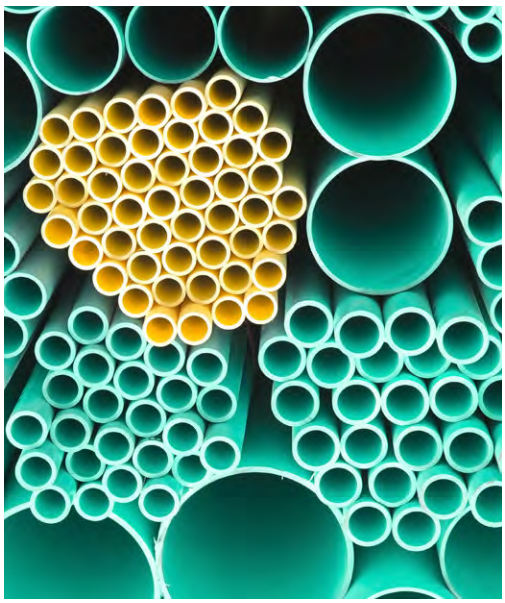
Integrated Expertise. Locally Delivered.
islengineering.com



Water Master Servicing Study

ISL Engineering and Land Services

Town of Strathmore

Final Report

April 2020

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

Corporate Authorization

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

Sarah Barbosa, P.Eng., ENV SP
Technical Author

Geoffrey Schulmeister, P.Eng., SCPM
Senior Reviewer

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

April 23, 2020

Our Reference: 27399

Town of Strathmore
680 Westchester Road
Strathmore, AB T1P 1J1

Attention: Freda Isaac, P.Eng.

Dear Madam:

Reference: Water Master Servicing Study Final Report

Enclosed is the final report for the Water Master Servicing Study. We trust that it meets your expectations.

The focus of the Water Master Servicing Study is to meet the Town's long range goals, while addressing the needs of existing and future water distribution system under key milestone growth scenarios. The Study will help the Town understand the implications of servicing the new development and the servicing approach and constraints. By applying a comprehensive design, consistent approaches to issues, and sound engineering principles, while all the time protecting the natural and human environment, this Study will guide effective infrastructure implementation.

We sincerely appreciate the opportunity to undertake this project on behalf of the Town of Strathmore. Should you have any questions or concerns, please do not hesitate to contact the undersigned at 403.254.0544.

Sincerely,

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

Executive Summary

Background

The Town of Strathmore (the Town) retained ISL Engineering and Land Services Ltd. (ISL) to undertake the Water Master Servicing Study (the Study) encompassing water infrastructure. The focus of the Study is to meet the Town's long range goals, while addressing the needs of existing and future systems under key milestone growth scenarios. For that purpose, a robust WaterCAD model was constructed and calibrated to enable a comprehensive assessment of the water system.

The Town's 2014 Municipal Development Plan suggests that there is an increased demand for residential development, including development of new lots as well as densification of the downtown core. This is reinforced by the completion of the East Calgary Regional Waterline (ECRWL) and approval of the wastewater treatment facility and outfall. Additionally, the Town maintains its position as being a key hub for commercial and industrial developments. From when the 2012 MSS Update was completed to the last census in 2018, the Town has grown by approximately 1,200 people which translates to a growth of 8% over 6 years, or 1.33% per year.

The need for an updated Water Master Servicing Study was triggered by the following:

- Updated population reflecting a growth of 8%
- Consideration of a reduction in water consumption rates based on water conservation initiatives throughout the province
- Completion of the Wildflower Reservoir
- Extension of the Town's growth horizon
- Evaluation of proposed servicing concepts identified in the Town's Area Structure Plans
- Updated cost estimates and timeline projections based on the proposed upgrades and servicing concepts in 2019

Conclusions

Conclusions for the Study are as follows:

1. The existing water servicing network generally performs adequately under existing conditions in terms of pressure and fire flow requirements.
2. The range between highest and lowest pressures suggests that servicing outside the current elevation band would require the addition of new pressure zones.
3. The existing distribution system generally appears to meet fire flow requirements, with some deficiencies in older areas with predominantly iron watermains. Deficiencies are also noted in the north, near some institutional facilities such as schools, the hospital, churches, and recreation centres, although if sprinklered these facilities have sufficient fire flows.
4. Under existing conditions, the Wildflower and Brentwood Reservoirs are sufficient in terms of storage and pumping capacity.
5. The Brentwood Reservoir is sufficiently filled under ADD and MDD reservoir filling scenarios.
6. To service the distribution system only with the Wildflower Reservoir for the interim growth horizon, an expansion to the Wildflower Reservoir is needed both for storage and pumping capacity. This is proposed to be expanded in the adjacent green space to the east.
7. A servicing concept has been developed to provide water distribution considering full build-out of the Town's boundary.
8. Expansion of the system to the northwest and southeast will require two additional pressure zones. It is noted that as these pressure zones are lower in elevation compared to the Main Pressure Zone, new reservoirs are not required, unless the Town wishes to introduce further system redundancy.

