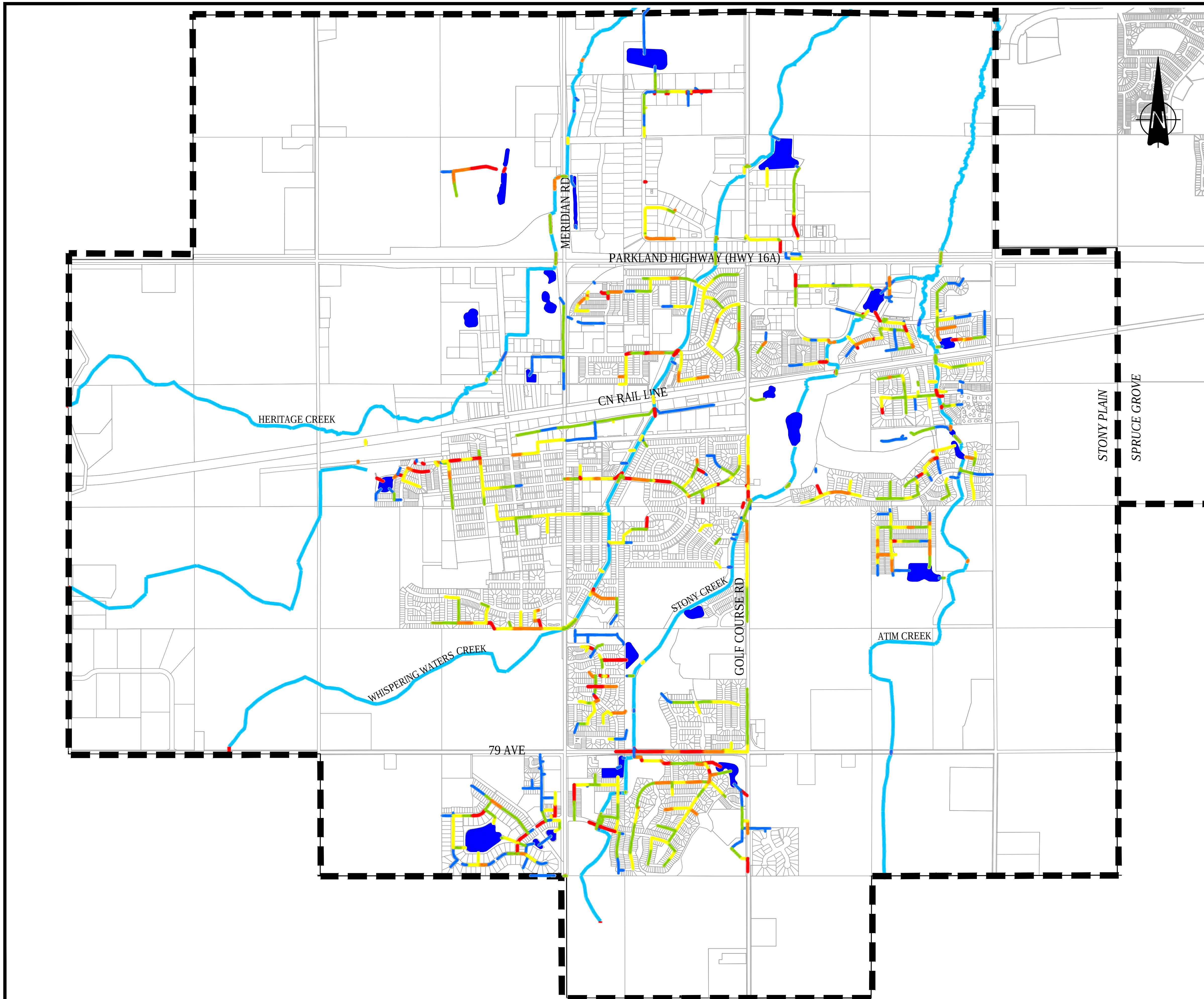
Project:

Stormwater Master Plan

Title:

Simulation Results - Existing System
1:100-year 4-hour Event - Sewer Surcharge

Scale:	Figure:
1:25,000	6.5

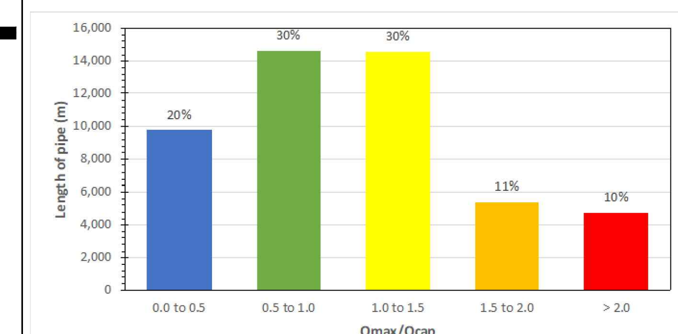


LEGEND

- CITY BOUNDARY
- PROPERTY LINE
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY

THEORETICAL LOADING Qp / Qc

- ≤ 0.5
- 0.51 - 1.0
- 1.01 - 1.5
- 1.51 - 2.0
- > 2.0



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Project:

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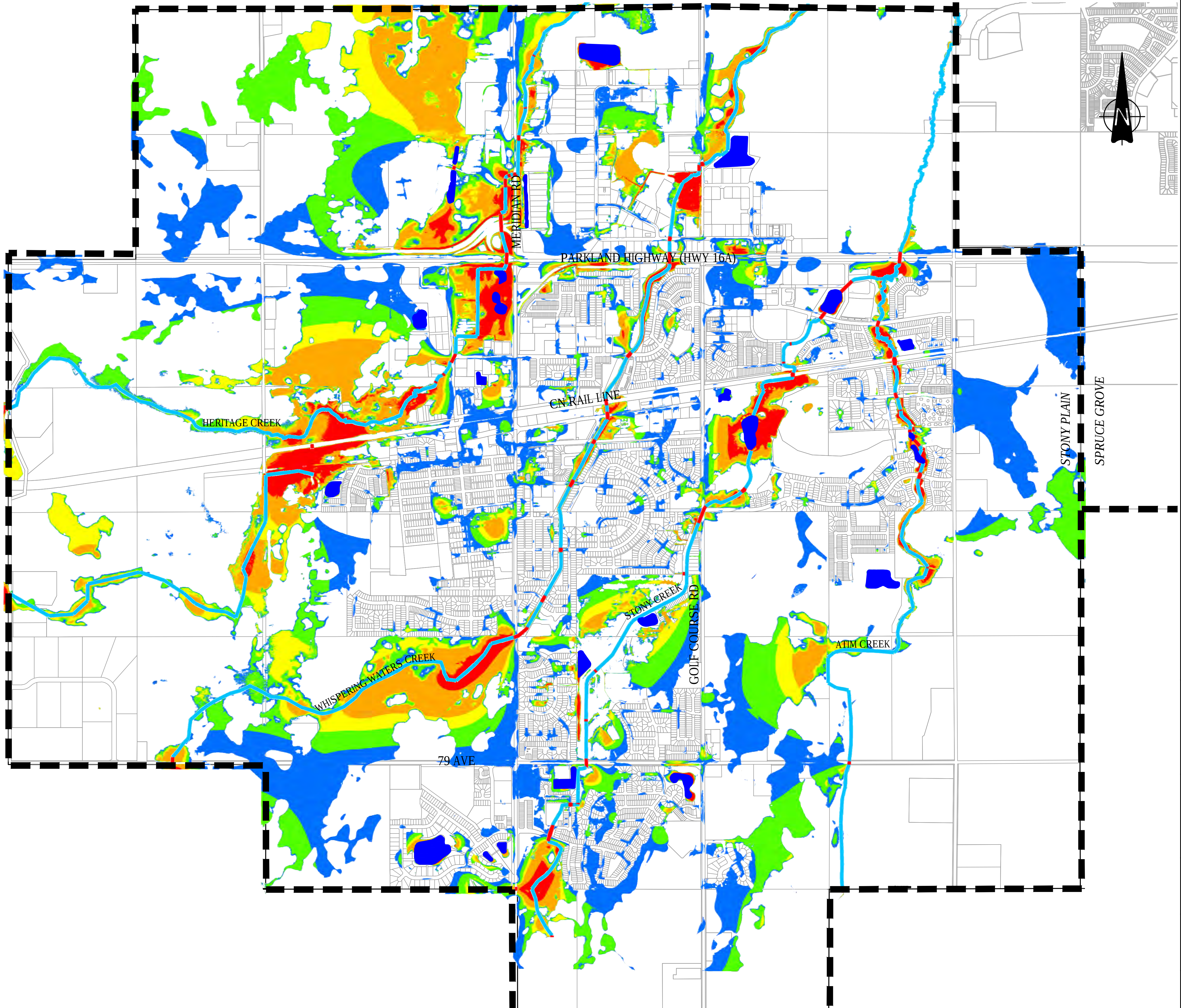
Title:

Simulation Results - Existing System
1:100-year 4-hour Event - Theoretical Loading in Pipe

Scale:	Figure:
1:25,000	6.6

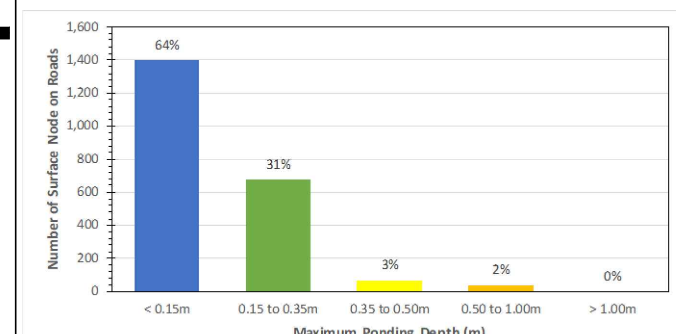


LEGEND

- CITY BOUNDARY
- PROPERTY LINE
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY

SURFACE PONDING DEPTH

- <0.15m
- 0.16m - 0.35m
- 0.36m - 0.50m
- 0.51m - 1.00m
- >1.00m



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Project:

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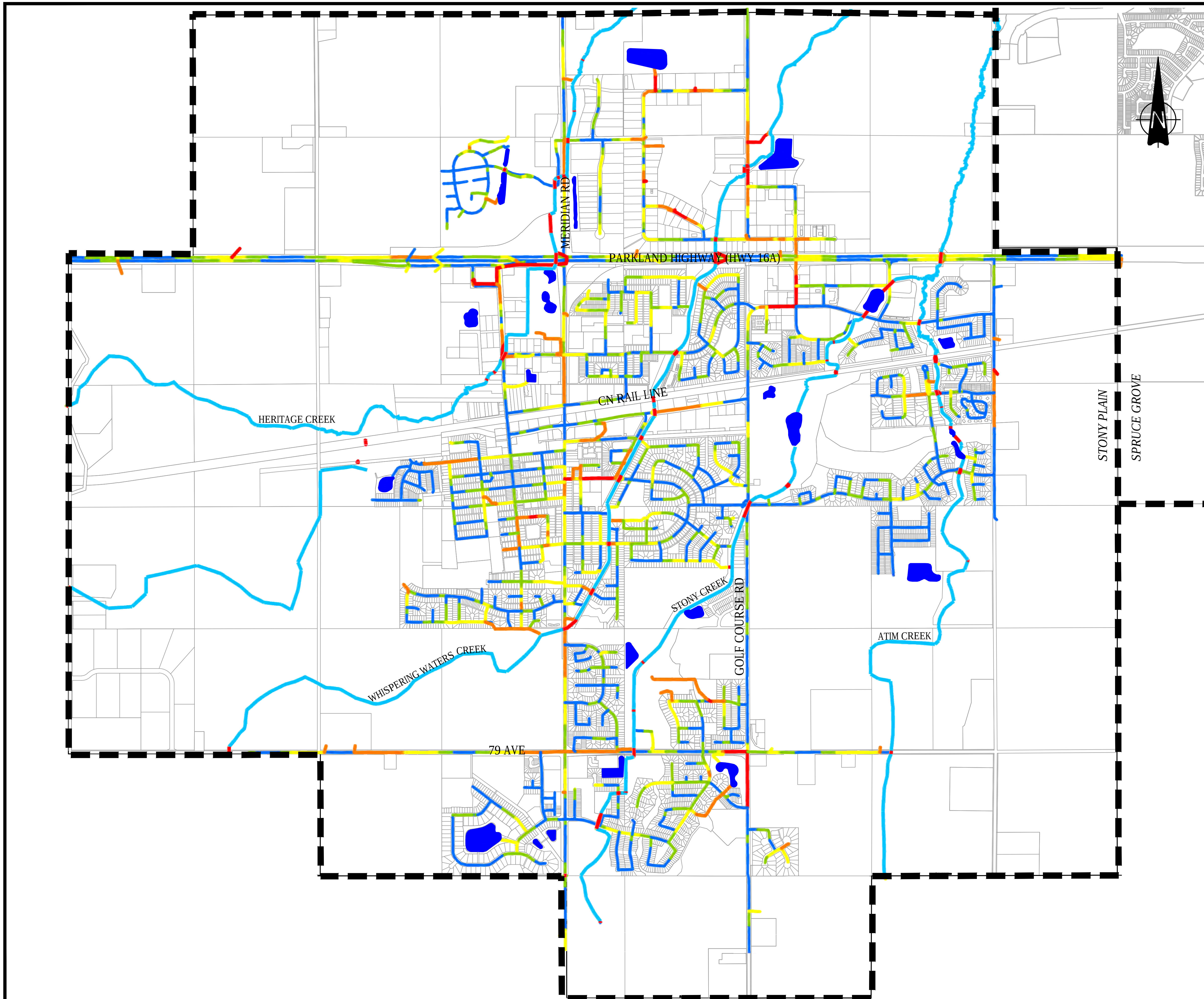
Title:

Simulation Results - Existing System
1:100-year 4-hour Event - Surface Ponding

Scale:	Figure:
1:25,000	6.7

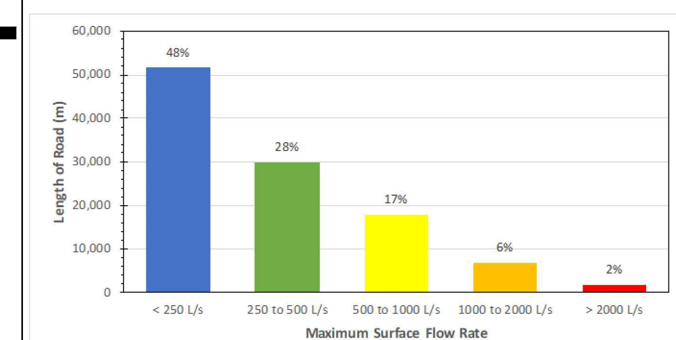


LEGEND

- CITY BOUNDARY
- PROPERTY LINE
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY

PEAK SURFACE FLOW RATE

- 0 - 250 L/s
- 251 - 500 L/s
- 501 - 1000 L/s
- 1001 - 2000 L/s
- > 2000 L/s



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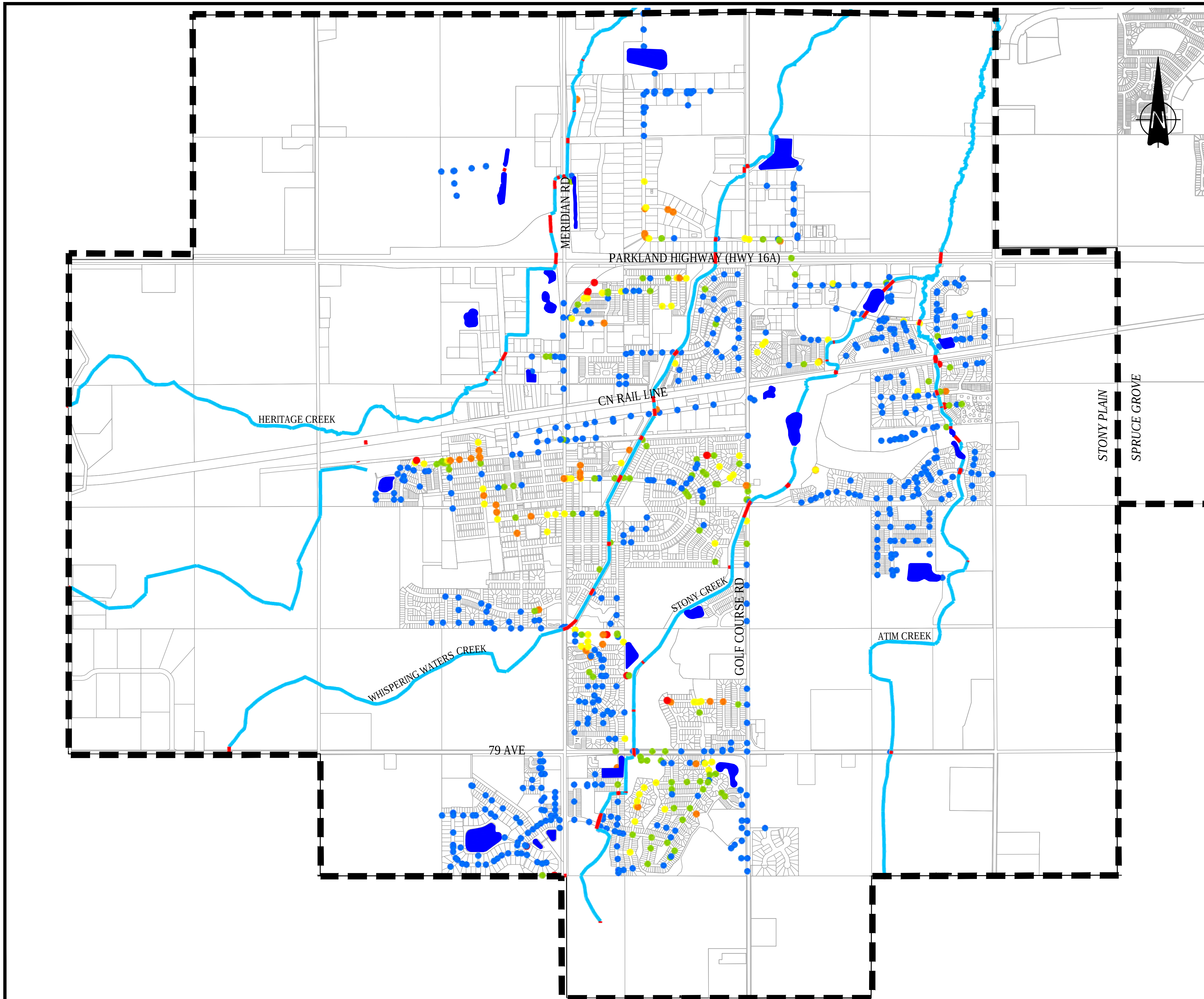
Title:

Simulation Results - Existing System
1:100-year 4-hour Event - Peak Surface Flow Rate

Scale: 1:25,000

Figure: 6.8

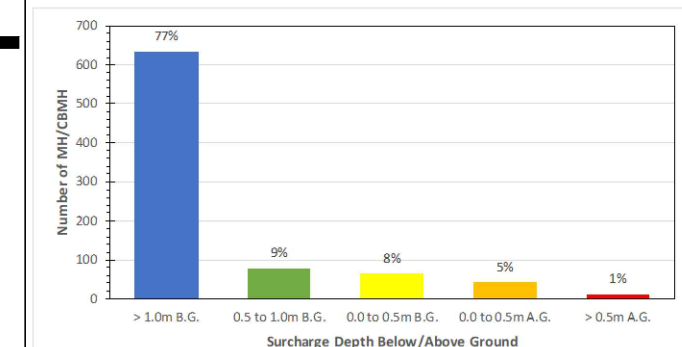


LEGEND

- CITY BOUNDARY
- PROPERTY LINE
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY

SURCHARGE DEPTH

- ≥ 1.0m BELOW GROUND
- 0.5 TO 1.0m BELOW GROUND
- 0.0 TO 0.5m BELOW GROUND
- 0.0 TO 0.5m ABOVE GROUND
- > 0.5m ABOVE GROUND



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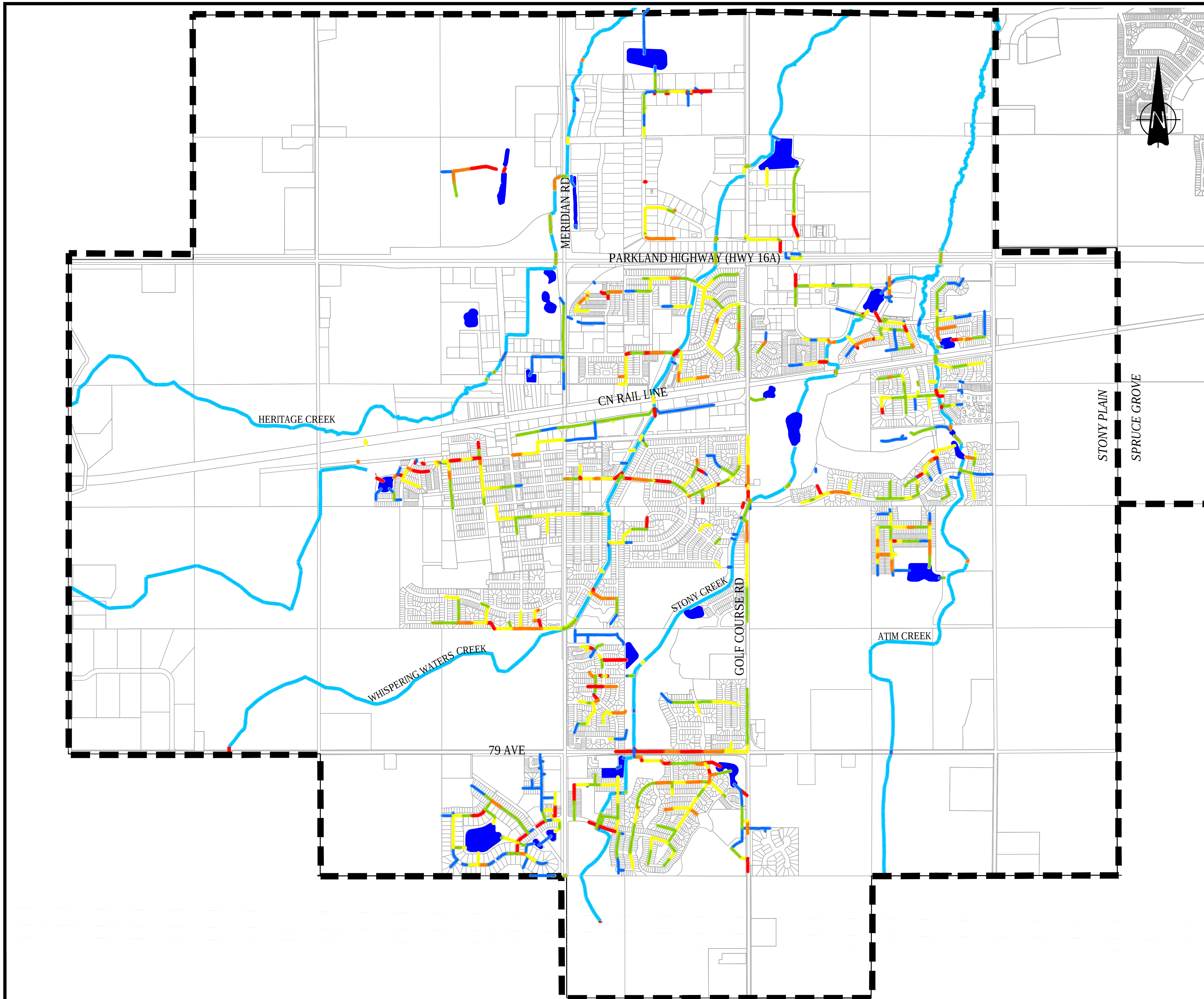
Title:

Simulation Results - Existing System
1:100-year 24-hour Event - Sewer Surcharge

Scale: 1:25,000

Figure: 6.9



LEGEND

CITY BOUNDARY

PROPERTY LINE

EXISTING WATERCOURSE

EXISTING STORMWATER MANAGEMENT FACILITY

THEORETICAL LOADING Qp / Qc

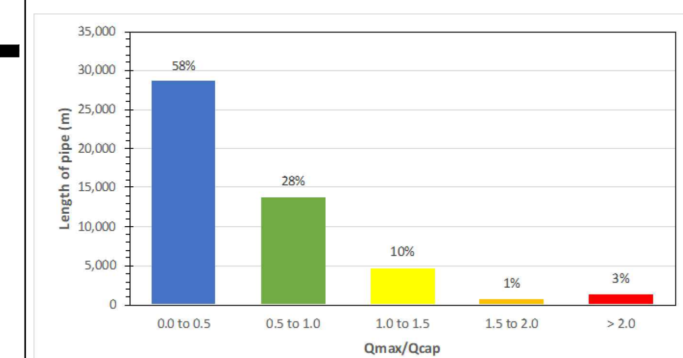
≤ 0.5

0.51 - 1.0

1.01 - 1.5

1.51 - 2.0

> 2.0



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Title:

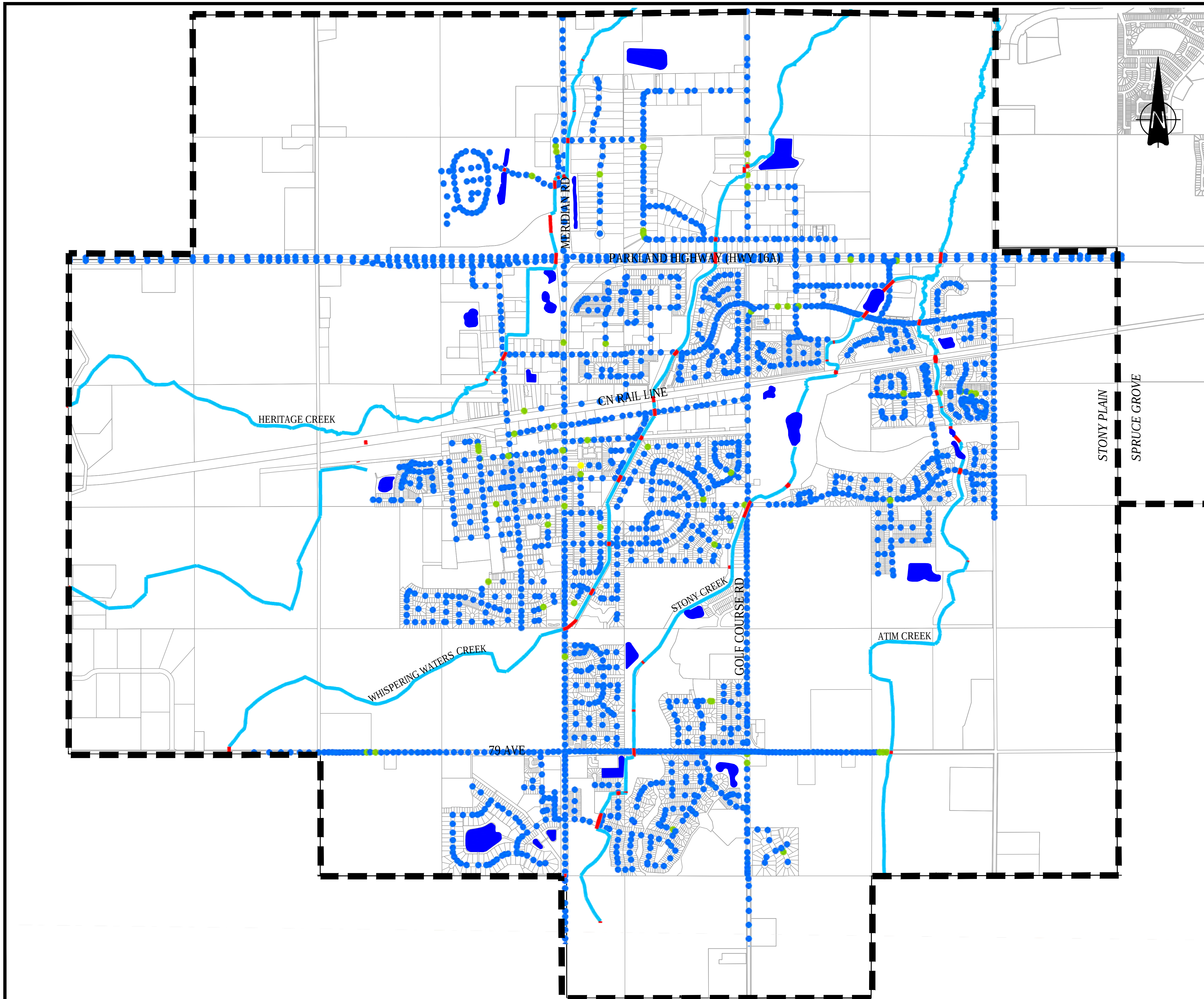
Simulation Results - Existing System
1:100-year 24-hour Event - Theoretical Loading in Pipe

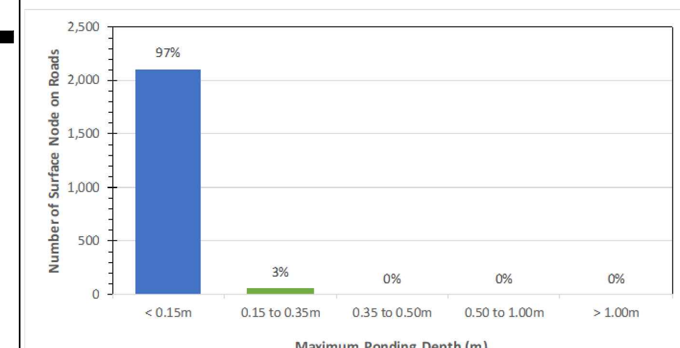
Scale:

1:25,000

Figure:

6.10





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Project:

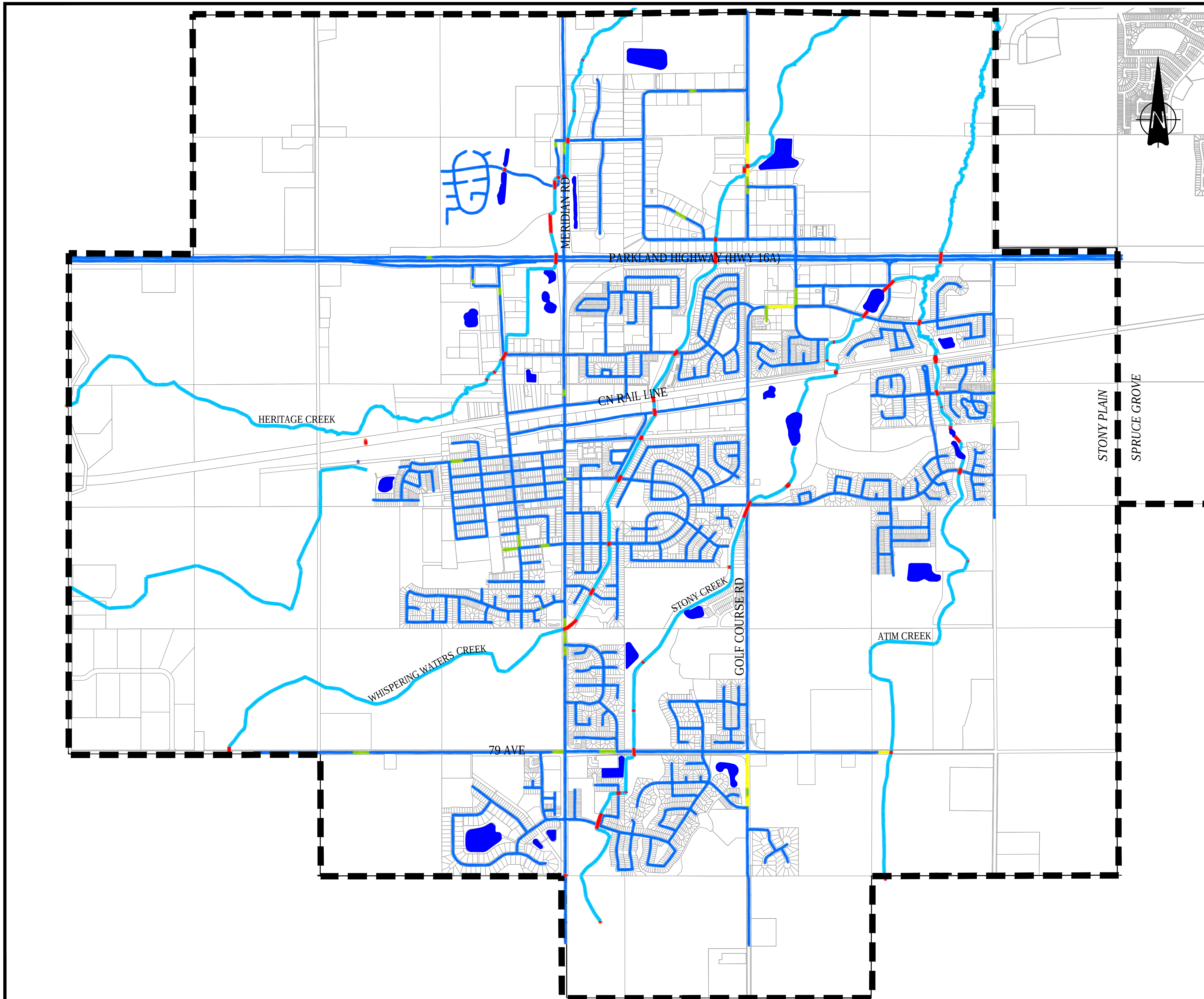
Stormwater Master Plan

Title:

Simulation Results - Existing System
1:100-year 24-hour Event - Surface Ponding

Scale: 1:25,000

Figure: 6.11

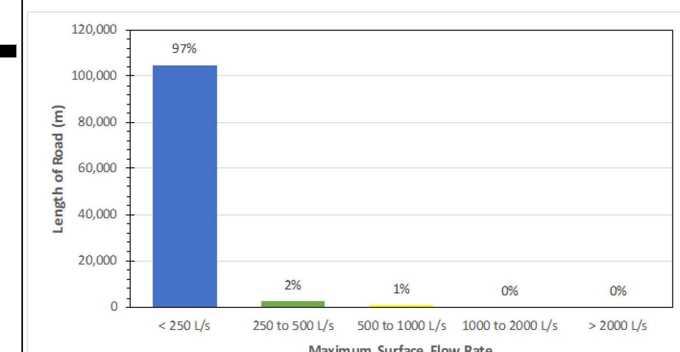


LEGEND

- CITY BOUNDARY
- PROPERTY LINE
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY

PEAK SURFACE FLOW RATE

- 0 - 250 L/s
- 251 - 500 L/s
- 501 - 1000 L/s
- 1001 - 2000 L/s
- > 2000 L/s



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Client:

TOWN OF STONY PLAIN

Project:

Stormwater Master Plan

Title:

Simulation Results - Existing System
1:100-year 24-hour Event - Peak Surface Flow Rate

Scale:	Figure:
1:25,000	6.12

7.0 Improvement Concept Plans for Existing Drainage System

7.1 Overview

Drainage improvements were conceptualized for developed areas of the Town that are at a higher risk of flooding, with a goal to provide relieve ideas for these locations. The conceptual approach for the improvement is achieve flood mitigation during a 100-year event. The following describes these concepts, which areas they benefit. As the majority of these flood risk areas are localized and require additional investigation and engineering, there are no capital cost estimates provided as a part of this report All locations recommended for improvement are illustrated with surface ponding on Figure 7-1.

7.2 Improvement Concepts by Area

7.2.1 Overview

A total of 7 areas are identified as having flooding risk based on the previous section. The areas are listed in the following table.

Table 7-1: List of Flood Risk Areas for Improvement

Area ID	Location	Reason for flooding	Improvement
A	Boulder Blvd. and Granite Dr.	Major drainage overflows towards depressions, especially on southwest corner of Boulder Blvd. The area has a poor major drainage system.	Improve ditch through private property
B	Egerland Pl. and 47 St.	Significant major drainage flows pooling at large surface depressions with inadequate major drainage overflow.	Reduce runoff tributary to trap low by roadway regrading
C	44 Ave. between St Andrews St. and St Andrews Dr.	Water level increases in the creek raises the water level in the sewer pipe and therefore cause ponding on road.	Develop dry pond storage
D	49 Ave. east of 50 St.	Significant major drainage flows pooling at large surface depressions.	Develop dry pond storage.
E	41 Ave. and 43 St.	A number of surface depressions causing water to pool. The area has a poor major drainage system.	Improve surface drainage towards Whispering Waters Creek.
F	46 St. between 54	High water level in Whispering Waters	Regrade

	Ave. and 55 Ave.	Creek backs up combined with high volume local flows from 55th Avenue become trapped.	intersection
G	Golf Course Rd. N and Crystal Dr.	Not enough culvert capacity and downstream the creek.	Upgrade culvert WWC-C-100. Identify downstream creek upgrade scope.

7.2.2 Area A: Boulder Boulevard. and Granite Drive.

In this area, the model suggests that the ditch does not have enough capacity to cope with the surface flow on Boulder Blvd. The surface runoff on Boulder Blvd. is 800 L/s from the north and 600 L/s south of the ditch. The existing sewer can only convey 100 L/s of flow during the 100-year event. Therefore, the pipe does not have enough capacity and the major drainage system needs to convey the excess flow.

To develop a design that address the flooding risk at this location, more detailed investigation needs to be completed including an elevation survey of the roadways and the ditch system which currently provides this overflow function. The problem is that part of the ditch network is through private property. It is recommended that the Town conduct this investigation as a separate, local drainage improvement initiative in order to develop an economical solution. This may include consideration to acquire a suitable easement to upgrade and maintain the ditch through private property.

