



McElhanney



City of Camrose Stormwater Master Plan

May 1, 2026

Submitted to: City of Camrose
Prepared by McElhanney

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**Your Challenge.
Our Passion.**

May 1, 2026

City of Camrose
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Camrose, Alberta T4V 0S8

Attention: Jeremy Enarson, Manager – Engineering Services, Infrastructure

City of Camrose Stormwater Master Plan

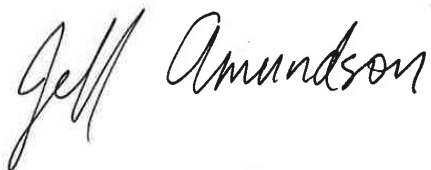
McElhanney Ltd. is pleased to submit the City of Camrose Stormwater Master Plan.

A detailed investigation and assessment was undertaken by McElhanney to:

1. Import the previous XPSWMM computational model into PCSWMM format, and supplement with updates to the existing City base,
2. Calibrate the stormwater system model to match recorded flow conditions, and further validate the stormwater system model through verification of expected release rates,
3. Identify capacity-related deficiencies in the existing stormwater collection system;
4. Evaluate and recommend alternatives to improve the stormwater system, to accommodate existing and expected future development conditions; and
5. Prepare a cost estimate and capital plan to budget and prioritize projects to improve the stormwater system.

We trust this report provides the necessary information as needed by the City for capital planning related to the stormwater system. If you have further comments or concerns, please feel free to contact the undersigned.

Sincerely,



Jeff Amundson, P.Eng.

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587-937-8281

REVISION RECORD

REVISION	DESCRIPTION	DATE	ISSUED BY
DRAFT	Stormwater Master Plan	September 11, 2025	J. Amundson
DRAFT	Stormwater Master Plan	March 3, 2026	J. Amundson
FINAL	Stormwater Master Plan	May 1, 2026	J. Amundson

REPORT SIGNATURE

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Please direct any questions or clarification regarding the contents of this report to the following team members who prepared this report.

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Executive Summary

McElhanney Consulting Services Ltd (McElhanney) was retained by the City of Camrose (the City) to develop an updated Stormwater Master Plan Report, meant to replace the previous *Stormwater Master Plan Update (2008)* by Associated Engineering. The overarching objective of the updated SWMP was to guide the planning, cost forecasting, design and construction of the City's stormwater management system. An analysis was completed to evaluate the ability of the City's existing and proposed drainage systems to safely capture and convey the runoff for selected return periods.

This Stormwater Master Plan has been prepared as an update to the previous report due to its age. The previous model was done in XPSWMM computational software. Since then, industry standard has moved to more user-friendly and accessible software, with PCSWMM being the most common; McElhanney recommended the City adopt PCSWMM for this reason, to which the City agreed. For this analysis, McElhanney imported the previous model, supplementing it with the most recent City GIS information.

The drainage analysis was completed to develop strategies for the management of stormwater within the City boundary. The following documents were used to develop design criteria for this assignment:

- *City of Camrose Minimum Design Standards for Development* (April 2004), published by the City of Camrose.
- *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems: Part 5 Stormwater Management Guidelines of a Total of 5 Parts* (March 2013), published by Alberta Government.
- *Volume 3 Drainage. Vol 3-03: Design Guidelines* (February 2022), published by EPCOR.
- *Code of Practice for the Hydraulic Modeling of Urban Drainage Systems Version 01*, published by Chartered Institution of Water and Environmental Management (CIWEM).
- *Camrose Stormwater Management Plan Update* (January 2008), by Associated Engineering.
- *Camrose Flood Hazard Study* (2019), by Northwest Hydraulic Consultants.

Runoff within the City is conveyed via two systems, typically referred to as the minor and major systems. This differentiation refers to the storm recurrence interval and storm intensities expected to be conveyed by the systems, respectively. The minor system consists of catch-basins (inlets and leads) and the underground piped system, complete with manholes, designed to capture minor and moderate flow and to prevent nuisance flooding. By contrast, the major system is designed to safely convey major overland flows and reduce the risk of major flooding. This system typically includes curb and gutter containment along roadways within an urban cross section, drainage ditches, natural creeks, and storm water management facilities. The City operates both wet and dry stormwater management facilities (SWMFs), including; Cascades, Cornerstone, West Park, Duggan, Valleyview, CRE, and Mohler. Other smaller SWMFs and on-site storage facilities are present within the existing system.

The drainage analysis was undertaken with the following objectives:

- The minor system has adequate capacity to convey the runoff from the 1:2-year return period storm event; and



- The major system (ditches, roadways, etc.) has adequate capacity to safely convey runoff during the 1:100-year return period storm – with some nuisance flooding being deemed acceptable.

The previous *Stormwater Master Plan Update (2008)* identified that a significant percentage of stormwater pipes exceeded the 5-yr level of service, and recommended decreasing the level of service to 2-yrs. This recommendation has been maintained in this analysis for overall project feasibility.

A flow monitoring program was performed, to calibrate and validate model results. Flow monitors for residential areas produced reasonable results according to stated evaluation criteria, while flow monitors for the commercial and industrial areas were not consistent with modelled results. The following inferences have been made from flow monitor results:

- Residential area model results are reliable for the purposes of this report, and can be used for analyzing system capacity.
- Industrial area model results do not fit the flow monitoring data. Results from analysis in the industrial area should be reviewed once the root cause of the discrepancy is addressed.
- Commercial area model results do not fit the flow monitoring data. Results from analysis in the downtown commercial area should be reviewed once the root cause of the discrepancy is addressed.

Given the model discrepancies with the flow monitoring data, additional verification was performed to review commercial and industrial model results against literature values. The difference from modeled results to rational method were within expectations, so it is unlikely the problem was with model inputs. Possible causes include:

- Upstream infrastructure being different than the GIS database / record drawings,
- Upstream blockages, and
- Unaccounted-for losses, such as that into other infrastructure i.e. the sanitary system or through exfiltration.
- Failed calibration due to irregularly dry weather, although given the high variance from established literature values / standard results this is considered unlikely.

This should be investigated as a follow-up to this report.

Pipes were deemed to be under capacity, and therefore recommended for upgrade, if the design flow was greater than the capacity of the pipe ($Q_{DES} > Q_{CAP}$). Typically, there are limited maintenance concerns, and residents are satisfied with the gravity drainage system, so long as there is positive drainage sufficient to eliminate standing water, so upgrades to the gravity drainage system are considered low urgency. Instead, upgrades can be folded into renewal projects as they are performed across the City, to minimize disruption and promote project economy. Pipe upgrades have been recommended per **Figure 11: Proposed System Upgrades**.

Concerning the major system, the system was first evaluated to determine whether there are areas within the City where modeled results indicate a risk of flooding. Given that Stoney Creek flows through the



center of the City, and reasonable grades are largely achieved, the City is overall at low risk of flooding. Overland flow routes typically have the capacity to convey the 100-year runoff within the right-of-way (ROW) to the nearest ditch or SWMF. The model and follow-up analysis indicates minor risk from elevated flood levels at three locations; 51st Avenue & 46th Street, 54th Avenue & 46th Street, and 47th Avenue & Montclare Avenue. As this is considered low risk, a review of existing grades could be performed to determine level of risk, combined with ongoing monitoring.

A release rate of **5.0 L/s/ha** for the 100-year design storm will be required for all proposed developments being completed on previously undeveloped areas. This is intended to remain consistent with the previous *Stormwater Master Plan Update (2008)* and *City of Camrose Minimum Design Standards for Development (2004)*. This value was confirmed against the latest flood analysis, *Camrose Flood Hazard Study (2021)* by Northwest Hydraulic Consultants, on behalf of the Alberta Government.

For future development, the City was evaluated at 10-yr, 25-yr, 50-yr, and Ultimate horizons, using future development areas provided by the City. Future development and required infrastructure are shown on **Figure 12: Future Development Proposed Stormwater Infrastructure**.

Proposed system upgrades have generally been conceptualized to accomplish the following:

- Expand the system to service Stage 1 (10-yr), Stage 2 (25-yr), Stage 3 (50-yr), and Ultimate future growth horizons,
- Take advantage of existing grades to the extent possible to optimize bury depths,
- Take advantage of likely development sequencing,
- For 10-year horizons, focus on connecting to existing infrastructure, to limit requirement for large capital investments to support new development, and
- Configure pipe network to limit new lift station construction, while avoiding unfeasibly deep bury depths.

Future development largely does not impact existing infrastructure, as stormwater management infrastructure has generally been conceptualized to discharge to tributaries to Stoney Creek or existing wetlands. An exception to this is the development in the SE Industrial / Commercial, which will trigger an upgrade to the Camrose Drive stormwater main. As a further note, wetlands will require hydrologic and environmental review for increase in total volume and sensitivity to contamination prior to being used for this purpose. Additionally, two large wetlands have been identified for conversion to wet SWMFs; additional environmental studies are required to determine potential impacts on affected wetlands prior to construction, and necessary environmental approvals by Alberta Environment obtained before this plan can be finalized, and is expected to be an arduous process.

Cost estimates have been prepared for both upgrades to the existing system, and for proposed development. An additional step has also been taken to identify percent usage by multiple areas making common use of stormwater infrastructure, to provide context for planning documents and potentially offsite levies. This information is detailed in **Table 12: Cost Estimate – Existing Minor System Upgrade** and **Table 13: Cost Estimate – Future Development**.



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1. Introduction

1.1. PROJECT DESCRIPTION AND SCOPE OF WORK

The City of Camrose (the City) covers an area of approximately 41.67 km², with a population of 19,457¹. It is serviced by a stormwater management system which is generally composed of a combination of overland drainage and a gravity collection pipe network discharging to Stoney Creek. Several tributaries to Stoney Creek are present throughout the City. Refer to **Figure 1: Existing Minor System** for visual representation of the stormwater management system.

The City's previous *Stormwater Master Plan Update (2008)* was completed by Associated Engineering. Given the age of the report, the City decided to proceed with an update to the model and report to include updated plans for existing and new development. McElhanney Limited (McElhanney) was retained by the City to develop an updated Stormwater Master Plan (SWMP) Report to evaluate the City's stormwater management system. An updated Stormwater Master Plan will guide the City in planning for accommodation of future development, determine any deficiencies in the existing drainage system, recommend stormwater infrastructure upgrades, and evaluate alternatives to improve stormwater servicing.

The scope of the work is summarized as follows:

EXISTING DATA REVIEW

- Review background information, including GIS data, record information, and past reports.
- Complete a 'gap' analysis to identify areas of missing information.

MODEL CONVERSION & MODEL UPDATE

- Import previous hydraulic model into PCSWMM format.
- Update model to include new development and previously completed upgrades.

MODEL VERIFICATION

- Develop and implement a flow monitoring program to facilitate modeled flow calibration.
- Develop and agree on applicable design criteria and level of service for system loading and pipe functionality.
- Prepare a calibrated hydraulic model, to assess the capacity of the existing stormwater management system.

¹Statistics Canada. 2023. (table). Census Profile. 2021 Census of Population. Statistics Canada Catalogue no. 98-316-X2021001. Ottawa. Released November 15, 2023.
<https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/index.cfm?Lang=E> (accessed May 6, 2025)

FUTURE MODEL

- Establish 10-yr, 25-yr, 50-yr, and Ultimate development horizons.
- Conceptualize required infrastructure to support future development horizons.

CAPITAL PLAN

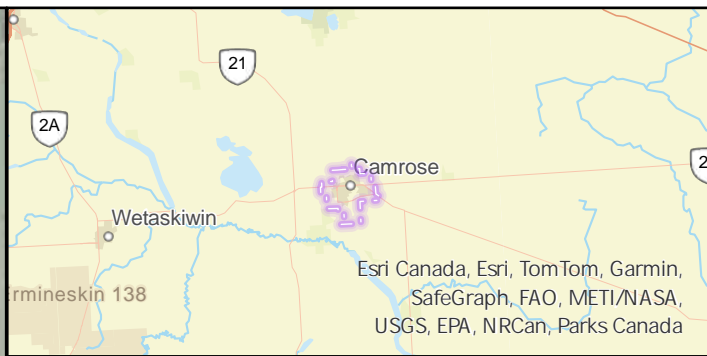
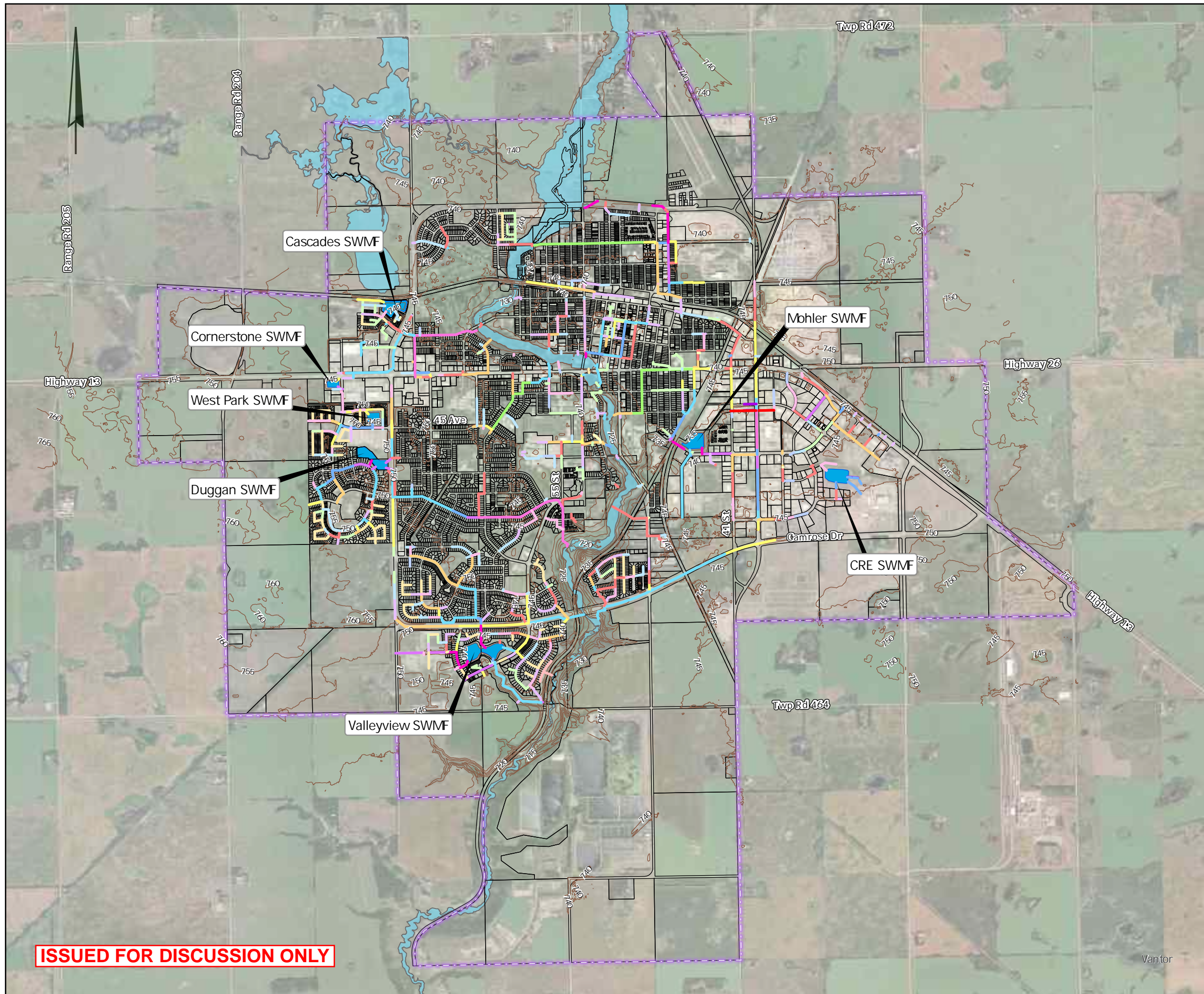
- Develop a series of proposed capital upgrades and future infrastructure which would, once constructed, meet the agreed upon design criteria and level of service outlined.
- Prepare preliminary, Class 'D', cost estimates for the construction of the proposed capital upgrades.

1.2. AVAILABLE DATA

Background information relevant to the stormwater management system assessment was reviewed to develop an understanding of the system and to determine the design criteria. This included past reports, record drawings, GIS / CAD base information, aerial imagery, and LiDAR data. Relevant information that was reviewed and used in the analysis is listed below.

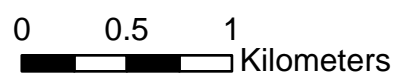
- *Stormwater Master Plan Update (January 2008)*, by Associated Engineering.
- Record drawings
 - Stormwater management facilities
 - Permit approvals – site specific stormwater management plans
- LiDAR data (2025), supplied by Provincial Geospatial Centre (Government of Alberta)
- City GIS / CAD base
- Land use & zoning maps, by Associated Engineering
- *City of Camrose Growth Study (2023)*, by Green Space Alliance
- Flood study extents
- *Railway Junction Intermunicipal Area Structure Plan (April 2021)*, by ISL Engineering and Land Services
- *East Gateway Area Structure Plan (July 2016)*, by ISL Engineering and Land Services
- *Camrose Flood Hazard Study (2019)*, by Northwest Hydraulic Consultants





LEGEND

- City of Camrose Limit
- Topographic Contour
- 100 Year Flood Extent
- Existing Conduits**
- Pipe Diameters (mm)**
- 150
- 200
- 250
- 300
- 375
- 400
- 450
- 525
- 600
- 675
- 750
- 825
- 900
- 1050
- 1200
- 1350
- 1500
- 1650
- 2150



TITLE

Figure 1
Existing Minor System

ISSUED FOR DISCUSSION ONLY

1.3. SITE DESCRIPTION

1.3.1.1. Study Area

The study area is confined to areas within the City boundary, and areas discharging into existing or proposed development areas, shown in **Figure 2: Major Catchments** and **Figure 12: Future Development Proposed Stormwater Infrastructure**. Areas outside of the City boundary not impacting existing or proposed development areas, and areas not affected by development or infrastructure, were also generally removed from the model, provided they did not impact the analysis.

1.3.1.2. Soil Conditions

For soil conditions, McElhanney referenced the findings of the previous master plan and supplemented this with geotechnical reports from recent construction projects. Based on an overview of these sources of data, the soil type used for the drainage analysis was assumed to be clay loam with moderate infiltration potential. The infiltration losses in the computational modeling were calculated using the Green-Ampt method.

1.3.1.3. Watersheds and Subcatchments

Per **Figure 2: Major Catchments**, Stoney Creek is the main watershed flowing through the City and stormwater infrastructure generally discharges to this waterbody.

Stormwater runoff from developed areas can adversely affect the receiving water bodies. Increased runoff rates and volumes can increase the rates of erosion within creeks and stormwater can generally contain high levels of sediments and nutrients. This can result in increased sedimentation in downstream waterbodies. In addition, urbanization can introduce numerous pollutants which can be transferred and conveyed to natural aquatic receiving systems. The most common pollutants include suspended solids, oil and greases, nitrogen, phosphorus, and various metals.

Sediment loading in stormwater is generally characterized by the Total Suspended Solids (TSS). Pollutants such as metals, nutrients and other constituents attach to suspended solids and, as a result, their removal rates relate to TSS removal efficiency. Water Quality standards in Canada are governed by the *Fisheries Act* and are subsequently enforced by each Province. The *Fisheries Act* states that you may not discharge a deleterious substance into a receiving water body. The *Fisheries Act* defines a deleterious substance as:

- “(a) any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water, or
- (b) any water that contains a substance in such quantity or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any other water, degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water,”



The stormwater runoff quality requirement will depend on the water body it is being discharged into. In most of Central and Northern Alberta, an adopted standard of 85% removal of Total Suspended Solids above 75 microns has been deemed the appropriate level of treatment for most receiving water bodies. This has been adopted as a guideline in the design of stormwater management infrastructure in some municipalities.

1.3.1.4. Land Use

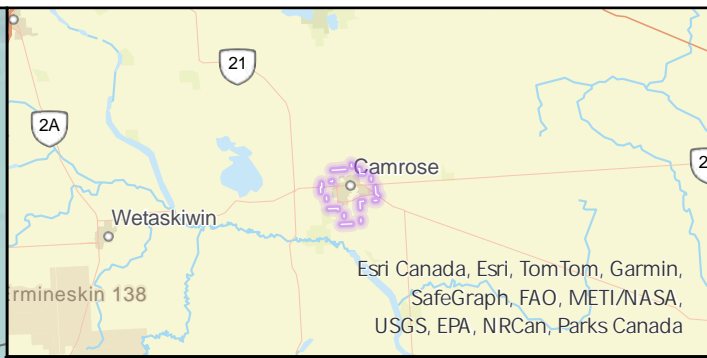
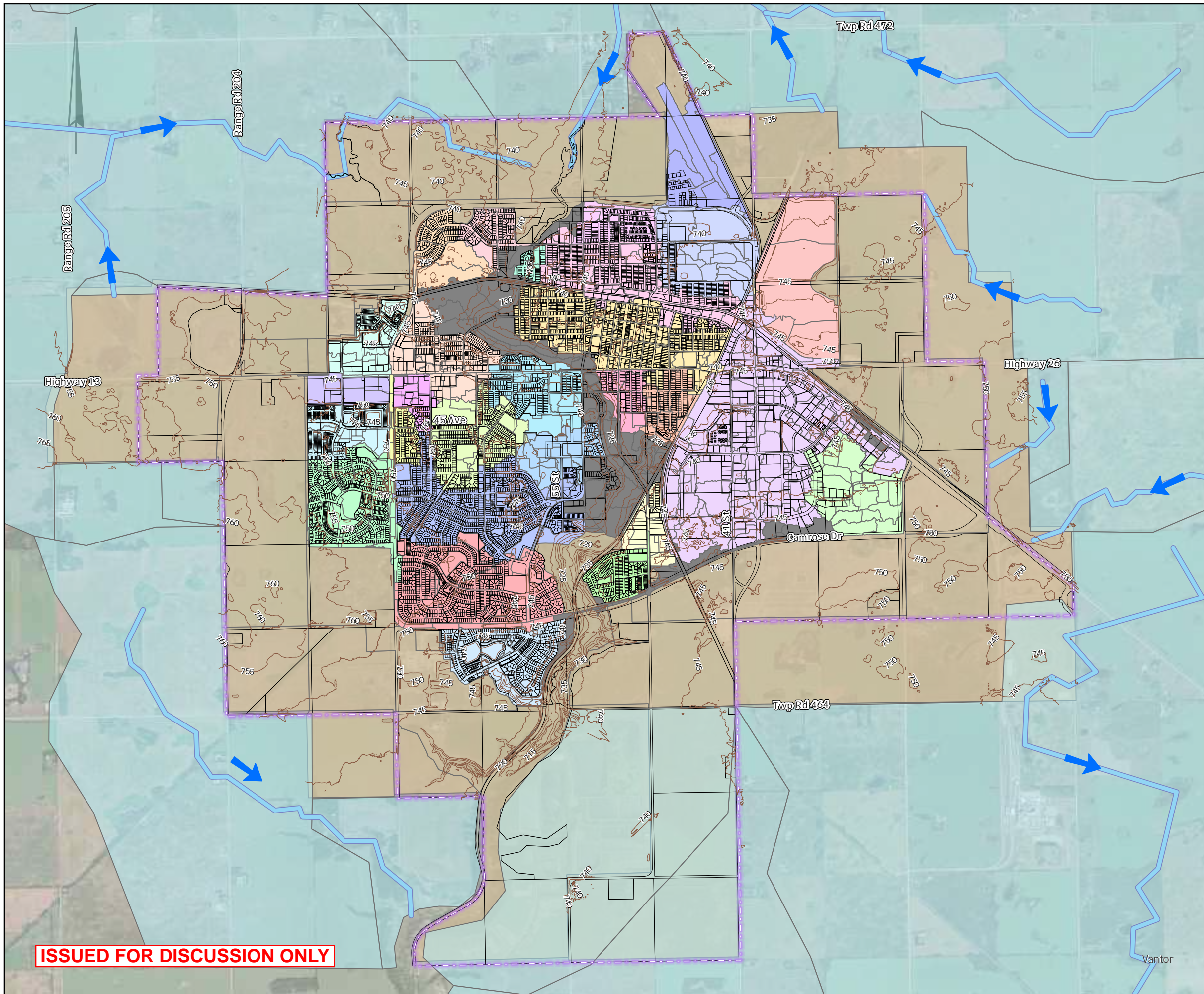
Refer to **Figure 5: Projected Growth – Development Type**. Land use for the purpose of assigning imperviousness has been assigned through a combination of review of aerial photography and closer inspection through Google Street View at-ground photography. The City is generally laid out according to the following pattern:

- Residential
 - Concentrated north and southwest of Stoney Creek
 - Additional subdivisions east and south of downtown
- Commercial
 - Downtown approximately bounded by 51st Avenue / 46th Street / 48th Avenue / 52nd Street
 - In proximity to the Highway 13 corridor, at the east industrial area
 - In proximity to the Highway 13 / 48th Avenue corridor, west of Stoney Creek
- Industrial
 - East of Stoney Creek, generally bounded by the rail line / Highway 13 / Camrose Drive
- Institutional
 - Near Stoney Creek, south of the Highway 13 / 48th Avenue corridor

1.3.1.5. Topography

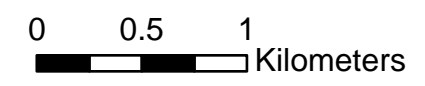
Topography within the City generally slopes toward Stony Creek, which flows from north to south. There are also small tributaries to Stony Creek present within the City. A more detailed discussion of site specific drainage affecting future development is included in **Section 4**. Refer to **Figure 3: Topography** for a visual representation of Town topography.





LEGEND

- City of Camrose Limit
- Topographic Contour
- Drainage Courses
- Watersheds
- Future Growth



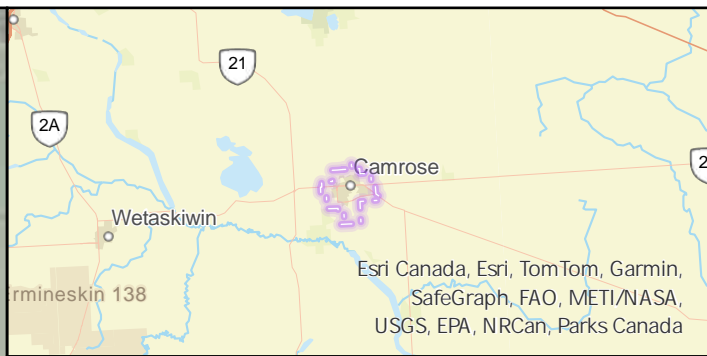
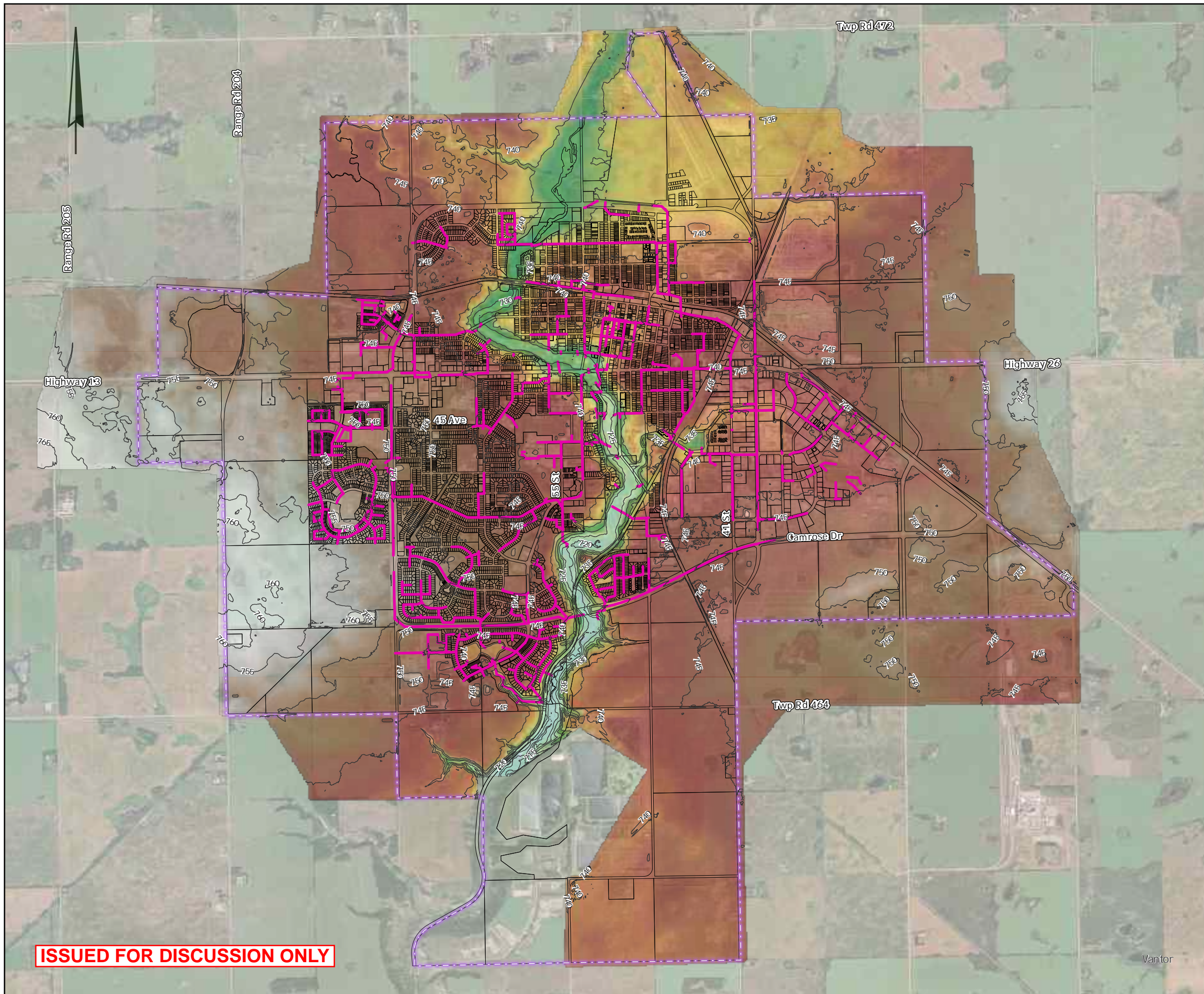
TITLE

**Figure 2
Major Catchments**

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Date: 4/30/2026

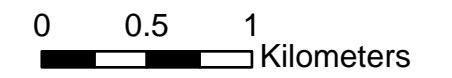


LEGEND

- City of Camrose Limit
- Topographic Contour
- Existing Conduits

Elevation (m)

700 770



TITLE

Figure 3 Topography

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Vantor

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NAD 1983 3TM 114

Date: 4/30/2026

1.4. GROWTH FORECAST

1.4.1. Summary

The City has been working with Associated Engineering on the Water Master Plan concurrent to this study. As part of the Water Master Plan the City has confirmed growth horizons; these growth horizons have been used for this study for consistency in approach. This has been included in **Figure 4: Projected Growth – Phasing**.

Population forecasting has been summarized in **Table 1: Population Growth**. This is included for information purposes, to support estimations in land coverage, as this does not directly affect model analysis. The City has published *Growth Study 2023-2048* (published 2024), produced by Green Space Alliance. A 0.9% population growth per the overall average growth rate for a medium growth scenario was selected. Background information on details and assumptions supporting projected growth rates can be found within the referenced report.

Table 1: Population Growth

GROWTH HORIZON	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	POLICY REVIEW	POPULATION
Stage 0 (2025)					² 19,457*
Stage 1 (10-year)	7.1 ha	6 ha			21,281
Stage 2 (25-year)	179 ha	30 ha	98 ha		24,342
Stage 3 (50-year)	509 ha	56 ha	325 ha		30,453
Ultimate	410 ha	618 ha	178 ha	263 ha	-

*Based on 2021 census data, adjusted to 2025 with 0.9% growth rate

1.4.2. Naming Convention

1.4.2.1. Zone and Subzone Naming

To simplify discussion, and supporting figures and tables, different growth areas have also been further grouped into six zones. These zones have been grouped according to a logic-based combination of both planned land use and prevailing drainage patterns. Efforts have also been made to keep zones similar to the *City of Camrose Sanitary Master Plan (2026)* where possible for consistency in planning.

- **N Residential:** Comprised of planned residential development, on the north boundary of existing residential development and west of Camrose Airport.
- **NW Residential / Commercial:** Includes a mix of residential and commercial mixed use, with commercial growth concentrated along Highway 13. This zone also includes quarter sections

² Statistics Canada. 2023. *Census Profile*. 2021 Census of Population. Statistics Canada Catalogue no. 98-316-X2021001. Ottawa. Released November 15, 2023.
<https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm?Lang=E&SearchText=Camrose&DGUIDlist=2021A00054810011&GENDERlist=1,2,3&STATISTIClist=1&HADERlist=0> (accessed April 15, 2025).



more directly west of the City, as these areas are conceptualized drain north. NW_RES_201 was also included in NW Residential / Commercial, to stay consistent with the *City of Camrose Sanitary Master Plan (2026)*, although it discharges to the existing stormwater system to the east.

- **SW Residential:** Largely planned for residential development, with a small commercial mixed-use area. This zone is west of Stoney Creek and existing residential subdivisions, and south of the future extension of Camrose Drive to the west.
- **NE Industrial / Commercial:** Includes commercial / industrial and industrial use. This zone is adjacent to existing industrial development, north of Highway 26 and east of the airport.
- **E Industrial / Commercial:** Includes commercial / industrial, commercial mixed, and industrial use. This zone is opposite to existing industrial development northeast of Highway 13 / CP rail line, and south of Highway 26.
- **SE Industrial / Commercial:** Mix of industrial use south of Camrose Drive, commercial / industrial use north of Township Road 461, and residential and commercial mixed use immediately east of Stoney Creek.
- **Policy Review:** This area is adjacent to the City of Camrose wastewater treatment lagoon system and the Camrose Regional Landfill. The strategy for developing this zone is under consideration by the City, and planned land use is undecided.

Areas within these zones have been further broken down into smaller subzones, broken down according to a logic-based combination of planned land use, development horizon, and sewershed area. The naming convention uses the following rules:

- Zone
 - **N Residential:** N
 - **NW Residential / Commercial:** NW
 - **SW Residential:** SW
 - **NE Industrial / Commercial:** NE
 - **E Industrial / Commercial:** E
 - **SE Industrial / Commercial:** SE
- Land Use
 - **Residential:** RES
 - **Commercial:** COMM
 - **Industrial:** IND
- Development Horizon
 - **Stage 1:** 1
 - **Stage 2:** 2
 - **Stage 3:** 3



- **Ultimate: U**
- Zone Number
 - Two-digit ascending (e.g. 01, 02)

An example subzone following this convention, located in the SW Residential zone, Stage 1 development horizon, first in the assumed development sequencing, would appear as follows: SW_RES_101.

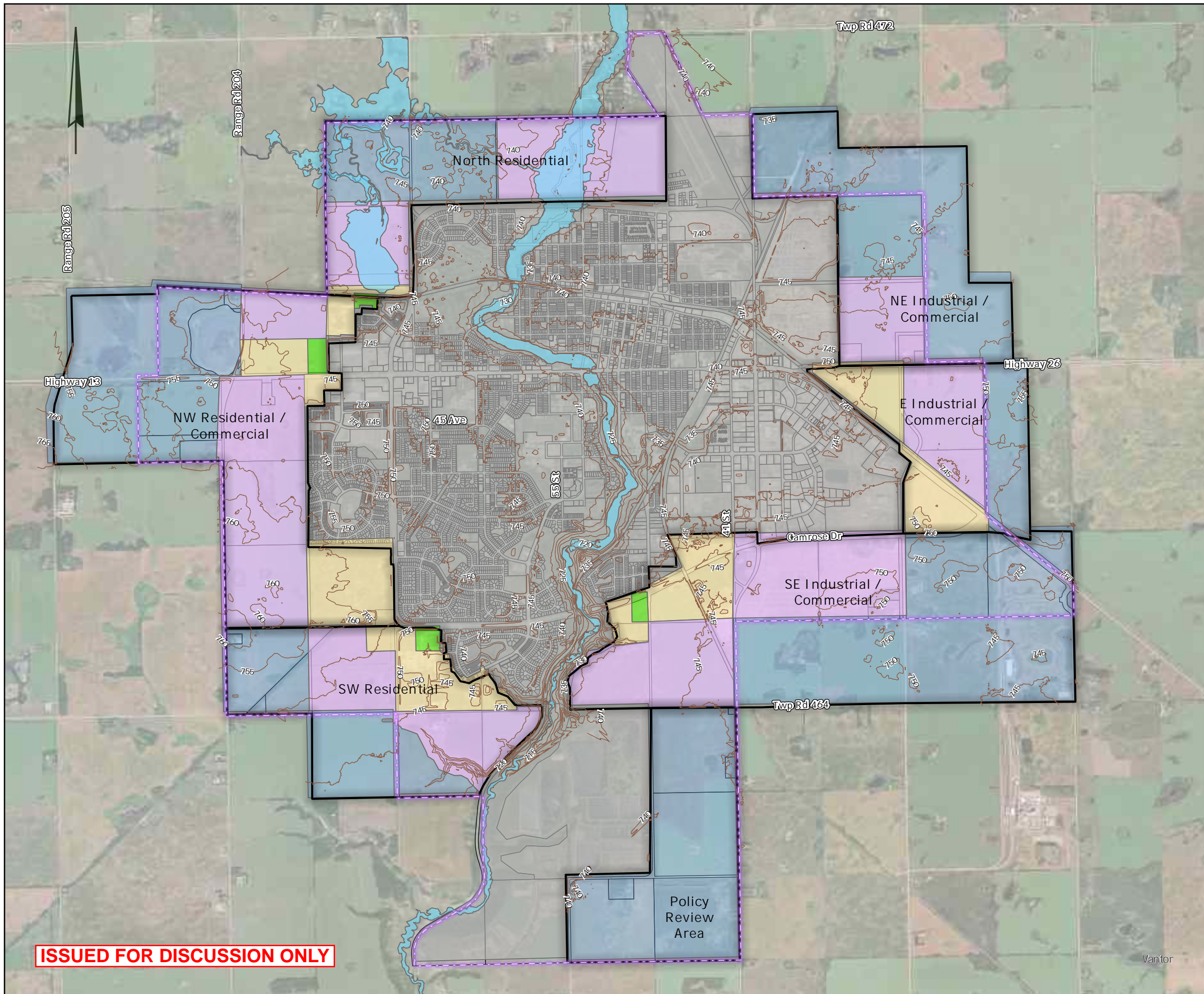
1.4.2.2. Stormwater Management Facility Naming

Stormwater Management Facilities (SWMFs) have been named making use of the zone they are located in followed by radially ascending numbers to help the reader more quickly find the SWMF on the maps. The radially ascending numbers start in the NW corner at NW_RES_U04, increasing counterclockwise. The naming convention uses the following rules:

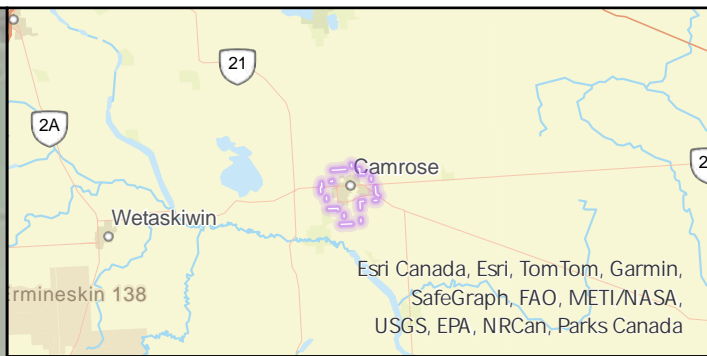
- Zone
 - **N Residential: N**
 - **NW Residential / Commercial: NW**
 - **SW Residential: SW**
 - **NE Industrial / Commercial: NE**
 - **E Industrial / Commercial: E**
 - **SE Industrial / Commercial: SE**
- Land Use
 - **Residential: R**
 - **Commercial: C**
 - **Industrial: I**
- SWMF Number
 - Three-digit ascending radially (e.g. 001, 002)
 - It is recommended to add an A, B, etc. suffix if SWMFs are required at a later date
 - Some numbers have been skipped as SWMF placement has changed through the planning process

An example SWMF following this convention, located in the SW Residential zone, would appear as follows: SW_R_011.