9. A new reservoir, the East Reservoir, is required for the Main Pressure Zone to effectively service the east and north. A 600 mm fill line from the Wildflower Reservoir is needed, which can be accomplished either by upsizing the existing Brentwood fill line and expanding east, or implementing a new line altogether. The East Reservoir is required prior to any growth outside of the interim growth horizon.
10. An analysis of the ECRWL suggests that there is capacity in the supply line to accommodate growth beyond the interim growth horizon. That said, additional capacity is required prior to complete development of the full build-out horizon.
11. Consideration for two additional residential quarter sections in the northwest was analyzed, resulting in minor implications to the developed servicing concept (apart from additional storage and pumping capacity to meet these additional demands, plus further watermain looping).
12. A staging plan considering the existing conditions plus the two growth horizons over short-, medium-, and long-term growth was made.

Recommendations

Recommendations for the Study are as follows:

1. To pinpoint critical locations in the system that are limited fire flows, it is suggested that the Town implements a cast/ductile iron replacement program and consider conducting a condition assessment.
2. Consideration for upgrading areas with small fire flow deficiencies could be made during roadworks programs. The recommendation in this case would be to replace 100 mm to 150 mm watermains with 200 mm to 300 mm mains, respectively, to improve fire flows in Town. That said, this would only make sense in conjunction with roadworks programs, given minor deficiencies in fire flow would make it difficult to justify larger capital expenditures. This will improve fire flows to meet standards over time. These programs should also contemplate replacement of any iron or asbestos cement pipes with safer and less problematic PVC piping. This would offer a solution to improve the low roughness coefficients derived through the calibration process for AC, CI, and DI.
3. To improve the fire flows south of the TCH and through portions of the center of Town, install a 300 mm trunk watermain from west to east. This has been proposed through the Westmount subdivision; consisting of an upsized 300 mm PVC pipe from the intersection of Westmount Road and Westmount Drive down to Westridge Road, ultimately tying into the intersection of Wheatland and 3rd Avenue.
4. Localized fire flow improvements can be made along 5th Avenue, by upsizing the existing watermains to 300 mm.
5. Increase the pumping capacity of Wildflower Reservoir by 110 L/s by adding a fifth pump in order to decommission the Brentwood Reservoir and meet required flows. Note here that decommissioning the Brentwood Reservoir decreases the available fire flow in the north further, adding a degree of risk to the institutional facilities in the north. It also reduces the system's resiliency, and presents potential challenges regarding the operation and maintenance of the Wildflower Reservoir.
6. Connect the Brentwood Reservoir fill line to the distribution system, and decommission the Brentwood Reservoir.
7. Implement an adjacent Wildflower Reservoir to increase storage to meet the ECRWL requirements under full build-out, which is equivalent to an additional storage of 6,177 m^3 (total storage of 17,677 m^3). This storage is sufficient under the interim growth horizon when Wildflower Reservoir is the only active reservoir (required storage in terms of ECRWL's criteria of 17,055 m^3).
8. Implement 102 L/s of additional pumping capacity at the Wildflower Reservoir to ensure required flows under the interim and full build-out growth horizons are met. It is noted that these upgrades can be performed simultaneously with Recommendation #5 to avoid multiple upgrade projects at the same reservoir.
9. Upsize the 300 mm watermain along Centennial Drive to a 350 mm watermain, and the 300 mm watermain along Edgefield Gate to a 400 mm watermain.
10. Implement the looped networks within the short-term developments based on timing of these developments.
11. Implement the looped network within the medium-term developments based on timing of these developments.

12. Implement a 600 mm fill line from the Wildflower Reservoir to the East Reservoir by either building a new fill line, or upsizing the existing fill line to the Brentwood Reservoir.
13. Build the East Reservoir prior to any development beyond the interim growth horizon being implemented.
14. Increase the Town's ECRWL contribution by 247 L/s (MDD + 10%).
15. Continue growth within the full build-out horizon such that it is in line with the development timeline. This includes the implementation of all looped watermains and PRVs needed to maintain the Southeast and Northwest Pressure Zones.

