Bremner ACP
Utilities Master Plan

Final Draft

March 28, 2019

Prepared for:

Strathcona County
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Prepared by:

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Sign-off Sheet

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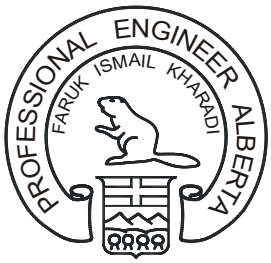
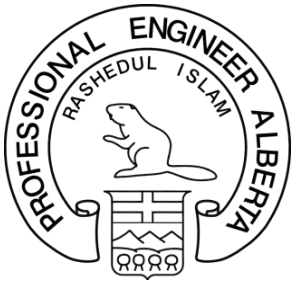


Project Engineer: Faruk Kharadi, P. Eng.



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Executive Summary

Strathcona County (County) retained Stantec Consulting Ltd. (Stantec) to update and refine the Bremner Area Concept Plan (ACP). As part of this ACP update, this utilities master plan has been prepared to develop water, wastewater and stormwater drainage servicing plans at a conceptual planning level. This utilities master plan is intended to define the onsite and offsite servicing requirements as well as the corresponding planning level opinion of probable costs. The utilities master plan also identifies interim servicing requirements and an overall implementation plan based on anticipated growth projections.

The Bremner ACP has been proposed to accommodate future urban population growth in Strathcona County. The proposed ACP area is located east of Highway 21, west of Range Road 222, south of Pointe-aux-Pins Creek and north of the Canadian National (CN) Railway. The area between the CN Railway and Highway 16 is also known as the Local Employment Area (LEA) and will primarily be used for industrial development. The rest of the area will be developed as residential and commercial districts.

The scope of this project was to develop water, wastewater and stormwater drainage servicing concepts for Bremner ACP for onsite and offsite servicing for the ultimate development. Interim servicing requirements for water and wastewater have also been reviewed. Water and stormwater servicing concepts have also been developed for the LEA. The LEA is located in the Rural Service Area as opposed to the Urban Service Area of the County. It is also identified within the Rural Area of the Edmonton Metropolitan Region Growth Plan; therefore, an urban level of service is not required. The County currently has a substantial industrial land supply that requires urban levels of service located in the North of Yellowhead and West of 21 area. Through consultation it was also noted that the majority of the development in the LEA is anticipated to be large lot industrial and warehousing with low water usage. As higher intensity uses are not anticipated, it was determined early in the ACP process that rural water standards, onsite septic tank disposal wastewater servicing and onsite fire suppression would be suitable for the area.

The following sections provide a summary of and key conclusions and recommendations for the various servicing concepts.

Water Servicing Concept

The Bremner ACP water servicing concept is developed based on urban servicing for Bremner and rural servicing for the LEA (i.e. trickle feed water supply and onsite fire protection by owner). For the ultimate water supply to Bremner, three main supply options were considered. A water supply option from CRNWSC was eliminated due to concerns that the CRNWSC infrastructure upgrade requirement would significantly impact the current rate structure. Of the remaining two options, an ultimate supply option from the Clareview Reservoir is preferred by EPCOR and the County. For the County, it provides a secondary feed, providing redundancy and reducing the risk of a supply disruption to the entire Strathcona County service area. This option also allows EPCOR potential to directly service their own customers within the City of Edmonton east of the North Saskatchewan River. Confirmation of the preferred supply option is ongoing with EPCOR as EPCOR needs to determine their preferred service location based on the extent of their internal system upgrade requirements.

For interim supply, two options were considered based on the existing and planned County water distribution system within the North of Yellowhead area. An interim supply option from the County's existing 400 mm main along CP Rail is recommended. For this interim supply option, a reservoir and pumphouse is required for the higher density

residential and non-residential service. This interim supply line could be used to service the single family residential area for the initial development stages until a reservoir is constructed. A second supply option through Cambrian Crossing was identified, but it is considered to be difficult to implement due to uncertainties in development timing in Cambrian and it would also require numerous sections through undeveloped land.

For onsite servicing, two reservoirs are required from a hydraulic perspective, one in the southwest and one in the southeast. A third reservoir in the northwest part of Bremner was included to accommodate initial development in Bremner. The development in Bremner is expected to start in the northwest area, and due to proximity to the existing water main, interim water servicing can be easily accommodated. The northwest reservoir also makes the County's preferred supply option easier due to lower delivery pressure requirements. Although the addition of this third reservoir would increase some operation and maintenance costs, a third reservoir also provides additional operational flexibility if one of the reservoirs was to be shut down for maintenance.

The onsite servicing plan based on the three reservoirs is shown on **Figure E.1**. The onsite system water mains range from 250 mm to 600 mm diameter. The flow triggers for major water distribution system components based on Option 1 interim and Option 1 ultimate supply are summarized in **Table E.1**.

Table E.1 Summary of Interim and Ultimate Water Supply Requirements

Year	Trigger	Water Infrastructure Implementation	Remark
2023	Development start with single family residential	Construction of interim supply line	HNA required to ensure sufficient fire protection is available
2025	Development start of higher density residential and/or non-residential service areas	Construct initial stage of northwest reservoir and pumphouse	
2035	Total Bremner and LEA ADD demand reaches 55 L/s	Construct 2nd stage of northwest reservoir and pumphouse	Timing based on County design standards
2040	Total Bremner and LEA ADD demand reaches 97 L/s	Construct offsite water main to Clareview reservoir	Coordinate with EPCOR
2043	Total Bremner and LEA ADD demand reaches 131 L/s	Construct Southwest Reservoir	
2052	Total Bremner and LEA ADD demand reaches 260 L/s	Construct Southeast Reservoir	

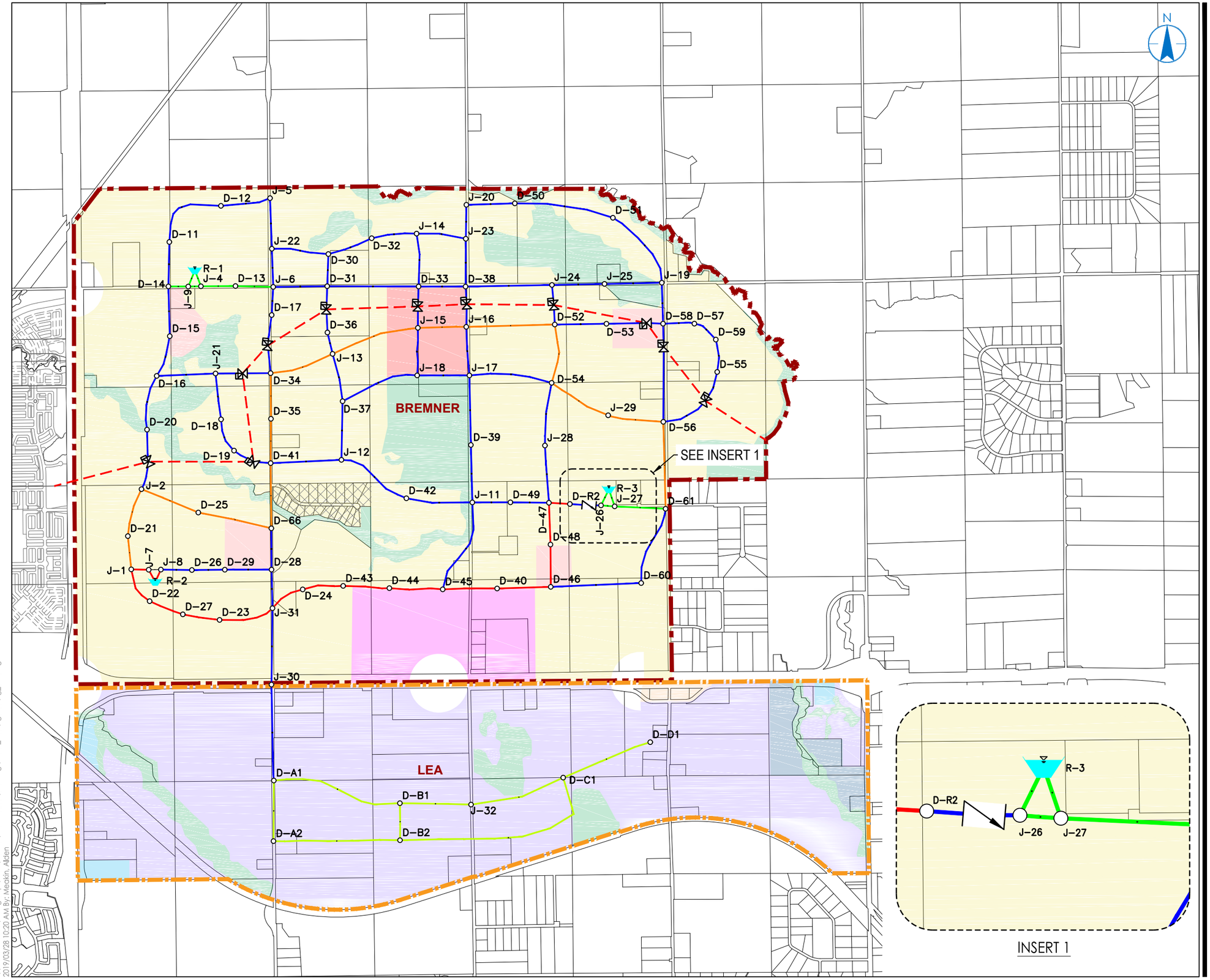
The above triggers are based on growth projections provided by the County for Bremner, LEA and Cambrian Crossing. The offsite supply main is projected to be required in 2040. This timing requirement is subject to change based on the County's Water Master Plan update to determine the County's water infrastructure's ability to supply the required flow rates considering growth in NoY and West of 21.

The water servicing conclusions and recommendations are as follows:

Offsite Servicing

The key conclusions and recommendations for offsite water servicing are as follows:

- Two offsite water supply connection options for Bremner were considered, (see **Figure E.2** for alignments):



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Legend

- D-60 Demand Node
- J-25 Junction Node
- 250mm Dia. watermain
- 300mm Dia. Watermain
- 400mm Dia. Watermain
- 450mm Dia. Watermain
- 600mm Dia. Watermain
- R-3 Reservoir
- PRV-12 PRV
- Check Valve
- Bremner Project Boundary
- LEA Boundary
- Pressure Zone Boundary

Scale

1:30,000 — 0 250 500 1000 1500m

Client/Project

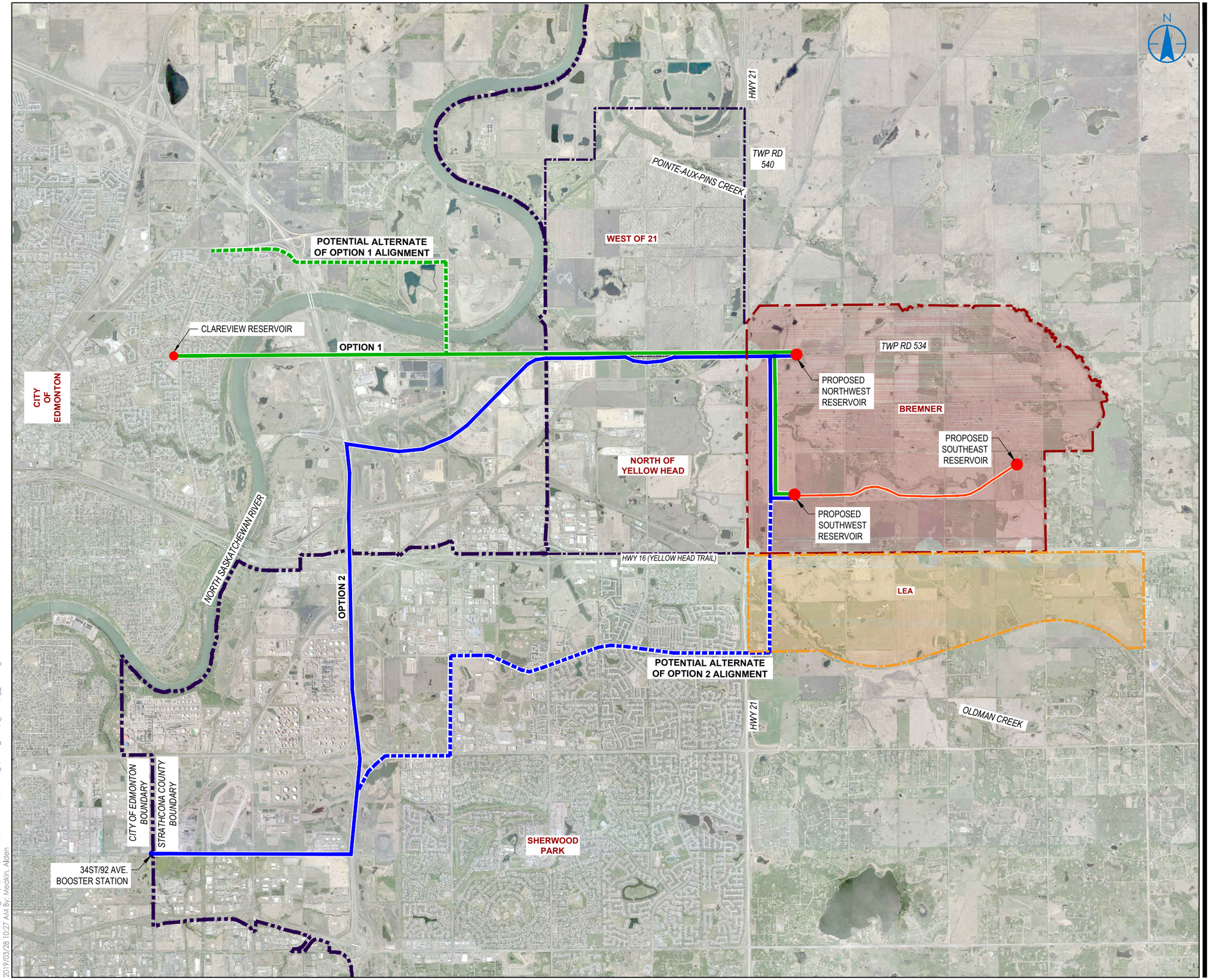
STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.

E-1

Title

Proposed Onsite Water Servicing Plan



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Legend

- Area Boundary
- County/City Boundary
- Option 1 Watermain
- Option 2 Watemain
- Option 1/2 Watermain
- Bremner Project Boundary
- LEA Boundary

Scale

1:60,000 — 0 500 1000 2000 3000m

Client/Project

STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.

E.2

Title

Offsite Water Servicing Options

  - Option 1 - Clareview Reservoir in northeast Edmonton, 900 mm diameter, approximately 12.8 km in length and total estimated cost of $52M
  - Option 2 - 34 Street and 92 Avenue where the County currently receives water from, 900 mm diameter, approximately 20.6 km in length and total estimated cost of $78M
- For sizing of the supply main, EPCOR's lower water consumption rates standards have been used.
- Option 1 is preferred by the County as it provides a secondary supply source for the County which would reduce potential risk of supply disruption.
- Preliminary assessment completed by EPCOR indicates that the City's internal system may need to be upgraded to accommodate Bremner and other Edmonton area developments. EPCOR is currently assessing in detail both the internal growth of the City as well as the external growth of it's regional customers through transmission master planning process. This analysis will inform EPCOR regarding which water supply connection option (Option 1 – Clareview Reservoir or Option 2 - 34 Street and 92 Avenue) service location is preferable.
- Both supply options require a portion of the supply main to be installed within the City of Edmonton boundary. EPCOR has indicated they may likely construct the section within Edmonton and own and operate this section. For Option 1 a river crossing is required within Edmonton. Ownership and cost sharing is ongoing between the County and EPCOR and will have to be documented in a Bremner Water Supply Agreement.

Interim Servicing

For interim water servicing, two potential supply options were considered:

- Option 1 – Utilize the existing 400 mm main along the CP Rail at TWP RD 534 west of Highway 21
- Option 2 – Utilize the proposed 600 mm main along RR 231 via Cambrian

Based on the review of the two options, Option 1 is a preferred interim servicing option due to its proximity to the proposed initial development in the northwest part of Bremner. With Option 1, construction of the first stage of the reservoir in the northwest part of Bremner will be required in 2025 to meet higher density residential and non-residential fire flow requirements. With the interim supply, the ultimate offsite supply line is required in 2041.

Onsite Servicing

The onsite water servicing plan is shown on **Figure E.1**. Details of the onsite servicing are as follows:

- Three equally sized reservoirs are proposed to service the Bremner ACP. The total required storage volume is 76,200 m^3 and the total cost of the three reservoirs including the pump houses is $114M.
- Within Bremner the distribution pipe sizes range from 300 mm to 600 mm diameter. As LEA is serviced to rural standards, 250 mm to 300 mm diameter pipe sizes are used. The total cost of the onsite distribution is approximately $70.5M.
- Due to the topography, the lower elevation northern part of the Bremner service area is serviced by a separate pressure zone.

Wastewater Servicing Concept

For Bremner offsite wastewater servicing, two primary options were considered. Option 1 is conveying the flow directly to the ACRWC wastewater treatment plant. Option 2 consisted of pumping the Bremner flow via a lift station into the proposed NoY wastewater gravity trunk sewer which would discharge the flow to the existing ACRWC's SERTS trunk sewer on RR 232. Both options were discussed with ACRWC, and ACRWC has indicated that Option 2 is not viable due to insufficient capacity in the SERTS trunk and that it would not support this option. As a result,

Option 1 is recommended for servicing of Bremner ACP. This offsite wastewater trunk is also designed to accommodate all of the West of 21 service area. The LEA area will be serviced to rural standards with onsite septic tank and septic tank content disposal via truck haul to the Clover Bar Wastewater Transfer Site, i.e. no flow contribution to the Bremner offsite wastewater trunk.

For interim servicing, two servicing options were considered. Option 1 consists of pumping Bremner wastewater flow via a forcemain and discharging the flow to the ACRWC's SERTS trunk on RR 232 at TWP RD 534. Option 2 is similar to Option 1 with the flow discharging to the proposed NoY gravity trunk in Cambrian Crossing on the west side of Oldman Creek. As exact timing for the proposed NoY trunk is not confirmed, Option 1 is recommended for the interim servicing of Bremner. The SERTS trunk has an allocated capacity of 429 L/s for the NoY servicing including Cambrian Crossing. The total flow from Bremner and NoY is expected to approach 429 L/s in 2033, at this time the ultimate offsite wastewater trunk for Bremner will need to be completed in coordination with the ACRWC as a portion of this sewer will need to be completed by the ACRWC.

Onsite wastewater servicing is shown on **Figure E.3**. The onsite system consists of the main wastewater collection system, with local sewers to be designed in subsequent stages. The onsite system includes two local lift stations in the low-lying area in the north part ACP area. The onsite wastewater collection system conveys flow to the northwest due to the area topography and offsite servicing requirements. The wastewater collection system pipe sizes range from 300 mm to 1,200 mm diameter. The onsite system is not sized to accommodate any LEA flow. The onsite wastewater collection system opinion of probable cost is $117M including the cost of the two proposed lift stations.

The key wastewater servicing conclusions and recommendations are as follows:

Offsite Servicing

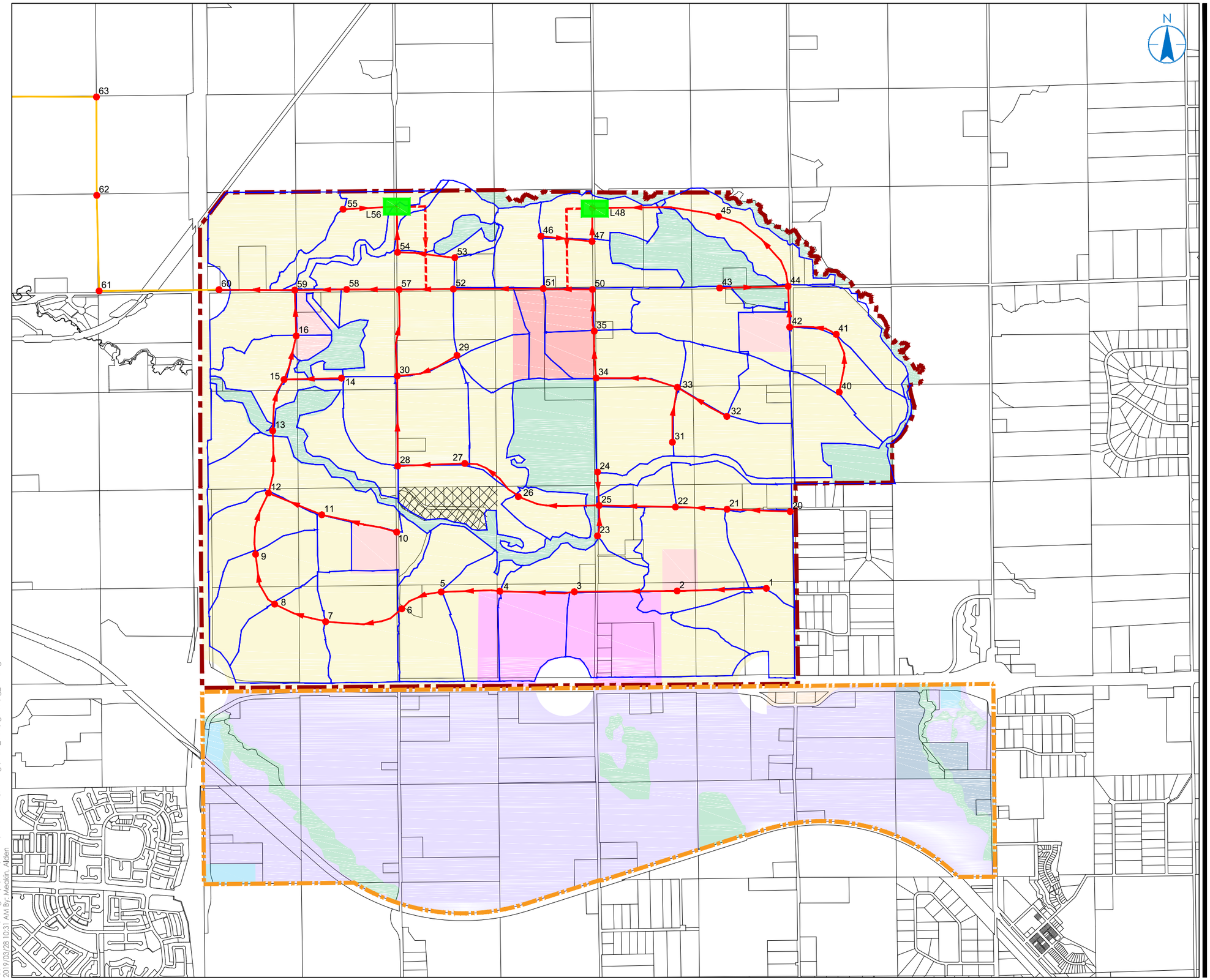
The key conclusions and recommendations for the offsite wastewater servicing are as follows:

- Two offsite wastewater conveyance options for Bremner were considered, see **Figure E.4** for alignments:
    - Option 1 – install a new trunk sewer to service Bremner and West of 21 through West of 21 from TWP RD 534 and Highway 21 to ACRWC's system at TWP RD 540 and RR 232, requires a 1,350 mm diameter trunk, approximately 6.6 km in length and total estimated cost of $45M.
    - Option 2 – Convey all the Bremner flow via a lift station to the proposed NoY wastewater trunk west of Cambrian Crossing. The upsized NoY trunk will convey flow to ACRWC's SERTS trunk on RR 232 at TWP RD 534. ACRWC has indicated it does not support this ultimate servicing due to extensive upgrading and/or twinning requirements for the SERTS trunk. This option was not further evaluated.
- For the proposed Option 1 offsite trunk, ACRWC has indicated it would cover the cost of the section along TWP RD 540 from RR 231 to RR 232 (approximately 25% of the total length). This cost split needs to be confirmed with the ACRWC in writing.
- LEA is to be serviced to rural standards with installation of onsite septic tanks and septic tank content disposal via truck haul to the Clover Bar Wastewater Transfer Site.

Interim Servicing

Interim wastewater servicing conclusions and recommendations are as follows:

- Provide interim servicing through the existing ACRWC's SERTS trunk along RR 232 at TWP RD 534.
- The estimated cost for the interim lift station and forcemain is approximately $4.5M.



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Legend

- 54 — Manhole / Manhole Number
- Proposed Sanitary Trunk
- Sanitary Subcatchment Boundary
- Proposed Forcemain
- Proposed Offsite Sanitary Trunk
- Proposed Lift Station
- Bremner Boundary
- LEA Boudary

Scale

1:30,000 — 0 250 500 1000 1500m

Client/Project

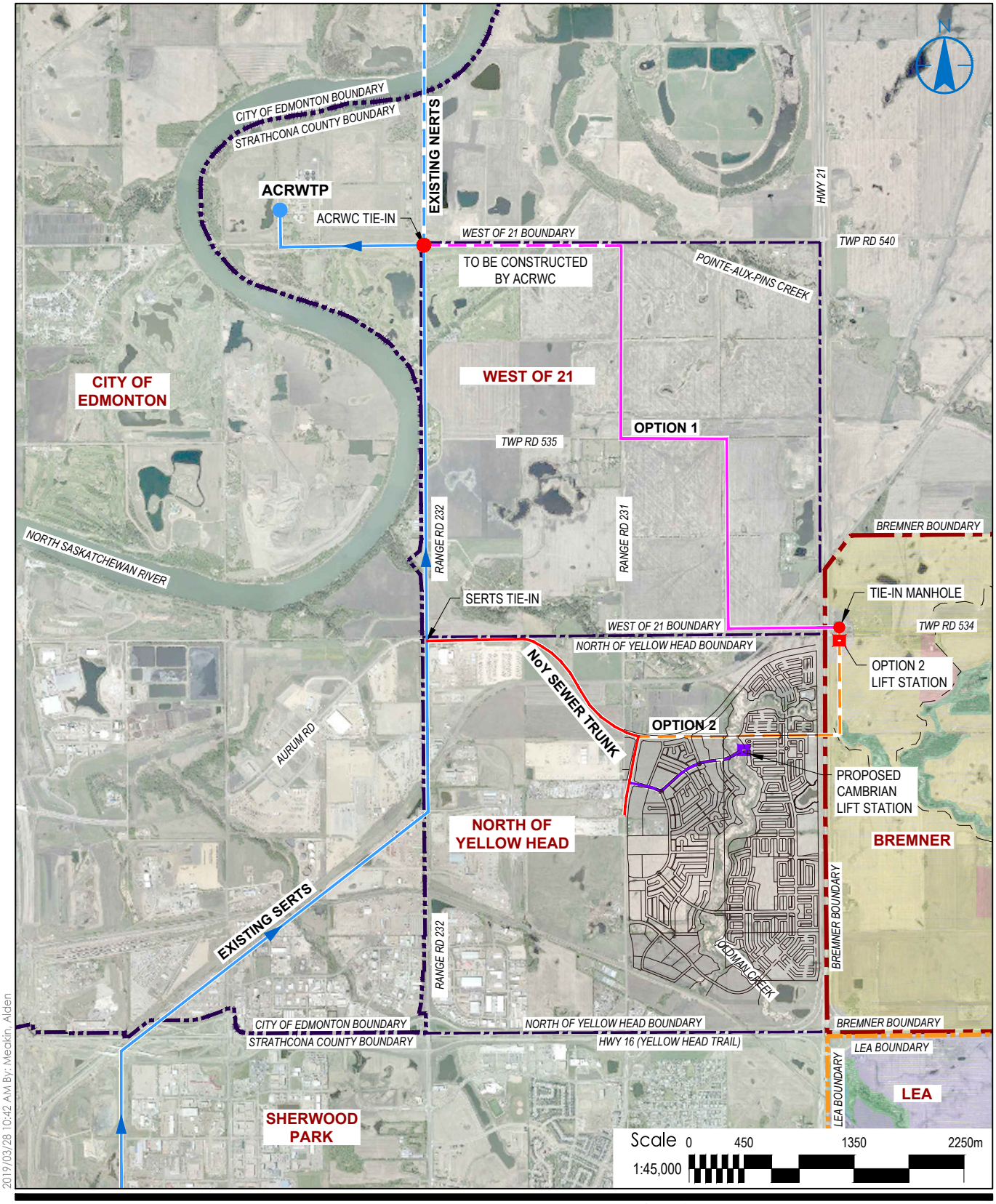
STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.

E.3

Title

Proposed Onsite Wastewater Servicing Plan



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Legend

- Area Boundary
- County/City Boundary
- Option 1 Trunk Sewer (By County)
- Option 1 Trunk Sewer (By Acrwc)
- Option 2 Trunk Sewer
- Option 2 Forcemain
- NoY Trunk Sewer
- Proposed Cambrian Trunk
- Proposed Cambrian Forcemain
- Existing SERTS
- Existing NERTS

Client/Project

STRATHCONA COUNTY

BREMNER ACP UTILITIES MASTER PLAN

Figure No.

E.4

Title

Ultimate Wastewater Servicing Options

- The outlet through the SERTS trunk is available until 2033, at which time the developers in NoY will require the allocated capacity in the SERTS trunk and the ultimate offsite trunk will need to be constructed.

Onsite Servicing

Onsite wastewater servicing plan for Bremner ACP is shown on **Figure E.3**. Details of the onsite servicing are as follows:

- Onsite wastewater servicing generally conveys flow to the northwest due to the area topography and offsite servicing requirements.
- The onsite wastewater collection system pipe sizes range from 300 mm to 1,200 mm diameter.
- The onsite system is not sized to accommodate any LEA flow as the septic tank disposal will be via truck haul to the Clover Bar Wastewater Transfer Site.
- Due to the topography, the northern parts of the Bremner area will need to be serviced by lift stations.
- The onsite wastewater collection system opinion of probable cost is $117M including the cost of two proposed lift stations.

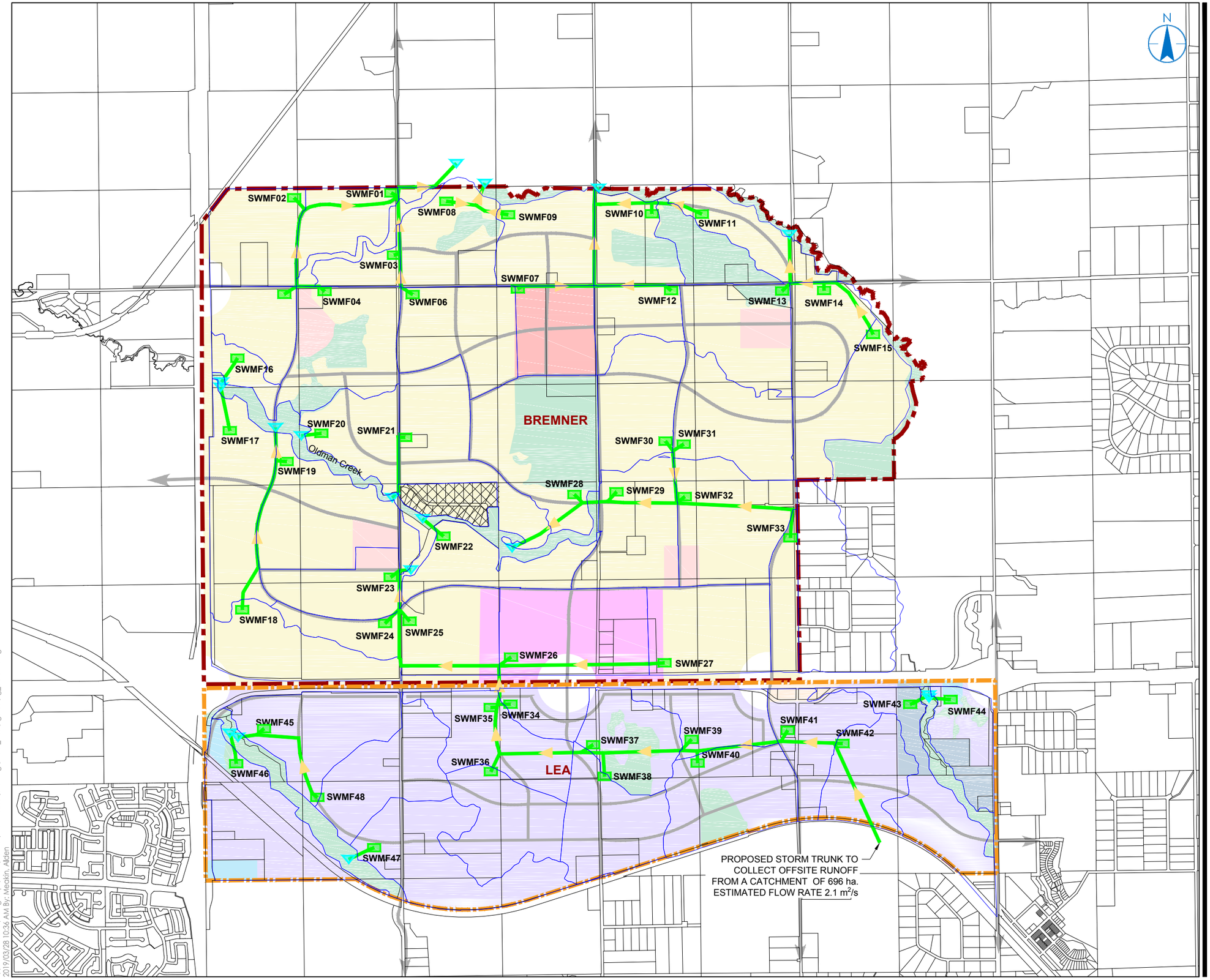
Stormwater Servicing Concept

The proposed stormwater servicing concept for Bremner and LEA is shown on **Figure E.5**. The proposed servicing concept includes 48 SWMFs and 17 stormwater outfall locations. The drainage catchment areas, ponds and outfall locations are conceptual and may be revised during subsequent design stages due to roadway layout and ownership considerations. Some of the pond outlet systems are interconnected to minimize the number of outfalls required. Where feasible, existing wetlands and natural drainage channels should be incorporated in the stormwater management plan.

Based on the flood frequency analysis of Pointe-aux-Pins Creek and Oldman Creek, a 3 L/s/ha maximum allowable discharge rate is proposed. Also based on the previously completed assessment for Oldman Creek by Northwest Hydraulics for the NoY project, a two-stage outlet is recommended to be implemented with a maximum of 1 L/s/ha release rate up to a 1:5 year rainfall event and 3 L/s/ha for larger rainfall events.

A limited creek erosion assessment was completed for the Bremner area through observation of reaches of the creek from public access points and review of historical air photos. The assessment indicates there is potential for erosion of the banks and valleys and recommends a more detailed assessment of the creeks, avoiding development encroachment of ravines and maintaining predevelopment flows to each creek. It is recommended that the more detailed assessment be completed at the time of the first Sub-Area Structure Plan stage so the cost associated with the detailed erosion assessment and the costs of future erosion mitigation measures required within the creek could potentially be shared across the Bremner and LEA areas through a creek erosion levy.

For water quality enhancement, runoff volume control and additional creek protection from erosion is recommended. As part of the Bremner ACP development, a high level LID practice review was completed for areas across North America. Based on this review, several LID features that are viable for cold climate and require relatively low maintenance have been identified and included in the Bremner ACP Design and Construction Guideline document. In consultation with various stakeholders, the LID features are proposed to be encouraged within Bremner to capture up to 25 mm of total annual rainfall over the development area.



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Legend

- Outfall
- Stormwater Management Facility
- Storm Sewer Trunk
- Stormwater Subcatchment Boundary
- Project Boundary

Notes

The sub-catchment area boundaries are approximate based on existing topography and will require further refinement at the sub-area structure plan stage.

Scale

1:30,000

0 250 500 1000 1500m

Client/Project

STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.

E.5

Title

Proposed Stormwater Servicing Plan

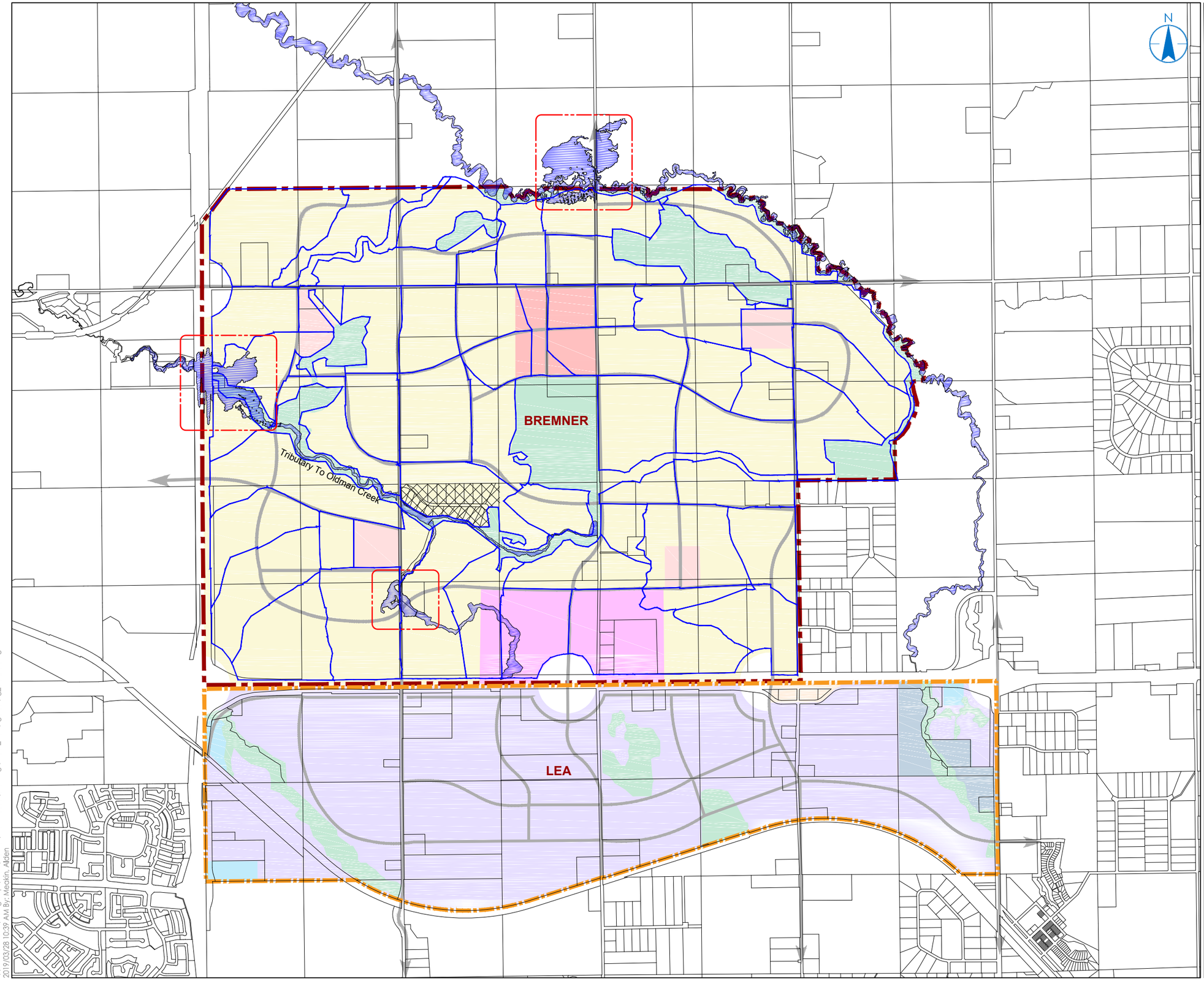
Executive Summary

A flood plain assessment for a tributary of Oldman Creek and Pointe-aux-Pins Creek within Bremner indicates three potential flooding areas as shown on **Figure E.6**. Appropriate flood mitigation protection measures will need to be considered in subsequent design stages for these locations.