ISSUED FOR DISCUSSION ONLY



LEGEND

- City of Camrose Limit
- 100 Year Flood Extent
- Topographic Contour
- Land Use Zones
- Growth Horizons**
- Existing Built-up Area
- Stage 1 (10 yrs)
- Stage 2 (25 yrs)
- Stage 3 (50 yrs)
- Ultimate Build-out



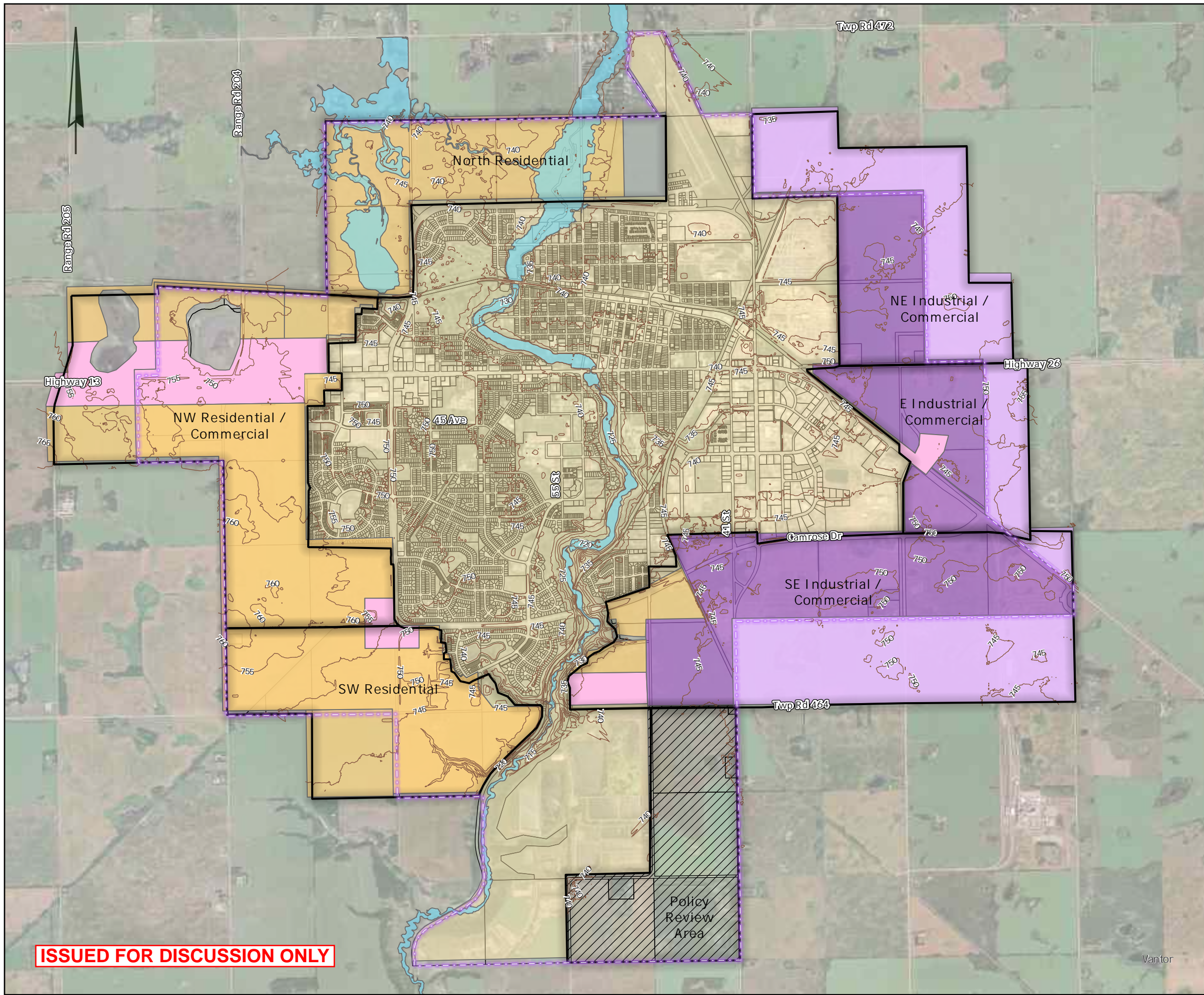
TITLE

**Figure 4
Projected Growth -
Phasing**

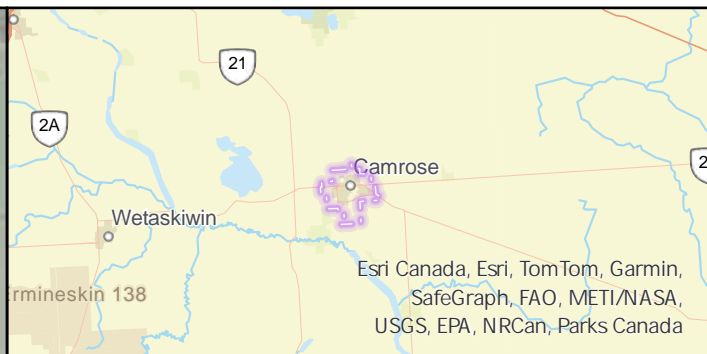
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NAD 1983 3TM 114
Date: 4/30/2026

Vantor



ISSUED FOR DISCUSSION ONLY



LEGEND

- City of Camrose Limit
 - 100 Year Flood Extent
 - Topographic Contour
 - Land Use Zones
- Land Use at Ultimate Stage Area**
- Airport
 - Existing Development
 - Commercial - Industrial
 - Commercial - Mxed Use
 - Future Residential
 - Industrial
 - Policy Review

0 0.5 1 Kilometers



TITLE

**Figure 5
Projected Growth -
Development Type**

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NAD 1983 3TM 114

Date: 4/30/2026

Vantor

2. Analysis Methodology

2.1. DESIGN CRITERIA

The drainage analysis was undertaken with the following aims:

- The minor system has adequate capacity to convey runoff generated by a storm with a return period of 5 years; and
- The major system (ditches, roadways, etc.) has adequate capacity to convey runoff generated by a storm with a return period of 100 years – with some nuisance flooding being deemed acceptable.

The following rate control and quality control targets were adopted for this study and are recommended to be adopted within future developments in the City:

- A maximum release rate of **5.0 L/s/ha** for the 100-year design storm will be required for all proposed developments being completed on previously undeveloped areas.
 - The previous *Stormwater Master Plan Update (2008)* prescribed a maximum release rate of **5.0 L/s/ha** for the 100-year design storm. This was designed to balance two design objectives:
 - The previous Alberta Environment floodplain study for the City of Camrose identified pre-development flows in the Camrose Creek basin at 3.5 L/s/ha; the intention is for post-development flows to match pre-development flows.
 - Previous City of Camrose Development Standards required flood storage be emptied within 72 hours after the end of the storm. To accomplish this, release rates were required at 5 L/s/ha for residential areas, 6 L/s/ha in industrial areas, and 7 L/s/ha in commercial areas.
 - An update to the floodplain study was published, the *Camrose Flood Hazard Study (2021)* by Northwest Hydraulic Consultants on behalf of the Alberta Government. This report identified peak discharges were noticeably higher than the previous study with the exception of the 2-year estimates. This has been copied from the *Camrose Flood Hazard Study (2021)* for reference below, with Average Percent Increase computed:

Table 2: Comparison with Previous Flood Frequency Estimates

	SITE 1 (UNNAMED CREEK AT THE MOUTH)		SITE 2 (CAMROSE CREEK AT WSC STATION 05FA025)		SITE 3 (CAMROSE CREEK ABOVE THE CP RAIL CROSSING)		SITE 5 (CAMROSE CREEK AT THE DOWNSTREAM END)		AVERAGE PERCENT INCREASE
	AENV (1993)	This Study	AENV (1993)	This Study	AENV (1993)	This Study	AENV (1993)	This Study	
Drainage Area (km ²)	31.3	33.6	355	409	411	457	444	500	
Drainage Area (km ²)	31.3	33.6	355	409	411	457	444	500	
Return Period (year)	Peak Instantaneous Discharge (m ³ /s)								
100	5.11	7.53	30.8	40.7	34.3	43.5	36.3	43.3	31.0%
50	3.92	6.14	23.6	33.2	26.3	35.5	27.9	36.7	39.9%
20	2.74	4.37	16.5	23.6	18.4	25.3	19.5	26.6	42.7%
10	1.98	3.11	12.0	16.8	13.3	17.9	14.1	19.0	40.3%
5	1.40	1.94	8.46	10.5	9.43	11.2	9.99	11.8	24.5%
2	0.69	0.69	4.16	3.74	4.64	4.00	4.91	4.22	2.2%

- Refer to **Appendix D – Camrose Flood Hazard Study: Study Area and Basin Overview** for flow change locations (Sites 1-5). These sites provide reasonable coverage across the City of Camrose, with different creek / tributary locations being captured, and no site being far outside the City boundary. This coverage should provide a satisfactory approximation of hydrologic characteristics in the City of Camrose.
- At an Average Percent Increase of **30.98%**, this increases the pre-development rate from the previous Alberta Environment floodplain study from 3.5 L/s/ha to 4.6 L/s/ha.
- The increased pre-development rate is still below the prescribed 5.0 L/s/ha release rate specified in the previous *Stormwater Master Plan Update (2008)*. Using the same logic, the 5.0 L/s/ha release rate is still a reasonable balance of objectives.
- Several municipalities in Alberta have introduced volume control targets to reduce the impact to downstream receiving water bodies (e.g., erosion) due to increased runoff volumes. A study could be considered to assess the impact of increased runoff volumes on Stoney Creek. The results of the study would indicate whether the City should adopt both rate and volume control targets. For



clarity, the purpose of this is to limit total runoff, rather than just attenuation. However, this is not commonly adopted unless there are known problems, as this can be an arduous burden on developers.

- To improve stormwater runoff quality and reduce the potential impact on the receiving waters, flows will be required to meet water quality targets as set out by Alberta Environment and Protected Areas. These targets require that at least 85% of TSS from stormwater runoff be removed for particle sizes greater than or equal to 75 microns.

Pipes were deemed to be under capacity, and therefore recommended for upgrade, if the design flow is greater than the capacity of the pipe ($Q_{DES} > Q_{CAP}$). For storm sewers recommended for upgrade based on capacity constraints, upgrades have been based on the existing system Hydraulic Grade Line (HGL) analysis and perceived importance in the drainage system. Perceived importance is based on:

- The relative size of the contributing catchment area;
- Location of sewer alignment (e.g., easement through private property, local road, arterial road, etc.); and
- Location of flooding upon sewer failure.

It is recommended that the City review and revisit the proposed upgrade phasing and adjust the project priorities based on available budget, other capital projects (e.g., roadway, water, sanitary, etc.) being completed in the area, known maintenance issues, etc.

As per the *City of Camrose Minimum Design Standards for Development* (April 2004), the 5-year 4-hour Chicago storm distribution (pipe conveyance), 100-year 4-hour Chicago storm distribution (overland conveyance), and 100-year 24-hour Huff storm distribution (storage) was used to analyze the City drainage system. These values are based on the 2022 IDF curve for Camrose Climate Station 3011240 developed by Environment Canada.

The previous *Stormwater Master Plan Update (2008)* recommended increasing the maximum active storage depth for dry and wet Stormwater Management Facilities (SWMFs) to 2.0 m to minimize footprint. This is a reasonable recommendation, and is recommended for adoption into *City of Camrose Minimum Design Standards for Development*.

The following guidelines and standards were used to establish design criteria, according to the following hierarchy.

- *City of Camrose Minimum Design Standards for Development* (April 2004), published by the City of Camrose.
- *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems: Part 5 Stormwater Management Guidelines of a Total of 5 Parts* (March 2013), published by Alberta Government.
- *Volume 3 Drainage. Vol 3-03: Design Guidelines* (February 2022), published by EPCOR.



- *Code of Practice for the Hydraulic Modeling of Urban Drainage Systems Version 01*, published by Chartered Institution of Water and Environmental Management (CIWEM).
- *Rules for Responsible Modeling (4th Edition)*, published by CHI (Computational Hydraulics International).
- *Camrose Stormwater Management Plan Update* (January 2008), by Associated Engineering.

Table 3: Design Criteria

DESIGN PARAMETER	VALUE	REFERENCE
DESIGN STORM		
Minor System (Pipe Conveyance)	1:5-yr Return Period 4-hour Duration Chicago Distribution	City of Camrose Minimum Design Standards for Development, Section 5. City of Camrose (2004)
Major System (Overland Conveyance)	1:100-yr Return Period 4-hour Duration Chicago Distribution	City of Camrose Minimum Design Standards for Development, Section 5. City of Camrose (2004)
Major System (Storage)	1:100-yr Return Period 24-hour Duration Huff Distribution	City of Camrose Minimum Design Standards for Development, Section 5. City of Camrose (2004)
RELEASE RATE		
Q ₁₀₀ Maximum Allowable Release Rate	5.0 L/s/ha	Stormwater Master Plan Update. Associated Engineering (2008)
PIPE DESIGN		
Velocity	Minimum 0.6 m/s	Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems Part 5 Stormwater Management Guidelines of a Total of 5 Parts. Section 5.2.2.2 Table 5.1. Alberta Government (March 2013).



DESIGN PARAMETER	VALUE	REFERENCE
Minimum Slope	300 mm: 0.194% 375 mm: 0.145% 450 mm: 0.114% 525 mm: 0.092% 600 mm: 0.077% 675 mm: 0.065% 750 mm: 0.057% 900 mm: 0.045% 1050 mm: 0.036% 1200 mm: 0.031% 1350 mm: 0.027% 1500 mm: 0.023% 1650 mm: 0.020% 1800 mm: 0.018% 1950 mm: 0.016% 2100 mm: 0.015% 2250 mm: 0.013% 2400 mm: 0.012% 2550 mm: 0.011% 2820mm: 0.010%	Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems Part 5 Stormwater Management Guidelines of a Total of 5 Parts. Section 5.2.2.2 Table 5.1. Alberta Government (March 2013).
Minimum Diameter	300 mm	Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems Part 5 Stormwater Management Guidelines of a Total of 5 Parts. Section 5.2.2.2 Table 5.1. Alberta Government (March 2013).
Minimum Depth of Cover	1.85 m Can be reduced through the mitigative measures such as insulation.	City of Camrose Minimum Design Standards for Development, Section 5.3.1. City of Camrose (2004)
Maximum Manhole Spacing	120 m	City of Camrose Minimum Design Standards for Development, Section 5.4.2. City of Camrose (2004)



DESIGN PARAMETER	VALUE	REFERENCE
STORMWATER MANAGEMENT FACILITIES		
Minimum Freeboard	0.6 m	Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems Part 5 Stormwater Management Guidelines of a Total of 5 Parts. Section 5.2.2.2 Table 5.1. Alberta Government (March 2013).
Maximum Active Storage Depth	1.5 m (Recommended to be increased to 2.0 m)	City of Camrose Minimum Design Standards for Development, Section 5.8.10. City of Camrose (2004)
Minimum Interior Side Slopes	7H:1V between high water level and 0.5m below normal water level 4H:1V below 0.5m below NWL	City of Camrose Minimum Design Standards for Development, Section 5.8.10. City of Camrose (2004) Standard Drawings U12 & U13
Minimum Width (Minimum Measurement Across Centre of Facility)	25 m	City of Camrose Minimum Design Standards for Development, Section 5.8.9. City of Camrose (2004)

2.2. DESIGN STORMS

Per the *City of Camrose Minimum Design Standards for Development*, a storm duration of 4 hours will be used for evaluation of conveyance infrastructure, including the gravity pipe network and road gutter system. A storm duration of 24 hours will be used for the design and assessment of storage facilities and conveyance elements located downstream of storage facilities.



Table 4: Design Storm Rainfall Totals

RETURN PERIOD, DURATION, DISTRIBUTION	RAINFALL (2023) (mm)
5-year 4-hour Chicago Distribution (Minor System)	29.2
100-year 4-hour Chicago Distribution (Major System – Conveyance)	45.1
100-year 24-hour Huff Distribution (Major System – Storage)	78.6

2.3. MODEL DEVELOPMENT

2.3.1. PCSWMM Model

Hydraulic modeling was undertaken to ascertain the performance of the existing and proposed stormwater collection system, completed to develop strategies for the management of stormwater within the City boundary. Model results have been evaluated based on the capacity analysis criteria outlined in **Table 3: Design Criteria**. Single event computational modeling was undertaken to evaluate the existing and proposed drainage systems under peak design discharge conditions. The hydrologic / hydraulic model was developed in PCSWMM version 7.1. PCSWMM is an adaptation and enhancement of the well-known and widely used United States Environmental Protection Agencies (USEPA) Stormwater Management Model (SWMM) version 5.1. PCSWMM was developed by Computational Hydraulics International (CHI) as a combination hydrology-hydraulic model.

The hydrology component performs the rainfall to runoff conversion by applying a user-selected loss method that considers both pervious and impervious areas. A runoff hydrograph is then generated for each of the specified catchments, based on the catchment's characteristic width and roughness. The hydrograph is then routed to a junction. From there, the hydraulic portion of the model routes the flow through a series of conduits (ditches, storm sewers, culverts, etc.) and storage elements using a routing methodology, such as the Dynamic Wave equation used in this analysis. The Dynamic Wave methodology was selected for this assignment as it can effectively account for backwater (surcharge) effects.

The drainage system was analyzed using a dual drainage model. The dual drainage model was set up in PCSWMM using the dual drainage creator tool. Standard roadway cross sections corresponding to the *City of Camrose Minimum Design Standards for Development Table 7.1 Summary of Recommended Design Standards for Streets* were used to model the overland flow. Note that while the standard roadway cross sections was used to model the overland flow, there may be some existing roads within developed areas of the City that were constructed to a different standard, which could impact the model results by allowing more or less storage within the cross-section; this would affect the depth of ponding computed



within the roadways, affecting the flooding analysis. For this analysis, the dual drainage system was set up using established catch basin inlet capacity curves.

Hydrologic / hydraulic modelling requires several inputs to simulate the rainfall-to-runoff and routing process. **Table 5: Hydrologic Model Input Parameters** identifies the global input parameters required for the hydrologic / hydraulic simulation of the catchment areas and conduits. The following assumptions were made in the selection of parameters:

- Depression storages are based on typical values used for similar land uses and soils types; and
- Infiltration losses are estimated using the Green-Ampt method; these values are based on the soil characteristics outlined in **Section 1.3.1.2**.

Catchments were rationalized using a combination of current orthophoto, land use and property lines, LiDAR, and pipe layout, combined with the PCSWMM watershed delineation tool. Catchments were evaluated at a level of approximately ½ block, depending on individual characteristics.

Table 5: Hydrologic Model Input Parameters

DESIGN PARAMETER	VALUE	REFERENCE
Catchment Area	NA	Catchments delineated based on cadastral and LiDAR data
Overland Impervious Manning's Roughness Coefficient, n	0.013	Assumed for asphalt and concrete (Storm Water Management Model Reference Manual Volume I – Hydrology, pg. 75, 2016)
Overland Pervious Manning's Roughness Coefficient, n	0.15	Based on sheet flow through grass (Storm Water Management Model Reference Manual Volume I – Hydrology, pg. 75, 2016)
Catchment Slope	Varies	LiDAR data
Impervious Depression Storage	1.6 mm	Value approximated through review of various published ranges (Storm Water Management Model Reference Manual Volume I – Hydrology, pg. 77, 2016)
Pervious Depression Storage	3.2 mm	Value approximated through review of various published ranges (Storm Water Management Model Reference Manual Volume I – Hydrology, pg. 77, 2016)
Impervious Disconnect	Dependent of Location	NA



DESIGN PARAMETER	VALUE	REFERENCE
Infiltration Loss Method	Green-Ampt	NA
Suction Head	208.8 mm	Soil assumed to be clay loam (based on review of previous Stormwater Master Plan Update (2008) and historical geotechnical reports)
Conductivity	2.0 mm/hr	Soil assumed to be clay loam (based on review of previous Stormwater Master Plan Update (2008) and historical geotechnical reports)
Initial Deficit	0.25	Soil assumed to be clay loam (based on review of previous stormwater master plan and historical geotechnical reports)
Conduit Manning's Roughness Coefficient, n (Smooth-Walled Pipe)	0.013	City of Camrose Minimum Design Standards for Development, Section 5.1.0. City of Camrose (2004)

2.3.2. Model Calibration

A flow monitoring program was initiated to calibrate the model based on real-world data, to create a model describing the Camrose stormwater management system. This allows more accurate assessment of system performance and risk of flooding.

2.3.2.1. Flow Monitoring Objectives

The objective of selecting sites for flow monitoring is to identify manholes suitable for model calibration and validation. To confirm that the future collected flow data is reliable and meets the modeling objectives, monitoring locations should be selected based on the following characteristics:

- Located at project boundary points;
- Located on branch lines near trunk sewer;
- Upstream of a system loss;
- Upstream of pump stations;
- Upstream and downstream of split manholes;
- No detention tanks / SWMFs in the sub-catchment;
- Manholes without a drop between the inlet / outlet pipes;
- The inlet / outlet pipes should be of the same size, have bends smaller than 15 degrees and preferably with slopes less than 1%. This would avoid locations where turbulence or supercritical conditions may occur;
- No downstream bottlenecks, to avoid backwater effects; and
- The selected sites should represent the different soil textures and types of developments found in the region (e.g., flow monitors for older and newer residential developments).



A one-minute data collection interval was recommended for all locations.

Four sites were ultimately selected, with the intention that calibrated flow characteristics from these areas be broadly applied across the City:

- *Flow Monitor 1 (South of 39 Avenue)*: Intended to capture flow patterns from southwest residential areas, including Duggan SWMF and Marler Drive corridor.
- *Flow Monitor 2*: Intended to capture flow patterns from established western residential areas.
- *Flow Monitor 3 (South of 53 Street / 48A Avenue)*: Downstream of downtown commercial area.
- *Flow Monitor 4 (Rail Crossing East of Mohler Industrial Area)*: Receiving storm sewer main for large part of Mohler industrial area.

The acceptability of model results was based on the *Rules for Responsible Modeling* and the *Urban Drainage Group Code of Practice for the Hydraulic Modeling of Urban Drainage Systems* per **Section 2.1**. The standards employed are as follows:

- Percent Error in Peak Flow: +25% to -10% is considered good, +30% to -15% is considered reasonable and >30% to <-15% is considered poor.
- Percent Error in Volume: +20% to -10% is considered good, +25% to -15% is considered reasonable and >25% to <-15% is considered poor.
- Nash Sutcliffe Efficiency: a score higher than 0.5 is considered good, a score between 0.4 and 0.5 is considered reasonable and a score lower than 0.4 is considered poor.

2.3.2.2. Rainfall

Rainfall data retrieved from the temporary tipping bucket rain gauge installed at the Camrose Fire Hall building was analysed to determine a suitable time period of dry weather and was reviewed against the Camrose Environment Canada Rain Gauge 3011240 located at the Camrose Airport immediately north of the City. A second temporary rain gauge was installed at the South Lift Station (servicing the sanitary sewer system) at a later date, as described below.

Three significant storms were observed during the reporting period: June 27, July 28-30, August 4-5,

- June 27 4:00 – June 27 19:00: 18.3 mm (total). Rainfall was concentrated over a 3-hour period between 12:00 and 15:00 with a depth of 15.6 mm.
- July 29 20:00 – July 29 21:55: 12.6 mm (total). Rainfall was fully concentrated over a 2-hour period.
- August 4 12:00 – Aug 5 10:00: 43.8 mm (total). Rainfall was concentrated over a 3-hour period between August 4 23:00 and August 5 2:00 with a depth of 43.8 mm.



Results from these events are summarized in **Table 6: June 27 Modeled and Monitored Peak Flow**, **Table 7: July 29 Modeled and Monitored Peak Flow**, and **Table 8: Aug 4-5 Modeled and Monitored Peak Flow**.

The project rain gauge at the Camrose Fire Hall was reviewed after a May 6-8 storm event recorded as part of a separate project, and rainfall noted was significantly lower than that recorded by the Environment Canada rain gauge. A new rainfall gauge was installed to replace the previous gauge at the South Lift Station. Audit of the second rain gauge data at the South Lift Station showed significantly lower rainfall than the Environment Canada rain gauge as well. Additionally, rainfall was not reported during periods of known rainfall.

For these reasons, data from the installed project rain gauges were dismissed in favor of the Environment Canada rain gauge due to these inconsistencies. The drawback to the Environment Canada rain gauge is the data is reported hourly as opposed to the more precise 5 minute increments in the project rain gauge. To create a rain gauge with 5-minute increments from this hourly data, a Gaussian (or normal) distribution was applied to periods of concentrated rainfall. This was verified against patterns in flow monitor data, to confirm regular patterns.

2.3.2.3. Results

Table 6: June 27 Modeled and Monitored Peak Flow

FLOW MONITOR	DAY	MODELED (L/s)	MONITORED (L/s)	DIFFERENCE (%)
1	June 27	500	536	7.2%
2	June 27	300	381	27.4%
3	June 27	180	161	-10.2%
4	June 27	693	292	-57.9%

Table 7: July 29 Modeled and Monitored Peak Flow

FLOW MONITOR	DAY	MODELED (L/s)	MONITORED (L/s)	DIFFERENCE (%)
1	July 29	372	299	-19.7%
2	July 29	266	228	-14.4%
3	July 29	154	222	44.0%
4	July 29	69	16	-77.5%



Table 8: Aug 4-5 Modeled and Monitored Peak Flow

FLOW MONITOR	DAY	MODELED (L/s)	MONITORED (L/s)	DIFFERENCE (%)
1	Aug 4-5	1,255	1,321	-5.3%
2	Aug 4-5	1,009	1,005	-0.4%
3	Aug 4-5	901	459	-49.1%
4	Aug 4-5	1,181	749	-36.6%

Table 9: Modeled and Monitored Absolute Average Percent Difference

FLOW MONITOR	ABSOLUTE DIFFERENCE (%)	RELIABILITY
1	10.7%	Reasonable
2	14.1%	Reasonable
3	34.4%	Poor
4	57.3%	Poor

Flow monitor data was reviewed for consistency. Flow Monitors 1 and 2 produced reasonable results according to stated evaluation criteria, while Flow Monitors 3 and 4 were not consistent with modelled results. The following inferences have been made from flow monitoring results:

- Residential area model results are reliable for the purposes of this report and can be used for analyzing system capacity.
- Industrial area model results do not fit the flow monitoring data. Results from analysis in the industrial area should be reviewed once the root cause of the discrepancy is addressed.
- Commercial area model results do not fit the flow monitoring data. Results from analysis in the downtown commercial area should be reviewed once the root cause of the discrepancy is addressed.

2.4. MODEL VERIFICATION

Given the model discrepancies with the flow monitoring data, additional verification was performed to review commercial and industrial model results against literature values. Model results have been compared against rational method results as an additional verification check. The rational method is a rudimentary analysis often used for small-scale watershed analysis, widely used because of its simplicity. Drawbacks for the rational method include only reviewing peak runoff, not accounting for antecedent soil conditions, and complexity in determining time of concentration significantly affecting results. The rational method is typically conservative, producing high runoff. While the rational method has limitations, it is still helpful in giving context to model results.



Table 10: Rational Method Absolute Average Percent Difference

DEVELOPMENT TYPE	PERCENT INCREASE FROM MODEL TO RATIONAL METHOD CALCULATION
Industrial	29%
Commercial	28%
Residential	21%

Given known limitations of the rational method, the difference from modeled results to rational method are completely within expectations. This is an expected outcome of this analysis, as values used for the model were in line with industry-standard and literature values. With that said, the cause for the inconsistency in Flow Monitors 3 and 4 remain unknown; possible causes include:

- Upstream infrastructure being different than the GIS database / record drawings,
- Upstream blockages, and
- Unaccounted-for losses, such as that into other infrastructure (i.e., the sanitary system or through exfiltration).
- Failed calibration due to irregularly dry weather, although given the high variance from established literature values / standard results this is considered unlikely.



3. Existing Stormwater Servicing

3.1. EXISTING DRAINAGE SYSTEM

Drainage patterns generally trend towards Stoney Creek, so the drainage system is generally built to discharge to Stoney Creek or Stoney Creek tributaries. The City overland flow system consists of roadside ditches, culverts, and urban curb and gutter, partly controlled by SWMFs. The City is serviced by an underground gravity storm sewer network, ranging from 150 mm diameter services to 2135 mm trunk main diameter, per **Figure 1: Existing Minor System**.

3.1.1. Stormwater Management Facilities

A series of SWMFs are operated across the City. These SWMFs have been summarized in **Table 11: Existing SWMFs**.

3.2. MINOR SYSTEM CAPACITY ASSESSMENT

Computational modelling was undertaken to simulate the rainfall-to-runoff process and determine the peak flows from the sub-catchments during the design storm events. A modeling scenario was developed in PCSWMM to determine if the existing minor system has adequate capacity to convey the 5-year design flows.

Modelling revealed that peak runoff exceeds the capacity of a number of the City's existing storm sewers during the 5-yr 4-hour event, per **Figure 6: Existing Minor System HGL Assessment**. The colour classification depicts the manholes where the modeled design storm HGL is:

- Below the crown of the connecting pipes (green),
- Within 0.3 m of the surface, but still under the surface (yellow), and
- Above the ground, resulting in surface ponding (red).

Storm sewers which are over-utilized (undersized) cause the storm sewer system to surcharge. The modeling was completed using a dual drainage model. Therefore, flow unable to be conveyed in the City's piped storm sewer system is conveyed overland along the roadway.

Typically, there are limited maintenance concerns, and residents are satisfied with the gravity drainage system as long as there is positive drainage sufficient to eliminate standing water, so upgrades to the gravity drainage system are considered low urgency. Instead, upgrades can be included as part of street renewal projects as they are performed across the City, to minimize disruption and promote project economy.

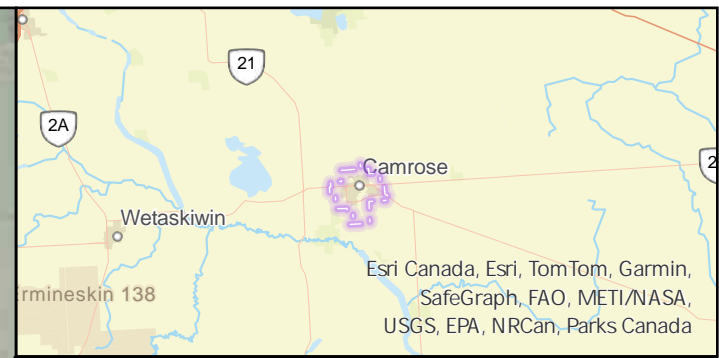
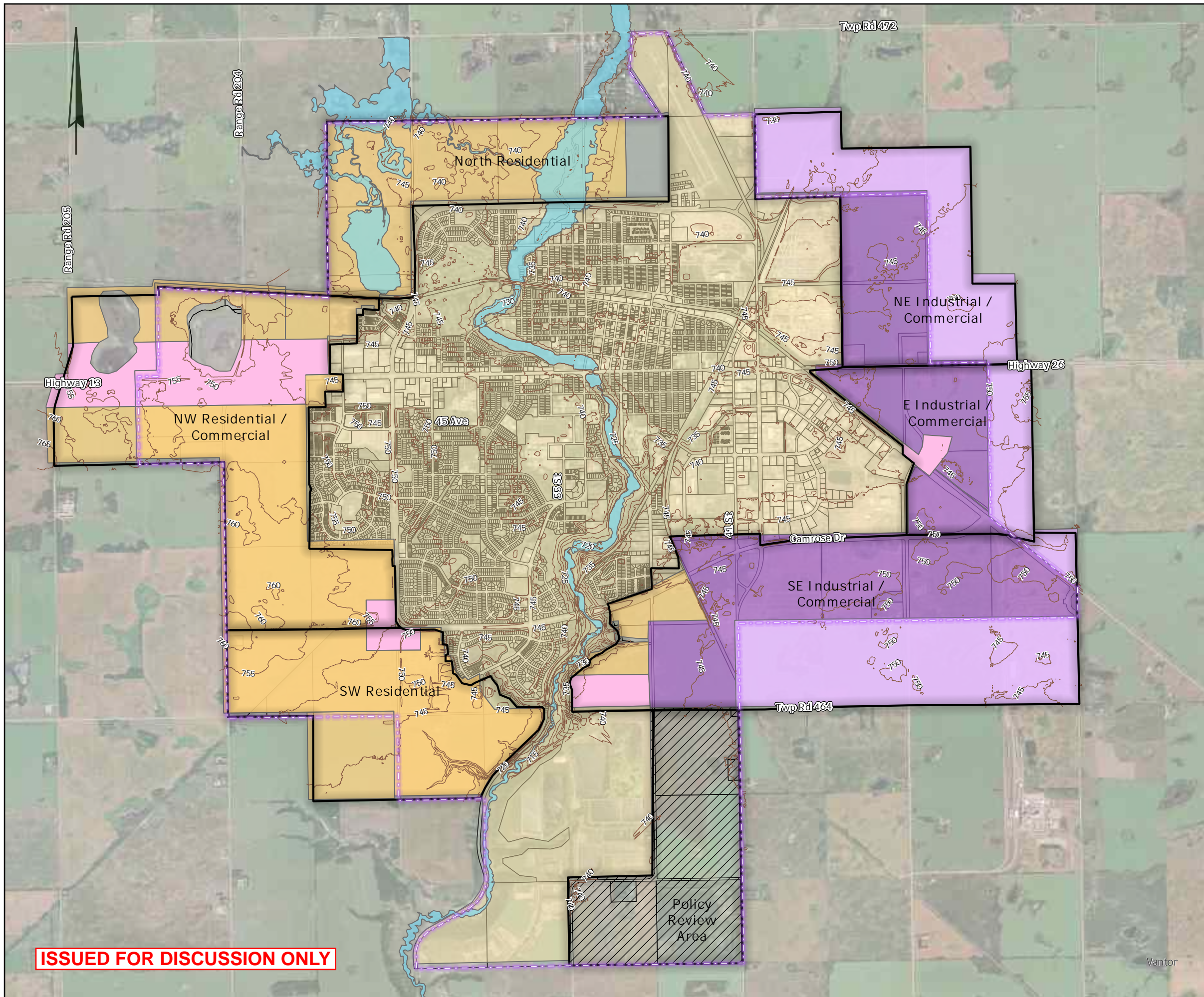
The previous *Stormwater Master Plan Update (2008)* identified that a significant percentage of stormwater pipes exceeded the 5-yr level of service, and recommended decreasing the level of service to 2-yrs. This recommendation has been maintained in this analysis for overall project feasibility.



Table 11: Existing SWMFs

ATTRIBUTES	CASCADES POND	CN MOHLER POND	CORNERSTONE POND	CRE POND	DUGGAN POND POND	VALLEYVIEW POND	WEST PARK POND
NWL (m)	742.51	733.2	742.5	741.3	745.85	739.4	744.5
HWL (m)	743.49	736.4	744.35	742.7	748.9	741.5	746
Active Storage Depth (m)	0.98	3.00	1.85	1.4	3.05	2.1	1.5
Computed Maximum Active Storage Depth (m)	0.52	0.92	1.63	0.18	0.81	0.86	0.58
Orifice	1200 mm x 900 mm Box Culvert	1500 mm \varnothing Outlet / 2.4 m x 2.4 m Control Structure	*	1200 mm \varnothing / 600 mm \varnothing / Weir Overflow Control Structure	600 mm \varnothing with Outlet Structure	300 mm x 300 mm Low Level Outlet with Gate / 900 mm \varnothing Reinforced Concrete	1050 mm \varnothing
Notes	Release controlled by downstream water level meter and valve; valve closes at upstream conduit from Cascades Pond when flow is registered at MH 484 PCSWMM model simulates water level meter and valve through control rule	1500 mm \varnothing Steel Culvert + 1535 mm x 1560 mm Concrete Box Culvert Downstream	*750 mm \varnothing Outlet / 30 L/s Pump / 450 mm \varnothing Forcemain	Record drawing text barely legible	Elevation Datum incorrect on record drawings	Pond curve estimated due to partial drawing	No control orifice or outlet structure specified





LEGEND

- City of Camrose Limit
- 100 Year Flood Extent
- Topographic Contour
- Land Use Zones

Land Use at Ultimate Stage

- Area**
- Airport
 - Existing Development
 - Commercial - Industrial
 - Commercial - Mxed Use
 - Future Residential
 - Industrial
 - Policy Review



TITLE

**Figure 5
Projected Growth -
Development Type**

ISSUED FOR DISCUSSION ONLY

3.3. MAJOR SYSTEM CAPACITY ASSESSMENT

Overland flow routes are incorporated within a drainage system with the intent of providing a safe flow path when the minor storm system becomes overwhelmed during a major storm event (greater than 5-year recurrence interval). As discussed in **Section 2.3**, the modeling was completed using a dual drainage model based on the LiDAR data provided, with the road layout and classification being taken from the City's GIS library, and cross-sections being referenced from *City of Camrose Minimum Design Standards for Development (2004)*. As per the design criteria stated in **Section 2.1**, and the design storms discussed in **Section 2.2**, the overland drainage system was assessed using the 100-yr 4-hr Chicago distribution design storm. For the purpose of evaluating risk, 0.5 m ponding depth in the major system was used to identify areas for further review; this assumes a gutter depth of 0.15 m and minimum building elevation 0.35 m above top of curb. This was also selected to maintain consistency with the previous *Stormwater Master Plan Update (2008)* analysis.

Given the City's access to Stoney Creek as a drainage discharge location, and that reasonable grade is achieved, the City is generally at low risk from flooding. Overland flow routes typically have the capacity to convey the 100-year runoff within the right-of-way (ROW) to the nearest ditch or SWMF.

The model indicates several areas indicating depths exceeding design criteria. These locations were reviewed against trap-low information generated by the LiDAR surface. Model results are shown in **Figure 10: Existing Major System Capacity Analysis**.

3.3.1. Overland Flow

3.3.1.1. 51st Avenue & 46th Street

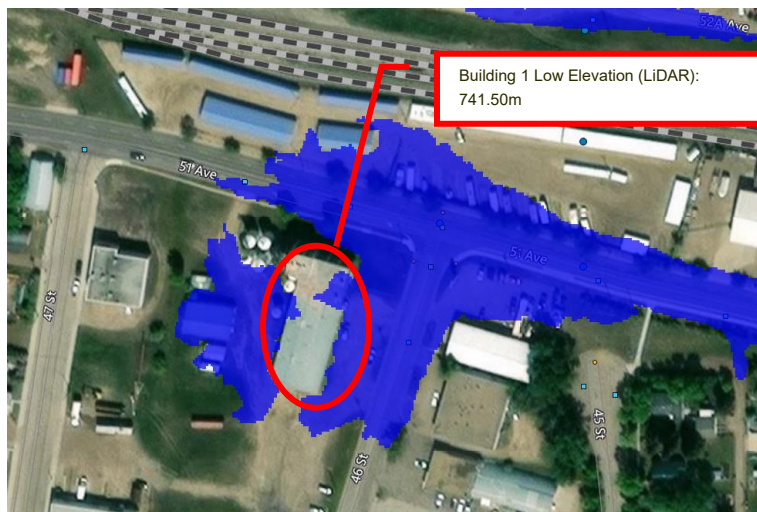


Figure 7: 51st Avenue & 46th Street Flood Risk Analysis

- 100-yr Maximum HGL: 741.5 m
- Building 1 Low Elevation from LiDAR: 741.5 m

LiDAR information indicates the building elevation may be near the maximum HGL. This is considered low risk, as the maximum HGL only slightly exceeds surface grades at the building. Given the uncertainty



in LiDAR data, a grade review could be performed to verify slab elevation as part of the flood risk assessment. If the building is sufficiently low, 2D analysis could be performed to determine where additional steps are required to protect the building.

3.3.1.2. 54th Avenue & 46th Street



Figure 8: 54th Avenue & 46th Street Flood Risk Analysis

- 100-yr Maximum HGL: 739.2 m
- Building 1 Low Elevation from LiDAR: 739.0 m
- Building 2 Low Elevation from LiDAR: 739.2 m
- Building 3 Low Elevation from LiDAR: 739.2 m

Building 1 is inside the trap low footprint, and is within the 100-yr flood elevation, so is at risk in a major storm. This may be a result of poor site grading during initial construction. This property should be reviewed for historical flooding; if there is nothing recorded, this property can be included in a monitoring program.

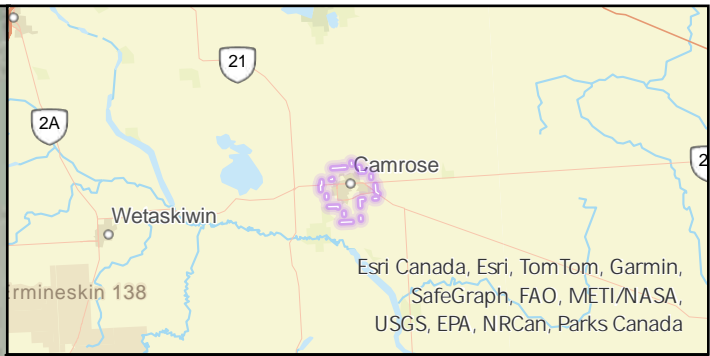
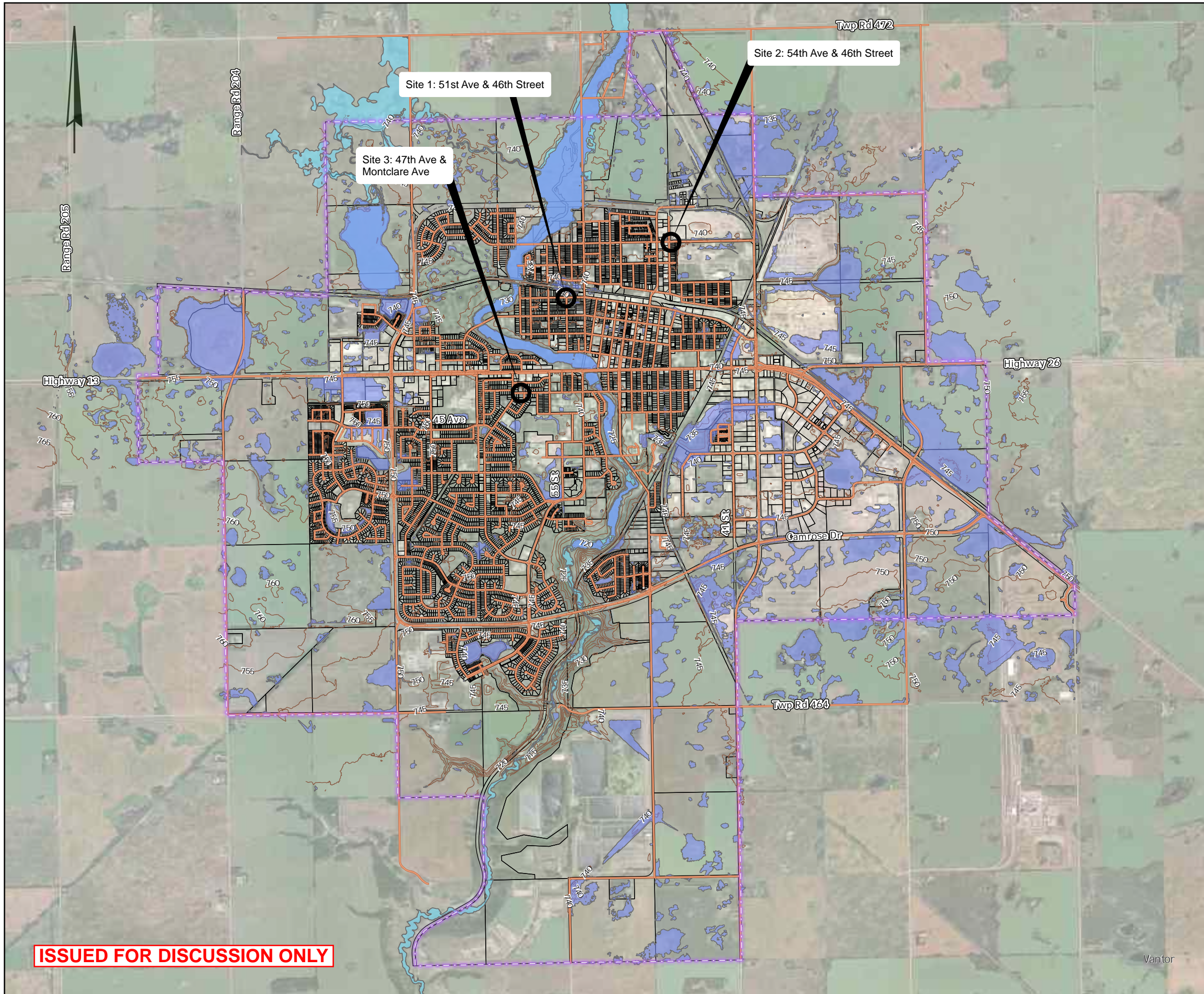
3.3.1.3. 47th Avenue & Montclare Avenue



Figure 9: 47th Avenue & Montclare Avenue Flood Risk Analysis

- 100-yr Maximum HGL: 740.8 m
- Building 1 Low Elevation from LiDAR: 739.9 m

The dual-drainage model indicates a depth exceeding design criteria. However, reviewing surrounding grades and trap low information, runoff during the major storm can discharge to the north properties, and east to Stoney Creek via 48 Avenue. As land patterns permit spillover, no trap low effectively forms, which is why no trap low appears on the figure. While not ideal, this will likely not result in property damage due to free flowing conditions. This area can be highlighted for future monitoring.



LEGEND

- City of Camrose Limit
- 100 Year Flood Extent
- Roadways
- Topographic Contour
- Trap Lows > 0.25 m

0 0.5 1 Kilometers



TITLE

**Figure 10
Existing Major System
Capacity Analysis**

ISSUED FOR DISCUSSION ONLY

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NAD 1983 3TM 114
Date: 4/30/2026

Vantor

4. Proposed System Upgrades

The proposed pipe system was analyzed using PCSWMM with the design criteria discussed in **Section 2.1**. Recommended upgrades are presented on **Figure 11: Proposed System Upgrades**. In locations where the existing system does not have capacity to convey existing flow, pipes have been recommended to be upsized such that the HGL falls within the pipe (i.e., Q_{DES} / Q_{CAP} is less than 1).