Table of Contents

1.0 Project Introduction 1
- 1.1 Authorization 1
- 1.2 Background 1
- 1.3 Purpose of Study 2

2.0 Study Area 3
- 2.1 Location 3
- 2.2 Development Type 3
- 2.3 Population Horizons 4

3.0 Design Criteria 7
- 3.1 Existing System Consumption Rates 7
- 3.2 Future System Consumption Rates 9
- 3.3 Peaking Factors 9
- 3.4 Assessment Scenarios 10
- 3.5 Operating Pressure Criteria 10
- 3.6 Fire Flow Criteria 10
- 3.7 Reservoir Storage 10
- 3.8 Design Standards and Procedures for Development and Subdivision Infrastructure Policy Review/Comparison 11

4.0 Existing Water System 13
- 4.1 Water Distribution System 13
- 4.2 Water Supply System 14
- 4.3 Water Consumption and Production 15

5.0 Hydraulic Model Development 17
- 5.1 Model Set-up 17
- 5.2 Service Area Delineation 17
- 5.3 Hydrant Testing 19
- 5.4 Calibration 20

6.0 Existing System Assessment and Upgrades 23
- 6.1 Pressure Assessment 23
- 6.2 Fire Flow Assessment 24
- 6.3 Reservoir and Pumping Capacity Assessment 24
- 6.4 Reservoir Filling Assessment 25
- 6.5 Decommissioning Brentwood Reservoir 26
- 6.6 Emergency Management Assessment 27
- 6.7 Existing System Recommendations 28
- 6.8 Existing System Upgrades Cost Estimates 29

7.0 Future System Assessment and Upgrades 31
- 7.1 Water Servicing Concept 31
- 7.2 Full Build-out Horizon Concept Analysis 32
- 7.3 Interim Growth Horizon Concept Analysis 36
- 7.4 Timing of the East Reservoir 38
- 7.5 Evaluation of ECRWL Capacity 38
- 7.6 Consideration for Additional Quarter Sections 39
- 7.7 Staging Plan 41

8.0 Conclusions and Recommendations 43
8.1 Conclusions 43
8.2 Recommendations 44

9.0 References 47

APPENDICES

Appendix A WaterCAD Model Files
Appendix B Fire Flow Test Reports
Appendix C Detailed Cost Estimates

TABLES

On Page

Table 2.1: Land Use District Descriptions 3
Table 3.1: Residential Consumption Rate Derivation 7
Table 3.2: Commercial Consumption Rate Derivation 8
Table 3.3: Irrigation Consumption Rate Derivation 8
Table 3.4: UFW Rate Derivation 9
Table 4.1: Water Distribution System Summary 13
Table 4.2: Reservoir Characteristics 13
Table 4.3: Pump Characteristics 14
Table 4.4: ECRWL Service Regions 14
Table 5.1: Summary of Existing Service Areas 18
Table 5.2: Summary of Build-out Service Areas 18
Table 5.3: Summary of Interim Service Areas 19
Table 5.4: Hydrant Flow Test Results 19
Table 5.5: Hazen-Williams 'C' Values 20

Following Page

Table 5.6: Calibrated Model Comparison to Hydrant Flow Tests 20

On Page

Table 6.1: Existing System Demands 23
Table 6.2: Existing System Pressure Ranges 23
Table 6.3: Existing Reservoir Storage Requirements 25
Table 6.4: Emergency Management of an ECRWL Closure 27
Table 6.5: Class D Cost Estimates for Recommended Upgrades to the Existing System 29

Table 7.1: Build-out System Demands 32
Table 7.2: Future System Pressure Ranges 32
Table 7.3: Proposed Reservoir Storage Requirements 33
Table 7.4: Proposed Reservoir/Pump Station Specifications under the Full Build-out Growth Horizon 34
Table 7.5: Class D Cost Estimates for Proposed Build-out Concept 35
Table 7.6: Annual Operation and Maintenance Costs for the Proposed Servicing Concept 36
Table 7.7: Interim System Demands 37
Table 7.8: Class D Cost Estimates for Proposed Interim Concept 38
Table 7.9: ECRWL Contributions per Growth Horizon 39
Table 7.10: Additional Population Growth Available based on Spare Capacity in the ECRWL 39
Table 7.11: Additional Demands Associated with Potential Annexation of Quarter Sections 39
Table 7.12: Updated Reservoir Storage/Pump Station Specifications with the Two Additional Quarter Sections 40
Table 7.13: Summary of Required Additional Infrastructure 41
Table 7.14: Staging Plan 42