The opinion of probable cost for the stormwater servicing concepts for Bremner and LEA is approximately $230M not including the upstream neighbourhood stormwater collection system connected to each pond. These costs also do not include any offsite or creek erosion mitigation costs that may be required.

The key stormwater servicing conclusions and recommendations are as follows:

- The stormwater servicing concept for Bremner and LEA is shown on **Figure E.5**. The proposed servicing concept includes 48 SWMFs and 17 stormwater outfall locations. The drainage catchment areas, ponds and outfall locations are conceptual and may be revised during subsequent design stages.
- Some of the pond outlet systems are interconnected to minimize the number of outfalls required.
- Based on the flood frequency analysis of Pointe-aux-Pins Creek and Oldman Creek, a 3 L/s/ha maximum allowable discharge rate is proposed.
- Based on the previously completed assessment for Oldman Creek by Northwest Hydraulics for the NoY project, a two stage outlet is recommended to be implemented with a maximum of 1 L/s/ha release rate up to a 1:5 year rainfall event and a maximum of 3 L/s/ha for larger rainfall events.
- For water quality enhancement, runoff volume control and additional creek protection from erosion, it is recommended that LID features be encouraged to capture up to 25 mm of total annual rainfall over the development area.
- The opinion of probable cost for the stormwater servicing concepts for Bremner and LEA is approximately $228M not including the upstream neighbourhood stormwater collection system connected to each pond.
- A flood plain assessment for a tributary of Oldman Creek and Pointe-aux-Pins Creek within Bremner indicates three potential flooding areas as shown on **Figure E.6**.
- A limited creek erosion assessment was completed for the Bremner area through observation of reaches of the creeks from public access points and review of historical air photos. The assessment indicates some potential for erosion of the creek banks and valleys and recommends a more detailed assessment of the creeks, avoiding development encroachment of ravines and maintaining predevelopment flows to the creek.
- Complete a more detailed assessment at the time of the first Sub-Area Structure Plan stage so the cost associated with the detailed erosion assessment and the costs of future erosion mitigation measures required within the creek could potentially be shared across the Bremner and LEA areas through a creek erosion levy.



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Legend

- Flooding Area
- Project Boundary

Notes

1. Flood risk map does not include LEA.

Scale

1:30,000

0 250 500 1000 1500m

Client/Project

STRATHCONA COUNTY

BREMNER ACP UTILITIES MASTER PLAN

Figure No.

E.6

Title

100 Year Flood Risk Map

Abbreviations

ACP	Area Concept Plan
ACRWC	Alberta Capital Region Wastewater Commission
ACRWCTP	Alberta Capital Region Wastewater Commission Treatment Plan
ADD	Average Day Demand
AHD	Anthony Henday Drive
BMP	Best Management Practice
CN	Canadian National
CRNWSC	Capital Region Northeast Water Service Commission
GMS	Growth Management Strategy
HGL	Hydraulic Grade Line
HNA	Hydraulic Network Analysis
I/I	Inflow / Infiltration
LEA	Local Employment Area
LID	Low Impact Drainage/Development
MDD	Maximum Day Demand
NERTS	Northeast Regional Trunk Sewer
NoY	North of Yellowhead
NSR	North Saskatchewan River
PAC	Permanent Area Contribution
PRV	Pressure Relief Valve
RR	Range Road
RTC	Real Time Control
SERTS	Southeast Regional Trunk Sewer
SWMF	Stormwater Management Facility
TUC	Transportation Utility Corridor
TWP RD	Township Road

USA	Urban Service Area

1.0 INTRODUCTION

The Bremner Area Concept Plan (ACP) has been proposed to accommodate future urban population growth in Strathcona County. The proposed ACP area is located east of Highway 21, west of Range Road 222, south of Pointe-aux-Pins Creek and north of the Canadian National (CN) Railway. The area between the CN Railway and Highway 16 is also known as the Local Employment Area (LEA) and will primarily be used for industrial development. The rest of the area will be developed as residential and commercial districts. The study area is shown on **Figure 1.1** and has a gross area of 21 km^2 in Bremner and 10 km^2 in LEA.

This draft Utilities Master Plan document addresses onsite and offsite water servicing, wastewater management, and stormwater management concepts which support the overall goals for the community. The report also provides findings of high-level floodplain and erosion control assessments of the creeks within the study area. For stormwater servicing, LID concepts have also been considered. Offsite water and wastewater servicing requirements, staging and/or interim servicing options have also been considered.

This draft report summarizes the onsite and offsite servicing analysis and includes all pertinent information from previously completed reports and data collected for this study, design computations and model results, servicing plans illustrating onsite and offsite servicing requirements, planning level offsite capital costs and the conclusions and recommendations.

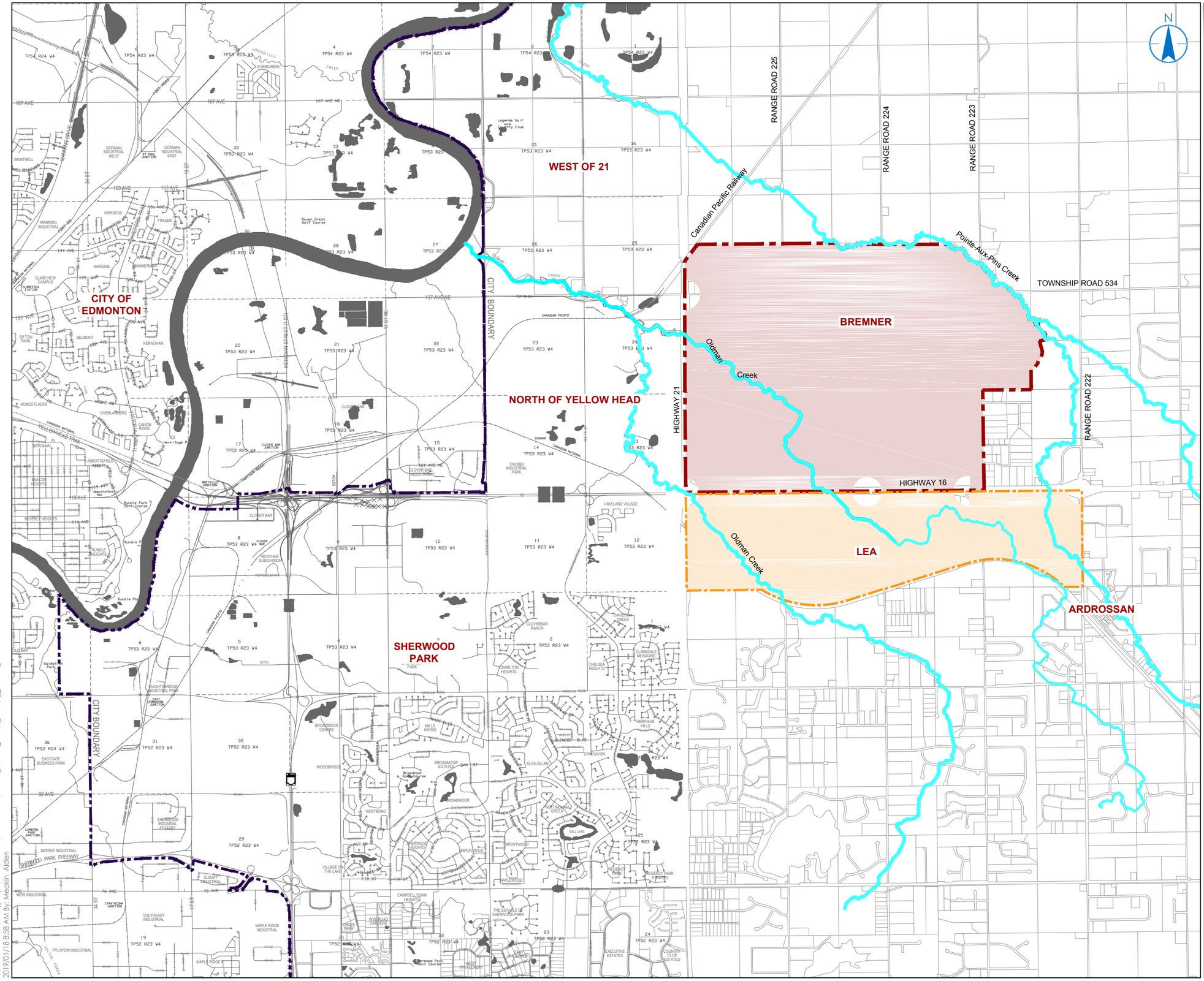
1.1 BACKGROUND

Strathcona County (County) has retained Stantec Consulting Ltd. (Stantec) to update and refine the Bremner Area Concept Plan (ACP). As part of this ACP update, a utilities master plan is required to develop water, wastewater and stormwater drainage servicing plans at a conceptual planning level. This utilities master plan is to define the onsite and offsite servicing requirements as well as the corresponding planning level opinion of probable costs. The utilities master plan also identifies interim serving requirements and an overall implementation plan based on anticipated growth projections.

1.2 PREVIOUSLY COMPLETED REPORTS

The following reports were reviewed to develop an understanding of the previously completed works:

- Technical Memorandum County of Strathcona Bremner Water Demand Analysis, EPCOR, 23 October 2018
- Technical Memorandum Hydraulic Model Update NERTS and SERTS North Wastewater Transmission System – New Option, Model Update and Analysis, GHD, 22 October 2018
- ACRWC Hydraulic Model Update NERTS and SERTS-North Wastewater Transmission System Report, GHD, April 2018
- Capital Region Integrated Growth Management Plan: Final Report on Core Infrastructure, Alberta Infrastructure and Transportation, November 2017
- Bremner Area Concept Plan Biophysical Assessment (Draft), Strathcona County, September 2017
- Capital Region Northeast Water Services Commission Master Plan, Associated Engineering, January 2017
- Strathcona County Facts and Stats 2017, Strathcona County
- Re-imagine, Plan, Build. Edmonton Metropolitan Region Growth Plan Schedules and Tables, Capital Region Board, October 2016



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Legend

- Bremner Boundary
- LEA Boundary

Scale

1:60,000 — 0 600 1800 3000m

Client/Project

STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.

1.1

Title

Study Area

- Strathcona County North of Yellowhead Design Services Utilities Preliminary Design Report, Stantec, August 2016
- Conceptual Sanitary Servicing Options for Bremner, Stantec, July 2016
- Draft Report Bremner Servicing Assessment, Associated Engineering, June 2016
- West of 21 ACP Design Brief, Stantec, October 2014
- Mattamy Cambrian Site: Oldman Creek Erosion Threshold Assessment, Geoprocess Research Associates, October 2014
- Bremner Growth Management Strategy, Strathcona County, September 2014
- Engineering Design Brief Hamlet of Ardrossan, Stantec, March 2014
- Connecting Bremner, Technical Background and Discussion Paper, Strathcona County, November 2013
- Draft Consolidated Report Oldman Creek Erosion and Runoff Study: Hydrotechnical Component, Northwest Hydraulic Consultants Ltd., November 2013

Brief summaries of the relevant findings of these reports are as follows:

Technical Memorandum County of Strathcona Bremner Water Demand Analysis, EPCOR, 23 October 2018

This technical memorandum was prepared by EPCOR to provide commentary on water consumption rates for large scale developments such as Bremner. EPCOR indicated that in their experience the application of the City of Edmonton's design standards can lead to increased infrastructure requirements. In this memo, EPCOR has provided historical water consumption for both Edmonton and Strathcona County for information purposes and recommends that the County conduct it's own analysis.

The memo indicates that EPCOR is observing a declining trend in water consumption per customer in the Edmonton service area since the early 1980's due to water efficient appliances and fixtures. The total average water demand (residential and non-residential) per capita has now dropped slightly below 300 L/c/d. A similar comparison for Strathcona County indicates that the total average daily demand, from 2009 to 2018, has stayed relatively constant despite an increase in population/growth (Sherwood Park's population in 2009 was 61,660, which increased to 71,332 in 2018, according to the County website).

In terms of water consumption rates, EPCOR is suggesting the possibility of reducing the residential water consumption rate in the design standards from the current 250 L/c/d to 220 L/c/d in the near future as the actual average consumption rate is around 175 L/c/d for newer neighbourhoods. For non-residential areas, EPCOR suggests the 2017 average water consumption rate was approximately 4,000 L/ha/d.

The memo provides an estimated average day demand for Bremner and LEA based on the various recorded consumption rates that were reviewed.

Technical Memorandum Hydraulic Model Update NERTS and SERTS North Wastewater Transmission System – New Option, Model Update and Analysis, GHD, 22 October 2018

This technical memorandum was prepared in response to inquiries for the Bremner area servicing in the follow up to the April 2018 NERTS and SERTS North Wastewater Transmission System Report. The memo looked at the option of connecting the proposed Bremner sanitary trunk to SERTS North at TWP RD 535 instead of TWP RD 540.

The simulation results indicate that the proposed twinning of the existing 900 mm pressure main for 960 m would need to be upsized from 900 mm to 1,200 mm for 700 m. The remaining 260 m would be twinned with 900 mm pipe.

Remaining upgrades involved sealing two manholes across Oldman Creek and upsizing an existing 1,500 mm sewer on TWP RD 540 to 2,000 mm to convey NERTS and SERTS North flows to the plant.

Note that the Bremner servicing requirements were analyzed up to 2055. The modeled flows are based on calibration parameters and not based on the County design standards. The ACRWC model also uses a lower growth projection rate for Bremner and other areas.

ACRWC Hydraulic Model Update NERTS and SERTS North Wastewater Transmission System Report, GHD, April 2018

The report provides detailed analysis of the NERTS and SERTS wastewater transmission mains primarily servicing Fort Saskatchewan and Strathcona County, respectively. Based on the hydraulic analysis results, most of the SERTS system appears to have adequate capacity (see Figure 6.11 - 2055 Growth Scenario for the 1:25 year 24 hour rainfall event) with the exception of the 900 mm sewer toward the downstream end of the system. The study appears to have included a significant portion of the Bremner area serviced through the NoY system. The recommended upgrade requirements for the SERTS system are approximately $1.7M. The study also suggests that the County implement an I/I reduction program.

Bremner Area Concept Plan Biophysical Assessment (Draft), Strathcona County, September 2017

The objective of this study was to update the 2014 Biophysical Assessment to reflect the change in land use plan and to provide a finer level of detail for the development of Bremner ACP. The objective of the biophysical assessment is to identify the natural features and their functions and values in order to provide Strathcona County's Council, planners and residents with information to make sustainable planning decisions. The assessment was completed in compliance with Municipal Policy SER-009-032 Biophysical Assessment.

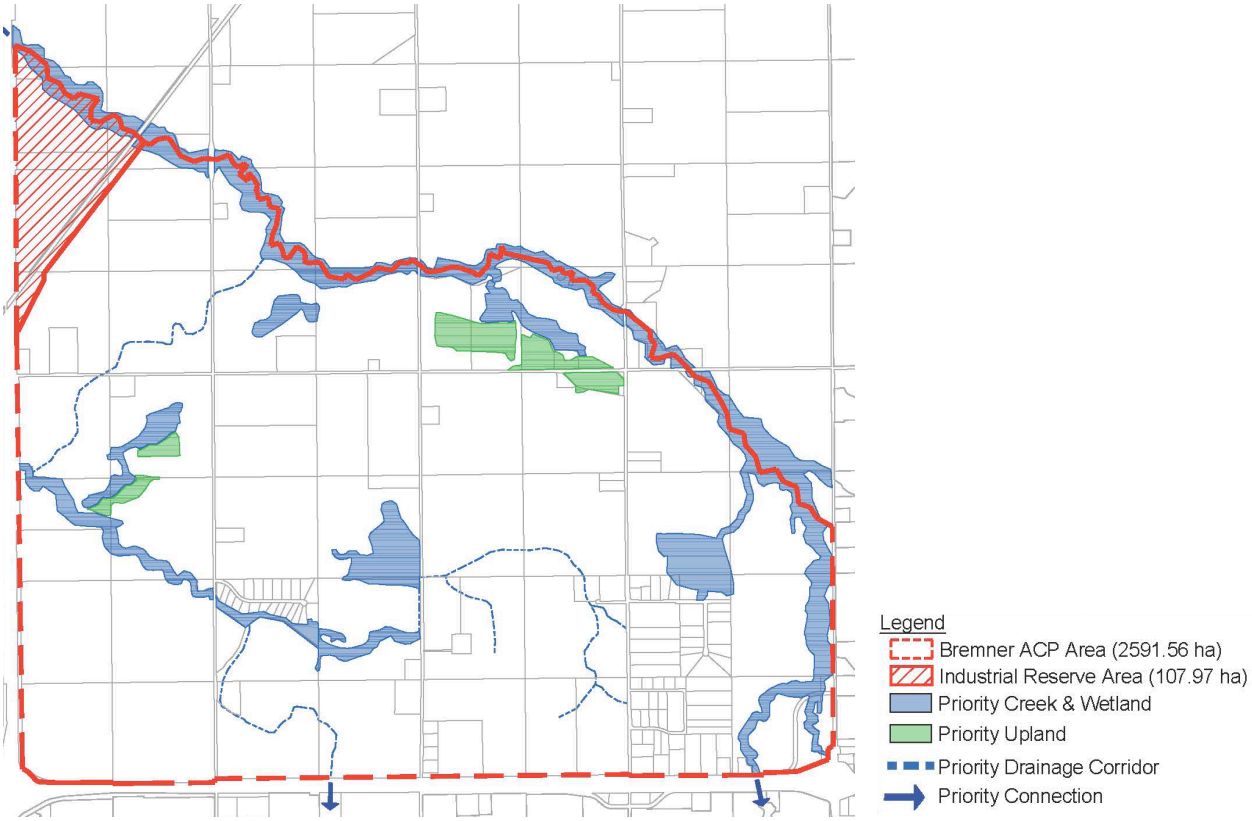
The study was completed based on review of previous environmental reports, review of historical aerial photographs and limited site surveys from publicly accessible locations. The site survey was designed to determine site characteristics, through a floral and faunal survey and habitat identification. The surveys were conducted in August 2017, at which time the plant communities and overall habitat were assessed. Wildlife observations were also completed which included direct visual observations and indirect observations, such as browse and bedding indicators, vocalizations, tracks, and scat.

The key recommendations from the study for conservation planning are:

- A minimum 100 metre setback from the top of bank from Pointe-Aux-Pins Creek should be established for all development.
- Any development proposals near Pointe-Aux-Pins Creek should be accompanied by an ungulate impact study identifying mitigation measures to ensure connectivity across the landscape and decrease human/wildlife interactions.
- A minimum 50 metre setback from the top of bank from Oldman Creek tributary should be established for all development.
- A detailed Biophysical Assessment should be completed prior to planning at the Area Structure Plan level when full land access is available.
- Several wetlands with distinct connections to the creeks and upland habitats were prioritized for conservation. This is a subset of the existing wetlands observed and identified through aerial photographs and provincial mapping. Planning at the Area Structure Plan level will require compliance reporting for both the municipal and provincial wetland policies.

- Several uplands with distinct connections to the creeks and wetland habitats were prioritized for conservation. These uplands should be conserved and integrated into the open space system.
- Incorporating natural landscape features (drainage corridors, wetlands, planted shelter belts) for green infrastructure should be considered.

The study indicates that as per the MDP, top of bank is defined as “the top of a water body’s valley or ravine. Where a bank is not well defined (i.e. in the case of lakes and wetlands) the top of bank shall be equivalent to the 1:100 year floodplain.” The following map identifies priority creek, wetland and upland habitats for conservation based on size, connectivity and diversity.



Capital Region Northeast Water Services Commission 2016 Master Plan, Associated Engineering, January 2017

The purpose of this study was to update the Capital Region Northeast Water Services Commission (CRNWSC) master plan completed in 1992 due to significant growth within its customer base. The CRNWSC services Fort Saskatchewan, Gibbons, Bon Accord, Redwater, Hwy 28/63 Regional Water Service Commission, John S. Batiuk Regional Water Service Commission and private customers in Edmonton, Strathcona County and Sturgeon County. The study also reviewed the potential for servicing Bremner.

The CRNWSC is currently supplied through two main connection points: the City of Edmonton distribution system via a 900 mm diameter main and the Strathcona County distribution system via a 400 mm diameter main. The study indicates that under the current agreement with Strathcona County, the annual quantity is 250 ML (7.9 L/s) with a

peaking factor of 1.8, the maximum supply rate could be 14.2 L/s. This agreement ends in 2021 and after that the supply rate is assumed to be zero. The available pressure at the meter vault is 600 kPa or an HGL of 710.3 m.

Hydraulic assessment for Bremner was completed for 2020, 2025, 2035 and ultimate development (assumes full build out by 2055) conditions for anticipated populations of 1,000, 6,000, 18,000 and 54,000, respectively. It assumes two reservoirs with a westerly reservoir servicing approximately 40% and an easterly reservoir servicing the remaining 60% of the development area. Ultimate Bremner demand was simulated with 2035 CRNWSC demands, which results in the northside 900 mm supply main being at capacity (at a velocity of 1.5 m/s). The study recommendations for Bremner are:

- Upsizing of a proposed 400 mm water main in 2020 to 750 mm from the 900 mm water main to the Westpark Reservoir
- Construct the westerly reservoir and a 400 mm lateral to supply the new reservoir in Bremner by 2020
- Construct a booster station on the existing 400 mm water main to supply Bremner in 2025 and thereafter
- Install a new 600 mm water main from the Westpark Reservoir to connect to the existing 400 mm water main at Highway 21 in 2035
- Twin the existing 400 mm water main with a new 600 mm water main and extend it to the second easterly reservoir in Bremner
- These recommendations are to be reviewed following further Bremner concept development including growth projections

Strathcona County Facts and Stats 2017, Strathcona County

The document provides general information about Strathcona County's vision, economy, etc. along with population, land use, utilities, transportation, and other miscellaneous statistics.

Strathcona County North of Yellowhead Design Services - Utilities Preliminary Design Report, Stantec, August 2016

This report was prepared in support of higher density residential, commercial, and industrial development in the NoY ACP area. As part of this design services project, preliminary and detailed designs for the offsite utility infrastructure for the area were prepared. The NoY area is bounded by Township Road 534 to the north, Highway 16 to the south, Highway 21 to the east, and Range Road 232 to the west. Oldman Creek runs through the eastern part of the area northward to its confluence with the North Saskatchewan River (NSR). At present, the western part of the NoY area is partially developed for industrial use, but most of the remaining area is undeveloped agricultural land. The eastern part of the NoY area is proposed to be primarily residential development.

The objective of this report was to document the preliminary design options for the offsite water, wastewater and stormwater utility infrastructure required to service the NoY area and provide recommendations regarding which options to carry forward for detailed design.

This preliminary design report was first completed in 2013 based on the information available at that time. In this 2016 update of the report, additional options for servicing were added to account for information available from more recent studies indicating changes in the land use plans, population densities and requirements for stormwater discharge into Oldman Creek.

Assessment of Oldman Creek was completed as part of this project by Northwest Hydraulics. The study concluded that the lower part of the reach (~4.5 km) is incising into the terrain at a presently unknown rate. In the upper reach, the erosional process seems to be lateral at a relatively low rate. The study recommended multi-stage outlets over a real time control (RTC) outlet because of cost and reliability considerations. The study also recommended establishing monitoring stations to determine erosion and incision rates to determine if future remediation of the creek will be necessary.

Conceptual Sanitary Servicing Options for Bremner, Stantec, July 2016

This letter report was prepared for a private developer in Bremner. The report provided a conceptual review of the following sanitary servicing options:

- "Bremner Growth Management Strategy Technical Background and Discussion Paper" provided a two trunk connection option to the ACRWC's SERTS line. The south line through West of 21 can be serviced by gravity but servicing of the north area would require a lift station. The report indicates a connection point was considered in the West of 21 ACP design brief but the trunk sewer size needs to be upsized to accommodate Bremner servicing requirements.
- The report indicates an opportunity to service the Bremner area south of TWP RD 534 through the proposed trunk sewer for NoY. The sewer is 900 mm and 9 to 10 m deep. The report suggests that to accommodate the initial development phases of Bremner, the trunk would need to be upsized. The study reviewed four upsizing options to service different service areas and determined incremental upsizing costs and suggests a substantial potential reduction in PAC costs.
- The report also indicates that if the lift station in Cambrian is moved to the west side of the creek, it may be possible to install shallower trunk sewer and further reduce the costs. It indicates that the creek elevations were reviewed, and it may be viable for Bremner to be serviced by a lift station on the west side of Cambrian.

Draft Report Bremner Servicing Assessment, Associated Engineering, June 2016

This report was prepared for Strathcona County to assess the viability of servicing Bremner from the CRNWSC's Southside 400 mm diameter water main that passes through the northeast corner of Bremner. This study was completed in conjunction with the CRNWSC 2016 Master Plan study. The CRNWSC Northside water main is 900 mm diameter and is located approximately 8 km north of Bremner. The assessment was completed based on development in Bremner beginning in 2020 and fully developed by 2055 with a total population of 55,000.

The key study findings were as follows:

- Construction of the southwest reservoir and a 400 mm supply line to the reservoir from the existing CRNWSC's 400 mm main in 2020, along with a 600 mm main parallel to the existing fill line to Fort Saskatchewan's main reservoir from the 900 mm transmission main north of the NSR.
- A booster station is required by 2025 on the CRNWSC's 400 mm main (Bremner population of 6,000).
- By 2035 a second 600 mm diameter feed line from the existing 900 mm main north of the NSR to the second reservoir is required

West of 21 ACP Design Brief, Stantec, October 2014

This report was prepared in support of the West of 21 ACP. The report presents conceptual servicing plans for water, wastewater and stormwater drainage requirements. The proposed development concept primarily consists of light and medium industrial uses over 1,230 ha of land located north of TWS RD 534 and west of Highway 21.

The proposed servicing concept for West of 21 ACP is as follows:

- Wastewater is proposed to flow to the west and connect to the existing 1,500 mm ACRWC SERTS line along RR 232. Downstream of the proposed connection to the 1,500 mm gravity sewer, the sewer becomes a 900 mm diameter pressure pipe. The projected design flow rate is 767 L/s. Some areas south of Pointe-aux Pins Creek are low and require a lift station.
- Stormwater servicing for West of 21 is provided through discharges to the NSR, Pointe-Aux Pins Creek and Oldman Creek. The allowable discharge rate of 4 L/s/ha is used for the NSR and Oldman Creek and 3.07 L/s/ha for Pointe-Aux Pins Creek. SWMFs are designed for the 1:100 year 24 hour rainfall event with 1.5 m of active storage depth. (Note: the 4 L/s/ha discharge rate to Oldman Creek was based on utilization of Real Time Control for discharges to the creek. Subsequent assessment in the NoY Utilities Preliminary Design Report has resulted in revision of the SWMF control strategy for Oldman Creek).
- Water servicing is provided through existing and proposed County distribution system servicing North of Yellowhead and City of Edmonton Aurum Industrial development areas.

Mattamy Cambrian Site: Oldman Creek Erosion Threshold Assessment, Geoprocess Research Associates, October 2014

The objective of this study was to assess the Oldman Creek reach within the Mattamy Cambrian Site for stormwater servicing requirements. The study finds Oldman Creek to be stable and in balance although it suggests the channel to be dynamic with bank erosion and channel migration persisting for much of the length. The channel erosion is limited within valley bottom and not eroding the valley walls. Based on this erosion threshold analysis, threshold discharge rates were established for three stages within Oldman Creek. The study recommends a three stage SWM discharge approach to correlate to erosion potential zones determined in the Oldman Creek cross section.

Bremner Growth Management Strategy, Strathcona County, September 2014

The purpose of this study was to describe and illustrate a vision, community design concept and set of policy directions intended to guide more detailed planning for Bremner. This section lists the high-level servicing concepts presented in the report:

- For onsite water servicing, the report identifies three potential reservoir locations near high points within Bremner. The report indicates that the locations of reservoirs and pipe sizing will need to be confirmed based on a detailed hydraulic analysis.
- For offsite water supply options identified in the *Connecting Bremner, Technical Background and Discussion Paper*, Option 4 is identified as the preferred interim servicing option and Option 1 has been identified as the 'most likely' ultimate servicing option.
- The proposed offsite sanitary trunk through West of 21 could be upsized to service both Bremner and West of 21 service areas.
- For stormwater management servicing, a detailed study is suggested to determine the maximum allowable release rate (e.g. L/s/ha) and allowable average annual discharge volume (mm/year). Limiting the release rate is

required to avoid flooding of the downstream creeks and limiting the annual discharge volume is required to prevent creek erosion.

- The report recommended completing a detailed hydraulic assessment for both Oldman Creek and Pointe-aux-Pins Creek to assess the available capacity to service Bremner under post development conditions.
- The report suggests incorporating bioswales, rain gardens and constructed wetlands to complement or replace conventional stormwater infrastructure to improve the water quality and to reduce the annual volume discharged to the receiving creeks.
- The report suggests defining a minimum 10.0 m wide buffer measured from the top of bank along the ravines for the environmental reserve. The top of bank along the ravines is to be established through field survey. In cases where the bank is not well defined, top of bank is to be determined based on the 1:100 year flood level. The estimation of width for the ER buffer is also to consider slope stability and biophysical analysis in addition to the 1:100 year flood level analysis and the 'top of bank' field survey.

Engineering Design Brief Hamlet of Ardrossan, Stantec, March 2014

This report was prepared for Strathcona County by Stantec in support of an area structure plan update. The objective of the study was to develop water, wastewater, and storm drainage system requirements for two potential development scenarios. As part of the study, a hydrologic analysis for Pointe-aux-Pins Creek was completed to establish the allowable release rate for the proposed developments in the Hamlet of Ardrossan, which is located within the Pointe-aux-Pins Creek's watershed.

The Pointe-Aux-Pins Creek assessment included review of measured creek flow data from 1979 to 2011 from a hydrometric station (5EB902) located on the Pointe-aux-Pins Creek. This was used to complete a flood-frequency analysis using a Log-Pearson Type III distribution. The peak flow rates for the 5, 25 and 100 year return periods were determined to be 3.4 m^3/s, 6.7 m^3/s and 9.6 m^3/s, respectively. These peak flow rates were used to determine an allowable discharge rate of 1.6 L/s/ha for the Pointe-aux-Pins watershed for the 100 year rainfall event. The computed allowable release rate is 3.07 L/s/ha when measured flow data from 1979 to 1997 were used for analysis. The dry period observed in the previous decade resulted in significantly lower measured flow rates in the creek and the corresponding lower allowable release rate. Based on this consideration, the study suggested using an allowable release rate of 3.07 L/s/ha for the future developments within the Hamlet of Ardrossan.

The study also assessed the potential for using various types of LID features, such as rain gardens, bio-swales, green roofs, permeable pavements, box planters, naturalized drainage paths and rainwater harvesting.

Connecting Bremner, Technical Background and Discussion Paper, Strathcona County, November 2013

This technical background and discussion paper identified opportunities and constraints from environmental, existing land uses, servicing infrastructure, transportation infrastructure, and pipeline, rail and highway impacts. This section provides a summary of servicing infrastructure details.

For water servicing, the report presented the following four potential water supply options for the Bremner area:

- Option 1 – From 34 Street Booster Station via TUC/127 Avenue/17 Street NE/TWP RD 534: This option would result in constructing a new water supply main form the existing booster station operated by EPCOR located at the intersection of 34 Street and 92 Avenue in Edmonton. The length of the supply main would be 17.6 km.
- Option 2 – From 34 Street Booster Station via TUC/Highway 628/RR 225/Highway 630/RR 224: This option would also result in constructing a new water main from the EPCOR booster station at 34 Street. For this option,

the water main would be installed south and east of Sherwood Park to reach Bremner. The length of the supply main would be 27.2 km, with a significant portion routed through less intensively developed areas.

- Option 3 – From EPCOR via a New River Crossing: This option would result in installation of a new water supply main originating from either a 600 mm EPCOR water main located north of the Clareview reservoir or a 900 mm Capital Region Northeast Water Service Commission (CRNWSC) water main. The proposed water main would cross the NSR and go east along TWP RD 540 to reach the northeast corner of Bremner. The length of the supply main would be 8.8 km.
- Option 4 – Connection to Existing 400 mm CRNWSC Waterline at Bremner: Under this option water would be supplied from an existing 400 mm CRNWSC water main crossing the northeast area of Bremner. This option does not require any new offsite water main connection provided the existing 400 mm CRNWSC water main has capacity to service Bremner.
- The study suggested two to four onsite potable water reservoirs to service Bremner.

For wastewater servicing, the report suggests connecting to the SERTS along RR 232. SERTS discharges to the Alberta Capital Region Wastewater Treatment Plant (ACRWTP) located on TWP RD 540. North of Yellowhead and West of 21 are also proposed to be developed and are located between Bremner and SERTS along RR 232. The report suggests two new sanitary trunks through West of 21 to service Bremner through SERTS. Due to the topographic constraint posed by Pointe-aux-Pins Creek, installing an offsite trunk along TWP RD 540 to the ACRWTP was considered to be not desirable as it would require pumping, a siphon or a tunnel to service Bremner.

Stormwater servicing for Bremner is to be provided by discharging flows to Oldman Creek or Pointe-aux-Pins Creek. Stormwater management can be provided by engineered wetlands and wet ponds, LID measures and minimization of impervious surfaces. The report identified numerous potential locations for Stormwater Management Facilities (SWMFs) and outlet locations based on the existing topography.

Draft Consolidated Report Oldman Creek Erosion and Runoff Study: Hydrotechnical Component, Northwest Hydraulic Consultants Ltd., November 2013

This report provides a morphologic and hydrotechnical assessment of the lower 12 km reach of Oldman Creek. This study was done as part of the North of Yellowhead (NoY) project. The key report findings are:

- Oldman Creek has meander bends in most of its reaches with meander wavelength ranging from 40 m to 100 m and sinuosity ranging from 1.2 to 1.9.
- The study found conclusive evidence that the creek is incising into the terrain by a process of head cutting in the 5 km reach upstream of the confluence point at the North Saskatchewan River. This vertical downcutting shows visible lateral instability (e.g. slumping banks and valley slopes) at certain locations.
- In the remainder of the upstream reaches studied, erosion is observed at the outer bank of meander bends. However, historical aerial photos revealed no significant lateral movement over the past 50 years.
- The study recommended monitoring future erosion by installing stakes at both banks and terrain above valley slopes at selected erosion prone sites.
- The study did not make any specific recommendation(s) on erosion protection in the creek as such measures will depend on erosion monitoring results.
- The study did not make any specific recommendation(s) on setback distance from the top of bank for development activities; it recommended geotechnical assessment for such delineation.
- A previous study conducted by Sameng in 2006 set 0.75 m^3/s as a threshold flowrate to avoid erosion along Oldman Creek. A continuous hydrologic model completed using HSPF showed that the flowrate will exceed 0.75 m^3/s five percent of the time for the existing development condition.

The study determined pond volumes for the NoY project for two scenarios: (1) the NoY development area release rate of 4.0 L/s/ha using conventional orifice-controlled SWMFs and (2) the NoY release at variable rates so that the total flowrates at Oldman Creek do not exceed 0.75 m^3/s using Real Time Control (RTC) enabled SWMFs. In Scenario 1, the flowrate in Oldman Creek exceeds 0.75 m^3/s occasionally. The conventional SWMFs (Scenario 1) needs a storage volume of 186,000 m^3 based on continuous hydrologic modeling. RTC enabled SWMFs (Scenario 2) needs a storage volume of 630,000 m^3. The study recommended exploring multi-stage orifice-controlled SWMFs to achieve a similar result as the RTC system. In a document entitled "North of Yellowhead Design Services Utilities Preliminary Design Report" published in August 2016 by Stantec it concluded that a multistage control orifice would be the most desirable solution to better match the pre-development release rate, since it would have a smaller release rate during frequent rainfall events. A two orifice outlet system was recommended by Stantec, where the first orifice is sized to control at 1:2 year or 1:5 year predevelopment discharge rate of 0.3 L/s/ha or 0.5 L/s/ha to the creek, respectively. While the second orifice installed at a higher level to provide a combined 4.0 L/s/ha discharge rate for the 1:100 year rainfall event.

1.3 DESIGN MANUALS AND STANDARDS

The following design manuals were reviewed to establish servicing standards:

- Strathcona County Design Standards, Urban Service Area, Strathcona County, December 2011
- Strathcona County Design and Construction Standards, Summary of Revisions 2017, October 2017
- Strathcona County Design and Construction Standards, Summary of Revisions 2015, November 2015
- Strathcona County Best Management Practices for Stormwater Management Facilities, June 2016
- Alberta Capital Region Wastewater Commission Trunk Connection Guidelines, October 2014
- Design and Construction Standards, Volume 4, Water, EPCOR, January 2013
- Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, Parts 1 and 2, Standards for Municipal Waterworks, Alberta Government, April 2012
- Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, Part 3, Wastewater Systems Standards for Performance and Design, Alberta Government, March 2013
- Standards and Guidelines for Municipal Waterworks, Stormwater Management Guidelines, Part 5, Alberta Government, March 2013
- Low Impact Development Best Management Practices Design Guide, City of Edmonton, December 2014

1.4 SCOPE OF WORK

The scope of work for this utilities master plan includes:

- Development of a concept level onsite and offsite utilities master plan for water, wastewater and stormwater drainage systems
- Prepare a conceptual design for offsite water and wastewater services
- Determine concept level 1:100 year flood level and erosion assessments for the main creeks within the study area
- Develop LID standards for incorporating in the ACP

The above scope of work has been completed through review of the previous works, meetings with EPCOR and ACRWC for offsite water and wastewater servicing requirements, and discussions with the County's planning and utilities staff.

2.0 STUDY DATA

This section provides a summary of the available data and information used to develop the utilities master plan for Bremner and LEA.

2.1 EXISTING DEVELOPMENT CONDITION

The existing development in the Bremner area can be seen on **Figure 1.1**. As seen on **Figure 1.1**, the ACP area is primarily used for agriculture purposes. In addition to the agricultural uses, there are two pockets of existing country residential development, a small industrial development in Bremner and two small pockets of commercial land use in the LEA. There are also some buried pipelines in the northwest corner of Bremner, a pipeline running across the study area north of Highway 16 and a wastewater forcemain servicing Ardrossan running parallel to CN rail through the LEA area.