7.2.3 Area B: Egerland Place and 47 Street.

This area has been identified to have flood risk during both the 1:5-year and the 1:100-year events. The model shows that this area has significant surface flow of more than 2000 L/s on 52 Avenue. The road grade would guide the flow towards Edgerland Place and form a surface ponding location at the mid point of Edgerland Place. The depth of ponding is estimated at 0.5 m for the 1:5-year event. The surface flow is more than 2000 L/s and the existing sewer pipe can only convey 1000 L/s of flow. Due to this relatively high flow rate, it is likely that a sewer pipe upgrade would not be cost-effective. A more cost effectively solution may involve slight changes in grading of Egerland Place. and 47 Street. to reduce the flow that is contributing to the trapped low. Such a solution will require a detailed site-specific roadway survey to determine the most effective modifications. This would be recommended for the Town as a separate, local drainage improvement initiative.

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7.2.4 Area C: 44 Ave. between St Andrews Street. and St Andrews Drive.

This area is a trap low along 44 Avenue between St Andrews Street and St Andrews Drive. The surface runoff along 44 Avenue is approximately 600 L/s. Although the existing sewer pipes maybe upgraded to accommodate the flow, this approach would be expensive and the continuation of only improving the conveyance system will eventually require the upgrading of the culvert crossing through CN. Therefore, an alternative to address the flooding risk in this area is to create a dry pond located in the St. Andrews Park southeast of the problem area. This dry pond would only be designed to receive and water during storms that produce more runoff than the pipe's capacity. In this fashion, common rainfall events would not affect the use of the park area.

Detailed investigation will need to be conducted to determined the feasibility of this approach.

7.2.5 Area D: 49 Street. and 54 Avenue.

This area is located in the old neighbourhood starting at the 53 Avenue and 51 Street following the sewer line to 49 Avenue and 54 Avenue. The model shows that the surface runoff (around 1700 L/s) is much higher than the pipe can transport (<1000 L/s). Again, pipe improvements to Whispering Waters Creek is possible however will be expensive and will increase peak flows in the Creek. Therefore, it is recommended that the Town consider storage as a preferred option.

Two potential dry pond areas for temporarily store the excess water can be located at SML Christian Academy playground and Lions Playground. Detailed analysis should be conducted to determine this concept's feasibility.

7.2.6 Area E: 41 Avenue and 43 Street

This area is located on the west shore of the Whispering Waters Creek just south of Highway 16A. In this area the additional surface runoff can reach up to 1000 L/s, and the existing sewer pipe capacity is approximately 600 L/s. Water can be redirected a green area located north of 42 Avenue and east of 43 Street for storage and then released back to the Creek when the system regains enough capacity. Detailed investigation will be necessary to determine this concept's feasibility.

7.2.7 Area F: 46 Street between 54 Avenue and 55 Avenue

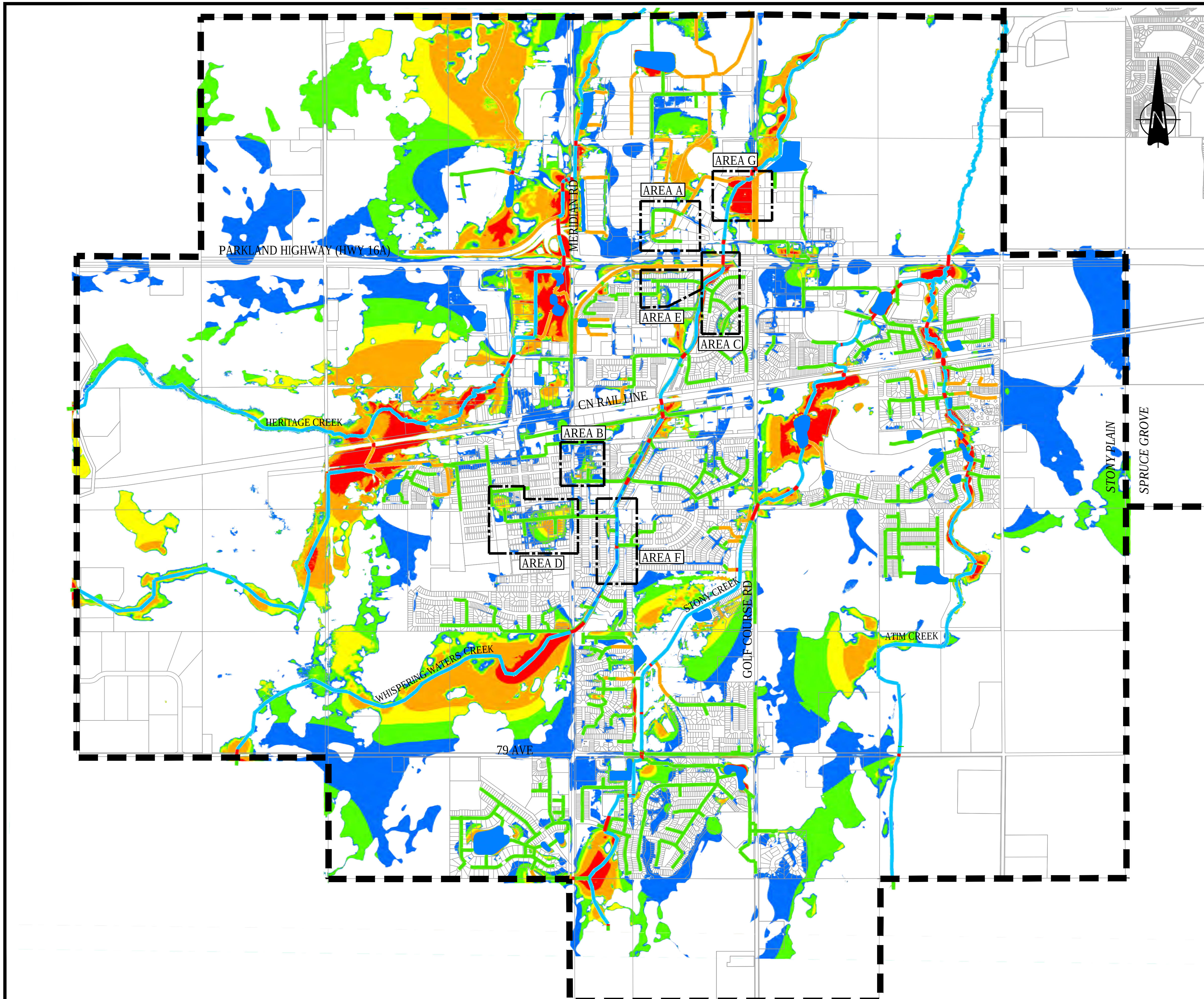
This area is a trap low along the 46 Street. The current sewer capacity is not enough to convey the surface runoff to the creek. The model also suggests that the surface runoff volume from 55 Avenue to 46 Street is relatively high. Therefore, an economic solution is to reduce the amount of runoff that is allowed to drain into 46 Street. The intersection of 46 Street and 55 Avenue ca re-graded to achieve this goal. Such a solution will require a detailed site-specific roadway survey to determine the most effective modifications.

7.2.8 Area G: Golf Course Road N and Crystal Drive

This area is located beside the Whispering Waters Creek north of Slate Avenue and west of Golf Course Road N. The limited culvert capacity of WWC-C-100 at 0.75 L/s/ha raises the water level in the creek and potentially cause flooding at the two industrial developments just upstream of the culvert. Current analysis suggests that upgrading the existing culvert at WWC-C-100 and WWC-C-101 to 3×1500 mm culverts would decrease the ponding depth on private property from 1.2 m to 0.75 m. The problem involves the backwater impact of Whispering Creek further downstream which extends beyond the current Town boundary. Further investigation will be necessary to solve this specific issue.

7.3 Cost Estimates

It is estimated that the cost to survey and develop conceptual solutions for each location will vary depending on the size of the area, land ownership of potential storage locations and, the accuracy of the survey required to define an alternative. As budgeting a guide, an average cost of approximately $25,000 for each area can be used based on past experience.



LEGEND:

	MUNICIPAL BOUNDARY
	IMPROVEMENT AREAS
	EXISTING WATERCOURSE
	EXISTING STORMWATER MANAGEMENT FACILITY
	EXISTING STORM PIPE
	EXISTING DITCH

SURFACE PONDING DEPTH

	<0.15m
	0.16m - 0.35m
	0.36m - 0.50m
	0.51m - 1.00m
	>1.00m

SURFACE PONDING SHOWN IS THE 1:100-YEAR, 4-HOUR EVENT

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Client:

TOWN OF STONY PLAIN

Project:

Stormwater Master Plan

Title:

Overview of Flood Risk Areas Recommended for Improvement

Scale:	Figure:
1:25,000	7.1

8.0 Climate Change Vulnerability Assessment

A 200-year 4-hour Chicago design rainfall simulation was completed to assess the impact of a more intense rainfall event on the performance of the Town's stormwater infrastructure. Results for the 200-year 4-hour design rainfall event simulation are presented in Figure 8-1. (sewer surcharge), Figure 8-2 (theoretical loading in pipe), Figure 8-3 (surface ponding and extents) and Figure 8-4 (surface flow).

MINOR DRAINAGE SYSTEM RESULTS

Figure 8-1 shows that storm sewers in the Town will surcharge during the 200-year event. About 364 manholes (44%) will be surcharged to 1.0m below ground or less, and more than 350 manholes (42%) will be surcharged to grade.

Figure 8-2 shows that a number of pipes will see flows exceeding their pipefull capacity, which correlates with the surcharge experienced in the sewer system. About 25 km of pipe (52%) will see peak flows exceed their pipefull capacity, and close to 5 km of pipe (10%) will flow at more than twice their capacity.

Compared with the 100-year 4-hour event, the simulation result shows a similar result in terms of the performance of the minor system. It can be state that the existing system can cope with more intense rainfall event without noticeable deterioration in its minor conveyance system performance.

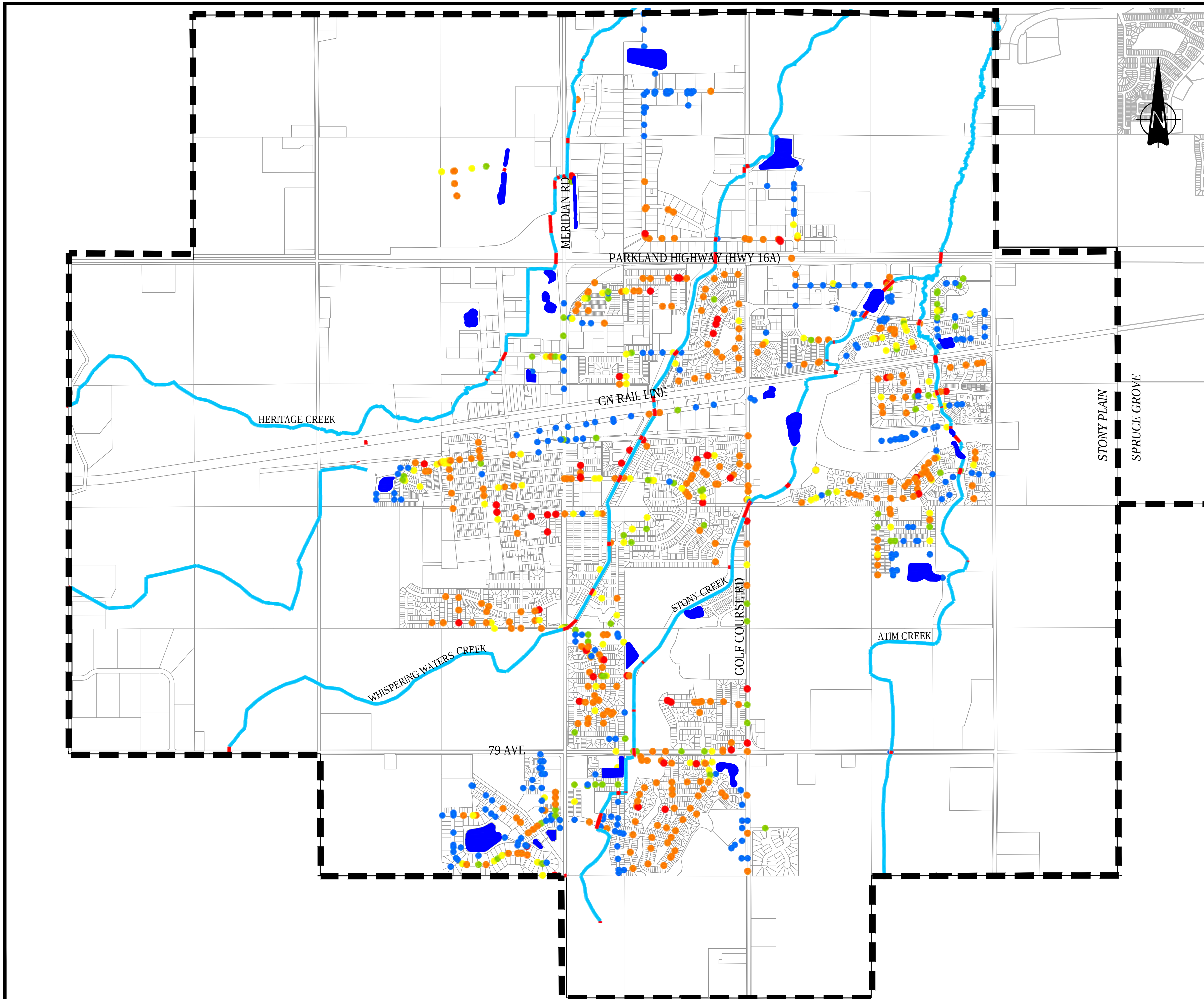
MAJOR DRAINAGE SYSTEM RESULTS

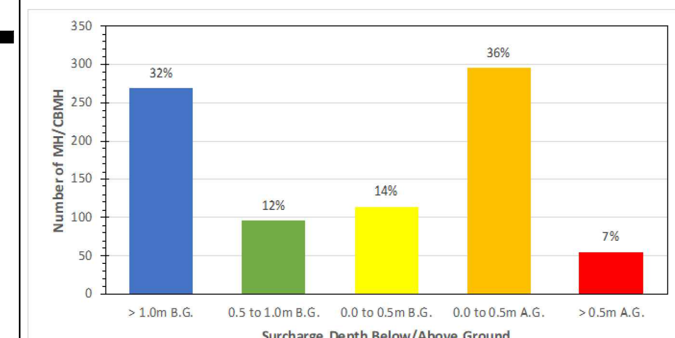
Figure 8-3 shows that surface ponding during the 200-year event which is similar to the 100-year simulation result. The total surface nodes excess 35 cm of ponding for 200-year event is 127 (6% of total nodes). There is 1 node where the surface ponding depth exceeding 1 m at 49 Street south of 54 Avenue. This area is also identified as a flood prone area during the 100-year event.

Figure 8-4 shows that surface flows are also similar to the 100-year event, as the storm runoff is mainly conveyed by roads. About 30% of the roads will see surface flows exceed 500 L/s, and 3% of road section will experience flows larger than 2,000 L/s.

FLOOD RISK AREAS

Areas at higher flood risks due to surface ponding during the 200-year 4-hour design event are the same as the 100-year event but with a slightly higher ponding depth.





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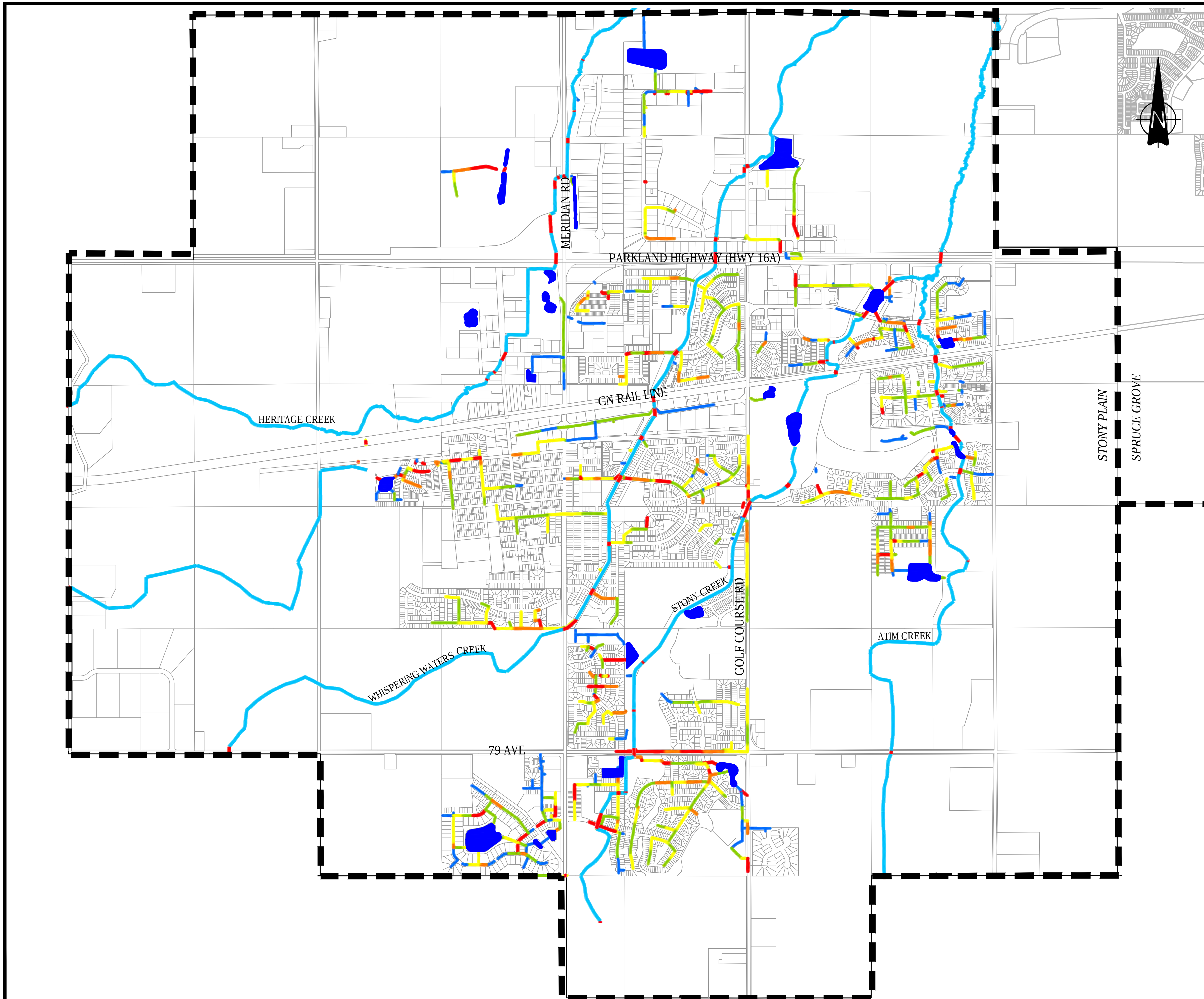
Title:

Simulation Results - Existing System
1:200-year 4-hour Event - Sewer Surcharge

Scale: 1:25,000

Figure: 8.1

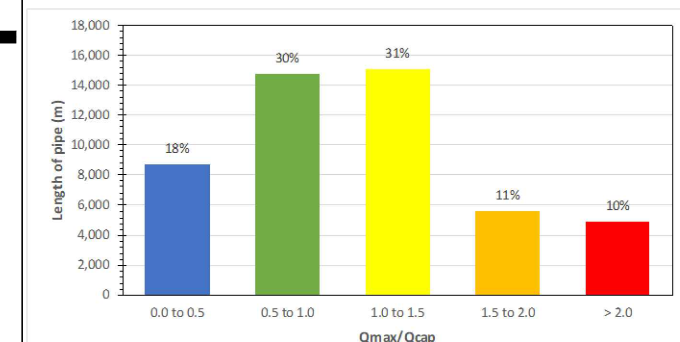


LEGEND

CITY BOUNDARY
PROPERTY LINE
EXISTING WATERCOURSE
EXISTING STORMWATER MANAGEMENT FACILITY

THEORETICAL LOADING Qp / Qc

≤ 0.5
0.51 - 1.0
1.01 - 1.5
1.51 - 2.0
> 2.0



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Project:

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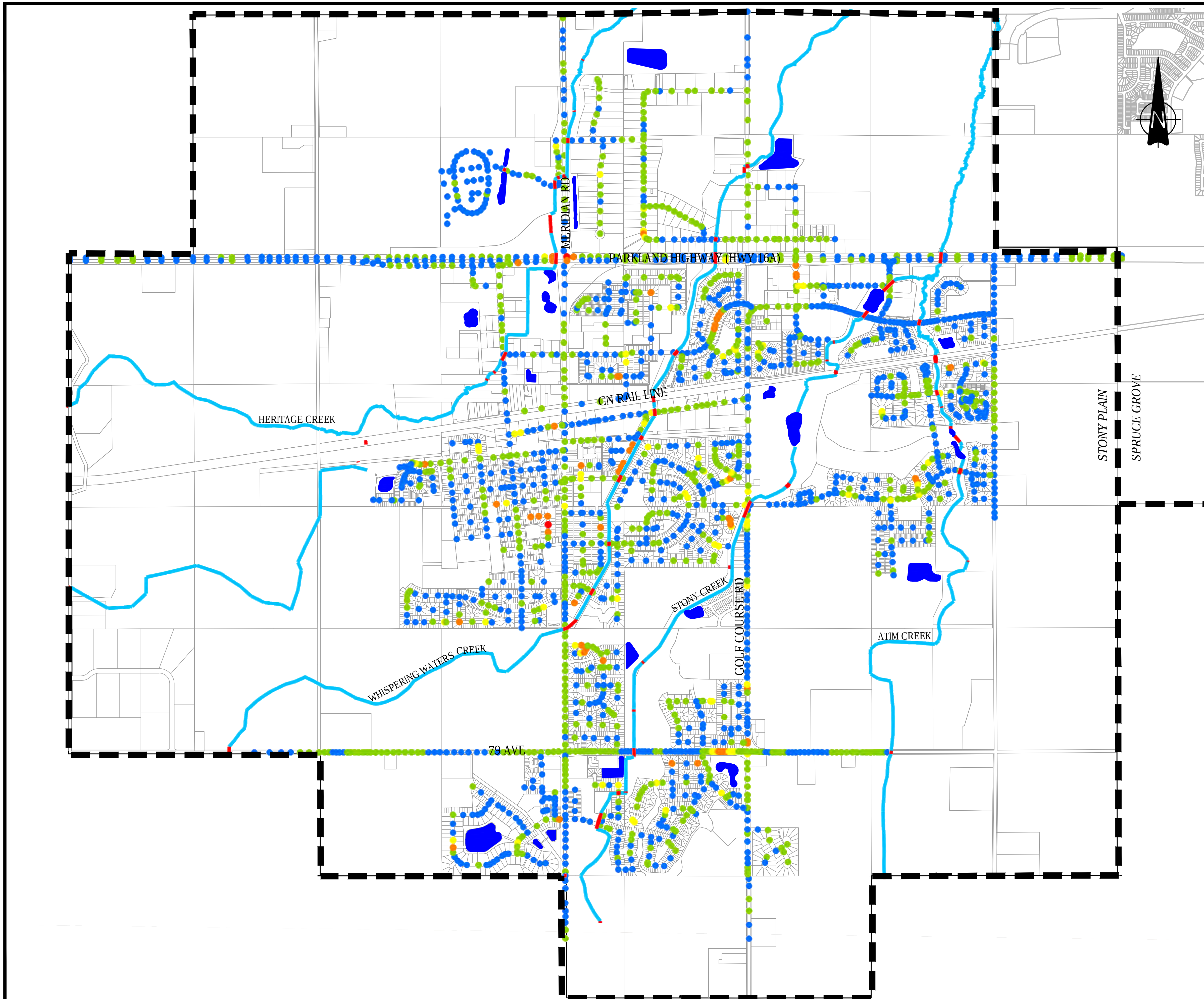
Title:

Simulation Results - Existing System
1:200-year 4-hour Event - Theoretical Loading in Pipe

Scale: 1:25,000

Figure: 8.2

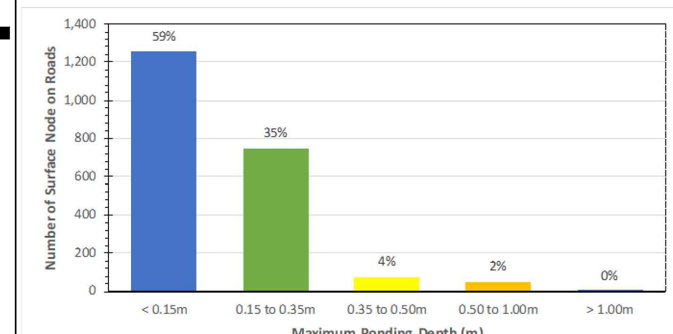


LEGEND

- CITY BOUNDARY
- PROPERTY LINE
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY

SURFACE PONDING DEPTH

- <0.15m
- 0.16m - 0.35m
- 0.36m - 0.50m
- 0.51m - 1.00m
- >1.00m



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Project:

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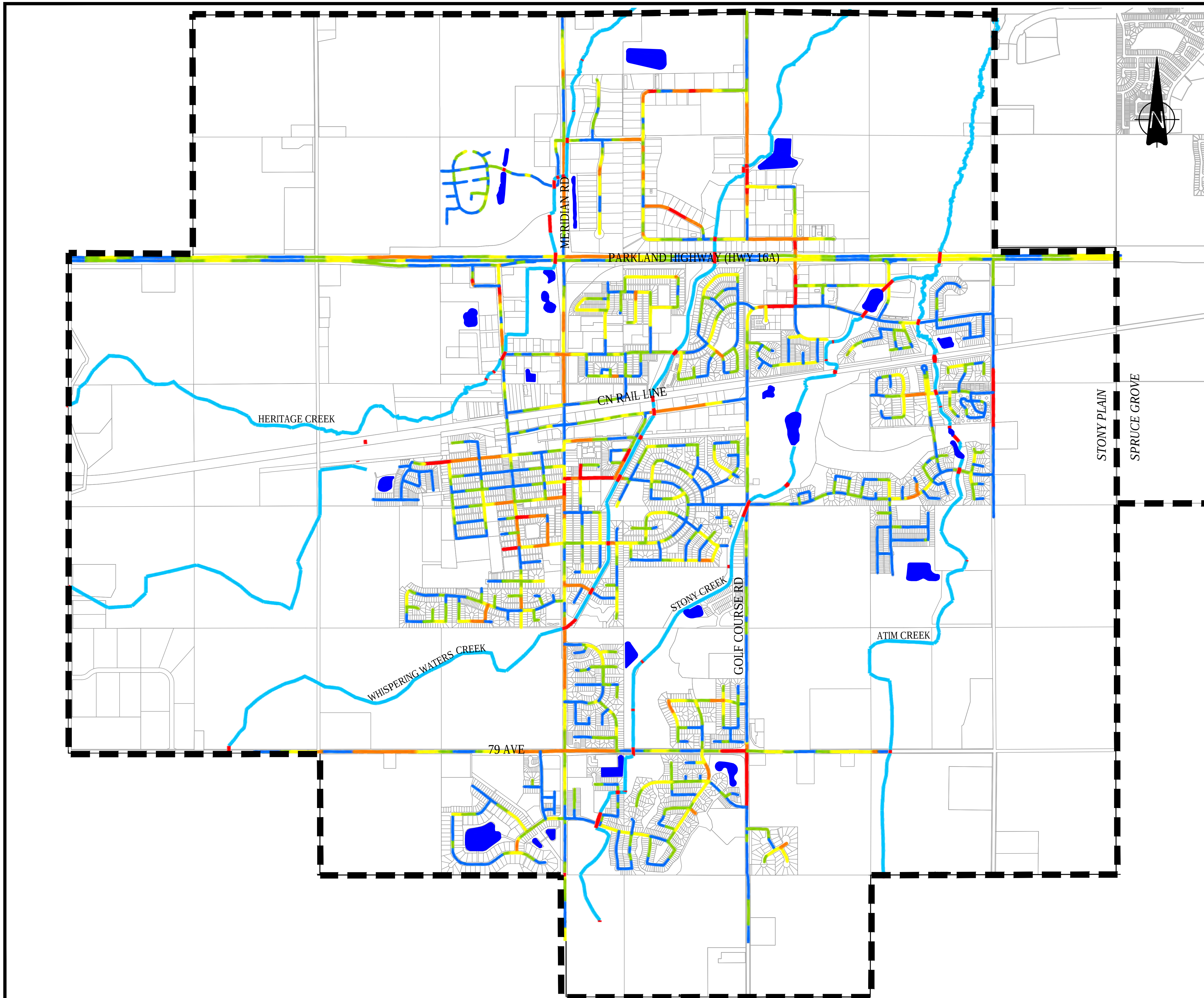
Title:

Simulation Results - Existing System
1:200-year 4-hour Event - Surface Ponding

Scale:	Figure:
1:25,000	8.3

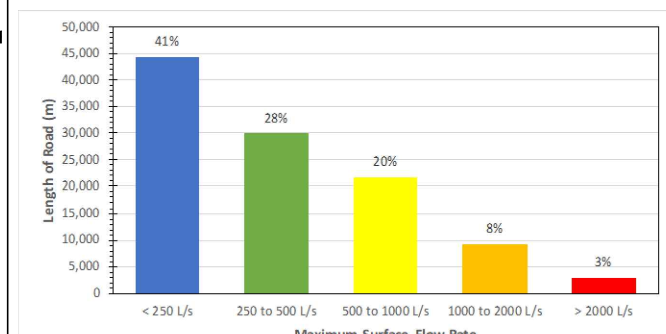


LEGEND

- CITY BOUNDARY
- PROPERTY LINE
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY

PEAK SURFACE FLOW RATE

- 0 - 250 L/s
- 251 - 500 L/s
- 501 - 1000 L/s
- 1001 - 2000 L/s
- > 2000 L/s



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Project:

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Title:

Simulation Results - Existing System
1:200-year 4-hour Event - Peak Surface Flow Rate

Scale:	Figure:
1:25,000	8.4

9.0 Storm Drainage Master Plan for Future Development Areas

9.1 Objectives of Storm Drainage Master Plan

One of the primary objectives of a Storm Drainage Master Plan is to provide a framework for planning and implementing drainage infrastructure to allow for growth and new developments. Infrastructure should be coordinated to provide consistent servicing throughout all new development.

The Master Plan includes consideration for:

- Standards for capturing runoff in the stormwater drainage system.
- Conveyance of captured runoff to storage facilities and outfalls to prevent flooding.
- Stormwater Management Facilities to buffer peak flows and manage water quality.
- Plan for maintenance and operational requirements.
- Monitor the performance of the system.

9.2 Overview of Previous Storm Drainage Master Plan's Drainage Concepts for Future Servicing Areas

The previous Storm Drainage Master Plan, prepared in 2008, generally followed existing drainage patterns, placing a number of proposed stormwater management facilities within wetlands or other potentially environmentally significant areas. The plan identified 39 proposed storage facilities, including ponds proposed in current Area Structure Plans and Outline Plans. The outflows limit and the storage of the ponds were not specified.

The 2008 drainage plan follows traditional stormwater management principals and it will work. The benefit of such a plan is that it follows tradition and the key stakeholders in the development of land have established processes to review and approve the subdivision proposals. The disadvantage of the plan is that it does not fully integrate the need for stormwater management with the preservation of natural water features of the land. In this regard, the utilization of land is not optimum, requiring the construction of man-made storage in addition to the preservation and sometimes compensation for the destruction of natural wetlands.

9.3 Receiving System Capacities

The topography of the future development areas of the Town indicate that most new developments can drain to new outfalls rather than to connect with existing infrastructure. The major drainage basins are shown in Figure 4-1. The current standard release rate of 2.5 L/s/ha will apply to developments draining to current creeks, either through existing or new outfalls. This has been an established practice for many years and has proven to help with the stability of the current creeks. It should therefore continue.

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9.4 Environmental Considerations

Urban development affects both aquatic and terrestrial ecosystems, and measures to mitigate these effects can vary; from the protection of a single species, to broad natural reservations.

Municipalities that prepare Master Drainage Plans can determine the cumulative impact on receiving waterbodies. These plans can be submitted for approval under the *Water Act.* This is a voluntary requirement; however, if a municipality can demonstrate the individual components comply with the Master Drainage Plan, there would be no requirement to get individual *Water Act* approvals on a project by project basis.

The *Water Act* also covers the policies for preserving and/or compensating for wetlands and riparian setbacks. Any disturbance or removal of wetlands requires approval which may include monetary compensation. This approval process is generally slow compared to other approvals, and current policies strongly discourage the removal of significant wetlands. By identifying potentially significant wetlands in the master drainage plan, approvals for plans that avoid natural wetlands or incorporate them into the stormwater drainage system can be gained well in advance of development needs.

A comprehensive environmental sensitive area survey in the Town's area is recommended to have a better understanding on its wetland distribution and potential ways of integration with stormwater management facilities.

9.5 Stormwater Management Planning

9.5.1 General

Stormwater Management is a process with several levels, from pollution avoidance, to watershed management strategies. By considering multiple components of stormwater management together, the master plan can identify opportunities for a plan that is greater than the sum of its parts.

9.5.2 Approach

The overall philosophy of this Drainage Master Plan is to use the natural topography, including existing wetlands, as much as possible. This will reduce disruption of natural runoff, and save in overall costs for development, maintenance, and environmental value.

9.5.3 Conveyance and Connectivity

Best practices for stormwater management systems includes both underground sewers and overland drainage. Underground sewers are typically sized to convey captured runoff up to a 1:5-year event, keeping water off roadways and providing adequate drainage to properties. Overland drainage systems are sized to convey 100-year peak flow rates, for flood prevention and conveying large runoff volumes safely to storage facilities and other areas designed for receiving these flows.

When elevations allow for building stormwater management facilities in series, there are several advantages. It improves the effectiveness of treatment for water quality; it reduces the size of storm pipes, and reduces the number of outfalls to lakes and creeks. Effective arrangement of facilities in series includes the design of conveyance between facilities, control structures, and overflows.

Overland conveyance design includes the road network, to eliminate trapped low areas, and ensure positive drainage away from buildings. Overland drainage is important in providing alternative flood protection when catchbasins become clogged by ice, hail or other debris.

Overland flow routes may be designed to convey more frequent flows, which can reduce the size of storm pipes and number of catchbasins required for adequate drainage. When overland conveyance is used in this way, it should not increase flow rates in downstream systems, so storage is still required in those cases.

Stormwater management facilities should be located in areas where overland drainage would naturally concentrate. This will make the design of conveyance systems, both above and below ground, easier to plan.

9.5.4 Urban and Rural Cross Sections

The Town of Stony Plain currently has mostly curb-and-gutter road cross sections, with runoff directed towards catchbasins. However, there are some areas with a rural cross section with roadside ditches. Rural cross sections typically occupy more space, and require additional maintenance. They are not recommended for intense urban developments. Where developers wish to use primarily overland conveyance, grassed bioswales should be used rather than roadside ditches.

Where planned drainage systems will receive extraneous flows from undeveloped lands with rural cross sections, the receiving system should be planned to account for spring runoff volumes from the extraneous basin as an interim condition. For example, downstream wet ponds may have their normal water level temporarily lowered in March and kept low until snow packs have melted.

9.5.5 Other End-of-Pipe Options

Provincial guidelines include other options for water quality treatment that are best combined with stormwater management facilities and/or on lot BMP. These include Oil/Grit separators, sand filters, infiltration trenches, and infiltration basins. These options have limited applicability and are not usually effective on their own, but they may be appropriate as secondary treatment.

9.5.6 Runoff and Storage Estimations

Stormwater facilities and pipes will need to be designed to meet the specific needs of each development, and it is recommended that computer modeling be required to calculate runoff rates and pond storage requirements, though rational method may still be appropriate for sizing upstream pipes and catchbasins.

For the purposes of this master plan, pond storage requirements are estimated using a simplified water balance, where Storage = (Runoff – Discharge) over a 24-hour period.

Runoff is based on the new City of Edmonton's IDF curves, assuming a peak discharge rate of 2.5 L/s/ha, a storage provision of 500 m^3/ha will accommodate a 100-year event with a runoff/rainfall ratio of 0.9. This volume is used to estimate volumes for storage ponds.

To estimate peak flow rates for sizing sewers, an average travel time of 1 hour was paired with a typical runoff coefficient of 0.6 to yield a rate of 35 L/s/ha. This rate estimate indicates a 1050 mm diameter storm sewer is needed to drain a 64-hectare development, without additional storage. The travel time and runoff coefficient are justifiable assuming best management practices for runoff control are used. It is recommended that no more than 64 hectares be drained to a single trunk without additional storage.

9.6 Land Use

9.6.1 General

The general land use for future development area was outlined in the Municipal Development Plan, as shown in Figure 1-5. See Section 1.3 for more information.

Land use will affect the volume, quality, and rate of discharge from runoff, so drainage system requirements will be based partly on the land use within a particular watershed.

9.7 Environmentally Sensitive Areas

Riparian corridors, wetlands, and other environmentally significant features were not assessed for the Town of Stony Plain.