FIGURES

Following Page

Figure 2.1: Study Area 6
Figure 2.2: Topography 6
Figure 2.3: Watershed Boundaries 6
Figure 2.4: Existing Land Use Districts 6
Figure 2.5: Population Horizons 6
Figure 2.6: Transportation Zones 6

On Page

Figure 2.7: Strathmore Growth Projection 5

Following Page

Figure 3.1: Top Water Users 12
Figure 4.1: Pipe Diameter 16
Figure 4.2: Pipe Material 16
Figure 4.3: Pipe Installation Year 16
Figure 4.4: East Calgary Regional Waterline Alignment 16

On Page

Figure 4.5: Historic Production and Consumption Volumes 15

Following Page

Figure 5.1: Existing Service Areas 22
Figure 5.2: Build-out Service Areas 22
Figure 5.3: Interim Service Areas 22
Figure 5.4: Hydrant Test Locations 22

On Page

Figure 5.5: Static Pressure Calibration Results at Residual Hydrant 21
Figure 5.6: Flowed Pressure Calibration Results at Residual Hydrant 21

Following Page

Figure 6.1: Existing System Analysis Average Day Demand 30
Figure 6.2: Existing System Analysis Maximum Day Demand 30
Figure 6.3: Existing System Analysis Peak Hour Demand 30
Figure 6.4: Existing System Analysis Maximum Day Demand plus Fire Flow 30
Figure 6.5: Watermain Break History 30
Figure 6.6: Existing System Analysis Average Day Demand plus Brentwood Reservoir Filling 30
Figure 6.7: Existing System Analysis Maximum Day Demand plus Brentwood Reservoir Filling 30
Figure 6.8: Existing System Analysis Brentwood Reservoir Offline Average Day Demand 30
Figure 6.9: Existing System Analysis Brentwood Reservoir Offline Peak Hour Demand 30
Figure 6.10: Existing System Analysis Brentwood Reservoir Offline Maximum Day Demand plus Fire Flow 30
Figure 6.11: Existing System Analysis Brentwood Reservoir Offline - Upgrades Average Day Demand 30
Figure 6.12: Existing System Analysis Brentwood Reservoir Offline - Upgrades Peak Hour Demand 30
Figure 6.13: Existing System Analysis Brentwood Reservoir Offline - Upgrades Maximum Day Demand plus Fire Flow 30
Figure 6.14: Existing System Analysis Brentwood Reservoir Offline - Upgrades Maximum Day Demand plus Fire Flow Comparison to Existing Conditions 30
Figure 6.15: Existing System Upgrades 30
Figure 6.16: Existing System Upgrade Analysis Average Day Demand 30
Figure 6.17: Existing System Upgrade Analysis Peak Hour Demand 30
Figure 6.18: Existing System Upgrade Analysis Maximum Day Demand plus Fire Flow 30
Figure 6.19: Existing System Upgrade Analysis Maximum Day Demand plus Fire Flow Comparison to Existing Conditions 30

Figure 7.1: Proposed Build-out Concept 42
Figure 7.2: Future Pressure Zones 42
Figure 7.3: Proposed Build-out Analysis Average Day Demand 42
Figure 7.4: Proposed Build-out Analysis Maximum Day Demand 42
Figure 7.5: Proposed Build-out Analysis Peak Hour Demand 42
Figure 7.6: Proposed Build-out Analysis Maximum Day Demand plus Fire Flow 42
Figure 7.7: Proposed Build-out Analysis Average Day Demand plus East Reservoir Filling 42
Figure 7.8: Proposed Build-out Analysis Maximum Day Demand plus East Reservoir Filling 42
Figure 7.9: Proposed Interim Concept 42
Figure 7.10: Proposed Interim Analysis Average Day Demand 42
Figure 7.11: Proposed Interim Analysis Maximum Day Demand 42
Figure 7.12: Proposed Interim Analysis Peak Hour Demand 42
Figure 7.13: Proposed Interim Analysis Maximum Day Demand plus Fire Flow 42
Figure 7.14: Additional Quarter Sections Service Areas 42
Figure 7.15: Proposed Build-out Concept with Additional Quarter Sections 42
Figure 7.16: Proposed Build-out Analysis with Additional Quarter Sections Average Day Demand 42
Figure 7.17: Proposed Build-out Analysis with Additional Quarter Sections Maximum Day Demand 42
Figure 7.18: Proposed Build-out Analysis with Additional Quarter Sections Peak Hour Demand 42
Figure 7.19: Proposed Build-out Analysis with Additional Quarter Sections Maximum Day Demand plus Fire Flow 42
Figure 7.20: Development Timeline 42
Figure 7.21: Staging Plan – Short-term 2020 to 2039 42
Figure 7.22: Staging Plan – Medium-term 2040 to 2059 42
Figure 7.23: Staging Plan – Long-term 2060 to Full Build-out 42