However, as discussed in the previous section, the storm sewer system is generally low priority as long as there is positive drainage and no standing water; therefore, it is recommended that the City prioritize upgrades based on available budget, planned capital projects (i.e., roadway, water, sanitary, etc.) being completed in the area, and known maintenance issues.

4.1. MINOR SYSTEM

Pipe grades were generally maintained in this analysis, to mitigate utility conflicts to the extent possible. Pipe upgrades to meet design criteria have been tabulated in **Appendix A – Pipe Upgrade Summary**. High level cost estimates for these upgrades have been included in **Table 12: Cost Estimate – Existing Minor System Upgrades**, discussed in **Section 6.2**.

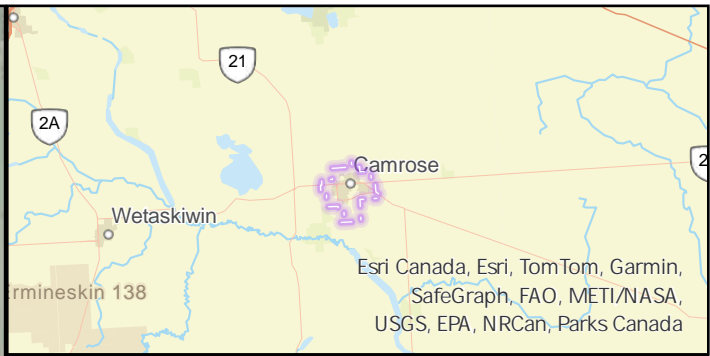
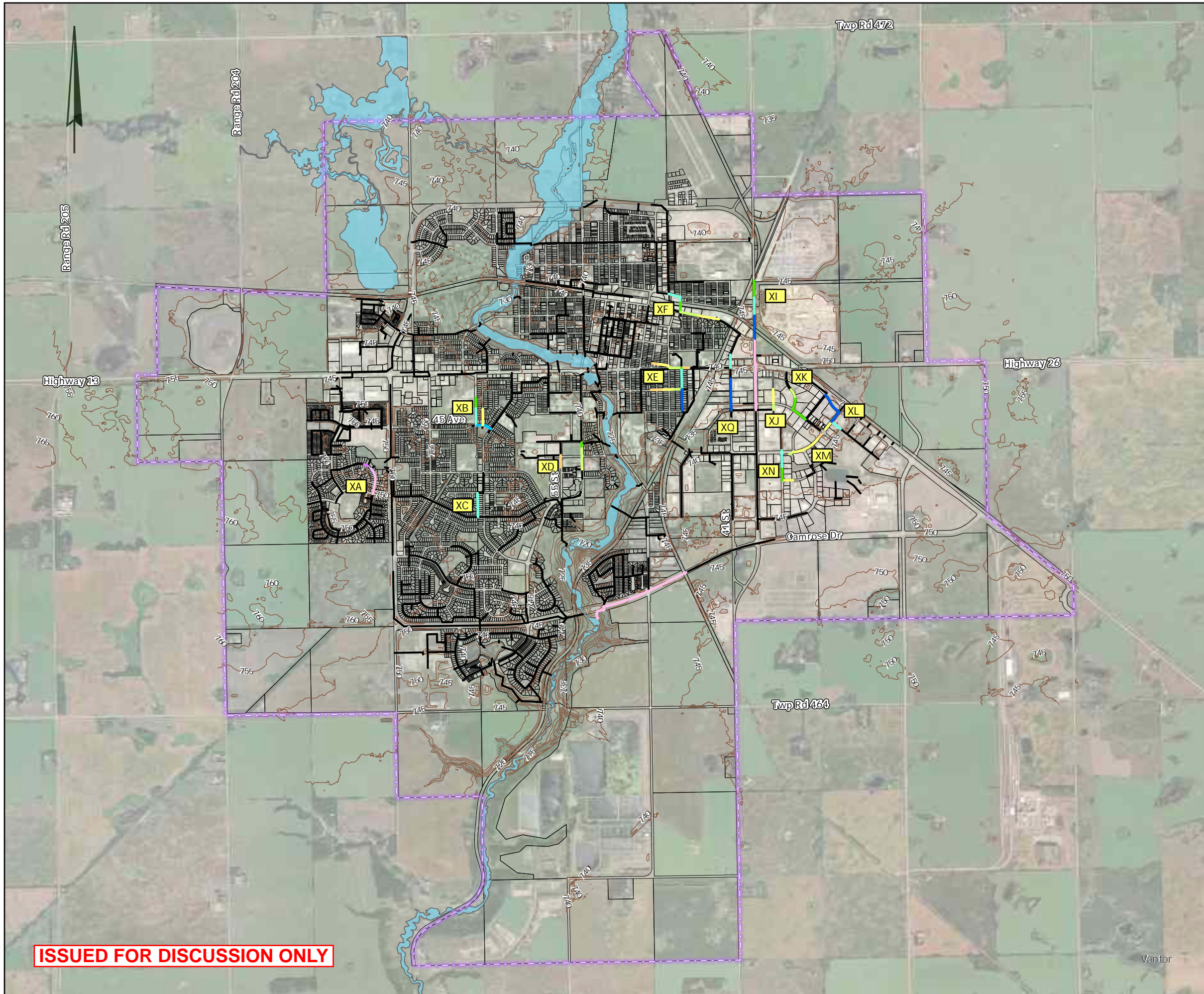
Several alternatives exist to eliminate ponding / flooding and reduce the HGL within the minor system other than increasing the pipe sizes as identified in this report. These alternatives include introducing storage elements wherever possible. Some examples of alternative methods that could be employed include:

- Oversized pipes;
- Underground storage tanks;
- Introducing Inlet Control Devices at strategic locations to create surface trap lows; and
- LID measures (such as rain gardens or soil/water underground storage tanks (i.e. Silva Cells)).

4.2. MAJOR SYSTEM

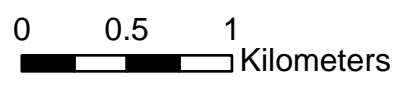
As discussed in **Section 3.3**, the model indicates several locations within the City with elevated flood levels; however, these locations are considered low risk, and upgrades are not recommended without further review.

Additionally, model results indicate existing SWMFs maximum depth is within the design active storage depth, and upgrades are not required at this time.



LEGEND

- City of Camrose Limit
- Topographic Contour
- 100 Year Flood Extent
- Existing Conduits
- Proposed Upgrades**
- Pipe Diameters (mm)**
- 375
- 450
- 525
- 600
- 675
- 750
- 825
- 900
- 1050
- 1200
- 1350
- 1650



TITLE

**Figure 11
Proposed System Upgrades**

ISSUED FOR DISCUSSION ONLY

5. Future Development Stormwater Strategy

5.1. APPROACH

Future growth horizons were provided by the City to match the Water Master Plan being produced concurrently, per **Figure 4: Projected Growth – Phasing**. To develop this land, a stormwater servicing strategy is required to confirm that the lands are developed sustainably and runoff is drained effectively and efficiently. The proposed developments will substantially increase impervious areas by introducing paved surfaces and buildings. This increase in imperviousness will cause runoff rates and volumes to increase, which must be mitigated to prevent flooding and damage of downstream property, infrastructure, and natural systems. Based on Alberta Environment and Protected Areas guidelines, post-development flows should be limited to pre-development rates. Per **Section 2.1**, the 5 L/s/ha release rate is recommended to be maintained from the previous *Stormwater Master Plan Update (2008)*.

Stormwater management has generally been conceptualized to accomplish the following objectives:

- Expand the system to service 10-yr, 25-yr, 50-yr, and Ultimate future growth horizons according to **Section 1.4**,
- Take advantage of existing grades to the extent possible to optimize bury depths and minimize the earthworks required to achieve positive drainage,
- Take advantage of likely development sequencing,
- Configure the pipe network to avoid new lift station construction, while avoiding unfeasibly deep bury depths,
- Where feasible, install neighbourhood-level stormwater management facilities to accommodate greater development areas, although targeting a maximum drainage catchment of a single quarter section, and
- Where feasible, avoid installing smaller stormwater management facilities in series, sometimes referred to as ‘leapfrogging’.

The SWMFs were placed at low points according to these objectives and near the identified discharge points. The SWMFs and storm sewer systems for the future developments were designed based on the following criteria:

- SWMFs are sized using the 100-year 24-hour Huff distribution design storm,
- SWMFs are located to act as regional SWMFs,
- SWMFs are located at low points within the developments,
- Permanent depths of 2 m are assumed for SWMFs for water quality,
- Future residential development was assumed to consist of suburban homes with a percent total percent imperviousness of 55%,
- Future commercial development was assumed at imperviousness of 75%, and

- Future industrial development was assumed at imperviousness of 65%.
- Offsite flows are conceptualized to overflow the outlet control structure. For this reason, some of the shown will exceed the 1.5m active storage depth design criteria by a small amount.

Future development largely does not impact existing infrastructure, as stormwater management infrastructure has generally been conceptualized to discharge to tributaries to Stoney Creek or existing wetlands to maintain pre-existing drainage patterns and limit excessive fills. This is further managed through SWMF design limiting discharge to 5.0 L/sha, to match pre-development peak discharge. As an additional note, wetlands will require hydrologic and environmental review for increase in total volume and sensitivity to contamination prior to being used for this purpose.

Any SWMFs within the vicinity of the airport are recommended to be developed as dry SWMFs, or incorporate other measures if developed as wet SWMFs, to avoid attracting waterfowl.

SWMF properties have been summarized in **Appendix C – Proposed SWMF Parameters**. High level cost estimates for these SWMFs have been included in **Table 13: Cost Estimate – Future Development**, discussed in **Section 6.3**.

Additionally, subdivision storm sewer networks have not been rationalized for the purpose of this analysis, other than where SWMFs are connected in series, as it is assumed layout will be heavily influenced by lot layout / road network, with costs born by the developer.

5.2. PROPOSED UPGRADE PHASING

5.2.1. North Residential

Drainage generally trends towards Stoney Creek. The north residential area is split into four different subcatchments, each requiring its own SWMF.

5.2.1.1. Stage 1 & 2

- There are no proposed developments within the Stage 1 or Stage 2 development horizons.

5.2.1.2. Stage 3

- N_RES_302, N_RES_303, and N_RES_304 are proposed to discharge to a series of three SWMFs, N_R_045, N_R_044, and N_R_043 respectively, all located at low points to minimize grading effort. These SWMFs are all proposed to discharge directly to Stoney Creek. SWMF N_R_045 will also service part of an Ultimate development area; SWMF N_R_045 will need to be fully constructed during Stage 3 construction to avoid construction staging constraints.
- NW_RES_301 on the southwest quarter section is proposed to discharge to SWMF N_R_047, in turn discharging to SWMF N_R_046 and SWMF N_R_045 all along a new conduit.
- There is an existing stormwater main on 66th Street, just north of 54th Avenue. This was reviewed as a potential discharge location for N_RES_301 and SWMF N_R_0047. However, high level review of site grades indicate this is likely not possible without unfeasible amount of import fill. Additionally, the stormwater main would require upsizing before being used for this purpose. It is



recommended to construct a new conduit and outfall as shown, although a high level feasibility study could be performed to refine the approach if this is contested.

- N_RES_301 indicates a large area identified in the *Camrose Flood Hazard Study* (2019), by Northwest Hydraulic Consultants. This will need to be reviewed by City planning and engineering to determine appropriate restrictions on development. For the purpose of this analysis, it is assumed development will be allowed to proceed, with SWMF N_R_047 being placed at a low point within quarter section N_RES_301.

5.2.1.3. *Ultimate*

- N_RES_U01 is proposed to discharge to SWMF N_R_044, in turn discharging to Camrose Creek.
- N_RES_U02 is proposed to discharge to SWMF N_R_046, discharging to SWMF N_R_045, then Camrose Creek.
- N_RES_U03 is proposed to discharge to SWMF N_R_047, discharging to SWMF N_R_046, SWMF N_R_045, then Camrose Creek.

5.2.2. Northwest Residential / Commercial

5.2.2.1. *Wetland Summary*

An important consideration of this are two low-lying wetlands within NW_RES_U04 / NW_COMM_U02 and NW_RES_301 / NW_COMM_U01 / NW_RES_U01:

- Surrounding areas drain towards these wetlands, and it is recommended that future development maintain these drainage patterns.
- These wetlands are proposed to be converted to wet pond SWMFs, to take advantage of natural drainage patterns and maximize developable land.
 - Additional environmental studies are required to determine potential impacts on affected wetlands prior to construction, and necessary environmental approvals by Alberta Environment obtained. This is expected to be an arduous process; further detail on necessary permitting has not been described here, as environmental approval processes are known to change depending on current government policy.
 - This also might include establishing wetlands elsewhere, the cost of which would need to be born by the developer.
- If environmental restrictions make this approach unfeasible, an alternative approach would be to have SWMFs discharging to the wetlands. This would require additional environmental studies / approvals as well, to determine impact from increased volume and pollution.



There is a drainage split along the future westerly extension of Camrose Drive, with areas north of Camrose Drive draining north / northeast. Development approach and staging are generally described below:

5.2.2.2. Stage 1

- There are two Stage 1 development areas.
 - There is a Stage 1 commercial development area, NW_COMM_101, proposed to discharge to a new SWMF NW_C_004. SWMF NW_C_004 is proposed to discharge to the northwest Cornerstone development perimeter swale.
 - There is a Stage 1 residential development area, NW_RES_101, proposed to connect to existing stormwater management infrastructure, discharging to the existing Cascade Pond. The Cascade Pond was reviewed for performance with this additional contributing area; model results indicate the modeled 100-yr HWL is below the design 100-yr HWL, so can accommodate the additional loading.

5.2.2.3. Stage 2

- There are four Stage 2 development areas.
 - The Stage 2 commercial development, NW_COMM_201, is proposed to discharge to a new SWMF NW_C_006, intended to discharge to the Cornerstone development perimeter swale. Results indicate the existing Cascade Pond can support this additional runoff.
 - The Stage 2 residential development to the north, NW_RES_203, is proposed to discharge to a new SWMF NW_R_005. SWMF NW_R_005 is proposed to discharge to the conduit connecting to SWMFs N_R_047, then N_R_046, then N_R_045.

Given the proximity to the Cascade stormwater management system, an alternative connection to existing infrastructure was considered; however, the downstream Cascade stormwater management system lacks capacity to accept this additional flow, so connection is not possible without expanding the Cascade SWMF.

- The Stage 2 residential development to the west of the existing Cornerstone development, NW_RES_202, is proposed to discharge to a new SWMF NW_C_004, tying into the northwest Cornerstone development perimeter swale.
- The Stage 2 residential development to the south, NW_RES_201, is proposed to discharge to a new SWMF NW_R_009, which in turn connects to the existing Camrose Drive sanitary main. This was preferred rather than an alternative to connection to Stage 3 infrastructure to the south, to avoid additional large capital costs to support Stage 2 development. Note that designing the SWMF NW_R_009 with a 5.0 L/s/ha release rate triggered upgrades to the downstream system. To mitigate downstream upgrades, SWMF NW_R_009 was oversized to accommodate a reduced release rate.



5.2.2.4. Stage 3 & Ultimate

- Stage 3 and Ultimate development areas are proposed to ultimately discharge to the proposed wetland conversions, SWMFs NW_WP_001 and NW_WP_002.
 - NW_RES_302 and NW_RES_303 are proposed to discharge to SWMF NW_R_007 and SWMF NW_R_008 respectively. These SWMFs are proposed to operate in series, discharging to the proposed wetland conversions.
 - The remaining Stage 3 and Ultimate development areas are proposed to discharge directly to SWMFs NW_WP_001 and NW_WP_002.
 - NW_WP_001 is proposed to maintain its existing natural drainage outlet to the north. Downstream conditions should be confirmed as part of any environmental / hydrology studies relating to the wetland conversions.
 - NW_WP_002 is proposed to connect to the downstream proposed SWMFs NW_R_003, N_R_047, N_R_046, and N_R_045, in order of sequence.

5.2.3. Southwest Residential

There is a tributary running through this development area to the south; surrounding areas drain into this tributary.

5.2.3.1. Stage 1 & Stage 2

- Stage 1 development area, and Stage 2 development area bounded by the future westerly extension of Camrose Drive, Camrose Drive, the Century Meadows / Valleyview subdivision, and Range Road 204 are proposed to connect to the existing Century Meadows / Valleyview stormwater management system. These areas have previously been incorporated into the Century Meadows / Valleyview subdivision plan. The existing Century Meadows SWMF outlet structure will also need to be modified to receive the additional contributing area.

5.2.3.2. Stage 3 & Ultimate

- Remaining Stage 3 and Ultimate development areas will require new SWMFs SW_R_010, SW_R_011, SW_R_012, SW_R_013, SW_R_014, and SW_R_015. SWMF SW_R_011 is proposed to discharge to SWMF SW_R_012 to accommodate site grading and avoid difficulties in development staging. Attempts have been made to limit the number of SWMFs, but layout is constrained by the unnamed Stoney Creek tributary.

5.2.4. Northeast Industrial / Commercial

Existing drainage patterns for these zones trend northwest. Several SWMFs have been conceptualized for the stormwater management strategy for the entire NE Industrial / Commercial development area:

5.2.4.1. Stage 1 & 2

- There are no proposed developments within the Stage 1 or Stage 2 development horizons.



5.2.4.2. Stage 3

- Stage 3 industrial development is proposed to drain to a new SWMF NE_I_037, which in turn discharges to NE_I_039. NE_I_039 is proposed to discharge to a new conduit that flows west along the south edge of the Camrose Airport property, tying into an established drainage channel discharging to Stoney Creek.

5.2.4.3. Ultimate

- Ultimate industrial subzone NE_IND_301 is proposed to discharge to SWMF NE_I_039, in turn discharging to a conduit connecting to an established drainage channel discharging to Stoney Creek.
- Ultimate commercial development areas are proposed to discharge to five different new SWMFs, NE_C_036, NE_C_038, NE_C_040, NE_C_041, and NE_C_42. NE_C_036 is proposed to discharge to NE_I_037. The remaining SWMFs are proposed to discharge to the established drainage channel discharging to Stoney Creek.
 - NE_C_040 was previously conceptualized to discharge north to the existing wetland area. However, poor drainage conditions, and coordination with other development in the NE Industrial / Commercial area, suggest tying into common downstream conveyance infrastructure is preferable. Also, this would maintain the drainage to within the City of Camrose, which is preferred over draining toward Camrose County. This will likely require significant site grading to permit positive drainage.
 - Similarly, NE_C_042 was previously conceptualized to discharge to the existing wetland area adjacent to the airport. Again, poor drainage conditions, and coordination with other development in the NE Industrial / Commercial area, indicate a preference for discharge to common downstream conveyance infrastructure.

5.2.4.4. Industrial Lot Considerations

In addition to considering stormwater management at a neighbourhood level per ASP or subdivision requirements, on-site stormwater management is sometimes required for large industrial lots, as stormwater runoff from industrial lots is sometimes required to be contained to prevent environmental contamination. The requirement for on-site stormwater retention would be required as part of the development permit. The City will need to review industrial development once further details are known to determine which stormwater management strategy best fits.

5.2.5. East Industrial / Commercial

For the east commercial and industrial zones, drainage patterns run southwest. Drainage for the commercial area to the east trends south.

5.2.5.1. Stage 1 & 2

- There are no proposed developments within the Stage 1 development horizons.



5.2.5.2. Stage 2

- Stage 2 industrial development is proposed to discharge to new SWMF E_I_030 and E_I_032. E_I_032 is proposed to connect to the 36th Street sewer main immediately following the Highway 13 crossing. As a cautionary note, conceptual analysis indicates downstream depth constraints at tie-in, and will need to be reviewed in detail against site grades and crossing constraints moving into preliminary design. In the event that conditions for direct tie-in are unfeasible, a pump system will need to be considered.

5.2.5.3. Stage 3

- Stage 3 industrial development is proposed to discharge to a new SWMF E_I_033. SWMF E_I_033 is proposed to discharge to SWMF E_I_030, which in turn discharges to the Mohler industrial area drainage channel.

5.2.5.4. Ultimate

- Ultimate commercial development is proposed to discharge to a new SWMF E_C_035. SWMF E_C_035 is proposed to discharge to E_I_030, discharging to the Mohler industrial area drainage channel.
- Offsite flows contribute to the total flow through the East Industrial / Commercial area. Allowing uncontrolled offsite flows results in overloading the downstream existing system. To mitigate this, the SWMFs have been oversized to mitigate expensive downstream upgrades. The City can also work with Camrose County to ensure that any developments from upstream are controlled.

5.2.6. Southeast Industrial / Commercial

Drainage patterns make this area difficult to conceptualize. Drainage patterns trend west towards Stoney Creek, but with noted undulation. Drainage is also split north and south. The SE quarter section is owned by Cargill Ltd. and is considered to be self-serviced for the purpose of this assessment.

5.2.6.1. Stage 1

- Stage 1 development is proposed to discharge to a new SWMF SE_R_017, tying into the Camrose Drive storm sewer main. SWMF SE_R_017 is intended to service SE_RES_101 and SE_RES_201, meaning the SWMF will initially be oversized.

5.2.6.2. Stage 2

- Stage 2 industrial development is proposed to discharge to several SWMFs: SE_I_018, SE_I_019, and SE_I_022, each discharging to the storm sewer main on Camrose Drive.
- Stage 2 residential development, SE_RES_202, is intended to discharge to SWMF SE_I_018. This results in SWMF SE_R_018 being oversized during Stage 2 development; if necessary, individual SWMFs can be considered for each, although this will be less efficient from a land use and earthworks perspective.



- The existing Camrose Drive stormwater main is required to be upgraded to support Stage 2 development, shown as upgrade XP on **Figure 12: Future Development Proposed Stormwater Infrastructure**. The stormwater main is adequate for Stage 1 development.

5.2.6.3. Stage 3

- Stage 3 development is proposed to discharge to several new SWMFs:
 - Stage 3 residential development, SE_RES_301, is proposed to discharge to SWMF SE_R_C_016.
 - Stage 3 commercial development, SE_COMM_301, is also proposed to discharge to SWMF SE_R_C_016, sharing with SE_RES_301.
 - Stage 3 industrial development is proposed to discharge to separate locations, depending on prevailing grading patterns.
 - SE_IND_301 is proposed to discharge to SWMF SE_I_025, in turn discharging to the Camrose Drive stormwater main.
 - SE_IND_302 is proposed to discharge to SWMF SE_I_026, in turn discharging to the Camrose Drive stormwater main.
 - SE_IND_303 is proposed to discharge to SWMF SE_I_018, in turn discharging to the Camrose Drive stormwater main.
 - SE_IND_304 is proposed to discharge to SWMF SE_I_019, in turn discharging to the Camrose Drive stormwater main.
 - SE_IND_305 is proposed to discharge to SWMF SE_C_I_024, in turn discharging to SWMF SE_C_023, then to the south along an existing drainage channel.

5.2.6.4. Ultimate

- Ultimate industrial development is proposed to discharge to several new SWMFs:
 - SE_IND_U01 is proposed to discharge to SWMF SE_I_031. SWMF SE_I_031 is proposed to discharge to SWMF E_I_033, then E_I_030, which in turn discharges to the Mohler channel.
 - SE_IND_U02 is proposed to discharge to SWMF SE_I_027. SWMF SE_I_027 is proposed to discharge to SE_I_026, in turn discharging to the Camrose Drive stormwater main.
 - SE_IND_U03 is proposed to discharge to SWMF SE_C_I_029. SWMF SE_C_I_029 is intended to discharge to SWMF SE_C_028, which in turn is proposed to discharge to the south along an existing drainage channel.

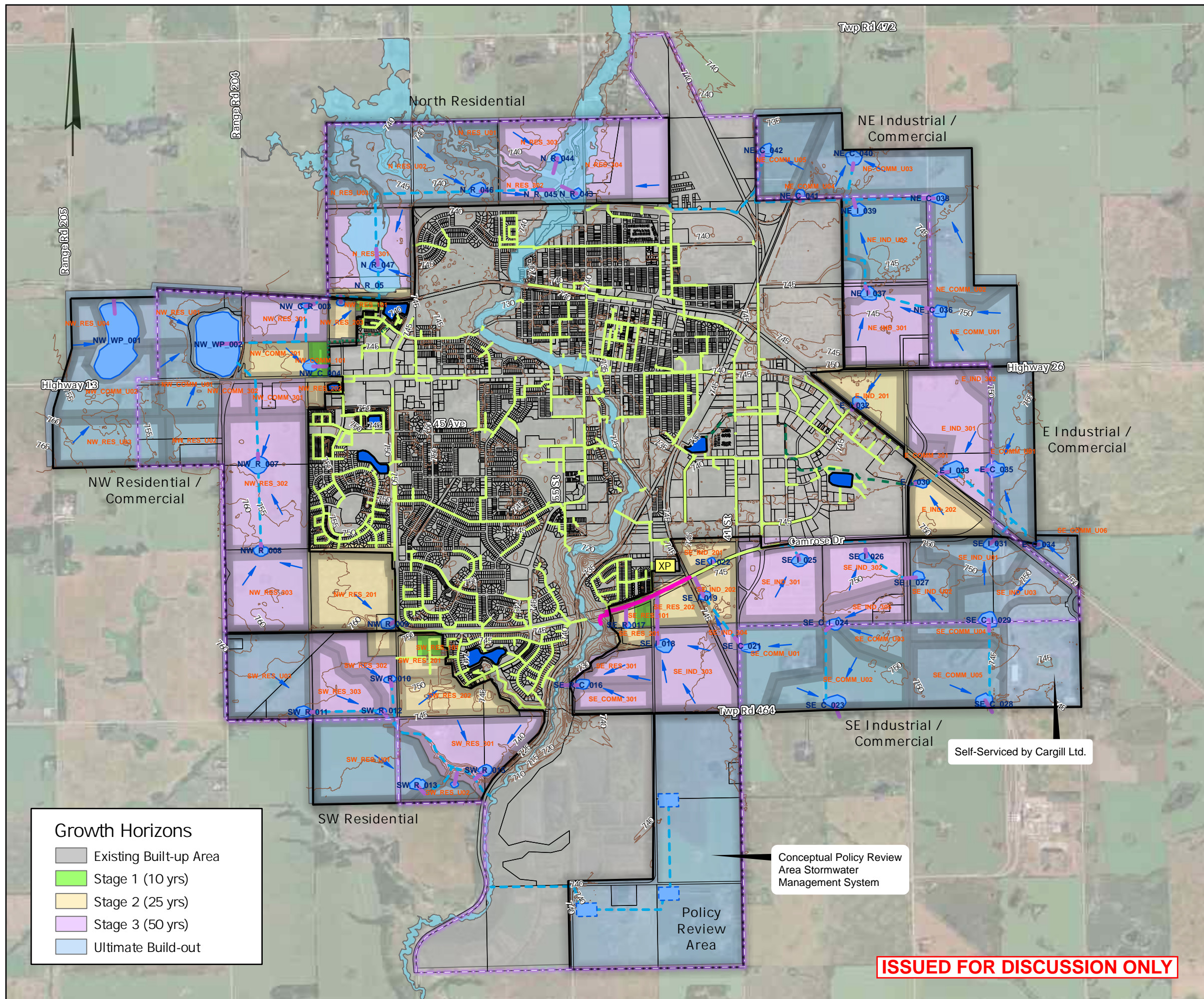


- Ultimate commercial development is also proposed to discharge to several new SWMFs, rationalized by grading patterns / constraints. SE_COMM_U01 – SE_COMM_U05 are proposed to discharge south towards existing drainage channels, while SE_COMM_U06 is proposed to discharge towards the E Industrial area, connecting to the Mohler channel.
 - SE_COMM_U01 is proposed to discharge to SWMF SE_C_021. SWMF SE_C_021 is proposed to discharge to SWMF SE_I_019, discharging to the Camrose Drive stormwater main.
 - SE_COMM_U02 is proposed to discharge to SWMF SE_C_023, discharging to the south along an existing drainage channel.
 - SE_COMM_U03 is proposed to discharge to SWMF SE_C_I_024. SWMF SE_C_I_024 is proposed to discharge to SWMF SE_C_023.
 - SE_COMM_U04 is proposed to discharge to SWMF SE_C_I_029. SWMF SE_C_I_029 is proposed to discharge to SWMF SE_C_028.
 - SE_COMM_U05 is proposed to discharge to SWMF SE_C_028, also discharging to the south along an existing drainage channel.
 - SE_COMM_U06 is proposed to discharge to SWMF SE_C_034. SWMF SE_C_034 discharges to SWMF E_I_033, then SWMF E_I_030, then discharging to the Mohler ditch.
- A significant amount of the Ultimate commercial and industrial areas are conceptualized draining south, where proposed SWMF SE_C_023 and SWMF SE_C_028 are proposed discharging to existing drainage routes through County lands. Downstream receiving areas may need further upgrades, either in the form of upgrades to road ditches, or cross-drainage agreements to maintain exiting drainage routes. This will require coordination between the City and the County to confirm downstream capacity, mitigate any downstream impact to private landowners and County infrastructure, and legally protect drainage routes where required.

5.2.7. Policy Review Area

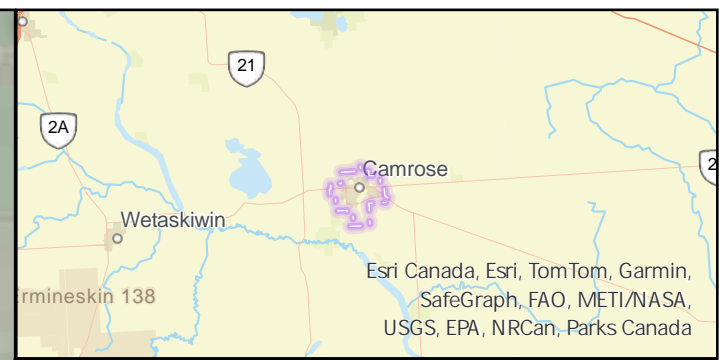
There is an area to the south immediately east of the lagoon system and the Camrose Regional Landfill. This area has been included for information only, and has not been included in the cost estimate as the City is still deliberating on land use. Drainage patterns trend south; a SWMF could be located towards the south, discharging to Stoney Creek. Alternatively, the area could be self-serviced via on-site stormwater management.





Growth Horizons

- Existing Built-up Area
- Stage 1 (10 yrs)
- Stage 2 (25 yrs)
- Stage 3 (50 yrs)
- Ultimate Build-out



LEGEND

- City of Camrose Limit
- 100 Year Flood Extent
- Topographic Contour
- Existing Conduits
- Ex_Ponds
- Future Ponds
- Potential SWMF within Policy Review Area
- Pond Outfall
- Slope Direction
- Overland Ditches
- Conduits
- Land_use_zones_lines
- Subcatchment Boundary

Pipes to Upgrade and Diameters (mm)

- 1050

0 0.5 1 Kilometers

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CITY OF Camrose

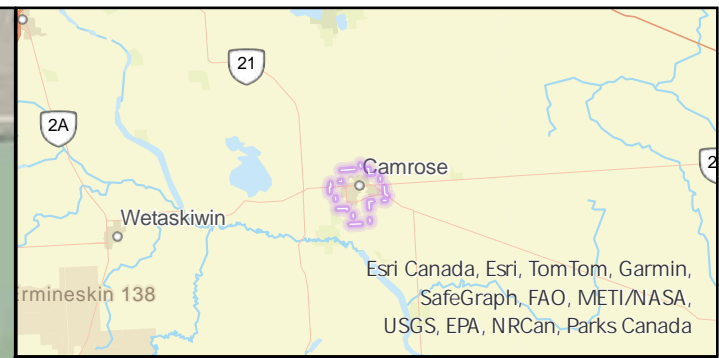
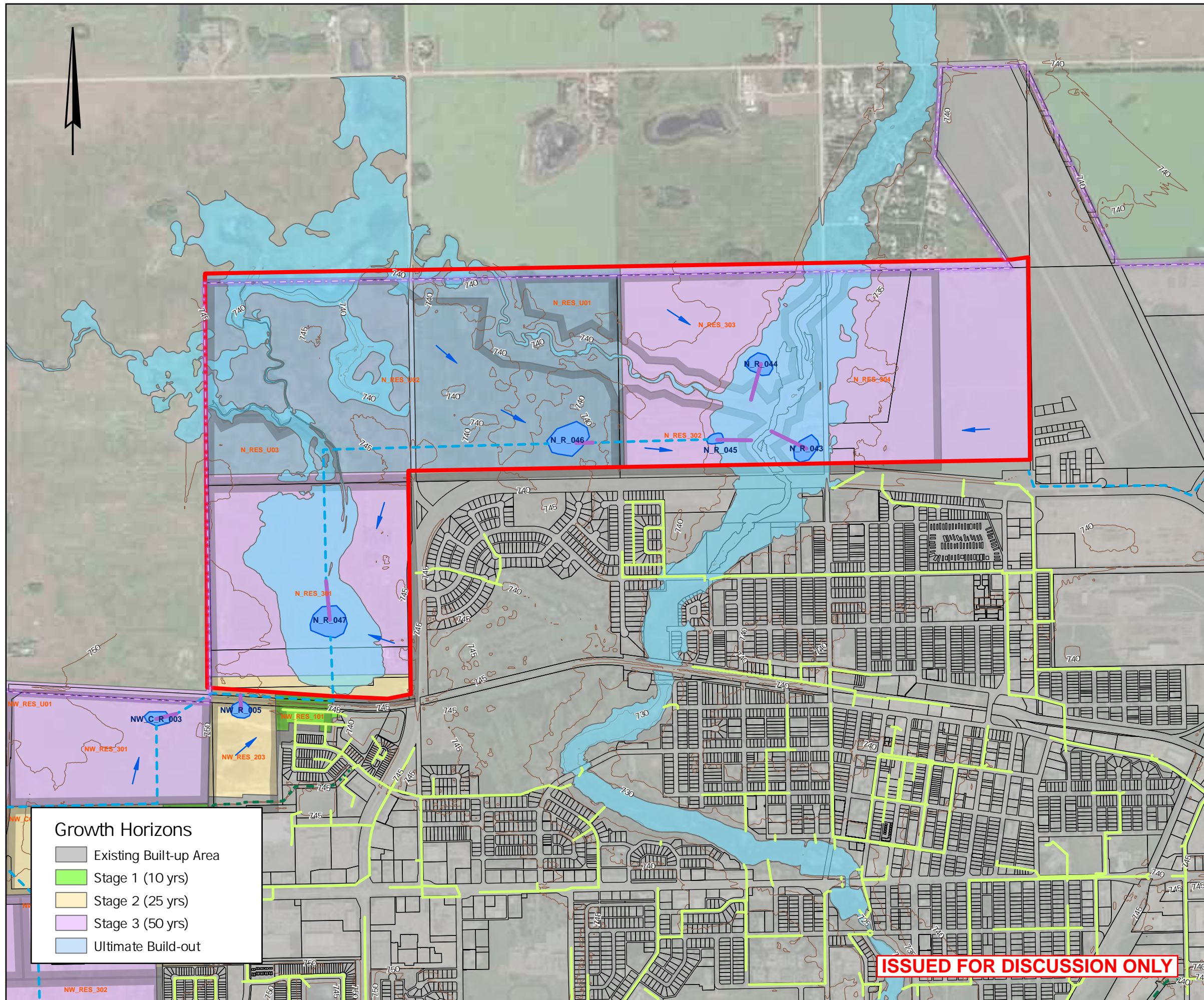
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**Figure 12
Future Development
Proposed Stormwater Infrastructure**

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Date: 5/1/2026



LEGEND

- City of Camrose Limit
- 100 Year Flood Extent
- Topographic Contour
- Existing Conduits
- Future Ponds
- Potential SWMF within Policy Review Area
- Pond Outfall
- Slope Direction
- Conduits
- Overland Ditches
- Subcatchment Boundary
- North Residential Land Use Zone

0.5
Kilometers



TITLE

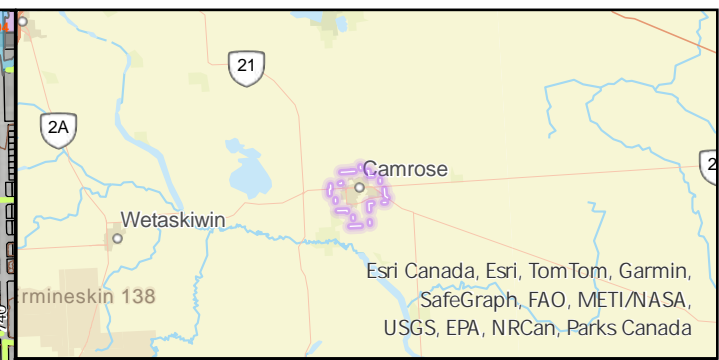
**Figure 13
Future Development
North Residential**

- Growth Horizons**
- Existing Built-up Area
 - Stage 1 (10 yrs)
 - Stage 2 (25 yrs)
 - Stage 3 (50 yrs)
 - Ultimate Build-out

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LEGEND

- City of Camrose Limit
- 100 Year Flood Extent
- Topographic Contour
- Existing Conduits
- Future Ponds
- Potential SWMF within Policy Review Area
- Pond Outfall
- Slope Direction
- Conduits
- Overland Ditches
- Subcatchment Boundary
- NW Residential / Commercial Land Use Zone

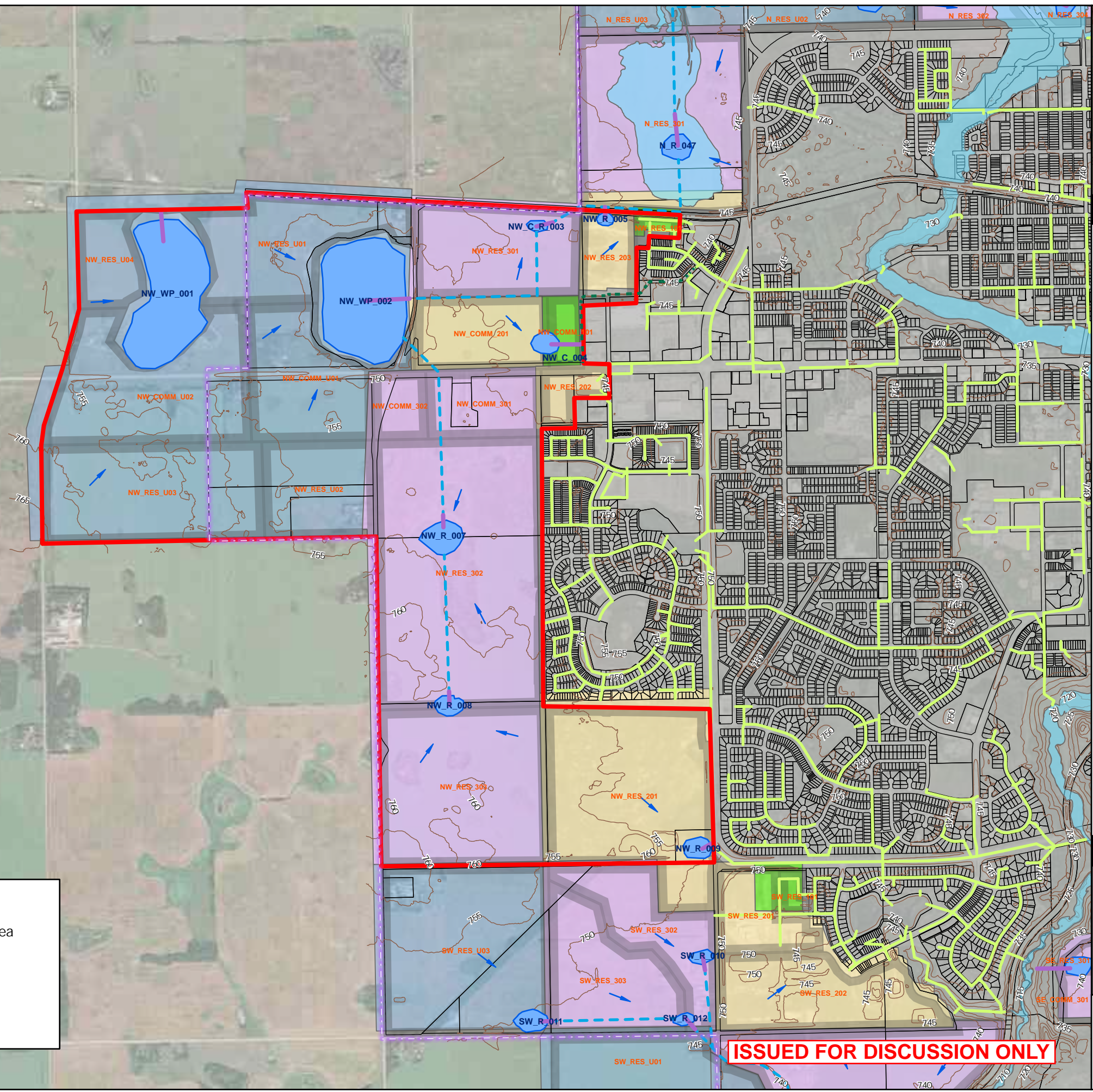
0.5 Kilometers



TITLE

Figure 14 Future Development NW Residential/Commercial

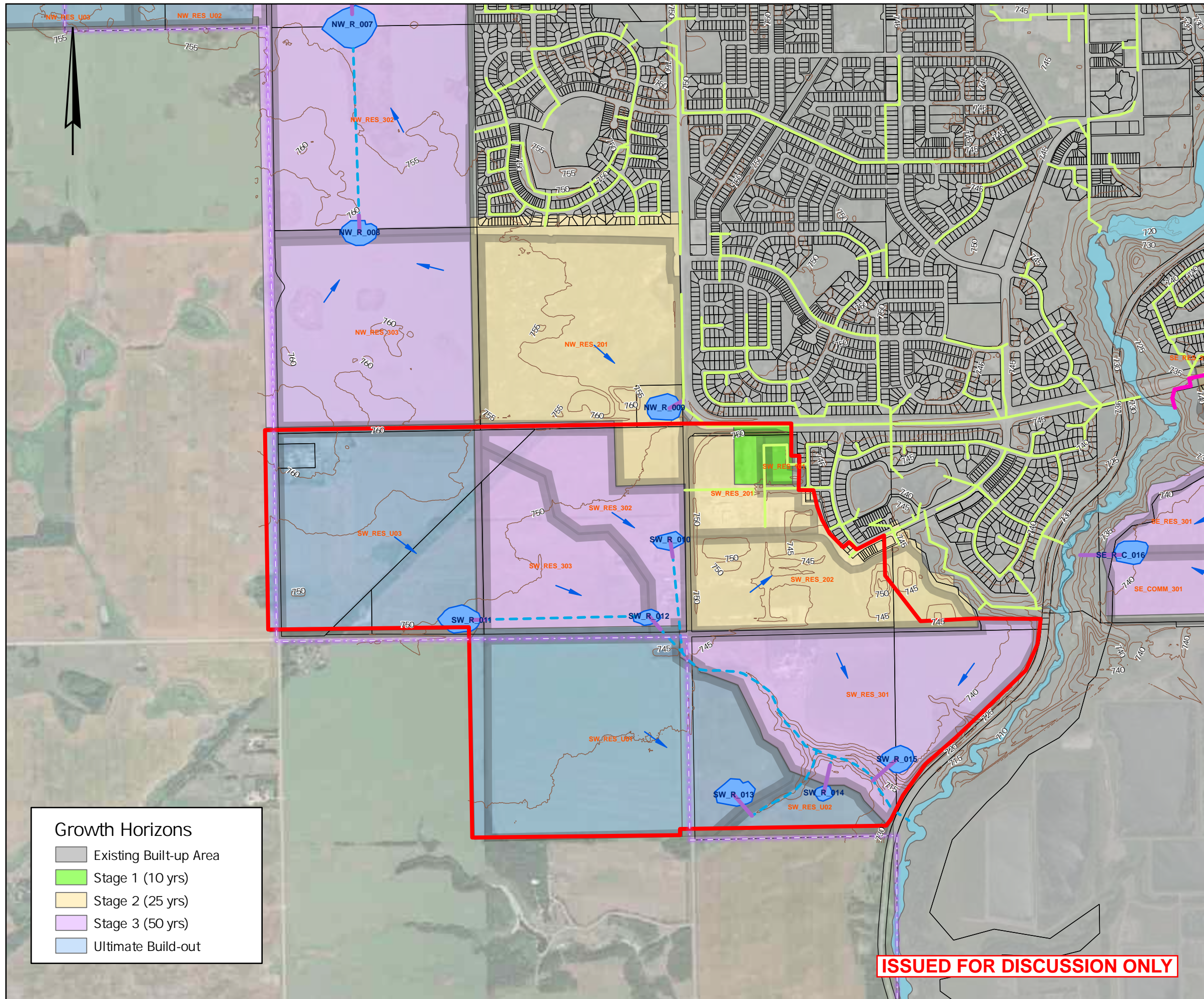
- #### Growth Horizons
- Existing Built-up Area
 - Stage 1 (10 yrs)
 - Stage 2 (25 yrs)
 - Stage 3 (50 yrs)
 - Ultimate Build-out