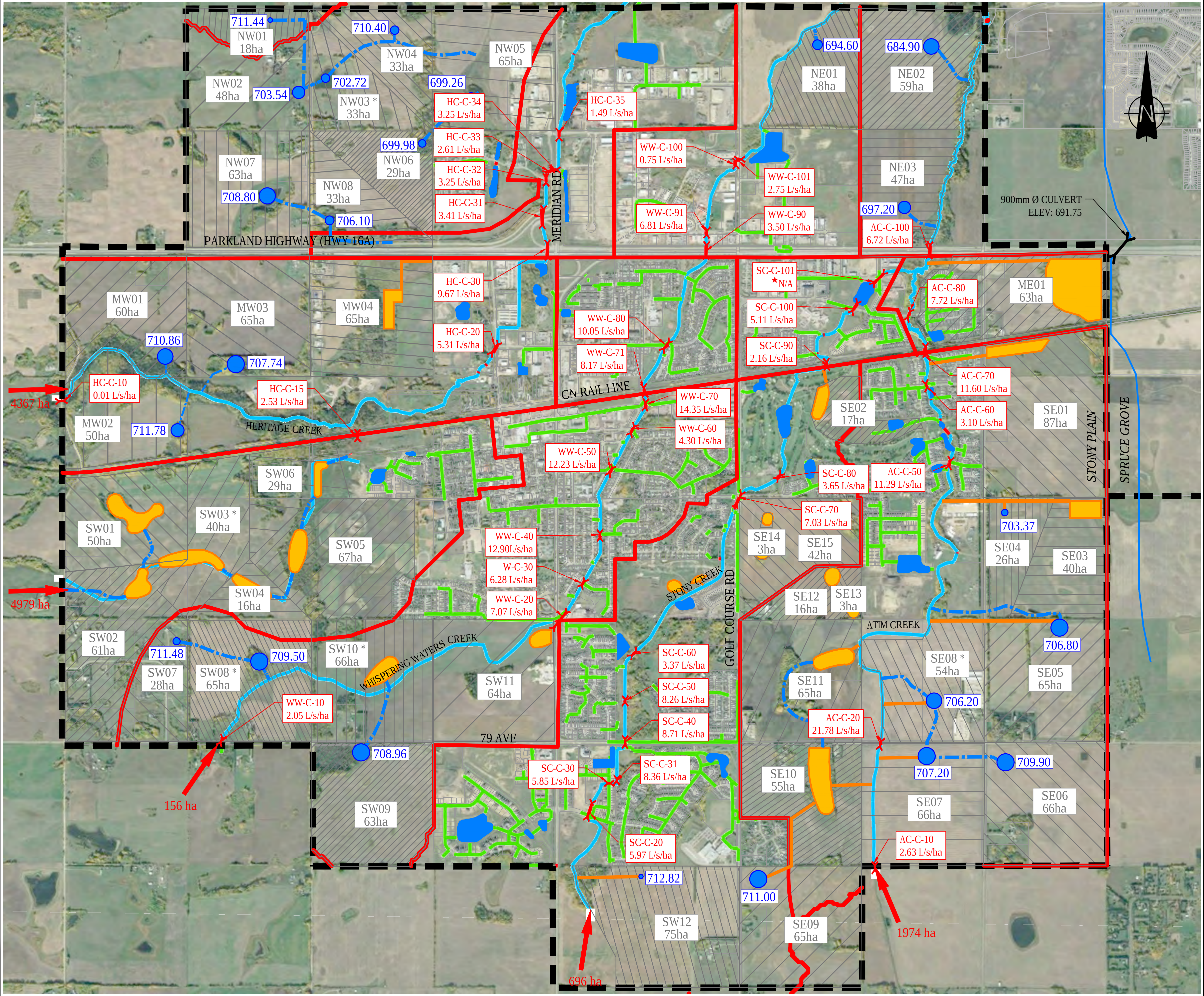
9.8 Stormwater Quality

Current standards for stormwater quality management facilities requires 85% TSS removal of particles 75 microns or greater, as well as regulation of nitrogen and phosphorus concentrations. The use of constructed wetlands, or natural wetland with forebays has been shown to be more effective than wet ponds in both sediment removal and nutrient regulation.

Additional water quality targets should be set by watershed area to effectively manage water quality in lakes and streams. For example, contamination containment may be required at potential pollution sources, especially upstream of environmentally sensitive areas. Specific water quality management targets should be determined through biological studies of receiving waterbodies, including specific monitoring requirements based on potential contamination risks.

9.9 Future Stormwater Management Watersheds

An overview of the future stormwater management plan is shown in Figure 9-1. It includes utilizing 29 natural areas for storage and water quality management with 18 constructed forebays, as well as an additional 54 constructed SWMF. Some of these SWMF are included in existing Outline Plans or Area Structure Plans.



LEGEND:

- MUNICIPAL BOUNDARY
- EXISTING WATERCOURSE
- EXISTING STORMWATER MANAGEMENT FACILITY
- EXISTING STORM PIPE
- BASIN BOUNDARY
- SWMF FROM AREA STRUCTURE PLAN
- PROPOSED SWMF LOCATION
- PROPOSED STORM TRUNK
- PROPOSED STORM CHANNEL

Pond ID	Catchment area (ha)	Future land use	Active Storage (m3)	Pond bottom (m)	NWL (m)	HWL (m)	Freeboard (m)
NE01	38	Commercial	63154	695	697	699	700
NE02	59	Commercial	90173	694	696	698	699
NE03	47	Commercial	78828	695	697	699	699
NW01	18	Residential	29722	715	717	719	719
NW02	48	Residential	80525	710	712	714	715
NW03*	33	Residential	54653	694	696	698	698
NW04	33	Residential	54972	703	705	707	707
NW05	33	Residential	55812	710	712	714	715
NW06	29	Residential	49008	710	712	714	714
NW07	63	Residential	105355	708	710	712	712
NW08	33	Residential	55812	710	712	714	715
ME01	41	Commercial	67841	695	697	699	699
MW01	60	Residential	100282	722	724	726	726
MW02	50	Residential	83179	719	721	723	724
MW03	65	Residential	109606	710	712	714	715
MW04	65	Commercial	108950	709	711	713	713
SE01	87	Residential	146179	697	699	701	701
SE02	2	Residential	2539	704	706	708	708
SE03	40	Residential	66312	706	708	710	711
SE04	26	Residential	42742	702	704	706	706
SE05	65	Residential	109370	704	706	708	708
SE06	66	Residential	109992	709	711	713	713
SE07	66	Residential	110832	710	712	714	714
SE08*	54	Residential	90330	702	704	706	706
SE09	65	Residential	108530	710	712	714	714
SE10	55	Residential	92453	706	708	710	711
SE11	65	Residential	109538	704	706	708	708
SE12	16	Residential	26933	704	706	708	708
SE13	3	Residential	5580	704	706	708	708
SE14	3	Residential	4034	705	707	709	710
SE15	42	Residential	70949	705	707	709	710
SW01	50	Residential	83952	721	723	725	726
SW02	62	Residential	103642	712	714	716	717
SW03*	40	Residential	66745	707	709	711	711
SW04	16	Residential	27403	708	710	712	713
SW05	67	Residential	112607	705	707	709	709
SW06	29	Residential	48403	706	708	710	710
SW07	28	Residential	47160	718	720	722	722
SW08*	66	Residential	110362	706	708	710	711
SW09	63	Residential	106346	711	713	715	715
SW10*	66	Residential	110244	703	705	707	708
SW11	64	Residential	107119	707	709	711	712
SW12	75	Residential	125851	711	713	715	716

* PUMP OUTLET
★ CONTROL STRUCTURE IN CULVERT

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Client:

TOWN OF STONY PLAIN

Project:

Stormwater Master Plan

Title:

Future Development Plan Overview

Scale: 1:25,000

Figure: 9.1

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10.0 Conclusions and Recommendations

- The current Town of Stony Plain servicing standards are mostly in conformance with Provincial guidelines for stormwater drainage design, as well as other Alberta municipalities. Some modifications to those standards are recommended.
- A comprehensive review and inventory of the existing storm drainage system was completed and is summarized in the report. Of note, the Town has 62 km of storm pipes, 63 storm outfalls and 40 stormwater management facilities. It is recommended that the Town develop a comprehensive asset management system based on the inventory created as part of this master plan. This would formalize the management and asset investment for this important component of municipal service.
- A dual-drainage hydraulic computer model was developed using the DHI Mike Urban software. This model was used to provide a better understanding of the drainage system performance under frequent and extreme rainfall events. The modeling results are believed to be representative of the system behavior and allowed the determination of its strength and weaknesses. Due to the lack of rainfall and flow monitoring information, it was not possible to calibrate the model to actual rainfall events. It is recommended that the Town begin a rainfall and flow monitoring program to gather data for future model calibration and refinement.
- It is recommended that the Town begin a process of recording flood incidents and flood complaints associated with severe rainfall events. This will allow correlation of the flood risk areas identified by the computer model with actual events. This will also help to determine the relative priority to upgrade the flood risk area's level of service.
- Seven areas were identified to be at risk of flooding during a 100-year storm event, due to lack of capacity in the storm sewer combined with a poor major drainage system. Due to the localized nature of these higher flood risk areas, it was concluded that the upgrade solution to these areas are dependent on local conditions. It is therefore recommended that the Town conduct local drainage investigations to fine tune the improvement concept described in the master plan.
- It is recommended that the Town complete an environmental sensitive areas assessment of the undeveloped lands within the Town's jurisdiction. This information can be used to refine the locations and the design parameters of the proposed stormwater management facilities and their integration with existing environmentally significant areas (or wetlands). We expect that the preservation of wetlands will in itself create storage which the stormwater management facilities need not duplicate. This would have the benefit of optimizing land use and reduce the need to destroy and then to compensate for the wetland areas. This approach may also reduce the lengthy approval requirements for wetland inventory and compensation proposals of individual developments.

Appendix A: Stormwater Management Facility Summary Sheets

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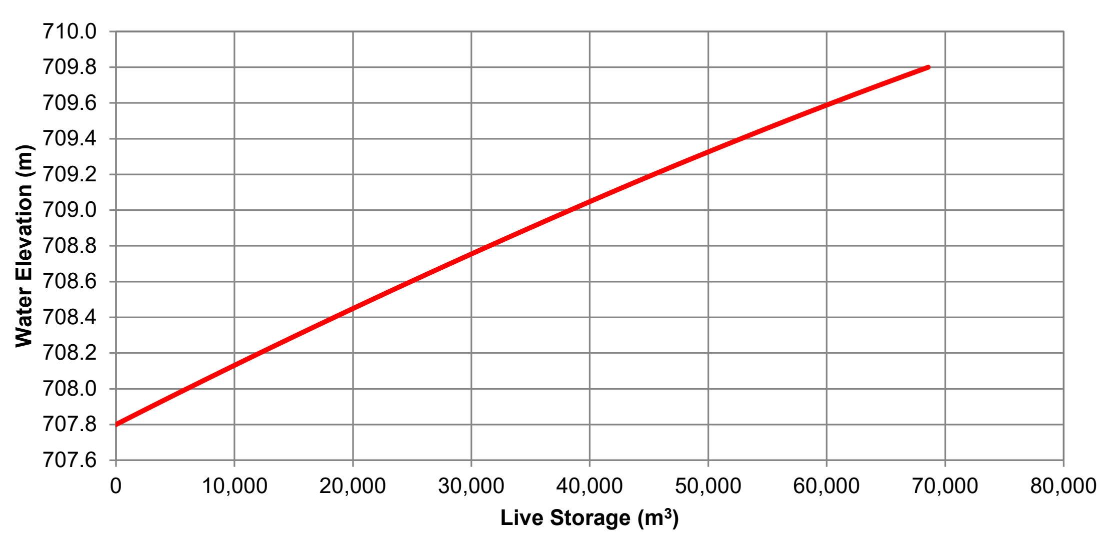
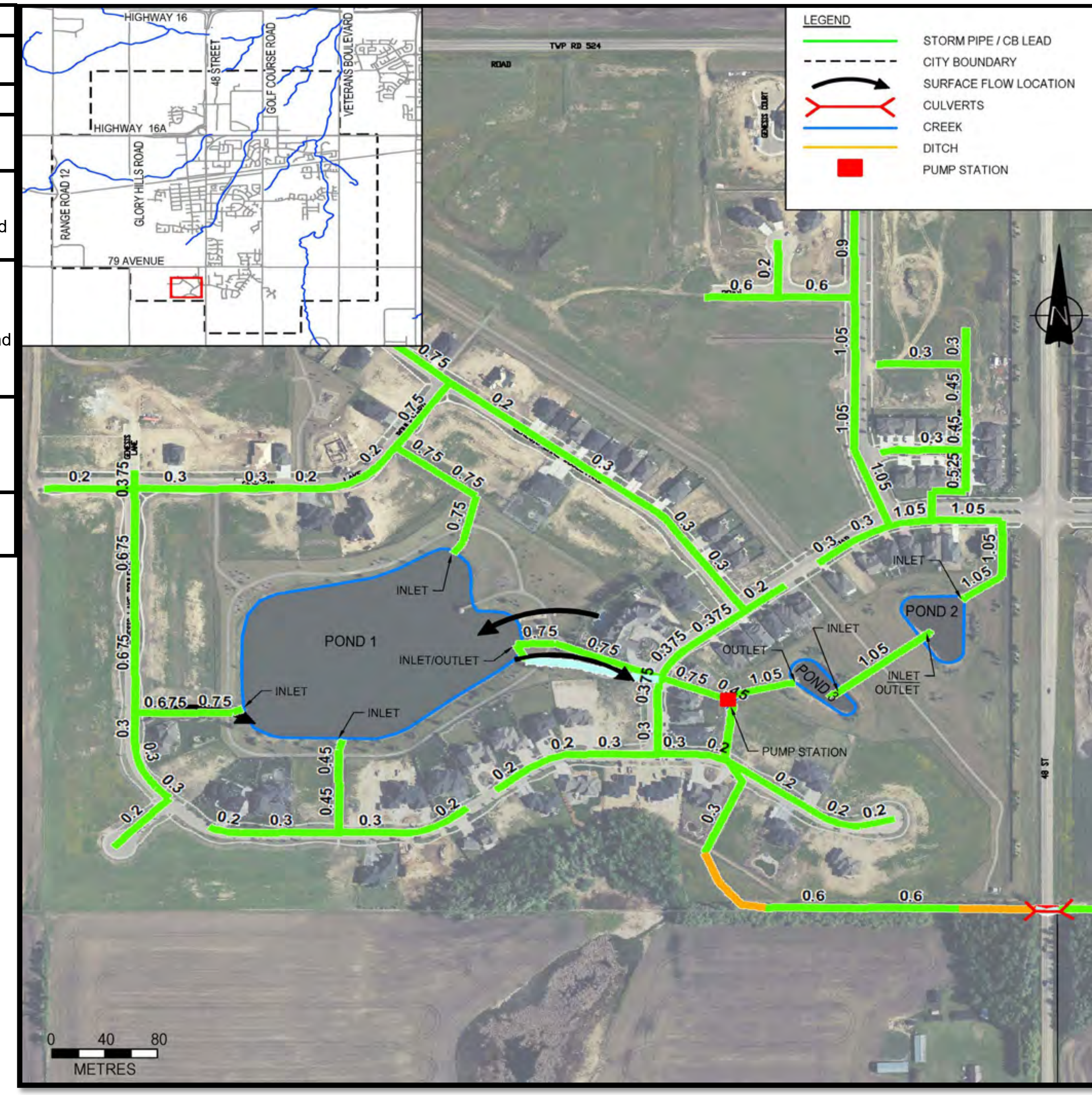
Pond ID	1	Neighbourhood	Genesis
Facility Type	Wet Pond	Location	West of community
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond (Genesis on the Lake) is still being developed.		
Inlet / Outlet	**Inlets:** 750mm to the north (708.29); 750mm to the west (708.00); 450 mm to the south (708.00); 750 mm to the east (705.50 m) **Outlets:** 750 mm to the east (705.50 m), The 750 mm pipe to the east serves as inlet and outlet		
Control Structure	**NWL**: Invert of 750 mm pipe at MH besides the lift station at 707.00 m **Flow Rate**: Lift station. (Pump_1 in model) **Others:** The surface flow to the east of the pond goes through a culvert under the trail and flows into the pond.		
Overflow	**Into Pond:** From the culvert crossing the trail to the east of the pond **Out of Pond:** Emergency Overflow to the east of the pond		
Comments	There is no desgined emergency overflow		

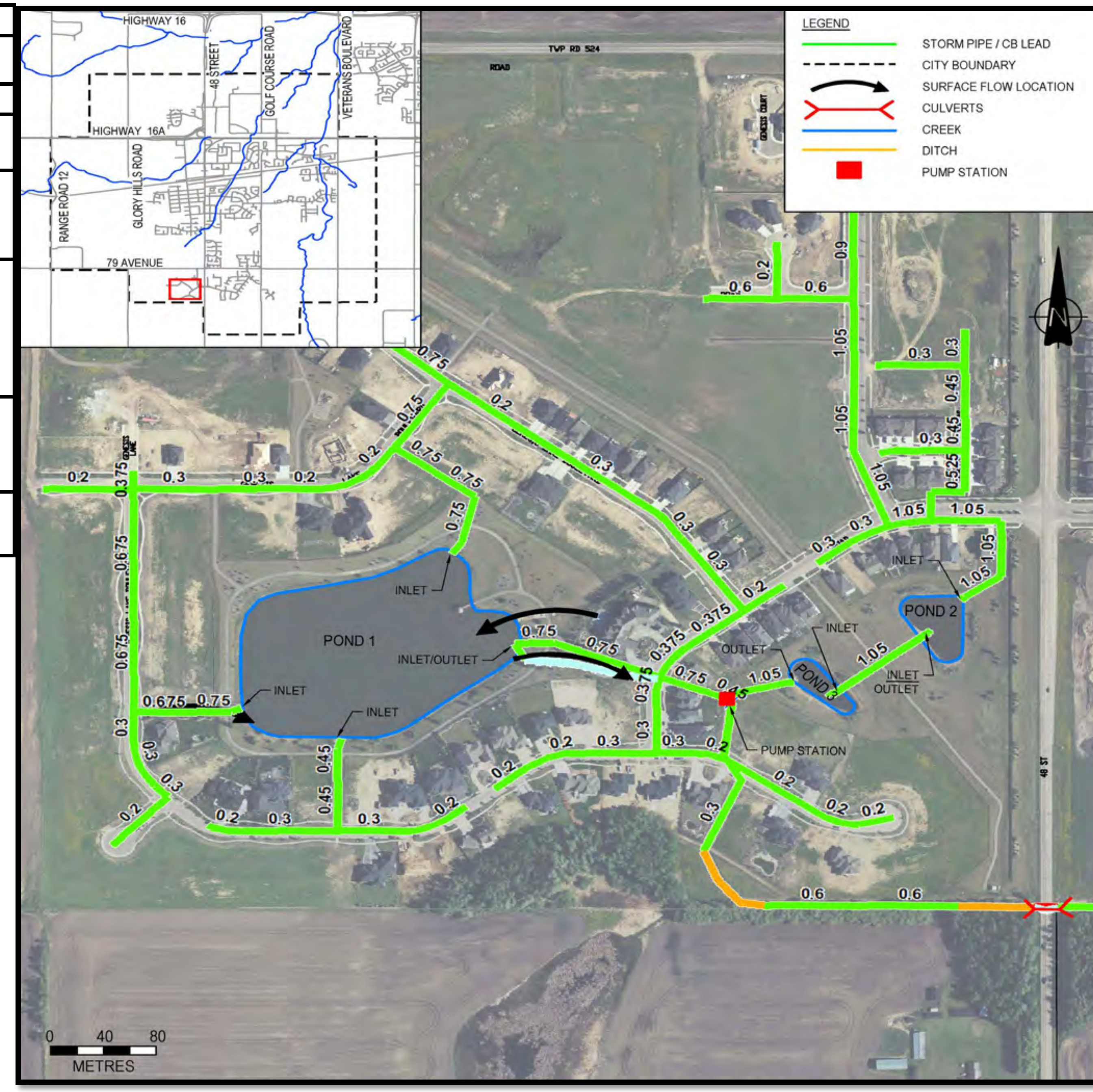
	Water Elevation (m)	Depth to NWL (m)
Design		
100yr Water Level (HWL)	708.28	0.75
5yr Water Level	707.53	0.53
Normal Water Level (NWL)	707.00	0.00
Pond Bottom	705.50	-1.50
Modeled / LiDAR		
100-year 24-hour	708.05	1.05
100-year 4-hour	707.74	0.74
5-year 4-hour	707.30	0.30
Normal Water Level (NWL)	707.00	0.00



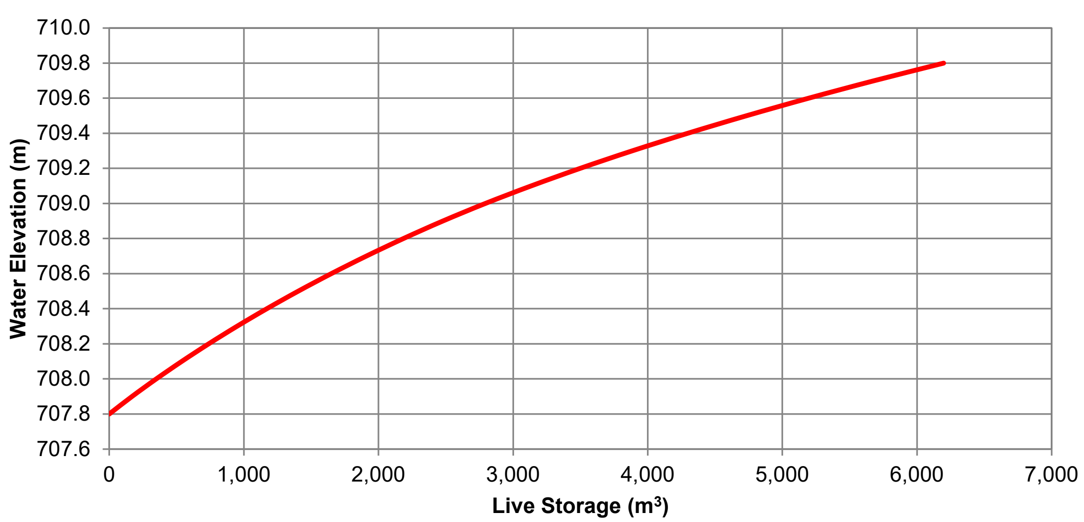
Note: Stage-Storage Curve derived from LiDAR (collected in 2014).



Pond ID	2	Neighbourhood	Genesis
Facility Type	Wet Pond	Location	East of community, northern one
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond (Genesis on the Lake) is still being developed.		
Inlet / Outlet	**Inlets:** 1050 mm to the northeast (707.24 m). **Outlets:** 1050 mm to the southwest (706.11 m)		
Control Structure	**NWL:** Invert of 750 mm pipe at MH besides the lift station at 707.00 m **Flow Rate:** Lift station. **Others:** This pond is connected to Genesis East Pond 2 with a culvert of 1050 mm.		
Overflow	**Into Pond:** N/A **Out of Pond:** N/A		
Comments			

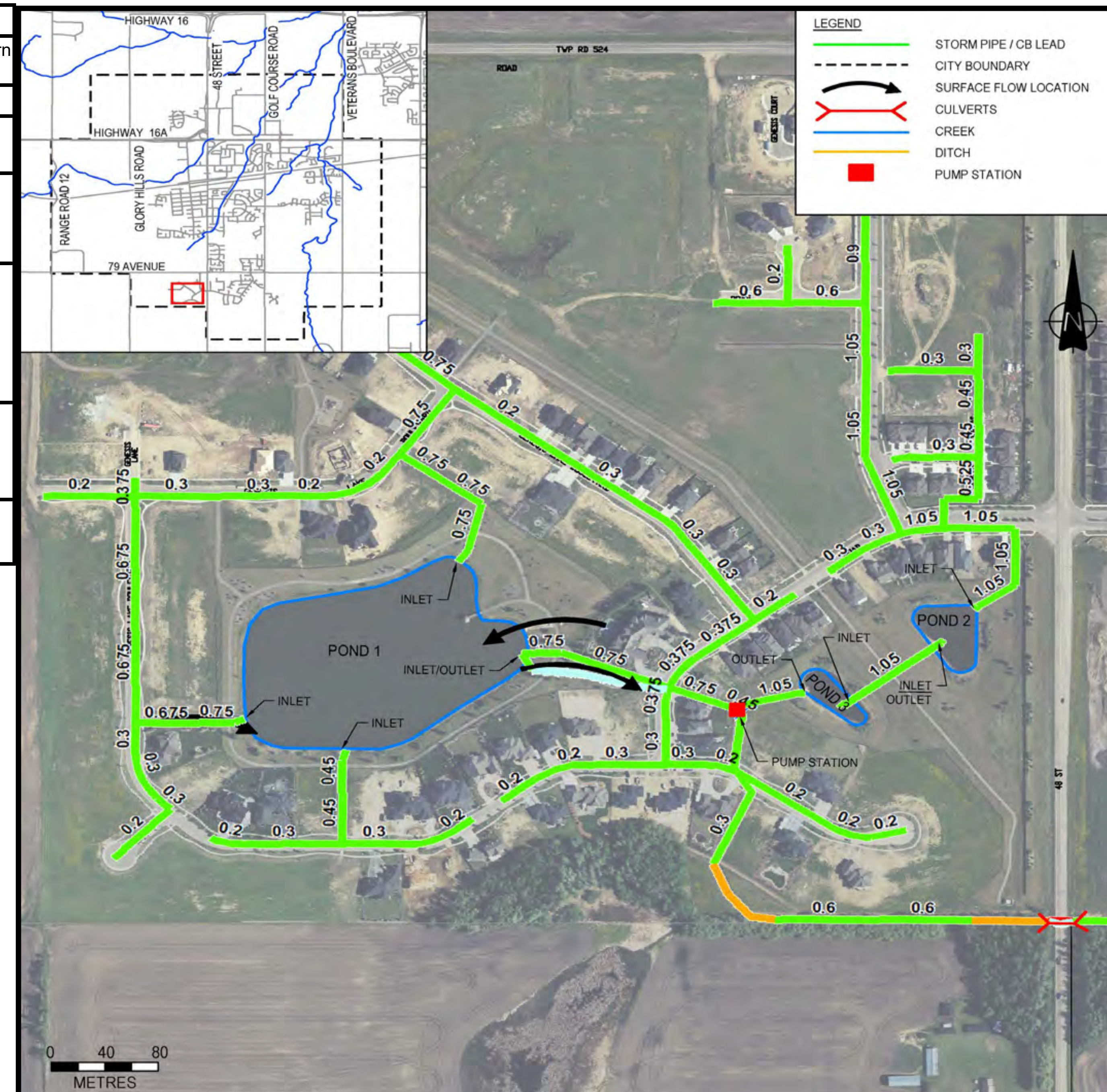


	Water Elevation (m)	Depth to NWL (m)
Design		
100yr Water Level (HWL)	708.59	0.83
5yr Water Level	707.76	0.76
Normal Water Level (NWL)	707.00	0.00
Pond Bottom	706.70	-0.30
Modeled / LiDAR		
100-year 24-hour	708.05	1.05
100-year 4-hour	707.90	0.90
5-year 4-hour	707.31	0.31
Normal Water Level (NWL)	707.00	0.00

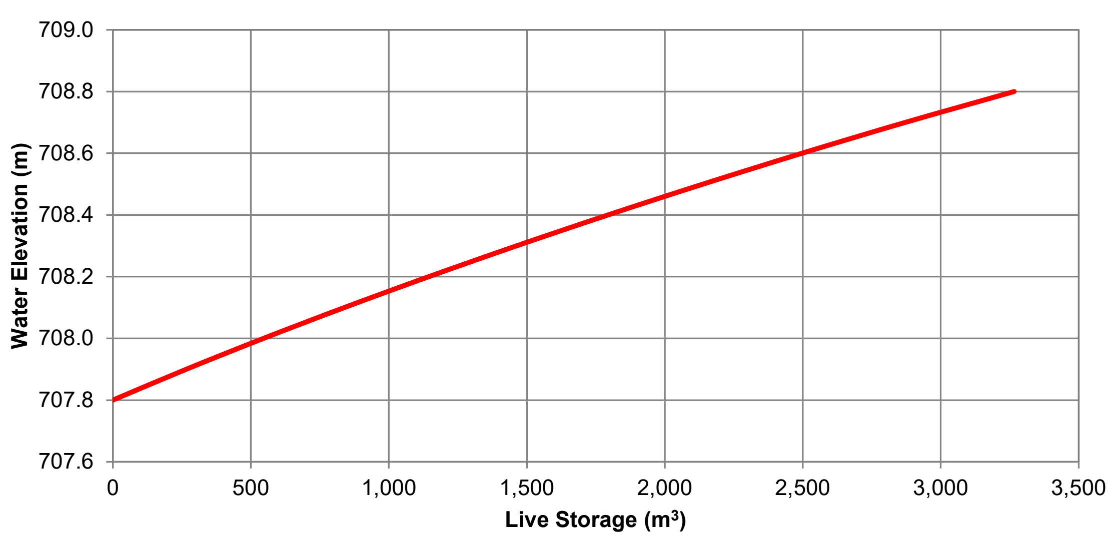


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

Pond ID	3	Neighbourhood	Genesis
Facility Type	Wet Pond	Location	East of communicty, southern one
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond (Genesis on the Lake) is still being developed.		
Inlet / Outlet	**Inlets:** 1050 mm to the east (705.77 m), 1050 mm to the west (706.90 m) **Outlets:** 1050 mm to the west (706.90 m), The 1050 mm pipe to the west serves as inlet and outlet		
Control Structure	**NWL**: Invert of 750 mm pipe at MH besides the lift station at 707.00 m **Flow Rate:** Lift station **Others:** This pond is connected to Genesis East Pond 1 with a culvert of 1050 mm.		
Overflow	**Into Pond:** Northeast of the pond along the 1050 mm pipe. **Out of Pond:**		
Comments			



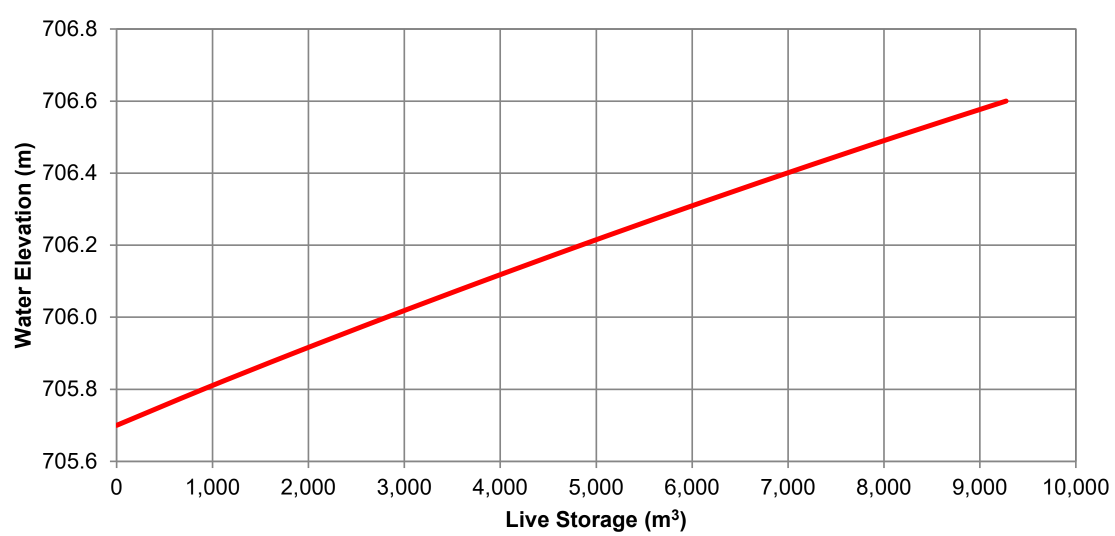
	Water Elevation (m)	Depth to NWL (m)
Design		
100yr Water Level (HWL)	708.48	0.77
5yr Water Level	707.71	0.71
Normal Water Level (NWL)	707.00	0.00
Pond Bottom	705.50	-1.50
100-year 24-hour	708.05	1.05
100-year 4-hour	707.89	0.89
5-year 4-hour	707.31	0.31
Normal Water Level (NWL)	707.00	0.00



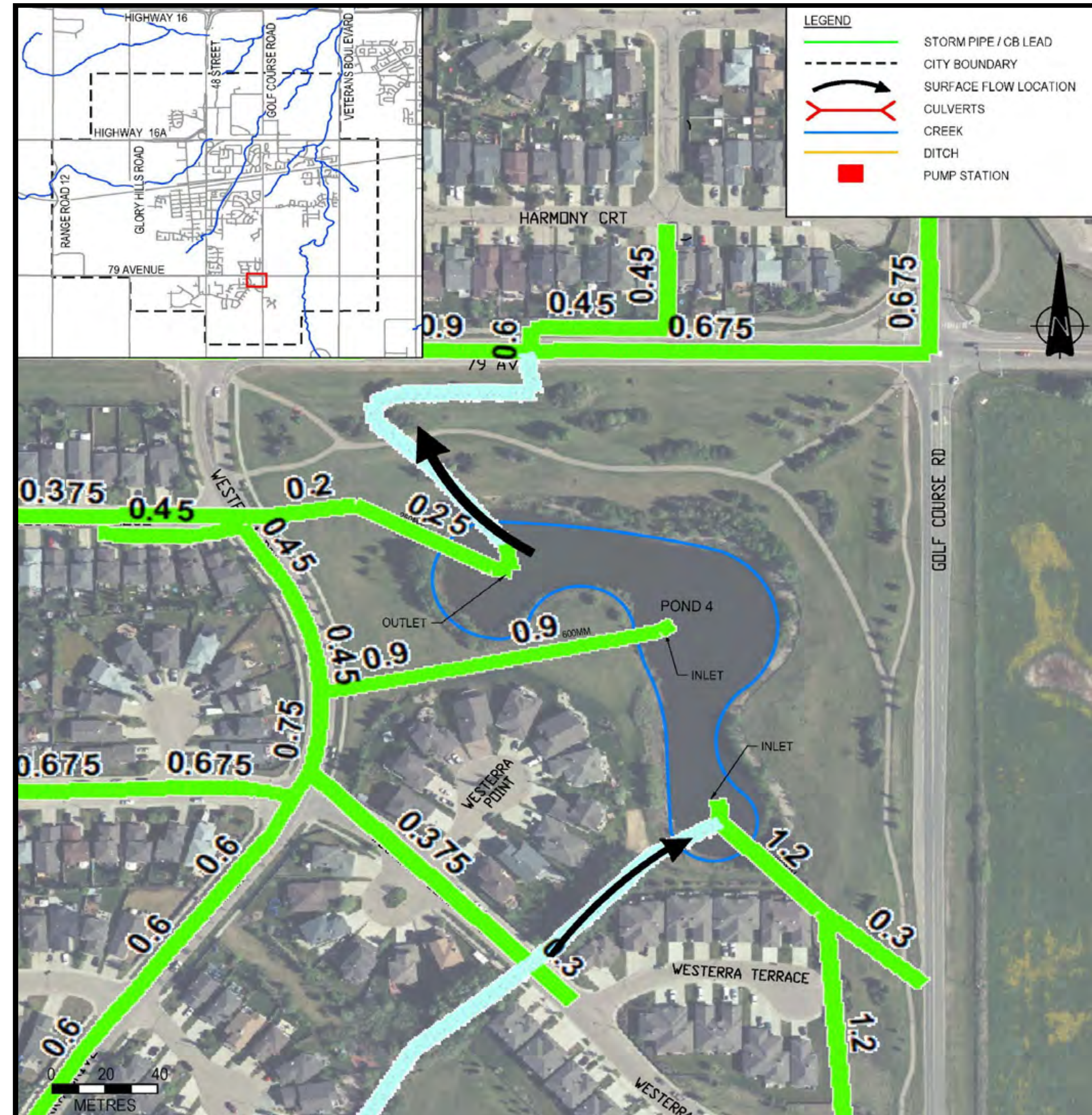
Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

Pond ID	4	Neighbourhood	Westerra
Facility Type	Wet Pond	Location	East of communicty
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond (Westerra east community) are fully developed.		
Inlet / Outlet	**Inlets:** 1200 mm to the south (???), 900 mm to the west (704.50 m) **Outlets:** 250 mm to the west (703.00 m)		
Control Structure	**NWL** invert of outlet pipe. **Flow Rate** invert of outlet pipe **Others:**		
Overflow	**Into Pond:** Southwest of the pond, ditch going in **Out of Pond:** Northwest of pond, flow goes into the 79 Avnue ditch.		
Comments	South inlet information missing		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	708.75	2.00
Normal Water Level (NWL)	706.75	0.00
Pond Bottom	704.75	-2.00
Modeled / LiDAR		
100-year 24-hour	709.33	2.58
100-year 4-hour	708.49	1.74
5-year 4-hour	707.60	0.85
Normal Water Level (NWL)	706.75	0.00

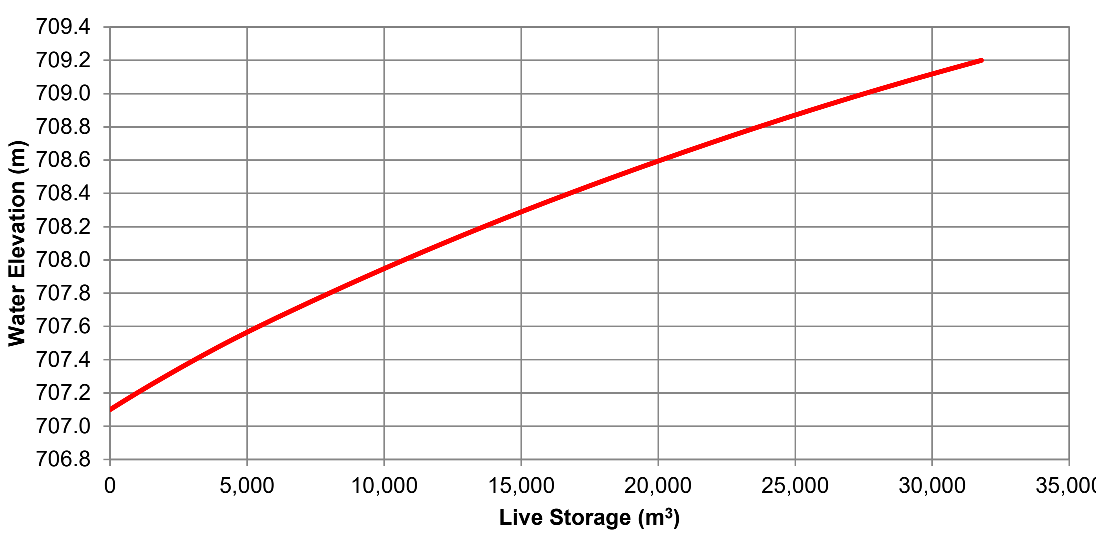


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

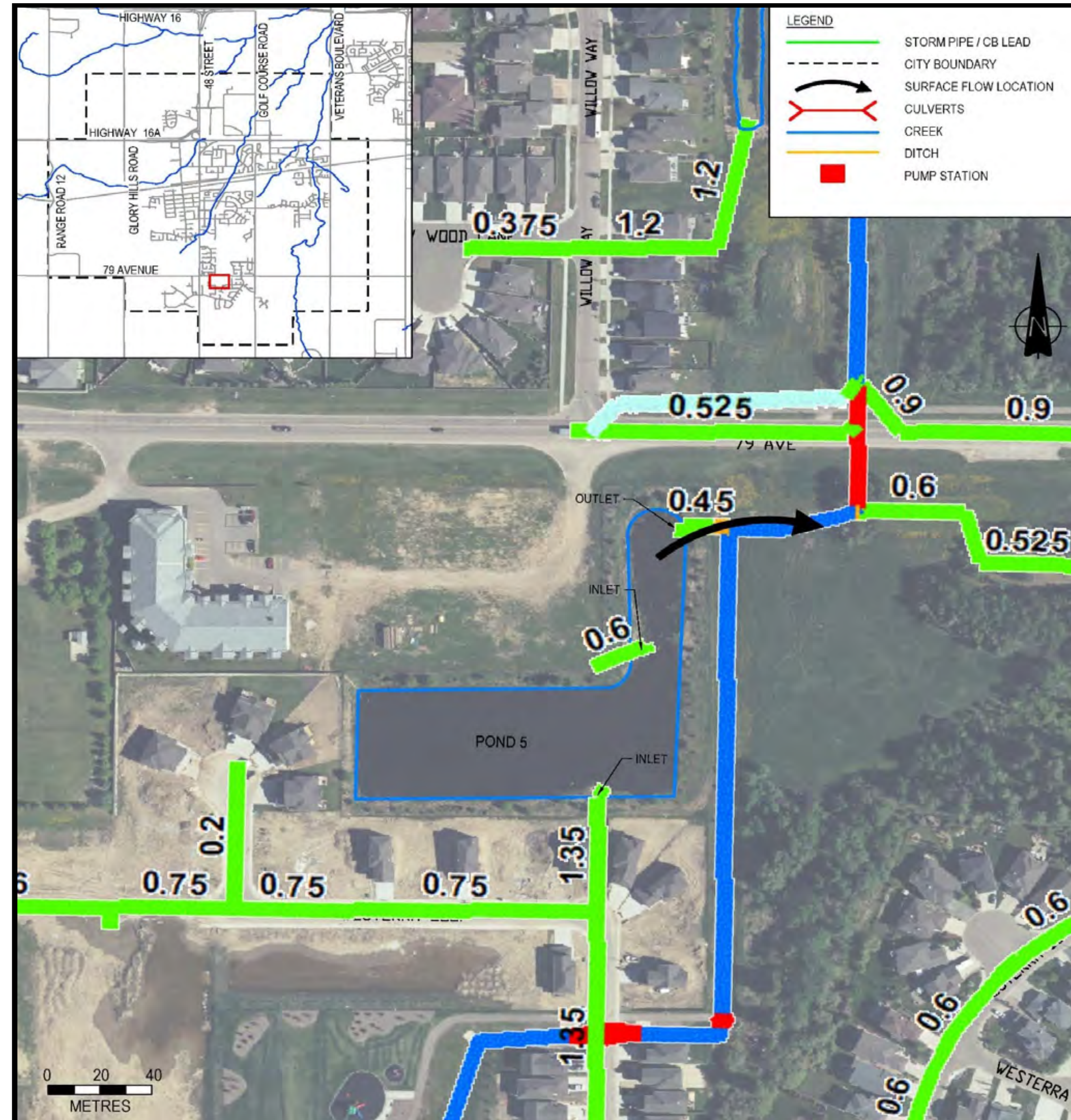


Pond ID	5	Neighbourhood	Westerra
Facility Type	Wet Pond	Location	West of community
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond (Westerra Loop, Westerra Manor etc.) is being developed.		
Inlet / Outlet	**Inlets:** 1350 mm to the south (705.40 m), 600 mm to the west (705.40m) **Outlets:** 450 mm to the north (705.33 m calculated based on slope & DS invert)		
Control Structure	**NWL:** Orifice plate 65 mm hole in bottom of plug, (Orifice_2) **Flow Rate:** Orifice plate **Others:**		
Overflow	**Into Pond:** Southwest of the pond, ditch going in **Out of Pond:** Northeast of pond, same route to outlet pipe (from design drawing) 706.50 m		
Comments	Outlet invert elevation missing		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	706.50	1.10
Normal Water Level (NWL)	705.40	0.00
Pond Bottom	705.15	-0.25
Modeled / LiDAR		
100-year 24-hour	707.01	1.61
100-year 4-hour	706.75	1.35
5-year 4-hour	705.97	0.57
Normal Water Level (NWL)	705.40	0.00



Note: Stage-Storage Curve derived from LiDAR (collected in 2014).