2.2 EXISTING TOPOGRAPHY AND DRAINAGE

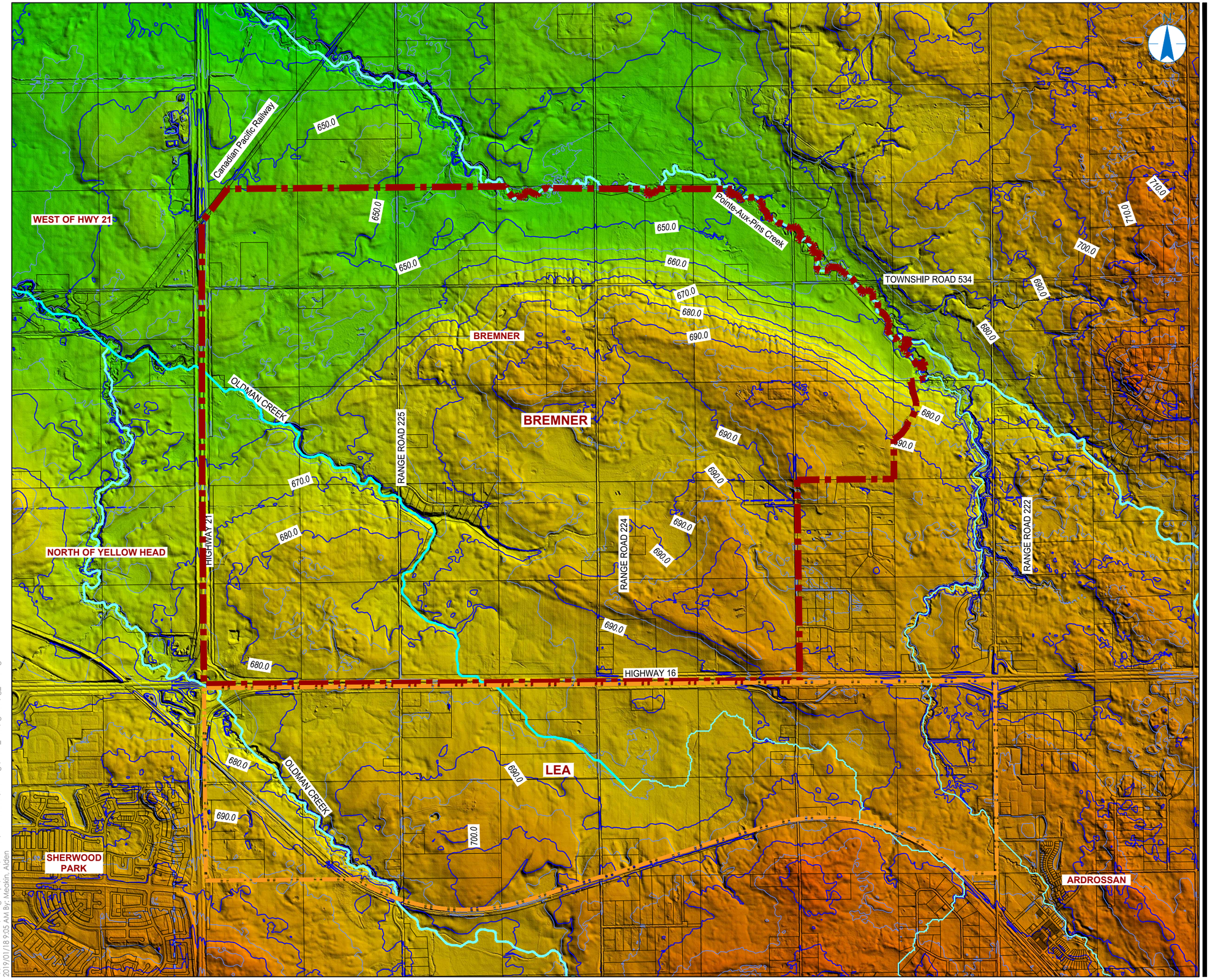
The study area topography and existing drainage are shown on **Figure 2.1**. As shown on **Figure 2.1**, the topography within the Bremner boundary varies from hummocky with high relief to gently undulating slopes. The elevation ranges from approximately 705 m to 635 m with a ridge located between the two creeks. The study area in general slopes in a northwesterly direction. Higher elevations are observed at the southeast and east areas of the ACP where elevations are typically greater than 685 m. The lower elevations are in the northwest part of Bremner, where the lowest elevation is approximately 635 m in the creek channel, while the lowest developable area elevation is approximately 645 m. Some steep slopes are observed along the banks of the creeks.

The study area drains through Oldman Creek and Pointe-aux-Pins Creek and their tributaries. The south portion of the study area is part of the Oldman Creek watershed and the north portion is part of the Pointe-aux-Pins Creek watershed.

Oldman Creek originates north of Cooking Lake and discharges water to the North Saskatchewan River close to TWP RD 534. The gross drainage area of this creek was delineated to be approximately 130 km^2 using 3.0 m LiDAR data. A tributary of Oldman Creek originates in the LEA and then crosses the Bremner area and merges with Oldman Creek west of Hwy 21. Approximately 13.3 km^2 of the Bremner area drains through this Oldman Creek tributary.

The Pointe-aux-Pins Creek also originates north of Cooking Lake and discharges water to the North Saskatchewan River close to TWP RD 543. The effective drainage area of this creek is 120 km^2 and the watershed area within Bremner is approximately 28.8 km^2. A hydrometric station operated by Environment Canada (Station ID 05EB902) is located on Pointe-aux-Pins Creek at the crossing of TWP RD 534.

Figure 2.2 shows the watershed boundaries and portion of the study area draining through both creeks.



Stantec
400-10220 103 Avenue NW
Edmonton AB
www.stantec.com

Scale
0 250 500 1000 1500m
1:30,000

Client/Project
STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.
2.1

Title
Existing Topography and Drainage

FORT SASKATCHEWAN

NORTH SASKATCHEWAN RIVER

POINTE-AUX-PINS CREEK

HWY 21

TWP RD 540

WEST OF 21

TWP RD 534

STATION: 05EB902

CITY OF EDMONTON

NORTH OF YELLOW HEAD

BREMNER

HWY 16 (YELLOW HEAD TRAIL)

LEA

NORTH SASKATCHEWAN RIVER

OLDMAN CREEK

HWY 21

SHERWOOD PARK

CITY OF EDMONTON BOUNDARY

STRATHCONA COUNTY BOUNDARY

N

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Legend

- Area Boundary
- County/City Boundary
- Watershed Boundary
- Subwatershed Boundary
- Creek
- Tributaries
- Bremner Project Boundary
- LEA Boundary

Scale

1:100,000

0 1000 3000 5000m

Client/Project

STRATHCONA COUNTY

BREMNER ACP UTILITIES MASTER PLAN

Figure No.

2.2

Title

Oldman Creek and Pointe-Aux-Pins Creek Watershed Boundaries

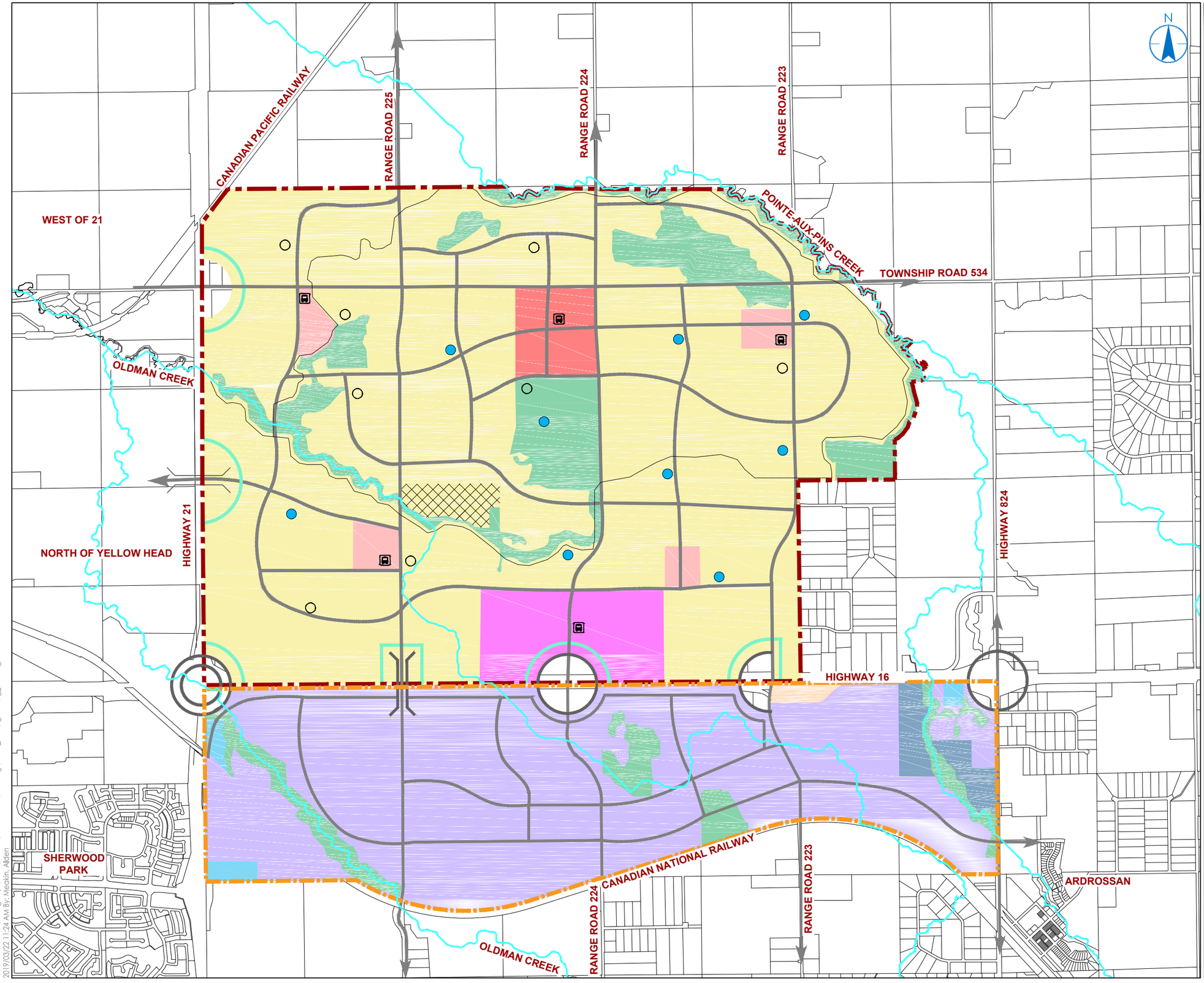
2.3 PROPOSED LAND USE

The proposed land uses in Bremner are shown on **Figure 2.3** and land use statistics are summarized in **Table 2.1**.

Table 2.1 Bremner Land Use Statistics

Land Use	Area (ha)
Gross Area	**2,108.52**
Existing Country Residential	21.51
Future Highway / Interchange Dedication	46.50
Priority Wetland and Creek ER	199.48
Additional ER / Crown Claimed at ASP	44.92
Total Non-Developable	**312.41**
Net Developable Area	**1796.11**
Town Centre Policy Area	**52.95**
…Commercial	*27.33*
…Public Service /Community Service	*7.4*
…Residential	*18.22*
Village Centres Policy Area (Total of 4)	**49.10**
…Commercial	*22.42*
…Community Service/ Public Service	*7.72*
…Recreation Centre and Open Space - MR	*4.00*
…Residential	*14.96*
Community Nodes (total of 17)	**88.44**
…Joint Site Primary School - MR	*29.16*
…Joint Primary School /Recreation Facility - MR	*4.86*
…Joint Primary School/Community Service - MR	*21.24*
…High School/Recreation Centre MR	*25.26*
…Residential	*3.96*
…Commercial	*3.96*
Priority Open Space	**82.18**
…Regional Park - MR	*30.28*
…Priority Uplands	*44.92*
…Major Open Space Corridor - MR	*6.98*
Business Park Policy Area	**97.35**
…Public Service/ Community Service	*15.65*
…Business Employment	*81.70*
Residential Policy Area	**816.07**
…Residential	*729.88*
…Parks and Trails - MR	*79.19*
…Community Commercial	*7.00*
Stormwater Management	**130.72**
Reservoirs	**2.00**
Street network (excluding Arterial Streets)	**373.49**
Arterial Street Right-of-Way	**103.81**

The projected Bremner area population based on various residential land uses is summarized in **Table 2.2**.



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LEGEND

- Transit Terminal/Transit Transfer Facility
- Interchanges Subject to Alberta Transportation Approval
- Flyover
- Gateways
- Bermner Project Boundary
- LEA Boundary

Community Node Policy Area

- Primary Community Node
- Secondary Community Node
- Industrial Area
- Environmental Features
- Major Open Space Corridor
- Neighborhood Policy Area
- Existing Country
- Commercial Area
- Town Centre Policy Area
- Community Service
- Major Public Services
- Business Park Policy Area
- Village Centre Policy Area

Scale

1:30,000 — 0 250 500 1000 1500m

Client/Project
STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.
2.3

Title
Proposed Land Uses

Table 2.2 Bremner Population Projection

Residential Uses	Area (ha)	Percentage of Total	Dwelling Units/ha	Dwelling Units	People / Dwelling Unit	Population
Single/Semi	378.00	49.3%	25	9,450	2.8	26,460
Row-house/townhouse	337.34	44.0%	45	15,180	2.8	42,505
Mid-rise Apartment	37.00	4.8%	90	3,330	1.8	5,994
Mixed Use Residential	5.55	0.7%	125	694	1.5	1,041
High-rise	9.11	1.2%	225	2,050	1.5	3,075
TOTAL	767.00	100.0%		30,704		79,074
Density - Dwelling Units Per Net Residential Hectare (du/nrha)						40.03

The projected land use statistics for the Local Employment Area (LEA) are summarized in **Table 2.3**. The LEA is located within the Rural Service Area of the County and as a result, the majority of development is anticipated to be large lot industrial and warehousing type usage.

Table 2.3 LEA Land Use Statistics

Land Use	Area (ha)
Gross Land Area	**969.62**
Existing Major Public Service	31.12
Existing Commercial	2.91
Existing Major Community Service	13.36
Future Highway / Interchange Dedication	31.85
Arterial Street Right-of-Way	86.6
Rail Right-of-Way	13.73
Priority Environmental Reserve	81.4
Additional ER/ Crown Claimed	-
Total Non-Developable	**260.97**
Net Developable Area	**708.65**
Stormwater Management	
Street Network (excluding Arterial Streets)	
Industrial	651.45
Major Public Service	**21.87**
…Large Operations Yard	12.77
…Snow-melt facility	9.10
Priority Open Space - MR	13.46
Remaining MR (Cash-in-Lieu)	57.41

2.4 POPULATION PROJECTION FOR BREMNER

The Strathcona County population is expected to grow at approximately 1.79% based on the 2012 to 2017 average growth rate trend in the County (Strathcona County Facts and Stats 2017). Based on this anticipated growth rate, the population projections are summarized in **Table 2.4** from 2015 to 2060. The development in Bremner is expected to start in 2023 and full development is expected to be reached in 2060, i.e. full build out is expected 38 years after commencement. The full development population is expected to reach 79,074. The population growth projections have been projected from the 2015 municipal census population of 95,597 for the County.

The growth split among various service areas within the County was determined in consultation with the County's Planning Department as indicated below:

- 85% of the County growth is allocated to urban service areas in 2016 to 2045, and 99.25% from 2046
- 15% of the County growth is allocated to rural service areas in 2016 to 2045 and 0.75% from 2046
- Assumes hamlets build out by 2045, growth allocation approximately 14.25%
- Cambrian area development to start in 2021 and be completed by 2037

Based on the above, the population of Bremner in 2044 is projected to be 29,070.

Table 2.4 Population Growth Projections

Year	Total County Population	Urban Growth (85%)	Rural Growth (15%)	Hamlets (Build out at 2045)	Bremner	Cambrian	Other Sherwood Park Urban Areas
2015	95,597						
2016	97,308	1,455	257	244			1,455
2017	99,050	2,935	518	492			2,935
2018	100,823	4,442	784	745			4,442
2019	102,628	5,976	1,055	1,002			5,976
2020	104,465	7,538	1,330	1,264			7,538
2021	106,335	9,127	1,611	1,530		397	8,730
2022	108,238	10,745	1,896	1,801		802	9,943
2023	110,176	12,392	2,187	2,077	412	1,214	10,767
2024	112,148	14,068	2,483	2,358	831	1,633	11,605
2025	114,155	15,774	2,784	2,645	1,684	2,486	
2026	116,198	17,511	3,090	2,936	2,552	3,354	
2027	118,278	19,279	3,402	3,232	3,436	4,238	
2028	120,396	21,079	3,720	3,534	4,336	5,138	
2029	122,551	22,911	4,043	3,841	5,252	6,054	
2030	124,744	24,775	4,372	4,154	6,184	6,986	
2031	126,977	26,673	4,707	4,472	7,133	7,935	
2032	129,250	28,605	5,048	4,796	8,099	8,901	
2033	131,564	30,572	5,395	5,125	9,083	9,884	
2034	133,919	32,574	5,748	5,461	10,084	10,885	
2035	136,316	34,611	6,108	5,802	11,102	11,904	

Study Data

Year	Total County Population	Urban Growth (85%)	Rural Growth (15%)	Hamlets (Build out at 2045)	Bremner	Cambrian	Other Sherwood Park Urban Areas
2036	138,756	36,685	6,474	6,150	12,139	12,941	
2037	141,240	38,796	6,846	6,504	13,195	13,997	
2038	143,768	40,945	7,226	6,864	15,344		
2039	146,341	43,133	7,612	7,231	17,531		
2040	148,961	45,359	8,005	7,604	19,758		
2041	151,627	47,626	8,405	7,984	22,024		
2042	154,341	49,933	8,812	8,371	24,331		
2043	157,104	52,281	9,226	8,765	26,680		
2044	159,916	54,671	9,648	9,165	29,070		
2045	162,779	57,104	10,077	9,573	31,503		
2046	165,692	59,996	10,099	9,573	34,395		
2047	168,658	62,940	10,121	9,573	37,339		
2048	171,677	65,936	10,144	9,573	40,335		
2049	174,750	68,986	10,167	9,573	43,385		
2050	177,878	72,091	10,191	9,573	46,490		
2051	181,062	75,251	10,214	9,573	49,650		
2052	184,303	78,468	10,239	9,573	52,866		
2053	187,602	81,742	10,263	9,573	56,141		
2054	190,961	85,075	10,289	9,573	59,474		
2055	194,379	88,468	10,314	9,573	62,866		
2056	197,858	91,921	10,340	9,573	66,319		
2057	201,400	95,436	10,367	9,573	69,835		
2058	205,005	99,014	10,394	9,573	73,413		
2059	208,674	102,656	10,421	9,573	77,055		
2060	212,410	106,363	10,449	9,573	80,762		

3.0 WATER SERVICING CONCEPT

This section provides the onsite and offsite water servicing concept plan. The offsite system includes water supply options to Bremner through various connection point locations. Interim supply options to Bremner have also been discussed. The onsite water servicing plan includes the water distribution system consisting of reservoirs and pump stations, and the distribution system network within the Bremner ACP.

The proposed distribution system includes the main potable water supply system for the LEA. The LEA is located within the Rural Service Area as opposed to the Urban Service Area of the County. It is also identified within the Rural Area of the Edmonton Metropolitan Region Growth Plan; therefore, an urban level of service is not required. The County currently has a substantial industrial land supply that requires urban service levels located in the North of Yellowhead and West of 21 areas. Through consultation it was also noted that the majority of the development is anticipated to be large lot industrial and warehousing with low water usage. As higher intensity uses are not anticipated, it was determined early in the ACP process that a rural water standard and onsite fire suppression would be suitable for the area.

Hence within the LEA, the local distribution system will be based on a commercial/industrial rural water servicing system, similar to a trickle feed system with on-lot cistern storage typical for rural residential developments and there will be no fire water supply as private onsite fire suppression systems will be installed by property owners.

3.1 DESIGN STANDARDS

For the development of the water supply concepts for the Bremner area, the Strathcona County design standards were used. The following sections provide a summary of the key design criteria used for the development of the onsite and offsite water servicing concepts.

3.1.1 Strathcona County Design Standards

For the computation of the onsite and offsite residential water demands, the following water consumption rates were used:

- Average Day Demand (ADD): 300 L/person/day
- Maximum Day Demand (MDD): 600 L/person/day (MDD Peaking Factor = 2.0 X ADD)
- Peak Hour Demand (PHD): 900 L/person/day (PHD Peaking Factor = 3.0 X ADD)

For commercial/industrial water demands for the urban service area:

- 20,000 L/ha/day (for preliminary planning purposes; for site specific design, the consumption rate is to be reviewed on a case-by-case basis)

Note: The County Standards for commercial/industrial area only identify a water consumption rate of 20,000 L/ha/day without indicating type of demand or peaking factors. For purposes of this study, the following water consumption rates were used for the commercial/industrial area:

- Average Day Demand (ADD): 10,000 L/ha/day
- Maximum Day Demand (MDD): 20,000 L/ha/day (MDD Peaking Factor = 2.0 X ADD)
- Peak Hour Demand (PHD): 20,000 L/ha/day (PHD Peaking Factor = 2.0 X ADD)

As currently there are no standards for non-residential rural service areas, water will be supplied at an average day demand rate of 10,000 L/ha/day for the LEA area. Utilization of this water consumption rate allows flexibility in terms of varying types of businesses to locate within the LEA. Unlike urban service areas, peaking factor, fire flow and looping requirements are excluded for rural service areas. However, in the future when non-residential rural servicing standards are developed by the County, the distribution main sizing within the LEA could be adjusted accordingly.

For comparison, Leduc County uses a water consumption rate of 4,300 L/ha/day for Nisku with MDD and PHD peaking factor of 2.0 and 3.0, respectively. However, since Nisku is an urban service area, the water main sizing is dictated by fire flow requirements and any significant variation in water consumption requirements among business can be easily accommodated.

The County Standards identify the following fire demands for various land uses for the maximum day demand scenario:

- Single Family Residential: 100 L/s (R1A, R1B, R1C land uses)
- Mid Value Multi-Family: 180 L/s (R2A, R2B and R3 land uses)
- High Value: 250 L/s (for R4, R5, Commercial and Industrial land uses)

For the purpose of this utilities master plan study, the fire flow analysis was conducted for 250 L/s at all node locations as the ACP doesn't identify different types of residential land uses.

Other Design Criteria:

- Hazen Williams "C" factor: 120
- Maximum flow velocity: 3.0 m/s
- Normal operating pressures:
  - Average day, maximum day and peak hour scenarios: 350 kPa (50 psi) to 700 kPa (100 psi)
  - Fire flow demand minimum residual pressure 140 kPa at ground level
  - For rural commercial/industrial service area, a minimum pressure requirement of 140 kPa is used as per the County's rural residential service area requirement.
- Water main sizes:
  - For residential: minimum 200 mm diameter (150 mm for cul-de-sacs without a hydrant connection)
  - For commercial / industrial: 300 mm diameter (except for LEA)

3.1.2 Other Standards

The following criteria have been used in sizing the offsite water main in addition to the standards mentioned above:

- The offsite transmission main is sized to supply the maximum day demand
- A minimum pressure of 140 kPa is maintained at the reservoir
- The maximum velocity for the transmission main is 1.5 m/s.

3.2 OFFSITE WATER SERVICING PLAN

This section provides a detailed offsite servicing plan for the proposed Bremner ACP. Offsite servicing includes water supply and onsite potable water storage requirements for interim and ultimate development conditions. For ultimate offsite water servicing, the following three water supply tie-in options were identified:

- Option 1: EPCOR North – Clareview Reservoir – supply from northeast Edmonton via connection to either Clareview Reservoir or a nearby transmission main
- Option 2: EPCOR South – 34 Street and 92 Avenue – supply from the existing County connection point in southeast Edmonton
- Option 3 – Northeast Water Service Commission (CRNWSC) System – Supply from existing and future infrastructure near Fort Saskatchewan

Options 2 and 3 were identified in the previously completed Bremner Growth Management Strategies studies. Option 1 was identified as it provides the County an independent secondary feed and a more direct connection to the EPCOR system. Based on consultation with the County, Option 3 was eliminated due to concerns that the CRNWSC infrastructure upgrade requirement would significantly impact the current rate structure.

The subsequent sections provide details of offsite servicing for Options 1 and 2. Assessment of these options consisted of the following steps:

- Determination of water supply requirements
- Hydraulic analysis of the offsite transmission main
- Consultation with EPCOR

3.2.1 Water Supply Requirements

EPCOR Water (EPCOR) supplies water to the City of Edmonton and surrounding regional municipalities including Strathcona County through an integrated water distribution network. Some of the distribution networks are operated by regional water service commissions which supply water to their regional customers.

In order to determine the viability of potential supply options, water demand estimates were required by EPCOR. The demand computations are summarized in **Table 3.1**. Strathcona County receives its water supply from EPCOR at 34 Street and 92 Avenue at a specific pressure. From this tie-in connection point, the County boosts pressure and transmits the water to various water reservoirs. The County also supplies water to the Highway 14 Regional Water Services Commission (Hwy14RWSC) and some flow to John S. Batiuk Regional Water Commission (JSBRWC). Most of the JSBRWC flow is now supplied by the Capital Region Northeast Water Service Commission (CRNWSC) and County water supply to JSBRWC commission is expected to stop by 2021.

For the County, Bremner ACP and the surrounding regional water service commission demand estimates for water supply requirements were determined as summarized in **Table 3.1** and **Table 3.2**, based on the County and EPCOR design standards' water consumption rates, respectively. As per EPCOR's request, demand projections for all of the County service areas are included for their network system analysis. The demands were computed for 2044 and ultimate development (2060 when full development in Bremner is anticipated) conditions. EPCOR will assess their internal supply network (within Edmonton) to meet the future demand requirements from the two primary alternate tie-in connection points: transmission main at or near Clareview Reservoir and 34 Street and 92 Avenue. The intermediate demand projection (2044) is required by EPCOR to assess approximately when upgrades within their system may be required.

The Bremner ACP includes servicing of LEA using rural standards. The population projections are based on **Table 2.4**. In absence of growth projections for non-residential service areas, for non-residential service areas within Bremner, LEA, North of Yellowhead and West of 21, demand projections were developed based on the population projections for Bremner and assumes full development by 2060. The North of Yellowhead and West of 21 areas will be serviced by the existing County supply and distribution systems.

Table 3.1 Water Demands for Strathcona County (Based on County Standards)

Service Area	Population	Residential Service Area (ha)	Non-Residential Service Area (ha)	Total Service Area (ha)	Average Day Res. Demand (L/s)	Average Day Non-Res Demand (L/s)	Total ADD (L/s)	MDD (L/s)
2044 Demands								
Bremner	29,070	282.0	95.5	377.4	101	11	112	224
LEA			269.7	269.7	0	31	31	31
Sub-Total Bremner/LEA	**29,070**	**282.0**	**365**	**647**	**101**	**42**	**143**	**255**
County USA	85,432	n/a	1067.3	n/a	297	124	420	840
NoY	13,634	n/a	131.2	n/a	47	15	63	125
West of 21			188.4	188.4	0	22	22	44
HW14RWSC	12,500	n/a		n/a	43	0	43	87
Sub-Total at 34 St/92 Ave	**111,566**	**n/a**	**1,387**		**387**	**161**	**548**	**1,096**
Total 2044	**140,636**	**n/a**	**1,752**		**488**	**203**	**691**	**1,351**
Ultimate (2060)								
Bremner	79,074	767.0	259.7	1026.7	275	30	305	609
LEA			733.5	733.5	0	85	85	85
Sub-Total Bremner/LEA	**79,074**	**767.0**	**993**	**1,760**	**275**	**115**	**390**	**694**
County USA	85,432	n/a	1067.3	n/a	297	124	420	840
NoY	13,634	n/a	357.0	n/a	47	41	89	177
West of 21			512.4	512.4	0	59	59	119
HW14RWSC	13,581	n/a		n/a	47	0	47	94
Sub-Total at 34 St/92 Ave	**112,647**	**n/a**	**1,937**		**391**	**224**	**615**	**1,231**
Total 2060	**191,721**	**n/a**	**2,930**		**666**	**339**	**1,005**	**1,925**

Note: Strathcona County Standards: Residential Water Consumption Rate at 300 L/c/d, Non-Res Water Consumption Rate at 10,000 L/d/ha and Maximum Day Demand at two times ADD

Table 3.2 Water Demands for Strathcona County (Based on EPCOR Standards)

Service Area	Population	Residential Service Area (ha)	Non-Residential Service Area (ha)	Total Service Area (ha)	Average Day Res. Demand (L/s)	Average Day Non-Res Demand (L/s)	Total ADD (L/s)	MDD (L/s)
2044 Demand								
Bremner	29,070	282.0	95.5	377.4	84	11	95	162
Local Employment Area			269.7	269.7	0	31	31	31
Sub-Total Bremner/LEA	**29,070**	**282.0**	**365**	**647**	**84**	**42**	**126**	**193**
County Urban Service Area	85,432	n/a	1067.3	n/a	247	124	371	630
NoY Area	13,634	n/a	131.2	n/a	39	15	55	93
Non-Residential West of 21 Area			188.4	188.4	0	22	22	37
Hyw 14 RWSC	12,500	n/a		n/a	36	0	36	61
Sub-Total 34 St./92 Ave	**111,566**	**n/a**	**1,387**		**323**	**161**	**483**	**822**
2044 Total Demand	**140,636**	**n/a**	**1,752**		**407**	**203**	**610**	**1,015**
Ultimate (2060)								
Bremner	79,074	767.0	259.7	1026.7	229	30	259	440
Local Employment Area			733.5	733.5	0	85	85	85
Sub-Total Bremner/LEA	**79,074**	**767.0**	**993**	**1,760**	**229**	**115**	**344**	**525**
County Urban Service Area	85,432	n/a	1067.3	n/a	247	124	371	630
NoY Area	13,634	n/a	357.0	n/a	39	41	81	137
Non-Residential West of 21 Area			512.4	512.4	0	59	59	101
Hyw 14 RWSC	13,581	n/a		n/a	39	0	39	67
Sub-Total 34 St./92 Ave	**112,647**	**n/a**	**1,937**		**326**	**224**	**550**	**935**
Ultimate Total Demand	**191,721**	**n/a**	**2,930**		**555**	**339**	**894**	**1,460**

Note: EPCOR Standards: Residential Water Consumption Rate at 250 L/c/d, Non-Res Water Consumption Rate at 10,000 L/d/ha and Maximum Day Demand at 1.7 times ADD)

Table 3.3 summarizes the demand forecast for the CRNWSC. The population for the CRNWSC was adopted from the CRNWSC 2016 Master Plan study report. The study provides the population and demand projections to 2035. For the purpose of this study, population and demands were extrapolated to years 2044 and 2060 to match the Strathcona County demand projection timelines. The demands for the CRNWSC are to be used by EPCOR for their internal supply network system assessment for the Clareview Reservoir supply option because CRNWSC is also supplied through Clareview Reservoir.

Table 3.3 Water Demand for CRNWSC

Development Scenario	CRNWSC Service Population	ADD (L/s)	MDD (L/s)
2044	111,559	359	646
2060	147,709	474	852

Based on the demand forecast in **Table 3.1** and **Table 3.2** for Strathcona County and **Table 3.3** for CRNWSC, total demand estimates for EPCOR were determined as indicated in **Table 3.4** and **Table 3.5** based on the County and EPCOR design standards. These tables were prepared at the request of EPCOR for their network system analysis and represent overall demand forecast for the two supply options.

Table 3.4 EPCOR Water Supply Requirements (County Standards)

Bremner Area Connection Point	Demand Year	Average DD (L/s)			Maximum DD (L/s)		
		Demand @ CRNWSC	Demand @ 34 St. & 92 Ave.	Clareview Reservoir / EPCOR Transmission	Demand @ CRNWSC	Demand @ 34 St. & 92 Ave.	Clareview Reservoir / EPCOR Transmission
Option 1 - EPCOR North (Clareview Reservoir or EPCOR Transmission)	2044	359	548	143	646	1,096	255
	2060	474	615	390	852	1,231	694
Option 2 - EPCOR South (34 Street and 92 Avenue)	2044	359	691	0	646	1,351	0
	2060	474	1,005	0	852	1,925	0

Table 3.5 EPCOR Water Supply Requirements (EPCOR Standards)

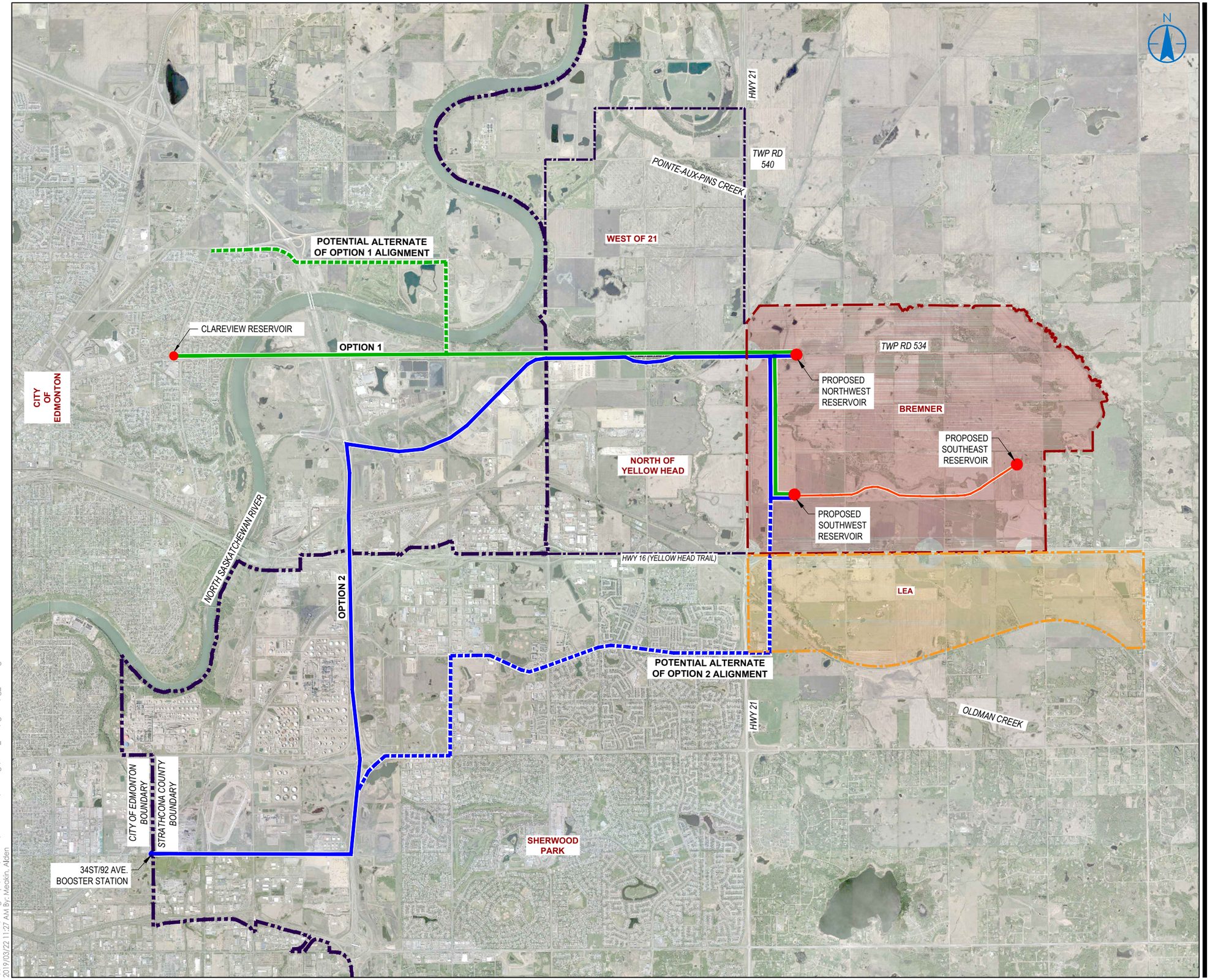
Bremner Area Connection Point	Demand Year	Average DD (L/s)			Maximum DD (L/s)		
		Demand @ CRNWSC	Demand @ 34 St. & 92 Ave.	Clareview Reservoir / EPCOR Transmission	Demand @ CRNWSC	Demand @ 34 St. & 92 Ave.	Clareview Reservoir / EPCOR Transmission
Option 1- EPCOR North (Clareview Reservoir or EPCOR Transmission)	2044	359	483	126	646	822	193
	2060	474	550	344	852	935	525
Option 2 - EPCOR South (34 Street and 92 Avenue)	2044	359	610	0	646	1,015	0
	2060	474	894	0	852	1,460	0

3.2.2 Ultimate Water Supply Options

Two potential options for the ultimate water supply have been considered to service Bremner ACP as shown on **Figure 3.1**. The two potential water supply options are as follows:

- Option 1 – EPCOR North: Supply from Clareview Reservoir via a new transmission main along TWP RD 534
- Option 2 – EPCOR South: Supply from the 34 Street and 92 Avenue existing County supply connection point via a new transmission main

Details of the above supply options are discussed in subsequent sections. While interim servicing requirements for Bremner are discussed in **Section 3.3.**



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Legend

- Area Boundary
- County/City Boundary
- Option 1 Watermain
- Option 2 Watemain
- Option 1/2 Watermain
- Bremner Project Boundary
- LEA Boundary

Scale

1:60,000 — 0 500 1000 2000 3000m

Client/Project

STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.

3.1

Title

Offsite Water Servicing Options

3.2.2.1 Option 1 – EPCOR North: Clareview Reservoir/Transmission Connection

Under this water supply option to Bremner, a new supply main would be constructed directly from the Clareview reservoir to the northwest and southwest reservoirs in Bremner. The exact operation of the supply main will need to be confirmed during detailed design depending on the available pressure at the tie-in connection point in the EPCOR system. If sufficient pressure is not available, all water may need to be supplied to the northwest reservoir and approximately two third of the supply would need to be pumped to the southwest reservoir via a dedicated supply main. The southwest reservoir would then supply water to the southeast reservoir via the proposed distribution system. Alternatively, the southwest reservoir could be supplied with an independent booster station supplying water from the main supply line from the Clareview Reservoir. For the purpose of this study, the required pressure at the EPCOR tie-in connection point is computed to supply water directly to the northwest and southwest reservoirs.

For the ultimate water supply requirement, the new water main would need to be 900 mm (see **Section 3.2.3**) in diameter and approximately 12.8 km in length. The Clareview reservoir is located at the northwest corner of 137 Avenue and Victoria Trail in Edmonton. The proposed alignment for this option is shown on **Figure 3.1**.

From Clareview Reservoir, the proposed alignment is along 137 Avenue and would require the water main to cross under the North Saskatchewan River, continuing along 137 Avenue north of the Edmonton Waste Management Centre and the Clover Bar Sludge Lagoons, to Bremner along TWP RD 534. The opinion of probable cost for this option is $52 million (see **Section 3.2.4**). Alternatively, the water main could connect to an existing transmission main on Victoria Trail at 153 Avenue and then run east along 153 Avenue and then along 17 Street NE to 137 Avenue, as shown on **Figure 3.1**. This alternative alignment is suggested as 137 Avenue appears to be congested with existing pipelines north of the Edmonton Waste Management Centre. The exact alignment will need to be agreed upon by EPCOR in the future.

3.2.2.2 Option 2 – EPCOR South: 34 Street and 92 Avenue Supply Connection

Under Option 2, a new 900 mm (see **Section 3.2.3**) water main is proposed from EPCOR's 34 Street and 92 Avenue booster station to the northwest and southwest reservoirs in Bremner. The exact operation of the supply main will need to be confirmed during detailed design depending on the available pressure at the tie-in connection point in the EPCOR system. If sufficient pressure is not available, all water may need to be supplied to the northwest reservoir and approximately two third of the supply would need to be pumped to the southwest reservoir via a dedicated supply main, the southwest reservoir would then supply water to the southeast reservoir via the proposed distribution system. Alternatively, the southwest reservoir could be supplied with an independent booster station supplying water from the main supply line near the northwest reservoir. For the purpose of this study, the required pressure at the EPCOR tie-in connection point is computed to supply water directly to the northwest and southwest reservoirs.