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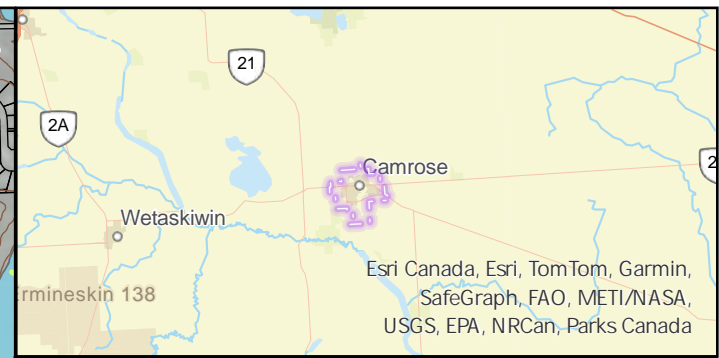
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Growth Horizons


- Existing Built-up Area
- Stage 1 (10 yrs)
- Stage 2 (25 yrs)
- Stage 3 (50 yrs)
- Ultimate Build-out



LEGEND

- City of Camrose Limit
- 100 Year Flood Extent
- Topographic Contour
- Existing Conduits
- Future Ponds
- Potential SWMF within Policy Review Area
- Pond Outfall
- Slope Direction
- Conduits
- Overland Ditches
- Subcatchment Boundary
- SW Residential Land Use Zone

0.5
Kilometers


CITY OF
Camrose

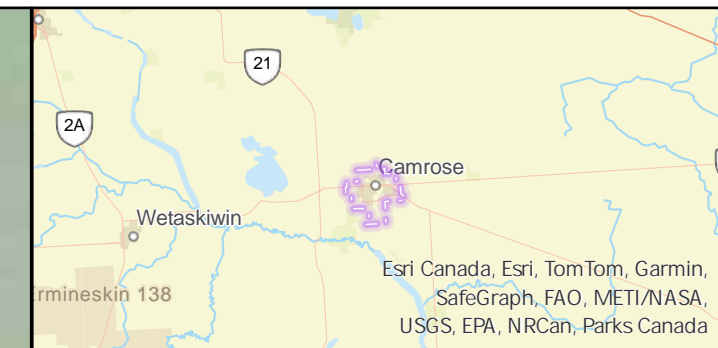
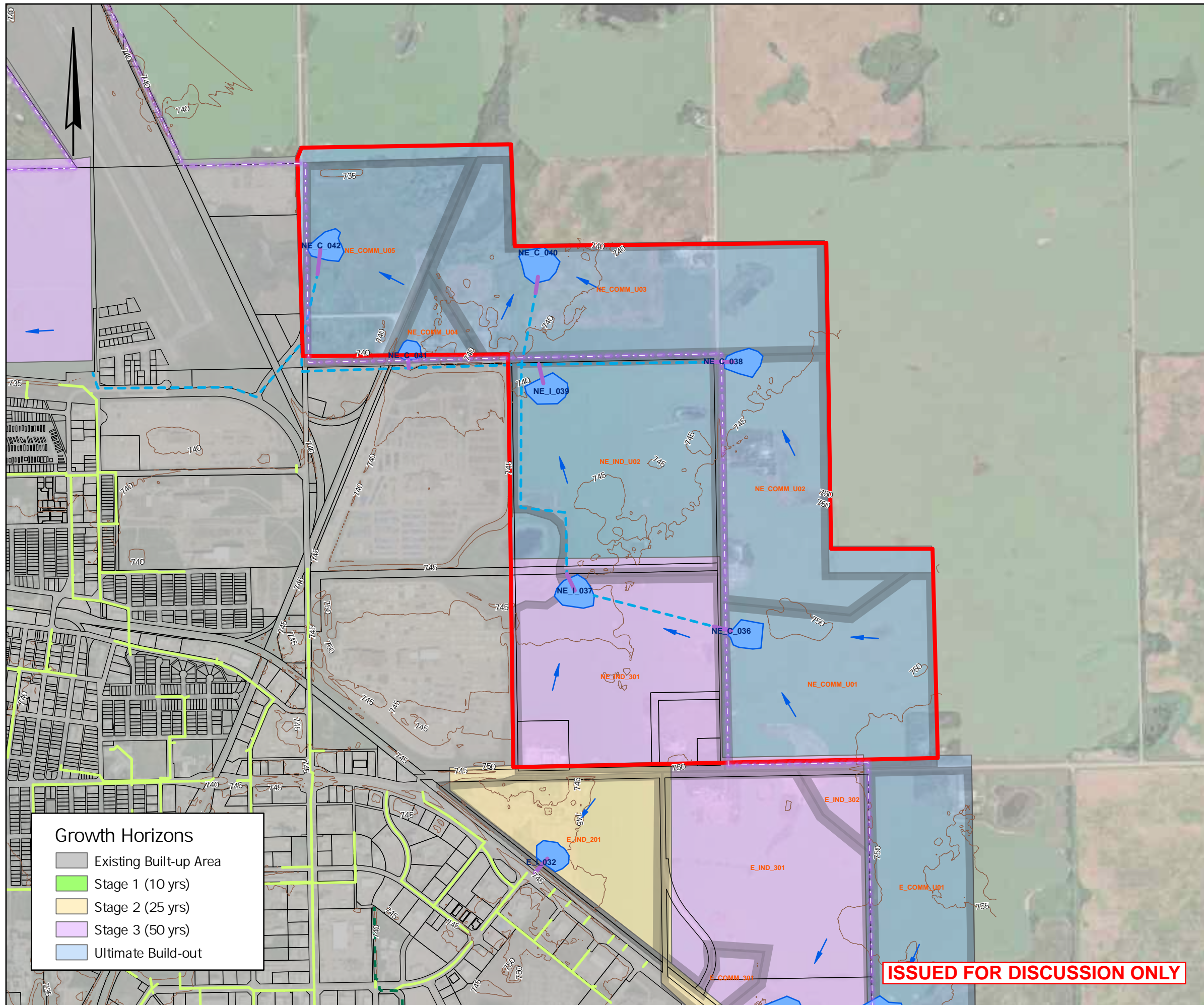
TITLE

**Figure 15
Future Development
SW Residential**

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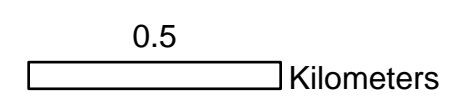
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LEGEND

- City of Camrose Limit
- 100 Year Flood Extent
- Topographic Contour
- Existing Conduits
- Future Ponds
- Potential SWMF within Policy Review Area
- Pond Outfall
- Slope Direction
- Conduits
- Overland Ditches
- Subcatchment Boundary
- NE Industrial / Commercial Land Use Zone



- Growth Horizons**
- Existing Built-up Area
 - Stage 1 (10 yrs)
 - Stage 2 (25 yrs)
 - Stage 3 (50 yrs)
 - Ultimate Build-out

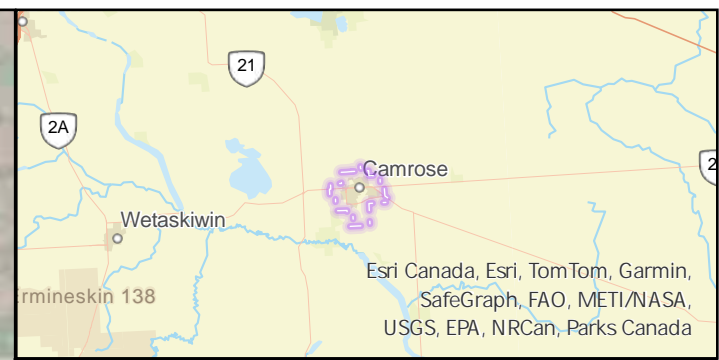
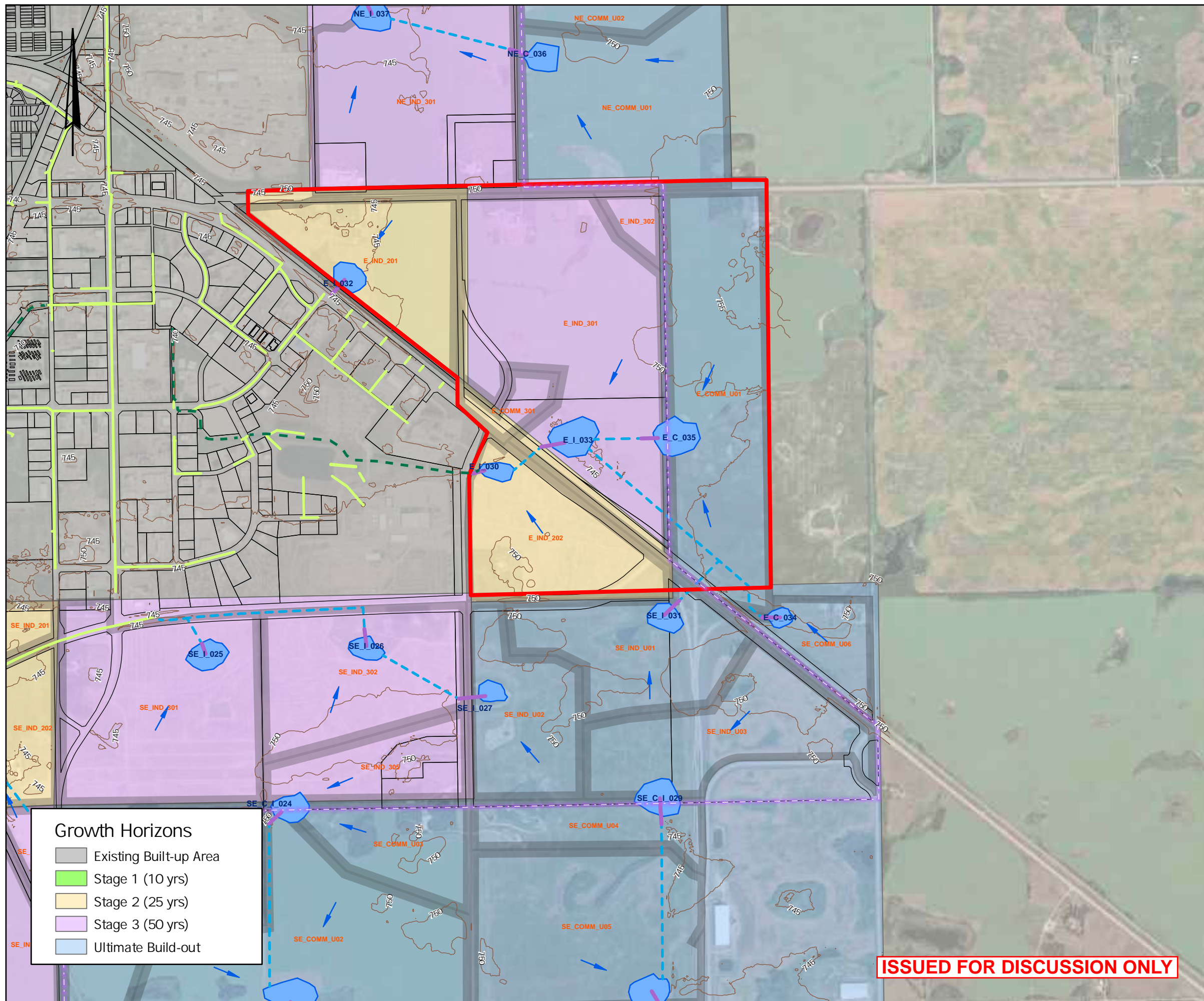
TITLE

**Figure 16
Future Development
NE Industrial / Commercial**

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LEGEND

- City of Camrose Limit
- 100 Year Flood Extent
- Topographic Contour
- Existing Conduits
- Future Ponds
- Potential SWMF within Policy Review Area
- Pond Outfall
- Slope Direction
- Conduits
- Overland Ditches
- Subcatchment Boundary
- East Industrial / Commercial Land Use Zone

0.5
Kilometers



TITLE

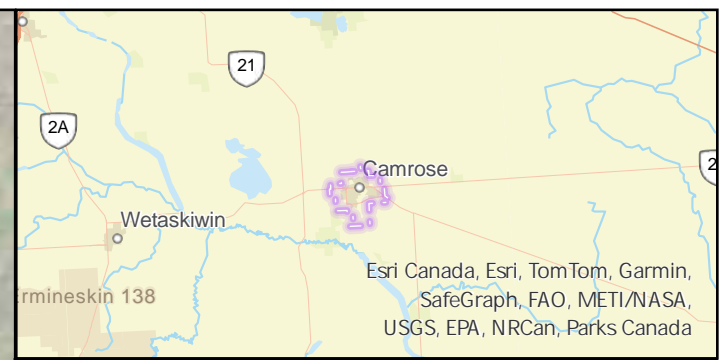
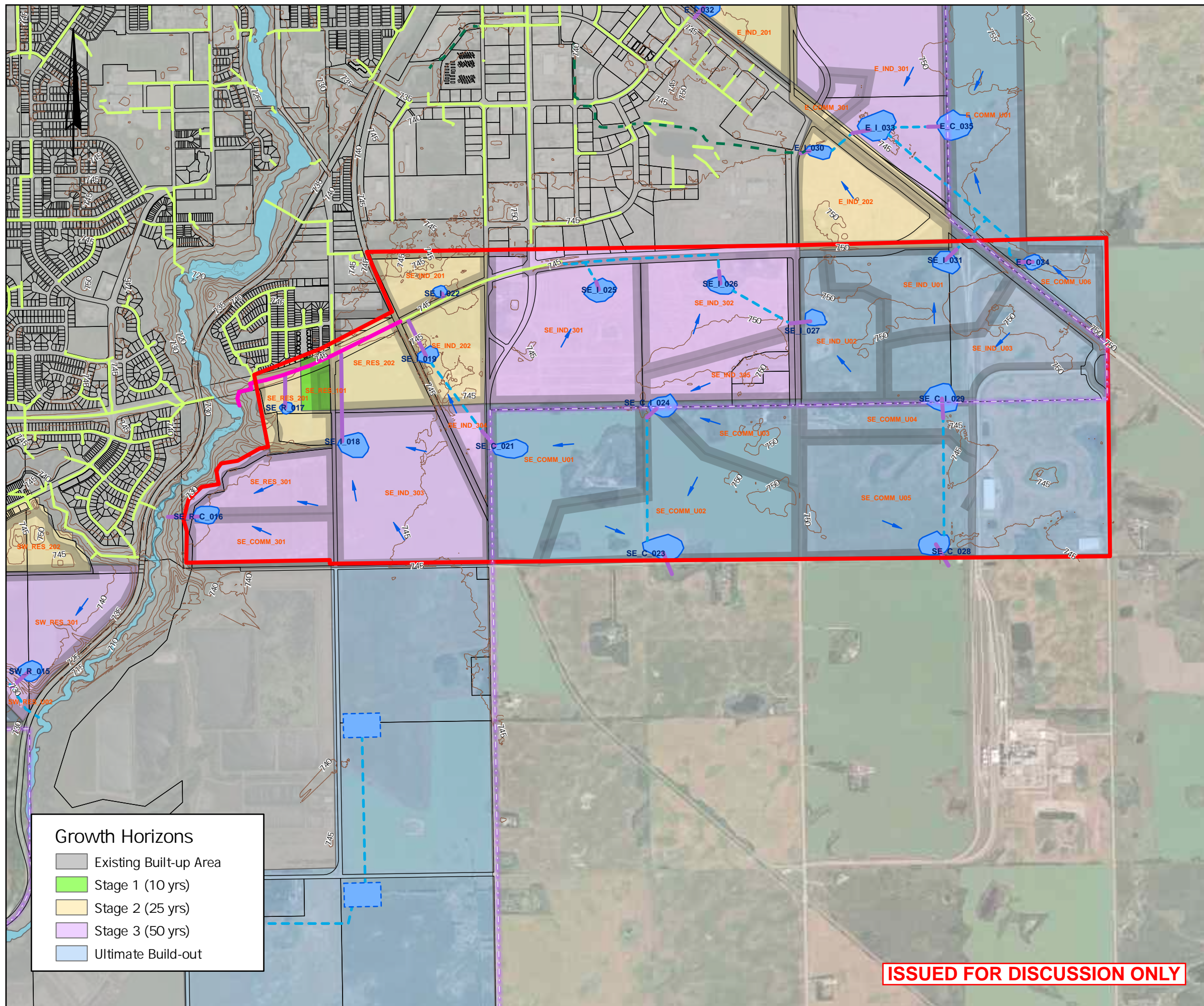
**Figure 17
Future Development
East Industrial / Commercial**

- Growth Horizons**
- Existing Built-up Area
 - Stage 1 (10 yrs)
 - Stage 2 (25 yrs)
 - Stage 3 (50 yrs)
 - Ultimate Build-out

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LEGEND

- City of Camrose Limit
- 100 Year Flood Extent
- Topographic Contour
- Existing Conduits
- Future Ponds
- Potential SWMF within Policy Review Area
- Pond Outfall
- Slope Direction
- Conduits
- Overland Ditches
- Subcatchment Boundary
- East Industrial / Commercial Land Use Zone

Pipes to Upgrade and Diameters (mm)

- 1050
- 0.5

Kilometers



- Growth Horizons**
- Existing Built-up Area
 - Stage 1 (10 yrs)
 - Stage 2 (25 yrs)
 - Stage 3 (50 yrs)
 - Ultimate Build-out

TITLE

**Figure 18
Future Development
SE Industrial / Commercial**

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6. Cost Estimate

6.1. APPROACH

Typically, for a Stormwater Master Plan, costs would be prioritized into high, medium, and low priority. However, since significant upgrades to the major system are not required, one of the major factors driving project urgency is eliminated. And, as previously noted, storm sewer upgrades are considered lower urgency, with the intention these be included as part of other street renewal projects. As such, the capital plan schedule can be prioritized separately according to both future development objectives, and opportunity as part of ongoing renewal projects. The cost estimates have been broken down as follows:

- Existing System Upgrades
- Future Development

Additionally, as discussed in the previous section, future subdivision storm sewer networks have not been included in this analysis, other than where SWMFs are connected in series, as it is assumed costs will be fully born by the developer.

6.2. COST ESTIMATE – EXISTING MINOR SYSTEM UPGRADES

A cost estimate was prepared for the pipe and SWMF upgrades identified in **Section 4**. A cost estimate is presented in **Table 12: Cost Estimate – Existing Minor System Upgrade**. Note that the proposed strategy is to upgrade these pipes as part of other renewal projects; the cost estimate assumes that restoration is not included. Unit prices are based on tender prices for similar projects completed recently and engineering judgement.

6.3. COST ESTIMATE – FUTURE DEVELOPMENT

A second cost estimate was prepared for required stormwater management infrastructure used to support future development, per **Section 5**. These costs have been summarized below in **Table 13: Cost Estimate – Future Development**, with the intention to provide guidance on capital expenditures needed for each development area. Unit prices are based on tender prices for similar projects completed recently and engineering judgement.

Table 12
Cost Estimate - Existing Minor System Upgrade

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total
XA - Section 1 - 69 St / Upstream of Duggan Pond								
1.1	Storm Sewer Main XA101 (1050mm CONC) - Remove & Replace	lm	\$ 1,400	99	\$ 138,090	\$ 13,809	\$ 48,332	\$ 200,231
1.2	Storm Sewer Main XA102 (1050mm CONC) - Remove & Replace	lm	\$ 1,400	39	\$ 54,120	\$ 5,412	\$ 18,942	\$ 78,474
1.3	Storm Sewer Main XA103 (1050mm CONC) - Remove & Replace	lm	\$ 1,400	37	\$ 52,440	\$ 5,244	\$ 18,354	\$ 76,038
1.4	Storm Sewer Main XA104 (1200mm CONC) - Remove & Replace	lm	\$ 1,600	78	\$ 125,190	\$ 12,519	\$ 43,817	\$ 181,526
1.5	Storm Sewer Main XA105 (1050mm CONC) - Remove & Replace	lm	\$ 1,800	38	\$ 68,670	\$ 6,867	\$ 24,035	\$ 99,572
1.6	Storm Manhole (2100mm) - Remove & Replace	ea	\$ 45,000	2	\$ 90,000	\$ 9,000	\$ 31,500	\$ 130,500
1.7	Storm Manhole (2400mm) - Remove & Replace	ea	\$ 55,000	5	\$ 275,000	\$ 27,500	\$ 96,250	\$ 398,750
Subtotal					\$ 803,510	\$ 80,351	\$ 281,229	\$ 1,165,090
XB - Section 2 - Southeast of Camrose Composite High School / 45 Ave & 61 St								
2.1	Storm Sewer Main XB101 (600mm CONC) - Remove & Replace	lm	\$ 800	103	\$ 82,180	\$ 8,218	\$ 28,763	\$ 119,161
2.2	Storm Sewer Main XB102 (750mm CONC) - Remove & Replace	lm	\$ 1,000	30	\$ 29,530	\$ 2,953	\$ 10,336	\$ 42,819
2.3	Storm Sewer Main XB103 (750mm CONC) - Remove & Replace	lm	\$ 1,000	63	\$ 63,400	\$ 6,340	\$ 22,190	\$ 91,930
2.4	Storm Sewer Main XB104 (750mm CONC) - Remove & Replace	lm	\$ 1,000	69	\$ 68,860	\$ 6,886	\$ 24,101	\$ 99,847
2.5	Storm Sewer Main XB105 (750mm CONC) - Remove & Replace	lm	\$ 1,000	10	\$ 10,380	\$ 1,038	\$ 3,633	\$ 15,051
2.6	Storm Sewer Main XB106 (825mm CONC) - Remove & Replace	lm	\$ 1,100	53	\$ 58,800	\$ 5,880	\$ 20,580	\$ 85,260
2.7	Storm Sewer Main XB107 (825mm CONC) - Remove & Replace	lm	\$ 1,100	89	\$ 97,990	\$ 9,799	\$ 34,297	\$ 142,086
2.8	Storm Sewer Main XB108 (450mm PVC) - Remove & Replace	lm	\$ 600	88	\$ 53,090	\$ 5,309	\$ 18,582	\$ 76,981
2.9	Storm Sewer Main XB109 (450mm PVC) - Remove & Replace	lm	\$ 600	54	\$ 32,410	\$ 3,241	\$ 11,344	\$ 46,995
2.10	Storm Sewer Main XB110 (450mm PVC) - Remove & Replace	lm	\$ 600	14	\$ 8,180	\$ 818	\$ 2,863	\$ 11,861
2.11	Storm Manhole (1200mm) - Remove & Replace	ea	\$ 15,000	2	\$ 30,000	\$ 3,000	\$ 10,500	\$ 43,500
2.12	Storm Manhole (1500mm) - Remove & Replace	ea	\$ 25,000	4	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000
2.13	Storm Manhole (1800mm) - Remove & Replace	ea	\$ 35,000	5	\$ 175,000	\$ 17,500	\$ 61,250	\$ 253,750
Subtotal					\$ 809,820	\$ 80,982	\$ 283,437	\$ 1,174,239
XC - Section 3 - East of Mount Pleasant Drive & South of 42 Ave leading into Marler Drive								
3.1	Storm Sewer Main XC101 (750mm CONC) - Remove & Replace	lm	\$ 1,000	114	\$ 113,740	\$ 11,374	\$ 39,809	\$ 164,923
3.2	Storm Sewer Main XC102 (750mm CONC) - Remove & Replace	lm	\$ 1,000	102	\$ 101,680	\$ 10,168	\$ 35,588	\$ 147,436
3.3	Storm Sewer Main XC103 (750mm CONC) - Remove & Replace	lm	\$ 1,000	12	\$ 11,960	\$ 1,196	\$ 4,186	\$ 17,342
3.4	Storm Manhole (1500mm) - Remove & Replace		\$ 25,000	3	\$ 75,000	\$ 7,500	\$ 26,250	\$ 108,750
3.5	Storm Manhole (1800mm) - Remove & Replace		\$ 35,000	1	\$ 35,000	\$ 3,500	\$ 12,250	\$ 50,750
Subtotal					\$ 337,380	\$ 33,738	\$ 118,083	\$ 489,201
XD - Section 4 - 53 St / 55 St & 44 Ave								
4.1	Storm Sewer Main XD101 (375mm PVC) - Remove & Replace	lm	\$ 500	54	\$ 27,180	\$ 2,718	\$ 9,513	\$ 39,411
4.2	Storm Sewer Main XD102 (375mm PVC) - Remove & Replace	lm	\$ 500	60	\$ 30,170	\$ 3,017	\$ 10,560	\$ 43,747
4.3	Storm Sewer Main XD111 (450mm PVC) - Remove & Replace	lm	\$ 600	23	\$ 13,640	\$ 1,364	\$ 4,774	\$ 19,778
4.4	Storm Sewer Main XD112 (525mm CONC) - Remove & Replace	lm	\$ 700	91	\$ 63,410	\$ 6,341	\$ 22,194	\$ 91,945
4.5	Storm Sewer Main XD113 (525mm CONC) - Remove & Replace	lm	\$ 700	107	\$ 74,820	\$ 7,482	\$ 26,187	\$ 108,489
4.6	Storm Sewer Main XD114 (600mm CONC) - Remove & Replace	lm	\$ 800	38	\$ 30,460	\$ 3,046	\$ 10,661	\$ 44,167
4.7	Storm Manhole (1200mm) - Remove & Replace	ea	\$ 15,000	4	\$ 60,000	\$ 6,000	\$ 21,000	\$ 87,000
4.8	Storm Manhole (1500mm) - Remove & Replace	ea	\$ 25,000	2	\$ 50,000	\$ 5,000	\$ 17,500	\$ 72,500
4.9	Storm Manhole (1800mm) - Remove & Replace	ea	\$ 35,000	1	\$ 35,000	\$ 3,500	\$ 12,250	\$ 50,750
Subtotal					\$ 384,680	\$ 38,468	\$ 134,638	\$ 557,786

Table 12
Cost Estimate - Existing Minor System Upgrade

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total	
XE - Section 5 - 47 Ave / 48 Ave & 45 St									
5.1	Storm Sewer Main XE100 (375mm PVC) - Remove & Replace	lm	\$ 500	67	\$ 33,650	\$ 3,365	\$ 11,778	\$ 48,793	
5.2	Storm Sewer Main XE101 (450mm PVC) - Remove & Replace	lm	\$ 600	88	\$ 52,690	\$ 5,269	\$ 18,442	\$ 76,401	
5.3	Storm Sewer Main XE102 (450mm PVC) - Remove & Replace	lm	\$ 600	28	\$ 17,060	\$ 1,706	\$ 5,971	\$ 24,737	
5.4	Storm Sewer Main XE103 (525mm CONC) - Remove & Replace	lm	\$ 700	111	\$ 77,550	\$ 7,755	\$ 27,143	\$ 112,448	
5.5	Storm Sewer Main XE104 (375mm PVC) - Remove & Replace	lm	\$ 500	73	\$ 36,610	\$ 3,661	\$ 12,814	\$ 53,085	
5.6	Storm Sewer Main XE105 (600mm CONC) - Remove & Replace	lm	\$ 800	17	\$ 13,890	\$ 1,389	\$ 4,862	\$ 20,141	
5.7	Storm Sewer Main XE106 (750mm CONC) - Remove & Replace	lm	\$ 1,000	98	\$ 98,410	\$ 9,841	\$ 34,444	\$ 142,695	
5.8	Storm Sewer Main XE107 (750mm CONC) - Remove & Replace	lm	\$ 1,000	89	\$ 89,500	\$ 8,950	\$ 31,325	\$ 129,775	
5.9	Storm Sewer Main XE108 (375mm PVC) - Remove & Replace	lm	\$ 500	118	\$ 58,780	\$ 5,878	\$ 20,573	\$ 85,231	
5.10	Storm Sewer Main XE109 (450mm PVC) - Remove & Replace	lm	\$ 600	67	\$ 40,040	\$ 4,004	\$ 14,014	\$ 58,058	
5.11	Storm Sewer Main XE110 (450mm PVC) - Remove & Replace	lm	\$ 600	41	\$ 24,330	\$ 2,433	\$ 8,516	\$ 35,279	
5.12	Storm Sewer Main XE111 (525mm PVC) - Remove & Replace	lm	\$ 700	70	\$ 48,760	\$ 4,876	\$ 17,066	\$ 70,702	
5.13	Storm Sewer Main XE112 (900mm CONC) - Remove & Replace	lm	\$ 1,200	94	\$ 113,140	\$ 11,314	\$ 39,599	\$ 164,053	
5.14	Storm Sewer Main XE113 (900mm CONC) - Remove & Replace	lm	\$ 1,200	109	\$ 130,770	\$ 13,077	\$ 45,770	\$ 189,617	
5.15	Storm Manhole (1200mm) - Remove & Replace	ea	\$ 15,000	6	\$ 90,000	\$ 9,000	\$ 31,500	\$ 130,500	
5.16	Storm Manhole (1500mm) - Remove & Replace	ea	\$ 25,000	3	\$ 75,000	\$ 7,500	\$ 26,250	\$ 108,750	
5.17	Storm Manhole (1800mm) - Remove & Replace	ea	\$ 35,000	2	\$ 70,000	\$ 7,000	\$ 24,500	\$ 101,500	
Subtotal					\$	1,070,180	\$ 107,018	\$ 374,563	\$ 1,551,761
XF - Section 6 - 45 St & 51 Ave									
6.1	Storm Sewer Main XF100 (750mm CONC) - Remove & Replace	lm	\$ 1,000	113	\$ 113,000	\$ 11,300	\$ 39,550	\$ 163,850	
6.1	Storm Sewer Main XF101_A (750mm CONC) - Remove & Replace	lm	\$ 1,000	7	\$ 7,300	\$ 730	\$ 2,555	\$ 10,585	
6.2	Storm Sewer Main XF101_B (750mm CONC) - Remove & Replace	lm	\$ 1,000	34	\$ 33,990	\$ 3,399	\$ 11,897	\$ 49,286	
6.3	Storm Sewer Main XF101_C (750mm CONC) - Remove & Replace	lm	\$ 1,000	10	\$ 9,700	\$ 970	\$ 3,395	\$ 14,065	
6.4	Storm Sewer Main Rail_XF102 (750mm CONC) - Remove & Replace	lm	\$ 2,000	44	\$ 87,400	\$ 8,740	\$ 30,590	\$ 126,730	
6.5	Storm Sewer Main XF103 (750mm CONC) - Remove & Replace	lm	\$ 1,000	49	\$ 49,100	\$ 4,910	\$ 17,185	\$ 71,195	
6.6	Storm Sewer Main XF104 (600mm CONC) - Remove & Replace	lm	\$ 800	94	\$ 74,930	\$ 7,493	\$ 26,226	\$ 108,649	
6.7	Storm Sewer Main XF105 (600mm CONC) - Remove & Replace	lm	\$ 800	81	\$ 64,450	\$ 6,445	\$ 22,558	\$ 93,453	
6.8	Storm Sewer Main XF106 (525mm CONC) - Remove & Replace	lm	\$ 700	79	\$ 55,320	\$ 5,532	\$ 19,362	\$ 80,214	
6.9	Storm Sewer Main XF107 (525mm PVC) - Remove & Replace	lm	\$ 700	120	\$ 83,950	\$ 8,395	\$ 29,383	\$ 121,728	
6.10	Storm Manhole (1200mm) - Remove & Replace	ea	\$ 15,000	6	\$ 90,000	\$ 9,000	\$ 31,500	\$ 130,500	
6.11	Storm Manhole (1500mm) - Remove & Replace	ea	\$ 25,000	2	\$ 50,000	\$ 5,000	\$ 17,500	\$ 72,500	
Subtotal					\$	719,140	\$ 71,914	\$ 251,699	\$ 1,042,753

Table 12
Cost Estimate - Existing Minor System Upgrade

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total
XI - Section 7 - 39 St from CN Rail Crossing to South of 47 Ave								
7.1	Storm Sewer Main XI101 (600mm CONC) - Remove & Replace	lm	\$ 800	59	\$ 47,130	\$ 4,713	\$ 16,496	\$ 68,339
7.2	Storm Sewer Main XI102 (600mm CONC) - Remove & Replace	lm	\$ 800	104	\$ 83,460	\$ 8,346	\$ 29,211	\$ 121,017
7.3	Storm Sewer Main XI103_A (750mm CONC) - Remove & Replace	lm	\$ 1,000	78	\$ 77,830	\$ 7,783	\$ 27,241	\$ 112,854
7.4	Storm Sewer Main XI103_B (750mm CONC) - Remove & Replace	lm	\$ 1,000	16	\$ 15,600	\$ 1,560	\$ 5,460	\$ 22,620
7.5	Storm Sewer Main XI104 (750mm CONC) - Remove & Replace	lm	\$ 1,000	80	\$ 79,920	\$ 7,992	\$ 27,972	\$ 115,884
7.6	Storm Sewer Main XI105 (900mm CONC) - Remove & Replace	lm	\$ 1,200	33	\$ 39,950	\$ 3,995	\$ 13,983	\$ 57,928
7.7	Storm Sewer Main XI106 (900mm CONC) - Remove & Replace	lm	\$ 1,200	64	\$ 76,870	\$ 7,687	\$ 26,905	\$ 111,462
7.8	Storm Sewer Main Rail_XI107 (900mm CONC) - Remove & Replace	lm	\$ 2,400	106	\$ 253,920	\$ 25,392	\$ 88,872	\$ 368,184
7.9	Storm Sewer Main XI108_A (900mm CONC) - Remove & Replace	lm	\$ 1,200	36	\$ 43,360	\$ 4,336	\$ 15,176	\$ 62,872
7.10	Storm Sewer Main XI108_B (1050mm CONC) - Remove & Replace	lm	\$ 1,400	75	\$ 104,330	\$ 10,433	\$ 36,516	\$ 151,279
7.11	Storm Sewer Main XI109_A (1050mm CONC) - Remove & Replace	lm	\$ 1,400	50	\$ 70,630	\$ 7,063	\$ 24,721	\$ 102,414
7.12	Storm Sewer Main XI109_B (1050mm CONC) - Remove & Replace	lm	\$ 1,400	17	\$ 24,260	\$ 2,426	\$ 8,491	\$ 35,177
7.13	Storm Sewer Main XI109_C (1050mm CONC) - Remove & Replace	lm	\$ 1,400	30	\$ 41,910	\$ 4,191	\$ 14,669	\$ 60,770
7.14	Storm Sewer Main XI110 (1050mm CONC) - Remove & Replace	lm	\$ 1,400	52	\$ 72,920	\$ 7,292	\$ 25,522	\$ 105,734
7.15	Storm Sewer Main XI111 (1050mm CONC) - Remove & Replace	lm	\$ 1,400	12	\$ 16,800	\$ 1,680	\$ 5,880	\$ 24,360
7.16	Storm Sewer Main XI112 (1050mm CONC) - Remove & Replace	lm	\$ 1,400	106	\$ 147,860	\$ 14,786	\$ 51,751	\$ 214,397
7.17	Storm Sewer Main XI113 (1050mm CONC) - Remove & Replace	lm	\$ 1,400	65	\$ 90,400	\$ 9,040	\$ 31,640	\$ 131,080
7.18	Storm Sewer Main XI114 (1050mm CONC) - Remove & Replace	lm	\$ 1,400	72	\$ 100,990	\$ 10,099	\$ 35,347	\$ 146,436
7.19	Storm Sewer Main XI115 (1050mm CONC) - Remove & Replace	lm	\$ 1,400	60	\$ 84,270	\$ 8,427	\$ 29,495	\$ 122,192
7.20	Storm Sewer Main XI116_A (1050mm CONC) - Remove & Replace	lm	\$ 1,400	56	\$ 78,880	\$ 7,888	\$ 27,608	\$ 114,376
7.21	Storm Sewer Main XI116_B (1050mm CONC) - Remove & Replace	lm	\$ 1,400	11	\$ 16,010	\$ 1,601	\$ 5,604	\$ 23,215
7.22	Storm Sewer Main XI117 (1050mm CONC) - Remove & Replace	lm	\$ 1,400	64	\$ 88,950	\$ 8,895	\$ 31,133	\$ 128,978
7.23	Storm Manhole (1200mm) - Remove & Replace	ea	\$ 15,000	2	\$ 30,000	\$ 3,000	\$ 10,500	\$ 43,500
7.24	Storm Manhole (1500mm) - Remove & Replace	ea	\$ 25,000	3	\$ 75,000	\$ 7,500	\$ 26,250	\$ 108,750
7.25	Storm Manhole (1800mm) - Remove & Replace	ea	\$ 35,000	10	\$ 350,000	\$ 35,000	\$ 122,500	\$ 507,500
7.26	Storm Manhole (2100mm) - Remove & Replace	ea	\$ 45,000	3	\$ 135,000	\$ 13,500	\$ 47,250	\$ 195,750
Subtotal					\$ 2,246,250	\$ 224,625	\$ 786,188	\$ 3,257,063
XJ - Section 8 - East of 39 St / South of 47A Ave leading into 47 Ave								
8.1	Storm Sewer Main XJ101_A (450mm PVC) - Remove & Replace	lm	\$ 600	9	\$ 5,260	\$ 526	\$ 1,841	\$ 7,627
8.2	Storm Sewer Main XJ101_B (450mm PVC) - Remove & Replace	lm	\$ 600	73	\$ 43,700	\$ 4,370	\$ 15,295	\$ 63,365
8.3	Storm Sewer Main XJ102 (450mm PVC) - Remove & Replace	lm	\$ 600	60	\$ 35,800	\$ 3,580	\$ 12,530	\$ 51,910
8.4	Storm Sewer Main XJ103 (525mm CONC) - Remove & Replace	lm	\$ 700	57	\$ 40,160	\$ 4,016	\$ 14,056	\$ 58,232
8.5	Storm Manhole (1200mm) - Remove & Replace	ea	\$ 15,000	3	\$ 45,000	\$ 4,500	\$ 15,750	\$ 65,250
Subtotal					\$ 169,920	\$ 16,992	\$ 59,472	\$ 246,384

Table 12
Cost Estimate - Existing Minor System Upgrade

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total
XK - Section 9 - 38 St & 47 Ave								
9.1	Storm Sewer Main XK101 (525mm CONC) - Remove & Replace	lm	\$ 700	102	\$ 71,250	\$ 7,125	\$ 24,938	\$ 103,313
9.2	Storm Sewer Main XK102 (600mm CONC) - Remove & Replace	lm	\$ 800	101	\$ 80,830	\$ 8,083	\$ 28,291	\$ 117,204
9.3	Storm Sewer Main XK103 (600mm CONC) - Remove & Replace	lm	\$ 800	158	\$ 126,660	\$ 12,666	\$ 44,331	\$ 183,657
9.4	Storm Manhole (1500mm) - Remove & Replace	ea	\$ 25,000	1	\$ 25,000	\$ 2,500	\$ 8,750	\$ 36,250
9.5	Storm Manhole (1800mm) - Remove & Replace	ea	\$ 35,000	2	\$ 70,000	\$ 7,000	\$ 24,500	\$ 101,500
9.6	Storm Manhole (3000mm) - Remove & Replace	ea	\$ 75,000	1	\$ 75,000	\$ 7,500	\$ 26,250	\$ 108,750
Subtotal					\$ 448,740	\$ 44,874	\$ 157,059	\$ 650,673
XL - Section 10 - 48 Ave & 36 St								
10.1	Storm Sewer Main XL101_A (750mm CONC) - Remove & Replace	lm	\$ 1,000	25	\$ 24,950	\$ 2,495	\$ 8,733	\$ 36,178
10.2	Storm Sewer Main XL101_B (750mm CONC) - Remove & Replace	lm	\$ 1,000	32	\$ 31,710	\$ 3,171	\$ 11,099	\$ 45,980
10.3	Storm Sewer Main XL102_A (750mm CONC) - Remove & Replace	lm	\$ 1,000	27	\$ 26,560	\$ 2,656	\$ 9,296	\$ 38,512
10.4	Storm Sewer Main XL102_B (750mm CONC) - Remove & Replace	lm	\$ 1,000	27	\$ 26,700	\$ 2,670	\$ 9,345	\$ 38,715
10.5	Storm Sewer Main XL103_A (450mm PVC) - Remove & Replace	lm	\$ 600	40	\$ 23,730	\$ 2,373	\$ 8,306	\$ 34,409
10.6	Storm Sewer Main XL103_B (450mm PVC) - Remove & Replace	lm	\$ 600	53	\$ 31,540	\$ 3,154	\$ 11,039	\$ 45,733
10.7	Storm Sewer Main XL104_A (900mm CONC) - Remove & Replace	lm	\$ 1,200	50	\$ 59,970	\$ 5,997	\$ 20,990	\$ 86,957
10.8	Storm Sewer Main XL104_B (900mm CONC) - Remove & Replace	lm	\$ 1,200	26	\$ 30,980	\$ 3,098	\$ 10,843	\$ 44,921
10.9	Storm Sewer Main XL104_C (900mm CONC) - Remove & Replace	lm	\$ 1,200	43	\$ 51,860	\$ 5,186	\$ 18,151	\$ 75,197
10.10	Storm Sewer Main XL105 (900mm CONC) - Remove & Replace	lm	\$ 1,200	74	\$ 88,270	\$ 8,827	\$ 30,895	\$ 127,992
10.11	Storm Sewer Main XL106 (900mm CONC) - Remove & Replace	lm	\$ 1,200	69	\$ 82,680	\$ 8,268	\$ 28,938	\$ 119,886
10.12	Storm Sewer Main XL107 (900mm CONC) - Remove & Replace	lm	\$ 1,200	71	\$ 85,360	\$ 8,536	\$ 29,876	\$ 123,772
10.13	Storm Manhole (1200mm) - Remove & Replace	ea	\$ 15,000	1	\$ 15,000	\$ 1,500	\$ 5,250	\$ 21,750
10.14	Storm Manhole (2100mm) - Remove & Replace	ea	\$ 45,000	4	\$ 180,000	\$ 18,000	\$ 63,000	\$ 261,000
10.15	Storm Manhole (2400mm) - Remove & Replace	ea	\$ 55,000	2	\$ 110,000	\$ 11,000	\$ 38,500	\$ 159,500
10.16	Storm Manhole (3000mm) - Remove & Replace	ea	\$ 75,000	1	\$ 75,000	\$ 7,500	\$ 26,250	\$ 108,750
Subtotal					\$ 944,310	\$ 94,431	\$ 330,509	\$ 1,369,250
XM - Section 11 - 36 St & 44 Ave								
11.1	Storm Sewer Main XM101_A (375mm PVC) - Remove & Replace	lm	\$ 500	29	\$ 14,430	\$ 1,443	\$ 5,051	\$ 20,924
11.2	Storm Sewer Main XM101_B (375mm PVC) - Remove & Replace	lm	\$ 500	25	\$ 12,320	\$ 1,232	\$ 4,312	\$ 17,864
11.3	Storm Sewer Main XM101_C (375mm PVC) - Remove & Replace	lm	\$ 500	9	\$ 4,350	\$ 435	\$ 1,523	\$ 6,308
11.4	Storm Sewer Main XM102 (450mm PVC) - Remove & Replace	lm	\$ 600	58	\$ 34,870	\$ 3,487	\$ 12,205	\$ 50,562
11.5	Storm Sewer Main XM103 (450mm PVC) - Remove & Replace	lm	\$ 600	89	\$ 53,570	\$ 5,357	\$ 18,750	\$ 77,677
11.6	Storm Sewer Main XM104 (450mm PVC) - Remove & Replace	lm	\$ 600	121	\$ 72,820	\$ 7,282	\$ 25,487	\$ 105,589
11.7	Storm Sewer Main XM105 (525mm CONC) - Remove & Replace	lm	\$ 700	42	\$ 29,650	\$ 2,965	\$ 10,378	\$ 42,993
11.8	Storm Manhole (1200mm) - Remove & Replace	ea	\$ 15,000	4	\$ 60,000	\$ 6,000	\$ 21,000	\$ 87,000
11.9	Storm Manhole (1500mm) - Remove & Replace	ea	\$ 25,000	1	\$ 25,000	\$ 2,500	\$ 8,750	\$ 36,250
Subtotal					\$ 307,010	\$ 30,701	\$ 107,454	\$ 445,165