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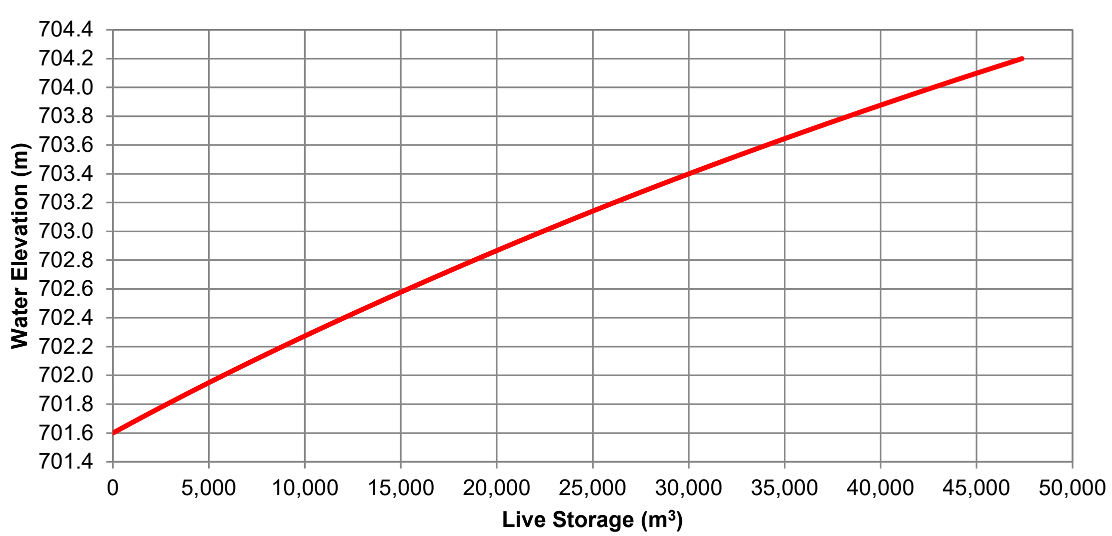
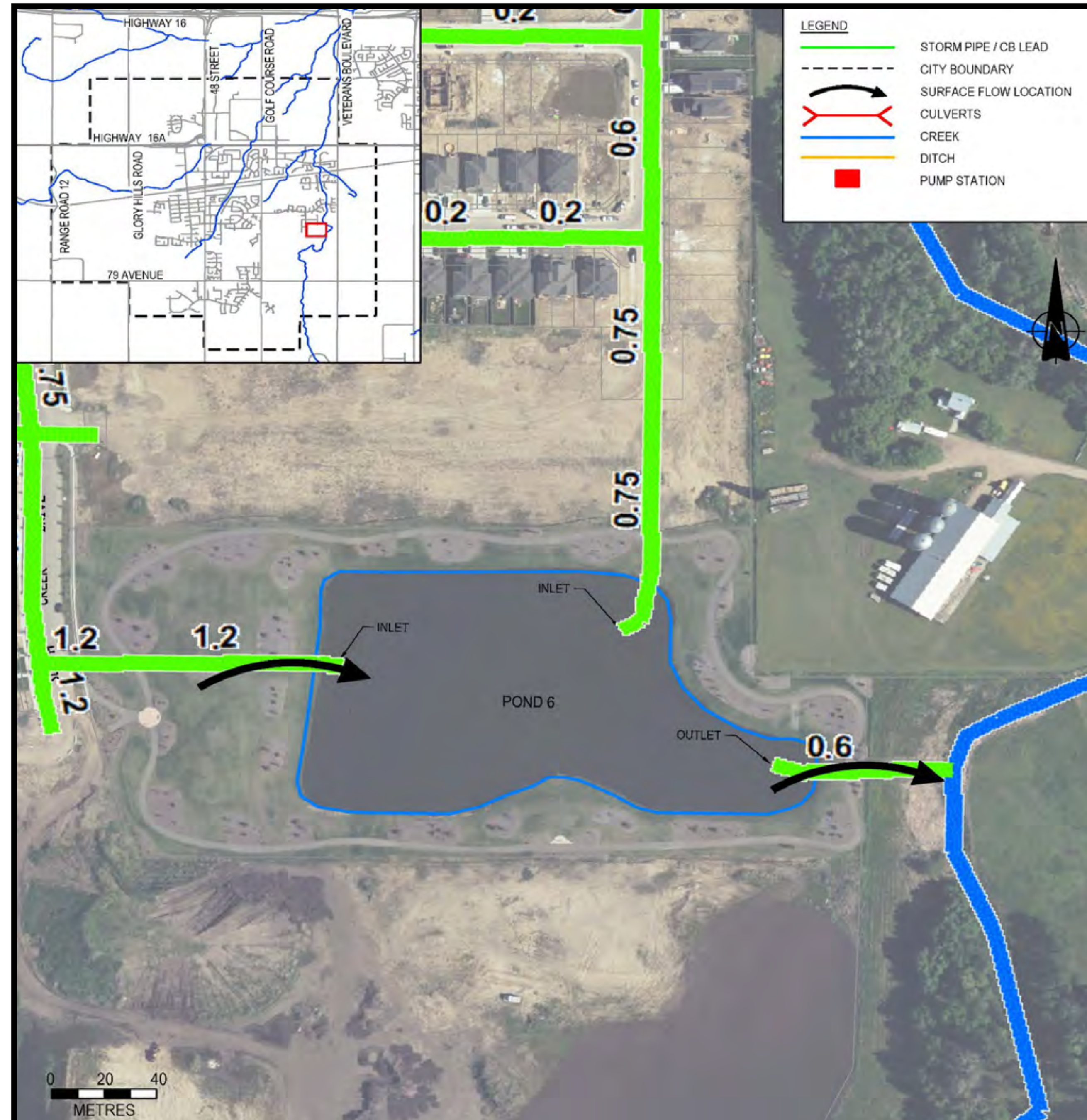
Pond ID	6	Neighbourhood	South creek
Facility Type	Wet Pond	Location	SE of community
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond (S Creek Wynd, S Creek Dr. etc.) is being developed.		
Inlet / Outlet	**Inlets:** 1200 mm to the west (700.467 m), 750 mm to the north (700.395 m) **Outlets:** 600 mm to the southeast (701.100 m)		
Control Structure	**NWL** ??? **Flow Rate** ??? **Others:** Control structure cannot find in as-built drawing		
Overflow	**Into Pond:** **Out of Pond:** East of pond into creek		
Comments	No control structure information.		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	704.18	1.35
Normal Water Level (NWL)	702.84	0.00
Pond Bottom	700.20	-2.64
Modeled / LiDAR		
100-year 24-hour	703.52	0.68
100-year 4-hour	703.31	0.47
5-year 4-hour	702.99	0.15
Normal Water Level (NWL)	702.84	0.00

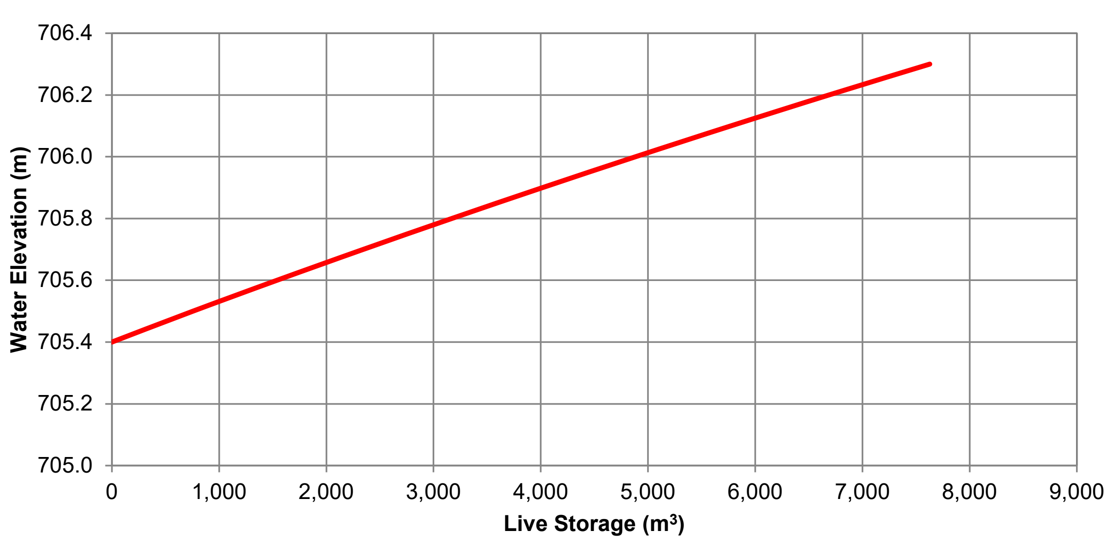


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

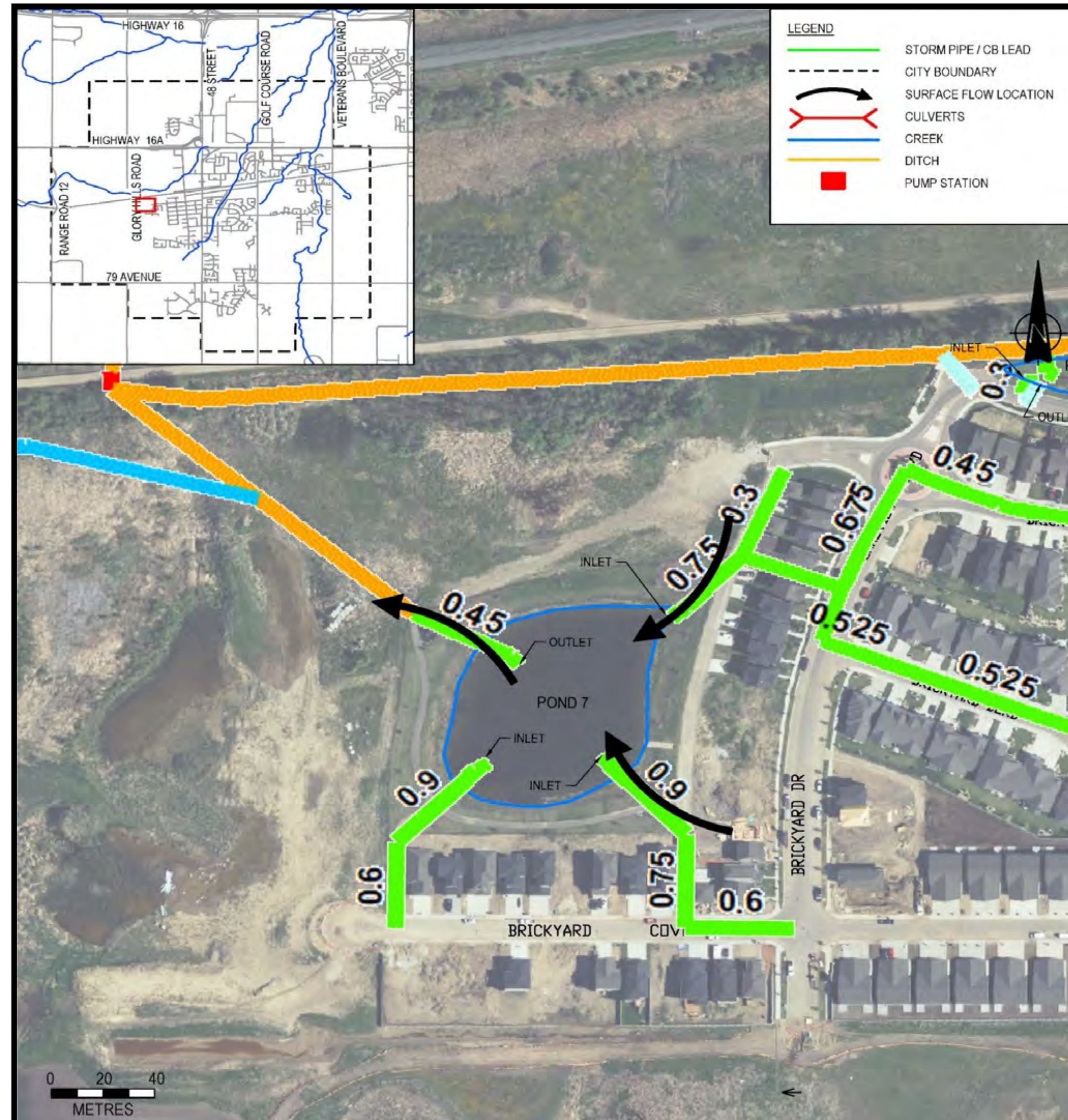


Pond ID	7	Neighbourhood	Brickyard
Facility Type	Wet Pond	Location	W of community
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond (Brickyard) is being developed.		
Inlet / Outlet	**Inlets:** 750 mm to the northeast (704.900 m), 900 mm to the southeast (703.400 m), 900 mm to the southwest (???) **Outlets:** 450 mm to the northwest (???)		
Control Structure	**NWL** N/A **Flow Rate** N/A **Others:** Control structure cannot find in as-built drawing		
Overflow	**Into Pond:** East of the pond via the riprap (from lidar data) **Out of Pond:** Northwest of pond, same route to outlet pipe		
Comments	No control structure information.		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	706.35	0.98
Normal Water Level (NWL)	705.37	0.00
Pond Bottom	703.40	-1.97
Modeled / LiDAR		
100-year 24-hour	705.93	0.56
100-year 4-hour	705.79	0.42
5-year 4-hour	705.54	0.17
Normal Water Level (NWL)	705.37	0.00

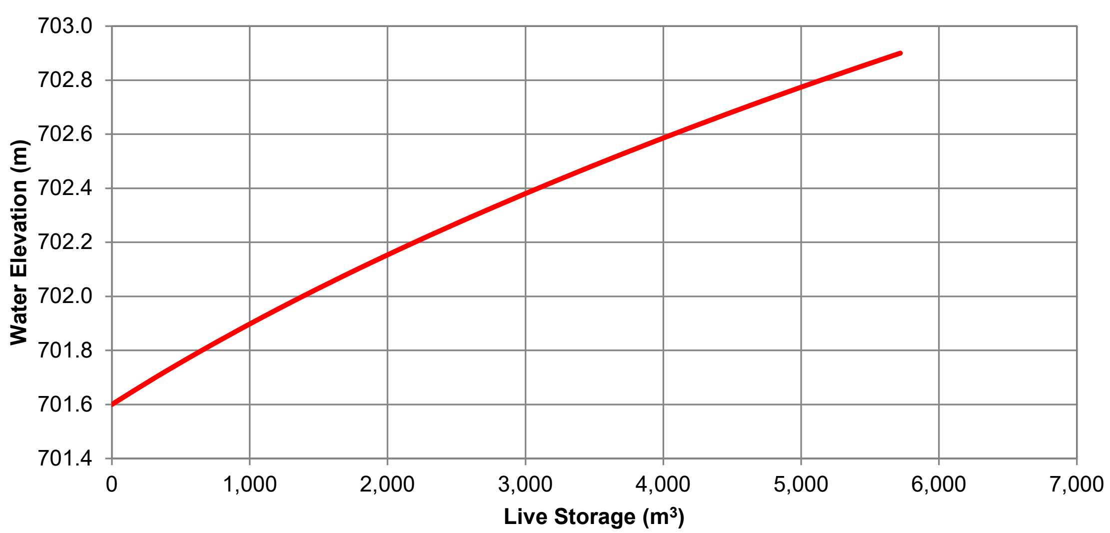


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

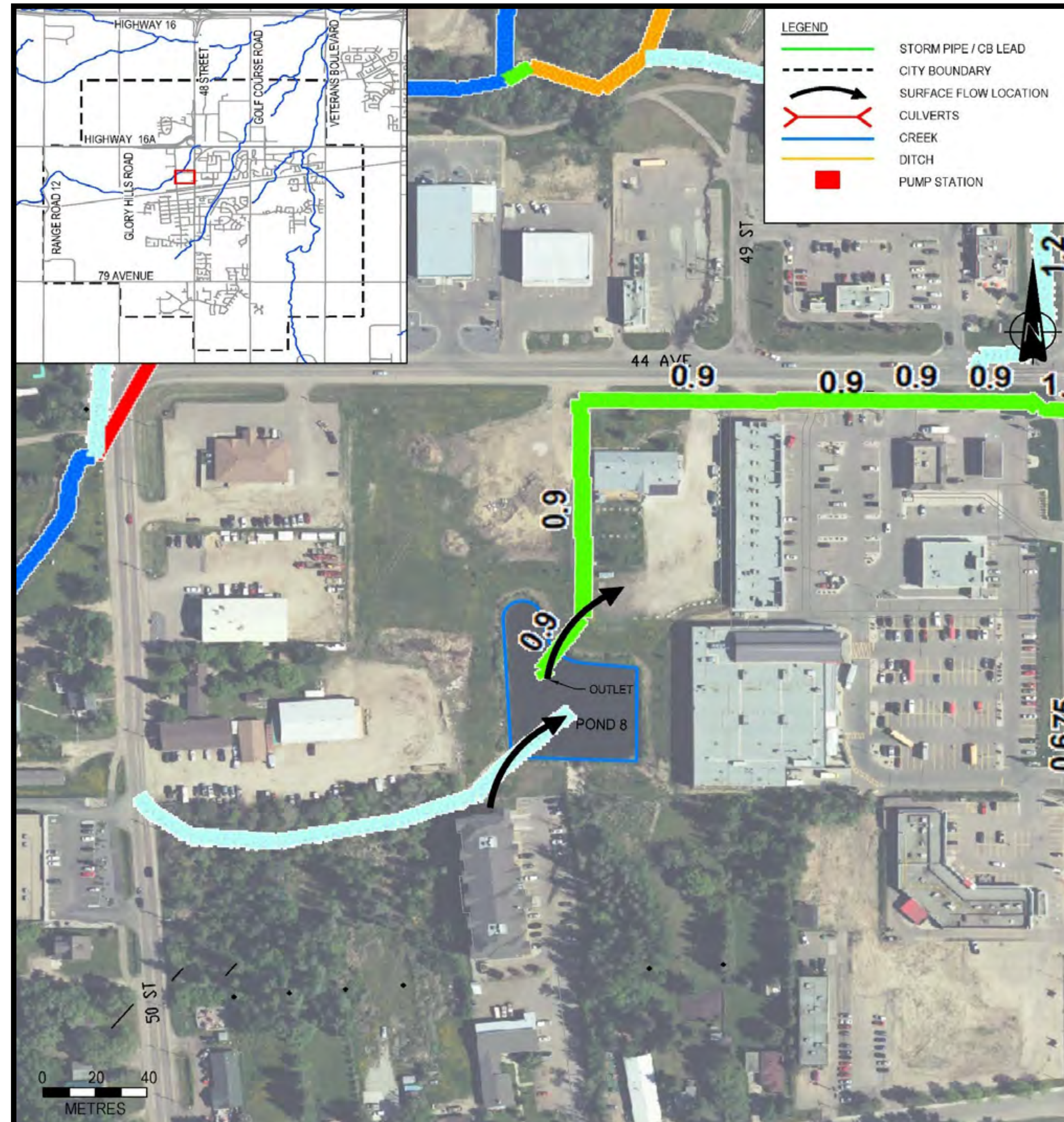


Pond ID	8	Neighbourhood	Freson pond
Facility Type	Wet Pond	Location	South of 44 Ave, between 50 St. and 48 St.
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** 375 mm to the northeast (not shown in model) **Outlets:** 900 mm to the north (699.500 m)		
Control Structure	**NWL:** Orifice 150 mm X 150 mm, Invert 701.487 m, (Orifice_3) **Flow Rate:** Orifice Plate **Others:** Control structure at MH 205233		
Overflow	**Into Pond:** Southwest and South of pond, northeast of pond **Out of Pond:** Northeast of pond, flow to ditch by 44 Ave.		
Comments	One inlet pipe missing in model		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	702.80	1.31
Normal Water Level (NWL)	701.49	0.00
Pond Bottom	699.00	-2.49
Modeled / LiDAR		
100-year 24-hour	701.90	0.41
100-year 4-hour	701.89	0.40
5-year 4-hour	701.65	0.16
Normal Water Level (NWL)	701.49	0.00

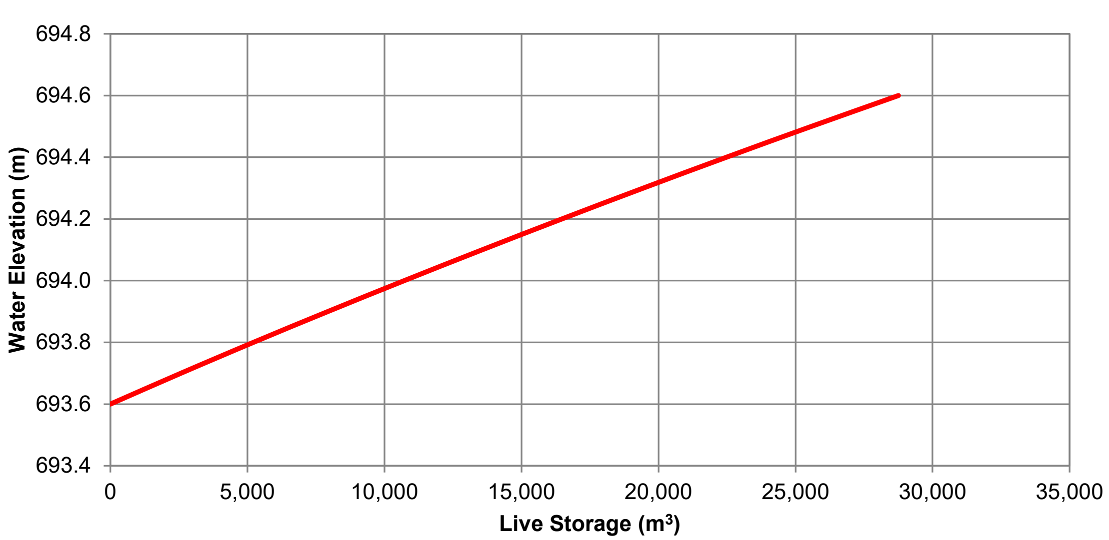


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

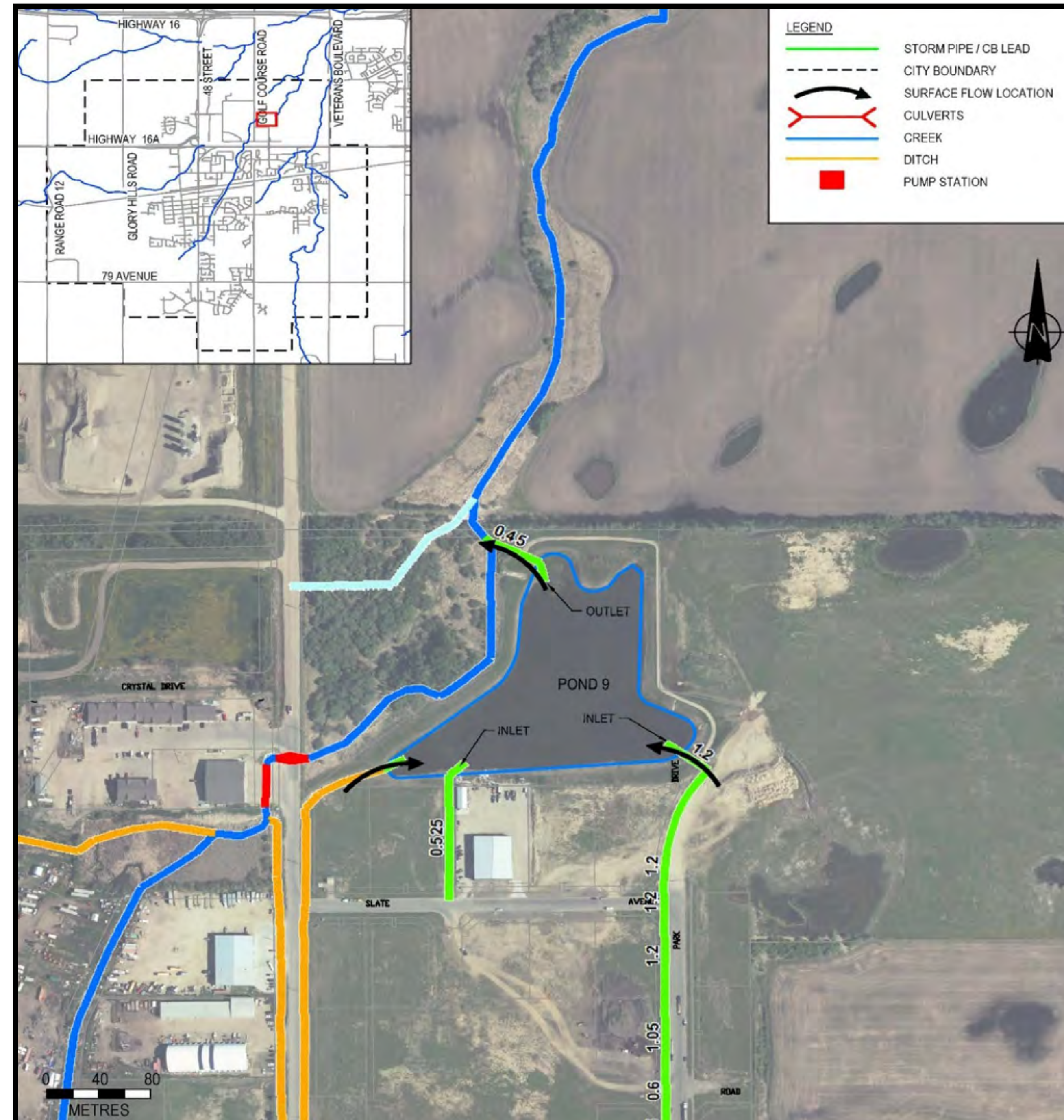


Pond ID	9	Neighbourhood	Quance North Industrial
Facility Type	Wet Pond	Location	East of Golf Course Rd. North of Slate Ave.
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** 1200 mm to the southeast (693.45 m), 525 mm to the southwest (693.48 m) **Outlets:** 450 mm to the north (693.50 m)		
Control Structure	**NWL:** Orifice 150 mm diameter 693.35 m, (Orifice_4) **Flow Rate:** Orifice plate **Others:** Control structure at Node_155		
Overflow	**Into Pond:** Southwest of pond, via ditch, East of pond (ralatively small) **Out of Pond:** Northwest of pond, into creek		
Comments			

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	694.65	1.15
Normal Water Level (NWL)	693.50	0.00
Pond Bottom	693.00	-0.50
Modeled / LiDAR		
100-year 24-hour	693.99	0.49
100-year 4-hour	693.81	0.31
5-year 4-hour	693.65	0.15
Normal Water Level (NWL)	693.50	0.00

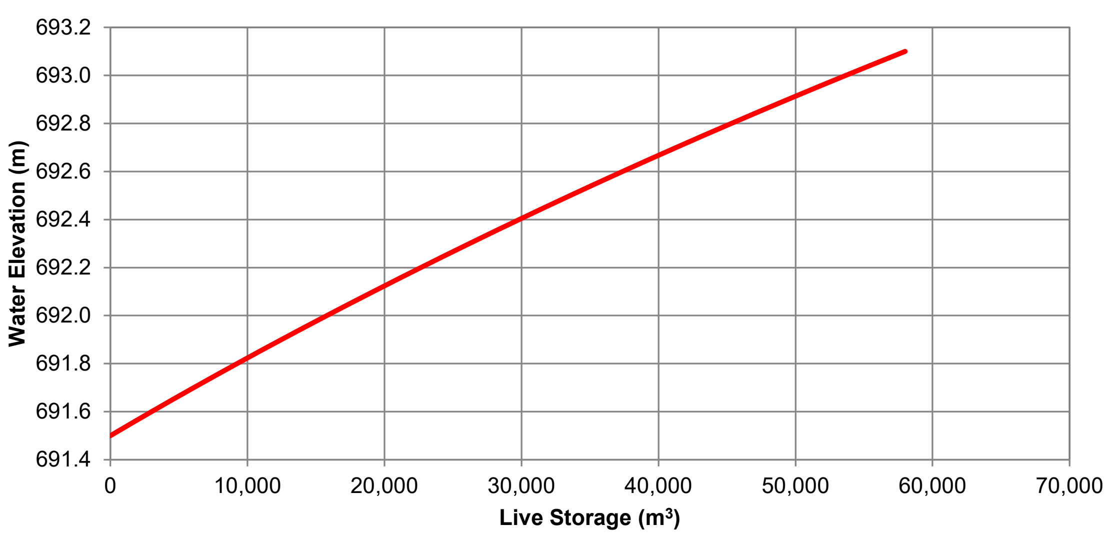


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

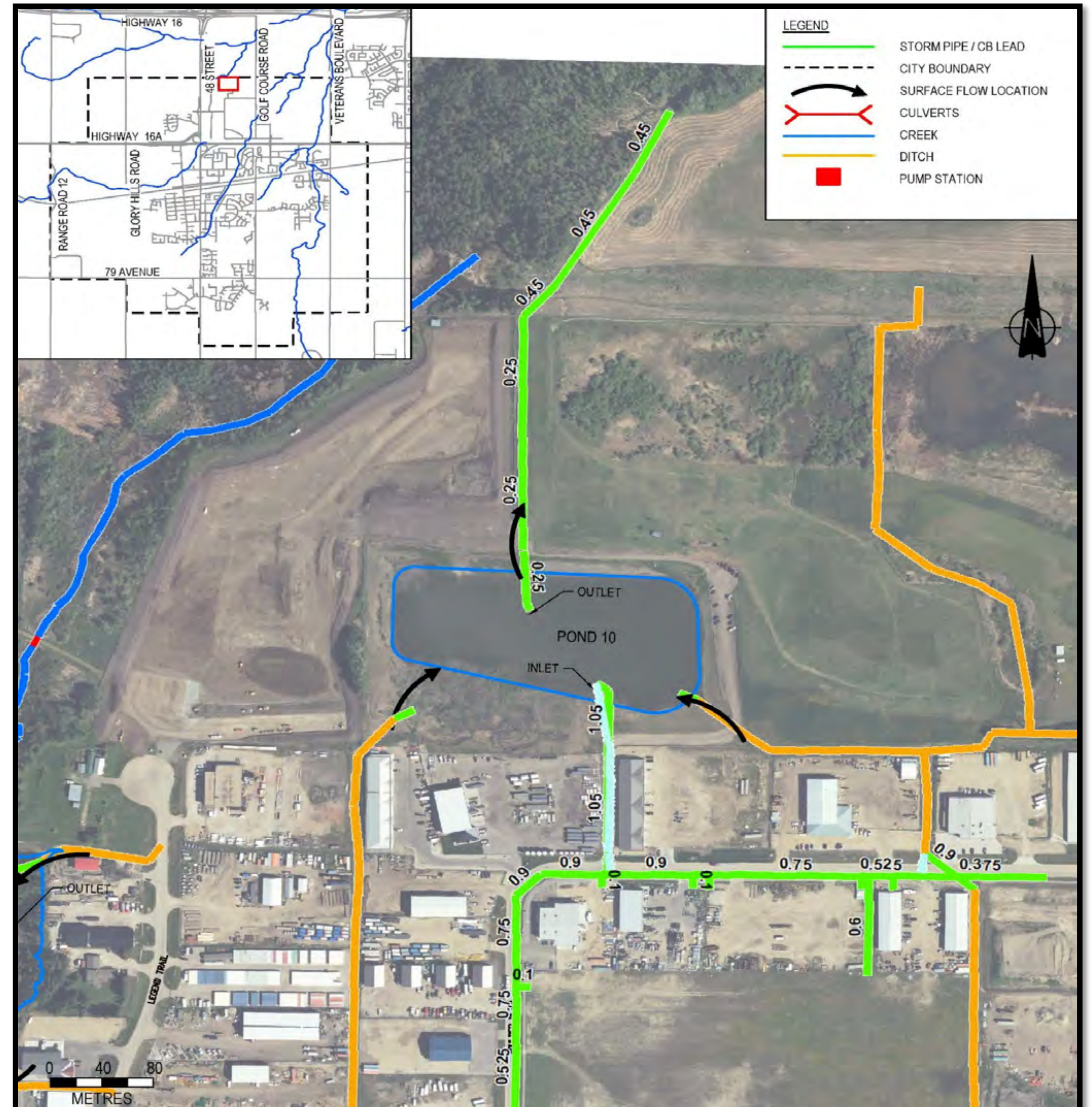


Pond ID	10	Neighbourhood	Umbach Bus Park
Facility Type	Wet Pond	Location	East of Hwy 779, north of Boulder Blvd.
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** 1050mm to the south (688.70 m) **Outlets:** 450 mm to the north (689.60 m)		
Control Structure	**NWL** Orifice 250 mm diameter at 691.20 m, (Orifice_5) **Flow Rate** Orifice **Others:** Control structure at MH 204351		
Overflow	**Into Pond:** Southwest coner, southeast coner via ditches **Out of Pond:** North of pond follow the outlet pipeline.		
Comments	Outlet pipe in model is 250 mm in diameter, but 450 mm in as-built		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	692.55	1.35
Normal Water Level (NWL)	691.20	0.00
Pond Bottom	688.70	-2.50
Modeled / LiDAR		
100-year 24-hour	693.31	2.11
100-year 4-hour	692.41	1.21
5-year 4-hour	691.87	0.67
Normal Water Level (NWL)	691.20	0.00