The water main will be constructed along 92 Avenue to Anthony Henday Drive (AHD) and then along AHD to the 130 Avenue / AHD interchange. From the interchange, it would be constructed east along Aurum Road and then TWP RD 534, tying in to a reservoir in the northwest part of Bremner. Since AHD is a designated Transportation Utility Corridor (TUC), constructing the water main within this corridor will be feasible; however, the exact easement allocation will need to be confirmed with Alberta Infrastructure. The proposed Option 2 alignment is shown on **Figure 3.1.** The total length of the proposed supply main to the reservoir location is approximately 20.6 km. The opinion of probable cost for this option is $78 million (see **Section 3.2.4**).

Alberta Transportation does not allow utilities to run along major highways such as Highway 16 and Highway 21, which requires a portion of the supply main to run within the City of Edmonton (i.e. through Aurum Industrial

neighborhood). Availability of an easement through Edmonton and ownership of infrastructure will need to be determined as discussions with EPCOR progress. Alternatively, the supply main could be routed through Sherwood Park, possibly from AHD, east along Baseline Road, then north along Broadmoor Boulevard, east along Lakeland Drive and north through LEA to the proposed reservoir. As this alternative Option 2 alignment requires extensive construction through the existing developed area, the opinion of probable cost is higher at $95M, and could be considered in more detail during subsequent design stages. Under this option, water could be supplied to the southwest and northwest reservoirs. If sufficient pressure is not available at the EPCOR system tie-in connection point a booster station may be required along the supply main to the southwest reservoir. Water to the northwest reservoir would be supplied via a dedicated supply main from the main supply line to southwest reservoir without any pumping requirement. The southwest reservoir would then supply water to the southeast reservoir via the proposed distribution system. For the purpose of this study, the required pressure at the EPCOR tie-in connection point is computed to supply water directly to the southwest and northwest reservoirs.

3.2.3 Offsite Hydraulic Analysis

Preliminary hydraulic analysis was completed to determine the required supply main sizes and the required hydraulic grade line (HGL) at the proposed tie-in points. This HGL represents minimum delivery pressure to be provided by EPCOR at the tie-in-point. EPCOR will use the computed HGLs to further assess the viability of the options and to determine the system upgrade requirements in Edmonton's transmission system to provide the required HGLs (delivery pressure) under medium (2044) and long-term (2060) demand scenarios. If the cost of upgrades to EPCOR's system in Edmonton is too high, EPCOR may end up supplying the water at lower delivery pressure which may require a booster station along the supply line. The computed HGLs and the required pipe sizes for the two development scenarios and two tie-in connection points are provided in **Table 3.6.** The supply line design computations are based on the maximum day demand condition for Bremner and LEA based on County and EPCOR water consumption rate design standards. The offsite water main sizing is primarily based on available pressure at the supply tie-in connection point to minimize overall system head losses.

For the purpose of computing the required delivery pressure at the tie-in connection point, the full water demand is supplied to the southwest reservoir for both supply line options shown on **Figure 3.1**. As noted in **Section 3.2.5**, storage volumes were assumed to be equally distributed across all three reservoirs. As a result, it was assumed that one third supply is going to the northwest reservoir and two thirds going to the southwest reservoir. The portion of supply main from the northwest to southwest reservoirs is also considered offsite water main and the length is included in the total offsite supply main length. For purposes of this study, all of the supply main is assumed to be the same size.

The initial development in Bremner is expected to start in the northwest part of Bremner as per the Bremner Area Concept Plan Sub-Area Structure Plan (ASP) and Boundaries Concept. The northwest part of Bremner provides optimal initial road access into the area off of Highway 21 and Township Road 534 and contains existing developer land holdings which would result in the first Sub-ASP being submitted for this area. The initial development in Bremner would benefit from the northwest reservoir if constructed first. Water supply to the northwest reservoir can be easily supplied due to the vicinity of the County's existing 400 mm main along CP Rail in the interim, and the Clareview Reservoir in the ultimate.

For both Options 1 and 2, the ultimate offsite supply lines are routed via the northwest reservoir to the southwest reservoir. For Option 2, this routing is selected due to ease of construction through the TUC and largely undeveloped areas. However for Option 2, if the alternative alignment was selected as shown on **Figure 3.1**, the southwest reservoir could be supplied first, and the northwest reservoir could even be eliminated considering the northwest

reservoir is primarily included to facilitate initial development in Bremner in the northwest area. A more in-depth cost benefit analysis of two versus three reservoirs to service Bremner should be performed in the design stages following confirmation of the supply connection point with EPCOR. Although addition of the third reservoir increases the cost of operation and maintenance, it also increases operational flexibility in case one of the reservoirs experiences any disruption in service.

Table 3.6 Offsite Water Main Size and Tie-in Point Delivery Pressure Requirements

Description	County Standards				EPCOR Standards			
Tie-in Locations	Option 1 -Clareview Reservoir		Option 2- 34 Street / 92 Avenue		Option 1 - Clareview Reservoir		Option 2 - 34 Street / 92 Avenue	
Scenario	2044	2060	2044	2060	2044	2060	2044	2060
Required Water Supply Rate (L/s)	255	694	255	694	193	525	193	525
Ground Elevation at Tie-in Connection Point (m)	649	649	666	666	649	649	666	666
Ground Elevation at Southwest Reservoir (m)	680	680	680	680	680	680	680	680
Pipe Diameter (mm)	900	900	900	900	900	900	900	900
Operating Velocity (m/s)	0.40	1.09	0.40	1.09	0.30	0.83	0.30	0.83
Pipe Length (km)	12.8	12.8	20.6	20.6	12.8	12.8	20.6	20.6
Head Loss (m)	2.6	16.4	4.1	26.3	1.5	9.8	2.5	15.7
Minimum Required Pressure at the Reservoir (kPa)	140	140	140	140	140	140	140	140
Minimum Required HGL at Tie-in Connection Point (m)	697	711	698	721	696	704	697	710
Minimum Required Pressure at Tie-in Connection Point (kPa)	469	604	318	536	459	540	301	431

Based on **Table 3.6**, the required supply main size is 900 mm for both Strathcona County and EPCOR standards to maintain the delivery pressure requirement at the tie-in connection point in an acceptable range. With the EPCOR water consumption standards, the required pressure for Option 1 under ultimate development condition is 540 kPa. If required (i.e. if EPCOR cannot meet 540 kPa delivery pressure), it may be possible to receive all of the water supply in the northwest reservoir and then have a reservoir pumphouse pump the water to the southwest reservoir in Bremner. This alternative configuration could ease the delivery pressure requirement for EPCOR making the preferred supply Option 1 more viable as the ground elevation at the northwest reservoir is approximately 655 m or 25 m lower than the southwest reservoir.

The exact sizing will need to be further confirmed during preliminary design along with the pipe material, construction costs and available pressure from EPCOR at the tie-in location. In order to minimize the pipe head losses, the pipe material is assumed to be PVC or HDPE with Hazen-William's roughness coefficient of 120.

Based on the review of the above water supply rates, the County has decided to utilize EPCOR's lower water consumption rate for sizing of the water supply main. In future, if the actual consumption rate turns out to be higher than the EPCOR rate, the supply main will operate at slightly higher velocity (1.09 m/s versus 0.83 m/s for County versus EPCOR standard flow rate). The increase in velocity also requires approximately 10 m and 6 m of higher head loss in the supply main for Option 1 and Option 2, respectively. Such increase in head loss could require a booster station to make up the additional losses assuming the required HGL at the supply tie-in point is maintained by EPCOR for the higher required flow rate and that EPCOR is able to provide the additional flow rate at the tie-in location. Such consequences are unlikely, as discussions and information provided by EPCOR suggest that the actual consumption rates will likely be lower.

3.2.4 Offsite Water Supply Main Cost

Table 3.7 provides a summary of ultimate supply main opinion of probable costs. The supply main costs are based on the primary alignment options shown on **Figure 3.1**. For Option 1, the river crossing plus 25% of the remaining length is assumed to be installed using trenchless construction methods while the remaining length is installed using open cut. For Option 2, it is assumed approximately 25% of the main would be installed using trenchless construction methods and the remaining sections utilizing open cut installation.

For the river crossing, a unit price of $12,000/m including 50% for engineering and contingencies is used based on Stantec's experience on an ongoing project in southwest Edmonton requiring crossing of the NSR. This project involves horizontal directional drilling (HDD) construction method for installation of 900 mm diameter steel pipe. The total river crossing cost depends on a number of factors including appropriate available space for entry and exit sites, pipe assembly space, geotechnical conditions, regulatory requirements as well as market conditions.

Table 3.7 Opinion of Probable Costs for Offsite Water Supply Main Options

Ultimate Water Supply Option	Description	Unit	Quantity	Unit Rate	Cost ($)	In Edmonton ($)	River Crossing ($)	In County ($)
Option 1 – Clareview Reservoir	900 mm Transmission Main in Edmonton – Open Cut Installation	m	4,125	3,000	12,375,000	12,375,000		
	900 mm Transmission Main in Edmonton – Trenchless Installation	m	1,375	6,500	8,937,500	8,937,500		
	900 mm River Crossing - Trenchless Installation	m	600	12,000	7,200,000		7,200,000	
	900 mm Transmission Main in County – Open Cut Installation	m	3,075	3,000	9,225,000			9,225,000
	900 mm Transmission Main in County – Trenchless Installation	m	1,025	6,500	6,662,500			6,662,500
	900 mm Transmission Main Reservoir 1 to Reservoir 2 – Open Cut Installation	m	2,600	3,000	7,800,000			7,800,000
	Option 1 – Total Cost				**52,200,000**	**21,312,500**	**7,200,000**	**23,687,500**
Option 2 – 34 Street and 92 Avenue	900 mm Transmission Main in Edmonton – Open Cut Installation	m	4,200	3,000	12,600,000	12,600,000		
	900 mm Transmission Main in Edmonton – Trenchless Installation	m	1,400	6,500	9,100,000	9,100,000		
	900 mm Transmission Main in County – Open Cut Installation	m	9,300	3,000	27,900,000			27,900,000
	900 mm Transmission Main in County – Trenchless Installation	m	3,100	6,500	20,150,000			20,150,000
	900 mm Transmission Main Reservoir 1 to Reservoir 2 – Open Cut Installation	m	2,600	3,000	7,800,000			7,800,000
	Option 2 – Total Cost				**77,550,000**	**21,700,000**		**55,850,000**

The portion of the supply main installed in Edmonton may be constructed, owned and operated by EPCOR. Ownership and cost for the required infrastructure will be determined through ongoing discussions with EPCOR.

Option 1 is less expensive compared to Option 2; however, EPCOR still needs to confirm that they can supply the required flow from the Clareview Reservoir. It is also EPCOR and the County's preference to use Option 1 for supply to Bremner as it provides a secondary feed to the County providing redundancy and reducing the risk of a supply disruption to the entire Strathcona County service area. Option 1 also allows EPCOR potential to directly service their own customers within the City of Edmonton east of the North Saskatchewan River.

3.2.5 Potable Water Storage Requirement

According to "Water Supply for Public Fire Protection" guidelines prepared by Fire Underwriters Survey issued in 1999, for 250 L/s fire flow requirements, storage needs to be provided for a duration of 3.25 hours. In addition to fire flow requirements, the County requires two days of average day demand storage. The fire flow storage is provided in all three proposed reservoirs. The required storage for Bremner is computed based on the following equation:

- Reservoir Storage Requirement = 2 Days of ADD + 3.25 hours of Fire Flow (250 L/s)

The potable water storage requirement for Bremner including the LEA servicing requirement has been determined based on the demand computations provided in **Table 3.1**. The estimated reservoir storage requirements for 2044 and 2060 are summarized in **Table 3.8**.

Table 3.8 Bremner Reservoir Storage Requirement

Development Scenario	Service Area	Average Day Demand (L/s)	Fire Flow Rate (L/s)	Number of Fire Flow Storage	Required Storage Volume (m^3)	Unit Price ($/$m^3$)	Opinion of Probable Cost ($)
2044	Bremner	112	250	1	27,635	1,500	**41,450,000**
	LEA	31					
2060	Bremner	305	250	3	76,167	1,500	**114,250,000**
	LEA	85					

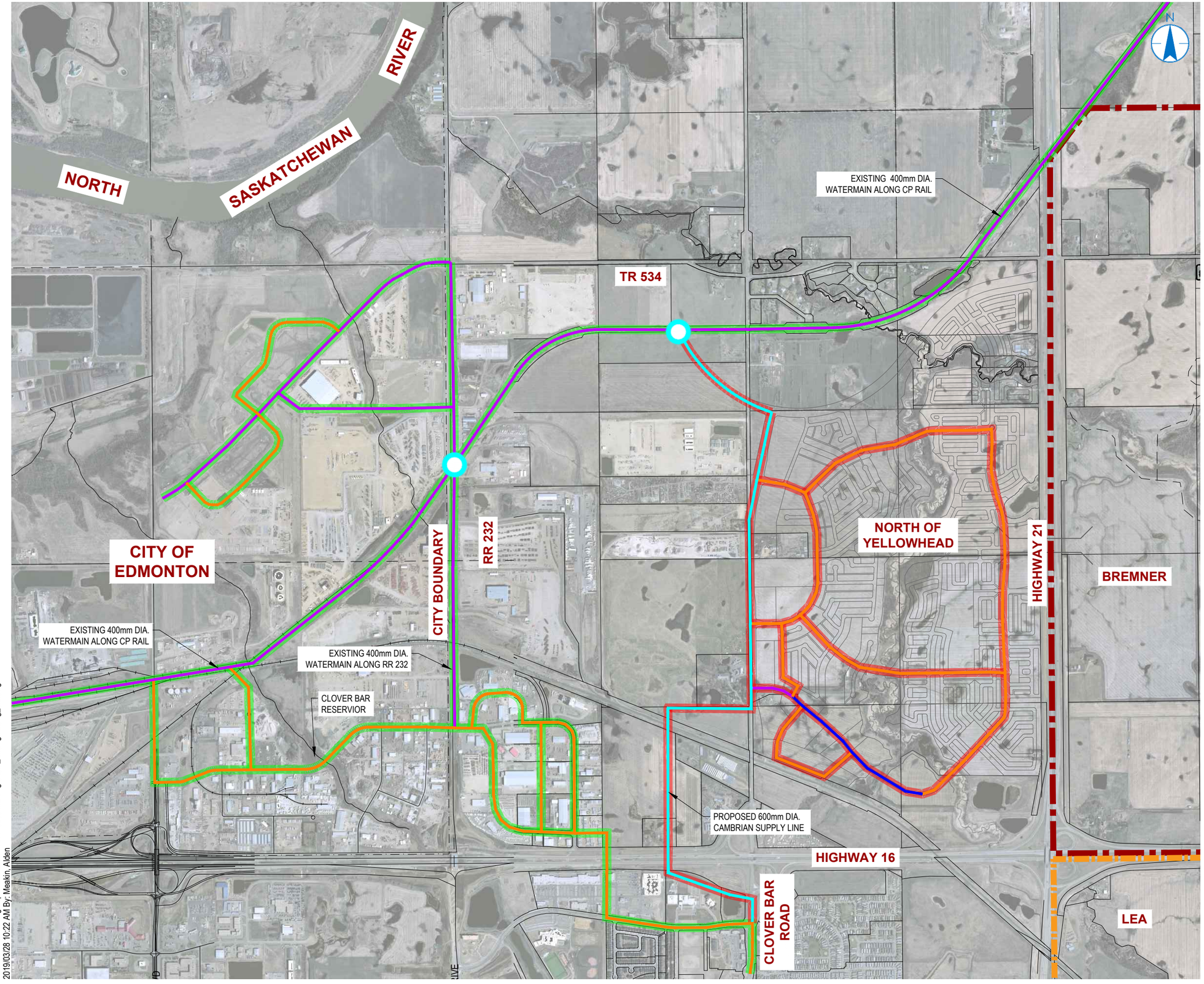
Based on the existing topography of the study area, a minimum of two reservoirs are required. The third reservoir in the northwest area will need to be constructed to facilitate initial development staging assuming development starts in the northwest first. The required storage volume is proposed to be split equally into the three reservoirs, each with a required storage volume of 25,400 m^3. The opinion of probable cost for all reservoirs and corresponding pumphouses is estimated to be approximately $114.3 million including 50% for engineering and contingencies. The cost does not include land costs.

3.3 INTERIM WATER SUPPLY OPTIONS

The existing and proposed Cambrian Crossing water distribution systems west of Bremner are shown on **Figure 3.2**. Based on these existing and proposed water mains, for Bremner interim water servicing, the following two potential water supply options were considered:

- Option 1 - 400 mm transmission main along CP Rail west of Highway 21
- Option 2 - 600 mm transmission main along Clover Bar Road (RR 231) north of Highway 16

In order to analyze these water supply options, boundary conditions were obtained from Strathcona County as summarized in **Table 3.9**.



Stantec
400-10220 103 Avenue NW
Edmonton AB
www.stantec.com

Legend

- 300mm Dia. Watermain
- 350mm Dia. Watermain
- 400mm Dia. Watermain
- 600mm Dia. Watermain
- Existing Piping
- Proposed Piping
- Proposed Connection
- City Boundary
- Bremner Project Boundary
- LEA Boundary

Scale

1:20,000 — 0 200 600 1000m

Client/Project

STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.

3.2

Title

Existing and Proposed Water Mains within North of Yellowhead Area

Table 3.9 Interim Water Supply Boundary Conditions

Year	Scenario	Option 1 400 mm Transmission Main Hydraulic Grade Line (m)	Option 2 600 mm Transmission Main Hydraulic Grade (m)
2025	MDD	716.42 m	719.87 m
	PHD	714.72 m	719.75 m
	MDD + 250 L/s	-	718.29 m
2030	MDD	709.71 m	719.47 m
	PHD	703.43 m	719.08 m
	MDD + 250 L/s	-	717.37 m
2035	MDD	697.48 m	718.75 m
	PHD	682.30 m	717.85 m
	MDD + 250 L/s	-	716.01 m

Boundary condition assumptions:

- For Option 1 interim servicing from the 400 mm main, it is assumed the NoY area is serviced from the future 600 mm, i.e. only domestic demand for Bremner and LEA are supplied from the existing 400 mm main. For this scenario, boundary conditions for the fire flow scenario were not simulated, i.e. a reservoir and pumphouse would be required.
- For Option 1 interim servicing, the 2035 scenario caused pressures within that line to drop below 300 kPa.
- For Option 2 interim servicing from the 600 mm main, the total demand (for Bremner, LEA and NoY) was placed on a single node located on the future main on RR 231.
- Interim servicing boundary assumes no development within West of 21.

For NoY water servicing, the “Issue for Tender” drawings show connections to the existing 400 mm transmission main along the CP Rail at the following two locations:

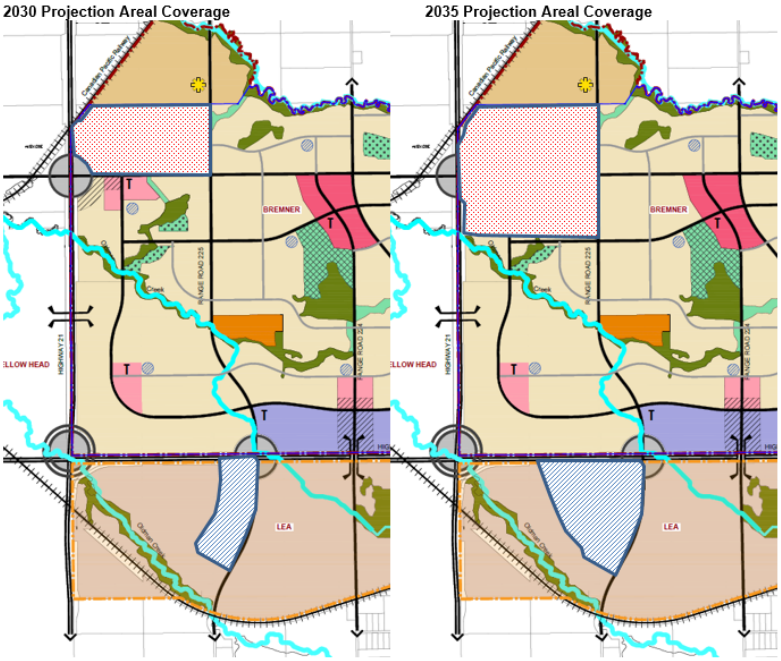
- Future 600 mm main along RR 231 at TWP RD 534
- Exiting 400 mm main along RR 232

As NoY is developed in the future, the above connections will further enhance available pressure in the 400 mm transmission main along the CP Rail. Although the maximum desired operating velocity of 1.5 m/s in the 400 mm transmission main will limit the maximum supply rate to 188 L/s to the year 2041 when the new supply main from the EPCOR system will need to be constructed to the Bremner reservoir. The proposed timeline for the new supply main from EPCOR will need to be confirmed with additional analysis by the County with the above two NoY connections to the 400 mm transmission main to confirm the 188 L/s can be supplied to Bremner at a minimum pressure of 140 kPa at the reservoir without impacting NoY servicing requirements. For the interim servicing analysis, the availability of sufficient water storage (if storage is not provided in Bremner) and the transmission system capacity to service the Bremner ACP through the existing County water infrastructure needs to be confirmed based on the anticipated water demand growth within the County’s urban service areas (USA), i.e. NoY including Cambrian and West of 21. If the existing County water infrastructure is not able to provide sufficient flow, timing for the offsite water supply main construction will need to be advanced. In addition, the boundary conditions provided by the County in **Table 3.9** are based on an anticipated growth in Cambrian indicated in **Table 2.4** and assumes no development in West of 21. A sensitivity analysis should be performed in terms of available supply rate for Bremner ACP should the development in Cambrian and West of 21 vary significantly.

The following sections provide an analysis for the two interim servicing supply options. As indicated in previous sections, three reservoirs are proposed for the ultimate servicing of Bremner. The reservoir in the northwest is included to accommodate interim servicing requirements.

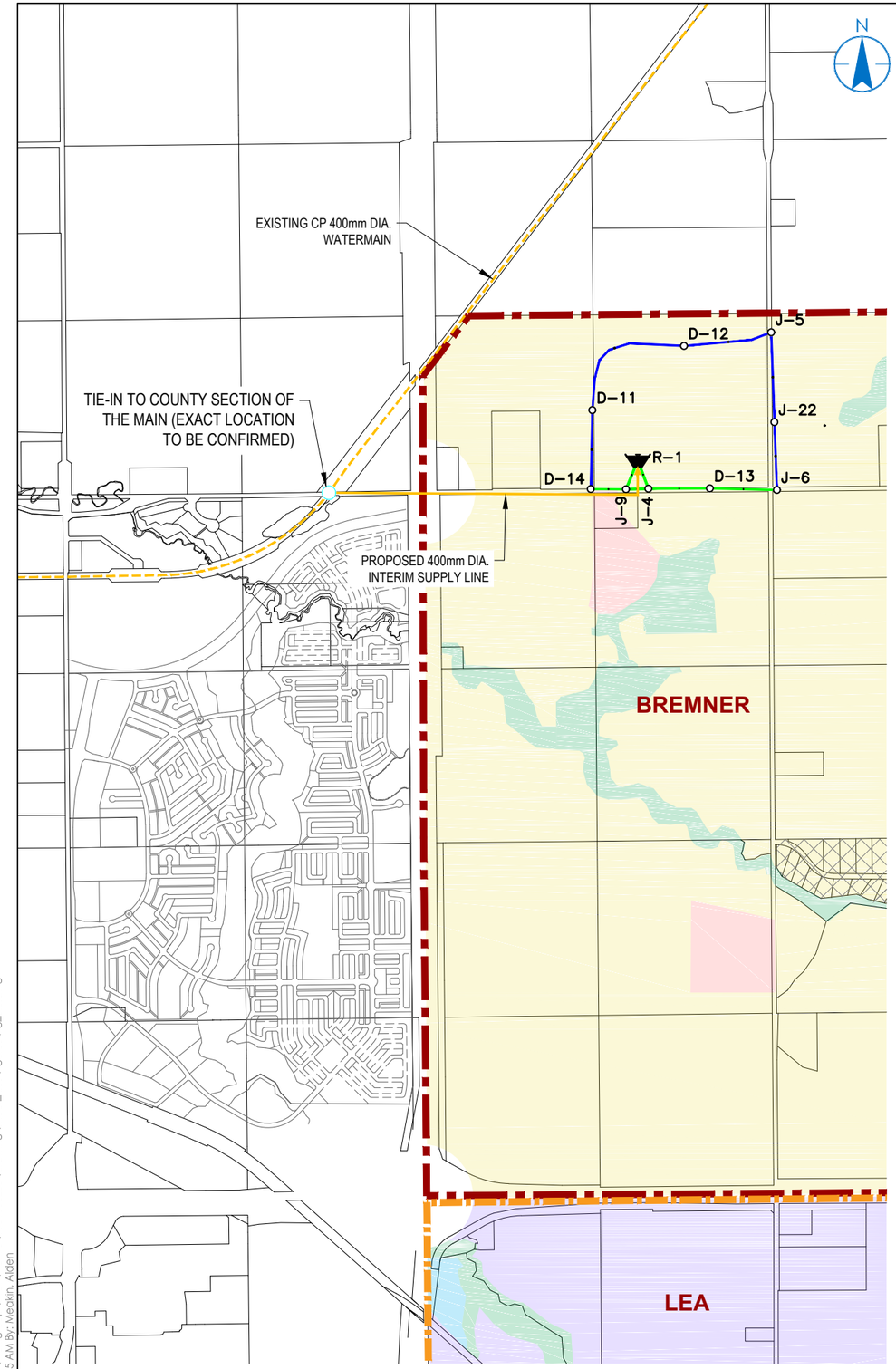
3.3.1 Option 1 - Supply from 400 mm Main along CP Rail

Under this interim supply option, water would be supplied from Strathcona County to a new reservoir and pumphouse constructed in the northwest part of Bremner. The existing 400 mm main along the CP Rail is owned by the County up to the Akenside subdivision. The water main from this point continues toward Fort Saskatchewan and is owned by the CRNWSC. The interim supply main for Bremner will need to be extended to Akenside subdivision and the connection to the CRNWSC line will need to be reconfigured or closed to avoid drawing water from the CRNWSC system. Option 1 distribution networks for 2030 and 2035 development scenarios in Bremner are shown on **Figure 3.3**. With the implementation of the northwest reservoir and pumphouse, servicing requirements in the anticipated development can be met. The service area coverage, indicated by red and blue hatching for Bremner and LEA, for 2030 and 2035 are shown below. The service areas are based on growth projections indicated in **Table 2.4** for residential and nonresidential service areas (the actual development may not occur at the exact location shown).

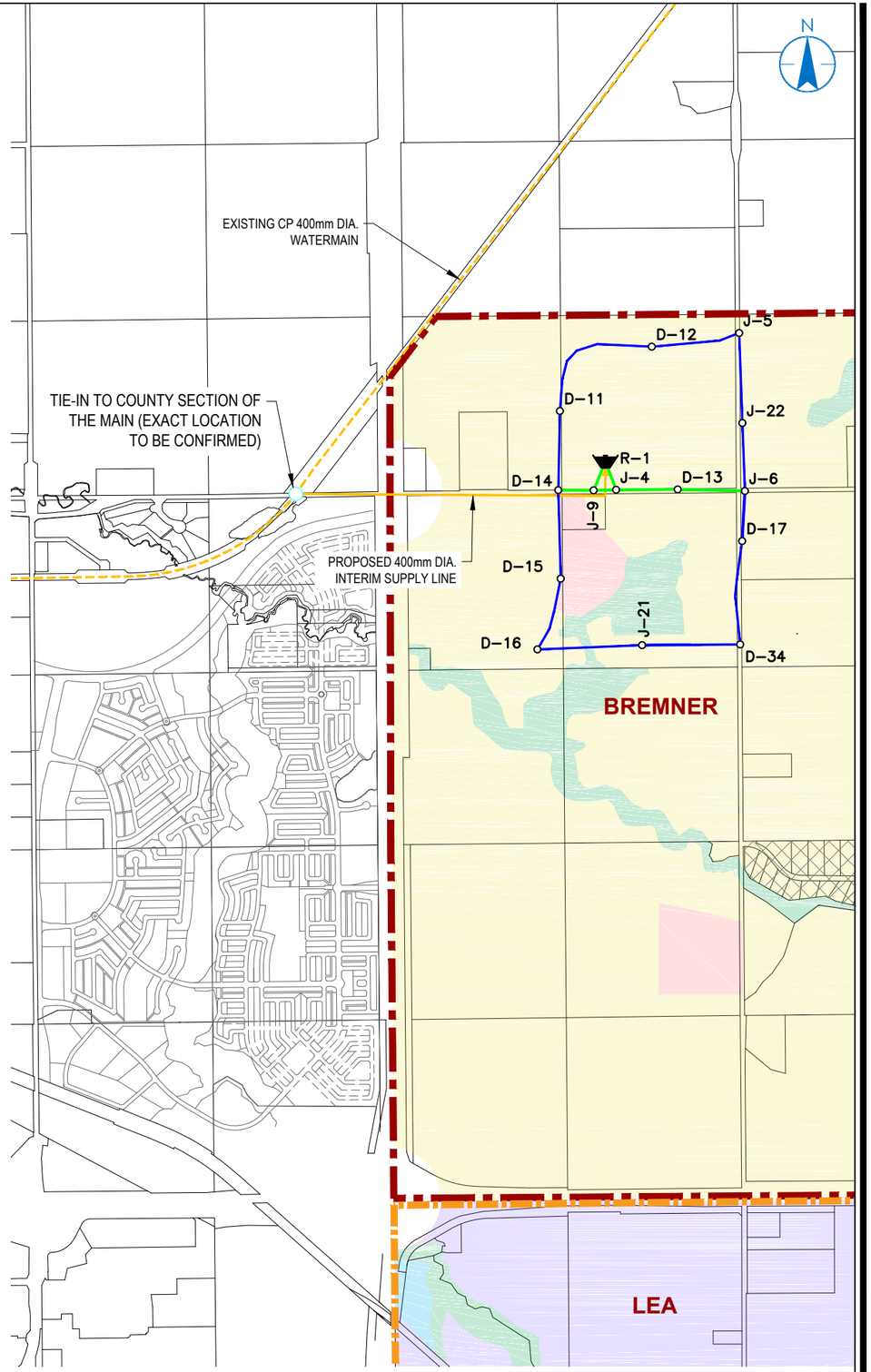


Service Area Modeled for 2030 and 2035 Growth Scenarios

The water would be pumped from the northwest reservoir to the distribution system in Bremner and the LEA. A high level hydraulic analysis for the interim supply line, based on the boundary conditions provided by the County, was completed to determine when the ultimate water supply line would need to be constructed. Findings of this analysis are presented in **Table 3.10** based on both the County and EPCOR design standards. For the anticipated interim operating period of up to approximately 2040, the hydraulic analysis results are similar for both design standards. However, the water demand for 2040 computed based on EPCOR standards is approximately 13% lower than that computed based on the County standards.



Option 1 - 2030 Interim Water Servicing Plan



Option 1 - 2035 Interim Water Servicing Plan

Stantec
400-10220 103 Avenue NW
Edmonton AB
www.stantec.com

Legend

- J-2 Available Fireflow at Node
- 300mm Dia. Watermain
- 400mm Dia. Watermain
- Existing 400mm Dia. Watermain
- 450mm Dia. Watermain
- R-1 Reservoir
- Bremner Project Boundary
- LEA Boundary

Scale

1:25,000 0 250 750 1250m

Client/Project
STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.
3.3

Title
Proposed Option 1 Interim Water Servicing Plan

Table 3.10 Option 1 Interim Offsite Servicing Analysis Results

Projection	Bremner Residential MDD (L/s)	Bremner/ LEA Non-Residential MDD (L/s)	Total MDD (L/s)	Available HGL at 400 mm Tie-in Point (m)	Supply Line Size (mm)	Pipe Length (km)	Velocity (m/s)	Head Loss [2] (m)	Required HGL at Tie-in Point [3] (m)	Notes
Based on County's 300 L/cap/d Standards										
2025	11.7	3.0	14.7	716.4	400	1.16	0.12	0.06	669	OK
2030	42.9	11.1	54.0	709.7	400	1.16	0.43	0.68	670	OK
2035	77.1	19.9	97.0	697.5	400	1.16	0.77	2.01	671	OK
2040	137.2	35.5	172.7	697.5 [1]	400	1.16	1.37	5.86	675	OK
2045	218.8	56.6	275.3	697.5 [1]	400	1.16	2.19	13.90	683	Normal operating velocity of 1.0 – 1.5 m/s is exceeded
2050	322.8	83.5	406.3	697.5 [1]	400	1.16	3.23	28.57	698	Maximum allowable operating velocity of 3.0.m/s is exceeded
2055	436.6	112.9	549.4	697.5 [1]	400	1.16	4.37	49.96	719	Not OK
Based on EPCOR's 250 L/cap/d Standards										
2025	9.7	3	12.7	716.4	400	1.16	0.10	0.0	669	OK
2030	35.8	11.1	46.9	709.7	400	1.16	0.37	0.5	670	OK
2035	64.2	19.9	84.1	697.5	400	1.16	0.67	1.5	671	OK
2040	114.3	35.5	149.8	697.5 [1]	400	1.16	1.19	4.5	674	OK
2045	182.3	56.6	238.9	697.5 [1]	400	1.16	1.90	10.7	680	Normal operating velocity of 1.0 – 1.5 m/s is exceeded
2050	269	83.5	352.5	697.5 [1]	400	1.16	2.81	22.0	691	Maximum allowable operating velocity of 3.0.m/s is exceeded
2055	363.8	112.9	476.7	697.5 [1]	400	1.16	3.79	38.4	707	Not OK

Notes:

1) Assumed HGL
2) Head losses based on Hazen-Williams Coefficient of 120
3) Required HGL based on ground elevation of 655.0 m at the reservoir and minimum residual head requirement of 14.0 m (20 psi) at the reservoir

The above analysis indicates that the required demand can be supplied at least until 2030. As indicated by the County, for 2035 boundary conditions, the HGL falls below 300 kPa in the 400 mm transmission main along CP Rail. The boundary condition provided by the County assumes no proposed connections to the existing 400 mm main along RR 232 or to the proposed 600 mm main along RR 231 for the NoY area servicing. The boundary conditions were developed to accommodate development in Bremner independent of development start in Cambrian. Note,

currently development in Cambrian is anticipated to start in 2021 and be completed by 2037 as indicated in **Table 2.4**. Based on this anticipated development projection for Cambrian, the proposed 600 mm transmission main connection to the existing 400 mm main along CP Rail will be completed and the available HGL in the 400 mm main along the CP Rail will be significantly improved and extend available supply to Bremner to 2040. However, this would need to be confirmed in the future depending on if the County's existing infrastructure can handle the demands from Bremner in addition to the projected growth in NoY and West of 21. Note as the supply rate increases, the velocity in the pipe increases along with an increase in head loss which may cause lower pressure in the system. Supply lines are generally designed to operate at 1.0 m/s to 1.5 m/s velocity range as excessive velocities can cause significant head losses in long transmission mains and could also increase the risk of potential transient issues.

The cost of the reservoir/pumphouse, supply lines and staging are summarized in **Table 3.11** for interim supply Option 1. This interim option would trigger the need for three reservoirs for the ultimate condition. The first reservoir in the northwest would be constructed in two stages with each stage having storage capacity of 12,700 m^3 for a total storage volume of 25,400 m^3. The remaining two reservoirs, each with 25,400 m^3 storage volume, are assumed to be constructed in one stage, however they can be constructed in multiple stages depending on the actual pace of development in Bremner.

Table 3.11 Option 1 Interim Water Supply System Opinion of Probable Costs

Year	ADD Demand (L/s)	Domestic Storage Volume (m3)	Fire Flow Storage (m3)	Total Required Storage (m3)	Reservoir Staging	Interim / Ultimate Supply Line
2025	8.2	1,425	2,925	4,350	12,700 m^3 at $19.1M	$1.2M
2030	30.3	5,232	2,925	8,157		
2035	54.4	9,392	2,925	12,317	12,700 m^3 at $19.1M	
2040	96.7	16,714	2,925	19,639		$52M (amount and timing to be confirmed)
2045	154.2	26,650	5,850	32,500	25,400 m^3 at $38.1M	
2050	227.6	39,328	5,850	45,178		
2055	307.8	53,182	8,775	61,957	25,400 m^3 at $38.1M	
2060 (Full Development	395.4	68,321	8,775	77,096		

The implementation of the above water infrastructure triggers are summarized in **Table 3.12** and were established based on the anticipated growth projections in **Table 2.4** and corresponding demand estimates computed based on the current County standards.