Table 12
Cost Estimate - Existing Minor System Upgrade

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total
XN - Section 12 - 38 St & 43 Ave								
12.1	Storm Sewer Main XN101 (450mm PVC) - Remove & Replace	lm	\$ 600	104	\$ 62,170	\$ 6,217	\$ 21,760	\$ 90,147
12.2	Storm Sewer Main XN102 (600mm CONC) - Remove & Replace	lm	\$ 800	131	\$ 104,860	\$ 10,486	\$ 36,701	\$ 152,047
12.3	Storm Sewer Main XN103_A (750mm CONC) - Remove & Replace	lm	\$ 1,000	15	\$ 15,400	\$ 1,540	\$ 5,390	\$ 22,330
12.4	Storm Sewer Main XN103_B (750mm CONC) - Remove & Replace	lm	\$ 1,000	116	\$ 115,670	\$ 11,567	\$ 40,485	\$ 167,722
12.5	Storm Sewer Main XN104 (750mm CONC) - Remove & Replace	lm	\$ 1,000	25	\$ 24,870	\$ 2,487	\$ 8,705	\$ 36,062
12.6	Storm Manhole (1200mm) - Remove & Replace	ea	\$ 15,000	1	\$ 15,000	\$ 1,500	\$ 5,250	\$ 21,750
12.7	Storm Manhole (1500mm) - Remove & Replace	ea	\$ 25,000	3	\$ 75,000	\$ 7,500	\$ 26,250	\$ 108,750
Subtotal					\$ 412,970	\$ 41,297	\$ 144,540	\$ 598,807
XQ - Section 13 - 41 St from North of 48 Ave to South of 47 Ave								
13.1	Storm Sewer Main XQ101_A (750mm CONC) - Remove & Replace	lm	\$ 1,000	109	\$ 108,690	\$ 10,869	\$ 38,042	\$ 157,601
13.2	Storm Sewer Main XQ101_B (750mm CONC) - Remove & Replace	lm	\$ 1,000	16	\$ 16,400	\$ 1,640	\$ 5,740	\$ 23,780
13.3	Storm Sewer Main XQ102 (900mm CONC) - Remove & Replace	lm	\$ 1,200	108	\$ 129,360	\$ 12,936	\$ 45,276	\$ 187,572
13.4	Storm Sewer Main XQ103 (900mm CONC) - Remove & Replace	lm	\$ 1,200	133	\$ 159,270	\$ 15,927	\$ 55,745	\$ 230,942
13.5	Storm Sewer Main XQ104 (900mm CONC) - Remove & Replace	lm	\$ 1,200	53	\$ 63,280	\$ 6,328	\$ 22,148	\$ 91,756
13.6	Storm Sewer Main XQ105 (900mm CONC) - Remove & Replace	lm	\$ 1,200	9	\$ 11,210	\$ 1,121	\$ 3,924	\$ 16,255
13.7	Storm Manhole (2100mm) - Remove & Replace	ea	\$ 45,000	1	\$ 45,000	\$ 4,500	\$ 15,750	\$ 65,250
Subtotal					\$ 533,210	\$ 53,321	\$ 186,624	\$ 773,155
SECTION A - CONSTRUCTION SUBTOTAL					\$ 9,187,120	\$ 918,712	\$ 3,215,492	\$ 13,321,324
Notes & Assumptions:								
1	Unit prices are based on past experience, comparable tenders, and some engineering judgement.							
2	Price does not include restoration; assumption has been made work will be done in tandem with other project.							
3	Manhole quantity assumed based on 120m spacing							

Table 13
Cost Estimate - Future Development

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total	Subzone Percent Contribution			
Section 1.0 - East Commercial / Industrial												
Section 1.1 - SubZone E_IND_201									E_IND_201			
1.1.1	New Storm Pond E_I_032	cu. m	\$ 20	12362	\$ 247,240	\$ 24,724	\$ 86,534	\$ 358,498	100%			
1.1.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	8501	\$ 68,010	\$ 6,801	\$ 23,804	\$ 98,615	100%			
1.1.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	8501	\$ 127,520	\$ 12,752	\$ 44,632	\$ 184,904	100%			
1.1.4	Seeding	sq. m	\$ 5	8501	\$ 42,510	\$ 4,251	\$ 14,879	\$ 61,640	100%			
1.1.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%			
Subtotal					\$ 585,280	\$ 58,528	\$ 204,848	\$ 848,656	\$ 848,656			
Section 1.2 - SubZone E_IND_202									E_IND_202			
1.2.1	New Storm Pond E_I_030	cu. m	\$ 20	8581	\$ 171,620	\$ 17,162	\$ 60,067	\$ 248,849	100%			
1.2.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	6241	\$ 49,930	\$ 4,993	\$ 17,476	\$ 72,399	100%			
1.2.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	6241	\$ 93,620	\$ 9,362	\$ 32,767	\$ 135,749	100%			
1.2.4	Seeding	sq. m	\$ 5	6241	\$ 31,210	\$ 3,121	\$ 10,924	\$ 45,255	100%			
1.2.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%			
Subtotal					\$ 446,380	\$ 44,638	\$ 156,233	\$ 647,251	\$ 647,251			
Stage 2 East Commercial / Industrial Subtotal					\$ 1,031,660	\$ 103,166	\$ 361,081	\$ 1,495,907				
Engineering (10%) + Contingency (35%)					\$ 464,247							
Stage 2 East Commercial / Industrial Total					\$ 1,495,907							
Section 1.3 - SubZone E_IND_301/302									E_IND_301	E_IND_302		
1.3.1	New Storm Pond E_I_033	cu. m	\$ 20	28225	\$ 564,500	\$ 56,450	\$ 197,575	\$ 818,525	94%	6%		
1.3.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	17562	\$ 140,500	\$ 14,050	\$ 49,175	\$ 203,725	94%	6%		
1.3.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	17562	\$ 263,430	\$ 26,343	\$ 92,201	\$ 381,974	94%	6%		
1.3.4	Seeding	sq. m	\$ 5	17562	\$ 87,810	\$ 8,781	\$ 30,734	\$ 127,325	94%	6%		
1.3.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	94%	6%		
Subtotal					\$ 1,156,240	\$ 115,624	\$ 404,684	\$ 1,676,548	\$ 1,576,154	\$ 100,394		
Stage 3 East Commercial / Industrial Subtotal					\$ 2,312,480	\$ 115,624	\$ 809,368	\$ 3,353,096				
Engineering (10%) + Contingency (35%)					\$ 1,040,616							
Stage 3 East Commercial / Industrial Total					\$ 3,353,096							
Section 1.4 - SubZone E_COMM_U01									E_COMM_U01			
1.4.1	New Storm Sewer Main (600mm CONC) - Supply & Install	lm	\$ 1,200	334	\$ 401,130	\$ 40,113	\$ 140,396	\$ 581,639	100%			
1.4.2	New Storm Manhole (1500mm DIA) - Supply & Install	ea	\$ 15,000	4	\$ 57,000	\$ 5,700	\$ 19,950	\$ 82,650	100%			
1.4.3	New Storm Pond E_C_035	cu. m	\$ 20	27006	\$ 540,120	\$ 54,012	\$ 189,042	\$ 783,174	100%			
1.4.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	16879	\$ 135,040	\$ 13,504	\$ 47,264	\$ 195,808	100%			
1.4.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	16879	\$ 253,190	\$ 25,319	\$ 88,617	\$ 367,126	100%			
1.4.6	Seeding	sq. m	\$ 5	16879	\$ 84,400	\$ 8,440	\$ 29,540	\$ 122,380	100%			
1.4.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%			
Subtotal					\$ 1,570,880	\$ 157,088	\$ 549,808	\$ 2,277,776	\$ 2,277,776			
Section 1.5 - SubZone E_COMM_U02									E_COMM_U02	SE_IND_U01		
1.5.1	New Storm Sewer Main (1050mm PVC) - Supply & Install	lm	\$ 2,100	520	\$ 1,092,730	\$ 109,273	\$ 382,456	\$ 1,584,459	32%	68%		
1.5.2	New Storm Manhole (2100mm DIA) - Supply & Install	ea	\$ 35,000	5	\$ 189,000	\$ 18,900	\$ 66,150	\$ 274,050	32%	68%		
1.5.3	New Storm Pond E_C_034	cu. m	\$ 20	7128	\$ 142,560	\$ 14,256	\$ 49,896	\$ 206,712	100%	0%		
1.5.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	5351	\$ 42,810	\$ 4,281	\$ 14,984	\$ 62,075	100%	0%		
1.5.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	5351	\$ 80,270	\$ 8,027	\$ 28,095	\$ 116,392	100%	0%		
1.5.6	Seeding	sq. m	\$ 5	5351	\$ 26,760	\$ 2,676	\$ 9,366	\$ 38,802	100%	0%		
1.5.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%	0%		
Subtotal					\$ 1,674,130	\$ 167,413	\$ 585,946	\$ 2,427,489	\$ 1,163,775	\$ 1,263,713		
Ultimate East Commercial / Industrial Subtotal					\$ 3,245,010	\$ 324,501	\$ 1,135,754	\$ 4,705,265				
Engineering (10%) + Contingency (35%)					\$ 1,460,255							
Ultimate East Commercial / Industrial Total					\$ 4,705,265							

Table 13
Cost Estimate - Future Development

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total	Subzone Percent Contribution					
									N_RES_301	N_RES_U03	N_RES_302	N_RES_303	N_RES_U01	
Section 2.0 - North Residential														
Section 2.1 - SubZone N_RES_301/U03														
2.1.1	New Storm Sewer Main (1500mm CONC) - Supply & Install	lm	\$ 3,000	1859	\$ 5,578,410	\$ 557,841	\$ 1,952,444	\$ 8,088,695	86%	14%				
2.1.2	New Storm Manhole (2400mm DIA) - Supply & Install	ea	\$ 45,000	17	\$ 742,500	\$ 74,250	\$ 259,875	\$ 1,076,625	86%	14%				
2.1.3	New Storm Pond N_R_047	cu. m	\$ 20	28262	\$ 565,240	\$ 56,524	\$ 197,834	\$ 819,598	86%	14%				
2.1.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	17583	\$ 140,670	\$ 14,067	\$ 49,235	\$ 203,972	86%	14%				
2.1.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	17583	\$ 263,750	\$ 26,375	\$ 92,313	\$ 382,438	86%	14%				
2.1.6	Seeding	sq. m	\$ 5	17583	\$ 87,920	\$ 8,792	\$ 30,772	\$ 127,484	86%	14%				
2.1.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	86%	14%				
Subtotal					\$ 7,478,490	\$ 747,849	\$ 2,617,472	\$ 10,843,811	\$ 9,319,512	\$ 1,524,298				
Section 2.2 - SubZone N_RES_302														
2.2.1	New Storm Pond N_R_045	cu. m	\$ 20	1871	\$ 37,420	\$ 3,742	\$ 13,097	\$ 54,259	100%					
2.2.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	1892	\$ 15,140	\$ 1,514	\$ 5,299	\$ 21,953	100%					
2.2.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	1892	\$ 28,390	\$ 2,839	\$ 9,937	\$ 41,166	100%					
2.2.4	Seeding	sq. m	\$ 5	1892	\$ 9,470	\$ 947	\$ 3,315	\$ 13,732	100%					
2.2.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%					
2.2.6	Outfall - Supply & Install	ea	\$ 75,000	1	\$ 75,000	\$ 7,500	\$ 26,250	\$ 108,750	100%					
Subtotal					\$ 265,420	\$ 26,542	\$ 92,897	\$ 384,859	\$ 384,859					
Section 2.3 - SubZone N_RES_304														
2.3.1	New Storm Pond N_R_043	cu. m	\$ 20	10715	\$ 214,300	\$ 21,430	\$ 75,005	\$ 310,735	100%					
2.3.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	7525	\$ 60,200	\$ 6,020	\$ 21,070	\$ 87,290	100%					
2.3.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	7525	\$ 112,880	\$ 11,288	\$ 39,508	\$ 163,676	100%					
2.3.4	Seeding	sq. m	\$ 5	7525	\$ 37,630	\$ 3,763	\$ 13,171	\$ 54,564	100%					
2.3.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%					
2.3.6	Outfall - Supply & Install	ea	\$ 75,000	1	\$ 75,000	\$ 7,500	\$ 26,250	\$ 108,750	100%					
Subtotal					\$ 600,010	\$ 60,001	\$ 210,004	\$ 870,015	\$ 870,015					
Section 2.4 - SubZone N_RES_303/U01														
2.4.1	New Storm Pond N_R_044	cu. m	\$ 20	9861	\$ 197,220	\$ 19,722	\$ 69,027	\$ 285,969	79%	27%				
2.4.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	7014	\$ 56,120	\$ 5,612	\$ 19,642	\$ 81,374	79%	27%				
2.4.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	7014	\$ 105,220	\$ 10,522	\$ 36,827	\$ 152,569	79%	27%				
2.4.4	Seeding	sq. m	\$ 5	7014	\$ 35,080	\$ 3,508	\$ 12,278	\$ 50,866	79%	27%				
2.4.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	79%	27%				
2.4.6	Outfall - Supply & Install	ea	\$ 75,000	1	\$ 75,000	\$ 7,500	\$ 26,250	\$ 108,750	79%	27%				
Subtotal					\$ 568,640	\$ 56,864	\$ 199,024	\$ 824,528	\$ 648,151	\$ 224,373				
Section 2.5 - SubZone N_RES_U02														
2.5.1	New Storm Sewer Main (1500mm CONC) - Supply & Install	lm	\$ 3,000	603	\$ 1,809,000	\$ 180,900	\$ 633,150	\$ 2,623,050	43%	5%	31%	5%	15%	
2.5.2	New Storm Manhole (2400mm DIA) - Supply & Install	ea	\$ 45,000	6	\$ 274,500	\$ 27,450	\$ 96,075	\$ 398,025	43%	5%	31%	5%	15%	
2.5.3	New Storm Pond N_R_046	cu. m	\$ 20	25174	\$ 503,480	\$ 50,348	\$ 176,218	\$ 730,046	100%	0%	0%	0%	0%	
2.5.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	16740	\$ 133,920	\$ 13,392	\$ 46,872	\$ 194,184	100%	0%	0%	0%	0%	
2.5.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	16740	\$ 251,100	\$ 25,110	\$ 87,885	\$ 364,095	100%	0%	0%	0%	0%	
2.5.6	Seeding	sq. m	\$ 5	16740	\$ 83,700	\$ 8,370	\$ 29,295	\$ 121,365	100%	0%	0%	0%	0%	
2.5.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%	0%	0%	0%	0%	
2.5.8	Outfall - Supply & Install	ea	\$ 75,000	1	\$ 75,000	\$ 7,500	\$ 26,250	\$ 108,750	100%	0%	0%	0%	0%	
Subtotal					\$ 3,230,700	\$ 323,070	\$ 1,130,745	\$ 4,684,515	\$ 2,957,631	\$ 154,398	\$ 943,982	\$ 162,871	\$ 465,634	
Stage 3 / Ultimate North Residential Subtotal					\$ 12,143,260	\$ 1,214,326	\$ 4,250,141	\$ 17,607,727						
Engineering (10%) + Contingency (35%)					\$ 5,464,467									
Stage 3 / Ultimate North Residential Total					\$ 17,607,727									

Table 13
Cost Estimate - Future Development

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total	Subzone Percent Contribution								
Section 3.0 - North East Commercial/Industrial																	
Section 3.1 - SubZone NE_IND_301									NE_IND_301	NE_COMM_U01	NE_COMM_U02	NE_COMM_U03	NE_COMM_U04	NE_COMM_U05	NE_IND_U02		
3.1.1	New Storm Sewer Main (900mm CONC) - Supply & Install	lm	\$ 1,800	901	\$ 1,622,250	\$ 162,225	\$ 567,788	\$ 2,352,263	53%	47%	0%	0%	0%	0%	0%	0%	
3.1.2	New Storm Manhole (1800mm DIA) - Supply & Install	ea	\$ 25,000	9	\$ 215,000	\$ 21,500	\$ 75,250	\$ 311,750	53%	47%	0%	0%	0%	0%	0%	0%	
3.1.3	New Storm Sewer Main (1350mm CONC) - Supply & Install	lm	\$ 2,700	385	\$ 1,038,920	\$ 103,892	\$ 363,622	\$ 1,506,434	20%	18%	15%	24%	0%	0%	22%		
3.1.4	New Storm Manhole (2100mm DIA) - Supply & Install	ea	\$ 45,000	4	\$ 193,500	\$ 19,350	\$ 67,725	\$ 280,575	20%	18%	15%	24%	0%	0%	22%		
3.1.5	New Storm Sewer Main (1500mm CONC) - Supply & Install	lm	\$ 3,000	1507	\$ 4,521,630	\$ 452,163	\$ 1,582,571	\$ 6,556,364	18%	16%	13%	21%	2%	12%	19%		
3.1.6	New Storm Manhole (2400mm DIA) - Supply & Install	ea	\$ 55,000	15	\$ 803,000	\$ 80,300	\$ 281,050	\$ 1,164,350	18%	16%	13%	21%	2%	12%	19%		
3.1.7	New Storm Pond NE_I_037	cu. m	\$ 20	19143	\$ 382,860	\$ 38,286	\$ 134,001	\$ 555,147	100%	0%	0%	0%	0%	0%	0%		
3.1.8	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	12432	\$ 99,460	\$ 9,946	\$ 34,811	\$ 144,217	100%	0%	0%	0%	0%	0%	0%		
3.1.9	Topsoil Placement (assume 300mm)	sq. m	\$ 15	12432	\$ 186,490	\$ 18,649	\$ 65,272	\$ 270,411	100%	0%	0%	0%	0%	0%	0%		
3.1.10	Seeding	sq. m	\$ 5	12432	\$ 62,170	\$ 6,217	\$ 21,760	\$ 90,147	100%	0%	0%	0%	0%	0%	0%		
3.1.11	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%	0%	0%	0%	0%	0%	0%		
Subtotal					\$ 9,225,280	\$ 922,528	\$ 3,228,848	\$ 13,376,656	\$ 4,343,138	\$ 2,808,914	\$ 1,280,675	\$ 2,055,804	\$ 150,893	\$ 897,592	\$ 1,840,154		
Stage 3 North East Commercial / Industrial					\$ 18,450,560	\$ 1,845,056	\$ 6,457,696	\$ 26,753,312									
Engineering (10%) + Contingency (35%)					\$ 8,302,752												
Stage 3 North East Commercial / Industrial Total					\$ 26,753,312												
Section 3.2 - SubZone NE_COMM_U01									NE_COMM_U01								
3.2.1	New Storm Sewer Main (600mm CONC) - Supply & Install	lm	\$ 1,200	565	\$ 677,840	\$ 67,784	\$ 237,244	\$ 982,868	100%								
3.2.2	New Storm Manhole (1500mm DIA) - Supply & Install	ea	\$ 15,000	6	\$ 87,000	\$ 8,700	\$ 30,450	\$ 126,150	100%								
3.2.3	New Storm Pond NE_C_036	cu. m	\$ 20	22602	\$ 452,040	\$ 45,204	\$ 158,214	\$ 655,458	100%								
3.2.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	14400	\$ 115,200	\$ 11,520	\$ 40,320	\$ 167,040	100%								
3.2.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	14400	\$ 216,000	\$ 21,600	\$ 75,600	\$ 313,200	100%								
3.2.6	Seeding	sq. m	\$ 5	14400	\$ 72,000	\$ 7,200	\$ 25,200	\$ 104,400	100%								
3.2.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%								
Subtotal					\$ 1,720,080	\$ 172,008	\$ 602,028	\$ 2,494,116	\$ 2,494,116								
Section 3.3 - SubZone NE_COMM_U02									NE_COMM_U02								
3.3.1	New Storm Sewer Main (1350mm CONC) - Supply & Install	lm	\$ 2,700	718	\$ 1,938,600	\$ 193,860	\$ 678,510	\$ 2,810,970	100%								
3.3.2	New Storm Manhole (2400mm DIA) - Supply & Install	ea	\$ 55,000	603	\$ 33,165,000	\$ 3,316,500	\$ 11,607,750	\$ 48,089,250	100%								
3.3.3	New Storm Pond NE_C_038	cu. m	\$ 20	18851	\$ 377,020	\$ 37,702	\$ 131,957	\$ 546,679	100%								
3.3.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	12266	\$ 98,130	\$ 9,813	\$ 34,346	\$ 142,289	100%								
3.3.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	12266	\$ 183,990	\$ 18,399	\$ 64,397	\$ 266,786	100%								
3.3.6	Seeding	sq. m	\$ 5	12266	\$ 61,330	\$ 6,133	\$ 21,466	\$ 88,929	100%								
3.3.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%								
Subtotal					\$ 35,924,070	\$ 3,592,407	\$ 12,573,425	\$ 52,089,902	\$ 52,089,902								
Section 3.4 - SubZone NE_COMM_U03									NE_COMM_U03								
3.4.1	New Storm Sewer Main (1050mm CONC) - Supply & Install	lm	\$ 2,100	382	\$ 802,200	\$ 80,220	\$ 280,770	\$ 1,163,190	100%								
3.4.2	New Storm Manhole (2400mm DIA) - Supply & Install	ea	\$ 55,000	4	\$ 231,000	\$ 23,100	\$ 80,850	\$ 334,950	100%								
3.4.3	New Storm Pond NE_C_040	cu. m	\$ 20	51330	\$ 1,026,600	\$ 102,660	\$ 359,310	\$ 1,488,570	100%								
3.4.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	30276	\$ 242,210	\$ 24,221	\$ 84,774	\$ 351,205	100%								
3.4.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	30276	\$ 454,140	\$ 45,414	\$ 158,949	\$ 658,503	100%								
3.4.6	Seeding	sq. m	\$ 5	30276	\$ 151,380	\$ 15,138	\$ 52,983	\$ 219,501	100%								
3.4.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%								
Subtotal					\$ 3,007,530	\$ 300,753	\$ 1,052,636	\$ 4,360,919	\$ 4,360,919								
Section 3.5 - SubZone NE_COMM_U04									NE_COMM_U04								
3.5.1	New Storm Pond NE_C_041	cu. m	\$ 20	3173	\$ 63,460	\$ 6,346	\$ 22,211	\$ 92,017	100%								
3.5.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	2809	\$ 22,480	\$ 2,248	\$ 7,868	\$ 32,596	100%								
3.5.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	2809	\$ 42,140	\$ 4,214	\$ 14,749	\$ 61,103	100%								
3.5.4	Seeding	sq. m	\$ 5	2809	\$ 14,050	\$ 1,405	\$ 4,918	\$ 20,373	100%								
3.5.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%								
Subtotal					\$ 150,433,004	\$ 15,043,300	\$ 52,651,551	\$ 218,127,856	\$ 351,089								
Section 3.6 - SubZone NE_COMM_U05									NE_COMM_U05								
3.6.1	New Storm Pond NE_C_042	cu. m	\$ 20	16783	\$ 335,660	\$ 33,566	\$ 117,481	\$ 486,707	100%								
3.6.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	11078	\$ 88,630	\$ 8,863	\$ 31,021	\$ 128,514	100%								
3.6.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	11078	\$ 166,170	\$ 16,617	\$ 58,160	\$ 240,947	100%								
3.6.4	Seeding	sq. m	\$ 5	11078	\$ 55,390	\$ 5,539	\$ 19,387	\$ 80,316	100%								
3.6.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%								
Subtotal					\$ 302,844,278	\$ 30,284,428	\$ 105,995,497	\$ 439,124,203	\$ 1,081,483								
Section 3.7 - SubZone NE_IND_U02									NE_IND_U02								
3.7.1	New Storm Pond NE_I_039	cu. m	\$ 20	21658	\$ 433,170	\$ 43,317	\$ 151,610	\$ 628,097	100%								
3.7.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	14364	\$ 114,920	\$ 11,492	\$ 40,222	\$ 166,634	100%								
3.7.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	14364	\$ 215,470	\$ 21,547	\$ 75,415	\$ 312,432	100%								
3.7.4	Seeding	sq. m	\$ 5	14364	\$ 71,830	\$ 7,183	\$ 25,141	\$ 104,154	100%								
3.7.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%								
Subtotal					\$ 606,623,946	\$ 60,662,395	\$ 212,318,381	\$ 879,604,722	\$ 1,356,316								
Ultimate North East Commercial/Industrial Subtotal					\$ 1,100,552,908	\$ 99,538,472	\$ 348,384,651	\$ 1,443,307,838									

Table 13
Cost Estimate - Future Development

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total	Subzone Percent Contribution					
Engineering (10%) + Contingency (35%)					\$ 495,248,809									
Ultimate North East Commercial/Industrial Total					\$ 1,595,801,717									

Table 13
Cost Estimate - Future Development

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total	Subzone Percent Contribution				
Section 4.0 - North West Residential/Commercial													
Section 4.1 - SubZone NW_COMM_101/201 / RES_202													
4.1.1	New Storm Pond NW_C_004	cu. m	\$ 20	14075	\$ 281,500	\$ 28,150	\$ 98,525	\$ 408,175	NW_COMM_101 16%	NW_COMM_201 63%	NW_RES_202 20%		
4.1.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	9506	\$ 76,050	\$ 7,605	\$ 26,618	\$ 110,273	16%	63%	20%		
4.1.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	9506	\$ 142,600	\$ 14,260	\$ 49,910	\$ 206,770	16%	63%	20%		
4.1.4	Seeding	sq. m	\$ 5	9506	\$ 47,540	\$ 4,754	\$ 16,639	\$ 68,933	16%	63%	20%		
4.1.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	16%	63%	20%		
Subtotal					\$ 647,690	\$ 64,769	\$ 226,692	\$ 939,151	\$ 154,002	\$ 592,868	\$ 192,281		
Stage 1 North West Residential/Commercial					\$ 647,690	\$ 64,769	\$ 226,692	\$ 939,151					
Engineering (10%) + Contingency (35%)						\$ 291,461							
Stage 1 North West Residential/Commercial					\$ 939,151								
Section 4.2 - SubZone NW_RES_201													
4.2.1	New Storm Pond NW_R_009	cu. m	\$ 20	21971	\$ 439,420	\$ 43,942	\$ 153,797	\$ 637,159	100%				
4.2.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	14042	\$ 112,340	\$ 11,234	\$ 39,319	\$ 162,893	100%				
4.2.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	14042	\$ 210,630	\$ 21,063	\$ 73,721	\$ 305,414	100%				
4.2.4	Seeding	sq. m	\$ 5	14042	\$ 70,210	\$ 7,021	\$ 24,574	\$ 101,805	100%				
4.2.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%				
Subtotal					\$ 932,600	\$ 93,260	\$ 326,410	\$ 1,352,270	\$ 1,352,270				
Section 4.3 - SubZone NW_RES_203													
4.3.1	New Storm Sewer Main (1500mm CONC) - Supply & Install	lm	\$ 3,000	1969	\$ 5,908,250	\$ 590,825	\$ 2,067,888	\$ 8,566,963	18%	37%	51%	6%	
4.3.2	New Storm Sewer Main (1350mm CONC) - Supply & Install	lm	\$ 2,700	692	\$ 1,867,980	\$ 186,798	\$ 653,793	\$ 2,708,571	41%	85%	0%	0%	
4.3.3	New Storm Manhole (2100mm DIA) - Supply & Install	ea	\$ 45,000	7	\$ 306,000	\$ 30,600	\$ 107,100	\$ 443,700	41%	85%	0%	0%	
4.3.4	New Storm Manhole (2400mm DIA) - Supply & Install	ea	\$ 55,000	18	\$ 962,500	\$ 96,250	\$ 336,875	\$ 1,395,625	18%	37%	51%	6%	
4.3.5	New Storm Pond NW_R_005	cu. m	\$ 20	3362	\$ 67,240	\$ 6,724	\$ 23,534	\$ 97,498	100%	0%	0%	0%	
4.3.6	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	2938	\$ 23,510	\$ 2,351	\$ 8,229	\$ 34,090	100%	0%	0%	0%	
4.3.7	Topsoil Placement (assume 300mm)	sq. m	\$ 15	2938	\$ 44,070	\$ 4,407	\$ 15,425	\$ 63,902	100%	0%	0%	0%	
4.3.8	Seeding	sq. m	\$ 5	2938	\$ 14,690	\$ 1,469	\$ 5,142	\$ 21,301	100%	0%	0%	0%	
4.3.9	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%	0%	0%	0%	
Subtotal					\$ 9,294,240	\$ 929,424	\$ 3,252,984	\$ 13,476,648	\$ 3,442,721	\$ 6,368,608	\$ 5,045,504	\$ 601,931	
Stage 2 North West Residential/Commercial Subtotal					\$ 9,294,240	\$ 929,424	\$ 3,252,984	\$ 13,476,648					
Engineering (10%) + Contingency (35%)						\$ 4,182,408							
Stage 2 North West Residential/Commercial Total					\$ 13,476,648								
Section 4.4 - SubZone NW_COMM_301/302/U01/RES U01/U02													
4.4.1	Enlarge Existing Wet Pond NW_WP_002	cu. m	\$ 20	23409	\$ 468,180	\$ 46,818	\$ 163,863	\$ 678,861	14%	7%	28%	31%	20%
4.4.2	Topsoil Placement (assume 300mm)	sq. m	\$ 15	23409	\$ 351,140	\$ 35,114	\$ 122,899	\$ 509,153	14%	7%	28%	31%	20%
4.4.3	Seeding	sq. m	\$ 5	23409	\$ 117,050	\$ 11,705	\$ 40,968	\$ 169,723	14%	7%	28%	31%	20%
4.4.4	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	14%	7%	29%	32%	21%
Subtotal					\$ 1,036,370	\$ 103,637	\$ 362,730	\$ 1,502,737	\$ 214,889	\$ 101,741	\$ 427,008	\$ 463,074	\$ 300,537
Section 4.5 - SubZone NW_RES_301													
4.5.1	New Storm Sewer Main (1350mm CONC) - Supply & Install	lm	\$ 2,700	298	\$ 804,750	\$ 80,475	\$ 281,663	\$ 1,166,888	100%				
4.5.2	New Storm Manhole (2100mm DIA) - Supply & Install	ea	\$ 45,000	4	\$ 157,500	\$ 15,750	\$ 55,125	\$ 228,375	100%				
4.5.3	New Storm Pond NW_C_R_003	cu. m	\$ 20	2839	\$ 56,780	\$ 5,678	\$ 19,873	\$ 82,331	100%				
4.5.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	2580	\$ 20,640	\$ 2,064	\$ 7,224	\$ 29,928	100%				
4.5.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	2580	\$ 38,700	\$ 3,870	\$ 13,545	\$ 56,115	100%				
4.5.6	Seeding	sq. m	\$ 5	2580	\$ 12,900	\$ 1,290	\$ 4,515	\$ 18,705	100%				
4.5.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%				
Subtotal					\$ 1,191,270	\$ 119,127	\$ 416,945	\$ 1,727,342	\$ 1,727,349				
Section 4.6 - SubZone NW_RES_302													
4.6.1	New Storm Sewer Main (900mm CONC) - Supply & Install	lm	\$ 1,800	1231	\$ 2,216,340	\$ 221,634	\$ 775,719	\$ 3,213,693	63%	37%			
4.6.2	New Storm Manhole (1800mm DIA) - Supply & Install	ea	\$ 35,000	11	\$ 395,500	\$ 39,550	\$ 138,425	\$ 573,475	63%	37%			
4.6.3	New Storm Pond NW_R_007	cu. m	\$ 20	26580	\$ 531,600	\$ 53,160	\$ 186,060	\$ 770,820	100%				
4.6.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	16641	\$ 133,130	\$ 13,313	\$ 46,596	\$ 193,039	100%				
4.6.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	16641	\$ 249,620	\$ 24,962	\$ 87,367	\$ 361,949	100%				
4.6.6	Seeding	sq. m	\$ 5	16641	\$ 83,210	\$ 8,321	\$ 29,124	\$ 120,655	100%				
4.6.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%				
Subtotal					\$ 3,709,400	\$ 370,940	\$ 1,298,290	\$ 5,378,630	\$ 3,977,126	\$ 1,401,504			
Section 4.7 - SubZone NW_RES_303													
4.7.1	New Storm Sewer Main (600mm CONC) - Supply & Install	lm	\$ 1,200	758	\$ 910,110	\$ 91,011	\$ 318,539	\$ 1,319,660	100%				
4.7.2	New Storm Manhole (1500mm DIA) - Supply & Install	ea	\$ 25,000	7	\$ 185,000	\$ 18,500	\$ 64,750	\$ 268,250	100%				
4.7.3	New Storm Pond NW_R_008	cu. m	\$ 20	15356	\$ 307,120	\$ 30,712	\$ 107,492	\$ 445,324	100%				
4.7.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	10252	\$ 82,020	\$ 8,202	\$ 28,707	\$ 118,929	100%				
4.7.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	10252	\$ 153,780	\$ 15,378	\$ 53,823	\$ 222,981	100%				
4.7.6	Seeding	sq. m	\$ 5	10252	\$ 51,260	\$ 5,126	\$ 17,941	\$ 74,327	100%				
4.7.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%				
Subtotal					\$ 1,789,290	\$ 178,929	\$ 626,252	\$ 2,594,471	\$ 2,594,478				
Stage 3 North West Residential/Commercial Subtotal					\$ 7,726,330	\$ 762,633	\$ 2,669,216	\$ 11,058,179					

Table 13
Cost Estimate - Future Development

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total	Subzone Percent Contribution		
									NW_COMM_U02	NW_RES_U03	NW_RES_U04
Engineering (10%) + Contingency (35%)					\$ 3,476,849						
Stage 3 North West Residential/Commercial Total					\$ 11,203,179						
Section 4.8 - SubZone NW_COMM_U02 / RES_U03 / U04											
4.8.1	Enlarge Existing Wet Pond NW_WP_001	cu. m	\$ 20	19516	\$ 390,330	\$ 39,033	\$ 136,616	\$ 565,979	44%	43%	12%
4.8.2	Topsoil Placement (assume 300mm)	sq. m	\$ 15	19516	\$ 292,750	\$ 29,275	\$ 102,463	\$ 424,488	44%	43%	12%
4.8.3	Seeding	sq. m	\$ 5	19516	\$ 97,590	\$ 9,759	\$ 34,157	\$ 141,506	44%	43%	12%
4.8.4	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	44%	43%	12%
Subtotal					\$ 880,670	\$ 88,067	\$ 308,235	\$ 1,276,972	\$ 568,126	\$ 553,330	\$ 155,516
Ultimate North West Residential/Commercial Subtotal					\$ 880,670	\$ 88,067	\$ 308,235	\$ 1,276,972			
Engineering (10%) + Contingency (35%)					\$ 396,302						
Ultimate North West Residential/Commercial Total					\$ 1,276,972						

Table 13
Cost Estimate - Future Development

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total	Subzone Percent Contribution						
Section 5.0 - South East Commercial/Industrial															
Section 5.1 - Subzone SE_IND_101 / RES 201										SE_RES_101		SE_RES_201			
5.1.1	New Storm Pond SE_R_017	cu. m	\$ 20	4635	\$ 92,700	\$ 9,270	\$ 32,445	\$ 134,415	8%	92%					
5.1.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	3782	\$ 30,260	\$ 3,026	\$ 10,591	\$ 43,877	8%	92%					
5.1.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	3782	\$ 56,740	\$ 5,674	\$ 19,859	\$ 82,273	8%	92%					
5.1.4	Seeding	sq. m	\$ 5	3782	\$ 18,920	\$ 1,892	\$ 6,622	\$ 27,434	8%	92%					
5.1.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	8%	92%					
Subtotal					\$ 298,620	\$ 29,862	\$ 104,517	\$ 432,999							
Stage 1 South East Commercial / Industrial Subtotal					\$ 298,620	\$ 29,862	\$ 104,517	\$ 432,999							
Engineering (10%) + Contingency (35%)					\$	\$	\$	\$							
Stage 1 South East Commercial / Industrial Total					\$ 432,999										
Section 5.2 - Subzone SE_IND_201										SE_IND_201					
5.2.1	New Storm Pond SE_I_022	cu. m	\$ 20	5282	\$ 105,640	\$ 10,564	\$ 36,974	\$ 153,178	100%						
5.2.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	4192	\$ 33,540	\$ 3,354	\$ 11,739	\$ 48,633	100%						
5.2.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	4192	\$ 62,880	\$ 6,288	\$ 22,008	\$ 91,176	100%						
5.2.4	Seeding	sq. m	\$ 5	4192	\$ 20,960	\$ 2,096	\$ 7,336	\$ 30,392	100%						
5.2.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%						
Subtotal					\$ 323,020	\$ 32,302	\$ 113,057	\$ 468,379	\$ 468,379						
Section 5.3 - Subzone SE_IND_202 / SE_IND_304										SE_IND_202		SE_IND_304			
5.3.1	New Storm Pond SE_I_019	cu. m	\$ 20	8975	\$ 179,500	\$ 17,950	\$ 62,825	\$ 260,275	74%	26%					
5.3.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	6480	\$ 51,840	\$ 5,184	\$ 18,144	\$ 75,168	74%	26%					
5.3.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	6480	\$ 97,200	\$ 9,720	\$ 34,020	\$ 140,940	74%	26%					
5.3.4	Seeding	sq. m	\$ 5	6480	\$ 32,400	\$ 3,240	\$ 11,340	\$ 46,980	74%	26%					
5.3.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	74%	26%					
Subtotal					\$ 460,940	\$ 46,094	\$ 161,329	\$ 668,363	\$ 493,704	\$ 174,659					
Section 5.4 - Subzone SE_RES_202 / SE_IND_303										SE_RES_202		SE_IND_303			
5.4.1	New Storm Sewer Main (600mm CONC) - Supply & Install	lm	\$ 1,200	248	\$ 297,860	\$ 29,786	\$ 104,251	\$ 431,897	27%	73%					
5.4.2	New Storm Manhole (1500mm DIA) - Supply & Install	ea	\$ 15,000	3	\$ 46,500	\$ 4,650	\$ 16,275	\$ 67,425	27%	73%					
5.4.3	New Storm Pond SE_I_018	cu. m	\$ 20	23637	\$ 472,750	\$ 47,275	\$ 165,463	\$ 685,488	27%	73%					
5.4.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	15475	\$ 123,810	\$ 12,381	\$ 43,334	\$ 179,525	27%	73%					
5.4.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	15475	\$ 232,140	\$ 23,214	\$ 81,249	\$ 336,603	27%	73%					
5.4.6	Seeding	sq. m	\$ 5	15475	\$ 77,380	\$ 7,738	\$ 27,083	\$ 112,201	27%	73%					
5.4.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	27%	73%					
Subtotal					\$ 1,350,440	\$ 135,044	\$ 472,654	\$ 1,958,138	\$ 534,012	\$ 1,424,126					
Stage 2 South East Commercial / Industrial Subtotal					\$ 2,134,400	\$ 213,440	\$ 747,040	\$ 3,094,880							
Engineering (10%) + Contingency (35%)					\$	\$	\$	\$							
Stage 2 South East Commercial / Industrial Total					\$ 3,094,880										
Section 5.5 - Subzone SE_IND_301										SE_IND_301		SE_IND_302		SE_IND_U02	
5.5.1	New Storm Sewer Main (900mm CONC) - Supply & Install	lm	\$ 1,800	126	\$ 226,800	\$ 22,680	\$ 79,380	\$ 328,860	49%	34%	23%				
5.5.2	New Storm Sewer Main (525mm CONC) - Supply & Install	lm	\$ 1,050	117	\$ 122,870	\$ 12,287	\$ 43,005	\$ 178,162	49%	34%	23%				
5.5.3	New Storm Manhole (1800mm DIA) - Supply & Install	ea	\$ 25,000	4	\$ 102,500	\$ 10,250	\$ 35,875	\$ 148,625	49%	34%	23%				
5.5.4	New Storm Pond SE_I_025	cu. m	\$ 20	19182	\$ 383,640	\$ 38,364	\$ 134,274	\$ 556,278	100%	0%	0%				
5.5.5	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	12454	\$ 99,640	\$ 9,964	\$ 34,874	\$ 144,478	100%	0%	0%				
5.5.6	Topsoil Placement (assume 300mm)	sq. m	\$ 15	12454	\$ 186,810	\$ 18,681	\$ 65,384	\$ 270,875	100%	0%	0%				
5.5.7	Seeding	sq. m	\$ 5	12454	\$ 62,270	\$ 6,227	\$ 21,795	\$ 90,292	100%	0%	0%				
5.5.8	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%	0%	0%				
Subtotal					\$ 1,284,530	\$ 128,453	\$ 449,586	\$ 1,862,569	\$ 1,530,054	\$ 222,882	\$ 152,392				
Section 5.6 - Subzone SE_IND_302										SE_IND_302		SE_IND_U02			
5.6.1	New Storm Sewer Main (750mm CONC) - Supply & Install	lm	\$ 1,500	786	\$ 1,179,080	\$ 117,908	\$ 412,678	\$ 1,709,666	59%	41%					
5.6.2	New Storm Manhole (1800mm DIA) - Supply & Install	ea	\$ 25,000	8	\$ 190,000	\$ 19,000	\$ 66,500	\$ 275,500	59%	41%					
5.6.3	New Storm Pond SE_I_026	cu. m	\$ 20	13826	\$ 276,520	\$ 27,652	\$ 96,782	\$ 400,954	100%	0%					
5.6.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	9361	\$ 74,890	\$ 7,489	\$ 26,212	\$ 108,591	100%	0%					
5.6.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	9361	\$ 140,420	\$ 14,042	\$ 49,147	\$ 203,609	100%	0%					
5.6.6	Seeding	sq. m	\$ 5	9361	\$ 46,810	\$ 4,681	\$ 16,384	\$ 67,875	100%	0%					
5.6.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%	0%					
5.6.8	Outfall - Supply & Install	ea	\$ 75,000	1	\$ 75,000	\$ 7,500	\$ 26,250	\$ 108,750	100%	0%					
Subtotal					\$ 2,082,720	\$ 208,272	\$ 728,952	\$ 3,019,944	\$ 2,213,803	\$ 806,141					
Section 5.7 - Subzone SE_IND_305 / IND U03										SE_IND_305		SE_COMM_U03			
5.7.1	New Storm Sewer Main (525mm CONC) - Supply & Install	lm	\$ 1,050	712	\$ 747,600	\$ 74,760	\$ 261,660	\$ 1,084,020	49%	51%					
5.7.2	New Storm Manhole (1500mm DIA) - Supply & Install	ea	\$ 15,000	7	\$ 105,000	\$ 10,500	\$ 36,750	\$ 152,250	49%	51%					
5.7.3	New Storm Pond SE_C_I_024	cu. m	\$ 20	15601	\$ 312,020	\$ 31,202	\$ 109,207	\$ 452,429	49%	51%					
5.7.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	10394	\$ 83,160	\$ 8,316	\$ 29,106	\$ 120,582	49%	51%					
5.7.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	10394	\$ 155,910	\$ 15,591	\$ 54,569	\$ 226,070	49%	51%					
5.7.6	Seeding	sq. m	\$ 5	10394	\$ 51,970	\$ 5,197	\$ 18,190	\$ 75,357	49%	51%					
5.7.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	49%	51%					
Subtotal					\$ 1,555,660	\$ 155,566	\$ 544,481	\$ 2,255,707	\$ 1,111,348	\$ 1,144,359					