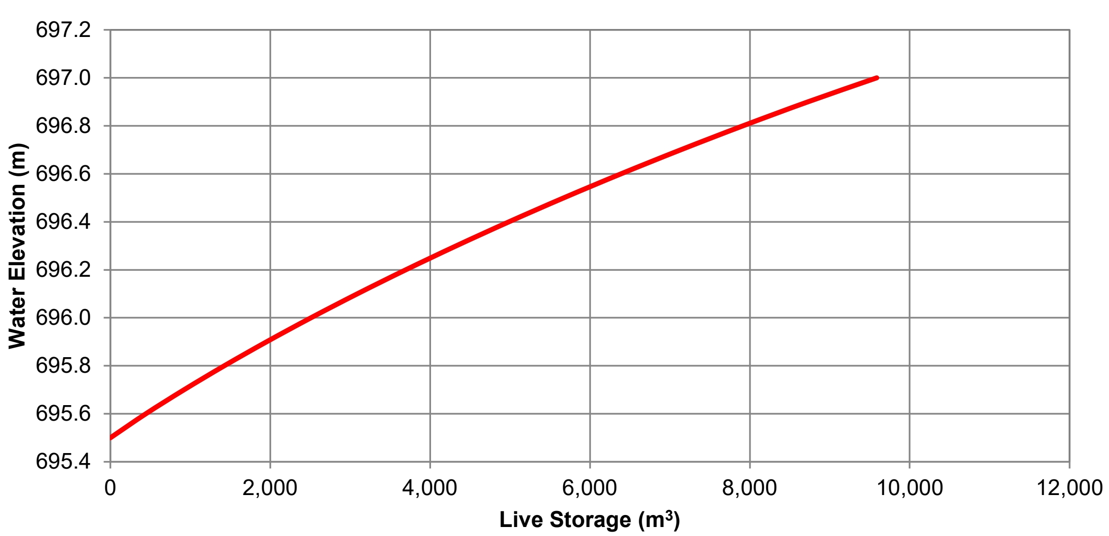


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

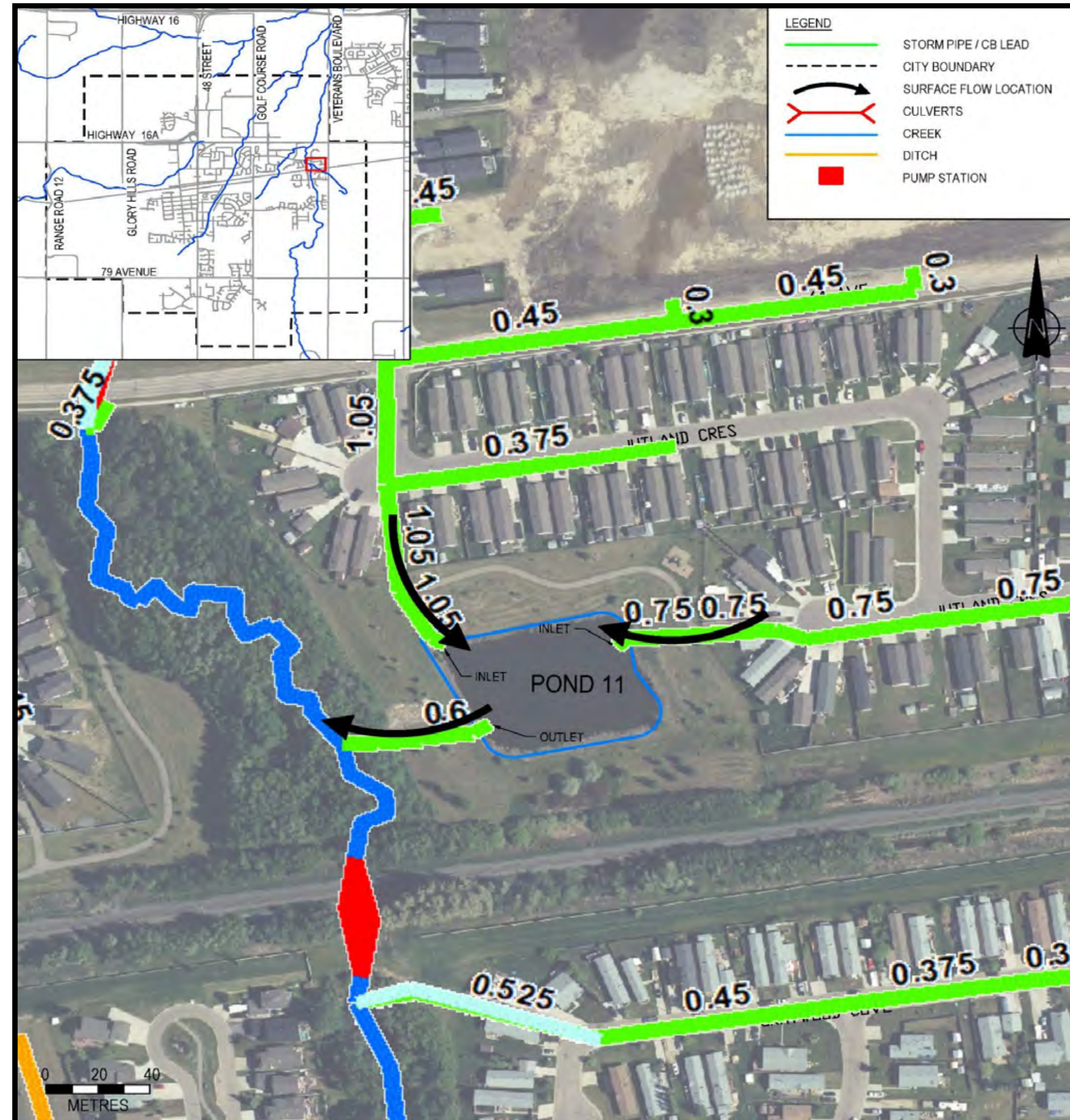


Pond ID	11	Neighbourhood	Jutland
Facility Type	Wet Pond	Location	Southwest of community
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** 1050mm to the northwest (694.90 m), 750 mm to the east (694.90 m) **Outlets:** 600 mm to the southwest (692.90 m)		
Control Structure	**NWL** Slide gate at 694.90 m (125 mm X 125 mm) with different openings for total area devleoped--------->>> **Flow Rate** Slide gate (Orifice_6) **Others:** Control structure at MH 203438		
Overflow	**Into Pond:** north of pond follow the inlet pipe, east of the pond **Out of Pond:** West of pond flows into creek		
Comments			

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	696.90	2.00
Normal Water Level (NWL)	694.90	0.00
Pond Bottom	692.40	-2.50
Modeled / LiDAR		
100-year 24-hour	695.98	1.08
100-year 4-hour	695.58	0.68
5-year 4-hour	695.24	0.34
Normal Water Level (NWL)	694.90	0.00

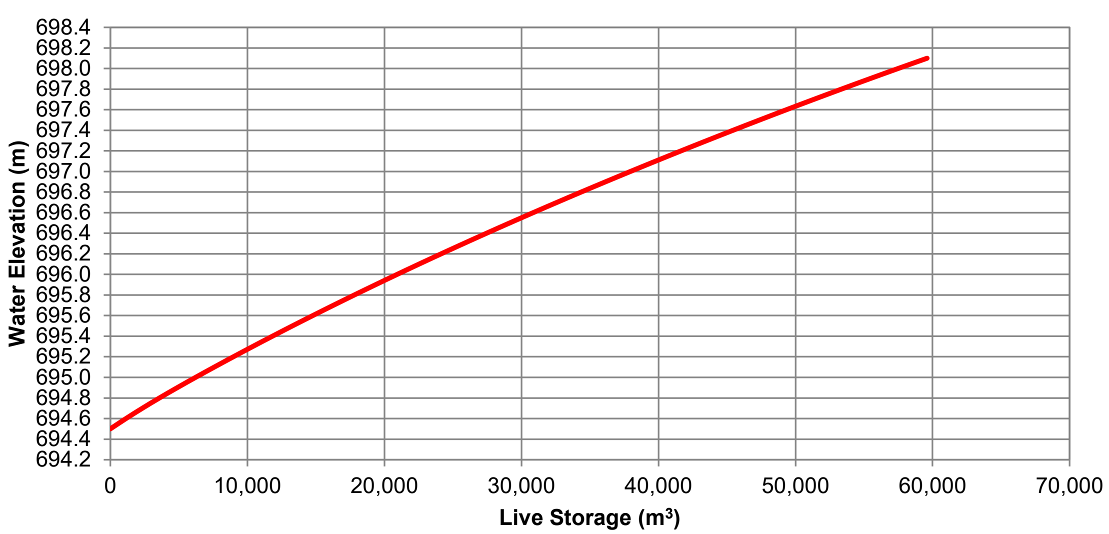


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

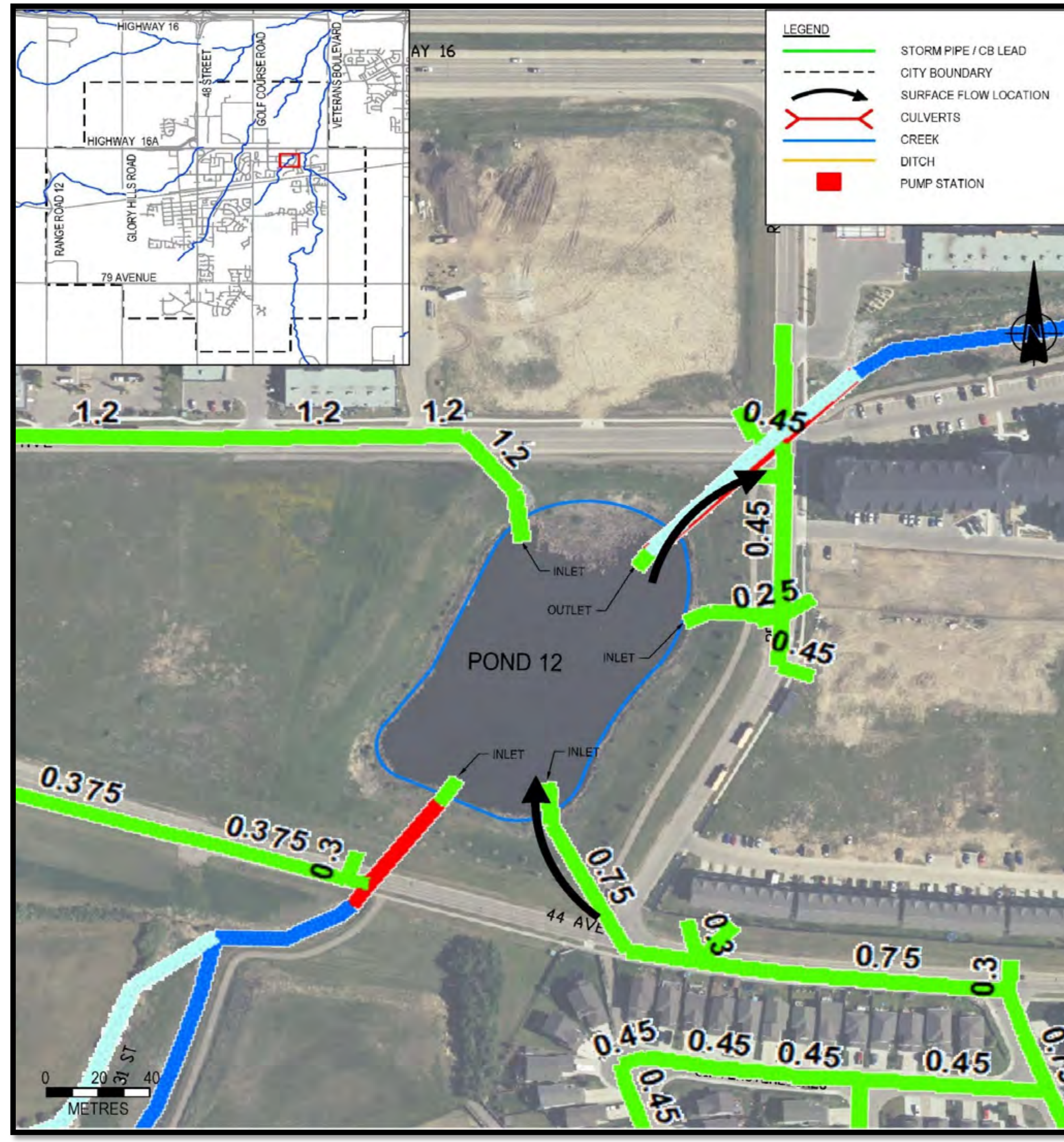


Pond ID	12	Neighbourhood	South Businiess Park
Facility Type	Wet Pond	Location	Between 43 and 44 Ave. West of 28 St.
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** 1500 mm to the south (culvert from creek), 750 mm to the southeast (695.00 m), 1200 mm to the northwest (695.817 m), 600 mm to the east (no information) **Outlets:** 1200 mm to the northeast (culvert to creek)		
Control Structure	**NWL:** no information **Flow Rate:** no information **Others:** Control structure at Node_132		
Overflow	**Into Pond:** West of pond. **Out of Pond:** Northeast of pond flow back into creek over road.		
Comments	This pond is on a streamcourse, no control structure information		

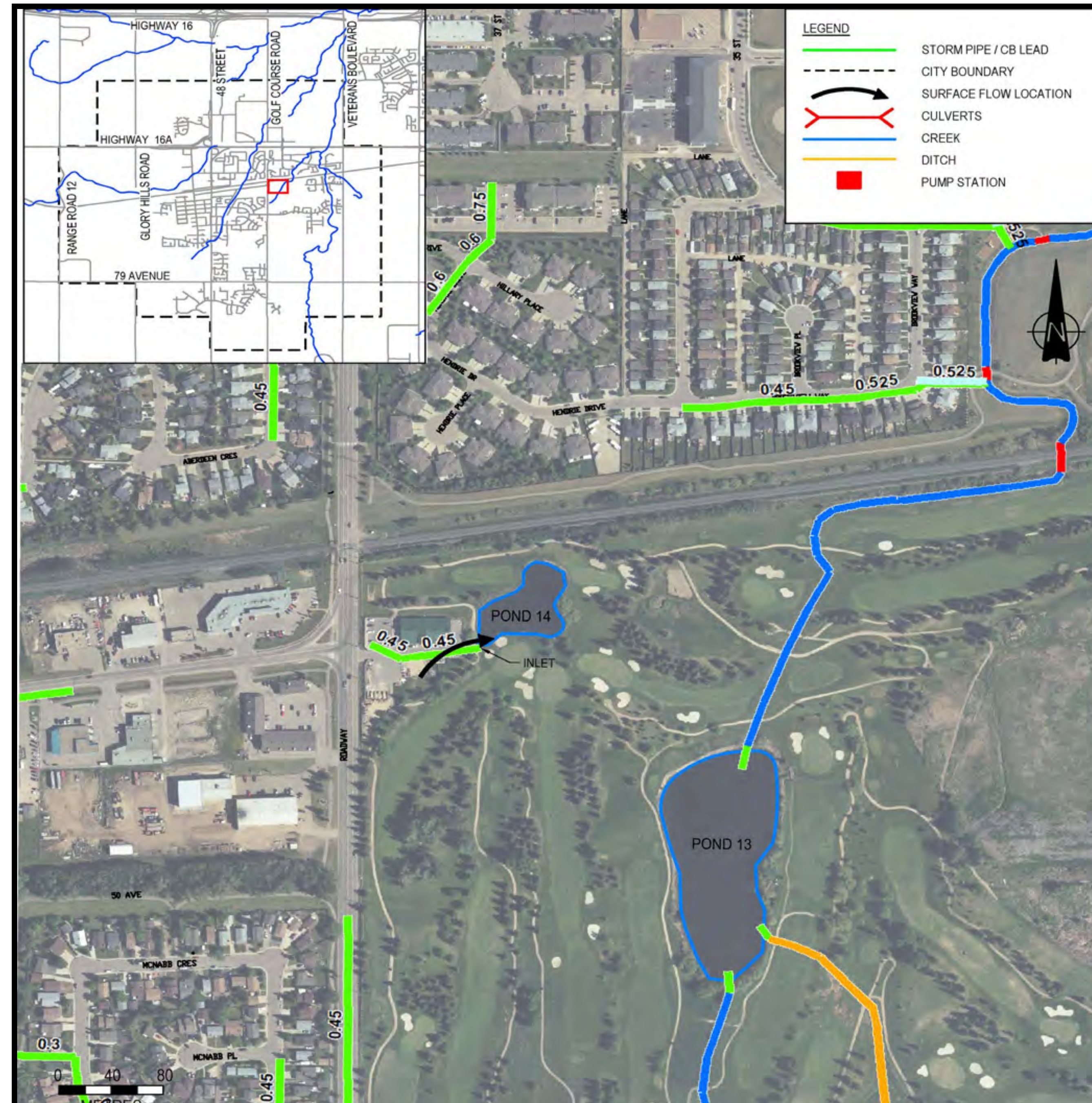
	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	698.00	3.50
Normal Water Level (NWL)	694.50	0.00
Pond Bottom	691.50	-3.00
Modeled / LiDAR		
100-year 24-hour	696.14	1.64
100-year 4-hour	696.13	1.63
5-year 4-hour	694.98	0.48
Normal Water Level (NWL)	694.50	0.00



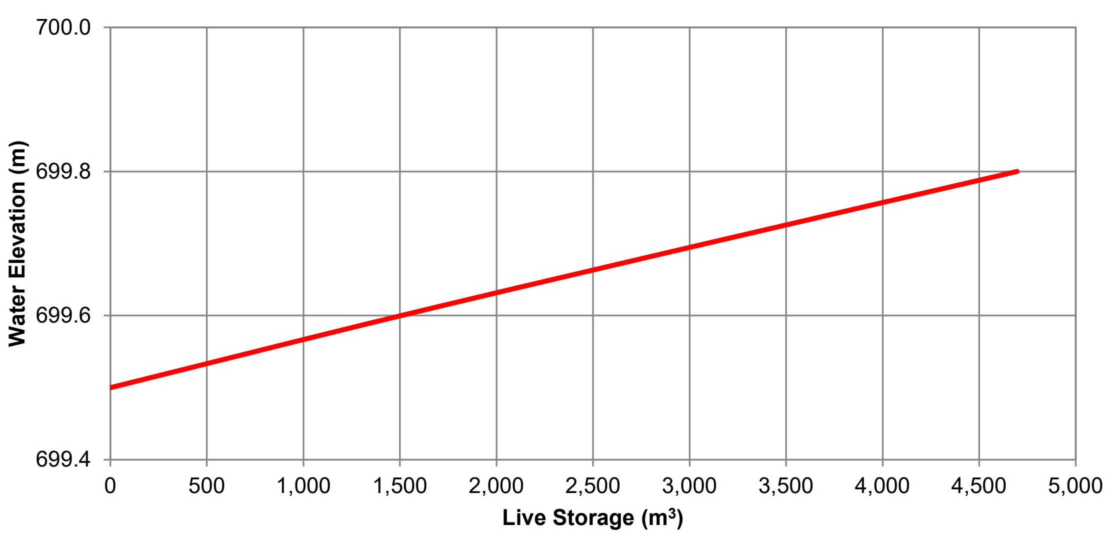
Note: Stage-Storage Curve derived from LiDAR (collected in 2014).



Pond ID	13	Neighbourhood	Golfcourse pond 1
Facility Type	Wet Pond	Location	Big pond in golfcourse
Catchment Area		Year of Construction	
Neighbourhood Development Stage	This pond is on golfcourse		
Inlet / Outlet	**Inlets:** **Outlets:**		
Control Structure	**NWL:** no information **Flow Rate:** no information **Others:**		
Overflow	**Into Pond:** south of pond via creek **Out of Pond:** north of pond via creek		
Comments	This pond is on a streamcourse, no pipe goes into this pond		



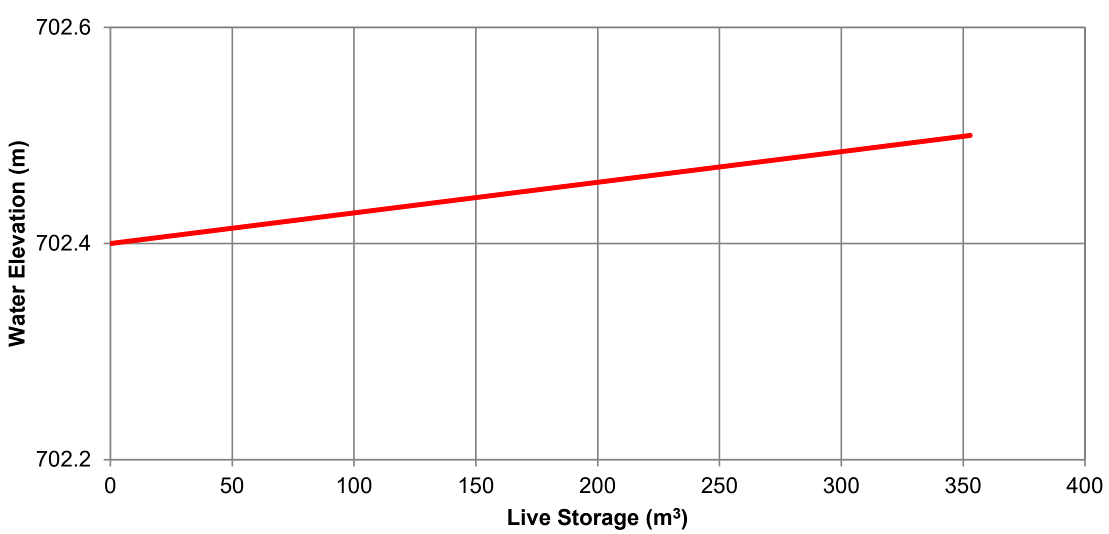
	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	N/A	N/A
Normal Water Level (NWL)	699.50	0.00
Pond Bottom	697.50	-2.00
Modeled / LiDAR		
100-year 24-hour	701.33	1.83
100-year 4-hour	701.51	2.01
5-year 4-hour	700.63	1.13
Normal Water Level (NWL)	699.50	0.00



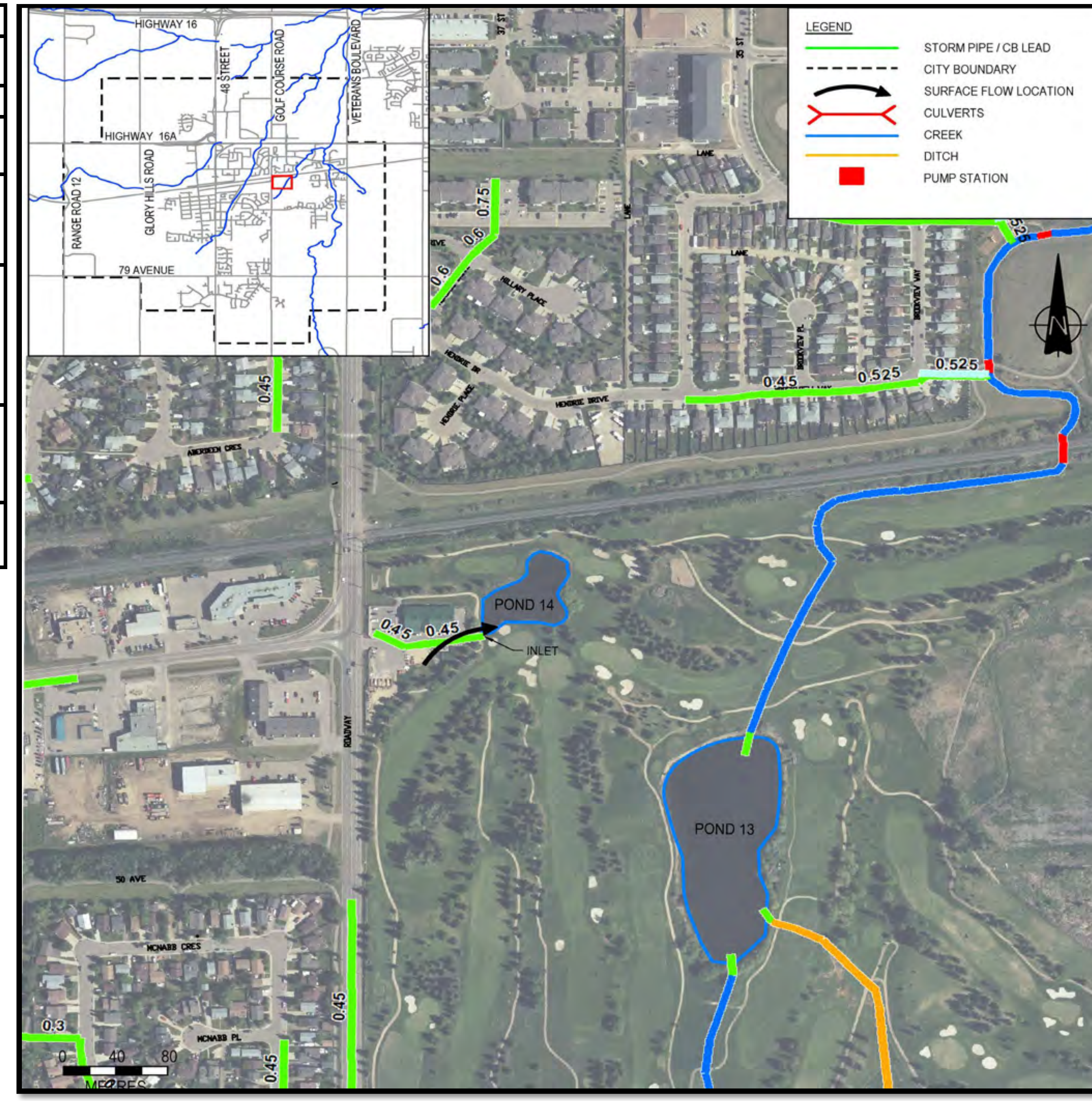
Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

Pond ID	14	Neighbourhood	Golfcourse pond 2
Facility Type	Wet Pond	Location	Smaller pond in golfcourse
Catchment Area		Year of Construction	
Neighbourhood Development Stage	This pond is on golfcourse		
Inlet / Outlet	**Inlets:** 450 mm (no more information) **Outlets:**		
Control Structure	**NWL:** no information **Flow Rate:** no information **Others:**		
Overflow	**Into Pond:** **Out of Pond:**		
Comments	No more information		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	N/A	N/A
Normal Water Level (NWL)	N/A	N/A
Pond Bottom	N/A	N/A
Modeled / LiDAR		
100-year 24-hour	N/A	N/A
100-year 4-hour	N/A	N/A
5-year 4-hour	N/A	N/A
Normal Water Level (NWL)	N/A	N/A

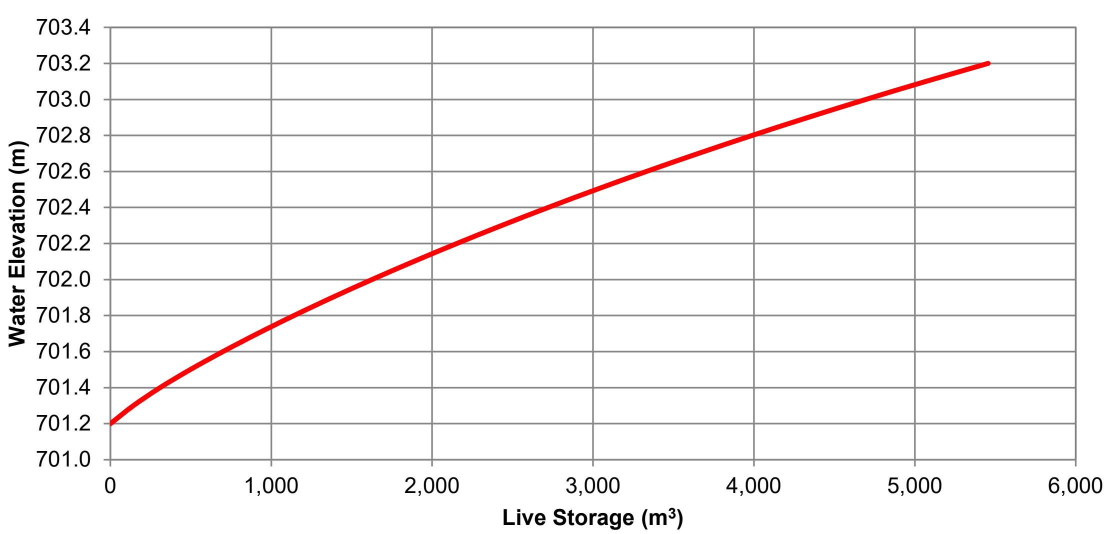


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

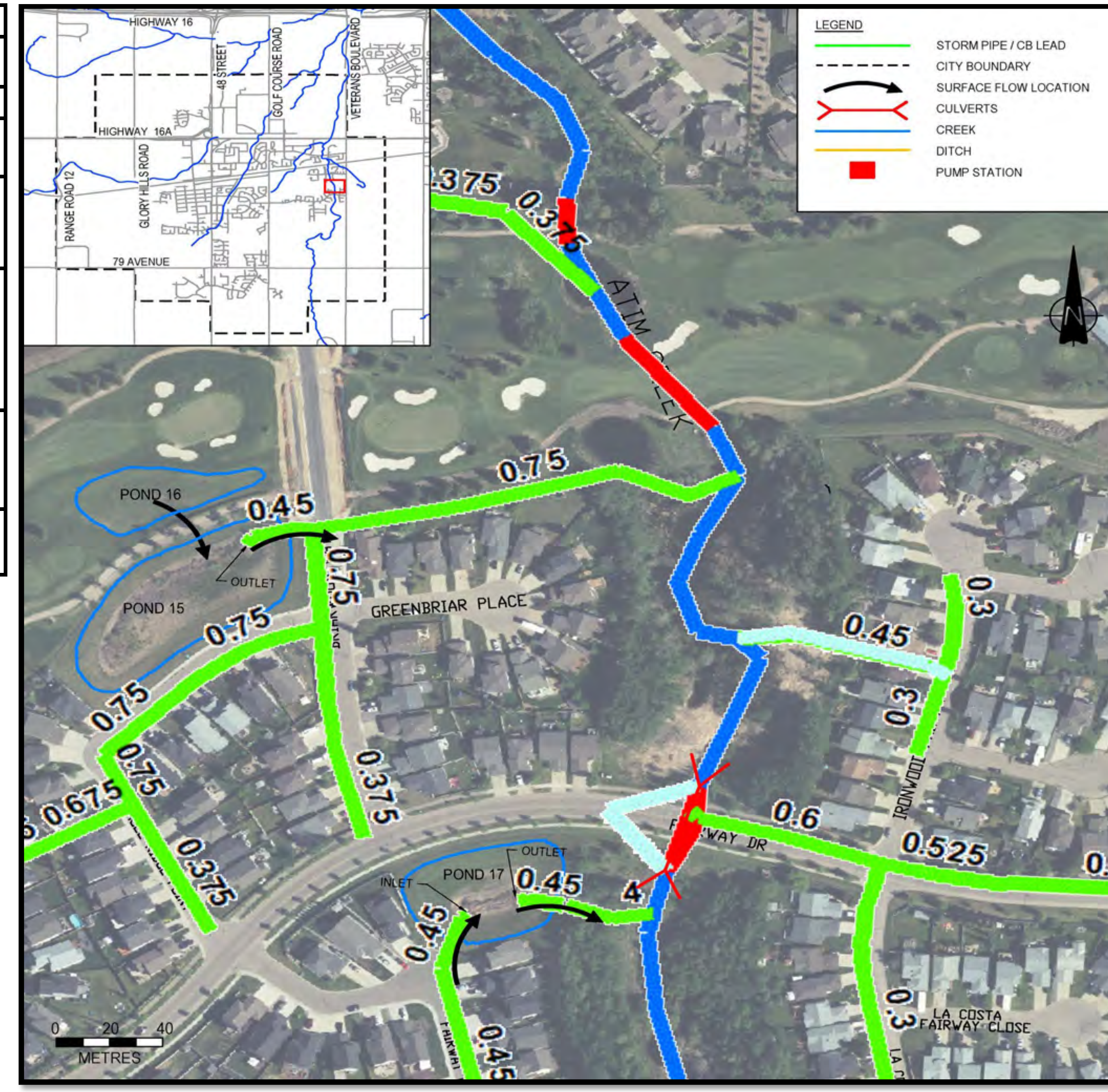


Pond ID	15	Neighbourhood	Fairways
Facility Type	Dry Pond	Location	North of Eagle Ridge Pont, West of Briarwood Ways
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is fully developed.		
Inlet / Outlet	**Inlets:** 300 mm to north (Invert level cannot read) **Outlets:** 450 mm to east (Invert level cannot read)		
Control Structure	**NWL** is controlled by orifice plate of which the diamter and invert cannot read, orifice plate submerged **Flow Rate** **Others:**		
Overflow	**Into Pond:** **Out of Pond:** Northeast of pond.		
Comments	south dry pond of two ponds in this area		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	703.20	2.45
Normal Water Level (NWL)	700.75	0.00
Pond Bottom	698.75	-2.00
Modeled / LiDAR		
100-year 24-hour	701.56	2.81
100-year 4-hour	700.98	2.23
5-year 4-hour	699.70	0.95
Normal Water Level (NWL)	698.75	0.00

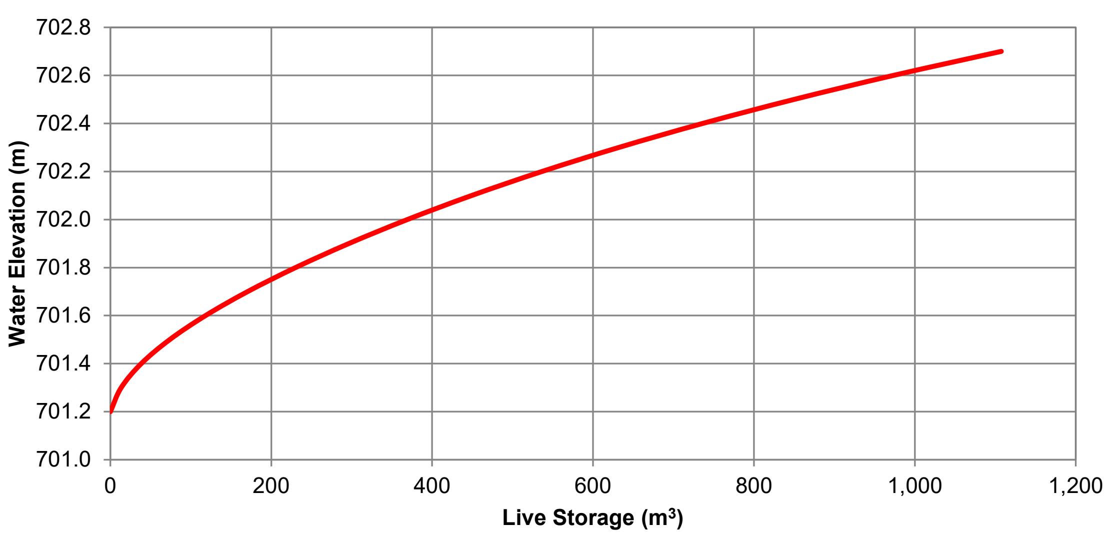


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

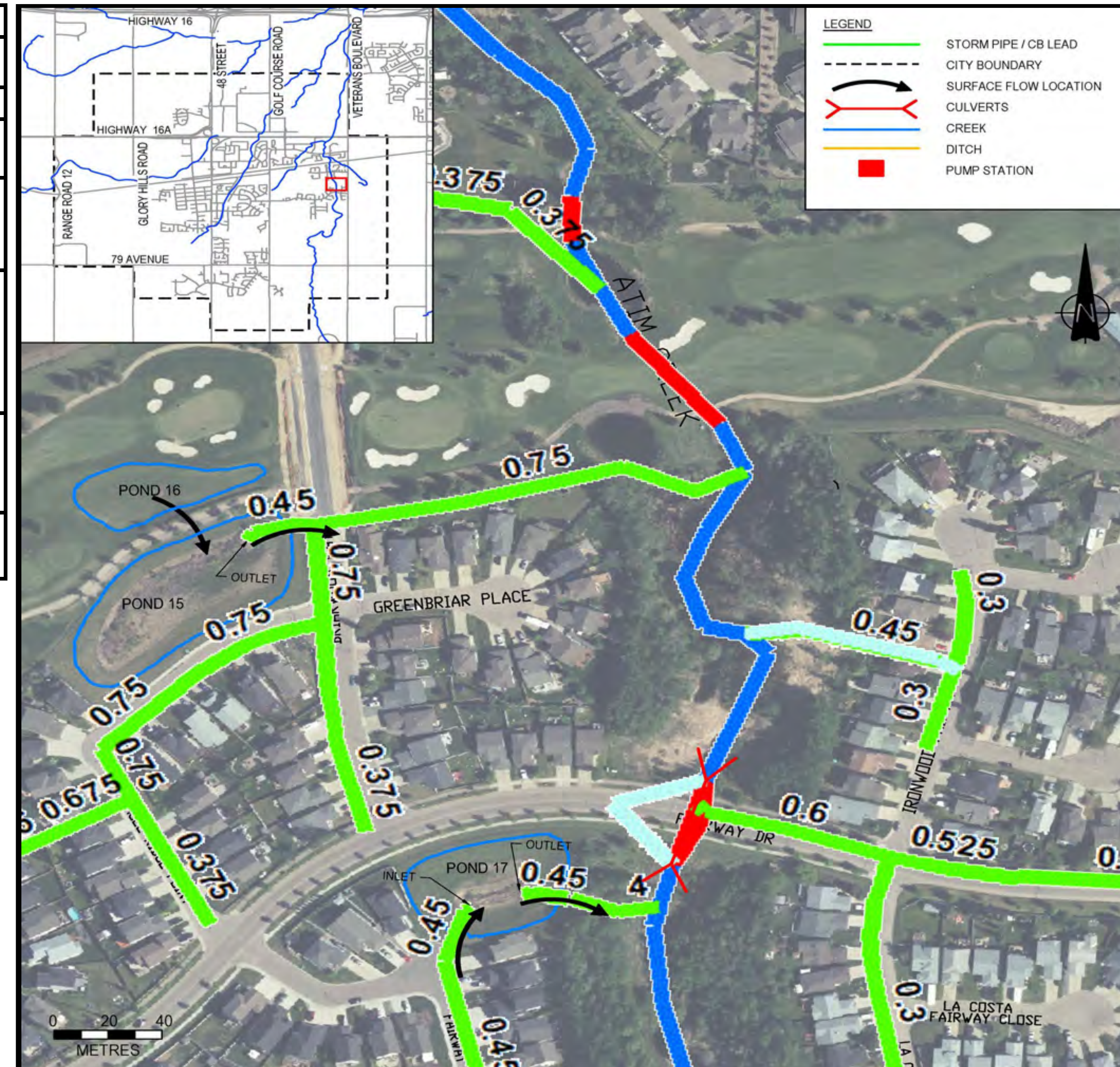


Pond ID	16	Neighbourhood	Fairways
Facility Type	Dry Pond	Location	similar to No. 15, northern one
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is fully developed.		
Inlet / Outlet	**Inlets:** **Outlets:** 300 mm to east (Invert level cannot read)		
Control Structure	**NWL** no information **Flow Rate** no information **Others:**		
Overflow	**Into Pond:** East of pond. **Out of Pond:** North of pond.		
Comments	north dry pond of two ponds in this area		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	703.20	2.36
Normal Water Level (NWL)	700.84	0.00
Pond Bottom	698.84	-2.00
Modeled / LiDAR		
100-year 24-hour	701.56	2.72
100-year 4-hour	700.99	2.15
5-year 4-hour	699.69	0.85
Normal Water Level (NWL)	698.84	0.00