ABBREVIATIONS

Abbreviation	Meaning
AC	asbestos cement
ADD	average day demand
AEP	Alberta Environment and Parks
ASP	Area Structure Plan
CI	cast iron
CMRB	Calgary Metropolitan Region Board
COC	City of Calgary
CU	copper
DI	ductile iron
ECRWL	East Calgary Regional Waterline
HDPE	high density polyethylene
ISL	ISL Engineering and Land Services Ltd.
LiDAR	light detection and ranging
MDD	maximum day demand
MDD + FF	maximum day demand plus fire flow
MDP	Municipal Development Plan
PE	polyethylene
PHD	peak hour demand
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
RF + ADD	reservoir filling under average day demand
RF + MDD	reservoir filling under maximum day demand
the Study	the Water Master Servicing Study
TCH	Trans-Canada Highway
the Town	the Town of Strathmore
TMP	Transportation Master Plan
UFW	unaccounted for water

1.0 Project Introduction

1.1 Authorization

The Town of Strathmore (the Town) retained ISL Engineering and Land Services Ltd. (ISL) to undertake the Water Master Servicing Study (the Study) encompassing water infrastructure. The focus of the Study is to meet the Town's long range goals, while addressing the needs of existing and future systems under key milestone growth scenarios. For that purpose, a robust WaterCAD model was constructed and calibrated to enable a comprehensive assessment of the water system. The Study will provide Council and Engineering staff with the information required to assess the Town's existing infrastructure and the capability of the infrastructure to accommodate short- and long-term growth. This information is useful in order to carry out short and long range planning and budgeting, as well as to assist with updating the Town's Off-site Levy Bylaw. The Study will aid in making informed decisions on capital projects, and will provide solutions for efficient, economic, and sustainable municipal services to residents.

1.2 Background

The Town of Strathmore is located within Wheatland County along the Trans-Canada Highway (TCH) approximately 50 km east of Calgary. Its proximity to Calgary and its location along the TCH makes the Town a desirable community for young families.

The Town's 2014 Municipal Development Plan (MDP) suggests that there is an increased demand for residential development, including development of new lots as well as densification of the downtown core. This is reinforced by the completion of the East Calgary Regional Waterline (ECRWL) and approval of the wastewater treatment facility and outfall. Additionally, the Town maintains its position as being a key hub for commercial and industrial developments. From when the 2012 MSS Update was completed to the last census in 2018, the Town has grown by approximately 1,200 people which translates to a growth of 8% over 6 years, or 1.33% per year.

The need for an updated Water Master Servicing Study was triggered by the following:

- Updated population reflecting a growth of 8%
- Consideration of a reduction in water consumption rates based on water conservation initiatives throughout the province
- Completion of the Wildflower Reservoir
- Extension of the Town's growth horizon
- Evaluation of proposed servicing concepts identified in the Town's Area Structure Plans (ASP)
- Updated cost estimates and timeline projections based on the proposed upgrades and servicing concepts in 2019

The Study will help the Town understand the implications of servicing the new development and the servicing approach and constraints. By applying a comprehensive design, consistent approaches to issues, and sound engineering principles, while all the time protecting the natural and human environment, the Study will guide effective infrastructure implementation. The Study will also examine the capacity of the system to determine the extent of upgrades required to accommodate population densification within the Town's current boundary.

1.3 Purpose of Study

The purpose of developing a Water Master Servicing Study is outlined below:

- To inventory and analyze the existing infrastructure under existing conditions.
- To determine if any upgrades are required to the existing system in order to properly meet the needs of the municipality.
- To determine if any upgrades are required to allow for future growth to occur.
- To develop plans for future growth. This might include locations and timing of future developments based on the availability of sufficient servicing needs. Locations and timing may also be dependent on developable land locations, and community planning.
- To provide cost estimates related to required infrastructure upgrades.
- To comment on possible staging options of upgrades to assist in an overall municipal capital plan.