Table 13
Cost Estimate - Future Development

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total	Subzone Percent Contribution									
Section 6.0 - South West Residential																		
Section 6.1 - Subzone SW_RES_301									SW_RES_301	SW_RES_302	SW_RES_303	SW_RES_U01	SW_RES_U02	SW_RES_U03				
6.1.1	New Storm Sewer Main (1350mm CONC) - Supply & Install	lm	\$ 2,700	218	\$ 588,210	\$ 58,821	\$ 205,874	\$ 852,905	22%	10%	12%	29%	4%	24%				
6.1.2	New Storm Sewer Main - Rail Crossing (1350mm CONC) - Supply & Install	lm	\$ 5,400	25	\$ 137,490	\$ 13,749	\$ 48,122	\$ 199,361	22%	10%	12%	29%	4%	24%				
6.1.3	New Storm Pond SW_R_015	cu. m	\$ 20	15883	\$ 317,660	\$ 31,766	\$ 111,181	\$ 460,607	100%	0%	0%	0%	0%	0%				
6.1.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	10558	\$ 84,470	\$ 8,447	\$ 29,565	\$ 122,482	100%	0%	0%	0%	0%	0%				
6.1.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	10558	\$ 158,370	\$ 15,837	\$ 55,430	\$ 229,637	100%	0%	0%	0%	0%	0%				
6.1.6	Seeding	sq. m	\$ 5	10558	\$ 52,790	\$ 5,279	\$ 18,477	\$ 76,546	100%	0%	0%	0%	0%	0%				
6.1.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%	0%	0%	0%	0%	0%				
6.1.8	Storm Manhole (1800mm) - Supply & Install	ea	\$ 35,000	2	\$ 70,000	\$ 7,000	\$ 24,500	\$ 101,500	100%	0%	0%	0%	0%	0%				
6.1.9	Storm Manhole (2400mm) - Supply & Install	ea	\$ 55,000	5	\$ 275,000	\$ 27,500	\$ 96,250	\$ 398,750	100%	0%	0%	0%	0%	0%				
6.1.10	Outfall - Supply & Install	ea	\$ 75,000	1	\$ 75,000	\$ 7,500	\$ 26,250	\$ 108,750	100%	0%	0%	0%	0%	0%				
Subtotal					\$ 1,858,990	\$ 185,899	\$ 650,647	\$ 2,695,536	\$ 1,875,404	\$ 101,062	\$ 123,762	\$ 306,903	\$ 38,090	\$ 250,315				
Section 6.2 - Subzone SW_RES_302									SW_RES_302	SW_RES_303	SW_RES_U01	SW_RES_U02	SW_RES_U03					
6.2.1	New Storm Sewer Main (1200mm CONC) - Supply & Install	lm	\$ 2,400	260	\$ 624,650	\$ 62,465	\$ 218,628	\$ 905,743	12%	15%	37%	5%	31%					
6.2.2	New Storm Sewer Main (1050mm CONC) - Supply & Install	lm	\$ 2,100	708	\$ 1,486,820	\$ 148,682	\$ 520,387	\$ 2,155,889	12%	15%	0%	0%	31%					
6.2.3	New Storm Sewer Main (600mm CONC) - Supply & Install	lm	\$ 1,200	380	\$ 456,550	\$ 45,655	\$ 159,793	\$ 661,998	12%	15%	0%	0%	31%					
6.2.4	New Storm Manhole (1500mm DIA) - Supply & Install	ea	\$ 15,000	4	\$ 63,000	\$ 6,300	\$ 22,050	\$ 91,350	12%	15%	0%	0%	31%					
6.2.5	New Storm Manhole (2100mm DIA) - Supply & Install	ea	\$ 45,000	10	\$ 454,500	\$ 45,450	\$ 159,075	\$ 659,025	12%	15%	0%	0%	31%					
6.2.6	New Storm Pond SW_R_010	cu. m	\$ 20	7033	\$ 140,660	\$ 14,066	\$ 49,231	\$ 203,957	100%	0%	0%	0%	0%					
6.2.7	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	5293	\$ 42,350	\$ 4,235	\$ 14,823	\$ 61,408	100%	0%	0%	0%	0%					
6.2.8	Topsoil Placement (assume 300mm)	sq. m	\$ 15	5293	\$ 79,390	\$ 7,939	\$ 27,787	\$ 115,116	100%	0%	0%	0%	0%					
6.2.9	Seeding	sq. m	\$ 5	5293	\$ 26,470	\$ 2,647	\$ 9,265	\$ 38,382	100%	0%	0%	0%	0%					
6.2.10	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%	0%	0%	0%	0%					
Subtotal					\$ 3,474,390	\$ 347,439	\$ 1,216,037	\$ 5,037,866	\$ 1,115,178	\$ 675,150	\$ 338,940	\$ 42,066	\$ 1,365,523					
Section 6.3 - Subzone SW_RES_303									SW_RES_303	SW_RES_U03								
6.3.1	New Storm Sewer Main (900mm CONC) - Supply & Install	lm	\$ 1,800	125	\$ 224,200	\$ 22,420	\$ 78,470	\$ 325,090	27%	67%								
6.3.2	New Storm Manhole (1800mm DIA) - Supply & Install	ea	\$ 25,000	2	\$ 52,500	\$ 5,250	\$ 18,375	\$ 76,125	27%	67%								
6.3.3	New Storm Pond SW_R_012	cu. m	\$ 20	8069	\$ 161,380	\$ 16,138	\$ 56,483	\$ 234,001	100%	0%								
6.3.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	5929	\$ 47,440	\$ 4,744	\$ 16,604	\$ 68,788	100%	0%								
6.3.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	5929	\$ 88,940	\$ 8,894	\$ 31,129	\$ 128,963	100%	0%								
6.3.6	Seeding	sq. m	\$ 5	5929	\$ 29,650	\$ 2,965	\$ 10,378	\$ 42,993	100%	0%								
6.3.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%	0%								
Subtotal					\$ 704,110	\$ 70,411	\$ 246,439	\$ 1,020,960	\$ 728,138	\$ 268,474								
Stage 3 South West Residential Subtotal						\$ 6,037,490	\$ 603,749	\$ 2,113,122	\$ 8,754,361									
Engineering (10%) + Contingency (35%)						\$ 2,716,871												
Stage 3 South West Residential Total						\$ 8,754,361												
Section 6.4 - Subzone SW_RES_U01									SW_RES_U01									
6.4.1	New Storm Sewer Main (600mm CONC) - Supply & Install	lm	\$ 1,200	383	\$ 459,380	\$ 45,938	\$ 160,783	\$ 666,101	100%									
6.4.2	New Storm Manhole (1500mm DIA) - Supply & Install	ea	\$ 15,000	4	\$ 63,000	\$ 6,300	\$ 22,050	\$ 91,350	100%									
6.4.3	New Storm Pond SW_R_013	cu. m	\$ 20	19831	\$ 396,620	\$ 39,662	\$ 138,817	\$ 575,099	100%									
6.4.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	12826	\$ 102,610	\$ 10,261	\$ 35,914	\$ 148,785	100%									
6.4.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	12826	\$ 192,390	\$ 19,239	\$ 67,337	\$ 278,966	100%									
6.4.6	Seeding	sq. m	\$ 5	12826	\$ 64,130	\$ 6,413	\$ 22,446	\$ 92,989	100%									
6.4.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%									
Subtotal					\$ 1,378,130	\$ 137,813	\$ 482,346	\$ 1,998,289	\$ 1,998,289									
Section 6.5 - Subzone SW_RES_U02									SW_RES_U02									
6.5.1	New Storm Pond SW_R_014	cu. m	\$ 20	3575	\$ 71,500	\$ 7,150	\$ 25,025	\$ 103,675	100%									
6.5.2	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	3080	\$ 24,640	\$ 2,464	\$ 8,624	\$ 35,728	100%									
6.5.3	Topsoil Placement (assume 300mm)	sq. m	\$ 15	3080	\$ 46,200	\$ 4,620	\$ 16,170	\$ 66,990	100%									
6.5.4	Seeding	sq. m	\$ 5	3080	\$ 15,400	\$ 1,540	\$ 5,390	\$ 22,330	100%									
6.5.5	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%									
Subtotal					\$ 257,740	\$ 25,774	\$ 90,209	\$ 373,723	\$ 373,723									
Section 6.6 - Subzone SW_RES_U03									SW_RES_U03									
6.6.1	New Storm Sewer Main (750mm CONC) - Supply & Install	lm	\$ 1,500	645	\$ 967,550	\$ 96,755	\$ 338,643	\$ 1,402,948	100%									
6.6.2	New Storm Manhole (1500mm DIA) - Supply & Install	ea	\$ 15,000	6	\$ 96,000	\$ 9,600	\$ 33,600	\$ 139,200	100%									
6.6.3	New Storm Pond SW_R_011	cu. m	\$ 20	16511	\$ 330,220	\$ 33,022	\$ 115,577	\$ 478,819	100%									
6.6.4	Topsoil Stripping (assume 300mm)	sq. m	\$ 8	8133	\$ 65,070	\$ 6,507	\$ 22,775	\$ 94,352	100%									
6.6.5	Topsoil Placement (assume 300mm)	sq. m	\$ 15	10920	\$ 163,810	\$ 16,381	\$ 57,334	\$ 237,525	100%									
6.6.6	Seeding	sq. m	\$ 5	10920	\$ 54,610	\$ 5,461	\$ 19,114	\$ 79,185	100%									
6.6.7	New Outlet Control Structure	ea	\$ 100,000	1	\$ 100,000	\$ 10,000	\$ 35,000	\$ 145,000	100%									
Subtotal					\$ 1,777,260	\$ 177,726	\$ 622,041	\$ 2,577,027	\$ 2,577,027									
Ultimate South West Residential Subtotal						\$ 3,413,130	\$ 341,313	\$ 1,194,596	\$ 4,949,039									
Engineering (10%) + Contingency (35%)						\$ 1,535,909												
Ultimate South West Residential Total						\$ 4,949,039												

Table 13
Cost Estimate - Future Development

Item	Description	Unit	Estimated Rate	Estimate Quantity	Construction Cost	Engineering (10%)	Contingencies (35%)	Total	Subzone Percent Contribution						
TOTAL					\$ 1,185,581,088	\$ 107,915,666	\$ 378,109,514	\$ 1,566,453,699							
Notes & Assumptions:															
1	Unit prices are based on past experience, comparable tenders, and some engineering judgement.														
2	Price does not include restoration; assumption has been made work will be done in tandem with other project.														
3	Manhole quantity assumed based on 120m spacing														

7. Next Steps

The following next steps have been identified to upgrade the system and provide guidance for future development.

7.1. ENGINEERING

The following engineering and field investigation items are recommended to be completed during the next phase of the project to further refine the upgrades proposed.

1. We recommend the City complete additional investigation to determine why flows are so much lower than expected for the following two areas:
 - Mohler Industrial Area
 - North Downtown Area

Several causes have been hypothesized, but results can't be rationalized with the current data. Possible causes include:

- Upstream infrastructure being different than the GIS database / record drawings,
- Upstream blockages,
- Unaccounted-for losses, such as that into other infrastructure (e.g., the sanitary system or through exfiltration), and/or
- Failed calibration due to irregularly dry weather, although given the high variance from established literature values / standard results this is considered unlikely.

Investigation would include a combination of:

- Confirmation with City Operations staff,
 - Field review and survey to confirm GIS database,
 - Additional CCTV investigation, and
 - Additional flow monitoring in site vicinity
2. Engineering concept designs should be progressed once scope of projects and capital budget adequacy outlined in this report as development plans are refined.
 3. The model and follow-up analysis indicates minor risk from elevated flood levels at three locations:
 - 51st Avenue & 46th Street
 - 54th Avenue & 46th Street

- 47th Avenue & Montclare Avenue

51st Avenue & 54th Street, 54th Avenue & 46th Street, and 47th Avenue & Montclare Avenue indicate low risk. A review of existing grades could be performed to determine level of risk, combined with ongoing monitoring.

7.2. EXISTING SYSTEM UPGRADES

To minimize disruption and promote project economy, pipe upgrades identified in **Section 4** and **Section 5** are recommended to be reviewed by the City as street renewal projects occur. This will require interdepartmental coordination, to ensure opportunities to improve the stormwater management system aren't missed.

Upgrades to the existing major system are not required at this time, as model results indicate low risk of flooding, and the existing SWMFs maximum depths are below the design HWLs.

7.3. FUTURE DEVELOPMENT

Stormwater management projects required to support future development have been identified in **Section 5**, with cost estimates provided in **Section 6**. Planning studies for future development are required to account for stormwater management in accordance with the City's current Stormwater Master Plan. The recommendations provided in this report are conceptual, and will require further refinement as planning for future development progresses.

7.4. UPDATES TO STANDARDS

Small updates to the *City of Camrose Minimum Design Standards for Development (April 2004)* are recommended, to align with design criteria used in this report. This is not intended as a comprehensive standard review, rather general update as it relates to the Sanitary Master Plan.

- The previous *Stormwater Master Plan Update (2008)* recommended increasing the maximum active storage depth for dry and wet Stormwater Management Facilities (SWMFs) to 2.0 m to minimize footprint. This report maintains this recommendation. However, this is with the caveat that Alberta Government *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems: Part 5 Stormwater Management Guidelines of a Total of 5 Parts* specify 1.5m active storage depth for both wet and dry ponds. The Alberta Government should be consulted before incorporating this change to avoid complications in obtaining regulatory approvals.
- The Alberta Government *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems: Part 5 Stormwater Management Guidelines of a Total of 5 Parts* specify total suspended solids removal of 85% of particle size 75 µm or greater. This requirement should be incorporated into Camrose standards.



- Depending on site usage, industrial sites can generate environmental contamination, requiring on-site containment. A Stormwater Management Plan requirement complete with containment information can be included in the Development Permit approval checklist.



Appendices

APPENDIX A – PIPE UPGRADE SUMMARY

Table 14: Pipe Upgrade Summary

UPGRADE NAME	LOCATION	LENGTH (m)	INLET NODE	OUTLET NODE	EX DIA (mm)	PROP DIA (mm)	SLOPE (%)	Q	d/D
XA101	43 Ave / 69 St	38	1711	1710	1200	1350	0.11%	1313	0.98
XA102		78	1702	1701	900	1200	0.34%	831	0.98
XA103		37	1703	1702	900	1050	0.58%	850	0.95
XA104		39	1704	1703	900	1050	0.39%	740	0.91
XA105		99	1705	1704	900	1050	0.47%	464	0.62
XB101	Comp Rd / 61 St / 41 Ave	103	1832	1829	375	600	0.21%	141	0.51
XB102		30	1829	1830	375	750	0.37%	145	0.49
XB103		63	1830	1229	375	750	0.13%	306	0.48
XB104		69	1229	1228	375	750	0.66%	319	0.46
XB105		10	1228	1221	610	750	1.22%	495	0.58
XB106		53	1221	1220	686	825	0.39%	580	0.57
XB107		89	1220	1218	762	825	0.63%	671	0.63
XB108		88	1828	1827	375	450	0.30%	99	0.53
XB109		54	1827	1826	375	450	0.49%	97	0.69
XB110		14	1826	1220	375	450	0.40%	88	0.96
XC101	West of Mt. Pleasant Drive	114	1953	1955	600	750	0.17%	287	0.91
XC102		102	1955	1951	600	750	0.26%	340	0.78



UPGRADE NAME	LOCATION	LENGTH (m)	INLET NODE	OUTLET NODE	EX DIA (mm)	PROP DIA (mm)	SLOPE (%)	Q	d/D
XC104		12	1951	1950	600	750	0.90%	341	0.74
XD101	55 St & 44 Ave	54	1334	2444	300	375	0.47%	28	0.47
XD102		60	2444	1325	300	375	0.47%	85	0.74
XD111	53 St & 44 Ave	23	1337	1310	305	450	2.22%	45	0.59
XD112		91	1310	1309	450	525	0.32%	254	0.72
XD113		107	1309	1308	450	525	1.01%	277	0.48
XD114		38	1308	1307	533	600	5.02%	277	0.45
XE100	48 Ave & 45 St	67	862	861	300	375	0.24%	98	0.86
XE101		88	861	844	300	450	0.24%	97	0.81
XE102		28	844	843	300	450	0.70%	189	0.97
XE103		111	843	842	300	525	0.37%	299	0.94
XE104		73	841	842	300	375	0.42%	92	0.95
XE105		17	842	813	375	600	0.46%	369	0.83
XE106		98	813	812	375	750	0.20%	368	0.74
XE107		89	812	811	400	750	0.25%	408	0.88
XE108		118	817	816	300	375	0.52%	79	0.79
XE109		67	816	815	300	450	0.14%	159	0.94
XE110		41	815	814	300	450	0.42%	211	0.81
XE111	70	814	811	300	525	0.69%	208	0.83	



UPGRADE NAME	LOCATION	LENGTH (m)	INLET NODE	OUTLET NODE	EX DIA (mm)	PROP DIA (mm)	SLOPE (%)	Q	d/D
XE112		94	811	810	450	900	0.09%	646	0.77
XE113		109	810	805	450	900	0.22%	653	0.8
XF100	51 Ave / 45 St / 52 Ave	113	3042	3041	610	750	0.28%	623	0.6
XF101		7	J258	3042	450	750	0.29%	596	0.76
XF102		34	J256	J258	450	750	0.29%	588	0.77
XF103		10	3043	J256	450	750	0.30%	527	0.77
XF104		44	3044	3043	450	600	0.70%	468	0.87
XF105		49	3045	3044	450	600	0.43%	468	0.85
XF106		94	3046	3045	375	525	0.30%	224	0.95
XF107		81	J166	3046	375	525	0.22%	140	0.76
XF108		79	J165	J166	375	450	0.15%	142	0.82
XF109		120	J48	J165	300	450	0.21%	84	0.75
XI101		39 St	59	963	962	525	600	0.32%	0
XI102	104		962	961	525	600	0.12%	24	0.21
XI103	78		961	J371	600	750	0.22%	22	0.2
XI104	16		J371	960	600	750	0.26%	28	0.28
XI105	80		960	1038_POND	600	750	0.15%	76	0.36
XI106	33		1038_POND	1037	600	900	0.48%	232	0.44
XI107	64		1037	1036	750	900	0.23%	329	0.6



UPGRADE NAME	LOCATION	LENGTH (m)	INLET NODE	OUTLET NODE	EX DIA (mm)	PROP DIA (mm)	SLOPE (%)	Q	d/D	
XI108		106	1036	1035	750	900	0.01%	296	0.65	
XI109		36	1035	J323	750	900	0.14%	530	0.62	
XI110		75	J323	1034	750	1050	0.15%	527	0.53	
XI111		50	1034	J29	750	1050	0.11%	527	0.54	
XI112		17	J29	1033	750	1050	0.10%	529	0.54	
XI113		30	1033	1032	750	1050	0.13%	723	0.51	
XI114		52	1032	1031	750	1050	0.10%	724	0.43	
XI115		12	1031	1030	750	1050	1.52%	767	0.41	
XI116		106	1030	1042	750	1050	0.57%	849	0.45	
XI117		65	1042	1028	762	1050	0.65%	935	0.44	
XI118		72	1028	1027	762	1050	0.85%	971	0.41	
XI119		60	1027	1026	762	1050	1.16%	975	0.44	
XI120		56	1026	1025	914	1050	0.59%	1018	0.43	
XI121		11	1025	J39	914	1050	1.75%	1069	0.38	
XI122		64	J39	J193	914	1050	1.75%	1111	0.68	
XJ101		East of 39 St / North of 47 Ave	9	1024	J306	381	450	0.95%	129	0.47
XJ102			73	J306	J307	381	450	0.95%	126	0.51
XJ103			60	J307	1023	381	450	0.95%	161	0.52
XJ104			57	1023	1002	457	525	1.65%	216	0.71



UPGRADE NAME	LOCATION	LENGTH (m)	INLET NODE	OUTLET NODE	EX DIA (mm)	PROP DIA (mm)	SLOPE (%)	Q	d/D
XK101	38 St	102	1010	1009	457	525	0.54%	286	0.73
XK102		101	1009	1008	457	600	0.59%	333	0.81
XK103		158	1008	1005	533	600	0.51%	482	1
XL101	36 St North	25	1697	J153	675	750	0.23%	285	0.49
XL102		32	J153	1695	675	750	0.23%	297	0.46
XL103		27	1695	J152	675	750	0.70%	319	0.48
XL104		27	J152	1694	675	750	0.38%	333	0.56
XL105		40	1693	J154	300	450	1.44%	60	0.37
XL106		53	J154	1694	300	450	1.65%	159	0.67
XL107		50	1694	J212	675	900	0.19%	417	0.48
XL108		26	J212	J143	675	900	0.41%	455	0.47
XL109		43	J143	1050	675	900	0.41%	496	0.55
XL110		74	1050	1049	675	900	0.11%	543	0.55
XL111		69	1049	1048	675	900	0.42%	557	0.46
XL112		71	1048	1017	675	900	0.68%	596	0.69
XM101	36 St South	29	1692	J159	300	375	0.34%	25	0.41
XM102		25	J159	J157	300	375	0.34%	25	0.59
XM103		9	J157	1691	300	375	0.33%	103	0.66
XM104		58	1691	1690	300	450	0.44%	103	0.54



UPGRADE NAME	LOCATION	LENGTH (m)	INLET NODE	OUTLET NODE	EX DIA (mm)	PROP DIA (mm)	SLOPE (%)	Q	d/D
XM105		89	1690	1661	300	450	0.38%	105	0.7
XM106		121	1661	1660	305	450	0.62%	228	0.85
XM107		42	1660	OF16	381	525	0.75%	335	0.5
XN101	38 St / 42 Ave	104	1653	1652	381	450	0.28%	189	0.98
XN102		131	1652	1651	533	600	0.24%	255	0.67
XN104		15	1651	J389	610	750	0.44%	367	0.47
XN105		116	J389	1650	600	750	0.44%	391	0.43
XN106		25	1650	OF17	610	750	2.26%	562	0.33
XP101		Camrose Drive	103	J34	2036	900	1050	0.27%	744
XP102	128		2036	2035	900	1050	0.10%	747	0.6
XP103	168		2035	2034	900	1050	0.21%	747	0.51
XP104	134		2034	2033	900	1050	0.43%	773	0.37
XP105	148		2033	2032	900	1050	2.53%	780	0.29
XP106	90		2032	2031	900	1050	2.50%	791	0.33
XP107	85		2031	2030	900	1050	0.91%	788	0.41
XP108	3		2030	2029A	900	1050	0.67%	1219	0.47
XP109	27		2029A	2029	900	1050	1.47%	1220	0.37
XP110	37		2029	2028	900	1050	4.48%	1220	0.27
XP111	29		2028	2027	900	1050	20.60%	1219	0.22



UPGRADE NAME	LOCATION	LENGTH (m)	INLET NODE	OUTLET NODE	EX DIA (mm)	PROP DIA (mm)	SLOPE (%)	Q	d/D
XP112		13	2027	2026	900	1050	17.30%	1222	0.22
XP113		13	2026	2025	900	1050	21.58%	1221	0.26
XP114		11	2025	2024	900	1050	4.95%	1226	0.28
XP115		26	2024	2023	900	1050	10.33%	1230	0.24
XP116		13	2023	OF56	900	1050	22.99%	1233	0.21
XQ101		41 St	109	907	J275	600	750	0.29%	493
XQ102	16		J275	906	600	750	0.29%	485	0.89
XQ103	108		905	904	750	900	0.13%	511	0.61
XQ104	133		904	902	750	900	0.39%	721	0.59
XQ105	53		902	901	750	900	0.38%	818	0.41
XQ106	9		901	J431	380	900	17.28%	787	0.61