Table 3.12 Water Infrastructure Implementation Triggers for Option 1 Interim Servicing

Year	Trigger	Water Infrastructure Implementation	Remark
2023	Development start with single family residential	Construction of interim supply line	HNA required to ensure sufficient fire protection is available
2025	Development start of higher density residential and/or non-residential service areas	Construct initial stage of northwest reservoir and pumphouse	
2035	Total Bremner and LEA ADD demand reaches 55 L/s	Construct 2nd stage of northwest reservoir and pumphouse	Timing based on County design standards
2040	Total Bremner and LEA ADD demand reaches 97 L/s	Construct offsite water main to Clareview reservoir	Coordinate with EPCOR
2043	Total Bremner and LEA ADD demand reaches 131 L/s	Construct Southwest Reservoir	
2052	Total Bremner and LEA ADD demand reaches 260 L/s	Construct Southeast Reservoir	

3.3.2 Option 2 - Supply from 600 mm Main along RR 231

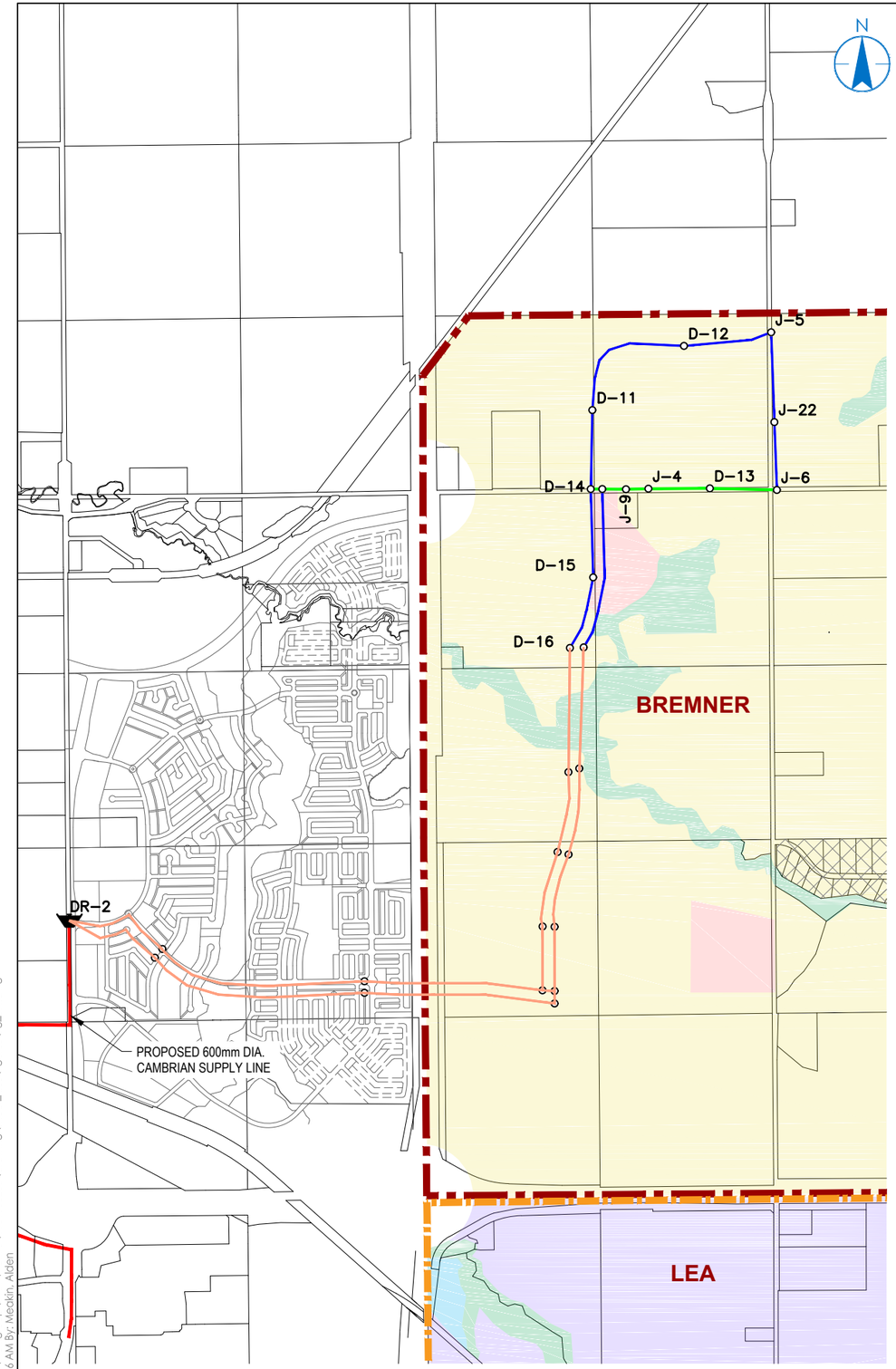
Under this interim supply option, water would be supplied from the Strathcona County system through Cambrian Crossing to the northwest part of Bremner where the initial development stage is planned. Under this interim servicing plan, the Bremner area would be serviced by a reservoir/pumphouse in Sherwood Park. A high level hydraulic network analysis was completed using WaterCAD based on the boundary conditions provided by the County.

Under this interim servicing plan, it is assumed a 600 mm main from Clover Bar Road south of Highway 16 is constructed to service Cambrian to a supply node shown on **Figure 3.4**. From this supply point, a pair of water mains for looping would be constructed through Cambrian across Highway 21 and north to the northwest part of Bremner. These water mains would require a number of easements from the affected land owners. Alternatively, a single supply main could be constructed to a new reservoir either in the northwest or southwest area of Bremner to service the initial growth area in Bremner. If the southwest reservoir is constructed, this interim supply option would provide an opportunity to eliminate the northwest reservoir if desired. Servicing all of Bremner with two reservoirs would reduce some operational cost compared with the three reservoir system; however, it would add operational risk should one of the reservoirs need to be shut down for maintenance.

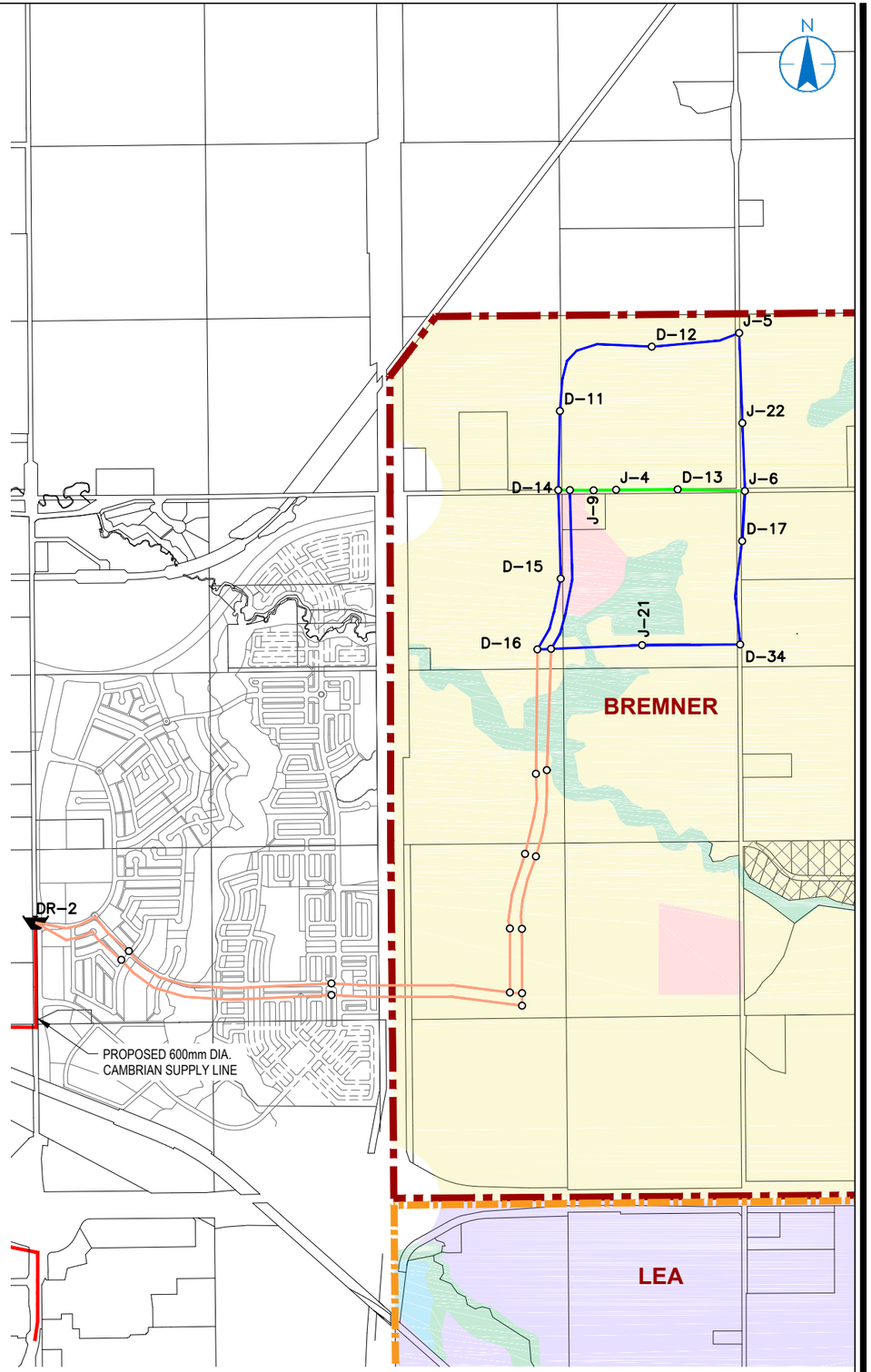
The County was requested to provide boundary conditions assuming varying levels of development (demand) within Cambrian Crossing. It should be noted that any adjustment of domestic supply requirement for this option is not expected to significantly alter the interim servicing simulation results in Bremner.

The model simulation results indicate that up to 250 L/s fire flow can be provided to the 2030 development scenario. For the 2035 development scenario, a minimum fire flow rate of 196 L/s was simulated for water main sizes shown on **Figure 3.4**. The required fire flow of 250 L/s could be achieved by some minor upsizing compared to ultimate system requirements. The required upsizing can be determined based on actual development staging.

The simulated network shown on Figure 3.4 is based on the ultimate servicing requirement; for interim servicing requirements, a pair of 400 mm water mains along the west most road would be sufficient to service the initial development stages. From RR 231 to the proposed initial development, approximately 4.0 km of supply mains would



Option 2 - 2030 Interim Water Servicing Plan



Option 2 - 2035 Interim Water Servicing Plan

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Legend

- D-14 Available Fireflow at Node
- 300mm Dia. Watermain
- 400mm Dia. Watermain
- 450mm Dia. Watermain
- 600mm Dia. Watermain
- DR-2 Reservoir
- Bremner Project Boundary
- LEA Boundary

Scale

1:25,000 — 0 250 750 1250m

Client/Project

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Figure No.

3.4

Title

Proposed Option 2 Interim Water Servicing Plan

need to be installed. Total cost to install these supply mains would be approximately $8.0M inclusive of 50% for engineering and contingencies. Based on the network analysis, by 2035, a reservoir and pumphouse will need to be constructed in either the southwest or northwest area of Bremner.

For interim supply Option 2, the cost of the reservoir/pumphouse, supply lines and staging are summarized in **Table 3.13** based on the County's design standards. The timing of construction for the ultimate supply will also depend on whether the County's existing infrastructure can handle the demands from Bremner in addition to the projected growth in NoY and West of 21 (see **Table 2.4** for anticipated growth projections). Beyond 2035, the pair of 400 mm water mains through Cambrian Crossing would only be used for supplying the reservoir(s) in Bremner up to a point when the County water infrastructure is unable to sustain Bremner supply requirements. Establishing this threshold/trigger point requires a detailed assessment of the County's existing and planned infrastructures (i.e. update of the Water Master Plan).

Also, deferral of reservoir construction for a significant period of time would require either additional interim connections across Highway 21 in Cambrian Crossing or connection to the existing County owned 400 mm water main along the CP Rail. This would also require sufficient storage for Bremner within the County's existing reservoirs.

Table 3.13 Option 2 Interim Water Supply System Opinion of Probable Costs

Year	ADD Demand (L/s)	Domestic Storage Volume (m^3)	Fire Flow Storage (m^3)	Reservoir Staging	Interim / Ultimate Supply Line
2023					$8.0M
2025	8.3	1,442	2,925		
2030	30.7	5,297	2,925		
2035	55.0	9,510	2,925	25,400 m^3 at $38.1M	
2040	97.9	16,924	2,925		$52M (timing to be confirmed)
2045	156.2	26,985	5,850	25,400 m^3 at $38.1M	
2050	230.5	39,822	5,850		
2055	311.6	53,850	8,775	25,000 m^3 at $38.1M	
2060 (Full Development	419.0	72,411	8,775		

Considering extensive easement requirement for the required supply line through non-developing areas, this interim servicing option is not recommended. The triggers for this option are summarized in **Table 3.14**. The exact timings for the offsite supply main may need to be adjusted based on the County's Water Master Plan update.

Table 3.14 Water Infrastructure Implementation Triggers Option 2 Interim Servicing

Year	Trigger	Water Infrastructure Implementation	Remark
2023	Development start including non-residential and higher density residential	Construction of twin interim supply line	HNA required to ensure sufficient fire protection is available
2035	Total Bremner and LEA ADD demand reaches 55 L/s	Construct northwest reservoir and pumphouse	Timing based on current County design standards
2040	Total Bremner and LEA ADD demand reaches 97 L/s	Construct offsite water main to Clareview reservoir	Timing to be confirmed based on updated County's Water Master Plan and coordinate with EPCOR
2043	Total Bremner and LEA ADD demand reaches 131 L/s	Construct Southwest Reservoir	
2052	Total Bremner and LEA ADD demand reaches 260 L/s	Construct Southeast Reservoir	

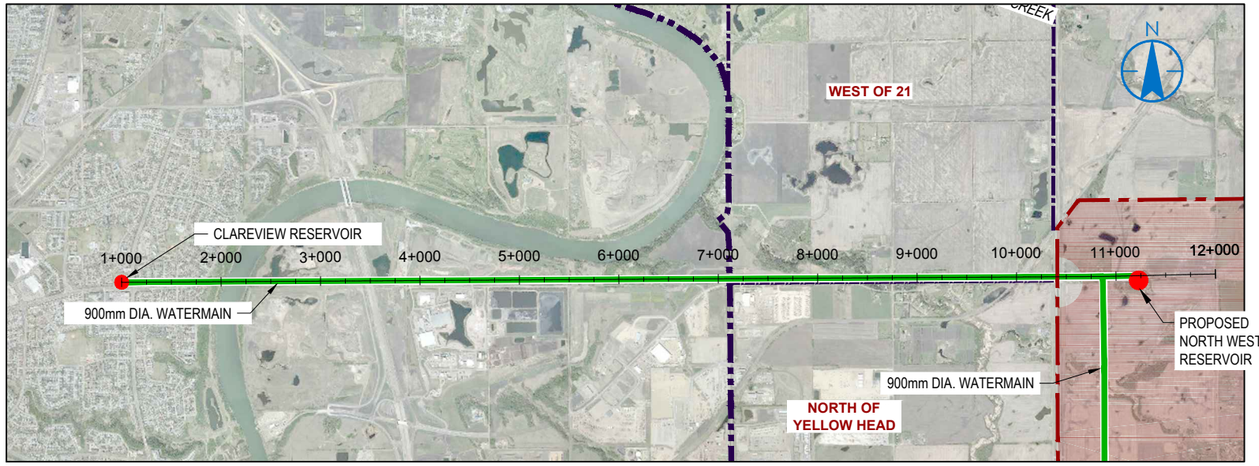
In addition to the above upgrades in Bremner, upgrades in the City may be required by EPCOR to accommodate increases in demands from the County. Annually, Strathcona County provides EPCOR a forecast of the quantity of water the County expects to purchase during each of the next five calendar years (a procedure which is outlined in the Water Supply Agreement with EPCOR). EPCOR has indicated it will continue to monitor the County's water demand and forecasted growth because future infrastructure/upgrades will be designed and constructed to accommodate both internal and regional growth, ensuring servicing standards are achieved. Further ongoing discussion between EPCOR and Strathcona County will be required as development of the Bremner area proceeds and demands are realized.

3.4 OFFSITE WATER MAIN CONCEPTUAL DESIGN

The offsite conceptual design for the preferred water supply option from the Clareview Reservoir is shown on **Figure 3.5**. The conceptual alignment will need to be confirmed based on ongoing discussions with EPCOR by Strathcona County. The proposed alignment follows TR 534 in an east-west direction from the northwest reservoir to the Clareview Reservoir in Edmonton. A second portion of the supply main from the northwest reservoir to the southwest reservoir will be constructed from a tee near the northwest reservoir when the southwest reservoir is constructed. The proposed water main will be 900 mm in diameter. The proposed east-west alignment also includes the North Saskatchewan River crossing which is expected to be constructed using HDD construction methods.

3.5 ONSITE SERVICING PLAN

For the onsite servicing plan, a detailed hydraulic network analysis was completed for the average day, maximum day and peak hour demand conditions as well as maximum day plus fire flow requirements. The hydraulic network analysis was completed to determine the ultimate development condition servicing requirements. The hydraulic assessment was completed in an iterative manner to establish the distribution system sizes, pressure relief valve (PRV) requirements and operating pressure for the pump stations at each reservoir. The hydraulic network assessment was completed using the Bentley WaterCAD modeling software.



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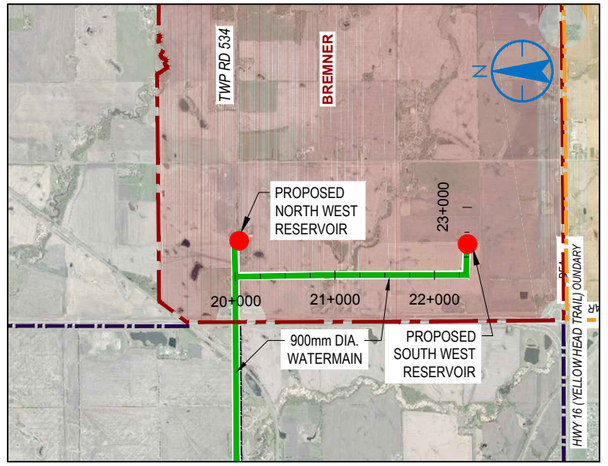

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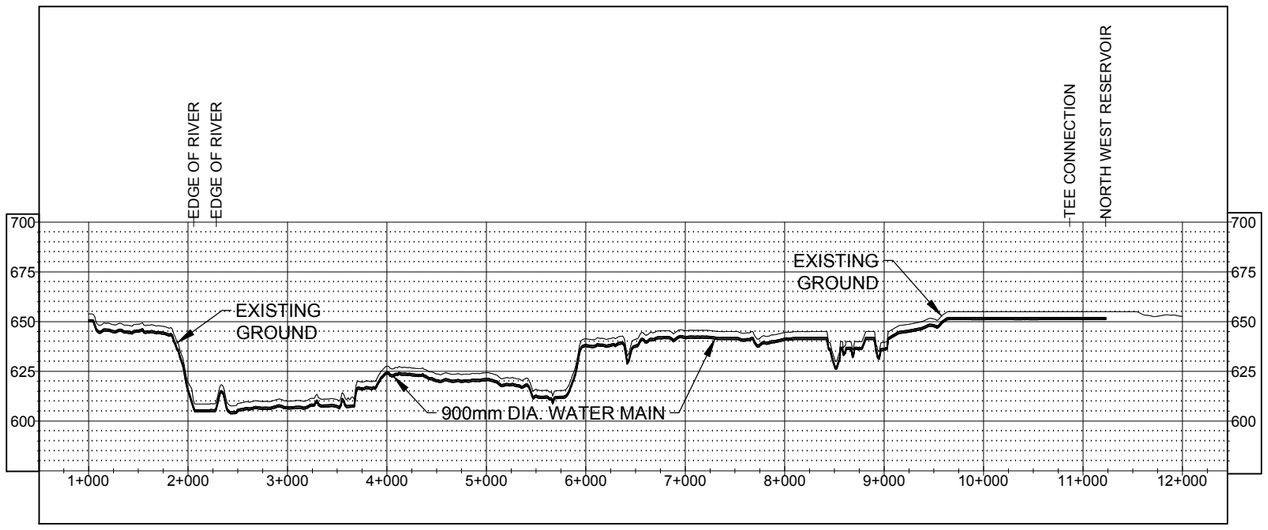
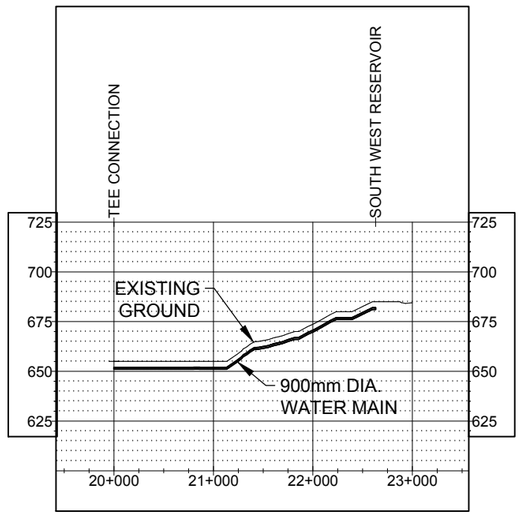


PROFILE
HORZ. 1:60000 VERT. 1:3000



PROFILE
HORZ. 1:60000 VERT. 1:3000

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Legend

- Area Boundary
- County/City Boundary
- Watermain
- Bremner Project Boundary
- LEA Boundary

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Figure No.
3.5

Title
WATER TRANSMISSION MAIN
PLAN AND PROFILE

The three proposed reservoir locations were selected based on the existing topography and distribution system operating requirements. The water supply line will need to be extended to the northwest and southwest reservoirs which is included as an offsite water main, supply to the southeast reservoir will be provided through the proposed oversized distribution main via the southwest reservoir. The two south reservoir locations are situated on higher ground to minimize the future distribution system pumping/operating costs. The northwest reservoir is located in a geographically lower portion of the system and will service a pressure zone separated by PRVs. The PRVs are required due to the service area topography to meet the minimum and maximum allowable operating pressure requirements. The requirement of these PRV's should be thoroughly investigated as more detail becomes available.

The proposed onsite servicing plan is shown on **Figure 3.6**. For LEA servicing requirements, a single 300 mm water main from Bremner is required. In the Bremner area, the north service area elevations drop rapidly and a set of PRVs are required to keep the pressures below the maximum allowable pressure of 700 kPa. The key highlights of the proposed distribution system are as follows:

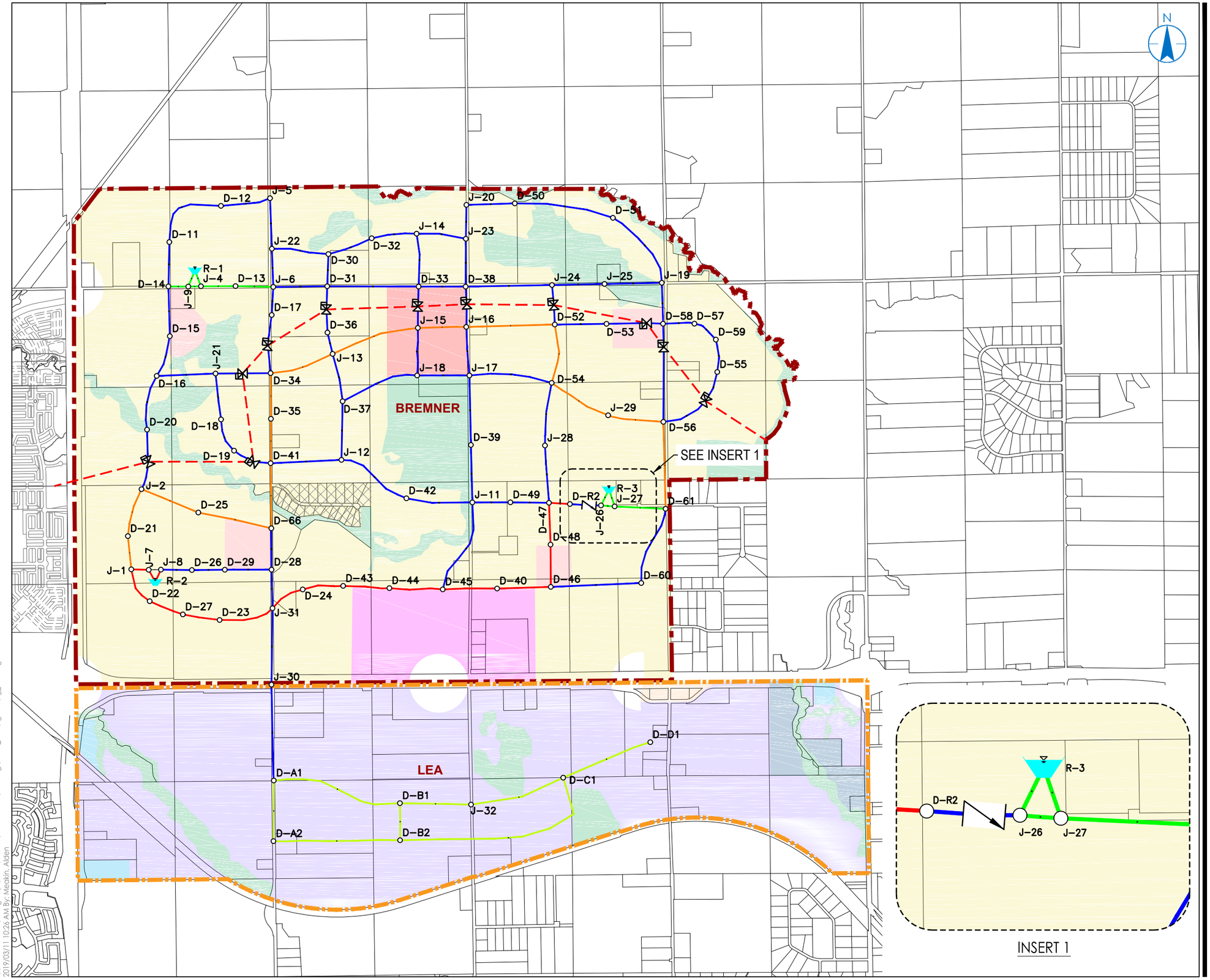
- Water for all of the Bremner and LEA areas will be supplied to the northwest reservoir from the offsite water supply main, and from the northwest reservoir to the southwest reservoir.
- The proposed southwest reservoir will supply water to the southeast reservoir via a 600 mm diameter distribution main with a constant flowrate of 276 L/s.
- In order to use the proposed distribution main to supply water to the southeast reservoir, a check valve is required to avoid recirculation.
- A total of eleven PRVs may be required to reduce pressures in the low areas along the north boundary of Bremner.
- The proposed distribution system includes 300 mm to 600 mm distribution mains in Bremner, while for LEA 250 mm mains are used due to the rural servicing requirements. The cost of the onsite distribution system is estimated at $70.5M as indicated in **Table 3.15**.

Table 3.15 Onsite Water Distribution System Opinion of Probable Cost

Pipe Sizes (mm)	Total Pipe Length (m)	Unit Price ($/m)	Cost ($)
250	6,854	600	4,112,400
300	32,928	750	24,696,000
400	7,674	1,050	8,057,700
450	1,969	1,280	2,520,320
600	5,051	1,500	7,576,500
Total Pipe Length/Costs	54,476		46,962,920
Valve Costs			11,300,000
Hydrant Costs			12,258,000
Total			**70,520,920**

Note: Hydrant and valve intervals estimated at 80 m of pipe length.

- The simulated pressures within the proposed distribution system have been maintained within the required pressure range of 350 kPa to 700 kPa at all node locations for all demand scenarios (i.e., ADD, MDD, PHD), with the following exceptions:
  - The simulated pressures within the LEA area are above the minimum required pressure of 140 kPa for rural residential service areas.



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Legend

- D-60 Demand Node
- J-25 Junction Node
- 250mm Dia. watermain
- 300mm Dia. Watermain
- 400mm Dia. Watermain
- 450mm Dia. Watermain
- 600mm Dia. Watermain
- R-3 Reservoir
- PRV-12 PRV
- Check Valve
- Bremner Project Boundary
- LEA Boundary
- Pressure Zone Boundary

Scale

1:30,000 — 0 250 500 1000 1500m

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STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.

3.6

Title

Proposed Onsite Water Servicing Plan

  - The maximum allowable pressure of 700 kPa is exceeded only at Node J-2 due to the low ground elevation at the node location. Servicing around this node area may require higher pressure rated pipes and/or additional local pressure reducing valves.
- For maximum day plus fire flow demand condition assessments, the minimum required pressure of 140 kPa is achieved at all node locations within Bremner. Due to the rural servicing standards for LEA, onsite fire suppression will be required.
- The required hydraulic grade lines (HGL) at the southwest and southeast reservoirs are set at 746 m and the HGL at the northwest reservoir is set at 716 m.

3.6 SUMMARY OF WATER SERVICING CONCEPT

Bremner ACP water servicing concept is developed based on urban servicing for Bremner and rural servicing for LEA (i.e. trickle feed water supply and onsite fire protection by owner). For the ultimate water supply to Bremner, three main supply options were considered. A water supply option from CRNWSC was eliminated due to concerns that the CRNWSC infrastructure upgrade requirement would significantly impact the current rate structure. Of the remaining two options, an ultimate supply option from Clareview Reservoir is preferred by EPCOR and the County. For the County, it provides a secondary feed, providing redundancy and reducing the risk of a supply disruption to the entire Strathcona County service area. This option also allows EPCOR potential to directly service their own customers within the City of Edmonton east of the North Saskatchewan River. Confirmation of the preferred supply option is ongoing with EPCOR as EPCOR needs to analyze the preferred connection location based on the extent of their internal system upgrade requirements.

For interim supply, two supply options were considered from the existing and planned County water distribution system in the North of Yellowhead area. An interim supply option from the County's existing 400 mm main along CP Rail is recommended. For this interim supply option, a reservoir and pumphouse is required to service higher density residential and non-residential service. This interim supply line could be used to service single family residential areas for the initial development stages until a reservoir is constructed. A second supply option through Cambrian Crossing was identified, but it is considered to be difficult to implement due to uncertainties in development timing in Cambrian and because it would require numerous crossing right of way agreements through undeveloped land.

For onsite servicing, two reservoirs are required from the hydraulic perspective, one in the southwest and one in the southeast. A third reservoir in the northwest part of Bremner was included to accommodate initial development in Bremner. The development in Bremner is expected to start in the northwest area, and due to proximity to the existing water main, interim water servicing can be easily accommodated. The northwest reservoir can also make the County's preferred supply option easier due to lower delivery pressure requirements. Although the addition of this third reservoir would increase some operation and maintenance costs, a third reservoir also provides some operational flexibility if one of the reservoirs was to be shut down for maintenance.

The onsite servicing plan based on three reservoirs is shown on **Figure 3.6**. The onsite system in general ranges from 250 to 600 mm diameter water mains. The flow triggers for major water distribution system components based on Option 1 interim and Option 1 ultimate supply main are summarized in **Table 3.16**.

Table 3.16 Summary of Interim and Ultimate Water Supply Requirements

Year	Trigger	Water Infrastructure Implementation	Remark
2023	Development start with single family residential	Construction of interim supply line	HNA required to ensure sufficient fire protection is available
2025	Development start of higher density residential and/or non-residential service areas	Construct initial stage of northwest reservoir and pumphouse	
2035	Total Bremner and LEA ADD demand reaches 55 L/s	Construct 2nd stage of northwest reservoir and pumphouse	Timing based on County design standards
2040	Total Bremner and LEA ADD demand reaches 97 L/s	Construct offsite water main to Clareview reservoir	Coordinate with EPCOR
2043	Total Bremner and LEA ADD demand reaches 131 L/s	Construct Southwest Reservoir	
2052	Total Bremner and LEA ADD demand reaches 260 L/s	Construct Southeast Reservoir	

The above triggers are based on growth projections provided in **Table 2.4** for Bremner, LEA and Cambrian Crossing. The offsite supply main is projected to be required in 2040. This timing requirement is subject to change based on the County's Water Master Plan update to determine the County's water infrastructure's ability to supply the required flow rates considering growth in NoY and West of 21.

3.7 WATER SERVICING CONCLUSIONS AND RECOMMENDATIONS

3.7.1 Offsite Servicing

The key conclusions and recommendations for offsite water servicing are as follows:

- Two offsite water supply connection options for Bremner were considered, (see **Figure 3.1** for alignments):
    - Option 1 - Clareview Reservoir in northeast Edmonton, 900 mm diameter, approximately 12.8 km in length and total estimated cost of $52M
    - Option 2 - 34 Street and 92 Avenue where the County currently receives water from, 900 mm diameter, approximately 20.6 km in length and total estimated cost of $78M
- For sizing of the supply main, EPCOR's lower water consumption rate standards have been used.
- Option 1 is preferred by the County as it provides a secondary supply source for the County which would reduce potential risk of supply disruption.
- Preliminary assessment completed by EPCOR indicates that the City's internal system may need to be upgraded to accommodate Bremner and other Edmonton area developments. EPCOR is currently assessing in detail both the internal growth of the City as well as the external growth of it's regional customers through transmission master planning process. This analysis will inform EPCOR regarding which water supply connection option (Option 1 – Clareview Reservoir or Option 2 - 34 Street and 92 Avenue) service location is preferable.

- Both supply options require a portion of the supply main to be installed inside the City of Edmonton boundary. EPCOR has indicated they may likely construct the section in Edmonton and own and operate this section. For Option 1 a river crossing is required in Edmonton. Ownership and cost sharing discussions are ongoing between the County and EPCOR and will have to be documented in a Bremner Water Supply Agreement.

3.7.2 Interim Servicing

For interim water servicing, two potential supply options were considered:

- Option 1 – Utilize the existing 400 mm main along the CP Rail at TWP RD 534 west of Highway 21
- Option 2 – Utilize the proposed 600 mm main along RR 231 via Cambrian

Based on the review of the two options, Option 1 is the preferred interim servicing option due to its proximity to the proposed initial development in the northwest part of Bremner. With Option 1, construction of the first stage of the reservoir in the northwest part of Bremner will be required by 2025 to meet higher density residential and non-residential fire flow requirements. With the interim supply, the ultimate offsite supply line is required in 2041.

3.7.3 Onsite Servicing

The onsite water servicing plan is shown on **Figure 3.6**. Details of the onsite servicing are as follows:

- Three equally sized reservoirs are proposed to service the Bremner ACP. The total required storage volume is 76,200 m^3 and the total cost of the three reservoirs including the pump houses is $114M.
- Within Bremner the distribution pipe sizes range from 300 mm to 600 mm diameter. As LEA is serviced to rural standards, 250 mm to 300 mm diameter pipe sizes are used. The total cost of the onsite distribution system is approximately $70.5M.
- Due to the topography, the lower elevation northern part of the Bremner service area is serviced by a separate pressure zone.

4.0 WASTEWATER SERVICING CONCEPT

This section provides the offsite and onsite wastewater servicing concept plan. The offsite system consists of wastewater conveyance to the Alberta Capital Region Wastewater Commission Treatment Plant (ACRWCTP). Interim conveyance options to the ACRWCTP have also been discussed. The onsite wastewater servicing plan includes the wastewater conveyance trunk system and identification of lift station requirements for low lying areas within Bremner.

As previously indicated, the LEA is located within the Rural Service Area as opposed to the Urban Service Area of the County. It is also identified within the Rural Area of the Edmonton Metropolitan Region Growth Plan; therefore, an urban level of service is not required. Through consultation it was also noted that the majority of the development in the LEA is anticipated to be large lot industrial and warehousing with low water usage and correspondingly low sewage generation rates. As higher intensity uses are not anticipated, it was determined early in the ACP process that rural water standards, onsite septic tank disposal for wastewater servicing and onsite fire suppression would be suitable for the area. Disposal of the septic tank contents will be achieved through a truck haul to the Clover Bar Wastewater Transfer Site.

The Bremner area will be serviced by the ACRWC treatment plant which is located northwest of the study area. Strathcona County is serviced by the Southeast Regional Trunk Sewer (SERTS) located on Range Road 232. As the existing SERTS has limited capacity, a new trunk system to service Bremner is required. However, interim servicing can be provided through the proposed Cambrian Crossing neighbourhood west of Bremner. As indicated in **Table 2.4**, development in Cambrian Crossing will start in 2021 and be completed in 2037.

The onsite wastewater servicing concept is also discussed in this section. The existing and planned wastewater infrastructure are shown on **Figure 4.1**.

4.1 WASTEWATER DESIGN STANDARDS

The wastewater servicing concept for the Bremner area has been designed using the Strathcona County standards. For the conveyance system design to the ACRWCTP, the offsite design flow has been determined based on ACRWC level of service design criteria for comparison purposes and potential storage requirement purposes. The following sections provide a summary of the design standards used for the design of the onsite and offsite wastewater collection system.

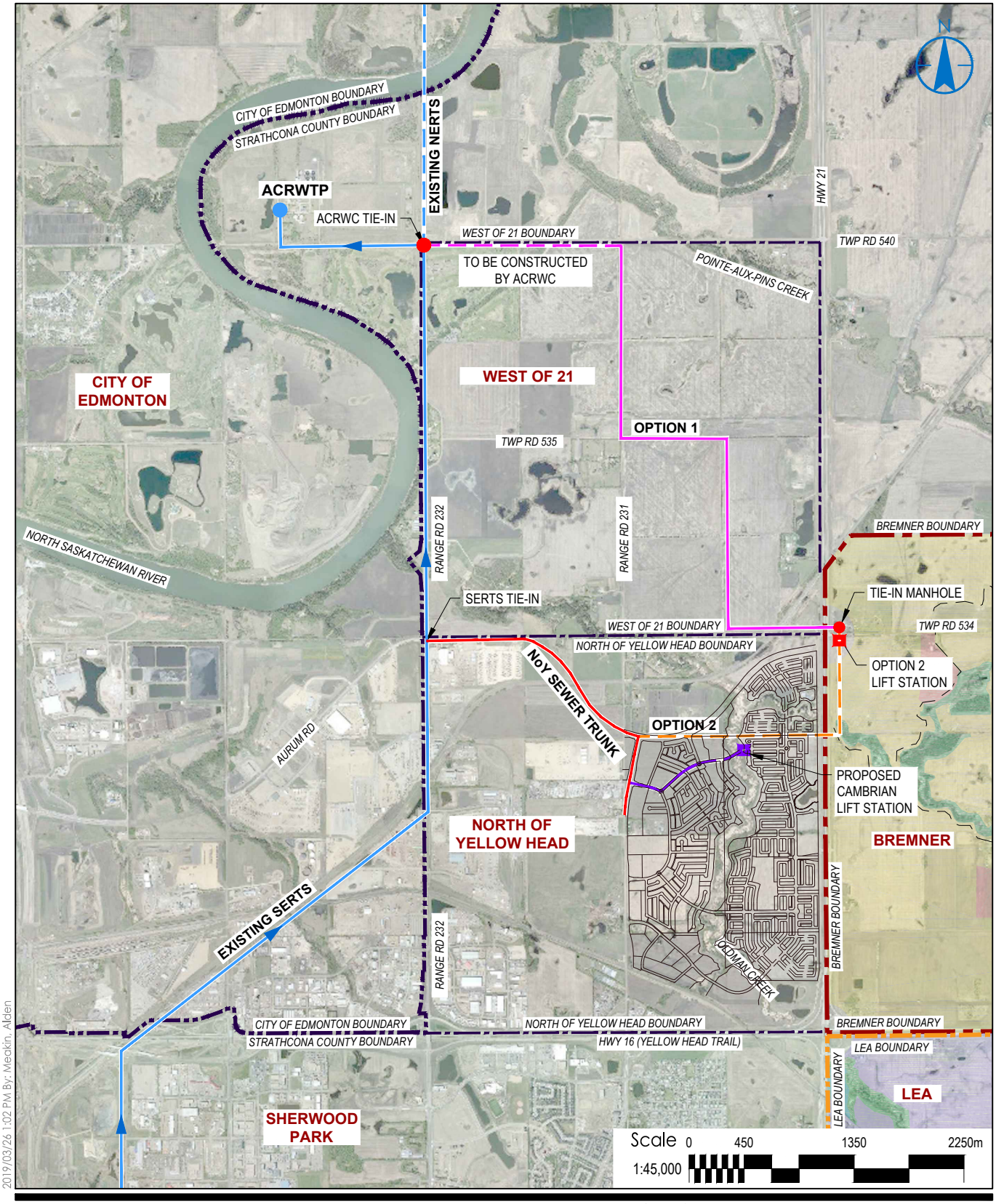
4.1.1 Strathcona County Design Standards

The key Strathcona County design parameters used in the design of the onsite and offsite wastewater collection system are as follows:

Average Wastewater Generation:

- Residential: 300 L/person/day
- Commercial / Industrial: 18,000 L/hectare/day

Residential Population Density: 3.5 persons/lot (Note: used for the onsite collection system design, for offsite conveyance system design the population density estimated for the ACP was used)



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Legend

- Area Boundary
- County/City Boundary
- Option 1 Trunk Sewer (By County)
- Option 1 Trunk Sewer (By Acrwc)
- Option 2 Trunk Sewer
- Option 2 Forcemain
- NoY Trunk Sewer
- Proposed Cambrian Trunk
- Proposed Cambrian Forcemain
- Existing SERTS
- Existing NERTS

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Figure No.