Specifically, the Study includes the following:

- Compilation and assessment of the existing water data.
  - Development of a WaterCAD model for the water distribution system.
  - GIS compatible files.
  - Water calibration to accurately represent the performance of the Town's existing water distribution system.
- Analysis of infrastructure under existing and future growth horizons.
  - Five demand scenarios for the water distribution system:
    - Average Day Demand (ADD)
    - Peak Hour Demand (PHD)
    - Maximum Day Demand plus Fire Flows (MDD + FF)
    - Reservoir Filling under Average Day Demand (RF + ADD)
    - Reservoir Filling under Maximum Day Demand (RF + MDD)
- Identification of the required upgrades to the infrastructure to meet existing and future needs.
  - Rehabilitation of existing pipes.
  - Constructing additional infrastructure to improve flows and pressures within the existing system.
  - Implementing additional infrastructure to accommodate future developments in two phases:
    - To the interim growth horizon
    - To the ultimate build-out development horizon for the annexation lands
- Detailed evaluation of servicing alternatives analysis, based on the 70,500 population threshold.
  - Recommended servicing options
  - Funding strategies
- Development of cost estimates for recommended upgrades for existing and future horizons.
- Analysis of the Design Standards and Procedures for Development and Subdivision Infrastructure Policy document.
- Evaluation of the capacity of the ECRWL to meet current and future demands.
- Development of a staging plan for implementing infrastructure upgrades in terms of short-term and long-term needs.

2.0 Study Area

2.1 Location

The Town of Strathmore is situated in southern Alberta in Wheatland County, approximately 50 km east of The City of Calgary. The Town is bounded by Township Road 244 to the north, George Freeman Trail to the east, Wildflower Road to the west, and Township Road 240 to the south. The TCH transects the Town, and provides a linkage to The City of Calgary.

The overall study area of the Study includes all water infrastructure to conduct modelling of the existing system, as well as any annexed land for future growth horizon considerations. The study area encompasses a total area of over 2,800 ha. Figure 2.1 highlights the area that was considered as part of the Study.

The Town falls within an elevation between 942.79 m in the southeast near the Town's lagoon and 989.83 m in the southwest near the intersection of Wildflower Road and Westridge Road. There is a ridge that bisects the Town diagonally from southwest to northeast, causing the majority of the Town to slope towards the southeast and a portion to slope to the northwest. A topographical map of Strathmore is shown in Figure 2.2.

Strathmore lies in the South Saskatchewan River watershed, which is part of the Nelson-Churchill (Hudson Bay) continental drainage basin. Within the South Saskatchewan River watershed, Strathmore is located in Regions 05BM and 05CE. 05BM represents a reach of the Bow River while 05CE represents a reach of the Red Deer River. A map of the watershed boundaries is shown in Figure 2.3.

2.2 Development Type

The development type influences water consumption rates, therefore obtaining an appropriate classification was vital in order to ensure an accurate representation of the Town's water distribution system could be achieved. When determining development classification for existing areas in Strathmore, a land use district shapefile provided by the Town was utilized. A land use district map for the existing development is illustrated in Figure 2.4, while Table 2.1 summarizes all land use district codes and their corresponding descriptions. The land uses were compared to aerial maps and Google Street View to confirm that parcels were properly categorized. For the purposes of the Study, many of these land use districts were grouped together to form an overall land use. In this manner, Strathmore was classified more broadly by a number of unique development types, including residential, commercial, industrial, institutional.

Table 2.1: Land Use District Descriptions

District Code	District Description	District Code	District Description
AG	Agriculture General District	P1	Public Service District
C1	Neighbourhood Commercial District	R1	Single Detached Residential District
CB	Central Business District	R1N	Single Detached Residential (Narrow Lot) District
CHWY	Highway Commercial District	R1S	Single Detached Residential (Small Lot) District
CR1	Country Residential District	R2	Low Density Residential District
M1	Light Industrial District	R2X	Medium Density Attached Housing District
M2	General Industrial District	R3	High Density Residential District
MHP	Mobile Home Park District	R3M	Medium Density Modest Residential District
MHS	Mobile Home Subdivision District	UR	Urban Reserve District

2.3 Population Horizons

Strathmore's water distribution system was assessed under three scenarios, shown in Figure 2.5:

- Existing conditions (population of 13,515); noting that this represents the serviced population
- Interim growth to 2052 (population of 30,703)
- Full build-out of the Town (population of 70,506)

The existing population was obtained from the Transportation Master Plan (TMP), also being completed by ISL. This was done to ensure there is consistency between the two documents. A summary of how the residential and employment populations were derived for the existing and interim population horizons is provided in the TMP. The population was derived in a shapefile format, and populations were assigned based on delineated transportation zones, as shown in Figure 2.6. Growth to 2049 was also obtained from the TMP in a shapefile format, and includes the build-out of five ASPs:

- Lakewood Meadows: Zone 20;
- Wildflower Ranch: Zones 22 and 100;
- Westcreek: Zones 110 and 101;
- Edgefield: Zones 158 and 159; and,
- Coldwell Ranch: Zone 141

The interim growth horizon presented in this document consists of the growth to the five ASP areas noted above, as well as densification throughout the existing system. Densification was assigned in order to be consistent with the 2017 Master Servicing Strategy. It was assumed that densification would occur throughout the existing system, and would represent a 20% growth. This results in an additional population of 2,703 for an approximate interim growth horizon of 2052, assuming the growth rate discussed below.