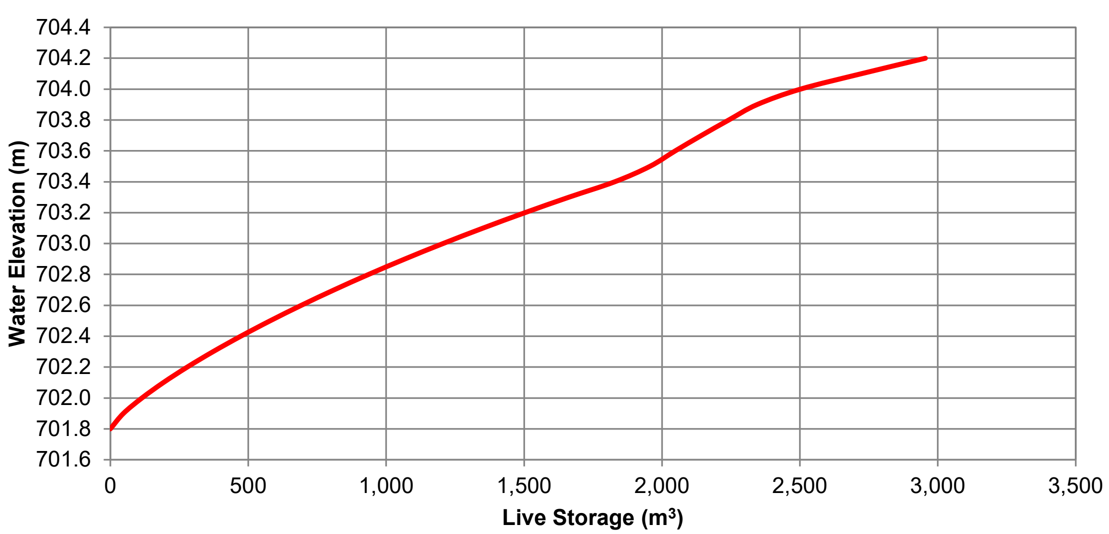


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

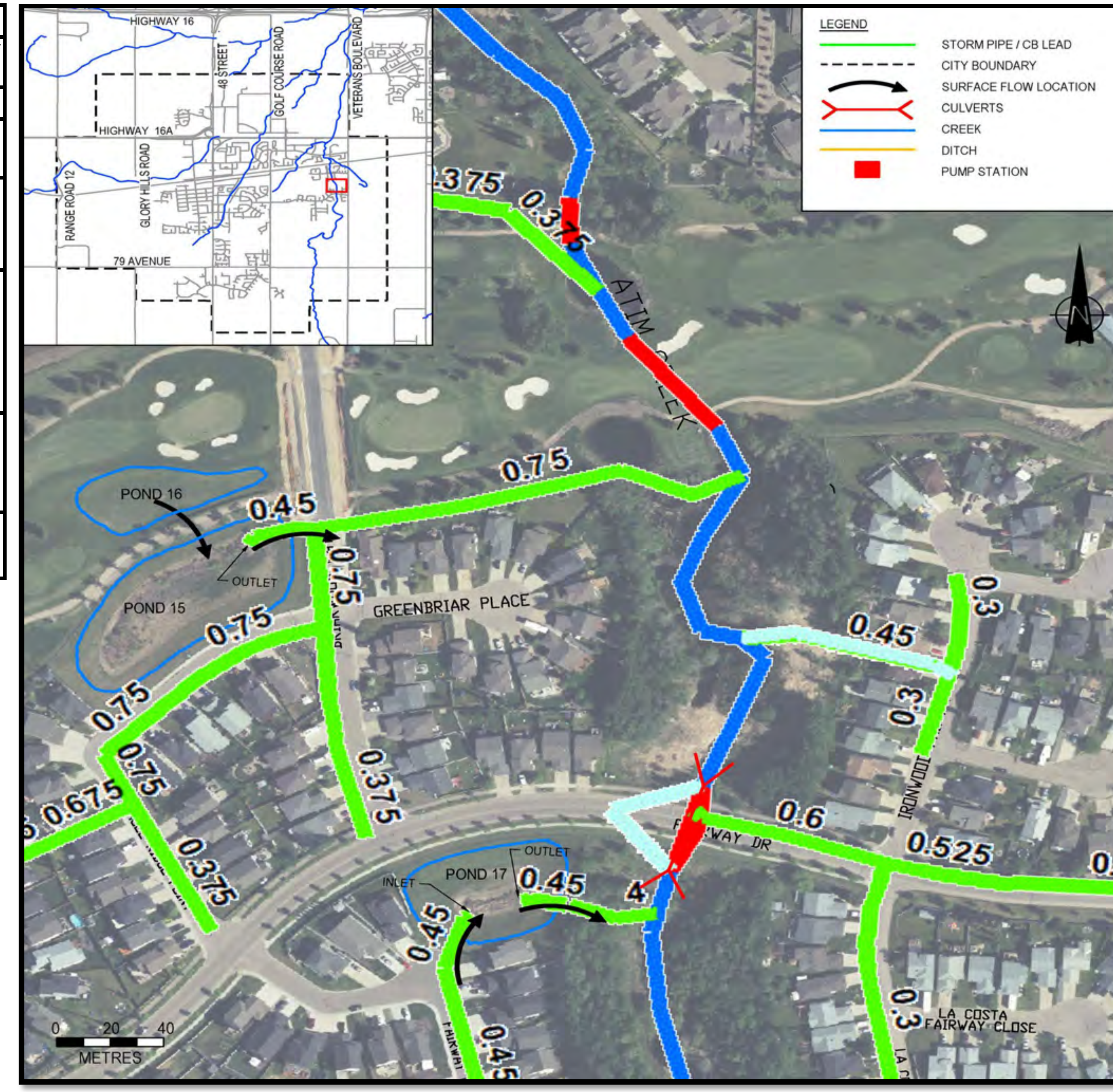


Pond ID	17	Neighbourhood	Fairways
Facility Type	Dry Pond	Location	South of Fairway Dr., north of Fairway Ct.
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is fully developed.		
Inlet / Outlet	**Inlets:** 450 mm to southwest (701.60 m) **Outlets:** 450 mm to east (701.56 m)		
Control Structure	**NWL** is controlled by an orifice plate of 54 mm at 701.638 m, (Orifice_7) **Flow Rate** is controlled by orifice plate **Others:**		
Overflow	**Into Pond:** Southwest of pond, follow the inlet pipe. **Out of Pond:** Northeast of pond.		
Comments			

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	703.70	2.00
Normal Water Level (NWL)	701.70	0.00
Pond Bottom	699.70	-2.00
Modeled / LiDAR		
100-year 24-hour	702.18	0.48
100-year 4-hour	702.10	0.40
5-year 4-hour	701.86	0.16
Normal Water Level (NWL)	701.70	0.00

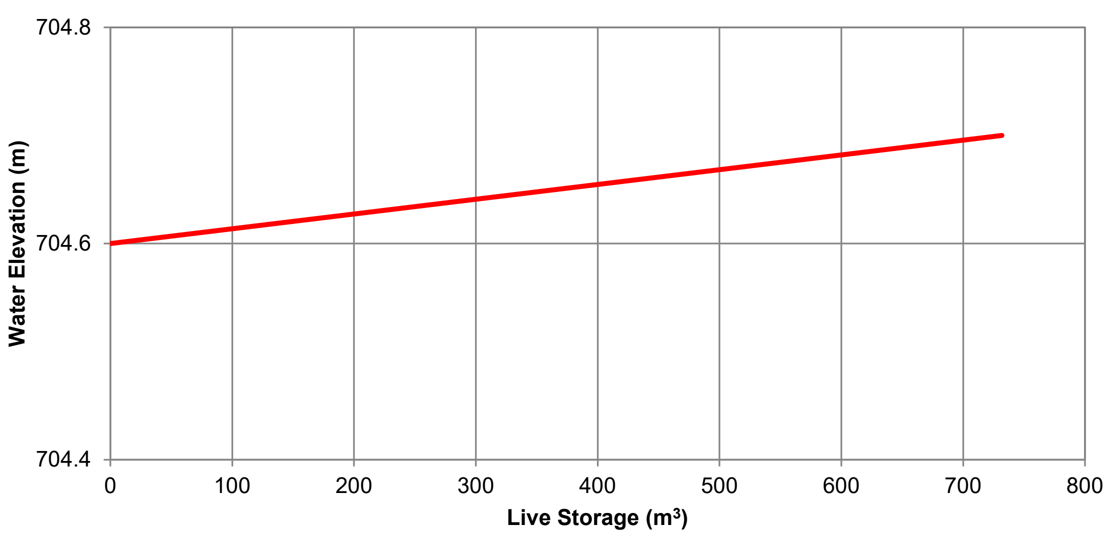


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

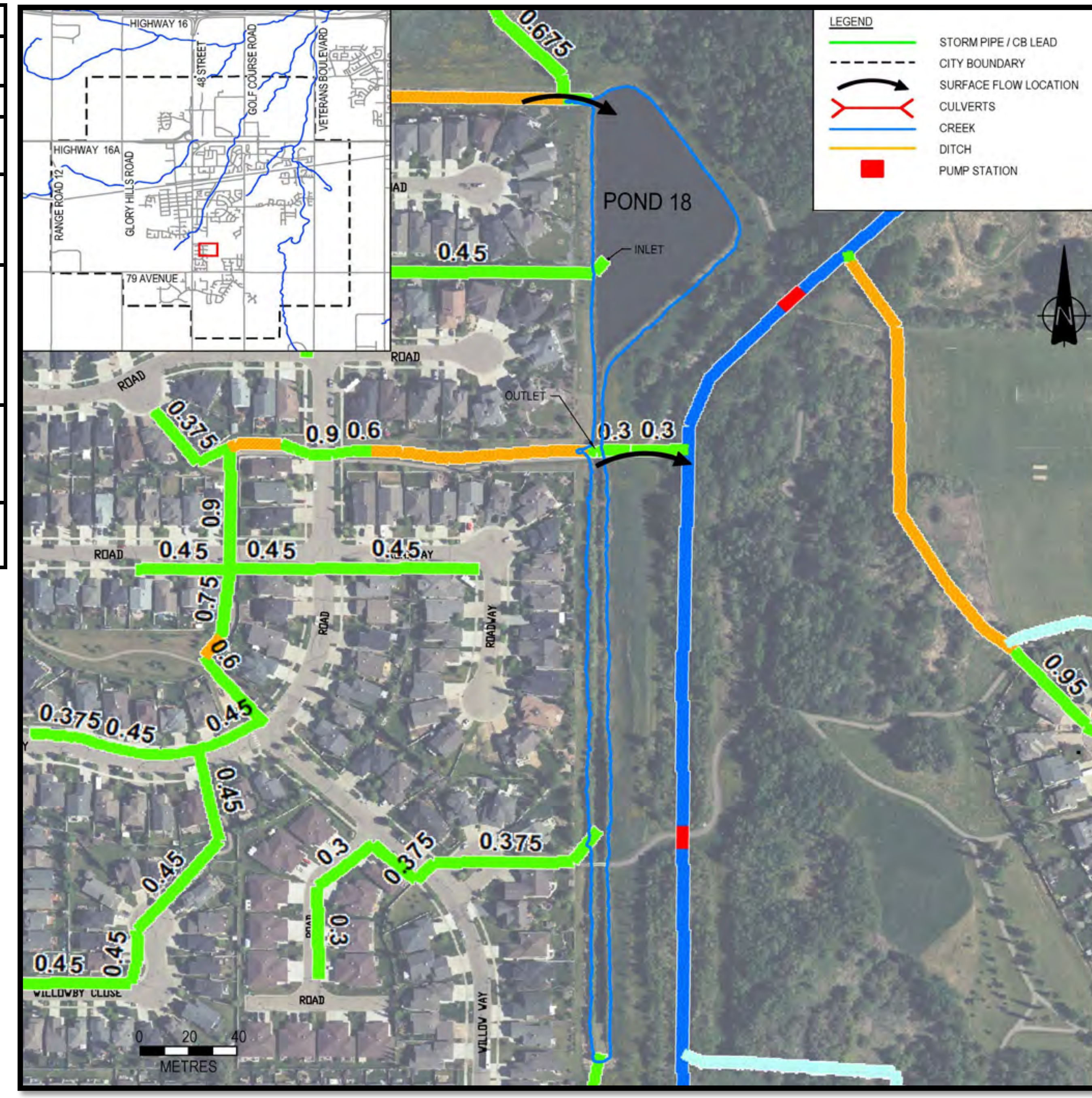


Pond ID	18	Neighbourhood	Willow park
Facility Type	Wet Pond	Location	East of community
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** 450 mm to the west (no more information), 150 mm to the southwest of ditch (704.400), 375 mm to the south end of ditch (704.290) **Outlets:** 300 mm at the ditch south of the pond (704.25 m)		
Control Structure	**NWL** is controled by orifice plate of 50 mm, (Orifice_1) **Flow Rate** is controled by orifice plate **Others:**		
Overflow	**Into Pond:** North of pond via ditch, south of pond via ditch **Out of Pond:** South of pond slightly south of the outlet pipe. Flow into creek		
Comments	No water level information		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	N/A	N/A
Normal Water Level (NWL)	704.60	0.00
Pond Bottom	702.60	-2.00
Modeled / LiDAR		
100-year 24-hour	705.92	1.32
100-year 4-hour	705.52	0.92
5-year 4-hour	705.04	0.44
Normal Water Level (NWL)	704.60	0.00

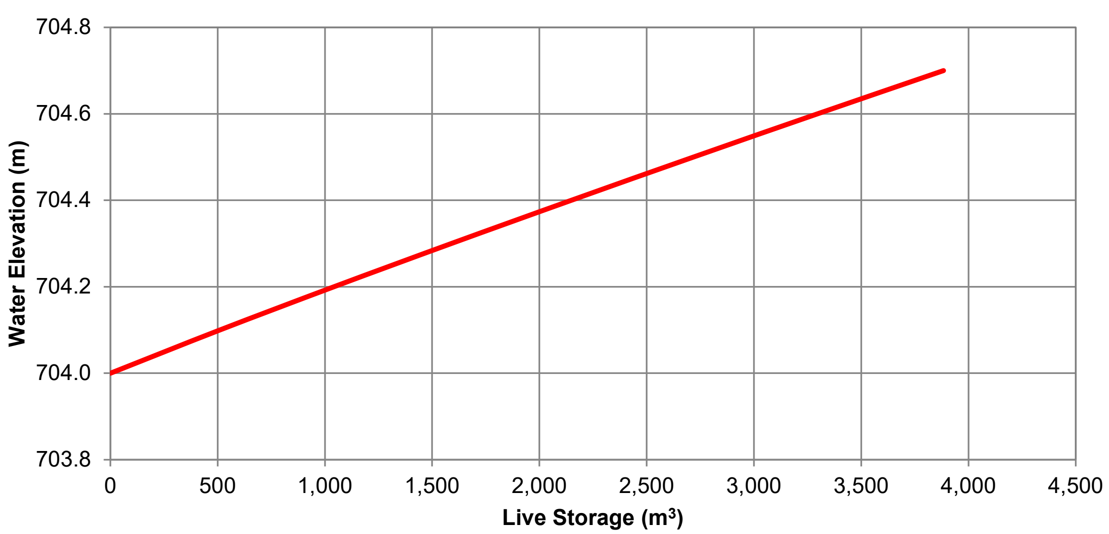


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

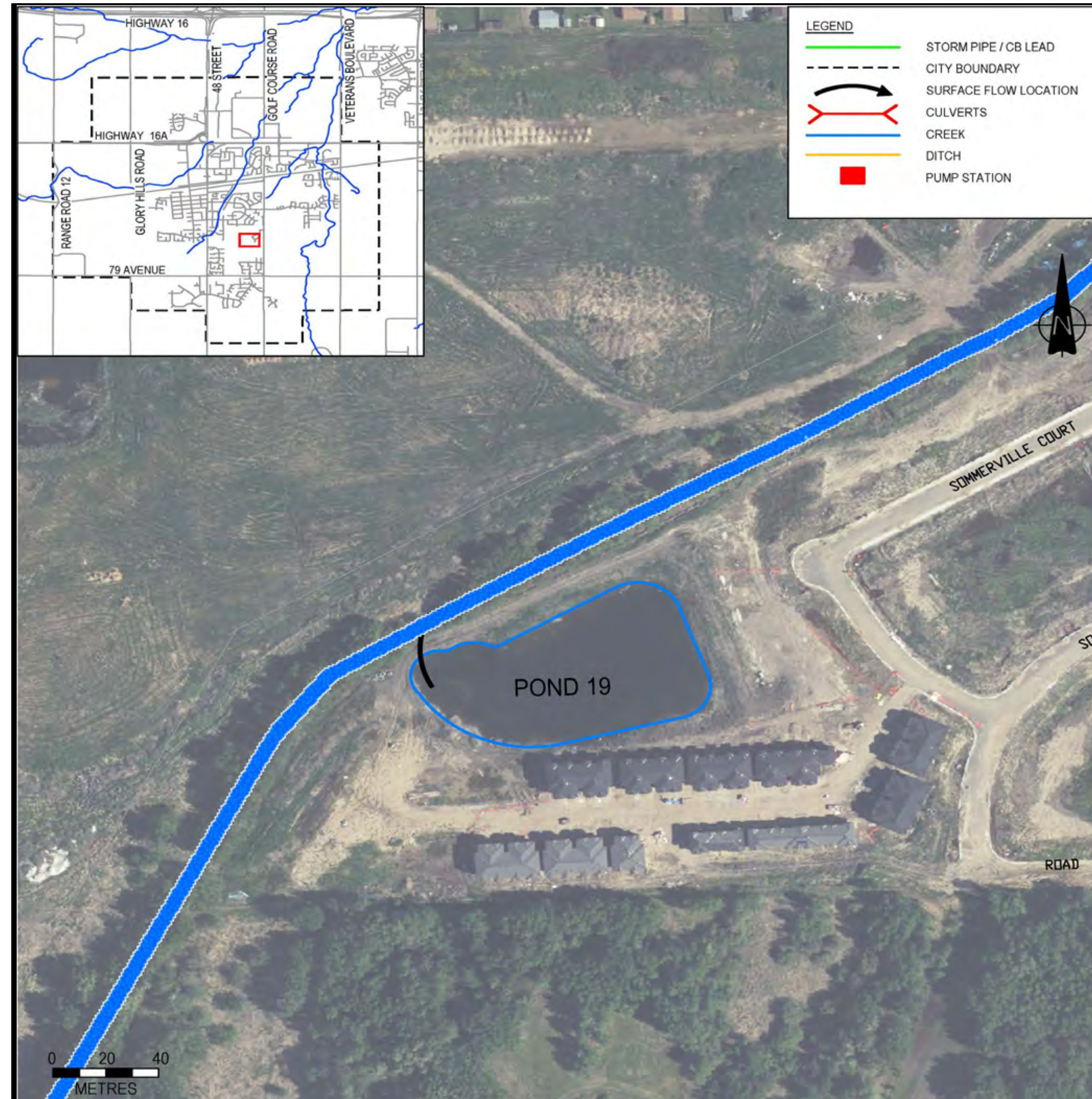


Pond ID	19	Neighbourhood	Sommerville
Facility Type	Wet/dry Pond	Location	West of community
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** 600 mm to the east (702.00) **Outlets:** 200 mm to the west (696.61)		
Control Structure	**NWL** is controled by pump **Flow Rate:** is controled by pump **Others:**		
Overflow	**Into Pond:** **Out of Pond:** elevation controled by spillway at 704.67 m		
Comments	Need information to see if this is a wet or dry pond		

	Water Elevation (m)	Depth to NWL (m)
Design		
Spillway	704.67	1.47
Maximum depth	703.20	0.00
Pond Bottom	701.70	-1.50
Modeled / LiDAR		
100-year 24-hour	N/A	N/A
100-year 4-hour	N/A	N/A
5-year 4-hour	N/A	N/A
Normal Water Level (NWL)	N/A	N/A



Note: Stage-Storage Curve derived from LiDAR (collected in 2014).



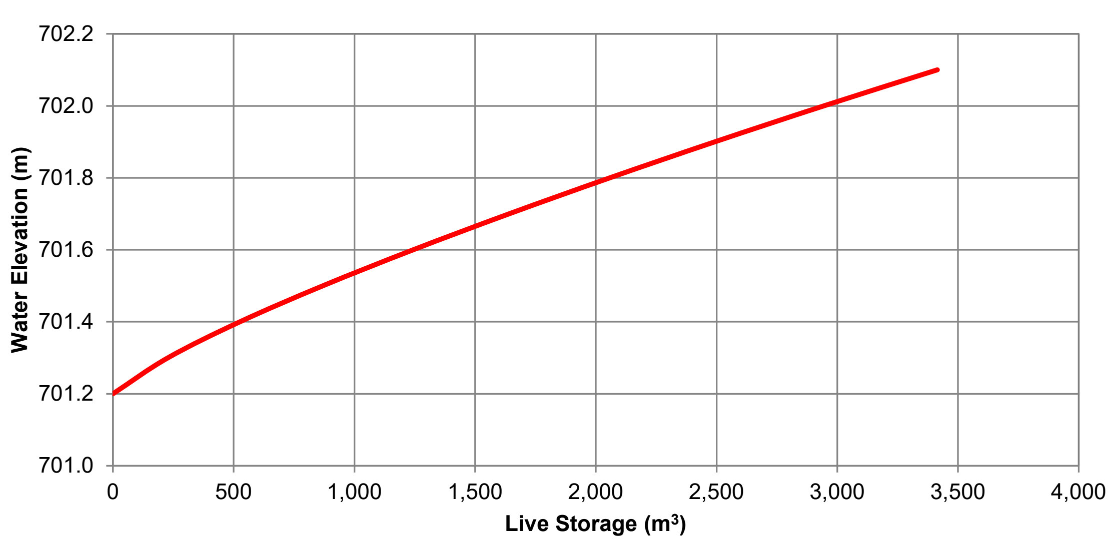
Pond ID	20	Neighbourhood	Fairway
Facility Type	Wet/dry Pond	Location	North of Fairways South of Graybriar
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** 600 mm to the west (700.00) **Outlets:** 675 mm to the east (700.000)		
Control Structure	**NWL** orifice 71 mm at 698.847 m, (Orifice_8) **Flow Rate:** is controled by orifice plate **Others:**		
Overflow	**Into Pond:** **Out of Pond:**		
Comments	Need information to see if this is a wet or dry pond		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	702.00	2.00
Normal Water Level (NWL)	700.00	0.00
Pond Bottom	698.00	-2.00
Modeled / LiDAR		
100-year 24-hour	700.00	0.00
100-year 4-hour	700.00	0.00
5-year 4-hour	700.00	0.00
Normal Water Level (NWL)	700.00	0.00

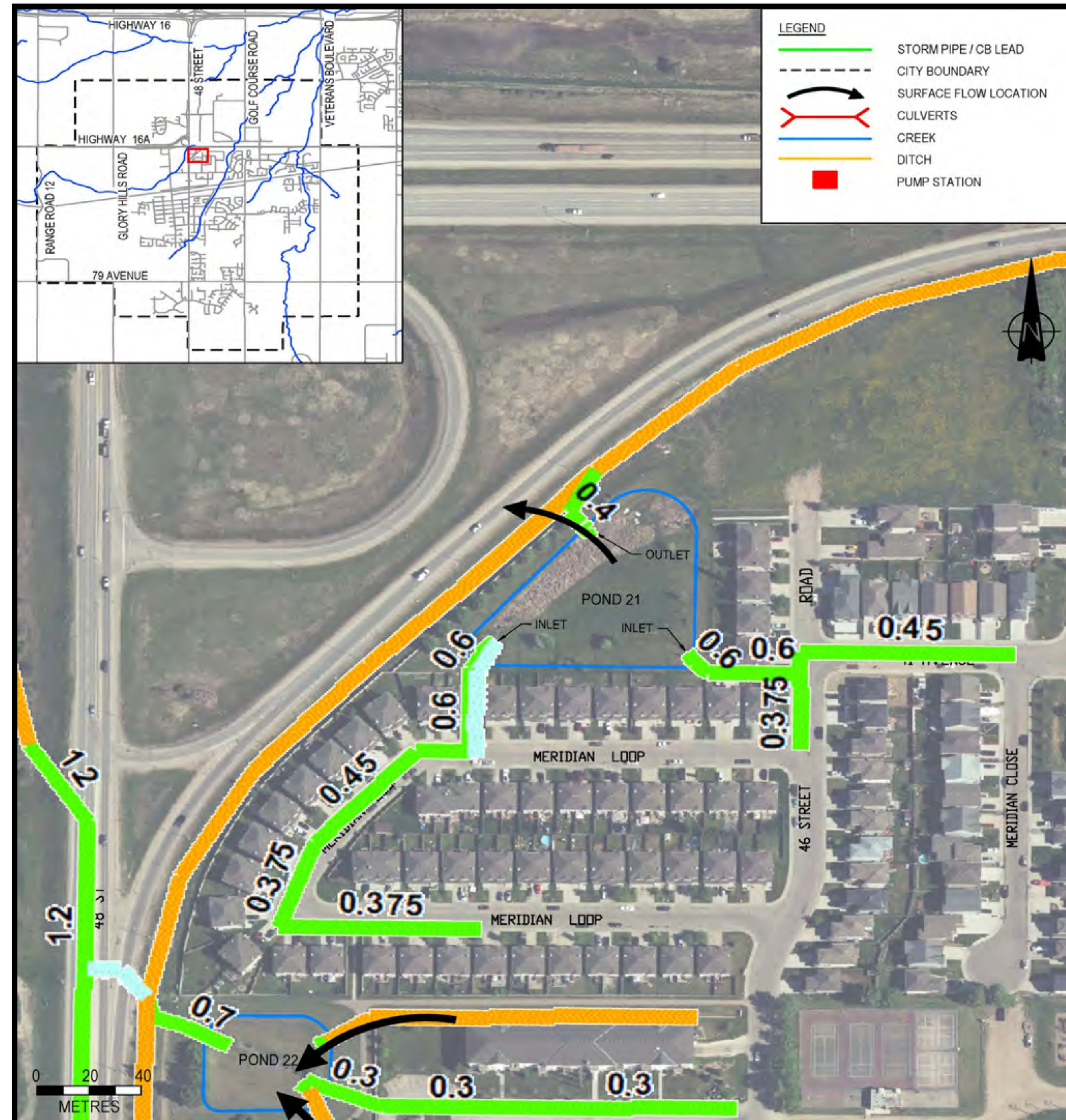
Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

Pond ID	21	Neighbourhood	Merdian height
Facility Type	Dry Pond	Location	Northwest of community
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** 600 mm to the southwest (701.100), 600 mm to the southeast (701.270) **Outlets:** 400 mm to the north (701.100)		
Control Structure	**NWL** orifice 91 mm at 701.100 m **Flow Rate:** is controled by orifice plate **Others:**		
Overflow	**Into Pond:** **Out of Pond:** north of pond at 702.13 via overflow channel		
Comments			

	Water Elevation (m)	Depth to NWL (m)
Design		
Spill channel	702.13	1.03
NWL	701.10	0.00
Pond Bottom	701.10	0.00
Modeled / LiDAR		
100-year 24-hour	703.00	1.90
100-year 4-hour	702.47	1.37
5-year 4-hour	701.82	0.72
Normal Water Level (NWL)	701.10	0.00

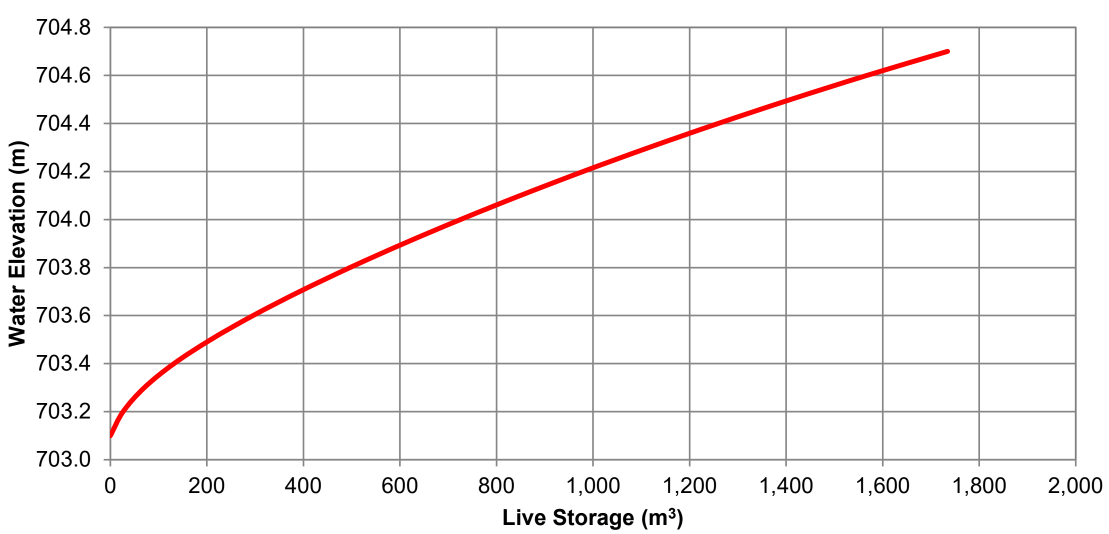


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

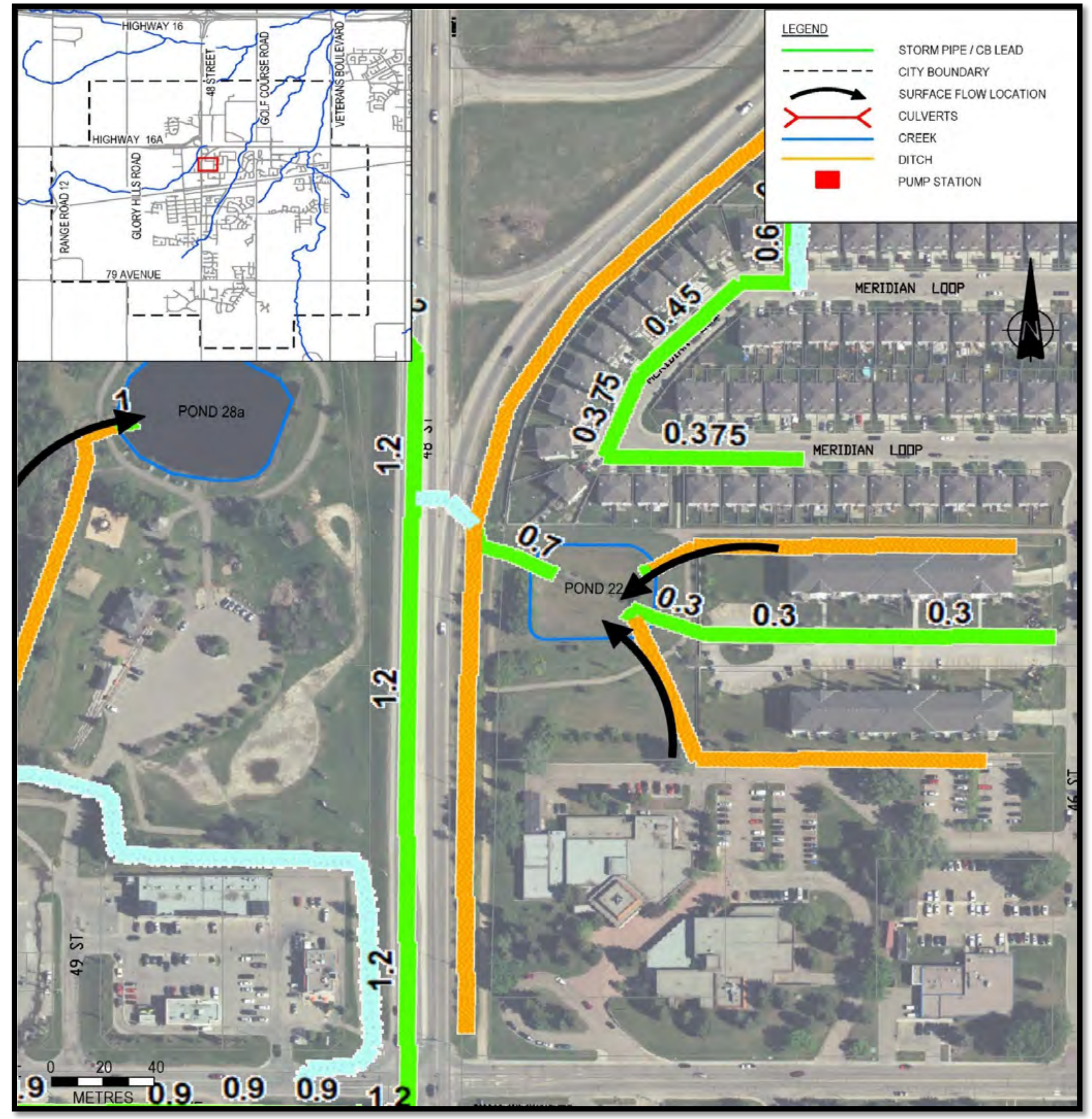


Pond ID	22	Neighbourhood	Merdian height
Facility Type	Dry Pond	Location	West of condo building
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is developed.		
Inlet / Outlet	**Inlets:** **Outlets:**		
Control Structure	**NWL**: **Flow Rate:** **Others:**		
Overflow	**Into Pond:** **Out of Pond:**		
Comments	No more information on this one		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	N/A	N/A
Normal Water Level (NWL)	702.96	0.00
Pond Bottom	702.96	0.00
Modeled / LiDAR		
100-year 24-hour	703.32	0.36
100-year 4-hour	703.28	0.32
5-year 4-hour	703.26	0.30
Normal Water Level (NWL)	702.96	0.00