4.1

Title

Ultimate Wastewater Servicing Options

Peaking Factor:

- Residential: The greater of 2 or 2.6 x $P^{-0.1}$ with provision for an additional 24% more design capacity in new pipes that have a diameter of 375 mm or greater, where P = the design population in thousands
- Commercial / Industrial: 10 x $Q^{-0.45}$ with minimum 2.5 and maximum 25

Inflow and Infiltration (I/I) Allowance:

- General infiltration allowance of 0.28 L/s/ha (gross area)

Other Design Criteria:

- The wastewater sewers are sized using Manning's Equation with a Manning's roughness coefficient of 0.013
- Required sewer capacity = estimated design flow / 0.86
- Wastewater sewers are designed with minimum and maximum flow velocities of 0.6 m/s and 3.0 m/s, respectively
- Minimum pipe slope 0.15% for pipe sizes greater than or equal to 375 mm
- Minimum pipe diameter of 200 mm for residential and 300 mm for commercial / industrial

4.1.2 ACRWC Level of Service Standards

The ACRWC provides transmission and treatment of wastewater from member municipalities. The ACRWC has developed the level of service criteria for the design of it's transmission system and accepting the maximum flow rate from member municipalities. Flows generated in excess of the level of service may require onsite storage by the member municipality. The key ACRWC level of service design parameters are as follows:

Average Wastewater Generation:

- Residential: 320 L/person/day
- Commercial / Industrial: 6,170 L/hectare/day
- Neighbourhood Commercial / Industrial: 6,170 L/hectare/day

Peaking Factor:

- Residential: 2.6 x $P^{-0.1}$, where P = the design population in thousands
- Commercial / Industrial: 3.0
- Neighbourhood Commercial / Industrial: 3.0

Inflow and Infiltration (I/I) Allowance:

- Residential: 0.28 L/s/ha
- Commercial / Industrial: I/I allowance included in the average sewage generation rate
- Neighborhood Commercial / Industrial: 0.28 L/s/ha
- Existing I/I based on the 25 year 24 hour rainfall event

4.2 OFFSITE WASTEWATER SERVICING PLAN

Sewage generated from the Bremner development area will be conveyed to the Alberta Capital Region Wastewater Treatment Plant (ACRWTP). The following two potential offsite servicing options were considered as shown on **Figure 4.1**:

- Option 1 - New transmission main to ACRWCTP
- Option 2 - Servicing through the proposed North of Yellowhead conveyance system connecting to the Southeast Regional Trunk Sewer (SERTS)

From discussion with the ACRWC, the SERTS system does not have sufficient capacity to provide ultimate servicing for Bremner. ACRWC has suggested it would construct a portion of the new transmission system required to service Bremner along TWP RD 540 from RR 231 to RR 232. For ultimate servicing, both of the above offsite servicing options to ACRWC are presented. For the interim servicing, only the SERTS system is considered.

4.2.1 Offsite Servicing Design Wastewater Flow Rates

The wastewater flow to the offsite trunk is computed for the population projections presented in Section 2. The flow projections include projected flow rates for Bremner, North of Yellowhead and West of 21. For non-residential service areas, the development projections have been estimated based on population projections in Bremner, i.e. non-residential service area development beginning in 2023 and completed in 2060. The design flows have been determined based on the County standards and ACRWC level of service parameters. The non-residential service area within Bremner is assumed to be neighborhood commercial / industrial areas for the purpose of computing I/I contributions when using the ACRWC level of service parameters. For LEA servicing, it is assumed that it will not contribute any flow.

The computed wastewater flows and required pipe sizes are provided in **Table 4.1** and **Table 4.2**, respectively, for the offsite trunk using the two design criteria. As portions of the offsite trunk will be design and constructed by the ACRWC and the County, the County and ACRWC should work together to identify appropriate design parameters for the offsite wastewater system design.

Depending on the conveyance option and combination of service areas, the required trunk sizes will be different as indicated in **Table 4.2**. The design flow rates and pipe sizing requirements were computed for 2044 and 2060. Full development of Bremner is expected by 2060 based on the population projections developed for the ACP. The residential service area in Cambrian is expected to be fully serviced by 2037 as per the ACP population projections, see **Table 2.4**. The non-residential service area within all of the affected areas (Bremner, N of Y and West of 21) is assumed to be fully developed by 2060.

Table 4.1 Offsite Servicing Capacity Requirements

Service Area	Population	Residential Service Area (ha)	Non-Residential Service Area (ha)	Total Service Area (ha)	Average Residential Flow Rate (L/s)	Average Non-Res Flow rate (L/s)	Residential Peaking Factor	Non-Residential Peaking Factor	Peak DWF (L/s)	Inflow / Infiltration (L/s)	Total Design Flow (L/s)	Required Sewer Capacity (L/s)
Strathcona County Standards Residential Wastewater Generation Rate: 300 L/c/d Non-Res Wastewater Generation Rate: 18 m^3/d/ha Residential Peaking Factor: 2.6 x $P^{-0.1}$, P in 1,000 and Minimum 2.0 Non-Res Peaking Factor: 10 x $Q^{-0.45}$, Min 2.5, Max 25 Inflow and Infiltration (I/I): 0.28 L/s/ha Required Sewer Capacity: Design Flow * 1.24 (for pipe sizes ≥375 mm diameter)												
2044 - Bremner	29,070	282.0	95.5	377.5	101	20	2.0	2.6	254	106	359	446
Ultimate - Bremner	79,074	767.0	259.7	1026.7	275	54	2.0	2.5	684	287	972	1,205
2044 - NoY	13,634	172.4	131.2	303.6	47	27	2.0	2.5	163	85	248	308
Ultimate - NoY	13,634	172.4	357.0	529.4	47	74	2.0	2.5	281	148	429	532
2044 - Wof21			188.4	188.4	0	39	0.0	2.5	98	53	151	187
Ultimate - Wof21			512.4	512.4	0	107	0.0	2.5	267	143	410	509
ACRWC Level of Service Parameters Residential Wastewater Generation Rate: 320 L/c/d Non-Res Wastewater Generation Rate: 6.17 m^3/d/ha, Residential Peaking Factor: 2.6 x $P^{-0.1}$, P in 1000 Non-Res Peaking Factor: 3.0 Inflow and Infiltration (I/I): 0.28 L/s/ha (for Residential and Neighbourhood Commercial/Industrial)												
2044 - Bremner	29,070	282.0	95.5	377.5	108	7	1.9	3.0	220	79	299	299
Ultimate - Bremner	79,074	767.0	259.7	1026.7	293	19	1.7	3.0	547	215	762	762
2044 - NoY	13,634	172.4	131.2	303.6	50	9	2.0	3.0	129	48	177	177
Ultimate - NoY	13,634	172.4	357.0	529.4	50	25	2.0	3.0	178	48	226	226
2044 - Wof21			188.4	188.4	0	13	0.0	3.0	40	0	40	40
Ultimate - Wof21			512.4	512.4	0	37	0.0	3.0	110	0	110	110

Note: 1) As per the ACRWC sewage generation parameters, separate I/I flow contribution is not computed for the non-residential service areas of NoY and West of 21, For ACRWC design flow computations, the 0.28 L/s I/I parameter only applies to residential and neighbourhood commercial/industrial areas.

2) The LEA will be serviced by septic tank with disposal via truck haul and as result there is no flow contribution to Bremner system.

Table 4.2 Offsite Trunk Sizes

						Required Pipe Size @0.15% Slope (mm)		
Offsite Bremner Wastewater Conveyance Option	**Growth Scenario**	**Bremner Required Capacity (L/s)**	**West of 21 Required Capacity (L/s)**	**NoY Required Capacity (L/s)**	**Total Required Capacity (L/s)**	**Bremner**	**Bremner + West of 21**	**Bremner + NoY**
Design Capacity Requirements and Trunk Sizes Based on Strathcona County Design Standards								
Option 1	2044	445.6	187.1		632.7	900.0	900.0	
	Ultimate	1205.1	508.8		1713.9	1200.0	1350.0	
Option 2	2044	445.6		307.7	753.3	900.0		1050.0
	Ultimate	1205.1		531.9	1737.0	1200.0		1350.0
Design Capacity Requirements and Trunk Sizes Based on ACRWC Level Service Design Parameters								
Option 1	2044	299.3	40.4		339.7	675.0	750.0	
	Ultimate	762.3	109.8		872.1	1050.0	1050.0	
Option 2	2044	299.3		177.5	476.8	675.0		900.0
	Ultimate	762.3		225.9	988.2	1050.0		1050.0

4.2.2 Option 1 - New Trunk via West of 21 to ACRWCTP

For Option 1, the proposed sanitary trunk to service Bremner will be constructed through the proposed West of 21 development. The proposed trunk will drain west along TWP RD 534, follow the quarter section line north to TWP RD 535, then drain west along TWP RD 535 to RR 231, then drain north parallel to the existing SERTS line along RR 231 to TWP RD 540 tying in to the existing siphon portion of the combined SERTS and NERTS line. Based on the recent study by ACRWC, the combined SERTS and NERTS line to the plant needs to be upsized for future servicing requirements. Based on discussions with the ACRWC, the ACRWC will fund a portion of the Bremner trunk along TWP RD 540 between RR 231 and RR 232, as shown on **Figure 4.1**.

The proposed alignment for Option 1 is shown on **Figure 4.1**. The proposed alignment is selected to avoid construction along Highway 21 due to Alberta Transportation restrictions and to avoid crossing the Oldman Creek valley near TWP RD 534 and RR231, and Pointe-Aux-Pins Creek near TWP RD 540.

Figure 4.2 shows the vertical configuration of the trunk along the proposed alignment. As shown on **Figure 4.2**, the existing topography allows gravity servicing of Bremner to the ACRWC system. The length of the proposed offsite trunk is approximately 6.6 km.

Onsite Bremner wastewater servicing is discussed in **Section 4.3**. Due to the significant drop in elevation in the north areas within Bremner, two lift stations for local servicing are required.

4.2.3 Option 2 – Servicing through NoY / SERTS System

Under this offsite servicing option, the wastewater flows from Bremner would be directed using a lift station in Bremner to the proposed NoY gravity trunk sewer in Cambrian Crossing on the west side of Oldman Creek. The flow would then be conveyed by the proposed NoY trunk as shown on **Figure 4.1**.

The wastewater from the NoY trunk would then flow downstream to the existing ACRWC's SERTS trunk along RR 232. The existing SERTS system conveys the flows to the ACRWC treatment plant located northwest of the corner of TWP RD 540 and RR 232. Based on the recent NERTS and SERTS North Wastewater Transmission System Report completed by the ACRWC, the existing SERTS trunk does not have sufficient capacity to service all of the Bremner service area and as a result ACRWC does not support this servicing option. However, ACRWC has indicated it would permit servicing of Bremner on an interim basis. Therefore, this option is only further reviewed for interim servicing. The existing SERTS trunk has capacity to service the NoY area.

This option is further considered in **Section 4.4** to provide interim servicing for Bremner until most of the available spare capacity within the existing and proposed systems is utilized.

4.2.4 Conceptual Design of Offsite Wastewater Trunk

A high level conceptual design (profile) of the offsite wastewater trunk sewer is shown on **Figure 4.2** for Option 1. The conceptual design indicates the following challenges along the proposed Option 1 alignment that will require actions to mitigate risks:

- Proposed interchange crossing at Highway 21 and TWP RD 534
- CP Rail crossing along TWP RD 534
- County's 400 mm diameter water main parallel to the CP Rail at TWP RD 534
- Oil and gas pipelines parallel to the CP Rail at TWP RD 534

- Major oil and gas pipeline corridor along TWP RD 534
- Approximately 2.4 km of easement within West of 21
- Connection to ACRWC's SERTS line at RR 232 and TWP RD 540
- Coordination with the ACRWC for funding and construction of the downstream segment from RR 231 to RR 232 along TWP RD 540

For Option 1 conceptual design pipe sizing purposes, it is assumed all of the West of 21 is serviced by the proposed offsite trunk at the upstream end of the system.

4.2.5 Offsite Wastewater Servicing Costs

The offsite wastewater servicing costs for the ultimate development condition have been estimated for Option 1 based on the conceptual design presented on **Figure 4.2**. The opinion of probable costs for offsite servicing is summarized in **Table 4.4** along with onsite servicing costs based on the identified design constraints in **Section 4.2.4.** For Option 1, approximately 2.4 km of the pipe length will need to be constructed using microtunneling and approximately 4.9 km of the pipe length will need to be constructed using open cut with possibly trench shoring and restoring roadways. The total proposed offsite trunk will cost approximately $45M. This cost includes 50% for engineering and contingencies.

4.3 INTERIM WASTEWATER SERVICING AND STAGING PLAN

For interim wastewater servicing, the following two outlet options were considered as shown on **Figure 4.3**:

- Option 1 – SERTS Trunk at TWP RD 535 and RR 232
- Option 2 – Proposed NoY Trunk in Cambrian Crossing

Details of the above interim servicing options are discussed in the following section.

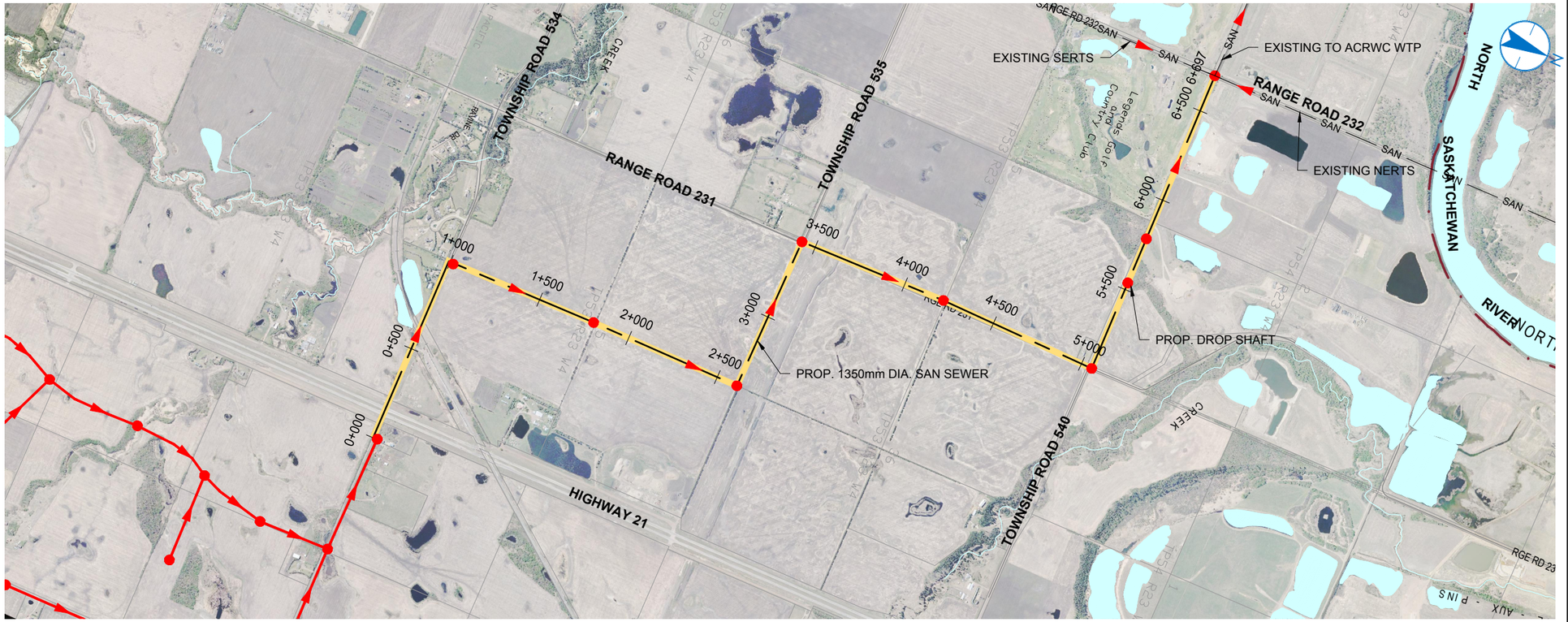
4.3.1 Option 1 - SERTS Trunk at TWP RD 535 and RR 232

For interim wastewater servicing Option 1, an interim lift station would be constructed to discharge flow via a forcemain to the existing SERTS trunk along RR 232. The forcemain would be installed along TWP RD 534 and would be approximately 3.5 km in length. The SERTS trunk has an allocated capacity of 429 L/s (see **Table 4.1** for NoY ultimate flow rate based on the County design standards) for the proposed NoY trunk sewer. A portion of this capacity could be utilized for Bremner servicing. The NoY service area includes Cambrian Crossing and a large non-residential service area. The growth projection for Cambrian Crossing is provided in **Table 2.4** which indicates start of development in 2021 and completion of development by 2037. Assuming the non-residential area is developed within the same timeframe, the combined projected flow rate of 429 L/s from the NoY and Bremner would reach in 2033. At this time, the projected wastewater flow in Bremner would be 125 L/s. When this capacity is reached the ultimate offsite wastewater trunk would need to be constructed.

The interim servicing cost for a 125 L/s lift station and 300 mm diameter 3.5 km forcemain would be $4.5M.

4.3.2 Option 2 – Proposed NoY Trunk in Cambrian Crossing

Under Option 2 interim wastewater servicing, an interim lift station would be constructed to discharge flow via a forcemain to the proposed NoY gravity trunk sewer immediately west of Cambrian Crossing at realigned TWP RD



PLAN
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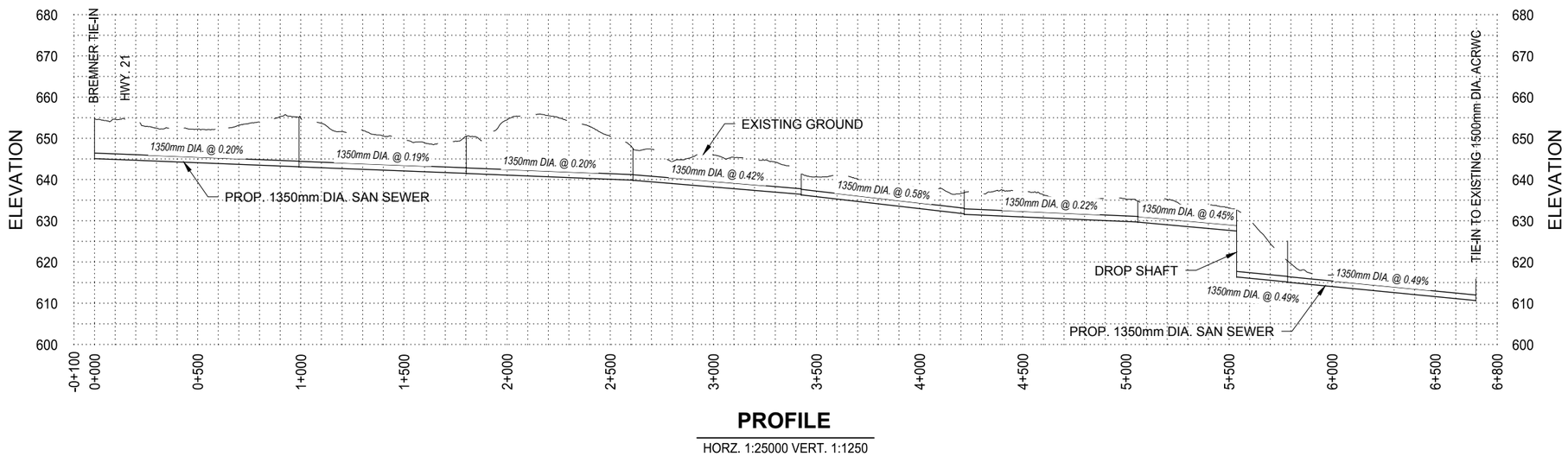


PROFILE
HORZ. 1:25000 VERT. 1:1250

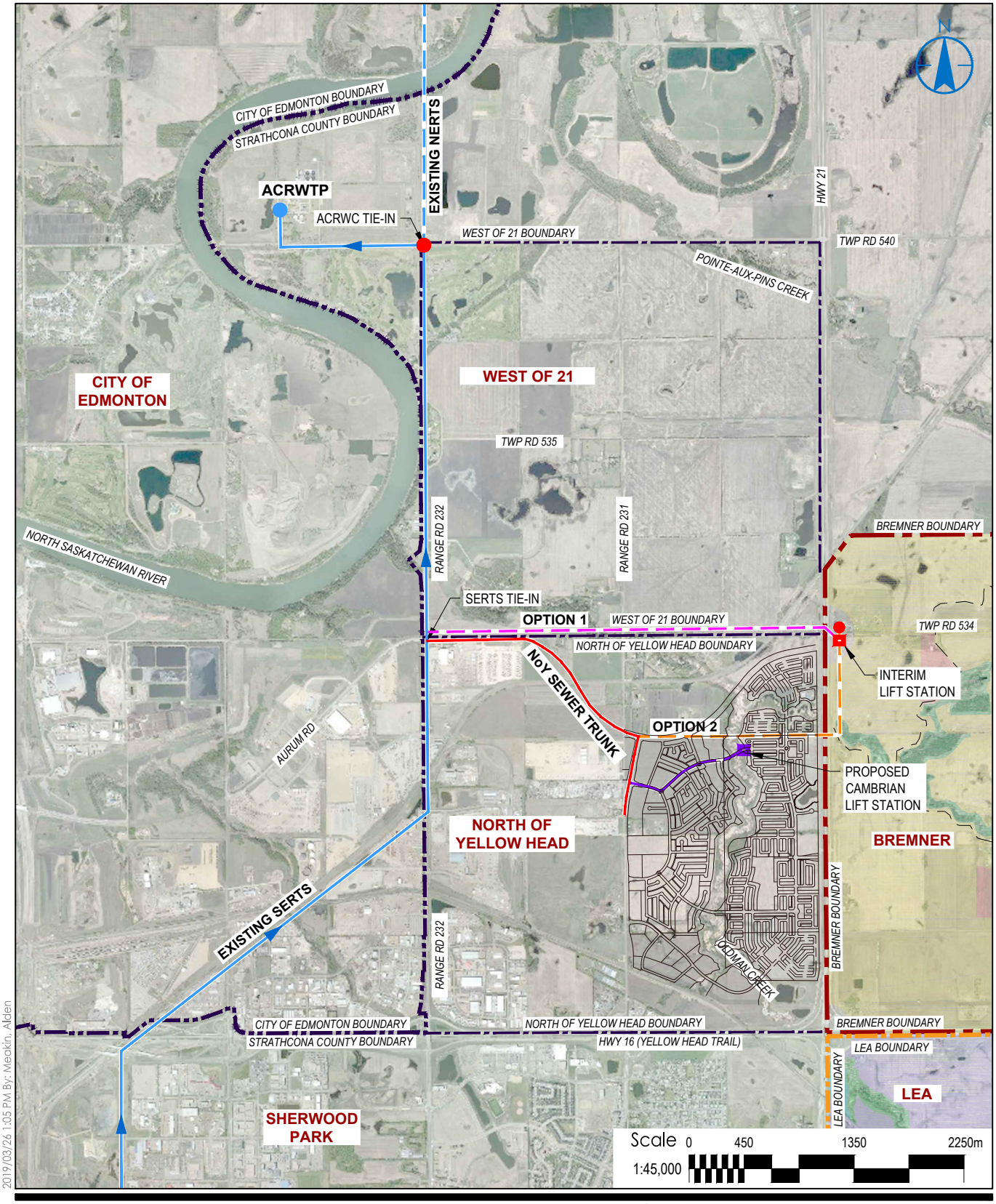
Stantec
400-10220 103 Avenue NW
Edmonton AB
www.stantec.com

Legend
- Proposed Offsite Sanitary Trunk
- Proposed Onsite Sanitary Trunk
- Proposed Onsite and Offsite Sanitary Manhole
- SAN — Existing ACRWC Sanitary Trunks

Client/Project
STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.
4.2

Title
Offsite Wastewater Trunk
Plan and Profile



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Legend

- Area Boundary
- County/City Boundary
- Option 1 Trunk Sewer (By County)
- Option 1 Trunk Sewer (By Acrwc)
- Option 2 Trunk Sewer
- Option 2 Forcemain
- NoY Trunk Sewer
- Proposed Cambrian Trunk
- Proposed Cambrian Forcemain
- Existing SERTS
- Existing NERTS

Client/Project

STRATHCONA COUNTY

BREMNER ACP UTILITIES MASTER PLAN

Figure No.

4.3

Title

Interim Wastewater Servicing Options

534 and RR 231. A part of the forcemain would be installed in Bremner on the east side Highway 21 and then west to the proposed NoY gravity trunk sewer at RR 231. The total length of the forcemain would be approximately 3.0 km.

The capacity of the proposed NoY trunk sewer immediately west of Cambrian Crossing is approximately 958 L/s (NoY Preliminary Design Report). Based on the growth projections indicated in **Table 2.4**, the combined projected flow rate of 429 L/s (allocated capacity within SERTS based on the County design standards) from the NoY and Bremner would be reached by 2033. At this time, the projected wastewater flow in Bremner would be 125 L/s. When this capacity is reached the ultimate offsite wastewater trunk would need to be constructed.

The interim servicing cost for a 125 L/s lift station and 300 mm diameter 3.0 km forcemain would be $4.3M. For this interim servicing option, the proposed NoY trunk in Cambrian Crossing needs to be constructed.

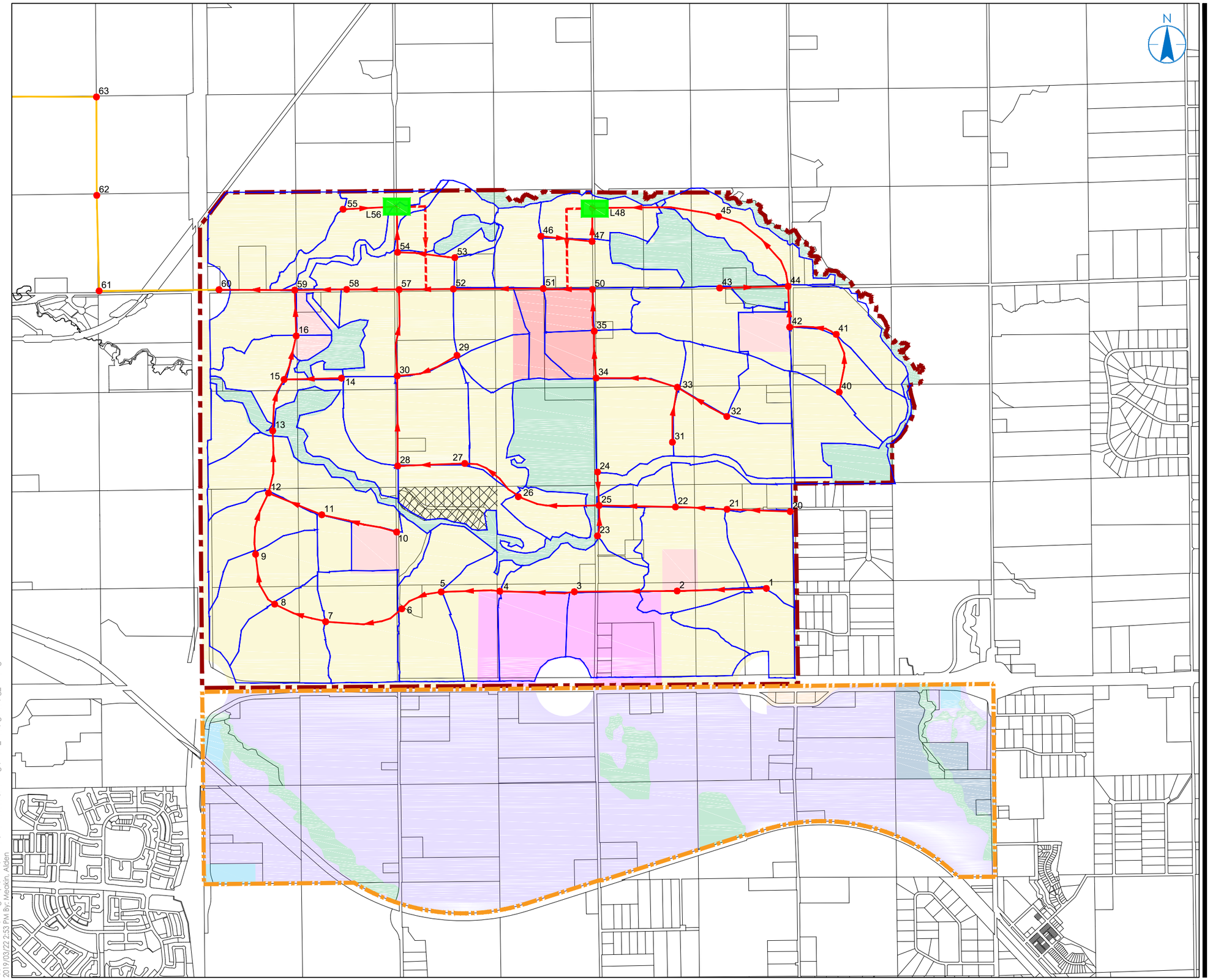
4.3.3 Interim Wastewater Servicing Option Summary

As the timeline for infrastructure in NoY is uncertain, Option 1 interim servicing is recommended as it does not rely on development in Cambrian Crossing. Due to the onsite and ultimate offsite servicing requirements, the interim lift station and forcemain will need to be abandoned when the offsite trunk sewer is constructed, i.e. all interim servicing cost will be a throw away cost.

Before the combined total flow of NoY and Bremner reaches the allocated capacity of 429 L/s, the proposed Bremner offsite trunk sewer will need to be constructed in coordination with the ACRWC at a total cost of $45M. This flow rate is projected in 2033. The projected flow rate for Bremner will be 125 L/s and 307 L/s for NoY.

4.4 ONSITE WASTEWATER SERVICING PLAN

The onsite wastewater servicing plan has been developed to convey the flow to the northwest area of Bremner near TWP RD 534 and Highway 21. From this point, the flow would be conveyed to the ACRWC treatment plant via an offsite trunk system through West of 21. The proposed onsite trunk system layout is shown on **Figure 4.4**. The trunk sewers generally follow the proposed road network in Bremner and have been designed by analyzing the existing topography and using the County's design standards outlined in **Section 4.1**. The proposed onsite wastewater collection system design calculations are provided in **Table 4.3**. As indicated in previous sections, the proposed onsite wastewater collection system does not include onsite servicing of LEA as it is proposed to be serviced by a septic tank system with disposal via a truck haul to the Clover Bar Wastewater Transfer Site.



Stantec

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Legend

- 54 — Manhole / Manhole Number
- Proposed Sanitary Trunk
- Sanitary Subcatchment Boundary
- Proposed Forcemain
- Proposed Offsite Sanitary Trunk
- Proposed Lift Station
- Bremner Boundary
- LEA Boudary

Scale

0 250 500 1000 1500m

1:30,000

Client/Project

STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.

4.4

Title

Proposed Onsite Wastewater Servicing Plan

BREMNER ACP UTILITIES MASTER PLAN

Wastewater Servicing Concept
March 26, 2019

Table 4.3 Onsite Wastewater Collection System Design Calculations

		Residential Flow							Non-Residential Flow																		Trunk Sewer Opinion of Probable Cost						
From MH	To MH	Added Net Residential Area (ha)	Added Population	Total Population	Added Residential ADWF (L/s)	Total Residential ADWF (L/s)	Peak Factor	Total Residential PDWF (L/s)	Added Non-Residential Area (ha)	Added Non-Residential ADWF (L/s)	Total Non-Residential ADWF (L/s)	Peak Factor	Total Non-Residential PDWF (L/s)	Total PDWF (L/s)	Added I/I (L/s)	Total I/I (L/s)	Design Flow (L/s)	Flow From Lift Station (L/s)	Factored Design Flow (L/s)	Length (m)	Sewer Diameter (mm)	Slope (%)	Sewer Capacity (L/s)	Ratio Q/Qc	Velocity (m/s)	Drop Provided (m)	US Grnd Elevation (m)	DS Grnd Elevation (m)	US Depth (m)	DS Depth (m)	Pipe Unit Price ($/m)	Pipe Cost ($)	Number of Manholes	Average Depth (m)	MH Unit Price ($/vm)	MH Cost ($)	Total Pipe Cost (s)
1	2	20.1	2079	2079	7.2	7.2	2.42	17.4	0.0	0.0	0.0	0.0	0.0	17	11	11	28	0	41	733	300	0.20	43	0.94	0.65		694.1	698.6	5.00	10.97							
2	3	5.6	577	2656	2.0	9.2	2.36	21.7	0.8	0.2	0.2	22.0	3.8	26	3	14	40	0	57	845	375	0.20	78	0.73	0.73		698.6	693.9	11.04	8.03	$6,000	$5,067,066	10	9.54	3,500	333,732	$5,400,798
3	4	16.6	1717	4373	6.0	15.2	2.24	34.1	41.8	8.7	8.9	3.7	33.2	67	21	35	102	0	147	613	375	0.92	168	0.87	1.60	1.6	693.9	683.6	9.66	5.00	$6,000	$3,678,918	7	7.33	3,500	179,582	$3,858,500
4	5	0.0	0	4373	0.0	15.2	2.24	34.1	36.9	7.7	16.6	2.8	46.8	81	10	45	126	0	181	482	525	0.20	192	0.94	0.98		683.6	683.1	5.15	5.61	$1,800	$867,328	6	5.38	3,500	113,019	$980,347
5	6	19.4	2008	6381	7.0	22.2	2.16	47.9	0.0	0.0	16.6	2.8	46.8	95	10	55	150	0	216	363	525	0.65	346	0.62	1.57	3.8	683.1	676.3	9.44	5.00	$6,750	$2,453,200	4	7.22	3,500	101,106	$2,554,306
6	7	30.3	3126	9507	10.9	33.0	2.08	68.5	0.0	0.0	16.6	2.8	46.8	115	16	72	187	0	270	660	600	0.20	275	0.98	1.07		676.3	685.4	5.08	15.49	$7,125	$4,702,001	8	10.28	3,500	287,978	$4,989,979
7	8	29.1	3006	12513	10.4	43.4	2.02	87.7	0.0	0.0	16.6	2.8	46.8	135	16	87	222	0	320	446	675	0.20	376	0.85	1.15		685.4	685.9	15.57	16.96	$7,875	$3,509,076	5	16.27	3,500	284,645	$3,793,722
8	9	25.9	2671	15184	9.3	52.7	2.00	105.4	0.0	0.0	16.6	2.8	46.8	152	14	101	253	0	365	459	675	0.20	376	0.97	1.17		685.9	678.0	16.99	10.01	$7,875	$3,614,554	5	13.50	3,500	236,251	$3,850,805
9	12	24.8	2567	17751	8.9	61.6	2.00	123.3	0.0	0.0	16.6	2.8	46.8	170	13	114	284	0	410	526	675	0.58	642	0.64	1.80	1.1	678.0	668.8	11.14	5.00	$7,875	$4,138,809	6	8.07	3,500	169,460	$4,308,269
10	11	4.7	488	488	1.7	1.7	2.79	4.7	13.9	2.9	2.9	6.2	17.9	23	6	6	29	0	42	632	300	0.84	89	0.47	1.09		678.4	673.1	5.00	5.00							
11	12	6.4	659	1147	2.3	4.0	2.56	10.2	0.0	0.0	2.9	6.2	17.9	28	3	10	38	0	55	473	300	0.84	89	0.62	1.16		673.1	668.8	5.33	5.00							
12	13	18.5	1915	20813	6.6	72.3	2.00	144.5	0.0	0.0	19.5	2.6	51.2	196	10	134	330	0	476	516	675	0.63	669	0.71	1.93	10.5	668.8	655.0	15.53	5.00	$7,875	$4,064,760	6	10.27	3,500	215,565	$4,280,325
13	15	31.3	3229	24042	11.2	83.5	2.00	167.0	0.0	0.0	19.5	2.6	51.2	218	17	151	369	0	532	440	900	0.20	810	0.66	1.31		655.0	658.9	5.23	10.00	$8,700	$3,824,398	5	7.61	3,500	133,255	$3,957,653
14	15	14.8	1528	1528	5.3	5.3	2.49	13.2	0.0	0.0	0.0	0.0	0.0	13	8	8	21	0	30	472	300	0.20	43	0.71	0.61		659.5	658.9	5.00	5.34							
15	16	16.3	1687	27257	5.9	94.6	2.00	189.3	0.0	0.0	19.5	2.6	51.2	240	9	168	408	0	588	373	900	0.20	810	0.73	1.36		658.9	654.5	10.03	6.38	$8,700	$3,246,422	4	8.21	3,500	114,903	$3,361,325
16	59	21.2	2185	29442	7.6	102.2	2.00	204.5	4.9	1.0	20.5	2.6	52.6	257	13	180	437	0	631	376	900	0.21	830	0.76	1.40		654.5	652.3	6.41	5.00	$2,400	$902,198	4	5.71	3,500	79,873	$982,072
20	21	17.2	1781	1781	6.2	6.2	2.45	15.2	0.0	0.0	0.0	0.0	0.0	15	9	9	24	0	35	519	300	0.20	43	0.81	0.63		689.5	695.3	5.00	11.84							
21	22	15.4	1591	3372	5.5	11.7	2.30	27.0	0.0	0.0	0.0	0.0	0.0	27	8	17	44	0	64	424	375	0.20	78	0.82	0.75		695.3	690.9	11.91	8.36	$6,000	$2,542,440	5	10.14	3,500	177,406	$2,719,846
22	25	21.3	2205	5577	7.7	19.4	2.19	42.4	10.0	2.1	2.1	7.2	15.0	57	14	32	89	0	128	627	375	0.62	138	0.93	1.36		690.9	683.6	8.39	5.00	$1,650	$1,035,108	7	6.70	3,500	164,043	$1,199,150
24	25	24.0	2480	2480	8.6	8.6	2.37	20.4	0.0	0.0	0.0	0.0	0.0	20	13	13	33	0	48	275	375	0.20	78	0.61	0.68		681.8	683.6	5.00	7.35	$1,650	$454,308	3	6.18	3,500	64,841	$519,149
23	25	17.8	1840	1840	6.4	6.4	2.45	15.6	0.0	0.0	0.0	0.0	0.0	16	10	10	25	0	36	252	300	0.20	43	0.84	0.62		683.2	683.6	5.00	5.90							
25	26	7.1	738	10635	2.6	36.9	2.05	75.8	0.0	0.0	2.1	7.2	15.0	91	4	58	149	0	214	676	600	0.20	275	0.78	1.04		683.6	683.9	7.58	9.23	$7,125	$4,817,134	8	8.40	3,500	235,249	$5,052,384
26	27	9.6	996	11631	3.5	40.4	2.03	82.2	0.0	0.0	2.1	7.2	15.0	97	5	63	160	0	231	557	600	0.20	275	0.84	1.04		683.9	685.4	9.26	11.87	$7,125	$3,966,858	6	10.56	3,500	221,857	$4,188,715
27	28	15.4	1655	13286	5.7	46.1	2.01	92.6	0.0	0.0	2.1	7.2	15.0	108	8	71	179	0	258	552	600	0.56	460	0.56	1.56	1.4	685.4	674.0	13.30	5.00	$7,125	$3,929,758	6	9.15	3,500	192,164	$4,121,922
28	30	23.1	2438	15724	8.5	54.6	2.00	109.2	0.0	0.0	2.1	7.2	15.0	124	12	84	208	0	300	739	675	0.20	376	0.80	1.13		674.0	675.6	5.07	8.15	$2,400	$1,774,325	9	6.61	3,500	208,351	$1,982,675
29	30	7.1	735	735	2.6	2.6	2.68	6.8	5.2	1.1	1.1	9.7	10.4	17	5	5	22	0	32	528	300	0.98	96	0.34	1.00	1.0	681.8	675.6	6.00	5.00							
30	57	24.0	2476	18935	8.6	65.7	2.00	131.5	0.0	0.0	3.2	6.0	18.8	150	13	102	252	0	364	712	675	0.55	623	0.58	1.70	13.4	675.6	655.1	21.58	5.00	$7,875	$5,610,607	8	13.29	3,500	372,170	$5,982,777
32	33	11.1	1152	1152	4.0	4.0	2.56	10.3	0.0	0.0	0.0	0.0	0.0	10	6	6	16	0	23	473	300	1.02	97	0.24	0.89	1.1	694.2	688.3	6.10	5.00							
31	33	22.5	2324	2324	8.1	8.1	2.39	19.3	0.0	0.0	0.0	0.0	0.0	19	12	12	31	0	45	454	375	0.20	78	0.58	0.67		684.2	688.3	5.00	10.01	$6,000	$2,724,912	5	7.50	3,500	131,323	$2,856,235
33	34	11.6	1201	4677	4.2	16.2	2.23	36.2	0.0	0.0	0.0	0.0	0.0	36	6	24	60	0	87	678	450	0.20	128	0.68	0.80		688.3	695.1	10.08	18.24	$6,375	$4,319,847	8	14.16	3,500	396,506	$4,716,353
34	35	0.0	0	4677	0.0	16.2	2.23	36.2	0.0	0.0	0.0	0.0	0.0	36	0	24	60	0	87	385	450	0.20	128	0.68	0.80		695.1	687.8	18.27	11.74	$6,375	$2,457,467	4	15.00	3,500	210,056	$2,667,523
35	50	14.8	1526	6203	5.3	21.5	2.17	46.7	13.8	2.9	2.9	6.2	17.9	65	12	36	101	0	145	345	450	0.70	239	0.61	1.46	5.8	687.8	672.8	17.57	5.00	$6,375	$2,198,706	4	11.28	3,500	157,987	$2,356,692
50	51	5.8	597	6800	2.1	23.6	2.15	50.7	13.9	2.9	5.8	4.5	26.2	77	7	43	120	213	481	405	750	0.22	516	0.93	1.29		672.8	671.9	5.30	5.27	$2,175	$880,025	5	5.28	3,500	92,487	$972,512
51	52	0.0	0	6800	0.0	23.6	2.15	50.7	14.8	3.1	8.9	3.7	33.2	84	4	47	131	213	497	739	750	0.54	819	0.61	1.84	4.7	671.9	662.9	10.00	5.00	$7,875	$5,816,010	9	7.50	3,500	236,250	$6,052,260
52	57	12.0	1239	8039	4.3	27.9	2.11	58.9	2.7	0.6	9.4	3.6	34.3	93	7	54	148	213	521	446	750	0.55	829	0.63	1.88	5.3	662.9	655.1	10.33	5.00	$7,875	$3,510,455	5	7.66	3,500	134,137	$3,644,592
Northeast Lift Station Basin																																				
40	41	18.2	1880	1880	6.5	6.5	2.44	15.9	0.0	0.0	0.0	0.0	0.0	16	10	10	26	0	37	492	300	0.95	94	0.39	1.05	23.6	694.8	666.5	28.60	5.00							
41	42	21.3	2200	4080	7.6	14.2	2.26	32.0	0.0	0.0	0.0	0.0	0.0	32	11	21	53	0	77	399	375	0.20	78	0.98	0.76		666.5	666.6	5.08	5.97	$1,350	$538,842	4	5.52	3,500	77,338	$616,180
42	44	1.9	195	4275	0.7	14.8	2.25	33.4	13.6	2.8	2.8	6.3	17.7	51	5	26	77	0	111	336	375	0.83	160	0.69	1.42	8.0	666.6	654.8	14.00	5.00	$6,000	$2,015,868	4	9.50	3,500	133,023	$2,148,891
43	44	20.6	2127	2127	7.4	7.4	2.41	17.8	0.0	0.0	0.0	0.0	0.0	18	11	11	29	0	42	563	300	0.92	93	0.45	1.09	3.9	663.9	654.8	8.90	5.00							
44	45	19.8	2050	8452	7.1	29.3	2.10	61.6	0.0	0.0	2.8	6.3	17.7	79	11	48	127	0	183	863	450	0.59	218	0.84	1.47		654.8	649.7	5.15	5.12	$1,650	$1,424,561	10	5.14	3,500	179,725	$1,604,286
45	L48	20.6	2124	10576	7.4	36.7	2.05	75.4	0.0	0.0	2.8	6.3	17.7	93	11	59	152	0	219	1044	525	0.31	240	0.91	1.21		649.7	646.3	5.20	5.04	$1,800	$1,879,324	13	5.12	3,500	232,960	$2,112,284
46	47	13.3	1369	1369	4.8	4.8	2.52	12.0	0.0	0.0	0.0	0.0	0.0	12	7	7	19	0	28	422	300	0.20	43	0.64	0.58		649.2	651.7	5.00	8.34							
47	L48	33.0	3407	4776	11.8	16.6	2.22	36.9	0.0	0.0	0.0	0.0	0.0	37	18	25	62	0	89	275	375	0.74	150	0.59	1.32		651.7	646.3	8.42	5.05	$1,650	$453,900	3	6.73	3,500	70,691	$524,591
Forcemain																																				
L48	50																																			