APPENDIX B – RATIONAL METHOD VERIFICATION

Table 15: Rational Method Verification

CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
CATCHMENT NAME	LAND USE	AREA (HA)	SLOPE (%)	IMPERV. (%)	PEAK RUNOFF (L/S)	PEAK RELEASE RATE (L/S/HA)	RUNOFF CO-EFFICIENT, C	PEAK RUNOFF (L/S)	PEAK RELEASE RATE (L/S/HA)	ABSOLUTE % DIFF
S101 1	Commercial	1.0	1.1	75	81	81.8	0.75	108	109.1	25%
S101 3	Commercial	0.6	1.0	75	57	90.0	0.75	70	109.1	18%
S103 1	Commercial	1.2	1.0	75	89	77.2	0.75	126	109.1	29%
S103 2	Commercial	2.7	0.9	75	158	57.9	0.75	297	109.1	47%
S103 3	Commercial	0.3	1.0	75	28	105.4	0.75	28	109.1	3%
S103 4	Commercial	1.8	1.0	75	123	69.6	0.75	192	109.1	36%
S103 6	Commercial	1.3	0.6	75	84	64.8	0.75	142	109.1	41%
S104 1	Commercial	0.4	1.3	75	45	100.9	0.75	49	109.1	7%
S104 11	Commercial	2.3	0.6	75	128	54.6	0.75	256	109.1	50%
S104 12	Commercial	1.7	0.9	75	115	66.8	0.75	187	109.1	39%
S104 13	Commercial	1.6	1.9	75	132	84.9	0.75	170	109.1	22%
S104 2	Commercial	0.2	1.0	75	26	107.6	0.75	26	109.1	1%
S104 5	Commercial	0.8	1.9	75	79	97.3	0.75	88	109.1	11%
S104 6	Commercial	3.6	0.9	75	196	54.8	0.75	390	109.1	50%
S104 7	Commercial	0.7	0.8	75	58	83.4	0.75	76	109.1	24%
S104 8	Commercial	0.2	0.3	75	18	89.9	0.75	22	109.1	18%
S104 9	Commercial	3.0	1.3	75	191	63.4	0.75	329	109.1	42%
S105 3	Commercial	2.1	0.8	75	130	61.2	0.75	231	109.1	44%
S105 7	Commercial	1.8	1.3	75	134	73.8	0.75	198	109.1	32%
S108 4	Commercial	2.3	1.2	75	153	67.9	0.75	246	109.1	38%
S111 2	Commercial	0.6	0.9	75	51	89.9	0.75	62	109.1	18%
S113 3	Commercial	2.0	2.8	75	176	87.0	0.75	221	109.1	20%
S126 5	Commercial	2.9	2.1	75	215	73.9	0.75	317	109.1	32%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S128 12	Commercial	1.7	6.8	75	179	106.5	0.75	183	109.1	2%
S128 9	Commercial	1.4	13.3	75	162	119.6	0.75	148	109.1	10%
S137 10	Commercial	1.3	1.0	75	96	75.5	0.75	138	109.1	31%
S137 13	Commercial	1.3	0.5	75	83	62.2	0.75	145	109.1	43%
S137 7	Commercial	2.4	0.7	75	133	56.4	0.75	258	109.1	48%
S137 8	Commercial	0.3	6.2	75	44	126.4	0.75	38	109.1	16%
S137 9	Commercial	1.0	0.4	75	65	63.8	0.75	112	109.1	42%
S141 4	Commercial	2.4	2.7	75	199	82.7	0.75	263	109.1	24%
S148 2	Commercial	3.5	5.7	75	315	90.0	0.75	382	109.1	17%
S150 4	Commercial	1.1	0.8	75	85	74.1	0.75	125	109.1	32%
S157 1	Commercial	1.0	0.4	75	63	64.2	0.75	107	109.1	41%
S36 7	Commercial	1.4	1.2	75	106	78.5	0.75	148	109.1	28%
S54 12	Commercial	1.2	0.7	75	85	69.1	0.75	134	109.1	37%
S54 13	Commercial	0.1	1.9	75	9	129.9	0.75	8	109.1	19%
S54 5	Commercial	1.7	0.5	75	98	57.7	0.75	184	109.1	47%
S54 6	Commercial	0.4	0.4	75	30	81.1	0.75	41	109.1	26%
S54 8	Commercial	2.0	1.1	75	139	68.7	0.75	221	109.1	37%
S54 9	Commercial	1.9	1.0	75	130	68.4	0.75	208	109.1	37%
S56 4	Commercial	1.3	1.6	75	107	85.4	0.75	137	109.1	22%
S56 5	Commercial	0.9	0.8	75	71	76.6	0.75	100	109.1	30%
S56 6	Commercial	1.8	1.0	75	123	68.6	0.75	196	109.1	37%
S56 8	Commercial	0.9	0.9	75	71	81.5	0.75	95	109.1	25%
S58 11	Commercial	2.1	1.3	75	148	72.0	0.75	224	109.1	34%
S58 12	Commercial	2.2	0.9	75	141	62.5	0.75	245	109.1	43%
S58 6	Commercial	1.9	0.9	75	128	65.8	0.75	212	109.1	40%
S58 7	Commercial	1.5	1.2	75	117	76.1	0.75	167	109.1	30%
S59 1	Commercial	2.0	0.4	75	100	51.5	0.75	213	109.1	53%
S59 10	Commercial	1.1	1.3	75	95	82.7	0.75	125	109.1	24%
S59 11	Commercial	0.8	2.6	75	81	102.9	0.75	85	109.1	6%
S59 12	Commercial	2.0	1.6	75	151	76.4	0.75	216	109.1	30%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S59 2	Commercial	1.8	0.7	75	110	62.8	0.75	191	109.1	42%
S59 3	Commercial	0.7	1.4	75	70	93.3	0.75	82	109.1	14%
S59 5	Commercial	0.8	1.5	75	76	92.3	0.75	89	109.1	15%
S59 6	Commercial	2.3	0.4	75	119	50.9	0.75	255	109.1	53%
S59 8	Commercial	1.3	0.3	75	72	55.3	0.75	142	109.1	49%
S59 9	Commercial	1.2	0.8	75	86	73.6	0.75	127	109.1	33%
S65 5	Commercial	1.7	0.9	75	114	67.3	0.75	184	109.1	38%
S65 6	Commercial	1.1	0.6	75	77	69.7	0.75	120	109.1	36%
S65 8	Commercial	1.0	0.7	75	72	74.4	0.75	106	109.1	32%
S72 6	Commercial	2.0	0.6	75	116	57.9	0.75	218	109.1	47%
S73 1	Commercial	2.3	3.2	75	202	87.1	0.75	253	109.1	20%
S73 5	Commercial	0.7	3.4	75	72	110.5	0.75	71	109.1	1%
S75 5	Commercial	2.1	1.1	75	144	67.4	0.75	233	109.1	38%
S75 7	Commercial	2.5	1.3	75	170	67.5	0.75	275	109.1	38%
S77 4	Commercial	0.4	0.0	75	16	44.6	0.75	39	109.1	59%
S78 10	Commercial	0.0	6.0	75	7	136.7	0.75	5	109.1	25%
S78 11	Commercial	0.1	0.7	75	12	115.8	0.75	11	109.1	6%
S78 12	Commercial	0.9	0.2	75	48	54.0	0.75	97	109.1	50%
S78 13	Commercial	0.6	0.7	75	48	82.6	0.75	64	109.1	24%
S78 14	Commercial	0.3	0.3	75	26	78.1	0.75	36	109.1	28%
S78 15	Commercial	0.7	0.6	75	52	76.5	0.75	74	109.1	30%
S78 16	Commercial	1.2	1.3	75	99	81.8	0.75	133	109.1	25%
S78 18	Commercial	0.9	2.6	75	89	101.5	0.75	95	109.1	7%
S78 2	Commercial	1.8	3.4	75	167	93.0	0.75	196	109.1	15%
S78 25	Commercial	0.8	2.6	75	82	102.6	0.75	87	109.1	6%
S78 27	Commercial	0.4	1.9	75	44	109.4	0.75	44	109.1	0%
S78 5	Commercial	0.2	1.5	75	27	114.2	0.75	25	109.1	5%
S78 7	Commercial	0.5	0.1	75	24	52.8	0.75	51	109.1	52%
S78 9	Commercial	0.9	2.5	75	88	100.7	0.75	95	109.1	8%
S79 4	Commercial	1.2	0.6	75	81	68.7	0.75	128	109.1	37%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S79 6	Commercial	2.5	1.2	75	163	65.7	0.75	271	109.1	40%
S81 2	Commercial	0.3	1.1	75	32	104.7	0.75	33	109.1	4%
S81 4	Commercial	0.6	1.1	75	54	91.9	0.75	64	109.1	16%
S81 5	Commercial	0.8	0.5	75	55	73.4	0.75	82	109.1	33%
S83 1	Commercial	0.8	1.4	75	74	91.8	0.75	88	109.1	16%
S83 6	Commercial	1.9	3.9	75	181	94.1	0.75	210	109.1	14%
S83 7	Commercial	1.4	2.4	75	127	91.2	0.75	152	109.1	16%
S87 1	Commercial	0.8	0.2	75	43	57.5	0.75	82	109.1	47%
S87 3	Commercial	1.3	0.4	75	75	57.8	0.75	141	109.1	47%
S87 4	Commercial	0.9	1.6	75	85	91.0	0.75	102	109.1	17%
S87 5	Commercial	0.9	1.3	75	78	87.9	0.75	96	109.1	19%
S87 6	Commercial	1.3	0.6	75	84	64.6	0.75	141	109.1	41%
S87 7	Commercial	1.3	0.8	75	92	69.9	0.75	144	109.1	36%
S87 8	Commercial	2.5	0.4	75	126	50.9	0.75	270	109.1	53%
S92 5	Commercial	0.1	0.3	75	7	105.6	0.75	8	109.1	3%
S94 1	Commercial	2.4	3.2	75	209	85.7	0.75	267	109.1	21%
S94 2	Commercial	1.8	2.9	75	159	90.0	0.75	193	109.1	18%
S99 10	Commercial	1.7	1.3	75	128	75.1	0.75	185	109.1	31%
S99 12	Commercial	1.8	0.9	75	121	67.6	0.75	196	109.1	38%
S99 4	Commercial	1.2	2.0	75	106	90.6	0.75	127	109.1	17%
S99 5	Commercial	0.9	0.7	75	68	77.0	0.75	97	109.1	29%
S99 7	Commercial	2.0	1.4	75	144	73.2	0.75	214	109.1	33%
S99 8	Commercial	0.9	1.5	75	81	91.3	0.75	97	109.1	16%
S99 9	Commercial	1.0	1.3	75	87	85.4	0.75	111	109.1	22%
										28%
S1	Industrial	10.0	0.7	64	380	38.1	0.64	929	93.1	59%
S100 1	Industrial	2.2	0.8	64	119	54.0	0.64	205	93.1	42%
S100 3	Industrial	8.3	4.1	64	486	58.7	0.64	770	93.1	37%
S100 5	Industrial	3.1	0.7	64	145	46.6	0.64	289	93.1	50%
S110 1	Industrial	0.6	0.4	64	38	62.4	0.64	56	93.1	33%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S110 10	Industrial	1.0	0.9	64	68	69.3	0.64	92	93.1	26%
S110 11	Industrial	1.2	1.8	64	93	78.4	0.64	111	93.1	16%
S110 12	Industrial	0.8	0.3	64	44	52.8	0.64	77	93.1	43%
S110 13	Industrial	2.5	2.4	64	179	70.2	0.64	237	93.1	25%
S110 14	Industrial	1.5	1.8	64	114	74.3	0.64	142	93.1	20%
S110 15	Industrial	0.5	0.7	64	41	76.9	0.64	50	93.1	17%
S110 2	Industrial	1.5	1.5	64	106	71.8	0.64	137	93.1	23%
S110 3	Industrial	0.7	0.1	64	33	45.3	0.64	68	93.1	51%
S110 4	Industrial	0.7	0.4	64	42	64.2	0.64	61	93.1	31%
S110 6	Industrial	1.5	0.7	64	87	57.0	0.64	141	93.1	39%
S110 7	Industrial	0.2	2.9	64	17	110.5	0.64	14	93.1	19%
S110 8	Industrial	1.4	0.8	64	82	60.6	0.64	126	93.1	35%
S110 9	Industrial	0.2	2.5	64	22	107.2	0.64	19	93.1	15%
S118 1	Industrial	3.9	1.1	64	190	48.0	0.64	367	93.1	48%
S118 4	Industrial	1.4	0.3	64	61	45.3	0.64	126	93.1	51%
S119 1	Industrial	1.6	1.3	64	109	67.2	0.64	150	93.1	28%
S119 3	Industrial	0.2	0.6	64	19	88.3	0.64	20	93.1	5%
S119 4	Industrial	0.5	0.8	64	42	77.5	0.64	50	93.1	17%
S119 5	Industrial	0.8	6.9	64	82	103.5	0.64	74	93.1	11%
S119 6	Industrial	1.8	0.6	64	94	52.0	0.64	167	93.1	44%
S119 7	Industrial	0.6	0.7	64	45	74.6	0.64	56	93.1	20%
S119 9	Industrial	0.2	0.8	64	19	93.2	0.64	19	93.1	0%
S121 1	Industrial	1.0	0.9	64	72	68.6	0.64	97	93.1	26%
S121 10	Industrial	0.9	0.4	64	51	58.1	0.64	82	93.1	38%
S121 15	Industrial	0.4	7.1	64	42	109.9	0.64	36	93.1	18%
S121 17	Industrial	0.3	3.5	64	35	105.4	0.64	31	93.1	13%
S121 19	Industrial	0.5	1.0	64	43	81.7	0.64	49	93.1	12%
S121 3	Industrial	0.9	2.4	64	76	88.7	0.64	80	93.1	5%
S121 4	Industrial	1.4	1.1	64	94	66.7	0.64	131	93.1	28%
S121 5	Industrial	0.9	0.3	64	45	50.1	0.64	84	93.1	46%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S121 7	Industrial	1.5	0.8	64	92	59.6	0.64	144	93.1	36%
S121 8	Industrial	0.6	1.2	64	48	84.0	0.64	54	93.1	10%
S122 1	Industrial	1.0	1.2	64	75	74.8	0.64	93	93.1	20%
S122 2	Industrial	2.3	0.5	64	108	46.9	0.64	215	93.1	50%
S122 3	Industrial	4.8	1.2	64	229	47.5	0.64	449	93.1	49%
S122 4	Industrial	0.1	1.6	64	14	106.6	0.64	12	93.1	14%
S122 6	Industrial	0.4	0.8	64	34	83.3	0.64	38	93.1	11%
S122 7	Industrial	0.7	1.1	64	53	80.6	0.64	61	93.1	13%
S122 8	Industrial	3.6	1.1	64	179	49.6	0.64	336	93.1	47%
S124 1	Industrial	0.2	1.5	64	21	101.6	0.64	19	93.1	9%
S124 10	Industrial	1.9	0.6	64	96	51.0	0.64	175	93.1	45%
S124 11	Industrial	0.2	0.7	64	19	92.0	0.64	19	93.1	1%
S124 13	Industrial	2.3	0.6	64	110	47.7	0.64	215	93.1	49%
S124 3	Industrial	0.7	0.4	64	41	59.1	0.64	65	93.1	36%
S124 4	Industrial	1.0	0.2	64	44	45.8	0.64	89	93.1	51%
S124 5	Industrial	1.0	0.5	64	59	56.6	0.64	97	93.1	39%
S124 7	Industrial	0.7	0.8	64	50	73.5	0.64	63	93.1	21%
S124 8	Industrial	0.3	0.4	64	26	75.3	0.64	32	93.1	19%
S124 9	Industrial	1.4	5.7	64	130	94.5	0.64	129	93.1	1%
S13 1	Industrial	6.9	0.6	64	274	39.9	0.64	638	93.1	57%
S136 1	Industrial	2.6	0.8	64	128	49.4	0.64	242	93.1	47%
S136 10	Industrial	3.6	1.3	64	193	53.6	0.64	335	93.1	42%
S136 11	Industrial	1.1	0.7	64	68	63.1	0.64	101	93.1	32%
S136 12	Industrial	0.8	1.2	64	62	78.5	0.64	74	93.1	16%
S136 13	Industrial	0.2	1.5	64	23	100.7	0.64	21	93.1	8%
S136 14	Industrial	5.4	0.9	64	235	43.2	0.64	507	93.1	54%
S136 15	Industrial	0.3	0.6	64	24	82.5	0.64	27	93.1	11%
S136 16	Industrial	0.3	1.1	64	32	91.2	0.64	32	93.1	2%
S136 2	Industrial	2.0	1.4	64	130	65.0	0.64	186	93.1	30%
S136 5	Industrial	0.4	0.7	64	35	78.8	0.64	41	93.1	15%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S136 6	Industrial	0.4	2.1	64	37	98.7	0.64	35	93.1	6%
S136 7	Industrial	1.5	0.8	64	88	58.7	0.64	140	93.1	37%
S136 8	Industrial	1.2	1.0	64	80	67.7	0.64	110	93.1	27%
S136 9	Industrial	3.0	0.7	64	140	47.0	0.64	276	93.1	49%
S139 1	Industrial	6.6	1.0	64	282	42.7	0.64	614	93.1	54%
S144 4	Industrial	0.9	0.3	64	48	53.7	0.64	84	93.1	42%
S144 6	Industrial	1.0	0.9	64	70	69.1	0.64	94	93.1	26%
S146 1	Industrial	0.5	0.3	64	33	62.4	0.64	49	93.1	33%
S146 10	Industrial	0.7	0.0	64	0	0.0	0.64	67	93.1	100%
S146 2	Industrial	0.5	1.7	64	50	90.5	0.64	51	93.1	3%
S146 5	Industrial	0.8	1.4	64	65	80.3	0.64	75	93.1	14%
S146 6	Industrial	1.6	1.1	64	101	63.8	0.64	147	93.1	31%
S146 7	Industrial	1.1	1.0	64	78	68.4	0.64	106	93.1	26%
S146 8	Industrial	1.9	0.5	64	92	47.4	0.64	181	93.1	49%
S146 9	Industrial	0.8	0.5	64	49	61.8	0.64	74	93.1	34%
S147 2	Industrial	2.8	1.9	64	181	64.4	0.64	262	93.1	31%
S15 1	Industrial	7.5	3.2	64	444	59.6	0.64	694	93.1	36%
S15 2	Industrial	2.3	0.5	64	109	47.9	0.64	212	93.1	49%
S153 10	Industrial	0.5	1.5	64	49	88.4	0.64	51	93.1	5%
S153 12	Industrial	0.8	2.1	64	69	88.4	0.64	72	93.1	5%
S153 2	Industrial	0.8	0.7	64	57	67.9	0.64	78	93.1	27%
S153 3	Industrial	2.0	1.7	64	137	67.7	0.64	189	93.1	27%
S153 5	Industrial	0.8	1.3	64	63	80.6	0.64	72	93.1	13%
S153 6	Industrial	0.5	1.1	64	43	85.1	0.64	47	93.1	9%
S153 7	Industrial	2.8	1.1	64	151	54.0	0.64	260	93.1	42%
S153 8	Industrial	0.5	2.6	64	45	98.6	0.64	42	93.1	6%
S153 9	Industrial	0.5	1.0	64	43	83.0	0.64	49	93.1	11%
S154 3	Industrial	4.0	2.2	64	239	60.5	0.64	368	93.1	35%
S154 4	Industrial	3.1	0.8	64	145	47.3	0.64	285	93.1	49%
S154 6	Industrial	2.4	0.6	64	112	47.1	0.64	221	93.1	49%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S162 1	Industrial	3.8	1.1	64	186	49.3	0.64	350	93.1	47%
S162 2	Industrial	0.9	0.4	64	49	54.7	0.64	84	93.1	41%
S162 3	Industrial	0.2	2.2	64	19	107.3	0.64	17	93.1	15%
S162 4	Industrial	3.3	1.1	64	170	51.8	0.64	306	93.1	44%
S162 5	Industrial	1.0	1.3	64	74	76.0	0.64	91	93.1	18%
S162 6	Industrial	1.0	0.7	64	68	65.1	0.64	97	93.1	30%
S162 8	Industrial	0.2	4.6	64	24	111.5	0.64	20	93.1	20%
S163 2	Industrial	1.4	1.0	64	93	64.3	0.64	134	93.1	31%
S163 4	Industrial	0.4	1.0	64	33	87.6	0.64	35	93.1	6%
S163 5	Industrial	1.0	1.7	64	84	80.1	0.64	97	93.1	14%
S163 7	Industrial	3.0	1.5	64	176	58.3	0.64	281	93.1	37%
S167 2	Industrial	1.8	1.0	64	107	60.0	0.64	166	93.1	36%
S167 3	Industrial	1.4	1.4	64	97	71.4	0.64	127	93.1	23%
S167 4	Industrial	2.6	0.6	64	123	46.7	0.64	244	93.1	50%
S167 5	Industrial	1.4	0.9	64	89	61.8	0.64	134	93.1	34%
S170 1	Industrial	1.0	0.7	64	66	65.3	0.64	94	93.1	30%
S170 2	Industrial	5.5	0.7	64	223	40.9	0.64	509	93.1	56%
S174 2	Industrial	0.9	0.6	64	59	62.5	0.64	88	93.1	33%
S175 1	Industrial	2.1	1.9	64	146	69.6	0.64	195	93.1	25%
S175 2	Industrial	3.0	0.9	64	149	50.1	0.64	277	93.1	46%
S175 3	Industrial	0.2	6.4	64	25	112.5	0.64	20	93.1	21%
S175 5	Industrial	3.7	0.5	64	156	42.0	0.64	346	93.1	55%
S175 7	Industrial	2.4	0.3	64	101	41.2	0.64	227	93.1	56%
S179 2	Industrial	0.8	1.4	64	65	80.4	0.64	76	93.1	14%
S182 2	Industrial	4.0	0.6	64	169	42.8	0.64	368	93.1	54%
S183 1	Industrial	1.7	1.1	64	110	63.2	0.64	161	93.1	32%
S183 2	Industrial	3.0	0.7	64	140	46.2	0.64	283	93.1	50%
S184 3	Industrial	0.7	0.6	64	49	68.4	0.64	67	93.1	27%
S184 4	Industrial	1.4	1.0	64	90	66.1	0.64	127	93.1	29%
S184 5	Industrial	1.1	3.5	64	99	90.9	0.64	102	93.1	2%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S184 6	Industrial	0.8	2.2	64	68	89.4	0.64	71	93.1	4%
S184 7	Industrial	0.6	0.8	64	48	74.0	0.64	60	93.1	20%
S184 8	Industrial	0.6	0.4	64	36	64.8	0.64	51	93.1	30%
S188 1	Industrial	2.9	0.4	64	116	40.5	0.64	267	93.1	57%
S188 3	Industrial	0.5	0.5	64	35	70.9	0.64	45	93.1	24%
S188 4	Industrial	3.8	0.5	64	158	41.4	0.64	356	93.1	56%
S188 5	Industrial	0.7	1.0	64	53	78.6	0.64	63	93.1	16%
S188 7	Industrial	0.5	2.2	64	50	94.4	0.64	49	93.1	1%
S189	Industrial	5.0	0.7	64	208	41.3	0.64	468	93.1	56%
S2 1	Industrial	50.0	1.1	64	1349	27.0	0.64	4655	93.1	71%
S2 2	Industrial	0.3	0.6	64	28	81.6	0.64	32	93.1	12%
S2 6	Industrial	24.3	1.2	64	841	34.7	0.64	2257	93.1	63%
S2 7	Industrial	4.0	2.0	64	240	59.6	0.64	374	93.1	36%
S2 8	Industrial	16.2	0.9	64	539	33.2	0.64	1508	93.1	64%
S21	Industrial	5.8	1.7	64	313	53.6	0.64	544	93.1	42%
S23	Industrial	1.8	2.1	64	131	73.8	0.64	165	93.1	21%
S23 2	Industrial	0.5	1.3	64	41	90.1	0.64	43	93.1	3%
S23 3	Industrial	1.2	1.2	64	87	74.5	0.64	108	93.1	20%
S23 5	Industrial	0.3	0.6	64	27	82.6	0.64	31	93.1	11%
S23 6	Industrial	1.0	1.5	64	84	80.4	0.64	97	93.1	14%
S24 1	Industrial	3.2	1.0	64	172	54.0	0.64	296	93.1	42%
S24 3	Industrial	3.2	1.0	64	177	54.6	0.64	301	93.1	41%
S24 4	Industrial	1.2	0.5	64	71	60.1	0.64	109	93.1	35%
S25	Industrial	4.2	1.3	64	213	50.1	0.64	396	93.1	46%
S27 1	Industrial	14.5	0.6	64	465	32.0	0.64	1351	93.1	66%
S27 2	Industrial	0.6	0.3	64	36	62.3	0.64	53	93.1	33%
S29 1	Industrial	1.4	1.1	64	99	68.7	0.64	134	93.1	26%
S29 2	Industrial	3.2	0.8	64	164	51.4	0.64	298	93.1	45%
S29 3	Industrial	0.5	0.7	64	40	79.3	0.64	47	93.1	15%
S29 5	Industrial	4.8	1.0	64	230	47.8	0.64	449	93.1	49%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S29 6	Industrial	0.7	0.6	64	51	70.1	0.64	68	93.1	25%
S3	Industrial	6.0	0.9	64	269	45.1	0.64	555	93.1	52%
S35 11	Industrial	0.6	1.4	64	55	86.2	0.64	59	93.1	7%
S35 13	Industrial	0.9	0.6	64	60	66.8	0.64	83	93.1	28%
S35 15	Industrial	0.5	0.4	64	33	69.8	0.64	43	93.1	25%
S35 5	Industrial	0.5	0.5	64	36	75.6	0.64	44	93.1	19%
S35 7	Industrial	0.7	0.7	64	52	75.2	0.64	64	93.1	19%
S37	Industrial	1.7	0.4	64	79	46.4	0.64	159	93.1	50%
S39	Industrial	1.9	0.5	64	190	101.4	0.64	174	93.1	9%
S4 10	Industrial	2.0	1.3	64	129	65.4	0.64	183	93.1	30%
S4 12	Industrial	1.0	1.1	64	74	74.5	0.64	92	93.1	20%
S4 13	Industrial	0.3	2.0	64	32	100.7	0.64	30	93.1	8%
S4 16	Industrial	0.8	1.1	64	61	77.2	0.64	74	93.1	17%
S4 2	Industrial	0.3	0.6	64	26	82.3	0.64	29	93.1	12%
S4 22	Industrial	0.7	1.8	64	64	87.1	0.64	68	93.1	6%
S4 24	Industrial	0.7	0.9	64	55	75.1	0.64	68	93.1	19%
S4 6	Industrial	1.0	0.9	64	73	69.8	0.64	97	93.1	25%
S4 7	Industrial	0.4	1.6	64	40	93.4	0.64	40	93.1	0%
S4 8	Industrial	0.9	0.7	64	63	66.9	0.64	87	93.1	28%
S40 1	Industrial	2.9	1.2	64	171	58.9	0.64	270	93.1	37%
S40 2	Industrial	0.7	1.4	64	60	85.7	0.64	65	93.1	8%
S40 3	Industrial	0.3	2.4	64	27	104.8	0.64	24	93.1	13%
S40 5	Industrial	1.5	0.3	64	73	49.2	0.64	138	93.1	47%
S40 6	Industrial	0.6	2.0	64	52	93.9	0.64	51	93.1	1%
S40 7	Industrial	2.1	0.3	64	94	45.3	0.64	193	93.1	51%
S40 8	Industrial	2.4	0.4	64	107	45.4	0.64	219	93.1	51%
S41 3	Industrial	1.2	0.2	64	56	47.3	0.64	110	93.1	49%
S41 4	Industrial	0.6	1.3	64	52	86.0	0.64	56	93.1	8%
S41 6	Industrial	1.9	0.7	64	111	58.3	0.64	177	93.1	37%
S41 7	Industrial	2.4	0.3	64	109	44.6	0.64	228	93.1	52%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S41 9	Industrial	0.8	0.5	64	53	64.8	0.64	76	93.1	30%
S44 2	Industrial	0.3	2.9	64	34	104.3	0.64	30	93.1	12%
S44 3	Industrial	1.0	3.8	64	95	92.7	0.64	96	93.1	0%
S44 5	Industrial	3.5	1.6	64	211	60.7	0.64	323	93.1	35%
S44 6	Industrial	4.2	1.2	64	205	48.4	0.64	395	93.1	48%
S44 7	Industrial	0.8	6.9	64	80	104.6	0.64	71	93.1	12%
S44 8	Industrial	1.1	1.1	64	78	70.7	0.64	103	93.1	24%
S44 9	Industrial	1.9	1.4	64	125	66.3	0.64	175	93.1	29%
S48 1	Industrial	2.4	0.6	64	121	49.7	0.64	226	93.1	47%
S48 2	Industrial	3.1	0.7	64	149	48.2	0.64	288	93.1	48%
S52 2	Industrial	3.0	1.7	64	192	64.4	0.64	278	93.1	31%
S52 7	Industrial	0.5	0.4	64	34	66.4	0.64	47	93.1	29%
S56 3	Industrial	1.3	1.5	64	101	76.5	0.64	123	93.1	18%
S56 7	Industrial	1.2	0.4	64	68	57.1	0.64	112	93.1	39%
S58 1	Industrial	0.8	1.5	64	67	84.0	0.64	74	93.1	10%
S58 2	Industrial	1.2	0.7	64	81	65.3	0.64	116	93.1	30%
S58 3	Industrial	1.6	0.8	64	99	62.8	0.64	147	93.1	33%
S58 4	Industrial	0.9	0.4	64	54	59.1	0.64	84	93.1	37%
S59 4	Industrial	0.1	0.7	64	14	97.5	0.64	13	93.1	5%
S6	Industrial	9.8	0.4	64	323	33.0	0.64	910	93.1	65%
S64 1	Industrial	1.9	1.1	64	124	65.2	0.64	177	93.1	30%
S64 5	Industrial	1.1	0.5	64	67	58.7	0.64	106	93.1	37%
S64 6	Industrial	1.3	1.0	64	89	69.7	0.64	118	93.1	25%
S74 2	Industrial	0.9	0.6	64	60	64.5	0.64	87	93.1	31%
S74 3	Industrial	2.5	0.4	64	110	43.9	0.64	234	93.1	53%
S74 4	Industrial	1.2	0.6	64	71	57.0	0.64	115	93.1	39%
S74 5	Industrial	1.0	0.8	64	64	66.8	0.64	89	93.1	28%
S74 6	Industrial	1.9	1.2	64	119	62.2	0.64	179	93.1	33%
S8	Industrial	5.9	1.8	64	320	54.5	0.64	548	93.1	41%
S82 1	Industrial	2.8	1.1	64	150	54.3	0.64	257	93.1	42%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S82 3	Industrial	3.0	0.6	64	135	45.0	0.64	279	93.1	52%
S82 4	Industrial	1.6	0.4	64	74	46.7	0.64	148	93.1	50%
S85 1	Industrial	0.4	1.5	64	37	93.3	0.64	37	93.1	0%
S85 3	Industrial	1.0	0.6	64	60	61.3	0.64	91	93.1	34%
S85 6	Industrial	0.7	0.4	64	45	62.0	0.64	67	93.1	33%
S85 8	Industrial	0.3	0.0	64	10	34.6	0.64	28	93.1	63%
S86 10	Industrial	0.3	0.4	64	26	75.1	0.64	32	93.1	19%
S86 11	Industrial	1.4	0.7	64	79	58.6	0.64	126	93.1	37%
S86 12	Industrial	0.6	1.3	64	48	86.3	0.64	52	93.1	7%
S86 14	Industrial	1.1	0.9	64	73	69.0	0.64	99	93.1	26%
S86 15	Industrial	0.5	0.6	64	39	73.3	0.64	49	93.1	21%
S86 17	Industrial	0.9	0.9	64	66	70.3	0.64	87	93.1	25%
S86 2	Industrial	1.2	0.4	64	59	51.5	0.64	108	93.1	45%
S86 4	Industrial	0.8	0.8	64	57	72.0	0.64	74	93.1	23%
S86 5	Industrial	0.2	0.8	64	22	91.2	0.64	22	93.1	2%
S86 6	Industrial	1.0	0.8	64	67	67.9	0.64	92	93.1	27%
S86 7	Industrial	0.9	0.7	64	59	67.6	0.64	82	93.1	27%
S86 8	Industrial	0.2	0.6	64	16	93.2	0.64	16	93.1	0%
S86 9	Industrial	0.6	0.8	64	45	76.1	0.64	54	93.1	18%
S89 1	Industrial	0.8	0.6	64	54	66.4	0.64	76	93.1	29%
S89 10	Industrial	0.8	2.2	64	72	87.8	0.64	76	93.1	6%
S89 11	Industrial	1.6	1.2	64	105	66.6	0.64	146	93.1	28%
S89 12	Industrial	0.7	0.9	64	53	74.8	0.64	66	93.1	20%
S89 13	Industrial	0.1	0.1	64	7	72.4	0.64	9	93.1	22%
S89 14	Industrial	0.7	1.0	64	53	77.6	0.64	64	93.1	17%
S89 15	Industrial	0.7	1.5	64	59	84.9	0.64	65	93.1	9%
S89 16	Industrial	0.8	0.8	64	57	71.2	0.64	74	93.1	24%
S89 2	Industrial	0.9	0.7	64	61	65.5	0.64	87	93.1	30%
S89 3	Industrial	0.5	0.7	64	37	77.2	0.64	44	93.1	17%
S89 5	Industrial	0.6	0.5	64	41	69.0	0.64	55	93.1	26%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S89 6	Industrial	0.5	1.0	64	42	82.9	0.64	47	93.1	11%
S89 7	Industrial	1.3	1.4	64	98	72.3	0.64	126	93.1	22%
S89 8	Industrial	0.8	0.8	64	56	72.1	0.64	73	93.1	23%
S89 9	Industrial	1.6	1.3	64	108	66.8	0.64	151	93.1	28%
S91 1	Industrial	0.2	0.5	64	14	91.5	0.64	15	93.1	2%
S91 11	Industrial	0.6	1.1	64	51	81.5	0.64	59	93.1	12%
S91 12	Industrial	0.2	2.2	64	16	108.6	0.64	14	93.1	17%
S91 13	Industrial	1.4	1.4	64	101	71.2	0.64	132	93.1	24%
S91 14	Industrial	0.3	1.3	64	29	95.8	0.64	28	93.1	3%
S91 2	Industrial	2.5	3.2	64	190	75.3	0.64	235	93.1	19%
S91 3	Industrial	4.1	0.8	64	182	44.8	0.64	379	93.1	52%
S91 4	Industrial	1.8	1.4	64	118	67.1	0.64	163	93.1	28%
S91 5	Industrial	0.5	0.8	64	38	80.9	0.64	44	93.1	13%
S91 7	Industrial	1.4	1.5	64	100	72.4	0.64	129	93.1	22%
S91 8	Industrial	1.9	0.8	64	103	55.6	0.64	173	93.1	40%
S91 9	Industrial	0.1	0.2	64	11	81.2	0.64	13	93.1	13%
S92 2	Industrial	2.3	0.6	64	116	51.4	0.64	210	93.1	45%
S92 6	Industrial	0.8	1.1	64	60	80.2	0.64	70	93.1	14%
S92 7	Industrial	0.5	0.6	64	38	78.3	0.64	45	93.1	16%
										29%
S101 4	Residential	2.6	1.4	55	154	58.5	0.55	211	80.0	27%
S101 5	Residential	1.4	2.7	55	107	76.7	0.55	112	80.0	4%
S101 6	Residential	1.0	0.7	55	63	62.9	0.55	80	80.0	21%
S101 7	Residential	1.6	1.4	55	106	66.2	0.55	128	80.0	17%
S102 1	Residential	2.2	1.8	55	142	65.6	0.55	173	80.0	18%
S102 3	Residential	1.5	2.1	55	107	72.7	0.55	118	80.0	9%
S102 5	Residential	1.8	2.1	55	127	69.7	0.55	146	80.0	13%
S102 7	Residential	1.8	2.0	55	128	69.2	0.55	148	80.0	14%
S104 3	Residential	1.5	1.0	55	94	62.7	0.55	120	80.0	22%
S105 2	Residential	1.8	1.3	55	117	63.3	0.55	148	80.0	21%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S105 4	Residential	0.9	1.2	55	64	72.4	0.55	71	80.0	9%
S105 5	Residential	1.3	1.1	55	83	66.1	0.55	100	80.0	17%
S105 6	Residential	1.3	0.6	55	71	55.8	0.55	102	80.0	30%
S107 1	Residential	1.3	0.8	55	77	60.9	0.55	101	80.0	24%
S107 2	Residential	2.2	0.8	55	118	53.2	0.55	178	80.0	33%
S107 3	Residential	1.3	1.2	55	87	66.3	0.55	105	80.0	17%
S107 4	Residential	0.0	0.4	55	4	91.4	0.55	4	80.0	14%
S109 2	Residential	0.8	1.3	55	59	74.4	0.55	63	80.0	7%
S109 3	Residential	0.7	0.3	55	37	53.9	0.55	55	80.0	33%
S109 4	Residential	2.7	0.8	55	133	50.0	0.55	213	80.0	38%
S109 6	Residential	1.5	0.4	55	73	47.1	0.55	123	80.0	41%
S11	Residential	1.0	2.3	55	79	78.8	0.55	80	80.0	1%
S111 3	Residential	1.8	0.9	55	101	57.7	0.55	140	80.0	28%
S111 5	Residential	3.6	1.2	55	189	52.6	0.55	287	80.0	34%
S111 6	Residential	2.8	1.0	55	151	53.6	0.55	225	80.0	33%
S112 1	Residential	0.7	1.5	55	54	78.4	0.55	55	80.0	2%
S112 3	Residential	0.2	3.2	55	22	95.0	0.55	18	80.0	19%
S112 4	Residential	0.5	0.0	55	0	0.0	0.55	38	80.0	100%
S112 6	Residential	0.4	2.1	55	35	87.5	0.55	32	80.0	9%
S112 7	Residential	1.0	2.5	55	77	80.4	0.55	76	80.0	0%
S112 8	Residential	0.5	0.0	55	0	0.0	0.55	40	80.0	100%
S112 9	Residential	0.5	0.8	55	34	75.8	0.55	36	80.0	5%
S113 1	Residential	2.6	4.0	55	190	74.1	0.55	205	80.0	7%
S113 4	Residential	1.9	1.2	55	116	61.4	0.55	151	80.0	23%
S114 1 E	Residential	1.2	0.9	55	78	63.2	0.55	99	80.0	21%
S114 2	Residential	1.4	0.5	55	76	54.5	0.55	112	80.0	32%
S115 1	Residential	0.2	0.4	55	16	76.0	0.55	17	80.0	5%
S115 5	Residential	1.1	1.2	55	75	69.7	0.55	86	80.0	13%
S115 6	Residential	2.5	2.1	55	165	65.5	0.55	201	80.0	18%
S117 1	Residential	2.8	0.8	55	139	49.6	0.55	225	80.0	38%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S117 3	Residential	1.1	0.7	55	68	61.9	0.55	88	80.0	23%
S117 7	Residential	1.7	3.3	55	128	76.9	0.55	133	80.0	4%
S120 1	Residential	0.8	0.8	55	54	67.6	0.55	64	80.0	16%
S120 2	Residential	2.9	1.1	55	154	53.7	0.55	229	80.0	33%
S120 3	Residential	0.4	0.2	55	25	59.9	0.55	34	80.0	25%
S120 4	Residential	0.7	0.5	55	44	61.8	0.55	57	80.0	23%
S120 5	Residential	2.5	1.4	55	149	59.9	0.55	200	80.0	25%
S120 6	Residential	1.3	1.2	55	89	65.8	0.55	108	80.0	18%
S120 8	Residential	2.5	0.9	55	133	52.9	0.55	202	80.0	34%
S120 9	Residential	0.9	0.5	55	53	59.8	0.55	72	80.0	25%
S125 10	Residential	1.4	0.8	55	83	59.9	0.55	111	80.0	25%
S125 2	Residential	1.4	1.7	55	97	70.5	0.55	110	80.0	12%
S125 3	Residential	1.9	0.7	55	104	53.3	0.55	156	80.0	33%
S125 4	Residential	2.3	0.6	55	112	48.9	0.55	183	80.0	39%
S125 5	Residential	1.6	2.0	55	114	70.9	0.55	129	80.0	11%
S125 6	Residential	1.1	0.7	55	67	62.0	0.55	86	80.0	22%
S125 8	Residential	1.5	1.1	55	92	63.3	0.55	116	80.0	21%
S125 9	Residential	1.4	0.8	55	81	59.8	0.55	109	80.0	25%
S128 1	Residential	0.0	0.0	55	0	0.0	0.55	2	80.0	100%
S128 4	Residential	2.2	1.2	55	129	59.5	0.55	174	80.0	26%
S128 8	Residential	0.8	2.4	55	64	82.4	0.55	62	80.0	3%
S129 1	Residential	1.7	0.9	55	99	59.3	0.55	134	80.0	26%
S129 5	Residential	1.3	3.0	55	105	78.3	0.55	108	80.0	2%
S129 7	Residential	3.4	2.1	55	210	61.0	0.55	275	80.0	24%
S129 8	Residential	2.0	1.2	55	123	60.2	0.55	163	80.0	25%
S129 9	Residential	1.2	2.7	55	96	78.3	0.55	98	80.0	2%
S130 3	Residential	0.6	0.5	55	40	65.5	0.55	48	80.0	18%
S130 4	Residential	0.9	0.9	55	60	67.4	0.55	71	80.0	16%
S130 5	Residential	1.4	0.9	55	86	62.4	0.55	111	80.0	22%
S130 6	Residential	0.5	0.7	55	37	72.8	0.55	41	80.0	9%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S130 7	Residential	0.7	0.9	55	52	70.3	0.55	60	80.0	12%
S130 8	Residential	0.5	0.5	55	34	68.8	0.55	39	80.0	14%
S130 9	Residential	0.4	1.0	55	32	79.9	0.55	32	80.0	0%
S131 1	Residential	1.5	1.1	55	97	63.8	0.55	121	80.0	20%
S131 2	Residential	0.7	0.8	55	47	69.6	0.55	54	80.0	13%
S131 3	Residential	0.4	0.8	55	31	77.1	0.55	32	80.0	4%
S131 5	Residential	1.3	1.2	55	88	66.4	0.55	106	80.0	17%
S131 6	Residential	0.6	0.5	55	37	66.9	0.55	44	80.0	16%
S132 1	Residential	1.4	0.4	55	66	48.4	0.55	109	80.0	39%
S132 2	Residential	1.8	0.9	55	102	57.3	0.55	143	80.0	28%
S132 7	Residential	0.9	0.3	55	50	52.7	0.55	75	80.0	34%
S133 3	Residential	1.8	1.0	55	107	59.3	0.55	144	80.0	26%
S133 5	Residential	0.3	0.0	55	0	0.0	0.55	20	80.0	100%
S133 6	Residential	1.1	0.8	55	70	62.4	0.55	90	80.0	22%
S133 7	Residential	1.4	1.0	55	87	63.0	0.55	110	80.0	21%
S133 8	Residential	0.6	0.0	55	0	0.0	0.55	51	80.0	100%
S134 1	Residential	1.4	2.9	55	110	77.1	0.55	114	80.0	4%
S134 4	Residential	1.6	1.4	55	105	65.6	0.55	128	80.0	18%
S134 5	Residential	2.9	0.5	55	119	41.7	0.55	229	80.0	48%
S134 6	Residential	1.6	2.3	55	118	72.6	0.55	130	80.0	9%
S134 7	Residential	1.1	1.9	55	82	75.7	0.55	86	80.0	5%
S134 8	Residential	0.9	1.5	55	64	75.5	0.55	68	80.0	6%
S135 1	Residential	1.3	0.8	55	80	61.8	0.55	103	80.0	23%
S135 5	Residential	1.3	0.7	55	77	59.2	0.55	104	80.0	26%
S135 6	Residential	3.1	0.7	55	146	46.7	0.55	249	80.0	42%
S137 11	Residential	1.8	1.4	55	115	65.0	0.55	141	80.0	19%
S137 12	Residential	0.9	1.6	55	66	75.8	0.55	70	80.0	5%
S137 5	Residential	0.8	0.5	55	47	60.6	0.55	62	80.0	24%
S138 4	Residential	1.2	1.5	55	86	70.4	0.55	97	80.0	12%
S14 2	Residential	1.0	1.2	55	70	69.8	0.55	80	80.0	13%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S140 1	Residential	1.1	0.8	55	68	62.8	0.55	87	80.0	22%
S140 2	Residential	1.6	0.7	55	90	56.8	0.55	127	80.0	29%
S140 3	Residential	1.0	0.3	55	50	52.8	0.55	76	80.0	34%
S140 4	Residential	1.2	0.5	55	65	55.5	0.55	94	80.0	31%
S140 6	Residential	0.4	0.6	55	29	73.6	0.55	32	80.0	8%
S141 5	Residential	0.0	0.0	55	0	0.0	0.55	3	80.0	100%
S142 3	Residential	1.0	0.6	55	63	60.3	0.55	84	80.0	25%
S142 4	Residential	1.7	2.2	55	123	71.4	0.55	138	80.0	11%
S142 5	Residential	0.6	1.2	55	44	78.2	0.55	45	80.0	2%
S142 6	Residential	1.1	0.5	55	62	57.5	0.55	86	80.0	28%
S142 7	Residential	0.6	1.0	55	47	74.2	0.55	51	80.0	7%
S142 8	Residential	0.4	0.5	55	28	70.7	0.55	32	80.0	12%
S142 9	Residential	1.2	1.3	55	82	69.2	0.55	95	80.0	13%
S143 1	Residential	0.6	11.1	55	55	96.7	0.55	46	80.0	21%
S143 3	Residential	0.8	6.2	55	69	91.5	0.55	60	80.0	14%
S143 5	Residential	1.1	3.4	55	94	81.9	0.55	92	80.0	2%
S148 3	Residential	1.5	3.2	55	119	77.7	0.55	123	80.0	3%
S149 1	Residential	1.1	0.5	55	62	56.0	0.55	88	80.0	30%
S149 3	Residential	1.4	1.1	55	90	64.0	0.55	113	80.0	20%
S149 4	Residential	2.5	1.9	55	161	63.7	0.55	202	80.0	20%
S150 2	Residential	3.3	0.8	55	157	47.6	0.55	264	80.0	40%
S150 5	Residential	2.2	0.6	55	109	49.4	0.55	177	80.0	38%
S150 6	Residential	1.9	0.9	55	109	56.3	0.55	155	80.0	30%
S151 4	Residential	0.3	5.2	55	33	95.4	0.55	28	80.0	19%
S151 5	Residential	1.9	1.2	55	117	61.5	0.55	153	80.0	23%
S151 6	Residential	2.8	1.7	55	170	61.2	0.55	223	80.0	24%
S152 2	Residential	1.3	1.2	55	87	67.0	0.55	104	80.0	16%
S153 1	Residential	0.4	1.8	55	31	87.7	0.55	28	80.0	10%
S155 10	Residential	1.9	0.7	55	99	52.9	0.55	150	80.0	34%
S155 2	Residential	1.7	1.3	55	108	64.9	0.55	133	80.0	19%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S155 3	Residential	1.2	2.3	55	91	77.0	0.55	95	80.0	4%
S155 4	Residential	1.0	0.8	55	62	64.9	0.55	77	80.0	19%
S155 5	Residential	1.1	0.7	55	68	61.6	0.55	88	80.0	23%
S155 7	Residential	1.3	0.7	55	80	59.3	0.55	108	80.0	26%
S155 8	Residential	1.0	0.7	55	64	63.2	0.55	81	80.0	21%
S155 9	Residential	1.2	0.9	55	77	63.5	0.55	97	80.0	21%
S156 3	Residential	2.4	4.4	55	181	76.3	0.55	190	80.0	5%
S156 4	Residential	2.8	3.4	55	198	70.3	0.55	225	80.0	12%
S158 1	Residential	1.2	1.2	55	80	68.1	0.55	94	80.0	15%
S158 10	Residential	1.5	0.9	55	90	60.0	0.55	120	80.0	25%
S158 11	Residential	1.1	1.5	55	78	72.6	0.55	86	80.0	9%
S158 12	Residential	1.6	1.2	55	102	63.2	0.55	129	80.0	21%
S158 2	Residential	1.9	1.0	55	111	58.3	0.55	152	80.0	27%
S158 3	Residential	1.1	0.6	55	64	58.1	0.55	88	80.0	27%
S158 4	Residential	1.4	1.0	55	88	62.8	0.55	112	80.0	21%
S158 5	Residential	1.2	2.4	55	92	77.5	0.55	95	80.0	3%
S158 6	Residential	0.8	1.6	55	63	76.9	0.55	65	80.0	4%
S158 8	Residential	1.4	1.1	55	88	64.4	0.55	110	80.0	19%
S158 9	Residential	1.1	1.1	55	75	67.9	0.55	89	80.0	15%
S159	Residential	0.0	0.4	55	4	92.3	0.55	4	80.0	15%
S160 2	Residential	0.9	0.9	55	61	67.7	0.55	72	80.0	15%
S160 4	Residential	2.1	2.1	55	140	68.1	0.55	164	80.0	15%
S160 5	Residential	1.8	0.8	55	102	55.7	0.55	146	80.0	30%
S160 6	Residential	2.2	1.5	55	136	62.3	0.55	174	80.0	22%
S160 7	Residential	1.3	0.8	55	81	61.4	0.55	106	80.0	23%
S165 1	Residential	1.1	0.4	55	60	54.7	0.55	87	80.0	32%
S165 2	Residential	1.7	2.3	55	121	72.3	0.55	134	80.0	10%
S165 4	Residential	0.8	1.3	55	58	74.7	0.55	63	80.0	7%
S165 5	Residential	1.7	1.2	55	105	63.3	0.55	132	80.0	21%
S165 6	Residential	1.3	0.5	55	69	55.1	0.55	101	80.0	31%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S165 7	Residential	1.5	0.8	55	89	59.2	0.55	121	80.0	26%
S165 8	Residential	1.7	0.5	55	86	51.6	0.55	134	80.0	35%
S166 1	Residential	1.5	0.5	55	77	51.3	0.55	120	80.0	36%
S168 1	Residential	1.2	0.3	55	60	49.0	0.55	99	80.0	39%
S168 3	Residential	2.4	2.2	55	159	67.1	0.55	189	80.0	16%
S168 4	Residential	1.0	0.9	55	67	66.3	0.55	81	80.0	17%
S168 6	Residential	0.9	0.6	55	59	62.4	0.55	76	80.0	22%
S168 7	Residential	1.9	1.0	55	111	58.0	0.55	154	80.0	27%
S168 8	Residential	0.8	0.4	55	46	56.1	0.55	66	80.0	30%
S168 9	Residential	0.6	0.8	55	43	71.7	0.55	48	80.0	10%
S169 1	Residential	0.7	0.8	55	50	68.9	0.55	58	80.0	14%
S169 14	Residential	1.8	1.8	55	120	67.9	0.55	142	80.0	15%
S169 2	Residential	0.7	0.7	55	47	68.1	0.55	55	80.0	15%
S169 4	Residential	2.0	1.1	55	117	59.5	0.55	158	80.0	26%
S169 6	Residential	0.0	0.6	55	3	97.1	0.55	2	80.0	21%
S169 7	Residential	2.0	11.5	55	178	88.5	0.55	161	80.0	11%
S169 9	Residential	2.2	1.0	55	124	55.7	0.55	178	80.0	30%
S171 1	Residential	0.9	0.6	55	59	62.2	0.55	75	80.0	22%
S171 2	Residential	1.0	0.3	55	50	50.2	0.55	79	80.0	37%
S171 4	Residential	1.3	0.7	55	78	58.3	0.55	107	80.0	27%
S171 5	Residential	1.9	1.1	55	112	59.7	0.55	150	80.0	25%
S171 6	Residential	2.7	0.4	55	112	41.7	0.55	216	80.0	48%
S172 1	Residential	1.9	1.5	55	122	64.5	0.55	152	80.0	19%
S173 1	Residential	0.9	1.2	55	64	72.3	0.55	71	80.0	10%
S173 2	Residential	0.6	3.7	55	57	88.6	0.55	52	80.0	11%
S173 3	Residential	2.5	0.7	55	124	50.4	0.55	196	80.0	37%
S173 5	Residential	1.6	2.3	55	120	72.7	0.55	132	80.0	9%
S174 5	Residential	0.3	1.5	55	24	88.5	0.55	21	80.0	11%
S176 1	Residential	0.9	0.9	55	59	68.5	0.55	69	80.0	14%
S176 10	Residential	1.2	0.5	55	68	55.5	0.55	97	80.0	31%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S176 2	Residential	3.3	1.3	55	178	54.2	0.55	262	80.0	32%
S176 3	Residential	1.3	0.5	55	68	54.1	0.55	101	80.0	32%
S176 4	Residential	3.2	0.8	55	155	48.8	0.55	254	80.0	39%
S176 5	Residential	0.6	0.7	55	43	70.2	0.55	49	80.0	12%
S176 6	Residential	0.8	1.2	55	57	73.7	0.55	61	80.0	8%
S176 8	Residential	1.0	1.0	55	71	67.3	0.55	84	80.0	16%
S176 9	Residential	0.7	0.5	55	41	62.7	0.55	53	80.0	22%
S177 1	Residential	1.9	0.7	55	100	53.6	0.55	150	80.0	33%
S177 2	Residential	1.8	0.7	55	102	55.1	0.55	147	80.0	31%
S178 1	Residential	2.6	1.8	55	163	62.9	0.55	207	80.0	21%
S178 3	Residential	0.9	2.2	55	74	79.3	0.55	75	80.0	1%
S178 4	Residential	4.1	0.9	55	191	46.9	0.55	326	80.0	41%
S18 2	Residential	1.2	1.5	55	85	71.4	0.55	95	80.0	11%
S18 3	Residential	0.2	6.3	55	21	98.3	0.55	17	80.0	23%
S18 4	Residential	0.9	1.5	55	68	74.3	0.55	73	80.0	7%
S18 5	Residential	0.1	3.8	55	14	97.9	0.55	12	80.0	22%
S18 6	Residential	0.1	2.9	55	9	98.4	0.55	8	80.0	23%
S18 7	Residential	0.1	7.3	55	7	100.9	0.55	5	80.0	26%
S18 8	Residential	1.3	1.8	55	93	72.5	0.55	103	80.0	9%
S180 1	Residential	3.1	0.6	55	133	43.3	0.55	246	80.0	46%
S180 2	Residential	2.0	1.2	55	118	60.6	0.55	156	80.0	24%
S180 5	Residential	1.1	0.8	55	70	62.5	0.55	89	80.0	22%
S185 2	Residential	0.5	2.1	55	46	84.5	0.55	44	80.0	6%
S185 3	Residential	1.1	1.1	55	75	67.6	0.55	89	80.0	15%
S185 4	Residential	1.7	3.0	55	127	75.8	0.55	134	80.0	5%
S185 6	Residential	0.6	0.0	55	0	0.0	0.55	47	80.0	100%
S186 1	Residential	1.7	2.1	55	119	71.2	0.55	133	80.0	11%
S186 2	Residential	0.2	1.1	55	15	89.9	0.55	14	80.0	12%
S186 4	Residential	1.3	0.7	55	75	59.0	0.55	102	80.0	26%
S186 5	Residential	1.2	0.5	55	69	55.5	0.55	99	80.0	31%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S186 6	Residential	1.1	0.5	55	61	55.6	0.55	88	80.0	30%
S187 2	Residential	1.5	1.2	55	95	64.5	0.55	118	80.0	19%
S187 3	Residential	1.1	0.2	55	48	42.9	0.55	89	80.0	46%
S187 5	Residential	1.4	0.6	55	79	55.0	0.55	115	80.0	31%
S187 6	Residential	1.2	1.2	55	81	68.5	0.55	94	80.0	14%
S187 7	Residential	1.2	0.8	55	73	63.5	0.55	92	80.0	21%
S187 9	Residential	2.1	1.2	55	126	60.4	0.55	167	80.0	25%
S19 2	Residential	0.2	0.0	55	0	0.0	0.55	15	80.0	100%
S190 2	Residential	3.0	0.6	55	137	45.8	0.55	240	80.0	43%
S190 3	Residential	1.1	0.8	55	68	64.1	0.55	85	80.0	20%
S190 5	Residential	1.8	0.8	55	101	57.4	0.55	141	80.0	28%
S190 6	Residential	1.5	1.0	55	92	62.4	0.55	117	80.0	22%
S190 7	Residential	1.0	0.2	55	43	43.6	0.55	79	80.0	45%
S191 1	Residential	1.7	1.0	55	103	59.8	0.55	137	80.0	25%
S194 10	Residential	0.7	0.8	55	48	70.3	0.55	54	80.0	12%
S194 11	Residential	1.5	0.9	55	92	61.1	0.55	121	80.0	24%
S194 2	Residential	0.6	0.1	55	25	40.2	0.55	49	80.0	50%
S194 3	Residential	1.4	0.7	55	78	57.6	0.55	109	80.0	28%
S194 4	Residential	1.3	1.2	55	89	66.6	0.55	107	80.0	17%
S194 5	Residential	0.4	0.6	55	30	73.1	0.55	33	80.0	9%
S194 7	Residential	2.5	0.7	55	124	50.8	0.55	196	80.0	37%
S194 8	Residential	1.2	1.3	55	84	69.4	0.55	96	80.0	13%
S194 9	Residential	1.8	0.9	55	102	57.7	0.55	142	80.0	28%
S196 2	Residential	1.1	0.6	55	64	60.0	0.55	85	80.0	25%
S2	Residential	0.6	2.1	55	54	82.9	0.55	52	80.0	4%
S200 1	Residential	0.2	0.7	55	17	82.9	0.55	17	80.0	4%
S210 10	Residential	0.7	1.4	55	53	77.1	0.55	55	80.0	4%
S210 11	Residential	0.2	0.2	55	15	62.1	0.55	19	80.0	22%
S210 12	Residential	1.2	1.4	55	82	70.4	0.55	93	80.0	12%
S210 2	Residential	1.1	0.3	55	53	49.9	0.55	85	80.0	38%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S210 4	Residential	0.8	0.4	55	46	60.1	0.55	61	80.0	25%
S210 6	Residential	1.1	0.4	55	59	53.4	0.55	88	80.0	33%
S210 7	Residential	0.7	1.1	55	50	74.9	0.55	53	80.0	6%
S210 8	Residential	0.6	0.0	55	20	33.5	0.55	47	80.0	58%
S210 9	Residential	1.2	0.6	55	70	58.8	0.55	95	80.0	26%
S211 1	Residential	1.5	0.7	55	85	58.2	0.55	117	80.0	27%
S211 2	Residential	1.2	2.2	55	94	75.6	0.55	99	80.0	6%
S211 4	Residential	0.8	1.6	55	60	77.9	0.55	61	80.0	3%
S211 5	Residential	0.5	1.2	55	41	79.3	0.55	41	80.0	1%
S211 6	Residential	0.9	0.0	55	28	31.9	0.55	70	80.0	60%
S211 7	Residential	0.3	1.1	55	26	84.1	0.55	25	80.0	5%
S212 10	Residential	0.6	5.3	55	51	92.7	0.55	44	80.0	16%
S212 2	Residential	1.2	1.7	55	88	72.6	0.55	97	80.0	9%
S212 4	Residential	2.0	2.2	55	140	68.8	0.55	162	80.0	14%
S212 5	Residential	0.5	0.0	55	0	0.0	0.55	41	80.0	100%
S212 6	Residential	0.7	0.9	55	49	71.0	0.55	55	80.0	11%
S212 7	Residential	1.0	5.7	55	90	88.4	0.55	81	80.0	11%
S212 8	Residential	1.4	3.8	55	114	80.6	0.55	113	80.0	1%
S213 2	Residential	0.3	4.4	55	26	95.8	0.55	22	80.0	20%
S214 1	Residential	0.6	0.8	55	43	72.6	0.55	48	80.0	9%
S215 1	Residential	0.3	3.8	55	27	94.8	0.55	23	80.0	19%
S215 3	Residential	0.0	8.1	55	1	102.6	0.55	1	80.0	28%
S216 2	Residential	2.0	1.7	55	130	66.5	0.55	157	80.0	17%
S216 3	Residential	1.8	0.7	55	96	54.8	0.55	140	80.0	31%
S216 4	Residential	1.2	1.5	55	86	70.9	0.55	97	80.0	11%
S217 1	Residential	2.0	1.1	55	121	59.0	0.55	164	80.0	26%
S217 10	Residential	1.0	0.7	55	64	62.8	0.55	81	80.0	21%
S217 11	Residential	1.2	0.7	55	72	61.1	0.55	94	80.0	24%
S217 12	Residential	0.4	1.8	55	32	86.8	0.55	30	80.0	8%
S217 2	Residential	1.2	0.8	55	75	63.3	0.55	95	80.0	21%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S217 3	Residential	1.7	0.6	55	89	52.8	0.55	134	80.0	34%
S217 4	Residential	1.4	0.5	55	74	54.0	0.55	109	80.0	33%
S217 5	Residential	2.0	1.5	55	131	64.1	0.55	163	80.0	20%
S217 6	Residential	3.4	0.8	55	162	47.1	0.55	276	80.0	41%
S217 7	Residential	1.3	0.6	55	73	57.8	0.55	101	80.0	28%
S217 8	Residential	1.3	0.5	55	69	54.5	0.55	101	80.0	32%
S218 3	Residential	1.1	0.8	55	68	63.3	0.55	86	80.0	21%
S218 4	Residential	1.7	1.0	55	102	60.7	0.55	135	80.0	24%
S219 1	Residential	1.3	0.9	55	83	63.3	0.55	105	80.0	21%
S219 10	Residential	0.9	1.5	55	64	75.3	0.55	68	80.0	6%
S219 4	Residential	1.4	1.1	55	93	64.9	0.55	114	80.0	19%
S219 5	Residential	0.8	1.2	55	57	74.4	0.55	61	80.0	7%
S219 6	Residential	1.2	0.4	55	63	51.4	0.55	98	80.0	36%
S219 8	Residential	0.8	0.3	55	45	54.8	0.55	65	80.0	31%
S22	Residential	0.0	0.5	55	3	96.8	0.55	2	80.0	21%
S220 10	Residential	1.3	0.9	55	80	63.9	0.55	100	80.0	20%
S220 11	Residential	1.4	1.0	55	90	63.7	0.55	113	80.0	20%
S220 12	Residential	1.1	4.0	55	89	84.5	0.55	84	80.0	6%
S220 13	Residential	1.3	3.3	55	101	80.5	0.55	101	80.0	1%
S220 14	Residential	0.8	2.5	55	64	83.0	0.55	62	80.0	4%
S220 15	Residential	1.4	0.6	55	77	55.6	0.55	110	80.0	30%
S220 16	Residential	0.7	1.9	55	54	81.8	0.55	53	80.0	2%
S220 17	Residential	1.3	2.1	55	99	74.4	0.55	107	80.0	7%
S220 18	Residential	0.9	1.2	55	66	72.0	0.55	73	80.0	10%
S220 19	Residential	1.7	1.0	55	104	61.2	0.55	136	80.0	23%
S220 2	Residential	1.3	1.7	55	95	71.3	0.55	106	80.0	11%
S220 20	Residential	0.9	2.0	55	69	78.6	0.55	70	80.0	2%
S220 21	Residential	1.8	0.8	55	103	56.1	0.55	147	80.0	30%
S220 22	Residential	1.2	0.8	55	76	62.2	0.55	97	80.0	22%
S220 24	Residential	1.3	0.5	55	69	54.3	0.55	102	80.0	32%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S220 25	Residential	1.5	0.9	55	92	61.1	0.55	120	80.0	24%
S220 26	Residential	1.0	1.3	55	74	70.8	0.55	83	80.0	11%
S220 27	Residential	0.6	1.6	55	50	80.2	0.55	50	80.0	0%
S220 29	Residential	1.4	0.5	55	72	52.6	0.55	109	80.0	34%
S220 3	Residential	2.5	3.7	55	182	73.4	0.55	198	80.0	8%
S220 30	Residential	2.1	1.6	55	134	64.5	0.55	166	80.0	19%
S220 31	Residential	2.7	1.6	55	162	60.7	0.55	214	80.0	24%
S220 32	Residential	2.1	1.3	55	131	61.5	0.55	171	80.0	23%
S220 34	Residential	1.8	0.8	55	102	56.3	0.55	145	80.0	30%
S220 35	Residential	0.2	0.0	55	0	0.0	0.55	14	80.0	100%
S220 5	Residential	1.2	1.4	55	86	70.1	0.55	98	80.0	12%
S220 6	Residential	0.8	1.3	55	61	73.7	0.55	67	80.0	8%
S220 7	Residential	1.5	1.9	55	106	71.5	0.55	119	80.0	11%
S220 8	Residential	0.5	0.4	55	35	65.4	0.55	43	80.0	18%
S220 9	Residential	1.2	1.0	55	78	65.6	0.55	95	80.0	18%
S221 2	Residential	0.8	0.4	55	45	59.6	0.55	61	80.0	25%
S222 1	Residential	0.5	5.8	55	49	93.6	0.55	42	80.0	17%
S223 1	Residential	0.4	2.0	55	34	87.9	0.55	31	80.0	10%
S223 10	Residential	0.3	0.9	55	21	84.3	0.55	20	80.0	5%
S223 11	Residential	2.0	0.8	55	108	55.1	0.55	157	80.0	31%
S223 12	Residential	0.6	0.2	55	32	56.2	0.55	46	80.0	30%
S223 14	Residential	0.4	0.9	55	28	80.7	0.55	28	80.0	1%
S223 7	Residential	0.9	0.8	55	60	65.4	0.55	74	80.0	18%
S223 8	Residential	0.3	1.0	55	28	81.3	0.55	27	80.0	2%
S223 9	Residential	1.1	0.4	55	59	53.6	0.55	88	80.0	33%
S224 4	Residential	1.0	3.3	55	82	83.2	0.55	79	80.0	4%
S224 6	Residential	0.5	1.8	55	40	84.8	0.55	38	80.0	6%
S226 4	Residential	1.3	1.9	55	97	72.6	0.55	107	80.0	9%
S226 5	Residential	2.0	2.8	55	143	72.8	0.55	157	80.0	9%
S226 6	Residential	1.3	2.2	55	100	74.3	0.55	108	80.0	7%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S227 1	Residential	1.2	5.0	55	99	85.9	0.55	92	80.0	7%
S229 3	Residential	1.1	4.1	55	93	84.3	0.55	88	80.0	5%
S229 4	Residential	2.1	6.7	55	175	82.7	0.55	169	80.0	3%
S23 1	Residential	0.4	4.6	55	38	93.6	0.55	33	80.0	17%
S230	Residential	0.0	19.9	55	1	103.2	0.55	1	80.0	29%
S231	Residential	0.1	0.5	55	8	89.0	0.55	7	80.0	11%
S232 2	Residential	1.3	2.0	55	93	73.9	0.55	101	80.0	8%
S233 10	Residential	0.2	2.6	55	20	98.9	0.55	16	80.0	24%
S233 11	Residential	0.5	5.0	55	49	92.5	0.55	43	80.0	16%
S233 12	Residential	1.2	1.0	55	80	65.0	0.55	99	80.0	19%
S233 14	Residential	0.9	1.1	55	61	71.0	0.55	68	80.0	11%
S233 15	Residential	1.4	1.1	55	91	65.0	0.55	112	80.0	19%
S233 16	Residential	0.3	1.5	55	26	87.3	0.55	23	80.0	9%
S233 17	Residential	0.3	17.8	55	28	100.1	0.55	22	80.0	25%
S233 3	Residential	2.1	3.0	55	151	73.0	0.55	165	80.0	9%
S233 4	Residential	2.3	1.4	55	140	61.5	0.55	182	80.0	23%
S233 5	Residential	1.5	0.9	55	94	61.0	0.55	123	80.0	24%
S233 6	Residential	1.2	1.8	55	86	73.9	0.55	93	80.0	8%
S233 7	Residential	0.5	2.8	55	48	87.5	0.55	44	80.0	9%
S233 8	Residential	1.1	0.9	55	74	64.6	0.55	92	80.0	19%
S233 9	Residential	1.1	0.9	55	71	66.2	0.55	85	80.0	17%
S234 10	Residential	1.2	1.6	55	86	72.0	0.55	95	80.0	10%
S234 11	Residential	1.0	1.6	55	76	73.8	0.55	82	80.0	8%
S234 2	Residential	1.6	1.9	55	113	70.7	0.55	128	80.0	12%
S234 3	Residential	1.7	0.8	55	99	57.9	0.55	137	80.0	28%
S234 6	Residential	1.4	2.4	55	103	75.9	0.55	108	80.0	5%
S234 7	Residential	2.1	3.7	55	157	75.9	0.55	165	80.0	5%
S234 8	Residential	1.8	1.0	55	105	59.4	0.55	141	80.0	26%
S234 9	Residential	2.2	1.0	55	125	56.6	0.55	176	80.0	29%
S235 1	Residential	0.6	0.6	55	41	68.9	0.55	48	80.0	14%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S235 10	Residential	1.2	0.7	55	74	59.8	0.55	99	80.0	25%
S235 11	Residential	1.3	0.7	55	79	59.5	0.55	106	80.0	26%
S235 12	Residential	0.8	16.8	55	79	96.9	0.55	65	80.0	21%
S235 13	Residential	0.9	0.7	55	60	64.6	0.55	74	80.0	19%
S235 14	Residential	1.9	0.9	55	110	56.6	0.55	155	80.0	29%
S235 16	Residential	1.3	1.0	55	83	65.1	0.55	102	80.0	19%
S235 17	Residential	0.5	0.3	55	30	59.6	0.55	41	80.0	25%
S235 18	Residential	1.7	1.9	55	120	69.8	0.55	137	80.0	13%
S235 19	Residential	0.7	0.6	55	44	66.2	0.55	53	80.0	17%
S235 2	Residential	1.5	1.5	55	104	67.5	0.55	123	80.0	16%
S235 20	Residential	0.3	3.2	55	25	94.2	0.55	21	80.0	18%
S235 3	Residential	2.1	1.0	55	121	57.8	0.55	167	80.0	28%
S235 4	Residential	2.0	1.2	55	122	60.0	0.55	162	80.0	25%
S235 5	Residential	1.2	0.5	55	63	54.9	0.55	93	80.0	31%
S235 6	Residential	2.1	1.4	55	133	62.4	0.55	170	80.0	22%
S235 7	Residential	2.2	1.2	55	134	59.6	0.55	180	80.0	26%
S235 8	Residential	1.7	1.4	55	110	65.9	0.55	134	80.0	18%
S235 9	Residential	1.3	2.9	55	104	78.1	0.55	107	80.0	2%
S236 1	Residential	4.3	1.9	55	243	56.8	0.55	343	80.0	29%
S237 1	Residential	0.9	0.0	55	23	24.7	0.55	73	80.0	69%
S237 2	Residential	0.3	0.0	55	6	20.6	0.55	23	80.0	74%
S237 6	Residential	2.8	1.5	55	166	58.6	0.55	227	80.0	27%
S237 7	Residential	2.4	0.6	55	114	47.7	0.55	191	80.0	40%
S237 9	Residential	1.3	1.3	55	89	67.7	0.55	105	80.0	15%
S238 1	Residential	1.0	4.4	55	83	86.3	0.55	77	80.0	8%
S238 10	Residential	0.9	1.2	55	62	73.0	0.55	68	80.0	9%
S238 2	Residential	1.2	0.9	55	77	64.1	0.55	97	80.0	20%
S238 3	Residential	0.7	0.4	55	43	60.8	0.55	57	80.0	24%
S238 4	Residential	1.2	1.2	55	84	67.5	0.55	100	80.0	16%
S238 5	Residential	1.4	1.3	55	92	66.8	0.55	110	80.0	16%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S238 5 E	Residential	1.4	1.3	55	92	66.8	0.55	110	80.0	16%
S238 6	Residential	1.2	4.6	55	102	84.6	0.55	96	80.0	6%
S238 7	Residential	1.1	1.9	55	82	75.4	0.55	87	80.0	6%
S238 9	Residential	1.0	4.6	55	88	86.2	0.55	82	80.0	8%
S239 11	Residential	0.2	0.0	55	0	0.0	0.55	15	80.0	100%
S239 3	Residential	0.2	2.7	55	18	95.3	0.55	15	80.0	19%
S241 2	Residential	1.1	3.5	55	92	82.7	0.55	89	80.0	3%
S241 5	Residential	1.2	1.8	55	91	72.8	0.55	100	80.0	9%
S241 6	Residential	0.2	0.0	55	0	0.0	0.55	16	80.0	100%
S241 7	Residential	1.2	1.1	55	80	67.1	0.55	96	80.0	16%
S25 10	Residential	1.2	1.2	55	80	68.3	0.55	93	80.0	15%
S25 11	Residential	1.1	0.4	55	59	51.5	0.55	91	80.0	36%
S25 12	Residential	1.0	4.5	55	86	86.1	0.55	80	80.0	8%
S25 2	Residential	1.5	2.3	55	110	73.7	0.55	119	80.0	8%
S25 4	Residential	0.7	0.3	55	36	55.3	0.55	53	80.0	31%
S25 5	Residential	1.2	0.8	55	74	63.3	0.55	93	80.0	21%
S25 7	Residential	0.7	0.7	55	50	67.9	0.55	59	80.0	15%
S25 8	Residential	0.6	1.0	55	45	75.3	0.55	48	80.0	6%
S26 5	Residential	1.9	1.6	55	126	65.2	0.55	154	80.0	19%
S28	Residential	0.2	0.0	55	10	41.8	0.55	19	80.0	48%
S28 3	Residential	2.4	2.3	55	162	67.1	0.55	193	80.0	16%
S29	Residential	1.7	0.7	55	90	54.5	0.55	132	80.0	32%
S30 3	Residential	1.3	1.5	55	93	69.8	0.55	107	80.0	13%
S30 4	Residential	0.9	1.0	55	64	68.0	0.55	75	80.0	15%
S30 5	Residential	0.6	0.2	55	32	54.3	0.55	47	80.0	32%
S31 2	Residential	0.8	0.5	55	47	60.2	0.55	62	80.0	25%
S31 3	Residential	1.6	2.0	55	112	71.5	0.55	126	80.0	11%
S31 4	Residential	0.6	1.9	55	52	82.2	0.55	50	80.0	3%
S31 6	Residential	2.2	0.8	55	120	53.7	0.55	178	80.0	33%
S31 7	Residential	0.8	1.3	55	62	73.6	0.55	67	80.0	8%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S31 8	Residential	1.0	1.1	55	69	69.2	0.55	79	80.0	14%
S32	Residential	1.2	3.6	55	100	81.7	0.55	98	80.0	2%
S32 1	Residential	1.6	1.3	55	102	65.5	0.55	125	80.0	18%
S32 10	Residential	0.8	1.4	55	63	74.5	0.55	68	80.0	7%
S32 2	Residential	0.8	1.3	55	62	73.9	0.55	67	80.0	8%
S32 4	Residential	1.4	1.0	55	88	62.3	0.55	113	80.0	22%
S32 5	Residential	0.8	1.6	55	58	77.5	0.55	60	80.0	3%
S32 6	Residential	1.4	4.6	55	119	82.8	0.55	115	80.0	3%
S32 7	Residential	0.9	2.8	55	72	82.7	0.55	69	80.0	3%
S32 8	Residential	0.9	2.1	55	70	79.0	0.55	71	80.0	1%
S32 9	Residential	1.7	3.1	55	126	76.2	0.55	133	80.0	5%
S34 2	Residential	1.7	3.5	55	131	77.4	0.55	135	80.0	3%
S34 3	Residential	1.5	0.8	55	87	58.5	0.55	119	80.0	27%
S34 4	Residential	2.5	1.2	55	142	57.2	0.55	198	80.0	28%
S35 1	Residential	0.4	0.3	55	23	64.3	0.55	29	80.0	20%
S35 10	Residential	1.7	0.9	55	98	59.0	0.55	133	80.0	26%
S35 14	Residential	1.1	0.5	55	60	56.7	0.55	85	80.0	29%
S35 16	Residential	0.5	0.4	55	34	66.0	0.55	41	80.0	18%
S35 17	Residential	0.6	1.3	55	49	77.6	0.55	50	80.0	3%
S35 2	Residential	0.6	0.7	55	41	70.7	0.55	47	80.0	12%
S35 3	Residential	1.2	1.0	55	81	64.9	0.55	100	80.0	19%
S35 8	Residential	1.2	0.8	55	76	61.6	0.55	98	80.0	23%
S35 9	Residential	2.3	0.5	55	104	46.4	0.55	180	80.0	42%
S36	Residential	0.3	0.9	55	27	80.7	0.55	27	80.0	1%
S36 1	Residential	1.4	1.1	55	92	63.3	0.55	116	80.0	21%
S36 2	Residential	0.9	0.6	55	56	61.0	0.55	73	80.0	24%
S36 3	Residential	0.8	0.0	55	18	23.6	0.55	62	80.0	71%
S36 6	Residential	2.7	0.9	55	138	51.3	0.55	216	80.0	36%
S36 8	Residential	1.6	0.5	55	81	51.8	0.55	124	80.0	35%
S36 9	Residential	1.0	1.7	55	75	75.2	0.55	80	80.0	6%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S37 1	Residential	3.6	0.2	55	120	33.7	0.55	284	80.0	58%
S37 3	Residential	0.9	0.8	55	58	66.3	0.55	71	80.0	17%
S37 4	Residential	2.3	2.5	55	157	68.8	0.55	183	80.0	14%
S37 5	Residential	0.3	0.6	55	23	77.2	0.55	24	80.0	4%
S37 6	Residential	1.4	0.6	55	75	54.9	0.55	110	80.0	31%
S37 7	Residential	2.4	1.2	55	138	58.5	0.55	189	80.0	27%
S39 2	Residential	1.0	1.0	55	69	67.0	0.55	82	80.0	16%
S39 3	Residential	2.1	0.8	55	115	54.8	0.55	167	80.0	32%
S39 4	Residential	2.4	1.3	55	143	58.5	0.55	195	80.0	27%
S39 5	Residential	0.9	0.8	55	61	66.9	0.55	73	80.0	16%
S39 6	Residential	1.4	0.7	55	81	57.9	0.55	112	80.0	28%
S39 7	Residential	1.6	1.4	55	106	65.9	0.55	128	80.0	18%
S4 1	Residential	0.9	3.5	55	76	84.8	0.55	71	80.0	6%
S4 17	Residential	1.3	1.3	55	89	67.4	0.55	106	80.0	16%
S4 18	Residential	4.7	0.7	55	190	40.6	0.55	374	80.0	49%
S4 20	Residential	0.6	2.2	55	49	84.3	0.55	47	80.0	5%
S4 21	Residential	0.8	0.8	55	57	67.7	0.55	68	80.0	15%
S4 9	Residential	2.1	0.6	55	107	50.6	0.55	168	80.0	37%
S40	Residential	0.1	0.5	55	11	104.2	0.55	8	80.0	30%
S41 10	Residential	1.7	0.6	55	90	53.6	0.55	134	80.0	33%
S41 5	Residential	0.0	0.7	55	0	100.0	0.55	0	80.0	25%
S41 8	Residential	1.0	0.1	55	36	35.6	0.55	82	80.0	56%
S42 2	Residential	2.8	5.5	55	216	76.8	0.55	224	80.0	4%
S42 4	Residential	0.8	2.5	55	69	81.7	0.55	68	80.0	2%
S43 2	Residential	0.8	1.0	55	59	69.6	0.55	67	80.0	13%
S43 3	Residential	1.2	0.7	55	74	60.8	0.55	97	80.0	24%
S43 4	Residential	1.8	4.7	55	146	80.2	0.55	146	80.0	0%
S43 5	Residential	2.3	1.9	55	150	64.8	0.55	185	80.0	19%
S43 6	Residential	1.9	2.0	55	131	68.4	0.55	153	80.0	14%
S43 7	Residential	1.4	0.7	55	79	58.5	0.55	108	80.0	27%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S43 8	Residential	0.8	0.6	55	52	64.4	0.55	64	80.0	19%
S47 1	Residential	0.3	0.5	55	23	72.9	0.55	25	80.0	9%
S47 2	Residential	2.3	0.6	55	108	47.8	0.55	181	80.0	40%
S47 3	Residential	2.0	0.8	55	110	54.2	0.55	162	80.0	32%
S47 4	Residential	1.7	0.7	55	96	55.7	0.55	138	80.0	30%
S49 1	Residential	1.1	0.4	55	56	52.5	0.55	86	80.0	34%
S49 3	Residential	1.7	0.9	55	101	57.8	0.55	139	80.0	28%
S49 4	Residential	1.8	0.4	55	86	47.2	0.55	146	80.0	41%
S49 5	Residential	1.8	0.5	55	89	49.8	0.55	143	80.0	38%
S49 6	Residential	1.4	0.4	55	69	48.4	0.55	114	80.0	39%
S5 1	Residential	0.5	0.5	55	31	68.0	0.55	36	80.0	15%
S5 3	Residential	1.4	7.8	55	120	88.5	0.55	108	80.0	11%
S5 5	Residential	2.0	4.1	55	156	77.4	0.55	162	80.0	3%
S5 6	Residential	1.0	0.2	55	45	45.0	0.55	81	80.0	44%
S50 5	Residential	0.4	1.5	55	32	85.0	0.55	30	80.0	6%
S50 6	Residential	0.8	2.7	55	69	82.9	0.55	67	80.0	4%
S52 1	Residential	1.2	0.7	55	75	60.6	0.55	100	80.0	24%
S52 3	Residential	2.5	1.0	55	135	55.1	0.55	196	80.0	31%
S52 4	Residential	1.1	2.5	55	90	78.3	0.55	92	80.0	2%
S52 6	Residential	2.0	0.8	55	111	54.4	0.55	163	80.0	32%
S52 8	Residential	0.5	0.8	55	36	74.7	0.55	39	80.0	7%
S53 1	Residential	1.0	0.7	55	66	62.7	0.55	84	80.0	22%
S53 2	Residential	1.6	4.0	55	126	79.8	0.55	126	80.0	0%
S53 3	Residential	0.9	0.7	55	59	65.0	0.55	73	80.0	19%
S53 4	Residential	1.6	1.1	55	101	61.7	0.55	131	80.0	23%
S53 6	Residential	2.2	0.4	55	94	43.2	0.55	175	80.0	46%
S53 7	Residential	1.1	0.5	55	61	55.8	0.55	87	80.0	30%
S53 8	Residential	0.4	2.0	55	38	86.3	0.55	35	80.0	8%
S54 1	Residential	1.6	0.5	55	82	52.3	0.55	125	80.0	35%
S54 10	Residential	2.2	1.4	55	137	61.1	0.55	179	80.0	24%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S54 3	Residential	0.1	0.5	55	6	90.6	0.55	6	80.0	13%
S54 4	Residential	2.6	0.9	55	140	53.1	0.55	211	80.0	34%
S54 7	Residential	2.4	0.6	55	117	48.0	0.55	195	80.0	40%
S55 2	Residential	2.1	2.4	55	145	69.7	0.55	166	80.0	13%
S55 3	Residential	1.9	1.0	55	114	59.0	0.55	155	80.0	26%
S55 4	Residential	1.8	0.9	55	105	58.3	0.55	144	80.0	27%
S56 2	Residential	1.4	0.4	55	71	51.5	0.55	110	80.0	36%
S57 2	Residential	0.1	0.8	55	12	88.4	0.55	11	80.0	11%
S58 10	Residential	0.9	1.4	55	68	73.9	0.55	74	80.0	8%
S58 5	Residential	1.3	0.8	55	77	61.3	0.55	100	80.0	23%
S58 8	Residential	1.3	0.7	55	77	58.3	0.55	105	80.0	27%
S61 1	Residential	2.2	1.1	55	129	57.5	0.55	179	80.0	28%
S61 2	Residential	1.2	3.2	55	96	80.6	0.55	96	80.0	1%
S61 3	Residential	1.2	0.4	55	66	52.7	0.55	100	80.0	34%
S61 4	Residential	2.5	0.5	55	110	43.6	0.55	201	80.0	46%
S63 1	Residential	0.7	0.7	55	50	67.7	0.55	59	80.0	15%
S63 3	Residential	0.7	0.6	55	46	66.6	0.55	56	80.0	17%
S63 4	Residential	0.5	0.2	55	31	56.6	0.55	43	80.0	29%
S63 5	Residential	1.3	0.2	55	58	43.9	0.55	106	80.0	45%
S63 6	Residential	0.2	0.9	55	18	85.9	0.55	16	80.0	7%
S64 3	Residential	1.2	2.1	55	91	75.6	0.55	96	80.0	6%
S64 4	Residential	1.4	0.6	55	77	55.3	0.55	111	80.0	31%
S65 2	Residential	0.6	2.4	55	52	84.5	0.55	50	80.0	6%
S65 3	Residential	1.1	2.6	55	89	78.8	0.55	90	80.0	2%
S65 4	Residential	1.0	2.9	55	81	81.7	0.55	79	80.0	2%
S65 7	Residential	0.7	3.6	55	63	87.2	0.55	58	80.0	9%
S66 1	Residential	1.4	1.3	55	94	66.4	0.55	114	80.0	17%
S66 3	Residential	1.4	6.0	55	118	86.0	0.55	110	80.0	7%
S66 4	Residential	0.3	1.6	55	23	89.2	0.55	21	80.0	12%
S67 1	Residential	1.1	6.0	55	97	88.1	0.55	88	80.0	10%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S67 2	Residential	0.4	2.0	55	36	86.8	0.55	34	80.0	9%
S67 3	Residential	1.5	3.2	55	114	78.2	0.55	116	80.0	2%
S68 1	Residential	2.8	1.5	55	166	59.3	0.55	224	80.0	26%
S68 2	Residential	1.3	2.7	55	98	77.9	0.55	100	80.0	3%
S68 7	Residential	1.6	2.7	55	122	74.9	0.55	130	80.0	6%
S69 1	Residential	1.9	1.7	55	128	66.1	0.55	154	80.0	17%
S69 3	Residential	1.0	1.5	55	72	74.2	0.55	77	80.0	7%
S69 4	Residential	0.7	2.7	55	56	85.4	0.55	52	80.0	7%
S7	Residential	1.3	5.1	55	109	85.0	0.55	103	80.0	6%
S70 2	Residential	0.4	2.4	55	36	88.8	0.55	32	80.0	11%
S70 3	Residential	3.3	0.8	55	158	47.2	0.55	267	80.0	41%
S72 3	Residential	0.8	1.4	55	60	75.0	0.55	64	80.0	6%
S72 4	Residential	0.4	3.2	55	37	91.1	0.55	33	80.0	14%
S75 1	Residential	0.2	0.1	55	12	62.9	0.55	15	80.0	21%
S75 2	Residential	2.3	0.8	55	122	53.2	0.55	183	80.0	34%
S75 6	Residential	0.3	0.9	55	21	83.2	0.55	20	80.0	4%
S76 1	Residential	0.9	0.6	55	57	62.2	0.55	73	80.0	22%
S76 10	Residential	0.1	0.6	55	8	90.5	0.55	7	80.0	13%
S76 2	Residential	0.3	0.3	55	19	70.7	0.55	22	80.0	12%
S76 3	Residential	2.0	1.7	55	129	66.2	0.55	157	80.0	17%
S76 4	Residential	1.5	0.6	55	81	54.5	0.55	119	80.0	32%
S76 5	Residential	0.6	0.3	55	38	58.9	0.55	51	80.0	26%
S76 7	Residential	1.8	0.7	55	99	55.1	0.55	144	80.0	31%
S76 8	Residential	1.3	0.5	55	70	55.6	0.55	101	80.0	31%
S77 1	Residential	1.2	2.5	55	96	77.0	0.55	100	80.0	4%
S77 3	Residential	0.2	16.6	55	21	100.5	0.55	17	80.0	26%
S78 1	Residential	1.6	4.7	55	134	81.5	0.55	132	80.0	2%
S78 21	Residential	3.4	5.3	55	253	73.9	0.55	274	80.0	8%
S78 22	Residential	2.3	6.1	55	184	80.5	0.55	183	80.0	1%
S78 24	Residential	2.5	2.0	55	161	65.1	0.55	198	80.0	19%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S78 3	Residential	1.8	1.5	55	118	65.6	0.55	144	80.0	18%
S78 4	Residential	0.0	0.0	55	0	0.0	0.55	2	80.0	100%
S78 6	Residential	0.0	0.0	55	0	0.0	0.55	2	80.0	100%
S78 8	Residential	1.0	0.9	55	65	67.0	0.55	78	80.0	16%
S79 3	Residential	0.2	3.9	55	15	97.7	0.55	13	80.0	22%
S80 1	Residential	0.8	2.2	55	67	80.2	0.55	67	80.0	0%
S81 1	Residential	2.0	2.0	55	137	68.1	0.55	161	80.0	15%
S81 3	Residential	1.7	2.1	55	122	70.6	0.55	139	80.0	12%
S81 7	Residential	1.7	2.0	55	119	70.5	0.55	136	80.0	12%
S81 8	Residential	1.2	1.5	55	88	70.7	0.55	99	80.0	12%
S81 9	Residential	2.1	1.0	55	121	57.1	0.55	169	80.0	29%
S83 5	Residential	0.6	1.3	55	50	76.9	0.55	52	80.0	4%
S84 2	Residential	0.9	0.6	55	54	62.4	0.55	70	80.0	22%
S84 4	Residential	0.7	0.8	55	49	68.9	0.55	57	80.0	14%
S84 5	Residential	0.2	0.2	55	14	62.7	0.55	18	80.0	22%
S84 6	Residential	0.2	1.5	55	14	92.7	0.55	12	80.0	16%
S84 7	Residential	1.7	0.6	55	92	52.8	0.55	139	80.0	34%
S84 8	Residential	1.2	0.4	55	62	49.8	0.55	100	80.0	38%
S84 9	Residential	2.2	0.9	55	121	55.6	0.55	173	80.0	30%
S85 2	Residential	1.2	1.3	55	79	69.1	0.55	92	80.0	14%
S85 7	Residential	0.2	0.4	55	16	75.3	0.55	17	80.0	6%
S9	Residential	0.9	1.2	55	62	72.1	0.55	69	80.0	10%
S92 3	Residential	3.0	0.6	55	137	45.8	0.55	239	80.0	43%
S92 4	Residential	1.2	1.2	55	82	68.1	0.55	96	80.0	15%
S93 2	Residential	1.7	0.8	55	96	57.2	0.55	134	80.0	29%
S93 3	Residential	1.6	0.6	55	87	54.8	0.55	127	80.0	31%
S93 4	Residential	1.4	0.3	55	66	47.5	0.55	111	80.0	41%
S94 4	Residential	2.0	1.1	55	117	59.4	0.55	158	80.0	26%
S94 6	Residential	1.1	4.7	55	91	86.2	0.55	84	80.0	8%
S94 7	Residential	0.2	0.7	55	16	84.4	0.55	15	80.0	6%