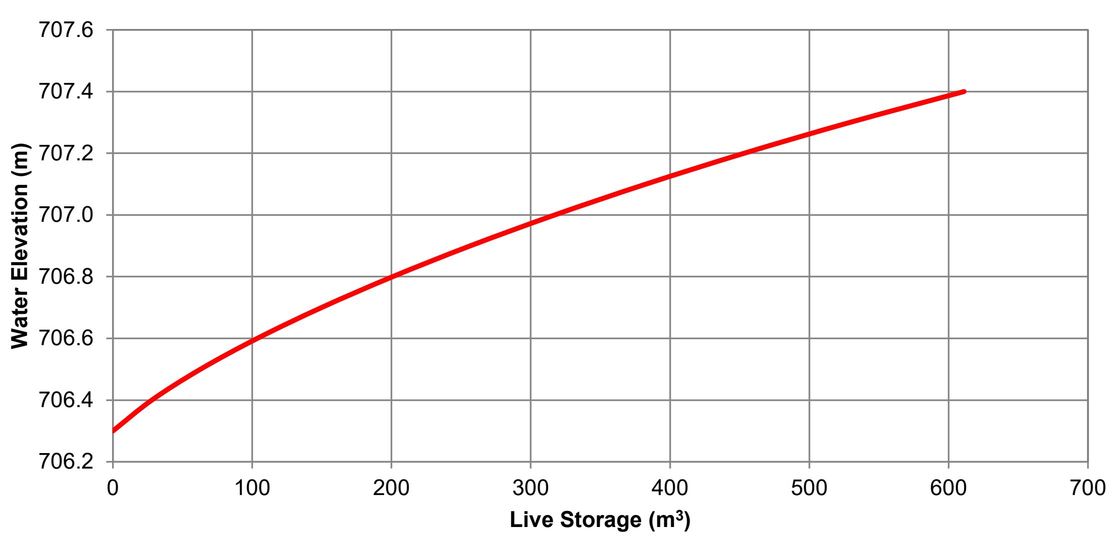


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

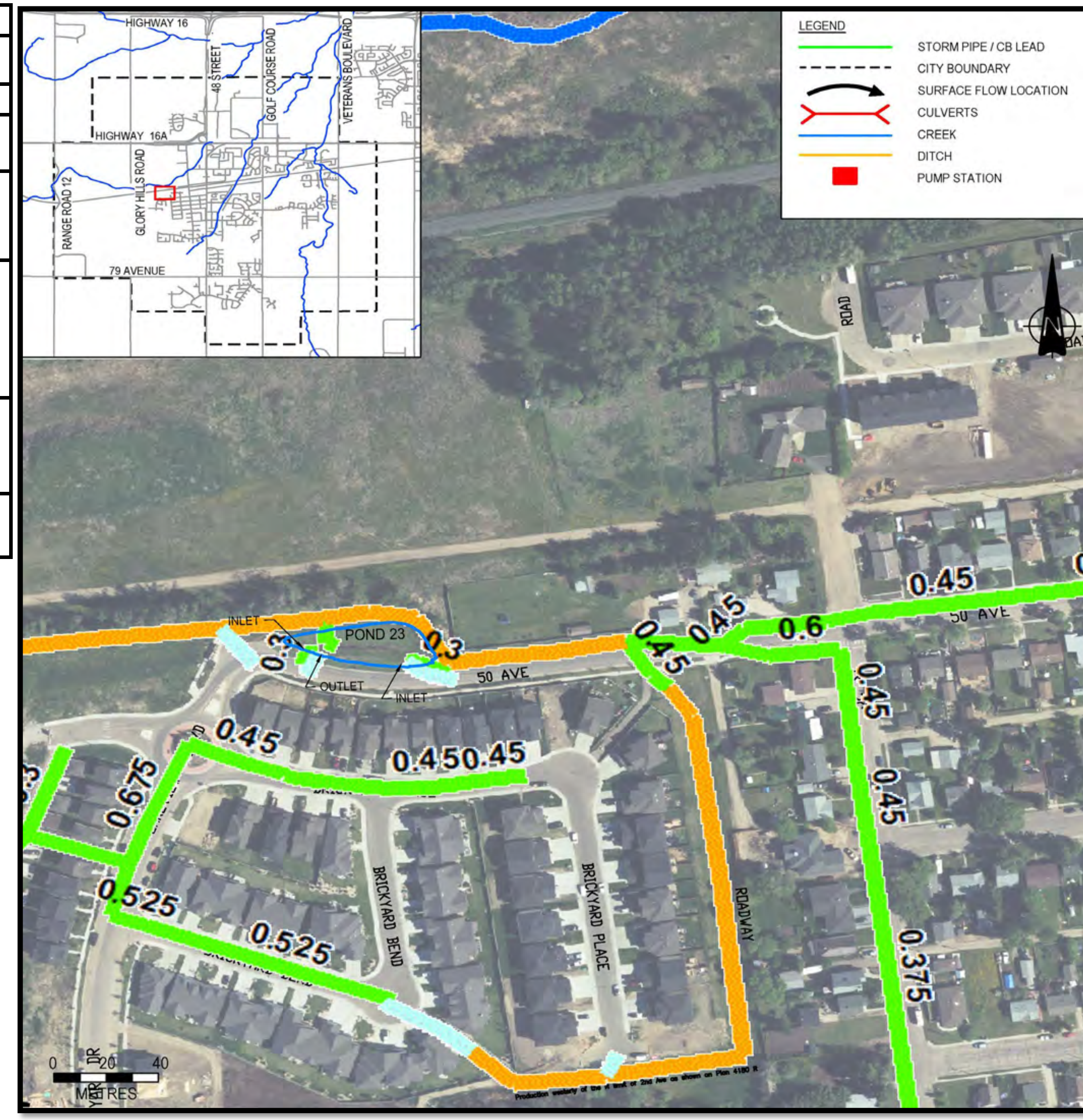


Pond ID	23	**Neighbourhood**	Brickyard
Facility Type	Dry Pond	**Location**	North of community
Catchment Area		**Year of Construction**	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** 300 mm southwest of pond (706.20), 300 mm southeast of pond (706.25) **Outlets:** 300 mm north of pond (706.200)		
Control Structure	**NWL**: orifice plate 34 mm at 706.200 m, (Orifice_10) **Flow Rate:** orifice plate **Others:**		
Overflow	**Into Pond:** **Out of Pond:**		
Comments	Need NWL, HWL etc.		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	N/A	N/A
Normal Water Level (NWL)	N/A	N/A
Pond Bottom	706.17	N/A
Modeled / LiDAR		
100-year 24-hour	707.09	0.92
100-year 4-hour	706.66	0.49
5-year 4-hour	706.44	0.27
Normal Water Level (NWL)	706.17	0.00

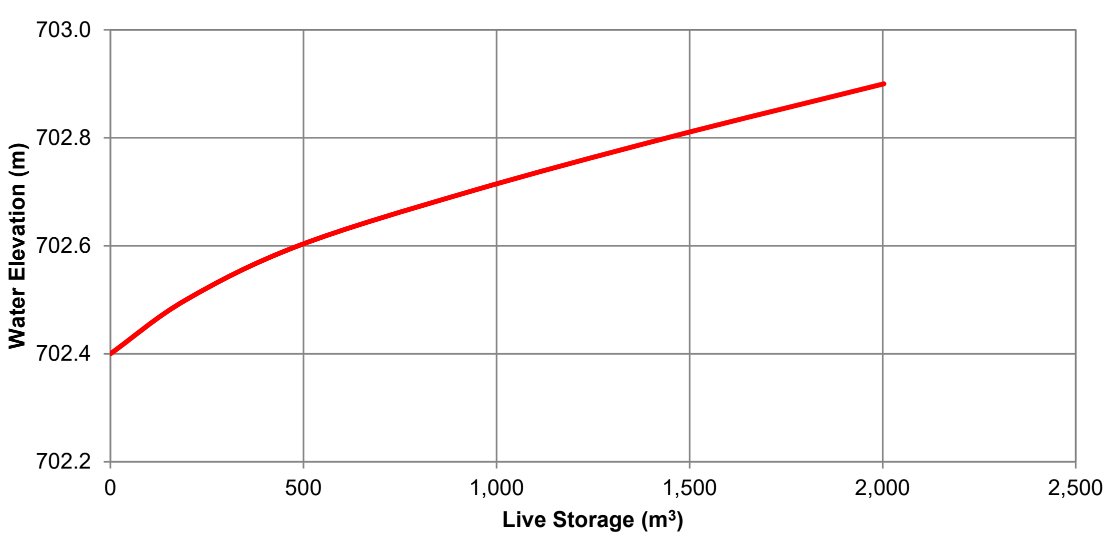


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

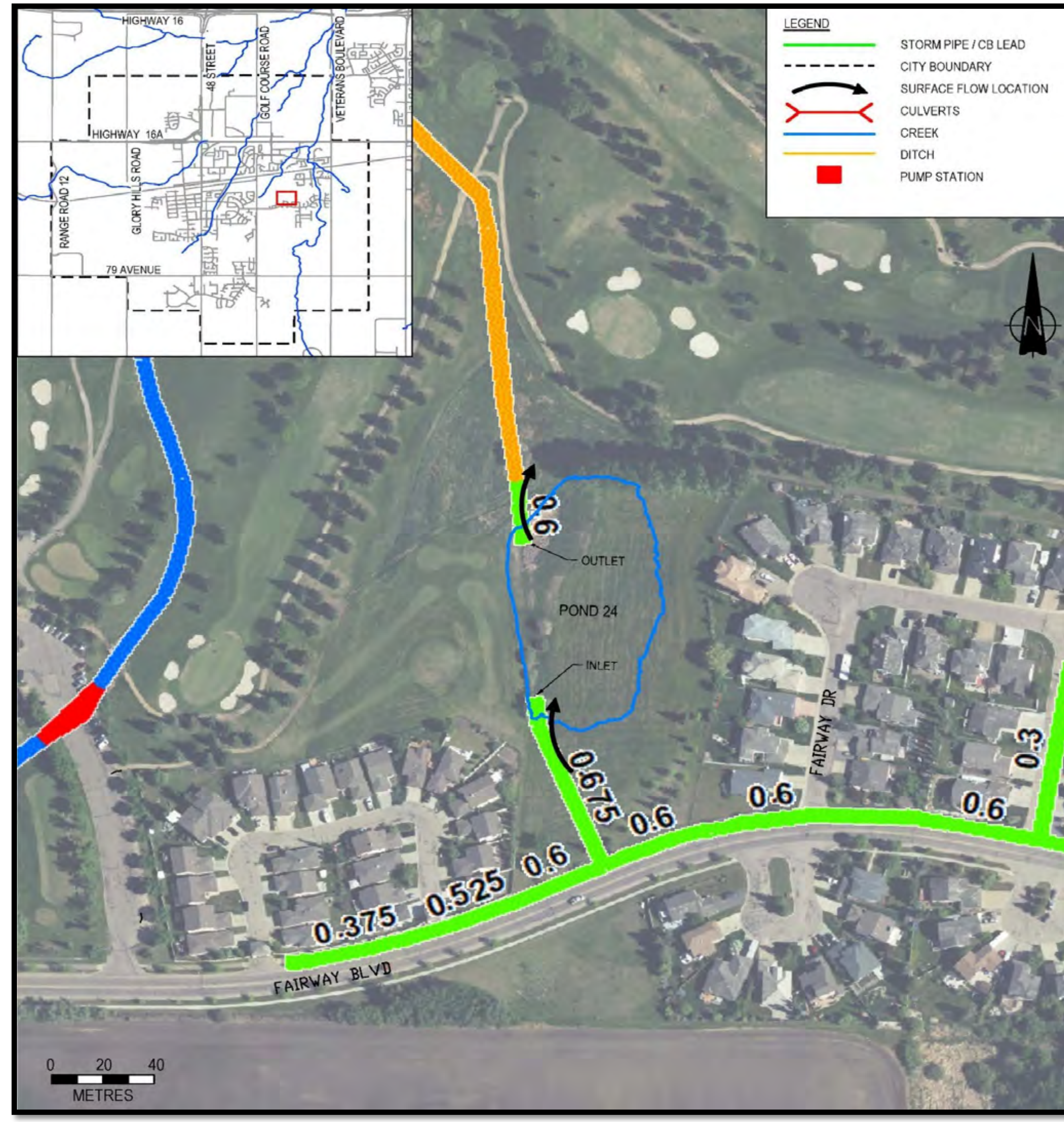


Pond ID	24	**Neighbourhood**	Fairways
Facility Type	Dry Pond	**Location**	North of Fariways Dr.. East of Fairway Green
Catchment Area		**Year of Construction**	
Neighbourhood Development Stage	All areas draining to this pond is developed.		
Inlet / Outlet	**Inlets:** 675 mm south of pond (702.500) **Outlets:** 600 mm north of pond (702.000)		
Control Structure	**NWL**: Orifice plate 150 mm at 701.912 m, (Orifice_11) **Flow Rate:** Orifice plate **Others:**		
Overflow	**Into Pond:** **Out of Pond:** north of pond at 704.500 m		
Comments			

	Water Elevation (m)	Depth to NWL (m)
Design		
Spillway	704.50	2.00
HWL	702.50	0.00
Pond Bottom	702.50	0.00
Modeled / LiDAR		
100-year 24-hour	703.73	1.23
100-year 4-hour	703.59	1.09
5-year 4-hour	702.92	0.42
Normal Water Level (NWL)	702.50	0.00

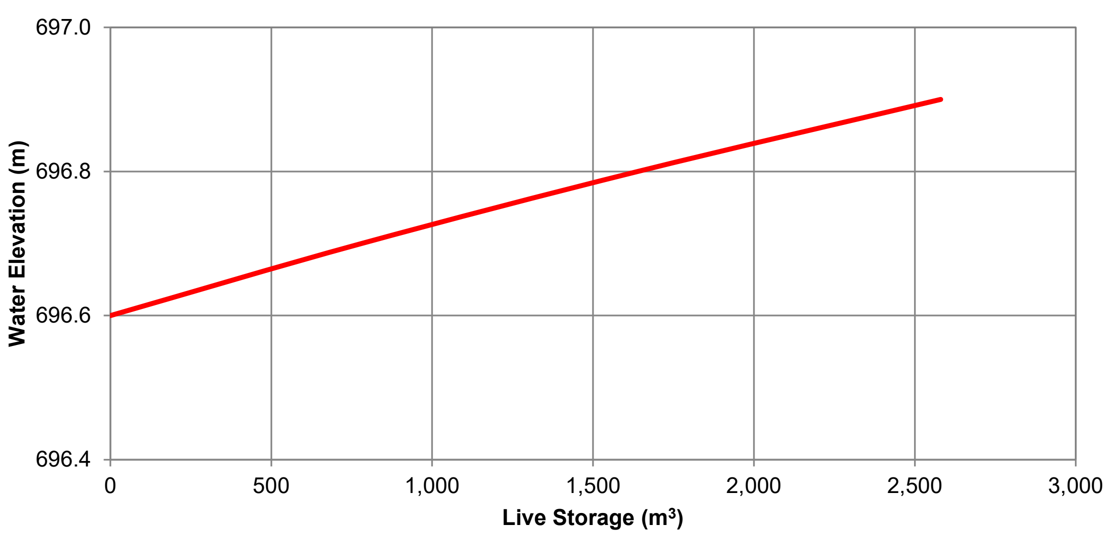


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

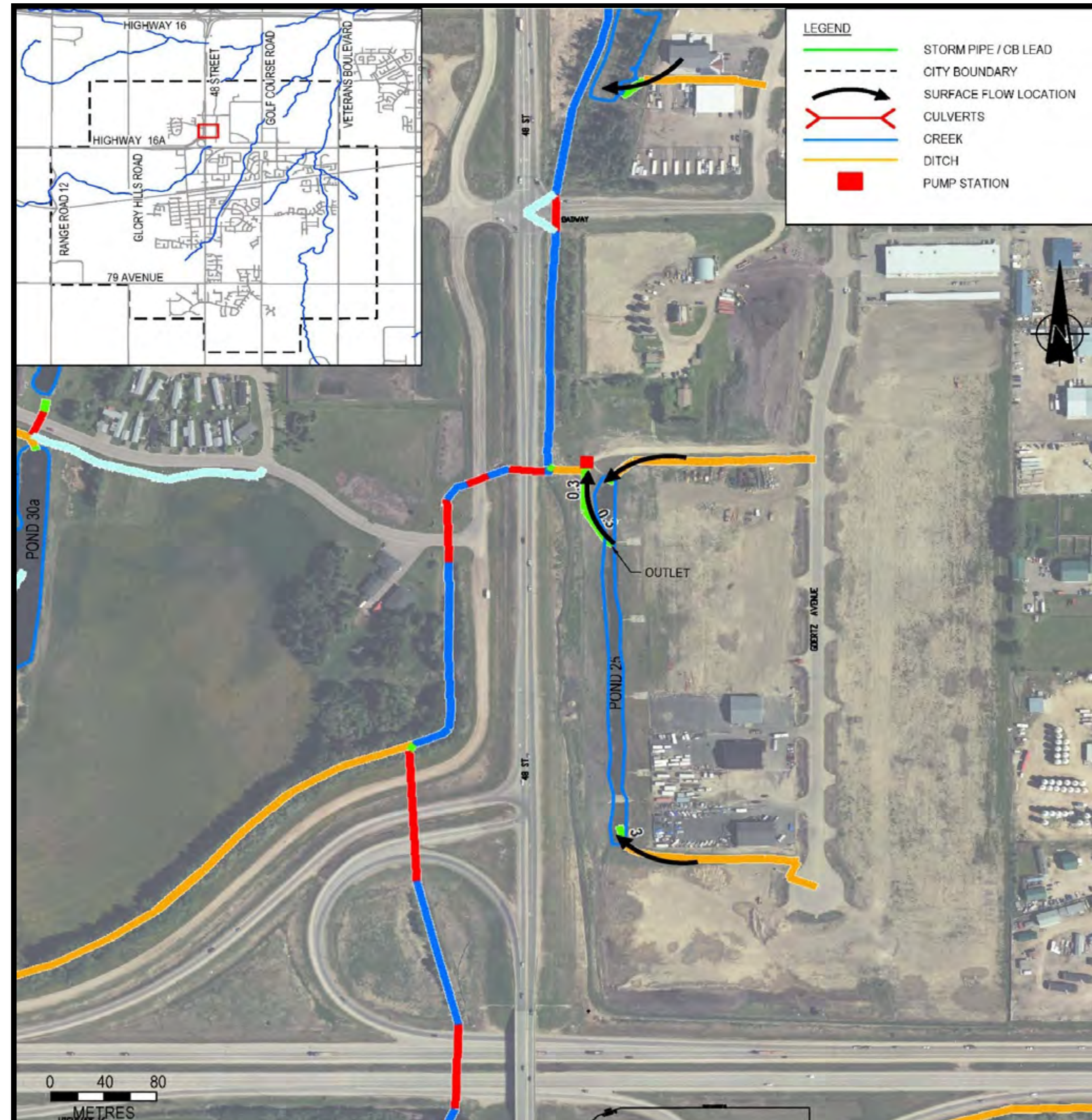


Pond ID	25	Neighbourhood	RJ Industrial Park
Facility Type	Wetland	Location	West of Industrial Park
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** Surface drain to pond **Outlets:** 300 mm northwest of pond (695.550 m)		
Control Structure	**NWL**: Pump station (Pump_2) **Flow Rate:** Pump station **Others:** Pump start: 694.700 m, Pump stop: 693.700 m, Pump high level start: 696.850, High level alarm: 697.350		
Overflow	**Into Pond:** East of pond via ripraps **Out of Pond:** Northwest of pond at 698.00 m		
Comments			

	Water Elevation (m)	Depth to NWL (m)
Design		
1:100 year water level	697.40	1.85
Normal Water Level (NWL)	695.55	0.00
Pond Bottom	693.55	-2.00
Modeled / LiDAR		
100-year 24-hour	696.28	0.73
100-year 4-hour	696.25	0.70
5-year 4-hour	695.75	0.20
Normal Water Level (NWL)	695.55	0.00

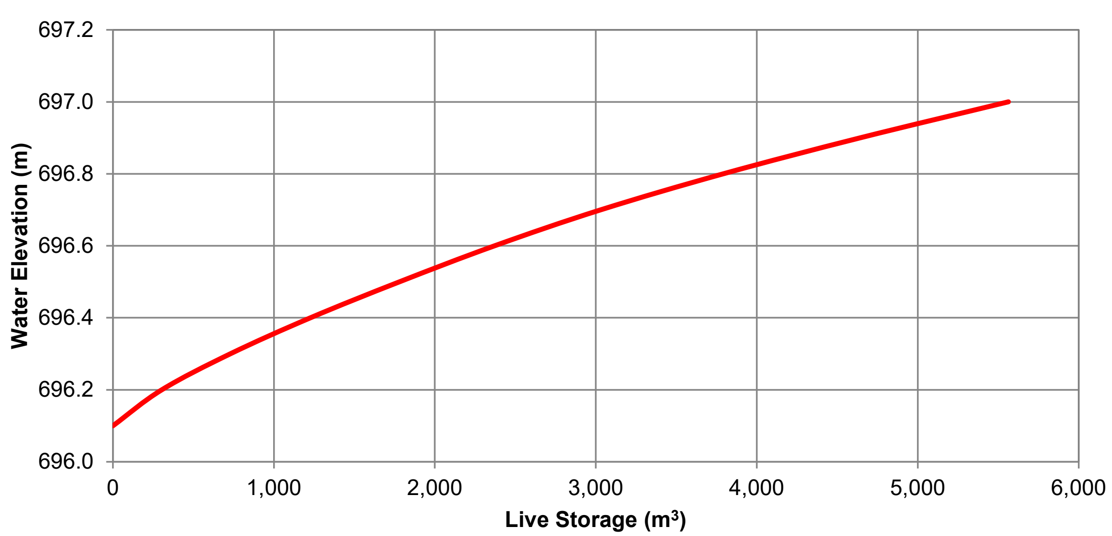


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

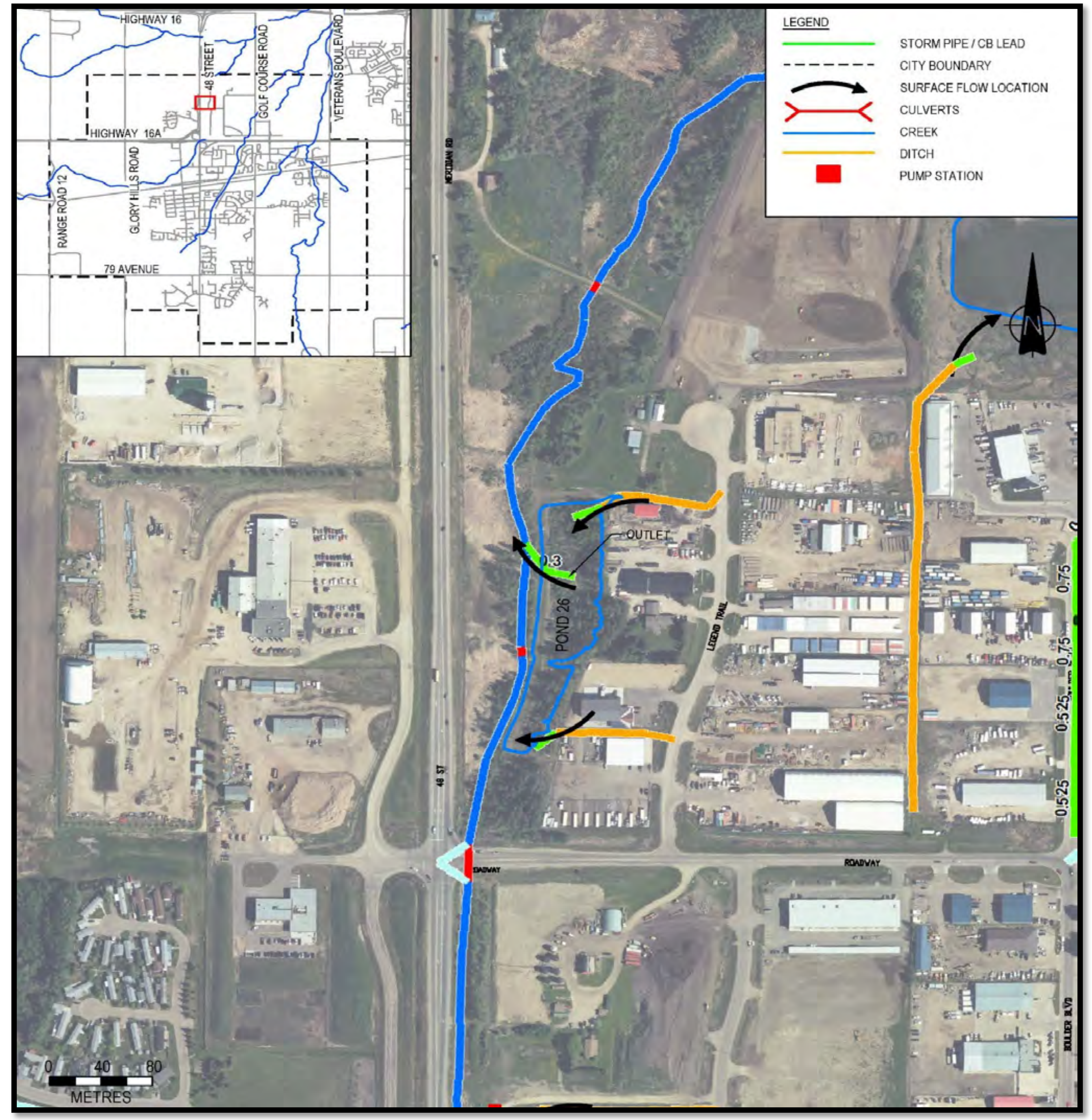


Pond ID	26	Neighbourhood	Legend trail industrial park
Facility Type	Dry Pond	Location	West of Legend Trail
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** Surface drain to pond **Outlets:** 300 mm west of pond (695.72 m)		
Control Structure	**NWL**: Orifice plate 77.5 mm at 695.80 m, (Orifice_13) **Flow Rate:** Orifice plate **Others:**		
Overflow	**Into Pond:** NE, SE of pond via ditches **Out of Pond:** Northwest of pond at 697.10 m		
Comments			

	Water Elevation (m)	Depth to NWL (m)
Design		
Spillway	697.10	0.30
HWL	696.80	0.00
Pond Bottom	695.75	-1.05
Modeled / LiDAR		
100-year 24-hour	697.60	0.80
100-year 4-hour	697.34	0.54
5-year 4-hour	697.05	0.25
Normal Water Level (NWL)	696.80	0.00

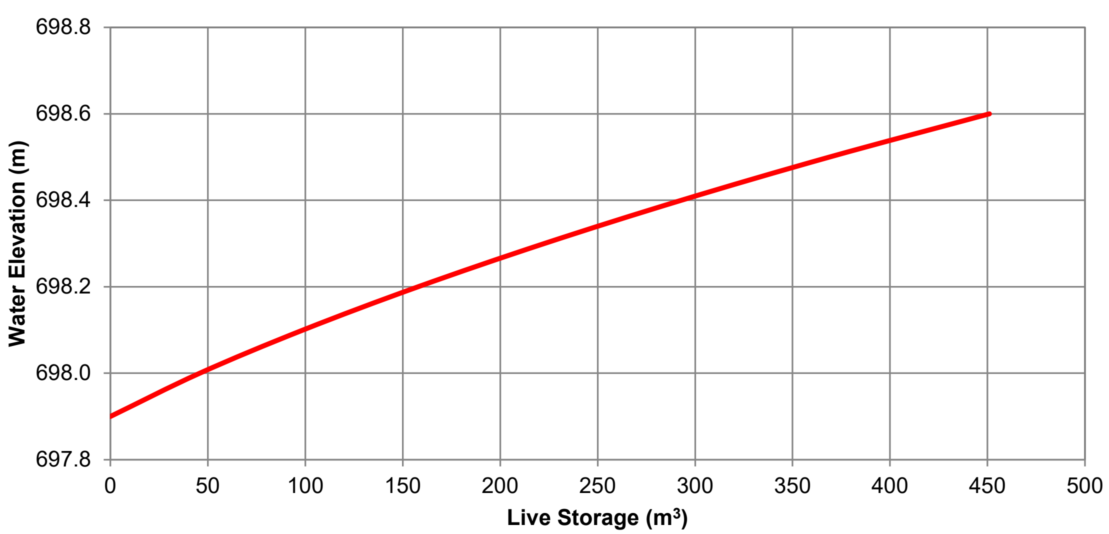


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).



Pond ID	27	Neighbourhood	Graybriar
Facility Type	Dry Pond	Location	South of Graybriar Dr., West of Briarwood Village
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is developed.		
Inlet / Outlet	**Inlets:** 750 mm south of pond (697.00 m) **Outlets:** 300 mm north of pond (696.85 m)		
Control Structure	**NWL**: N/A **Flow Rate:** N/A **Others:**		
Overflow	**Into Pond:** **Out of Pond:** West of pond at 697.80 m via over flow channel		
Comments			

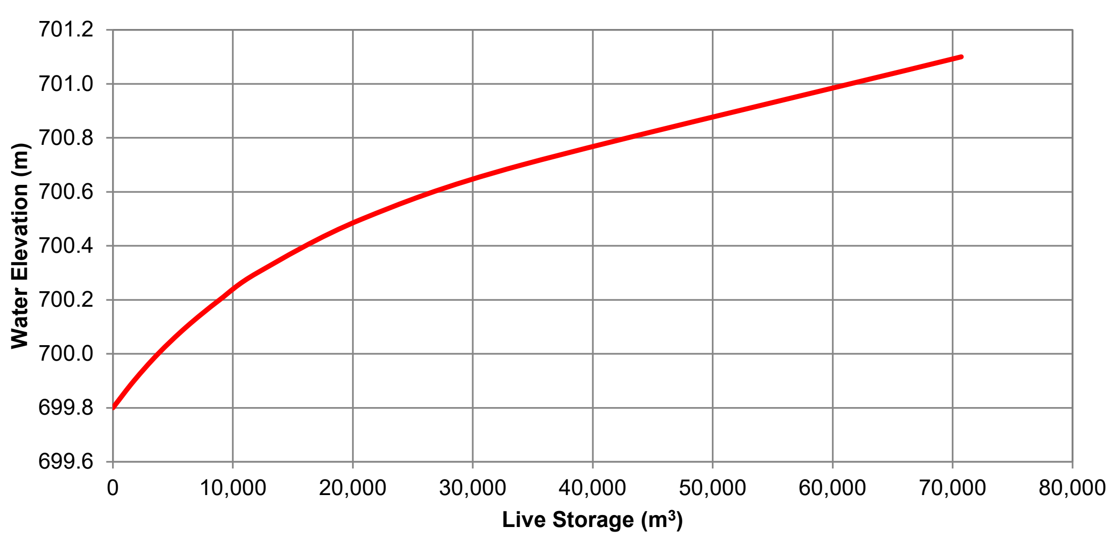
	Water Elevation (m)	Depth to NWL (m)
Design		
Spillway	697.80	0.80
HWL	697.00	0.00
Pond Bottom	697.00	0.00
Modeled / LiDAR		
100-year 24-hour	699.82	2.82
100-year 4-hour	698.96	1.96
5-year 4-hour	698.23	1.23
Normal Water Level (NWL)	697.00	0.00



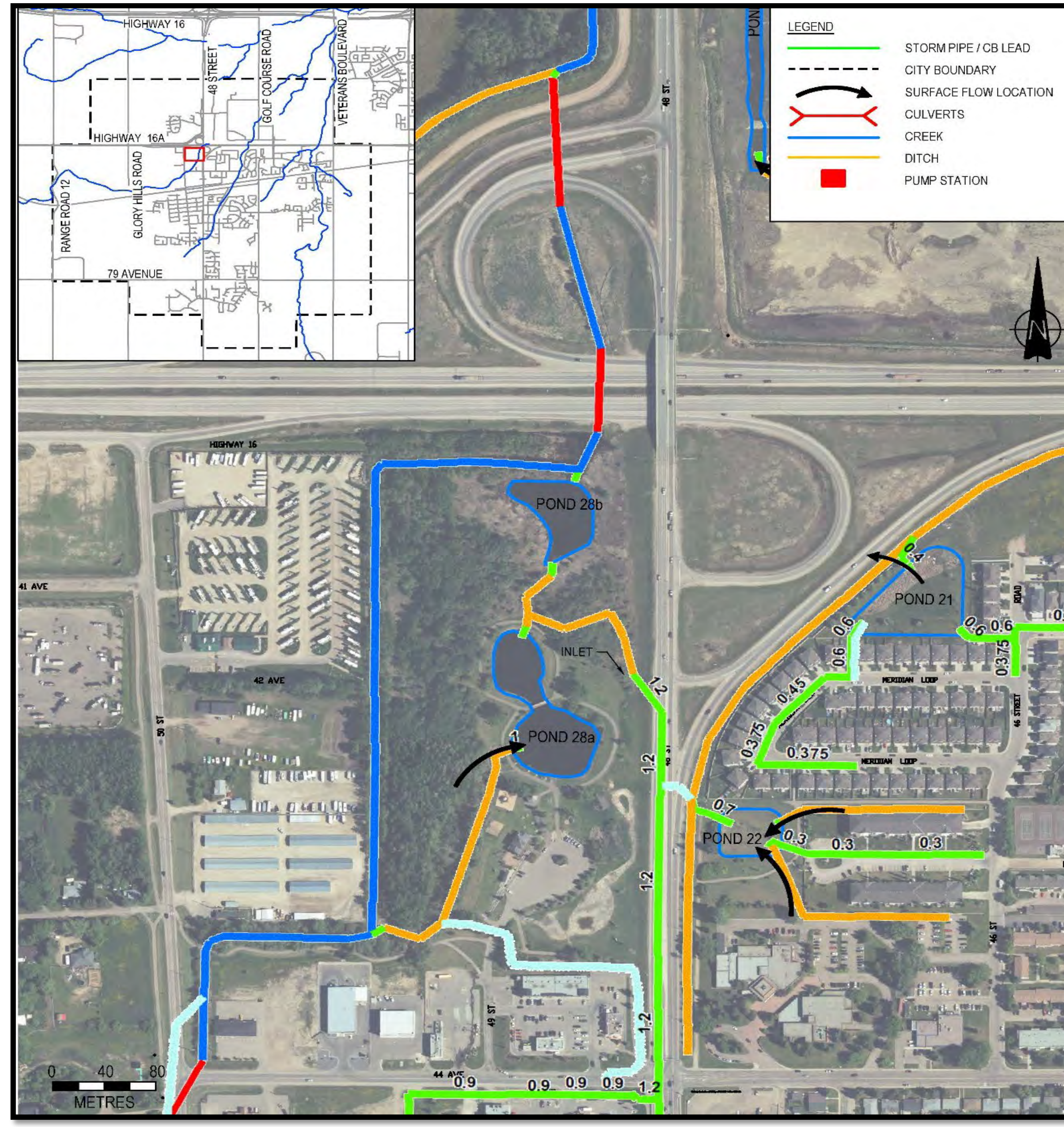
Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

Pond ID	28a	Neighbourhood	Rotary Park
Facility Type	Pond in park	Location	North in the park(South)
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is developed.		
Inlet / Outlet	**Inlets:** 1200 mm east of pond (697.00 m) **Outlets:** Pond drains to creek via ditches		
Control Structure	**NWL**: N/A **Flow Rate:** N/A **Others:**		
Overflow	**Into Pond:** **Out of Pond:** North of pond		
Comments	No other information		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	N/A	N/A
Normal Water Level (NWL)	699.62	0.00
Pond Bottom	697.62	-2.00
Modeled / LiDAR		
100-year 24-hour	701.00	1.38
100-year 4-hour	701.99	2.37
5-year 4-hour	699.96	0.34
Normal Water Level (NWL)	699.62	0.00