Table 4.3 Onsite Wastewater Collection System Design Calculations

		Residential Flow							Non-Residential Flow																		Trunk Sewer Opinion of Probable Cost						
From MH	To MH	Added Net Residential Area (ha)	Added Population	Total Population	Added Residential ADWF (L/s)	Total Residential ADWF (L/s)	Peak Factor	Total Residential PDWF (L/s)	Added Non-Residential Area (ha)	Added Non-Residential ADWF (L/s)	Total Non-Residential ADWF (L/s)	Peak Factor	Total Non-Residential PDWF (L/s)	Total PDWF (L/s)	Added I/I (L/s)	Total I/I (L/s)	Design Flow (L/s)	Flow From Lift Station (L/s)	Factored Design Flow (L/s)	Length (m)	Sewer Diameter (mm)	Slope (%)	Sewer Capacity (L/s)	Ratio Q/Qc	Velocity (m/s)	Drop Provided (m)	US Grnd Elevation (m)	DS Grnd Elevation (m)	US Depth (m)	DS Depth (m)	Pipe Unit Price ($/m)	Pipe Cost ($)	Number of Manholes	Average Depth (m)	MH Unit Price ($/vm)	MH Cost ($)	Total Pipe Cost (s)
Northwest Lift Station Basin																																			
53	54	4.8	494	494	1.72	1.72	2.79	4.8	0.0	0.0	0.0	0.0	0.0	5	3	3	7	0	11	472	300	1.55	120	0.09	0.70		654.9	647.3	5.30	5.00							
54	L56	31.5	3254	3748	11.30	13.01	2.28	29.6	0.0	0.0	0.0	0.0	0.0	30	17	19	49	0	71	376	300	0.76	85	0.84	1.22		647.3	644.4	5.03	5.00							
55	L56	49.9	5158	5158	17.91	17.91	2.21	39.5	0.0	0.0	0.0	0.0	0.0	40	27	27	66	0	96	442	300	1.11	102	0.94	1.52	4.8	654.1	644.4	9.80	5.00							
Forcemain																																				
L56	57																																			
57	58	16.1	1663	28637	5.8	99.4	2.00	198.9	0.0	0.0	12.6	3.2	40.2	239	9	165	404	329	1057	430	1050	0.27	1424	0.74	1.75		655.1	653.9	5.38	5.35	$2,700	$1,161,232	5	5.36	$3,500	$93,800	$1,255,032
58	59	13.9	1440	30077	5.0	104.4	2.00	208.9	0.0	0.0	12.6	3.2	40.2	249	7	172	421	329	1082	426	1050	0.29	1464	0.74	1.79		653.9	652.3	5.38	5.00	$2,700	$1,150,718	5	5.19	$3,500	$90,781	$1,241,500
59	60	17.8	1835	61354	6.4	213.0	2.00	426.1	6.4	1.3	34.4	2.5	86.0	512	11	364	876	329	1737	622	1200	0.20	1744	1.00	1.74		652.3	654.7	5.30	8.94	$9,750	$6,068,985	7	7.12	$3,500	$174,500	$6,243,485
																																		Total Onsite Trunk Cost =		**$107,097,135**
Offsite Trunk																																				
60	61	0.0	0	61354	0.0	213.0	2.00	426.1	508.8	106.0	140.4	2.5	351.0	777	142	506	1283	329	2325	984	1350	0.20	2387	0.97	1.88		654.7	654.6	9.09	10.96	$10,500	$10,336,946	12	10.03	$3,500	$421,234	$10,758,180
61	62	0.0	0	61354	0.0	213.0	2.00	426.1	0.0	0.0	140.4	2.5	351.0	777	0	506	1283	329	2325	785	1350	0.20	2387	0.97	1.88		654.6	650.5	10.99	8.46	$10,500	$8,244,842	9	9.73	$3,500	$306,466	$8,551,308
62	63	0.0	0	61354	0.0	213.0	2.00	426.1	0.0	0.0	140.4	2.5	351.0	777	0	506	1283	329	2325	809	1350	0.20	2387	0.97	1.88		650.5	647.5	8.49	7.11	$10,500	$8,489,733	10	7.80	$3,500	$273,100	$8,762,833
63	64	0.0	0	61354	0.0	213.0	2.00	426.1	0.0	0.0	140.4	2.5	351.0	777	0	506	1283	329	2325	815	1350	0.44	3526	0.66	2.56		647.5	641.5	7.44	5.00	$3,750	$3,057,698	10	6.22	$3,500	$217,724	$3,275,422
64	65	0.0	0	61354	0.0	213.0	2.00	426.1	0.0	0.0	140.4	2.5	351.0	777	0	506	1283	329	2325	791	1350	0.43	3485	0.67	2.56	1.2	641.5	636.9	6.23	5.00	$3,300	$2,608,756	9	5.62	$3,500	$176,873	$2,785,628
65	66	0.0	0	61354	0.0	213.0	2.00	426.1	0.0	0.0	140.4	2.5	351.0	777	0	506	1283	329	2325	842	1350	0.23	2582	0.90	2.00		636.9	634.9	5.03	5.00	$3,300	$2,777,079	10	5.01	$3,500	$175,525	$2,952,604
66	67	0.0	0	61354	0.0	213.0	2.00	426.1	0.0	0.0	140.4	2.5	351.0	777	0	506	1283	329	2325	479	1350	0.37	3243	0.72	2.42		634.9	632.6	5.53	5.00	$3,300	$1,582,020	5	5.26	$3,500	$92,137	$1,674,158
67	68	0.0	0	61354	0.0	213.0	2.00	426.1	0.0	0.0	140.4	2.5	351.0	777	0	506	1283	329	2325	247	1350	0.43	3515	0.66	2.56	10.6	632.6	620.9	15.63	5.00	$10,500	$2,591,054	3	10.32	$3,500	$108,308	$2,699,361
68	L69	0.0	0	61354	0.0	213.0	2.00	426.1	0.0	0.0	140.4	2.5	351.0	777	0	506	1283	329	2325	913	1350	0.43	3520	0.66	2.56	0.6	620.9	616.3	5.63	5.00	$3,300	$3,012,296	11	5.32	$3,500	$204,628	$3,216,924
																																		Total Offsite Trunk Cost =		**$44,676,416**

The opinion of probable costs for the onsite Bremner area wastewater trunk sewer system for 375 mm and larger pipe diameters and the two proposed onsite lift stations are summarized in **Table 4.4**. Costs for individual pipes are presented in **Table 4.3**. The opinion of probable costs includes 50% for engineering and contingencies.

Table 4.4 Summary of Onsite and Offsite Sanitary Trunk Sewers Costs

Item	Description	Unit	Quantity	Unit Price ($)	Cost ($)
1	Onsite Trunk Sewer Costs				
	a) Trunk Sewers & Manholes (see **Table 4.3** for breakdown)	l.s.	1	107,097,135	107,097,135
	b) Lift Stations & Forcemains	l.s.	2	5,000,000	10,000,000
2	Offsite Trunk Sewer Costs				
	a) Trunk Sewers & Manholes (see **Table 4.3** for breakdown)	l.s.	1	44,676,416	44,676,416
Total					161,773,551

Some challenges regarding the onsite sanitary servicing include:

- There are some areas with low elevations along the south top of bank of Pointe-Aux-Pins Creek that will require two lift stations and forcemains. Servicing of these areas is not feasible by gravity as it would require lowering some of the gravity sewers by approximately 10 m. The locations of the two proposed lift stations were selected based on existing topography and are shown on **Figure 4.4**.
- Crossing of tributary creeks within the study area are required at various locations and have been checked to be feasible based on available topographic information. Creek channel elevations will need to be confirmed during the design stages.
- The proposed vertical alignments for sewers have been designed based on the existing topography. During the design stages, some fringe areas may require lift stations and/or engineered fill to be serviced.
- In order to avoid critical flow in sewers, the pipe slopes were adjusted (lowered) to provide sub-critical flow by introducing a drop in the upstream end of the sewer. As indicated in **Table 4.3,** the required drop ranges from 0.6 m to 23.6 m.
- ACRWC will need to be consulted to coordinate implementation of the proposed offsite trunk.

4.5 SUMMARY OF WASTEWATER SERVICING ANALYSIS

For Bremner offsite wastewater servicing two main options were considered. Option 1 is conveying the flow directly to the ACRWC wastewater treatment plant. Option 2 consisted of pumping the Bremner flow via a lift station into the proposed NoY wastewater gravity trunk sewer which would discharge the flow to an existing ACRWC's SERTS trunk sewer on RR 232. Both options were discussed with ACRWC and ACRWC has indicated that Option 2 is not viable due to insufficient capacity in the SERTS trunk and that it would not support this option. As a result, Option 1 is recommended for servicing of Bremner ACP. This offsite wastewater trunk is also designed to accommodate all of the West of 21 service area. The LEA area will be serviced to rural standards with onsite septic tank and septic tank content disposal via truck haul to the Clover Bar Wastewater Transfer Site, i.e. no flow contribution to the Bremner offsite wastewater trunk.

For interim servicing, two servicing options were considered. Option 1 consists of pumping Bremner wastewater via a forcemain and discharging the flow to the ACRWC's SERTS trunk on RR 232 at TWP RD 534. Option 2 is similar to Option 1 with the flow discharging to the proposed NoY gravity trunk in Cambrian Crossing on the west side of Oldman Creek. As exact timing for the proposed NoY trunk is not defined, Option 1 is recommended for the interim servicing of Bremner. The SERTS trunk has an allocated capacity of 429 L/s for the NoY servicing including Cambrian Crossing. The total flow from Bremner and NoY is expected to approach the 429 L/s in 2033, at this time the ultimate offsite wastewater trunk for Bremner will need to be completed in coordination with the ACRWC as a portion of the sewer will need to be completed by the ACRWC.

Onsite wastewater servicing is shown on **Figure 4.4**. The onsite system shows the main wastewater collection system, local sewers will need to be designed in subsequent stages. The onsite system includes two local lift stations in the low-lying area in the north. The onsite wastewater collection system in general conveys flow to the northwest due to the area topography and offsite servicing requirements. The wastewater collection system pipe sizes range from 300 mm to 1,200 mm diameter. The onsite system is not sized to accommodate any LEA flow. The onsite wastewater collection system opinion of probable cost is $117M including the cost of the two proposed lift stations.

4.6 WASTEWATER SERVICING CONCLUSIONS AND RECOMENDATIONS

4.6.1 Offsite Servicing

The key conclusions and recommendations for the offsite wastewater servicing are as follows:

- Two offsite wastewater conveyance options for Bremner were considered, see **Figure 4.1** for alignments:
    - Option 1 – install a new trunk sewer to service Bremner and West of 21 through West of 21 from TWP RD 534 and Highway 21 to ACRWC's system at TWP RD 540 and RR 232, requires a 1,350 mm diameter trunk, approximately 6.6 km in length and total estimated cost of $45M.
    - Option 2 – Conveying all of Bremner flow via a lift station to the proposed NoY wastewater trunk in Cambrian Crossing on the west side of Oldman Creek and conveying the flow via an upsized NoY trunk to ACRWC's SERTS trunk on RR 232 at TWP RD 534. ACRWC has indicated it does not support this ultimate servicing option due to extensive upsizing and/or twinning requirements for the SERTS trunk. This option was not further evaluated.
- For the proposed Option 1 offsite trunk, ACRWC has indicated it would cover the cost of the section along TWP RD 540 from RR 231 to RR 232 (approximately 25% of the total length).
- LEA is to be serviced to rural standards with installation of onsite septic tanks and septic tank content disposal via truck haul to the Clover Bar Wastewater Transfer Site.

4.6.2 Interim Servicing

Interim wastewater servicing conclusions and recommendations are as follows:

- Provide interim servicing through the existing ACRWC's SERTS trunk along RR 232 at TWP RD 534.
- The estimated cost for the interim lift station and forcemain is approximately $4.5M.
- Outlet through the SERTS trunk is available until 2033, at which time the developers in NoY will require the allocated capacity in the SERTS trunk and the ultimate offsite trunk will need to be constructed.

4.6.3 Onsite Servicing

The onsite wastewater servicing plan for Bremner ACP is shown on **Figure 4.4**. Details of the onsite servicing are as follows:

- Onsite wastewater servicing generally conveys flow to the northwest due to the area topography and offsite servicing requirements.
- The onsite wastewater collection system pipe sizes range from 300 mm to 1,200 mm diameter.
- The onsite system is not sized to accommodate any LEA flow as the septic tank disposal will be via truck haul to the Clover Bar Wastewater Transfer Site.
- Due to the topography, the northern parts of the Bremner area will need to be serviced by lift stations.
- The onsite wastewater collection system opinion of probable cost is $117M including the cost of two proposed lift stations.

5.0 STORMWATER SERVICING CONCEPT

This section provides a stormwater servicing concept plan for Bremner and LEA. The servicing plan provides a high-level concept in terms of identification of potential stormwater management facility (SWMF) locations, SWMF interconnecting piping requirements and outfall locations. The SWMF locations and contributing drainage basin areas have been identified based on the existing topography. Both of these are considered to be tentative and intended to provide general guidelines. The SWMF locations and contributing drainage basin area boundaries will need to be refined during subsequent design stages. The minor (piped) and major (surface) drainage systems which collect and convey the storm runoff to the SWMFs will also be designed during subsequent design stages.

The proposed stormwater management facilities will collect the storm runoff volume and discharge to existing watercourses in a controlled manor through outfall structures. This section provides guidelines for controlling the discharge rates, a high level assessment of existing watercourse erosion, flood risk assessment and LID control features to enhance discharged water quality and mitigate erosion under post development conditions. A more detailed erosion assessment will be required prior to, or concurrent with, the first Sub-Area Structure Plan to cover the full length of the reaches within Bremner and the downstream portions of the creeks. The cost associated with the detailed erosion assessment and the costs of future erosion mitigation measures required for each creek could potentially be shared across the Bremner and LEA areas through a creek erosion levy.

5.1 DESIGN STANDARDS

The following design standards, based on the Strathcona County servicing requirements, have been used to develop the stormwater servicing concept:

- Minor drainage system design based on the 1:5 year design rainfall event
- Major conveyance system design based on the 1:100 year design rainfall event
- The stormwater management facility (SWMF) storage capacities based on the 1:100 year design rainfall event
- The accumulated runoff water from a SWMF needs to be released within a maximum of 4 days (96 hours)
- Pipe sizing based on a Manning's "n" value of 0.013
- Minimum velocity = 0.60 m/s and maximum velocity = 3.0 m/s
- Minimum depth of cover 1.5 m to top of pipe

A regional hydrologic analysis was completed to determine the allowable release rates from future stormwater management facilities. The post development outflow rates from future SWMFs are proposed to match the peak predevelopment flow rates in the watercourses.

The percent imperviousness required for the hydrologic analysis for the various land uses are not provided in the County's Design and Construction Standards. For this study, the following percent imperviousness were utilized for the post development hydrologic analysis:

- Residential = 60%
- Country Residential = 20%
- Commercial / Industrial = 80%
- Parks = 10%
- Rural Industrial = 40%

The stormwater management plan for Bremner is developed for the 1:100 year design rainfall event. With the potential climate change impact, the actual rainfall event volume and/or /intensity may be higher. The current County design standards require design features such as defined overland drainage routes, free board and emergency overflow features for stormwater management facilities, which are expected to address climate resiliency to some degree. The County may need to review in future if additional mitigation features are required to address the full range of climate resiliency factors.

5.2 ALLOWABLE DISCHARGE RATES

The existing topography and drainage for Bremner is shown on **Figure 2.1**. As discussed in **Section 2.2**, the Bremner ACP area drains through the Oldman Creek and Pointe-aux-Pins Creek systems.

To determine allowable release rates under post development conditions, predevelopment flow rates under the existing development conditions for Oldman Creek and Pointe-aux-Pins Creek watersheds were determined based on a regional analysis. The regional analysis was completed to determine flow rates through the Bremner ACP under the 5, 25 and 100 year flood events. Based on the findings of the regional analysis, allowable release rates from the proposed SWMFs within the ACP are considered. The Pointe-aux-Pins Creek and Oldman Creek watershed area boundaries are shown on **Figure 2.2**.

For the Pointe-aux-Pins Creek, a flood frequency analysis was completed using the data obtained from Environment Canada's hydrometric station 5EB902, located on Pointe-aux-Pins Creek at the crossing of TWP RD 534. A Log-Pearson Type III statistical distribution was applied to determine the peak flow rates for the watershed area covered by the hydrometric station. This is considered a preferred distribution for flood frequency analysis as it accounts for skewness. The 'Drainage Area Ratio' method was then applied to determine the peak flow rates at the Pointe-aux-Pins and Oldman Creek outlets at the North Saskatchewan River. The 'Drainage Area Ratio' method is typically used to estimate flood flows for an ungauged basin using the flood flow data of a gauged basin with similar basin characteristics. The release rates were then computed by dividing the peak flow rates by the corresponding watershed areas. The computed flood frequency analysis results are summarized in **Table 5.1**.

Table 5.1: Flood Frequency Analysis Results

Location / Creek	Drainage Basin Area (km^2)	Peak Flow Rates (m^3/s)			Peak Flow Rates (L/s/ha)		
		5-Year	25-Year	100-Year	5-Year	25-Year	100-Year
Pointe-aux-Pins Creek Station 5EB902	63.5	5.8	8.7	10.2	0.91	1.38	1.61
Pointe-aux-Pins at Outlet to NSR	120	11.2	16.9	19.8	0.80	1.21	1.42
Oldman Creek at Outlet to NSR	135	10.2	15.5	18.2	0.76	1.15	1.35

The above regional flood frequency analysis results in relatively low discharge rates for the 100 year flood event. The County has allowed a release rate of 4 L/s/ha for the NoY areas discharging into Oldman Creek. As part of the NoY Utilities Preliminary Design study, Northwest Hydraulics (NWH) had analyzed impact of a higher release rate on Oldman Creek and concluded that a staged outlet system be implemented. Under the staged outlet system, during more frequent rainfall events a lower release would be permitted, and higher release rate would be allowed during less frequent rainfall events to avoid the impact of a long drawdown time on the creek.

Based on the NWH findings, it is recommended that a two-stage outlet system be utilized for Bremner with a maximum of 1 L/s/ha allowable release rate for up to the 1:5 year rainfall event and a maximum combined allowable release rate of 3 L/s/ha for the 1:100 year rainfall event for all creeks and tributaries within the study area. A slightly lower release rate is recommended considering the combined size of the Bremner and LEA net developable area is approximately 2,600 ha and would result in a total maximum discharge rate of approximately 7.8 m^3/s between the two creeks.

The Mattamy Cambrian Site Oldman Creek Erosion Threshold Assessment study recommends a three stage outlet system with an average of 0.05 L/s/ha, 0.46 L/s/ha and 4.0 L/s/ha depending on the flow rate in the creek. Such strategy would require a real time control mechanism to implement the outlet system.

5.3 ONSITE STORM SERVICING PLAN

This section provides the onsite stormwater servicing concept for the Bremner and LEA areas under the post development condition. Under the post development condition, all stormwater runoff from the Bremner and LEA boundaries will be stored in the stormwater management facilities (SWMFs) identified on **Figure 5.1**. Following the event, the accumulated storm runoff volume will be discharged through control structures at up to a maximum allowable release rate(s) as recommended in **Section 5.2**. The SWMF locations and the contributing drainage areas, shown on **Figure 5.1,** were established based on the existing topography and ACP layout.

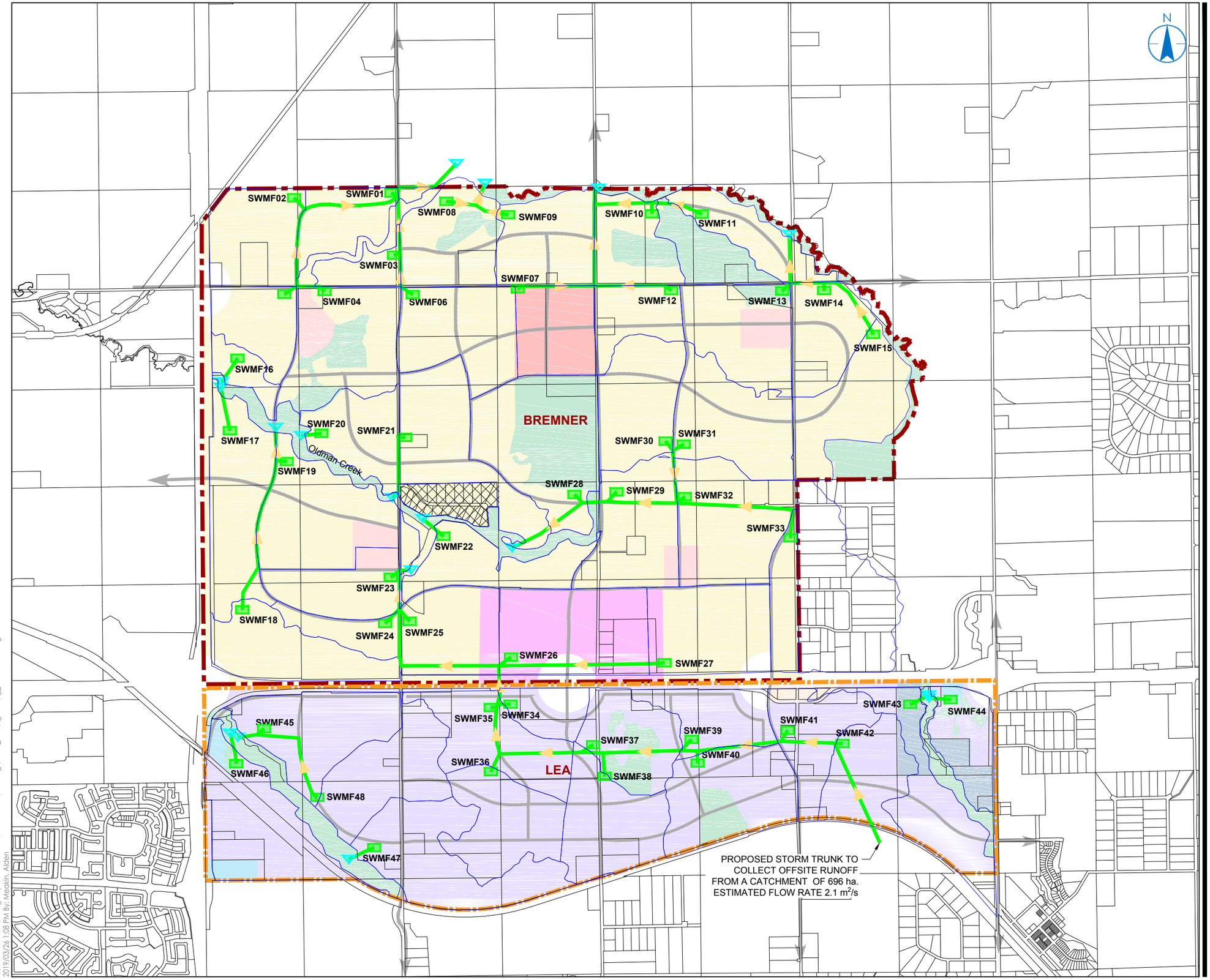
Hydrologic analyses were completed using a PCSWMM model to determine the runoff volume to each SWMF under the post development conditions. The post development condition drainage basin characteristics were determined based on the proposed land use in terms of the percent imperviousness. Based on the contributing drainage basin area and allowable discharge rates, the SWMF storage volume requirements were computed. The required storage volume for the 1:100 year 24 hour rainfall is computed based on an average of 50% of the allowable release rate during the rainfall and drawdown period. The proposed SWMF basin area, runoff volume, allowable discharge rate and required storage volumes are summarized in **Table 5.2**.

As indicated in **Table 5.2**, approximately 1,907 ha of Bremner and 899 ha of LEA area will drain through Oldman Creek and Pointe-aux-Pins Creek. The stormwater runoff within each basin area will be collected into the SWMF(s) through storm sewers and overland drainage systems.

The proposed storm servicing concept includes 48 stormwater management facilities and 17 outfalls. Several of these SWMFs will be interconnected forming various sub-systems to minimize the number of outfalls to Oldman Creek and Pointe-aux-Pins Creek.

Based on Strathcona County standards, it is understood that all SWMFs will need to be constructed as “constructed wetlands”. The constructed wetlands are expected to provide better water quality control than wet ponds before discharging into the receiving water body. In subsequent planning and design stages, attempts should be made to incorporate natural wetlands where feasible into stormwater management facilities in coordination with the Water Act, Public Lands Act and provincial and municipal wetland policies and regulatory requirements.

The configuration of the SWMFs will be as per Strathcona County design standards along with a drainage basin area grading plan, storm sewer system and overland drainage requirements. The discharge from each SWMF will need to be controlled through a two stage outlet control system and appropriately designed outfall structures in to the creeks to prevent erosion.



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Legend

- Outfall
- Stormwater Management Facility
- Storm Sewer Trunk
- Stormwater Subcatchment Boundary
- Project Boundary

Notes

The sub-catchment area boundaries are approximate based on existing topography and will require further refinement at the sub-area structure plan stage.

Scale

1:30,000 — 0 250 500 1000 1500m

Client/Project

STRATHCONA COUNTY
BREMNER ACP UTILITIES MASTER PLAN

Figure No.

5.1

Title

Proposed Stormwater Servicing Plan

Additionally, low impact development (LID) features are also encouraged for Bremner and LEA to reduce runoff volumes during smaller more frequent rainfall events. The LID features are proposed to reduce annual runoff volume to the creek to mitigate erosion potential due to increased runoff volume under the post development condition. The applicability of the LID features depends on land use and site configuration. The applicability of various LID features and design and maintenance guidelines are provided in the Design and Construction Standards document. LID features could be encouraged to capture up to 25 mm of total annual rainfall over the development area. As an example, for single family residential properties, a rain barrel type feature can be adopted to capture runoff and use for lawn watering purposes. For such a program to be effective, mandatory installation by home builders may be necessary along with a public education program by the County. For high density residential and non-residential areas rain gardens, bioswales and cistern type LID features should be encouraged. For some roadways, rain garden, infiltration and tree box type LID features can be encouraged.

Table 5.2 Proposed Stormwater Management Facilities

SWMF ID	Catchment Area (ha)	Imperviousness (%)	100 Year 24 Hour Rainfall (mm)	Runoff Depth (mm)	Runoff Coefficient	Runoff Volume (m^3)	Allowable Discharge Rate (L/s)	Required Storage Volume (m^3)
Bremner								
SWMF01	38.6	60	126.4	95.3	0.75	36,724	116	31,727
SWMF02	57.8	60	126.4	95.1	0.75	54,986	174	47,490
SWMF03	18.7	60	126.4	95.4	0.75	17,820	56	15,399
SWMF04	40.8	60	126.4	95.6	0.76	39,020	122	33,731
SWMF05	81.6	49	126.4	88.0	0.70	71,734	245	61,164
SWMF06	70.9	60	126.4	95.8	0.76	67,862	213	58,678
SWMF07	47.4	80	126.4	110.2	0.87	52,235	142	46,091
SWMF08	63.1	54	126.4	91.2	0.72	57,539	189	49,366
SWMF09	57.8	60	126.4	96.0	0.76	55,478	173	47,992
SWMF10	44.9	45	126.4	85.0	0.67	38,166	135	32,346
SWMF11	40.3	60	126.4	95.6	0.76	38,501	121	33,284
SWMF12	35.2	60	126.4	95.7	0.76	33,684	106	29,123
SWMF13	67.0	59	126.4	95.2	0.75	63,780	201	55,099
SWMF14	49.7	60	126.4	95.6	0.76	47,508	149	41,066
SWMF15	66.1	59	126.4	94.7	0.75	62,583	198	54,014
SWMF16	17.1	60	126.4	95.7	0.76	16,335	51	14,122
SWMF17	75.8	60	126.4	95.6	0.76	72,458	227	62,634
SWMF18	61.7	60	126.4	95.7	0.76	59,078	185	51,081
SWMF19	84.0	62	126.4	96.9	0.77	81,363	252	70,476
SWMF20	46.0	60	126.4	95.8	0.76	44,090	138	38,126
SWMF21	76.0	60	126.4	95.8	0.76	72,776	228	62,932
SWMF22	56.7	60	126.4	95.9	0.76	54,313	170	46,970
SWMF23	46.7	63	126.4	97.9	0.77	45,744	140	39,688
SWMF24	23.6	60	126.4	95.9	0.76	22,618	71	19,561

SWMF ID	Catchment Area (ha)	Imperviousness (%)	100 Year 24 Hour Rainfall (mm)	Runoff Depth (mm)	Runoff Coefficient	Runoff Volume (m^3)	Allowable Discharge Rate (L/s)	Required Storage Volume (m^3)
SWMF25	57.4	60	126.4	95.4	0.76	54,793	172	47,352
SWMF26	87.1	80	126.4	109.7	0.87	95,535	261	84,244
SWMF27	72.8	60	126.4	94.9	0.75	69,094	218	59,655
SWMF28	103.0	31	126.4	74.2	0.59	76,431	309	63,076
SWMF29	71.0	57	126.4	93.1	0.74	66,019	213	56,824
SWMF30	64.1	60	126.4	95.6	0.76	61,274	192	52,963
SWMF31	73.1	56	126.4	92.8	0.73	67,807	219	58,336
SWMF32	84.3	61	126.4	95.8	0.76	80,780	253	69,854
SWMF33	26.6	60	126.4	94.8	0.75	25,208	80	21,762
Sub-Total	**1907**					**1,803,338**	**5,720**	**1,556,227**
Local Employment Area								
SWMF34	25.0	50	126.4	105.1	0.83	26,303	75	23,058
SWMF35	62.0	50	126.4	105.1	0.83	65,106	186	57,075
SWMF36	62.8	50	126.4	105.1	0.83	65,978	188	57,839
SWMF37	53.4	36	126.4	99.2	0.78	52,941	160	46,026
SWMF38	65.1	50	126.4	105.1	0.83	68,387	195	59,951
SWMF39	42.3	50	126.4	105.0	0.83	44,361	127	38,884
SWMF40	76.3	43	126.4	102.0	0.81	77,832	229	67,939
SWMF41	49.1	50	126.4	105.0	0.83	51,499	147	45,140
SWMF42	51.7	52	126.4	105.7	0.84	54,605	155	47,911
SWMF43	64.4	55	126.4	106.7	0.84	68,708	193	60,361
SWMF44	39.7	60	126.4	108.6	0.86	43,097	119	37,952
SWMF45	73.3	50	126.4	104.7	0.83	76,723	220	67,224
SWMF46	81.6	54	126.4	106.0	0.84	86,553	245	75,973
SWMF47	86.0	50	126.4	104.7	0.83	90,025	258	78,879
SWMF48	66.5	50	126.4	104.7	0.83	69,578	199	60,964
Sub-Total	**899**					**941,695**	**2,697**	**825,174**
TOTAL	**2806**					**2,745,034**	**8,417**	**2,381,401**

A two-stage outlet system is recommended to maintain the predevelopment release rate of 1 L/s/ha for events up to the 1:5 year rainfall and a combined maximum release rate of 3 L/s/ha for the 1:100 year rainfall as discussed in **Section 5.2.** The North of Yellowhead stormwater servicing plan also recommended a similar strategy to maintain predevelopment flow rates during frequent rainfall events.

The proposed stormwater management concept includes 17 outfalls in total, discharging stormwater from the proposed developments into the existing creeks. The proposed outfall locations are shown on **Figure 5.1**. There will be a total of 6 outfalls discharging through Pointe-aux-Pins Creek and another 11 outfalls discharging through

Oldman Creek and it's tributaries. The proposed SWMFs are interconnected to minimize the number of outfalls and to meet outlet configuration requirements.

5.3.1 Water Quality

The primary purpose of the stormwater management facilities is to collect the runoff from new developments and control the outflow at the allowable discharge rate. However, a secondary purpose is to provide water quality enhancement. Alberta Environment requires that a minimum of 85% of sediments with a particle size of 75µm and greater be removed from the runoff.

In implementing the stormwater management concept, consideration should be given to mitigate water quantity and quality issues by providing naturalized or constructed wet ponds followed by a wetland at the end of each sub-system to further enhance the water quality. In addition, some LID features and water quality improvement options such as stormceptors may also be considered at the neighborhood design stage to further improve the water quality before discharging into the receiving water bodies.

The water quality enhancement in wet ponds is generally achieved with deep permanent storage by slowing down the runoff and thus inducing the settlement of particles. Whereas, in naturalized/constructed wetlands, enhanced water quality is achieved by establishing shoreline areas with native wetland plants and by providing forebays at the inlet.

Moreover, some low impact drainage (LID) features may also be considered during the neighborhood design stage in order to facilitate infiltration into the ground while further enhancing the water quality. LID features including integration of natural channels should be considered during subsequent design stages in place of storm sewers and/or SWMF interconnecting outlet systems.

5.3.2 Opinion of Probable Costs

The opinion of probable costs for the major storm drainage system components were also computed for the Bremner and LEA areas. The cost estimate includes the cost of 48 SWMFs with control structures, approximately 22 km of interconnecting piping with manholes and a total of 17 outfall structures.

The opinion of probable cost is based on Stantec's historical data. The assumptions used for determining the cost of each element are as follows:

- Stormwater Management Facilities & Control Manhole Structures
  - SWMF active storage is based on 1.5 m depth and 7:1 side slopes
  - Depth of freeboard to be 0.5 m with 7:1 side slopes
  - Minimum dead storage of 2.5 m with 3:1 side slopes
  - Excavation volume between freeboard elevation and the existing ground elevation was determined based on a 7:1 side slope
  - Excavation cost based on material used for onsite grading
- Interconnection Pipes and Manholes
  - Cost includes supply and installation of sewer mains and manholes
  - Manhole costs are based on the connecting pipe size and estimated height
- Outfalls
  - Price for a typical outfall structure having vertical depth of less than 6.0 m

- Outfalls having a vertical depth greater than 6.0 m may require customized outfall design. For these outfalls, allowance has been included for the drop manhole and customized outfall structure.