CATCHMENT PARAMETERS			MODEL RESULTS				RATIONAL METHOD			
S94 9	Residential	0.1	1.2	55	6	96.8	0.55	5	80.0	21%
S95 3 E	Residential	0.9	2.3	55	75	79.5	0.55	76	80.0	1%
S96 2	Residential	1.7	0.9	55	100	58.1	0.55	138	80.0	27%
S96 3	Residential	2.5	1.7	55	158	62.6	0.55	201	80.0	22%
S96 4	Residential	2.4	3.8	55	181	73.7	0.55	196	80.0	8%
S97 1	Residential	1.6	0.8	55	92	57.5	0.55	128	80.0	28%
S97 2	Residential	1.3	0.3	55	62	48.9	0.55	101	80.0	39%
S97 5	Residential	1.7	0.8	55	96	56.9	0.55	135	80.0	29%
S97 6	Residential	1.4	0.9	55	84	61.4	0.55	109	80.0	23%
S98 1	Residential	1.3	0.4	55	66	51.3	0.55	102	80.0	36%
S98 2	Residential	1.2	1.3	55	82	68.6	0.55	96	80.0	14%
S98 3	Residential	1.9	1.5	55	125	64.2	0.55	156	80.0	20%
S98 5	Residential	2.6	1.0	55	142	54.5	0.55	209	80.0	32%
S98 6	Residential	1.2	2.8	55	97	78.6	0.55	99	80.0	2%
S99 2	Residential	0.4	0.4	55	25	68.1	0.55	29	80.0	15%
S99 6	Residential	0.3	1.4	55	24	87.1	0.55	22	80.0	9%
										21%



APPENDIX C – PROPOSED SWMF PARAMETERS

Table 16: Proposed SWMF Parameters – North Residential

ATTRIBUTES	N_R_043	N_R_044	N_R_045	N_R_046	N_R_047
Contributing Drainage Area (ha)	42.7	38.7	578.8	562.3	463.2
Contributing Impervious Area (ha)	23.5	21.3	315.5	306.4	251.9
NWL Elevation (m)	730.2	730.2	730.9	734.8	740.1
Footprint at Top of SWMF (m ²)	7526	7014	1892	16741	17583
Active SWMF Volume (m ³)	7263	6652	1041	19539	20001
Active Storage Depth (m)	1.5	1.5	1.5	1.5	1.5
Maximum Allowable 1:100 Year Release Rate (L/s/ha)	5	5	5	5	5
1:100 Year Peak Discharge (L/s)	214	194	2838	2764	2315
1:100 Year Orifice Flow (L/s)	214	194	2838	2764	2313
Orifice Size (mm)	294	280	1193	1168	1129



Table 17: Proposed SWMF Parameters – Northwest Residential / Commercial

ATTRIBUTES	NW_WP_00 1	NW_WP_00 2	NW_C_R_0 03	NW_C_004	NW_R_005	NW_R_007	NW_R_008	NW_R_009
Contributing Drainage Area (ha)	194.1	331.1	366.7	36.6	12.5	168.0	62.2	67.7
Contributing Impervious Area (ha)	83.1	179.2	198.8	26.0	6.9	92.4	34.2	37.2
NWL Elevation (m)	749.0	747.8	745.9	744.4	744.8	751.0	756.4	749.3
Footprint at Top of SWMF (m ²)	19516	23409	2581	9506	2938	16641	10252	14042
Active SWMF Volume (m ³)	22479	27502	1731	9645	2077	18664	10603	15406
Active Storage Depth (m)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Maximum Allowable 1:100 Year Release Rate (L/s/ha)	5	5	5	5	5	5	5	5
1:100 Year Peak Discharge (L/s)	967	1647	1850	183	62	835	311	215
1:100 Year Orifice Flow (L/s)	967	1647	1844	183	62	835	311	215
Orifice Size (mm)	685	860	942	272	152	630	371	295



Table 18: Proposed SWMF Parameters – Southwest Residential

ATTRIBUTES	SW_R_010	SW_R_011	SW_R_012	SW_R_013	SW_R_014	SW_R_015
Contributing Drainage Area (ha)	27.2	67.4	100.8	82.7	10.3	62.5
Contributing Impervious Area (ha)	15.0	37.1	55.4	45.5	5.6	34.4
NWL Elevation (m)	744.0	747.1	745.7	740.3	739.4	739.2
Footprint at Top of SWMF (m ²)	5293	10920	5929	12826	3080	10558
Active SWMF Volume (m ³)	4621	11428	5383	13815	2227	10950
Active Storage Depth (m)	1.5	1.5	1.5	1.5	1.5	1.5
Maximum Allowable 1:100 Year Release Rate (L/s/ha)	5	5	5	5	5	5
1:100 Year Peak Discharge (L/s)	136	338	506	415	51	313
1:100 Year Orifice Flow (L/s)	136	338	506	415	51	313
Orifice Size (mm)	239	418	461	418	209	358



Table 19: Proposed SWMF Parameters – Northeast Industrial / Commercial

ATTRIBUTES	NE_C_036	NE_I_037	NE_C_038	NE_I_039	NE_C_040	NE_C_041	NE_C_042
Contributing Drainage Area (ha)	55.9	118.3	536.6	795.2	74.1	6.9	41.0
Contributing Impervious Area (ha)	41.9	81.8	83.6	263.4	55.5	5.2	30.7
NWL Elevation (m)	744.7	742.9	741.6	736.6	736.8	737.4	734.9
Footprint at Top of SWMF (m ²)	14400	12432	12266	22313	30276	2809	11078
Active SWMF Volume (m ³)	15732	12262	14986	19367	38294	1123	12794
Active Storage Depth (m)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Maximum Allowable 1:100 Year Release Rate (L/s/ha)	5	5	5	5	5	5	5
1:100 Year Peak Discharge (L/s)	282	627	1803	2219	311	68	196
1:100 Year Orifice Flow (L/s)	282	627	267	795	311	68	196
Orifice Size (mm)	382	526	320	900	426	180	279



Table 20: Proposed SWMF Parameters – East Industrial / Commercial

ATTRIBUTES	E_I_030	E_I_032	E_I_033	E_C_034	E_C_035
Contributing Drainage Area (ha)	582.4	35.3	547.7	315.4	108.0
Contributing Impervious Area (ha)	198.0	22.6	175.8	42.2	54.0
NWL Elevation (m)	742.0	742.1	742.7	746.6	745.1
Footprint at Top of SWMF (m ²)	6241	8501	17562	5351	16879
Active SWMF Volume (m ³)	6694	7644	21050	4988	20166
Active Storage Depth (m)	1.5	1.5	1.5	1.5	1.5
Maximum Allowable 1:100 Year Release Rate (L/s/ha)	5	5	5	5	5
1:100 Year Peak Discharge (L/s)	2618	175	2284	918	440
1:100 Year Orifice Flow (L/s)	175	175	705	86	334
Orifice Size (mm)	267	271	673	186	399

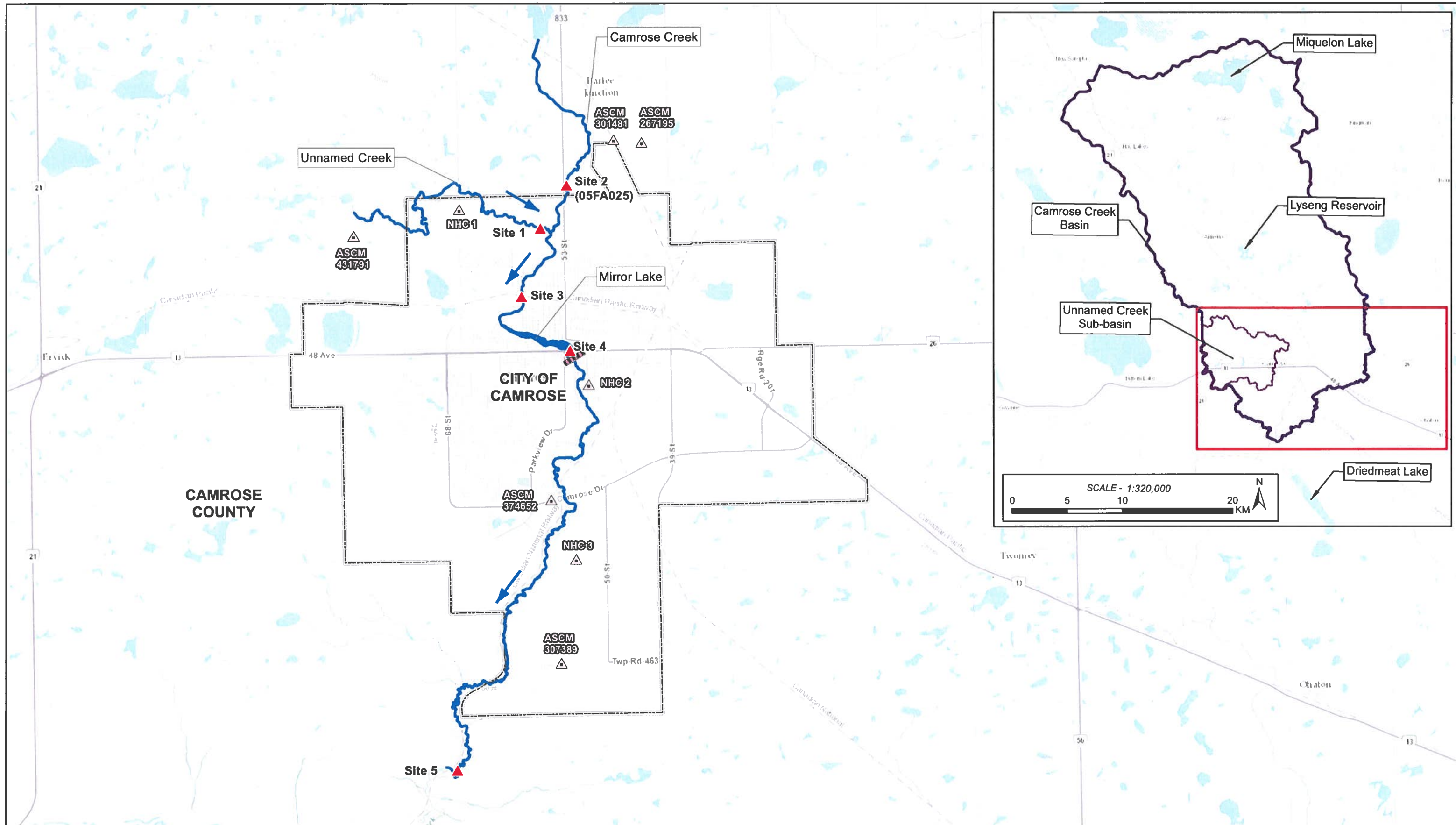


Table 21: Proposed SWMF Parameters – Southeast Industrial / Commercial

ATTRIBUTES	SE_R_C_016	SE_R_017	SE_I_018	SE_I_019	SE_C_021	SE_I_022	SE_C_023	SE_C_I_024	SE_I_025	SE_I_026	SE_I_027	SE_C_028	SE_C_I_029	SE_I_031
Contributing Drainage Area (ha)	42.9	99.7	82.5	82.7	52.3	15.2	106.2	42.7	62.0	72.0	29.2	116.5	58.5	35.0
Contributing Impervious Area (ha)	28.1	60.2	50.8	58.7	39.2	9.8	77.3	29.7	39.7	46.1	18.7	83.0	39.6	22.4
NWL Elevation (m)	737.2	739.2	740.4	742.8	743.9	742.7	744.9	747.5	743.2	744.0	746.0	742.3	743.9	744.5
Footprint at Top of SWMF (m ²)	10221	3782	15475	6480	13410	4193	16066	10394	12455	9361	6806	15191	12916	7788
Active SWMF Volume (m ³)	10550	3102	17051	6032	14608	3115	17953	10762	13987	9496	6366	16854	13900	7812
Active Storage Depth (m)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Maximum Allowable 1:100 Year Release Rate (L/s/ha)	5	5	5	5	5	5	5	5	5	5	5	5	5	5
1:100 Year Peak Discharge (L/s)	216	493	412	416	261	83	534	214	298	361	146	582	294	359
1:100 Year Orifice Flow (L/s)	216	493	412	416	261	83	534	214	298	361	146	582	294	284
Orifice Size (mm)	332	185	465	415	463	184	473	323	374	439	255	495	535	373



APPENDIX D – CAMROSE FLOOD HAZARD STUDY: STUDY
AREA AND BASIN OVERVIEW



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