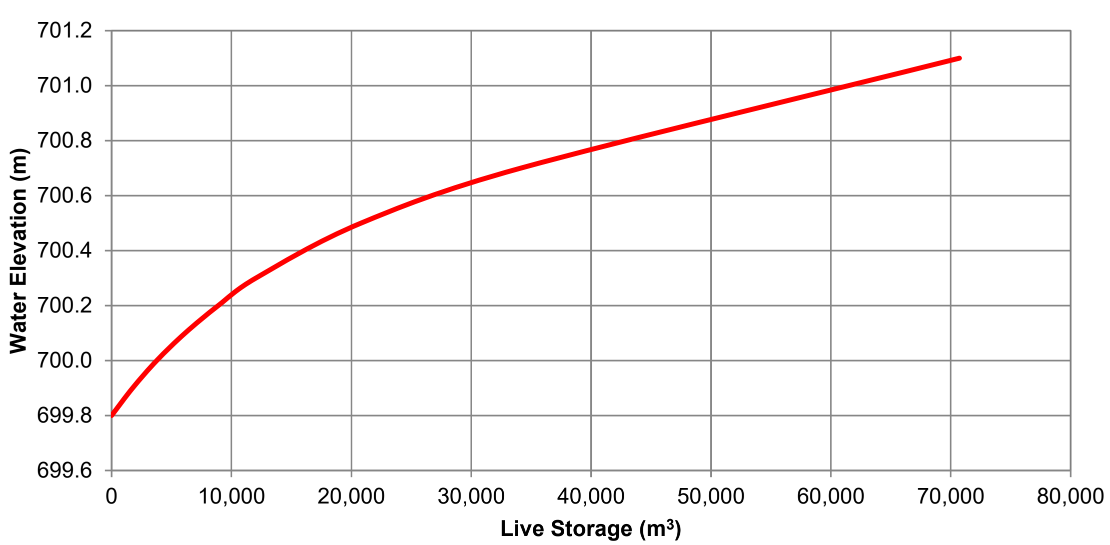


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

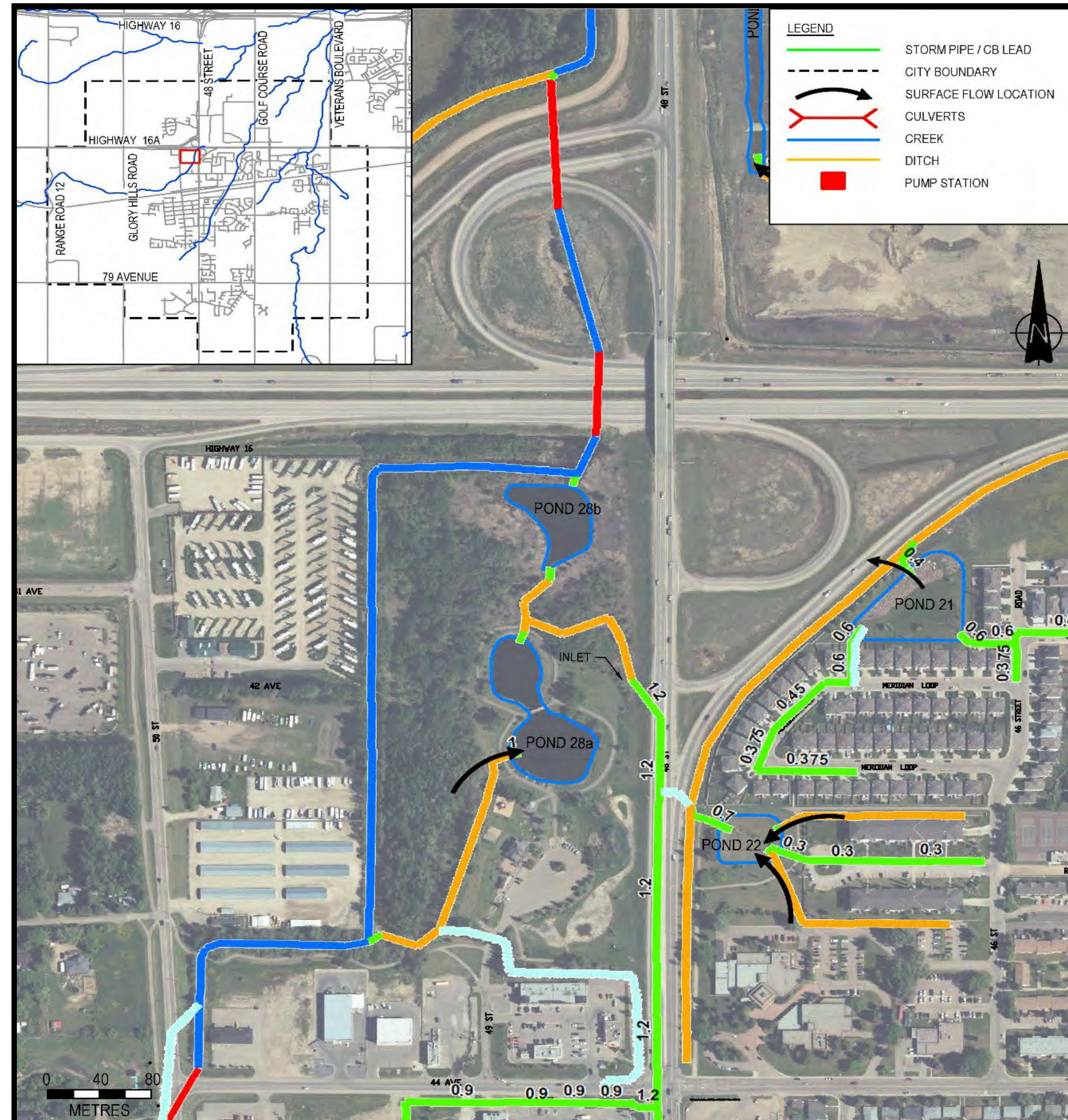


Pond ID	28b	Neighbourhood	Rotary Park
Facility Type	Pond in park	Location	North in the park(North)
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is developed.		
Inlet / Outlet	**Inlets:** 1200 mm west of pond (697.00 m) **Outlets:** Pond drains to creek via ditches		
Control Structure	**NWL**: N/A **Flow Rate:** N/A **Others:**		
Overflow	**Into Pond:** **Out of Pond:** North of pond		
Comments	No other information		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	N/A	N/A
Normal Water Level (NWL)	699.62	0.00
Pond Bottom	697.62	-2.00
Modeled / LiDAR		
100-year 24-hour	N/A	N/A
100-year 4-hour	N/A	N/A
5-year 4-hour	N/A	N/A
Normal Water Level (NWL)	N/A	N/A

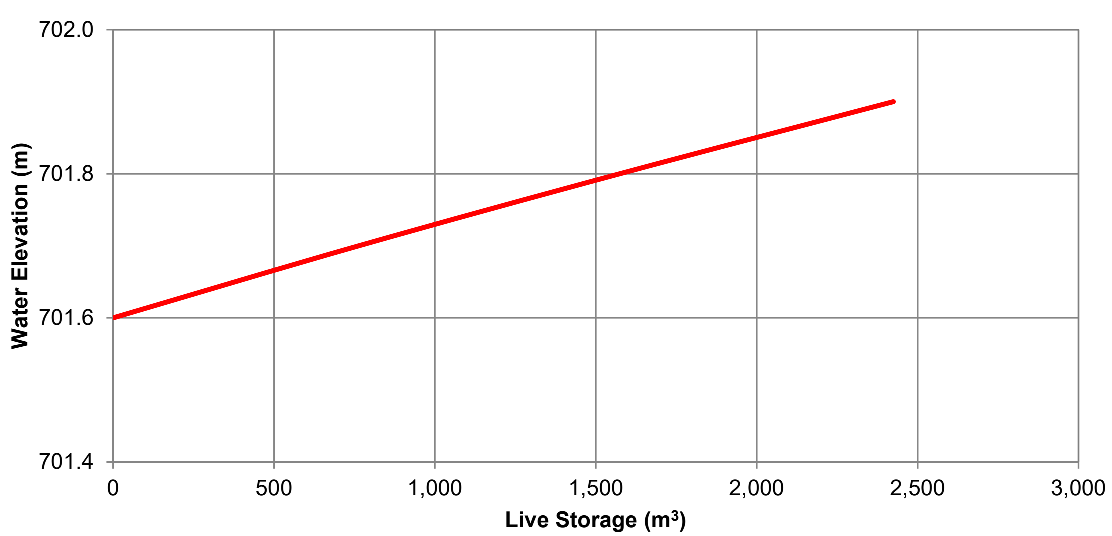


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

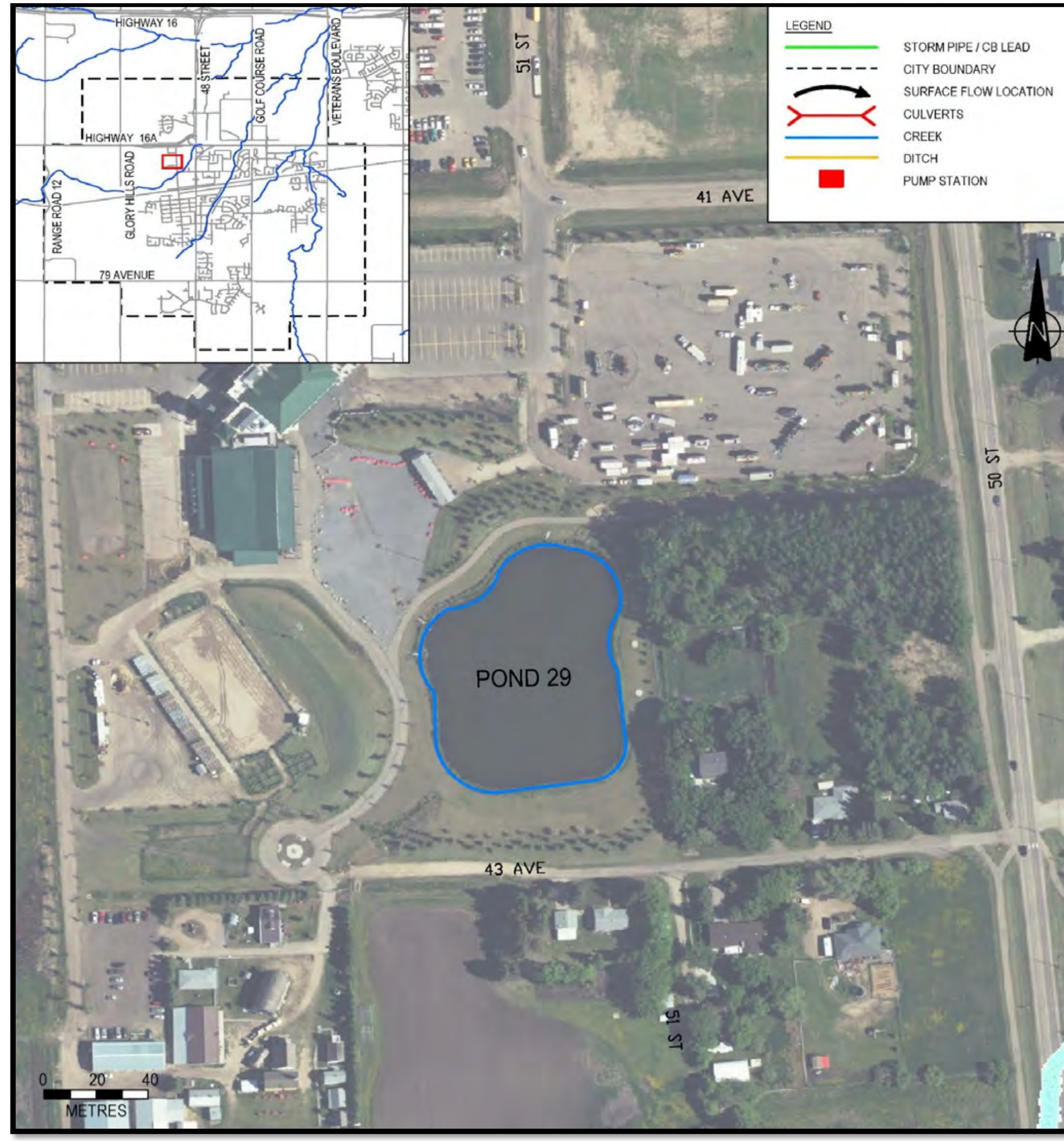


Pond ID	29	Neighbourhood	Heritage park
Facility Type	Pond in park	Location	East in the park
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is developed.		
Inlet / Outlet	**Inlets:** Surface drain to pond via culverts **Outlets:** No more information		
Control Structure	**NWL**: N/A **Flow Rate:** N/A **Others:**		
Overflow	**Into Pond:** Surface drain to pond via culverts **Out of Pond:** East of pond via ditches		
Comments	No other information		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	N/A	N/A
Normal Water Level (NWL)	N/A	N/A
Pond Bottom	N/A	N/A
Modeled / LiDAR		
100-year 24-hour	N/A	N/A
100-year 4-hour	N/A	N/A
5-year 4-hour	N/A	N/A
Normal Water Level (NWL)	N/A	N/A

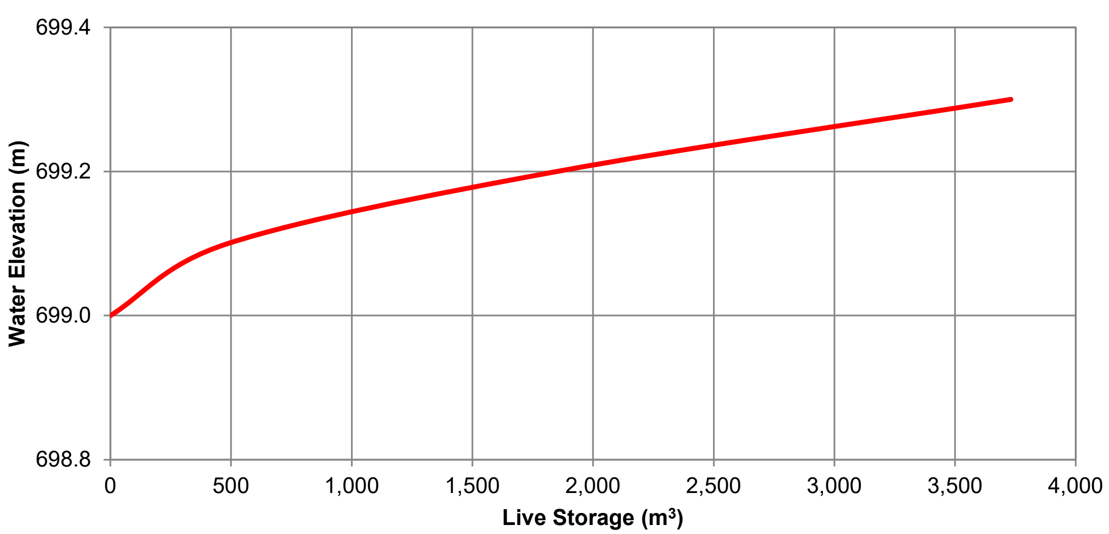


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

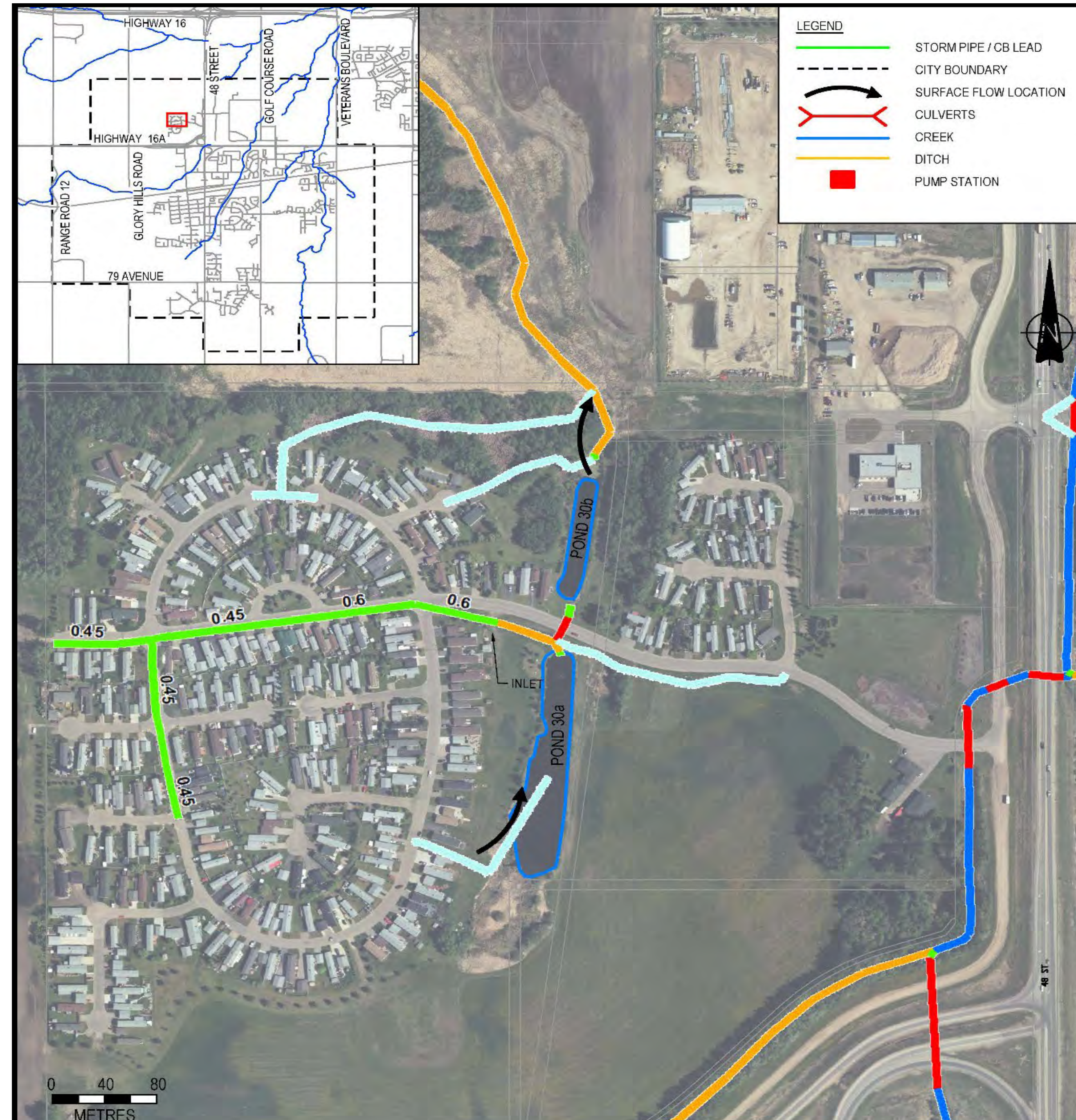


Pond ID	30a	Neighbourhood	Meridian Meadows
Facility Type	Wet pond	Location	East of community(South)
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** 600 mm west of pond via ditch **Outlets:** Surface drain to north		
Control Structure	**NWL**: N/A **Flow Rate:** N/A **Others:**		
Overflow	**Into Pond:** Southwest of pond via ditch from road **Out of Pond:** Surface drain to the north into creek		
Comments	No other information		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	N/A	N/A
Normal Water Level (NWL)	699.00	0.00
Pond Bottom	697.00	-2.00
Modeled / LiDAR		
100-year 24-hour	699.67	0.67
100-year 4-hour	699.69	0.69
5-year 4-hour	699.33	0.33
Normal Water Level (NWL)	699.00	0.00

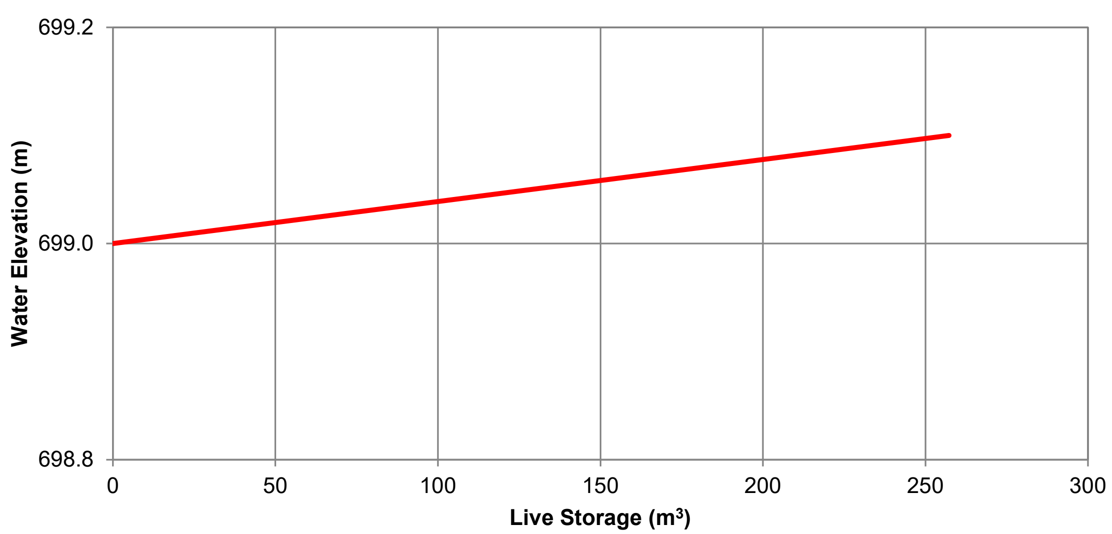


Note: Stage-Storage Curve derived from LiDAR (collected in 2014).

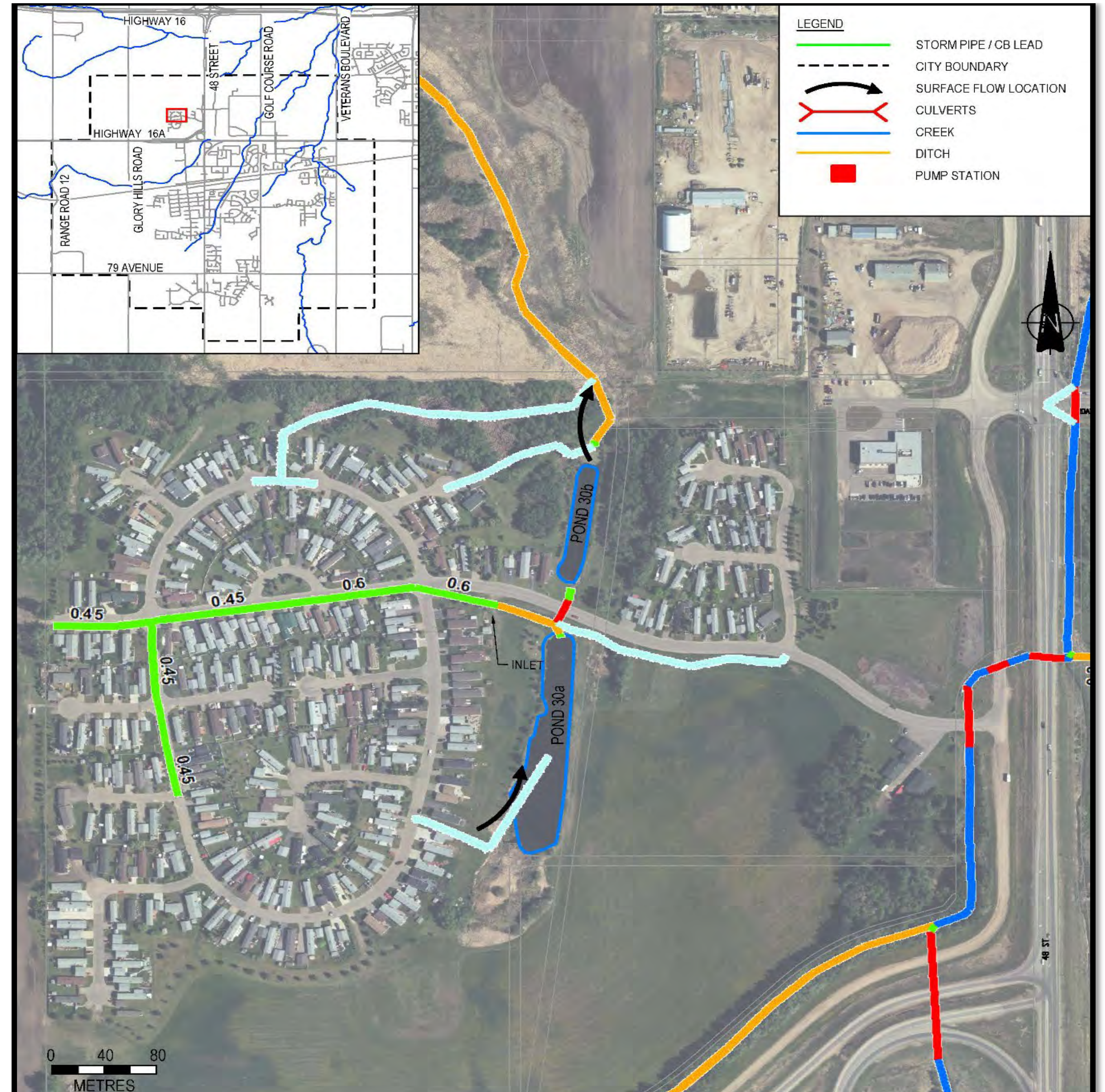


Pond ID	30b	Neighbourhood	Meridian Meadows
Facility Type	Wet pond	Location	East of community(North)
Catchment Area		Year of Construction	
Neighbourhood Development Stage	All areas draining to this pond is being developed.		
Inlet / Outlet	**Inlets:** 600 mm west of pond via ditch **Outlets:** Surface drain to north		
Control Structure	**NWL**: N/A **Flow Rate:** N/A **Others:**		
Overflow	**Into Pond:** Southwest of pond via ditch from road **Out of Pond:** Surface drain to the north into creek		
Comments	No other information		

	Water Elevation (m)	Depth to NWL (m)
Design		
High Water Level (HWL)	N/A	N/A
Normal Water Level (NWL)	699.00	0.00
Pond Bottom	697.00	-2.00
Modeled / LiDAR		
100-year 24-hour	699.67	0.67
100-year 4-hour	699.69	0.69
5-year 4-hour	699.33	0.33
Normal Water Level (NWL)	699.00	0.00



Note: Stage-Storage Curve derived from LiDAR (collected in 2014).



Appendix B: Meeting Minutes

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Meeting Minutes

Project Name	Stormwater Master Plan 2018		
Client	Town of Stony Plain		
Project Manager	John Illingworth (Town) David Yue (Sameng)	**Recorded by**	Maxime Belanger (Sameng)
Date	July 17, 2018	**Time**	10:05 AM to 11:35 AM
Location	Stony Plain Town Hall		
Description	Startup Meeting		

Attendees / Absentees:

Representative		**Company / Title**	**Attended**	**Regrets**
John Illingworth	JI	Town of Stony Plain / Project Manager and Engineer Technician at Planning and Infrastructure	X	
Greg Zirk	GZ	Town of Stony Plain / Manager of Operations at Public Works	X	
Ahmed Elsayed	AE	Town of Stony Plain / Engineering Technician at Planning and Infrastructure	X	
David Yue	DY	Sameng / Project Manager	X	
Maxime Belanger	MB	Sameng / Lead Project Engineer	X	
Darren Flynn	DF	City of Spruce Grove / Project Leader, Technical Services	X*	
Phil Moore	PM	Lamont Land Inc. / Senior Development Manager	X*	

* partial attendance

Distribution (other than above):

Representative		**Company / Title**
Yu Qian	YQ	Sameng / Project Engineer

Item	Discussion	Action (Due Date)
1.0	**MEETING OVERVIEW**	
	• This was the project startup meeting. • DF from the City of Spruce Grove and PM from Lamont Land Inc. (developer in west part of Spruce Grove) were of attendance for the discussions regarding “Drainage boundary between Stony Plain and Spruce Grove”. They left after these discussions.	
2.0	**DRAINAGE BOUNDARY BETWEEN STONY PLAIN AND SPRUCE GROVE**	

	• DF mentioned that the southeast corner of Stony Plain flows into Spruce Grove. Spruce Grove estimated 1,100 L/s coming from Stony Plain into Spruce Grove. Spruce Grove is assuming that Stony Plain is regulating their runoff flows to 2.5 L/s/ha into Spruce Grove.
	• DF will provide the following to JI:
	  • Most recent Spruce Grove Stormwater Master Plan;
	  • Spruce Grove LiDAR 2017 information;
	  • Delineation of watersheds in area;
	  • as-built information for infrastructure relevant to the Town of Stony Plain.
	• Lamont owns and is planning to develop the southwest lands in Spruce Grove, immediately adjacent to Stony Plain. There is currently an approved ASP for the land (Shiloh ASP). They provided a summary of the servicing plan for drainage. There are challenges with servicing the land for drainage due to topography and the railroad crossing. They plan to drain their land through a sewer pipe flowing north, still within Spruce Grove. There is no planned timeline for this storm trunk yet. It would likely follow a similar alignment than the sanitary trunk that is also yet to be constructed (2019-2020 timeline?). AT and CN were not yet consulted on this plan. There is a regulation of 2.5 L/s/ha for these lands.
	• PM will send the ASP for the Lamont Land, and the stormwater servicing plan figures to JI.
	• JI mentioned Town Council will be interested in knowing about the drainage plans along the Town and City boundary. The Edge lands future subdivision along the East Town boundary’s drainage system had to be designed with evaporation ponds.
		DF
		
		PM

3.0	**PROJECT ADMINISTRATION**	

	• The key team members were introduced, and lines of communication were established:
	  • John Illingworth with be the Town Project Manager and main contact.
	  • David Yue will be Sameng’s Project Manager and main contact.
	  • Maxime Belanger will be the lead engineer for Sameng.	

4.0	**PROJECT SCHEDULE AND BUDGET**	
	• The project start happened about 6 weeks later than planned. • It was agreed that the project timelines could be delayed slightly, but the final report should be completed by the end of December 2018 (so project costs are input under the 2018 budget). The interim report should be issued by the end of November.	

Item	Discussion	Action (Due Date)
	• No comments on the project budget since the project just started.	
5.0	**PROJECT SCOPE DISCUSSIONS**	

	• The Town is mostly concerned about getting a good drainage system inventory and having a good understanding of how their drainage system functions. Their current inventory is lacking, which makes it challenging to plan for future expansions and drainage upgrades. This will be a priority of the project.
	• The Town is also interested in understanding how much area drains into the Town, and what these flows are at City boundary and through the City. The current assumption is that upstream pre-development flows are 2.5 L/s/ha. DY is concerned that this is quite an underestimate of peak runoff flows from the upstream lands. The actual peak flows from upstream will be estimated as part of this project using computer modeling.
	• The Town is not very concerned about flooding under existing conditions. The drainage system seems adequate and there has not been much flooding. The existing system performance must still be confirmed through computer modeling.
	• The Town has no concerns with the Creek in terms of flows.
	• The Town needs to be better prepared to service future developments. An understanding of the existing drainage system will be necessary to plan for future developments.
	• Climate Change Resilience:
	  • This mostly result in more intense and more frequent rainfalls, which in terms can result in more frequent flooding.
	  • It was discussed that the small Highway and CN culvert crossings are concerns for resilience.
	  • Sameng will review the impact that climate change may have on the Town’s drainage system.	

6.0	**GENERAL DISCUSSIONS**	

	• Known floods / drainage issues were discussed:
	  • The 1996 event that overflowed the banks of a creek is the last known important flooding in the area.
	  • There are currently concerns with a storm manhole popping out at 52 Street and 50 Avenue. It is in the Brickyard area downstream of a steep hill.
	• Developers:
	  • Qualico owns 5 quarter sections and is a major developer.
	  • There is two active ASP.
	• Key stakeholders were discussed:
	  • Town of Stony Plain
	  • City of Spruce Grove
	  • Parkland County
	  • Alberta Transportation
	  • Alberta Environment
	  • Canadian National (CN) – railroad.
	    • JI will reach out to CN to gather more information about them twinning the tracks right now, and how that might impact drainage.
	• The City does not have environmentally sensitive area inventory. DY explained that this may be useful to use current wetlands as future storage / wet ponds. The Albert Government is stricter in terms of wetland protection, and it would be
		JI
		
		DY

<table>
<tr><th>Item</th><th>Discussion</th><th>Action (Due Date)</th></tr>
<tr><td></td><td>preferred to preserve them. DY will provide a scope of work to JI, as requested.</td><td></td></tr>
<tr><td>7.0</td><td>DATA COLLECTION AND REVIEW</td><td></td></tr>
<tr><td></td><td>• The Town will provide the following data to Sameng:
  • Previous studies;
  • Relevant information provided by the City of Spruce Grove;
  • LiDAR data for 2015 for Stony Plain and 2017 for Spruce Grove.
  • Air Photo for 2015 and 2017.
  • Cadastral – Property Lines.
  • As-built drawings for all sewer pipes and stormwater management facilities.
  • Stormwater pumping stations and location, details.
  • Land Use Zoning and Future Developments – Development Horizon – will be taken from the sanitary master plan currently being finalized.
  • ArcGIS contact – Eric
  • Previous computer models.
• The City does not have a drainage database. The only information shown on maps is the pipe and manhole location, and pipe diameter. Pipe inverts are not inventoried. Culverts are also not inventoried. Sameng will need to take that information from as-builts, or survey. Survey requirements will be identified and discussed with the Town, as it would be additional scope.
• The Town suggested that Sameng should spend time to walk the creeks and take survey shots of the creek and culverts. This would be an additional scope.
• The Town does not have an inventory of outfalls. This would have to be created. While walking the creeks, existing outfall conditions should be documented.
• The 10TM coordinate system will be used.</td><td>JI

GZ

DY</td></tr>
<tr><td>8.0</td><td>COMPUTER MODELING APPROACH</td><td></td></tr>
<tr><td></td><td>• Sameng will develop a computer model for the area using Mike Urban.
• Since there is no good previous model and no good system inventory, we will first need to compile this information prior to constructing the model.</td><td></td></tr>
<tr><td>9.0</td><td>NEXT PROJECT MEETING</td><td></td></tr>
<tr><td></td><td>• The next project meeting will be in 3 weeks from today (around August 7, 2018). JI and DY to schedule the meeting.</td><td>JI / DY</td></tr>
</table>

Meeting Minutes – Meeting #2 - Progress Meeting

Project Name	Stormwater Master Plan 2018		
Client	Town of Stony Plain		
Project Manager	John Illingworth (Town) David Yue (Sameng)	**Recorded by**	Maxime Belanger (Sameng)
Date	November 15, 2018	**Time**	10:10 AM to 11:40 AM
Location	Stony Plain Town Hall – Shikaoi Room		

Core Attendees / Absentees:

Representative		**Company / Title**	**Attended**	**Regrets**
John Illingworth	JI	Town of Stony Plain / Project Manager and Engineer Technician at Planning and Infrastructure	X	
Greg Zirk	GZ	Town of Stony Plain / Manager of Operations at Public Works	X*	
David Yue	DY	Sameng / Project Manager	X	
Maxime Belanger	MB	Sameng / Lead Project Engineer	X	

* partial attendance

Additional/Optional Attendees / Other Distribution::

Representative		**Company / Title**
Yu Qian	YQ	Sameng / Project Engineer

Item	Discussion	Action (Due Date)
1.0	**MEETING OVERVIEW**	
	• This is a progress meeting. • The previous meeting minutes were reviewed.	
2.0	**DRAINAGE INVENTORY**	

	• Sameng provided draft figures and tables to the Town showing basin delineation, pipe inventory, outfall inventory, culvert inventory and pond inventory. Most of these are still work in progress.
	• SURVEY:
	  • Sameng completed the storm system survey to inventory the existing drainage system, given all the data gaps.
	  • A few culvert inverts could not be obtained due to obstructions, such as fences.
	• DRAINAGE BASINS:
	  • Drainage basin delineations were made using the detailed LIDAR for the Town area, and rough LIDAR (free from government) for areas outside the City.
	  • The basin delineation shows the drainage basin of each watercourses flowing through the Town, including the areas upstream of the Town.
	• WATERCOURSES:
	  • Each watercourse was traced from LiDAR and air photos.
	  • Sameng named the watercourses; the Town will review.
		JI

	• Plan and profile of each watercourse, showing the culvert were provided. The elevation of the watercourse and crossing were taken from LiDAR.
	• CULVERTS:
	  • Sameng's surveyor walked all the main watercourses and shot all the culverts.
	  • The culvert inventory shows the culvert location, invert and diameter. The surveyed culvert invert and obvert were used to determine the pipe diameter. Culvert capacity were estimated based on inlet control condition with headwater equal to pipe diameter.
	  • The culverts capacity generally varies around 2 to 4 L/s/ha.
	  • Assuming inlet control may overestimate the culvert capacity. Outlet control calculations would be required to estimate the actual culvert capacity.
	  • GZ asked Sameng to create a similar culvert figure as provided, but with capacity indicated for quick reference.
		DY

	• JI commented that during the CN railroad twinning, the existing culverts were simply extended. • JI will contact CN to obtain information about their CN crossing.	JI

	• OUTFALLS:
	  • Sameng's surveyor walked all the main watercourses and shot all the outfalls. The outfalls are inventories and shown on a figure. Photos were also taken and will be sorted into folders and provided to the Town.
	• SWMF:
	  • There are 30 SWMFs in the City. Sameng started compiling the pond information and summarizing their information in figures for inventory purposes. The figure shows the pond, inlet and outlet, diameters, control structures, overflows, stage-storage curve, and it will show the 100-year water elevation, after the model is complete.
	  • Sameng will require the assistance of the City to confirm missing SWMF information. Sameng will send to the Town shortly.
		DY

Item	Discussion	Action (Due Date)
	• GZ identified a few additional ponds to be included as SWMFs, including in Rotary Park. Sameng will include.	DY
3.0	**COMPUTER MODELING**	
	• Sameng is continuing work on the model. • We have filled the gaps following the storm sewer survey work. • We do not have results yet; the model should be producing results in December.	
4.0	**KNOWN DRAINAGE ISSUES TO REVIEW**	
	• The Town would like Sameng to develop a drainage plan for the future recreation center and school, on land owned by the Town, north of 57 Avenue and west of 52 Street. DY will review. • The Town identified flooding issues in this area (Brickyard and The Glens) due to the melting of a snow dump. The meltwater appears to drain towards existing houses and cause flooding issues both north and south. Sameng will review the drainage patterns and topography in the area and comment.	DY DY
5.0	**ADDITIONAL DISCUSSIONS**	
	• Boundary Road is now named Veterans Boulevard. It is a 4-lane divided arterial road. • Spruce Grove objected to the Edgeland development sending drainage through their City, even though drainage of this area naturally drains through the City. • Sameng will complete a thorough investigation as to how drainage behaves in this area. Our preliminary delineations show part of Stony Plain naturally flowing east into a watercourse that flows through the City of Spruce Grove. It appears the City may have removed/blocked that watercourse to allow for development. • The Edgeland development east of boundary road is not happening. This is the development that proposed a holding pond as Spruce Grove does not want to receive their drainage. • Should we present the Master Plan to UDI? JI will contact them to see how they want to proceed. • The sanitary and water master plans are going to Council in January 2019. • A Water Act approval was not obtained for a SWMF in the Brickyard. Following meeting with Alberta Environment, Daytona (developer) is proposing to construct a constructed wetland to compensate. This was not yet approved. JI will provide information to Sameng. • Discussions were made regarding wetland compensation, and how there is more stringent rules from the Government regarding the removal of wetlands, and compensation of wetland removal. It is preferable to keep wetlands. • The Town does not have environmentally significant areas inventoried. DY explained that this may be useful to use current wetlands as future storage / wet ponds, especially if these features are considerable. DY will provide an estimate on doing a wetlands assessment study; we have a wetlands specialist on our team. • JI will provide pace and location of development for purposes of developed long-term drainage plans. They have it in three stages, used for the other master plans. • Sameng has yet to develop the drainage plan for the future development areas.	DY JI JI DY JI

Item	Discussion	Action (Due Date)
6.0	**PROJECT ADMINISTRATION**	
	• Town is without Director of Engineering for now. • No changes to project team.	
7.0	**PROJECT SCHEDULE AND BUDGET**	
	• Due to missing data and the need to complete surveys and investigations to find the data, Sameng requested for the project completion to be in February 2019. JI agreed; the Master Plan should be done well, not fast. • Council presentation at the end of March 2019 is targeted.	
8.0	**NEXT MEETING**	
	• The next project meeting will be aimed to happen in December.	JI / DY

This meeting minutes is considered to be a true and accurate record of all main discussions, decisions and action items. If any discrepancies or inconsistencies are noted, please contact the note taker within 7 days.