Table 5.3 provides a summary of the storm drainage system opinion of probable costs.

Table 5.3 Storm Drainage System Costs

Item	Description	Unit	Quantity	Unit Price ($)	Cost ($)
1	Stormwater Management Facilities and Control Structures				
	c) Excavation and Disposal	m^3	5,262,045	30	157,861,000
	d) Landscaping	m^2	575,953	20	11,519,000
	e) Control Structures	ea	48	100,000	4,800,000
2	Interconnection Piping				
	b) Piping	m	21,829	2,000	43,658,000
	c) Manholes	vm	1,364	3,000	4,092,000
3	Outfall Structures	ea	17	500,000	8,500,000
Total					230,430,000

5.4 CREEK FLOODPLAIN ASSESSMENT

A high level flood plain assessment was completed for the main channels of Oldman Creek and Pointe-aux-Pins Creek within the Bremner ACP. The intent of the floodplain mapping is to identify any flood risk areas along the main channels within the study area for the 100 year flood. The hydraulic assessment was completed using PCSWMM modeling software. A coupled 1D-2D flood mapping tool incorporated in the PCSWMM software was applied in delineating the floodplain boundary.

The study area includes Pointe-aux-Pins Creek and two tributaries of Oldman Creek. The two tributaries of Oldman Creek meet at the existing Tidan Heights neighborhood and then convey flow towards the crossing at Range Road 230. The cross-sections of these creeks have been extracted from a 3.0 m resolution LiDAR surface. A number of culverts exist along the creeks at crossings inside the project boundary. The diameters of these culverts were measured during a site visit on October 30, 2017 and these measured culvert diameters have been used in the model. Overall the flood plain of Pointe-aux-Pins Creek is densely vegetated and about a 1.0 m to 3.0 m wide narrow unvegetated channel exists inside the floodplain. The floodplain of Oldman Creek is also densely vegetated and any unvegetated incised channel was hardly visible during the site visit.

A hydrometric station (5EB902) exists at Pointe-aux-Pins creek at the TWP RD 534 crossing. The catchment area at the station is 63.5 km^2 and the 1:100 year peak flow for this station has been computed as 10.2 m^3/s using flood frequency analysis as indicated in **Table 5.1**. This flow rate has been used for the portion of the creek located upstream of the hydrometric station. The predevelopment catchments have been delineated for the portion of the creek downstream of the hydrometric station using PCSWMM and the runoff from these catchments has been generated for a 1:100 year event. The total runoff from the catchments downstream of station 5EB902 has been computed as 11.6 m^3/s. Since the total delineated catchment area is 37.6 km^2, the average release rate is 3.08 L/s/ha, which is fairly close to the determined post development flow rate. Therefore, findings from the flood mapping

study are applicable to the post development scenario. To better represent the post-development scenario, peak runoff from the catchments has been applied to the creek at a constant rate instead of using a runoff hydrograph.

The catchment areas for the tributaries of Oldman Creek have also been delineated using PCSWMM and runoff has been generated for the 1:100 year event. The total generated runoff is 9.2 m^3/s from a total delineated catchment area of 26.4 km^2, which provides the average runoff rate of 3.48 L/s/ha. Like Pointe-aux-Pins Creek, the runoff has been applied at a constant rate instead of using a hydrograph.

Results and Discussions

The depth of the Pointe-aux-Pins Creek ravine varies from approximately 5 m to 15 m in most areas inside the project boundary and flooding has not been identified as an issue in any of these areas. However, the ravine depth of the creek is approximately 2 to 3 m along a 1.5 km reach centered at RR 224. Flooding has been identified as an issue in this reach and therefore, the flooded area has been delineated using PCSWMM's 2D flood mapping tool to get a more accurate spatial extent of flooded areas. Other areas where the flow is confined within the ravines have been modeled using the 1D flood mapping tool. The delineated inundation area for the entire creek is shown on **Figure 5.2** and the area prone to flooding has been marked with a circle.

Inside the Bremner project boundary, Oldman Creek has two tributaries which meet at the existing Tidan Heights neighborhood. The tributary that exists south of the Tidan Heights neighborhood is shallow and wide close to the Highway 16 crossing, and then it turns into a narrow roadside ditch along the east edge of Range Road 225. During a 1:100 year flood event, water will spill over RR 225 and flood the low areas located west of RR 225. Another flood prone area has been identified at the Highway 21 crossing where the creek is approximately 0.5 m deep in places. Water will spread over large areas during a 1:100 year flood event. Like Pointe-aux-Pins Creek, these flooded areas have been modeled using the 2D flood mapping tool of PCSWMM. The delineated inundation areas for the tributaries of Oldman Creek inside the project boundary are shown on **Figure 5.2**, with the two areas prone to flooding being marked.

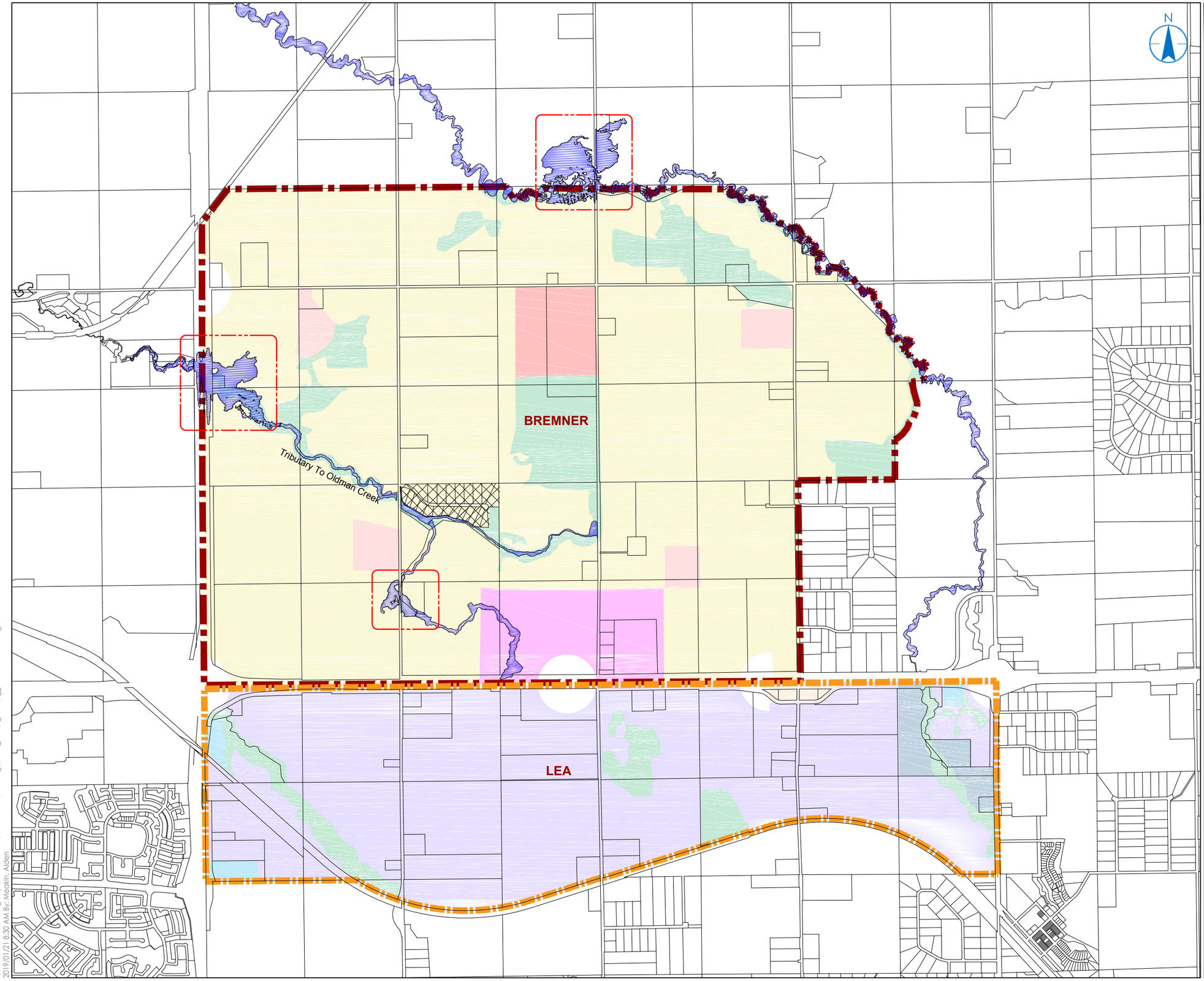
5.5 CREEK EROSION ASSESSMENT

Two Stantec staff visited Oldman (OM) and Pointe-Aux-Pins (PAP) Creeks on October 30, 2017. Due to private land restrictions, the investigation of the creeks was limited to locations accessible from public roadways. The field photo records are provided in **Appendix A**.

5.5.1 Oldman Creek

Oldman Creek is a low gradient, moderately sinuous watercourse that flows in a northwesterly direction through the Bremner Study Area. The Creek discharges into the North Saskatchewan River 4 km downstream of the Study Area. Oldman Creek was dry at all five locations visited on October 30 (see **Figure 5.3**), suggesting that discharge is intermittent and relies primarily on surface runoff for its discharge. The Oldman Creek ravine is generally wide, shallow and flat, though some small terraces were identified.

The channel was generally overgrown with cattails and reeds, and the banks were heavily vegetated with grass along the lower reaches inside the Bremner Study area. Channel width at the lower reaches of the Creek ranged from 1 m to 4 m. Oldman Creek (OM#1) immediately downstream of the Study Area is heavily ponded and surrounded by wetland vegetation (Photo A 2). Some bank erosion was observed at OM#3 on an outside bend of Oldman Creek (Photo A 5). The Range Road 225 road culvert at this location likely re-directed the creek into the side of a short



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Legend

- Flooding Area
- Project Boundary

Notes

1. Flood risk map does not include LEA.

Scale

0 250 500 1000 1500m

1:30,000

Client/Project

STRATHCONA COUNTY

BREMNER ACP UTILITIES MASTER PLAN

Figure No.

5.2

Title

100 Year Flood Risk Map

terrace where erosion is evident. Some short (0.3 m tall) vertical, bare earth banks were also observed at this location upstream of Range Road 225 (Photo A 6). The road ditch was eroding up from Oldman Creek at OM#3, likely due to an inappropriate grade set in the ditch. A meander in Oldman Creek was eliminated by the construction of Range Road 225 at OM#4. The channel at OM#4 is barely defined, less than a metre wide, and is heavily overgrown with grass. Oldman Creek has no defined bed or banks at OM#5. The depression shows Oldman Creek has been accessed by cattle, but also shows signs of wetland type vegetation. The channel upstream of Highway #21 at OM#5 is full of reeds and cattails. The bed and banks along this reach of Oldman Creek are comprised of fine grained sediment which are susceptible to erosion. The heavy vegetation helps to retain the shape of the channel, but this can fail in chunks of sod.

5.5.2 Pointe-Aux-Pins Creek (PAP Creek)

Pointe-Aux-Pins Creek is a moderately sinuous watercourse that flows in a westerly direction through the Bremner Study Area. The Pointe-Aux-Pins Creek discharges into a relic channel of the North Saskatchewan River approximately 2.5 km downstream of the site, and eventually into the North Saskatchewan River. Stantec staff visited Pointe-Aux-Pins Creek at 7 locations (see **Figure 5.3**). Discharge was observed in Pointe-Aux-Pins Creek at all locations except for the furthest upstream (PAP#7). The Pointe-Aux-Pins Creek ravine is shallow at the downstream end (PAP#1) but rises considerably in the upstream direction. The ravine generally increases in depth and decreases in width from downstream to upstream.

The Pointe-Aux-Pins Creek is incised downstream of Highway #21 (PAP#1), though the banks are heavily vegetated and generally appear stable. The outside left bank immediately downstream of the road culvert is failing as the creek is directed at a terrace (Photo A 11). Further downstream, the Pointe-Aux-Pins Creek flows beside a hill and is actively eroding the toe of this slope (Photo A 12). Coniferous trees were observed growing on an old beaver dam located between the two bank failures. Upstream of Highway #21 (PAP#2) a beaver dam has created a 5 m wide channel as far as could be observed. The banks are well vegetated and stable. The Pointe-Aux-Pins Creek ravine deepens at PAP#3 (Photo A 15, A 16). A beaver dam constructed at the outlet of the road culvert at this location blocks the bottom 1/4 of the conveyance area. More beaver dams were observed in the channel upstream. The banks are heavily vegetated and stable. The Pointe-Aux-Pins Creek banks at the new bridge crossing at PAP#4 are well vegetated and stable (Photos A 17 and A 18). The two road culverts at PAP#5 are mostly hidden by tall grasses at their upstream ends. A beaver dam is located upstream of the culvert mouths, backing up the creek. The banks upstream and downstream of the culverts are well vegetated and vertical and generally stable though some bank slumping was observed, likely due to the ponded water saturating the banks. The Pointe-Aux Pins Creek near Ardrossan (ID: 05EB902) Water Survey of Canada (WSC) hydrometric station is attached to the bridge at PAP#6 (Photo A 21). The WSC station has been in operation since 1979 and is seasonally (March to October) operated. The creek has a watershed area of 106 km^2 and mean monthly flows which range from 0.014 (September) to 0.438 (April) The creek was not flowing during the visit. Downstream of the bridge the outside bend of the creek was actively eroding, exposing a 2 m high, 15 m wide vertical bank. The creek downstream of the bridge meanders tortuously. Additional high, steep banks are actively eroding, or appear vulnerable. The Pointe-Aux-Pins Creek ravine at the Range Road 222 crossing (PAP#7) is 10 m deep with steep ravine walls. Evidence of a ponded area was noted downstream of the crossing, which caused some bank slumping. The creek is mildly incised downstream of the ponded area. The bed and banks along the reach of Pointe-Aux-Pins Creek are comprised of fine grained sediments which are susceptible to erosion. The heavy vegetation helps to retain the shape of the channel, but this can fail in chunks of sod.

The review of available historical aerial imagery (1996 to 2011) reveals that Oldman Creek has not migrated laterally during this 15 year period. However, the creek is of low gradient (<1%) and its valley is relatively flat, so lateral

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Scale
1:30,000
0 250 500 1000 1500m

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Figure No.
5.3

Title
Erosion Assessment
Field Sites

migration is expected. Historical images show a high incidence of beaver dams and ponded areas. These beaver dams can themselves cause lateral migration of the creek. Pointe-Aux-Pins Creek has also not significantly migrated laterally during the same period. The tortured sinuosity and low gradient of this creek suggests that lateral migration is a regular occurrence. Historically beavers have been active on this creek, causing ponding and potentially changing the creek's course.

5.5.3 Recommendations

Bank erosion and lateral migration in the Oldman and Pointe-Aux-Pins Creeks is a natural process. There is however the potential for a dramatic increase in erosion and migration as the watersheds are developed. Developing the watersheds will result in a decrease of infiltration and evapotranspiration with a corresponding increasing proportion of rainfall and snowmelt reaching the Creeks as overland runoff. This runoff will reach the creeks considerably quicker and at a higher discharge rate than under pre-development conditions. Two main policies must be established to limit the erosional stresses to the creeks. The first considers riparian corridors to address both creek function in its valley. The second concerns the stormwater management strategies in the developed areas.

Development should not encroach on the creeks' ravines. The natural meandering of the creeks should be allowed to continue within the ravines without threatening development. The setback distance should be established relative to the top of the ravine walls. A geotechnical engineering study is recommended to identify the safe setback distance from the ravine walls. The ravine widths range from approximately 35 m to 80 m in Oldman Creek and between 50 m and 180 m in Pointe-Aux-Pins Creek. The tall, steep valley walls have the potential to fail by slumping or sliding and are susceptible to erosion by the creek. These modes of failure could be exacerbated by the encroachment of development. Avoiding encroachment into the ravines will provide space for the creeks to safely operate and will maintain creek water quality, aquatic habitat, and provide recreational value to the corridors. Further, maintaining or increasing the quality and quantity of vegetation within the corridor will stabilize the soil and creek banks, bolstering erosion protection.

To identify potential locations in the valley walls susceptible to erosion, the entire lengths of the two creeks should be walked by a geomorphologist to identify areas where the creeks are currently abutting onto the ravine walls. It is in these locations where bank instability is at its highest. These areas should be identified prior to development and monitored post development to assess the effects of the altered hydrograph.

Standard stormwater management features match pre-development peak discharge in a watercourse by constricting outflows to the pre-development peak discharge rate, and storing the excess runoff. Discharge from these stormwater management features continues at the pre-development rate until the stored volume is exhausted. This is an important measure to avoid increasing discharge rates in the creeks which would cause increased erosion. However, this extended period of discharge at the pre-development discharge causes watercourse banks to become saturated and increasingly vulnerable to liquefaction and erosion. The goal of the stormwater management features should therefore be to match pre-development peak discharge rates, and to minimize the increase in rainfall runoff volume. This can be accomplished by constructing infiltration measures distributed across the watershed, and end-of-pipe infiltration galleries. The infiltration measures will also maintain baseflow in the creeks, increasing the quality of aquatic habitat.

The upper reaches of Pointe-Aux-Pins Creek have the potential for two types of erosion: bank and valley. The tortuous meanders near PAP#6 are illustrative of actively eroding steep banks. The erosion in this area should be measured, and mitigation measures considered if the post-development erosion rates are expected to be exacerbated. The steep valley walls along the upper reach of Pointe-Aux-Pins Creek are vulnerable to erosion from

surface runoff. The valley should be visited to identify any rill or gulley formations. Mitigation plans should then be created to manage this erosion.

5.6 LOW IMPACT DEVELOPMENT

This section provides the findings of the LID practice review and recommendations on potential design standards for implementation. For more specific design guidelines, refer to the Bremner ACP Design and Construction Guideline report.

5.6.1 LID Best Practices Review

LID also sometimes referred to as green infrastructure (GI) is a more holistic approach to stormwater management than traditional end-of-pipe designs. LID/GI promotes infiltration and filtration of stormwater, and seeks to maintain the existing hydrology of the site after development while improving water quality. LID facilities can be designed for both quantity reduction and quality treatment or either in isolation. In addition to volume/peak flow rate reduction and water quality improvements, LID has many other benefits such as increasing biodiversity, addition of green space in communities, recreation opportunities, reduction of heat islands, and air quality improvements.

LID facilities have also proven valuable in reducing flooding, as they slow down and infiltrate stormwater, shifting the peak flows from the catchment they serve to later in the storm. This shifting of peak flow timing often means the downstream infrastructure has capacity to handle larger storms events.

LID is most effective during the small, frequent rain events, typically the events that make up 90% of the rainfall events seen during a typical year. During these events LID absorb a significant portion of the runoff and treat the first flush. While LID do not remove the need for downstream infrastructure like wetlands and detention ponds, there are clear benefits in water quality treatment and increased infiltration.

A review of what has been proposed by different jurisdictions has been completed to document the best practices for LID. Additionally, a matrix adapted from the City of Edmonton, City of Calgary and Metro Vancouver manuals on LID has been developed to show different technologies that could be implemented for different land uses.

5.6.1.1 City of Edmonton

The City of Edmonton is moving forward on LID and GI initiatives, policies, and guidelines to develop and encourage environmental sustainability in infrastructure. LID and best management practices (BMPs) are two of the leading approaches/methods to design and build environmentally-sustainable stormwater infrastructure.

The City recognizes the many benefits of LID/GI and is promoting its use in its Environmental Strategic Plan "*The Way We Green"*. Additionally, the City has released the "*Low Impact Development Best Management Practices Design Guide", "Low Impact Development Construction, Inspection & Maintenance Guide",* and "*Rain Garden in a Box"* manual to address challenges and concerns of using LID and to encourage homeowners to install rain gardens on their lots. Phosphorus is of a particular concern to the City.

The City of Edmonton has identified three primary objectives for LID

- Stormwater Volume Control 90% of the typical year (26 mm)
- Stormwater Peak Flow Control
- Stormwater Water Quality 90% of the typical year (26 mm)

The Design Guide provides an overview of LID BMPs, focusing on facilities with the capability to adapt to the cold climate and soil conditions (clay to clay loam soils) experienced in Edmonton, which include:

- Bioretention/Rain Gardens
- Bioswales
- Green Roofs
- Permeable Pavement
- Box Planters
- Naturalized Drainage Ways
- Rainwater Harvesting

5.6.1.2 City of Calgary

The City of Calgary is committed to becoming an environmentally sustainable community by providing leadership to conserve, protect and improve the environment. The City is dedicated to encouraging and demonstrating resource conservation and pollution prevention.

Alberta Environment and the City of Calgary have developed a Total Loading Management Plan aimed at limiting pollutant discharge to the Bow River. Additionally the City has developed the "Stormwater Management & Design Manual", "Nose Creek Watershed Management Plan", "Pine Creek Watershed Study", and "the Stormwater Source Control Practices Handbook". Generally the City is more concerned with water quality treatment than volume reduction, except in the Nose Creek and Pine Creek watersheds.

These documents identify several targets for stormwater in the city. It is important to note that Calgary uses allowable discharge volumes not volume capture targets:

- 85% removal of TSS for particle sizes of 50 µm City wide
- Maximum Allowable Discharge Volume (75%-97% typical year capture) and Maximum allowable release for Nose and West Nose Creek (see Table below)
- Retain 90% of the typical year on site in the Pine Creek Watershed

	Average Runoff Volume Control Target (mm)			Max Allowable Unit Area Release Rate (L/s/ha)
Date of Implementation	2013	2017	2021	2013
Nose Creek	16	11	6.1	1.257
West Nose Creek	26	17	9.6	0.99

The Stormwater Source Control Practices Handbook focusses on seven source control practices:

- Better Planning Practices
- Grass Swales or Bioswales
- Absorbent Landscaping
- Bioretention Areas
- Porous Pavement

- Stormwater Reuse
- Green Roofs

Cities surrounding Calgary (Airdrie, Okotoks) are using Calgary guidelines and methods as well.

5.6.1.3 British Columbia

The province of British Columbia (B.C.) has implemented wide spread source control and stormwater management policies. Urban Creeks require an Integrated Stormwater Management Plan (ISMP) and within that plan are prescriptions for source controls and water quantity and quality targets. The Province has published the "B.C. Stormwater Management Planning Guidebook", which pioneered the use of adaptive management in stormwater management. The guidebook recommends a quantity and quality target of **90% of the yearly rainfall volume.** The guidebook simplifies the performance targets based on the Mean Annual Rainfall (MAR) which is roughly equivalent to the 2 year 24 hour event, using three tiers:

- Tier A Event- Small events that are less than half the size of a MAR event. Approximately 90% of all rainfall events are Tier A.
- Tier B Event- the large rainfall events that are greater than half of MAR, but smaller than MAR. Approximately 10% of events are Tier B.
- Tier C Event- Extreme events that exceed MAR, may not occur in any given year.

Each tier is addressed within the ISMP

- Rainfall capture is designed for Tier A events
- Runoff control is for Tier B events
- Flood management is for Tier C events

In addition to the Provincial guidance, Fisheries and Oceans Canada (still referred to as DFO in BC), has also established volume retention targets for creeks. In fact, the Capture and Water Quality targets within the "DFO Urban Stormwater Guidelines and Management Practices for the Protection of Fish and Fish Habitat" are more stringent and often supersede the Guidebook targets. The DFO targets are water quality and volume for **the 6 month storm (72% of the 2 year storm)**. Since the DFO criteria is required for approvals for instream works, it is recommended to be used. The Lower mainland of B.C. exclusively uses the DFO targets while the Guide book is more common in the North and Interior of B.C. The targets for DFO can be summarized as follows:

- Volume capture and water quality treatment of the 6 month storm and Detention for discharge to creeks and small rivers
- Water quality treatment for the 6-month storm for discharge to large rivers (Fraser) and the Ocean

The Metro Vancouver "Stormwater Source Control Guidelines" are used throughout the province for design of source controls. The guidelines cover the following practices:

- Absorbent Landscape
- Infiltration Swale System
- Infiltration Rain Garden
- Pervious Paving
- Green Roof

- Infiltration Trench and Soakaway Manhole

5.6.1.4 Saskatchewan

Currently under the Environmental Management and Protection Act and the Water Regulations; stormwater quality and most parts of its management are not specifically regulated. The Water Security Agency has provided a high level technical guideline for site specific stormwater management including both source controls and end of pipe controls.

5.6.1.5 U.S.A.

The US EPA's stormwater Phase II Rule establishes a stormwater management program for small municipal separate storm sewer systems (MS4s). The program is intended to improve the Nation's waterways by reducing pollutant loads in storm sewers during storm events. In 1990, the EPA implemented Phase I of the National Pollutant Discharge Elimination System (NPDES) for medium and large MS4s. The new rules extend coverage to small MS4s, and modifies the program slightly.

MONTANA

The Montana Pollutant Discharge Elimination System (MPDES) general permit is for stormwater discharges associated with MS4s. All MS4s require an MPDES by law to discharge stormwater into State waters.

Permittees must develop, implement, and enforce a stormwater management program (SWMP) designed to reduce the discharge of pollutants to the maximum extent practicable. Implementation of Best Management Practices are required and minimum control measures are laid out.

1. Public education and outreach on stormwater impacts
2. Public involvement/participation
3. Illicit discharge detection and elimination
4. Construction site stormwater runoff control
5. Post-construction stormwater management in new development and redevelopment (**Must include structural and/or nonstructural BMPS**)
6. Pollution prevention/good housekeeping for municipal operations

WASHINGTON STATE

Western Washington

The Stormwater Management Manual for Western Washington provides guidance on the measures necessary to control the quality and quantity of stormwater. It conforms to the NPDES permit system. It lays out minimum requirements for new development and redevelopment that includes source control of pollution and onsite stormwater management, and runoff treatment.

Source control of pollution requires source control BMPs that will prevent stormwater from coming in contact with pollutants.

Onsite stormwater management will infiltrate, disperse, and retain stormwater onsite to the extent feasible without causing flooding or erosion impacts. Stormwater discharge durations for post-development must match predevelopment discharge rates from 8% of the 2 year flow to 50% of the 2 year flow.

Runoff treatment is required for hard and pervious surfaces that contribute to water quality. The water quality design storm volume is a 6 month 24 hour storm or 91% of the typical runoff volume.

Puget Sound

The Puget Sound targets align with those of Western Washington (SWMMWW) and do not supersede the requirements of any NDPES permit or the Western Washington Stormwater Manual. The primary objective is to approximate predevelopment native forested hydrologic conditions over the full range of rainfall intensities and durations.

The minimum LID performance standard matches developed discharge durations to pre-development durations for the range of predeveloped discharge rates from 8% of the 2 year peak flow to 50% of the 2 year peak flow.

Eastern Washington

In 2014, the Eastern Washington Phase II NPDES municipal stormwater permit came into effect and takes incremental steps towards broad implementation of LID practices. The permit identifies a schedule for local governments to amend codes and ordinances to “allow” LID and to meet the proposed **10 year 24 hour storm event onsite retention standard.** LIDs are to be used to meet the core elements of runoff treatment and flow controls, including **treatment and infiltration of 90% of the typical year (6 month 24 hour storm)**.

5.6.2 Summary of LID Best Practice Review

Low impact development (LID) is encouraged within Bremner ACP. Application of LID features varies depending on land use and site configuration. **Table 5.4** lists selected LID features based on Strathcona County climate considerations to reduce runoff volume and enhance quality of water discharged to the downstream watercourses.

Table 5.4 Appropriate LID Facilities Based on Street Type and Land Use

Street Type	Bioretention/ Rain Garden	Bioswales	Structural Cell Tree Boxes	Absorbent Landscaping	Infiltration Chamber/ Trench	Harvesting/Reuse	
						Cistern	Rain Barrel
Laneway					+		
Reverse Housing Laneway	+				+		
Local	+		+		+		
Collector	+		+		+		
Primary Collector	+		+	o	+		
Main Street Collector	+		+		+		
Arterials	+		+	o	+		
Industrial Local	+	+					
Industrial Collector	+	+					
Industrial Arterial	+	+					

Land Use Area	Bioretention/ Rain Garden	Enhanced Swales/ Bioswales	Tree Boxes	Absorbent Landscaping	Infiltration Chamber/ Trench	Harvesting/Reuse	
						Cistern	Rain Barrel
Single Family Residential				+			+
Low Density Multi Family				+		+	+
High Density Multi Family	+	+		+	+	+	
Commercial	+	+		+	+	+	
Cold Climate	+	+		+	+	o	o
Maintenance				+	+	+	+

Note: Adapted from the City of Edmonton, City of Calgary and Metro Vancouver LID Manuals

Reference Table for Symbols in LID Appropriateness Table

Symbol	Application and Suitability	Cold Climate Suitability	Maintenance
+	Most Appropriate	Well suited for cold climates	Low
o	May be used if opportunities exist	Average suitability for cold climate	Medium

Better site design is also encouraged within Bremner ACP. Better site design involves techniques that consider site-level opportunities and constraints to stormwater management infrastructure from the beginning of the site design process. There are more than a dozen best management practice (BMP) techniques that can be applied early in the design process; however not every technique will apply to every site. BMP techniques include natural area conservation, site reforestation, soil conservation, buffers, open space design, disconnection of impervious cover or reducing impervious cover via innovative site design. Better site design will assist with the implementation of LID facilities planning, selection, and design.

5.6.3 LID Review References

The following list provides references used to complete the LID practice review:

- City of Edmonton
  - The Way We Green, City of Edmonton, July 2011
  - Low Impact Development Best Management Practices Design Guide Edition 1.1, City of Edmonton, December 2014
  - Low Impact Development Construction, Inspection & Maintenance Guide, City of Edmonton, May 2016
  - Rain Garden in a Box, City of Edmonton, April 2016
- City of Calgary
  - Total Loading Management Plan for the Bow River, City of Calgary, 2017 (updates every 5 years)
  - Stormwater Management & Design Manual, City of Calgary, 2011
  - Nose Creek Watershed Management Plan, The Nose Creek Watershed Partnership, January 2007
  - Bow and Elbow River WMP, City of Calgary, September 2008
  - Pine Creek Drainage Study, AMEC, 2007
  - Stormwater Source Control Practices Handbook, City of Calgary, November 2007
- British Columbia
  - B.C. Stormwater Management and Planning Guidebook, Ministry of Water, Land and Air Protection, May 2002
  - DFO Urban Stormwater Guidelines and Management Practices for the Protection of Fish and Fish Habitat, Department of Fisheries and Oceans, 2001
  - Stormwater Source Control Guidelines, Metro Vancouver, May 2012
- Saskatchewan
  - Stormwater Guidelines EPB 322, Water Security Agency, January 2014
- Ontario
  - Review of the Science and Practice of Stormwater Infiltration in Cold Climates, Toronto and Region Conservation Authority, August 2009
- U.S.A
  - EPA Stormwater Phase II Rule, National Pollution Discharge Elimination System, US EPA
  - Montana Pollutant Discharge Elimination System (MPDES), as authorized by the US EPA under the Clean Water Act
  - 2012 Stormwater Management Manual for Western Washington, as Amended in December 2014, Department of Ecology, State of Washington, December 2014
  - Low Impact Development Technical Guidance Manual for Puget Sound, Washington State University and Puget Sound Partnership, December 2012
  - Eastern Washington Low Impact Development Guidance Manual, Department of Ecology, State of Washington, June 2013
  - Stormwater BMP Design Supplement for Cold Climates, US EPA, December 1997

5.7 SUMMARY OF STORMWATER SERVICING

The proposed stormwater servicing concept for Bremner and LEA is shown on **Figure 5.1**. The proposed servicing concept includes 48 SWMFs and 17 stormwater outfall locations. The drainage catchment areas, ponds and outfall locations are conceptual and may be revised during subsequent design stages due to roadway layout and ownership considerations. Some of the pond outlet systems are interconnected to minimize the number of outfalls required. Where feasible, existing wetlands and natural drainage channels should be incorporated in the stormwater management plan.

Based on the flood frequency analysis of Pointe-aux-Pins Creek and Oldman Creek, a 3 L/s/ha maximum allowable discharge rate is proposed. Also based on the previously completed assessment for Oldman Creek by Northwest Hydraulics for the NoY project, a two-stage outlet is recommended to be implemented with a maximum of 1 L/s/ha release rate up to a 1:5 year rainfall event and 3 L/s/ha for larger rainfall events.

A limited creek erosion assessment was completed within the Bremner area through observation of the creek reaches visible from public access points and review of historical air photos. The assessment indicates some potential for erosion of creek bank and valleys and recommends: a more detailed assessment of the creeks, avoiding encroachment of ravines and maintaining predevelopment flows to the creek. It is recommended that the more detailed assessment be completed at the time of the first Sub-Area Structure Plan stage such that the cost associated with the detailed erosion assessment and the costs of future erosion mitigation measures required within the creek could potentially be shared across the Bremner and LEA areas through a creek erosion levy.

Water quality enhancement, runoff volume control and additional creek protection from erosion is recommended. As part of the Bremner ACP development, a high level LID practice review was completed across North America. Based on this review several LID features that are viable for cold climate and require relatively low maintenance have been identified and included in the Bremner ACP Design and Construction Guideline document. In consultation with various stakeholders, the LID features are proposed to be encouraged within Bremner to capture up to 25 mm of total annual rainfall over the development area.

A flood plain assessment for a tributary of Oldman Creek and Pointe-aux-Pins Creek within Bremner indicates three potential flooding areas as shown on **Figure 5.2**. Appropriate flood mitigation protection measures will need to be considered in subsequent design stages for these locations.

The opinion of probable cost for the stormwater servicing concepts for Bremner and LEA is approximately $230M, not including the upstream neighbourhood stormwater collection system connected to each pond. These costs also do not include any offsite or creek erosion mitigation costs that may be required.

5.8 STORMWATER SERVICING CONCLUSIONS AND RECOMMENDATIONS

The stormwater servicing conclusions and recommendations are as follows:

- The stormwater servicing concept for Bremner and LEA is shown on **Figure 5.1**. The proposed servicing concept includes 48 SWMFs and 17 stormwater outfall locations. The drainage catchment areas, ponds and outfall locations are conceptual and may be revised during subsequent design stages.
- Some of the pond outlet systems are interconnected to minimize the number of outfalls required.

- Based on the flood frequency analysis of Pointe-aux-Pins Creek and Oldman Creek, a 3 L/s/ha maximum allowable discharge rate is proposed.
- Based on the previously completed assessment for Oldman Creek by Northwest Hydraulics for the NoY project, a two stage outlet is recommended to be implemented with a maximum of 1 L/s/ha release rate up to a 1:5 year rainfall event and a maximum 3 L/s/ha for larger rainfall events.
- For water quality enhancement, runoff volume control and additional creek protection from erosion, it is recommended that LID features be encouraged to capture up to 25 mm of total annual rainfall over the development area.
- The opinion of probable cost for the stormwater servicing concepts for Bremner and LEA is approximately $230M not including the upstream neighbourhood stormwater collection system connected to each pond.
- A flood plain assessment for a tributary of Oldman Creek and Pointe-aux-Pins Creek within Bremner indicates three potential flooding areas as shown on **Figure 5.2**.
- A limited creek erosion assessment was completed within the Bremner area through observation of the reaches from public access points and review of historical air photos. The assessment indicates some potential for erosion of bank and valleys and recommends: a more detailed assessment of the creeks, avoiding encroachment of ravines and maintaining predevelopment flows to the creek.
- Complete a more detailed assessment at the time of the first Sub-Area Structure Plan stage such that the cost associated with the detailed erosion assessment and the costs of future erosion mitigation measures required within the creek could potentially be shared across the Bremner and LEA areas through a creek erosion levy.

APPENDIX A
BREMNER EROSION ASSESSMENT PHOTOGRAPHS

Appendix A Photographs

List of Photographs

Photo A-1 Old Man Creek OM#1, facing upstream (east) towards the southbound lanes of Hwy #21 (10/30/2017)

Photo A-2 Old Man Creek OM#1, facing downstream (west) (10/30/2017)

Photo A-3 **Old Man Creek OM#2, facing downstream (northwest) towards northbound lanes of Hwy #21. Culvert under service road (10/30/2017)**

Photo A-4 **Old Man Creek OM#2 facing east, upstream (10/30/2017)**

Photo A-5 **Old Man Creek OM#3, facing downstream (west). Notice the erosion on the outside bend of creek (10/30/2017)**

Photo A-6 **Old Man Creek OM#3, upstream end of culvert, facing west (10/30/2017)**

Photo A-7 **Old Man Creek OM#4, facing downstream (north). Creek also serves as road ditch (10/30/2017)**

Photo A-8 **Old Man Creek OM#4, facing upstream (south). Upstream of this point the creek loses definition in the field (10/30/2017)**

Photo A-9 **Old Man Creek OM#5, facing downstream (north) from shoulder of westbound Hwy #16. Cattle have full access to channel (10/30/2017)**

Photo A-10 **Old Man Creek OM#5, facing upstream (south) from eastbound Hwy #16 towards service road (10/30/2017)**

Photo A-11 Pointe-Aux-Pins PAP#1 facing downstream (west) of Hwy #21 (10/30/2017)

Photo A-12 Pointe-Aux-Pins PAP#1 facing downstream (west) of Hwy #21. Note the hillslope erosion on the right bank of the creek (10/30/2017)

Photo A-13 Pointe-Aux-Pins PAP#2, facing upstream (south). Note beaver dam upstream of culvert (10/30/2017)

Photo A-14 Pointe-Aux-Pins PAP#2, upstream end of culvert, facing east from the shoulder of the northbound lanes of Hwy #21 (10/30/2017)

Photo A-15 Pointe-Aux-Pins PAP#3, facing downstream (west) (10/30/2017)

Photo A-16 Pointe-Aux-Pins PAP#3, facing upstream (east) (10/30/2017)

Photo A-17 Pointe-Aux-Pins PAP#4, facing downstream (west) (10/30/2017)

Photo A-18 Pointe-Aux-Pins PAP#4, facing upstream (east) (10/30/2017)

Photo A-19 Pointe-Aux-Pins PAP#5, downstream end of road culvert, facing south (10/30/2017)

Photo A-20 Pointe-Aux-Pins PAP#5, upstream end of road culverts from the shoulder of Range Road 224 (facing east). Beaver dams at the head of both road culverts causing ponding (10/30/2017)

Photo A-21 Pointe-Aux-Pins PAP#6, facing downstream (northwest). Note WSC hydrometric station on bridge, and the bank erosion downstream of bridge (10/30/2017)

Photo A-22 Pointe-Aux-Pins PAP#6, downstream of bridge, facing (east). Bank erosion occurring on the outside bend (right bank) of the creek (10/30/2017)

Photo A-23 Pointe-Aux-Pins PAP#7, downstream end of culvert. Large ponded, eroded area caused by constriction in creek on the right of photo (10/30/2017)

Photo A-24 Pointe-Aux-Pins PAP#7, upstream side of culvert, facing east (10/30/2017)