All other ASP areas and undeveloped areas without ASPs were included as part of the full build-out of the Town. Land use classification was assigned depending on the land use stipulated in the 2014 MDP. For all areas without ASPs, densities of 44.3 and 34.0 persons per gross hectare were assumed for residential and non-residential areas respectively. This approach is consistent with the methodology applied in the 2017 Master Servicing Strategy.

The following graph in Figure 2.7 illustrates a 2.5% growth rate from the current serviced residential population of 13,515, noting that this growth is consistent with the 2017 Master Servicing Strategy. A growth rate of 2.5% also aligns with the population and growth horizon utilized in the TMP. That said, it is noted that a growth rate of 2.5% is conservative (i.e., results in infrastructure being required sooner rather than later). In this document, horizons are provided in terms of population and years, to provide more robust projections. The graph indicates the three population horizons for analysis of 2019, 2052 and full build-out, along with their associated populations.

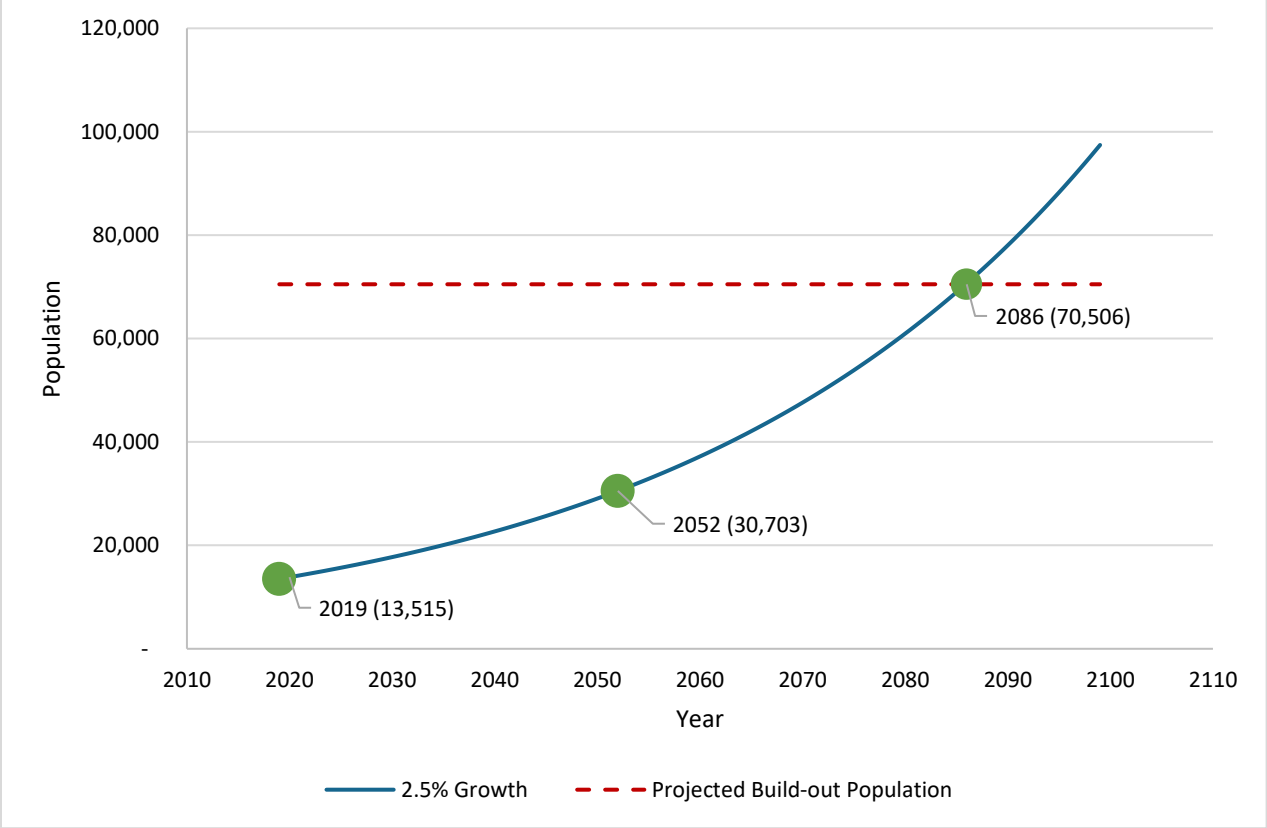
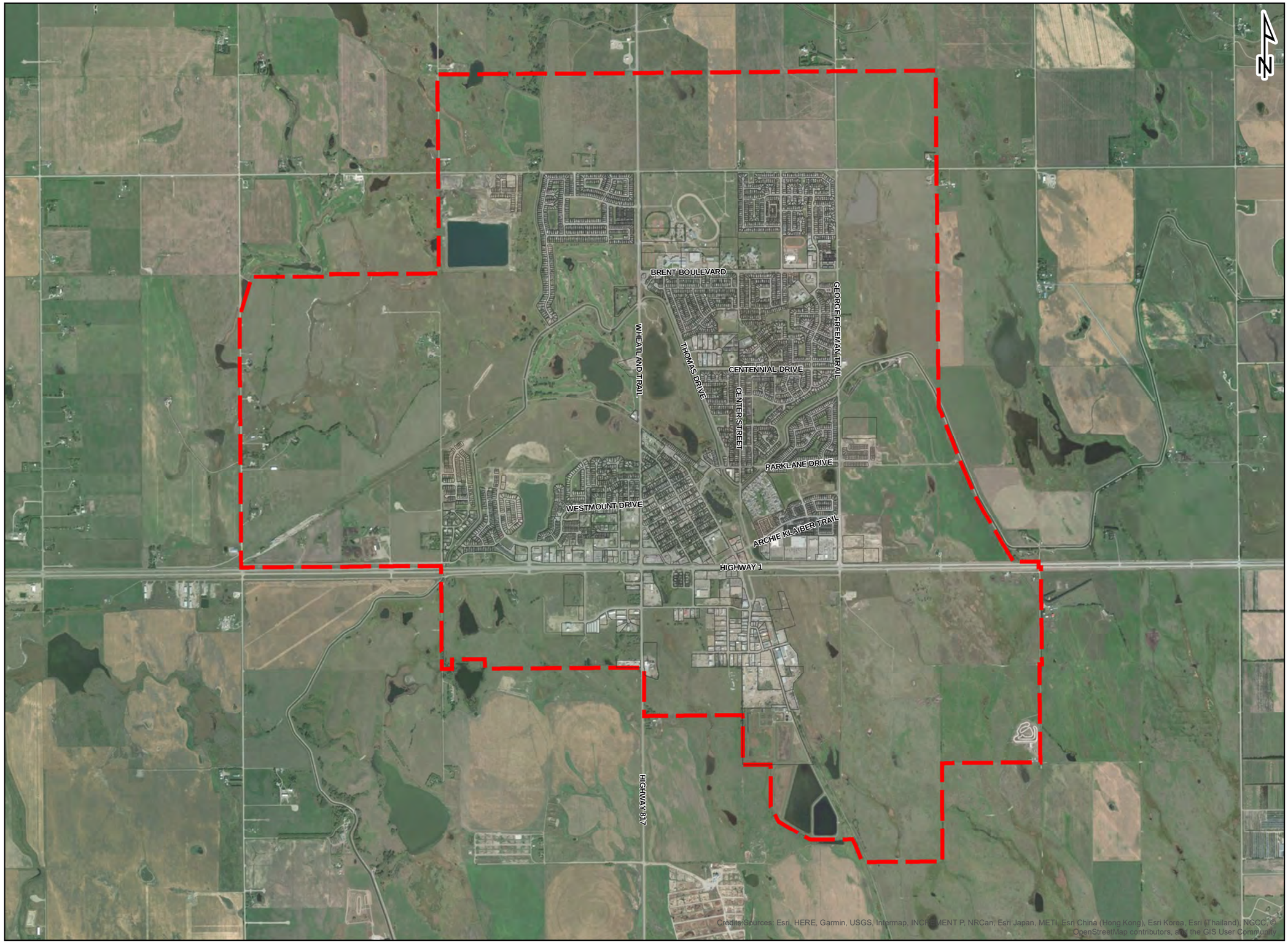


Figure 2.7: Strathmore Growth Projection

This page has been left blank intentially.



Legend

Legal

Study Area

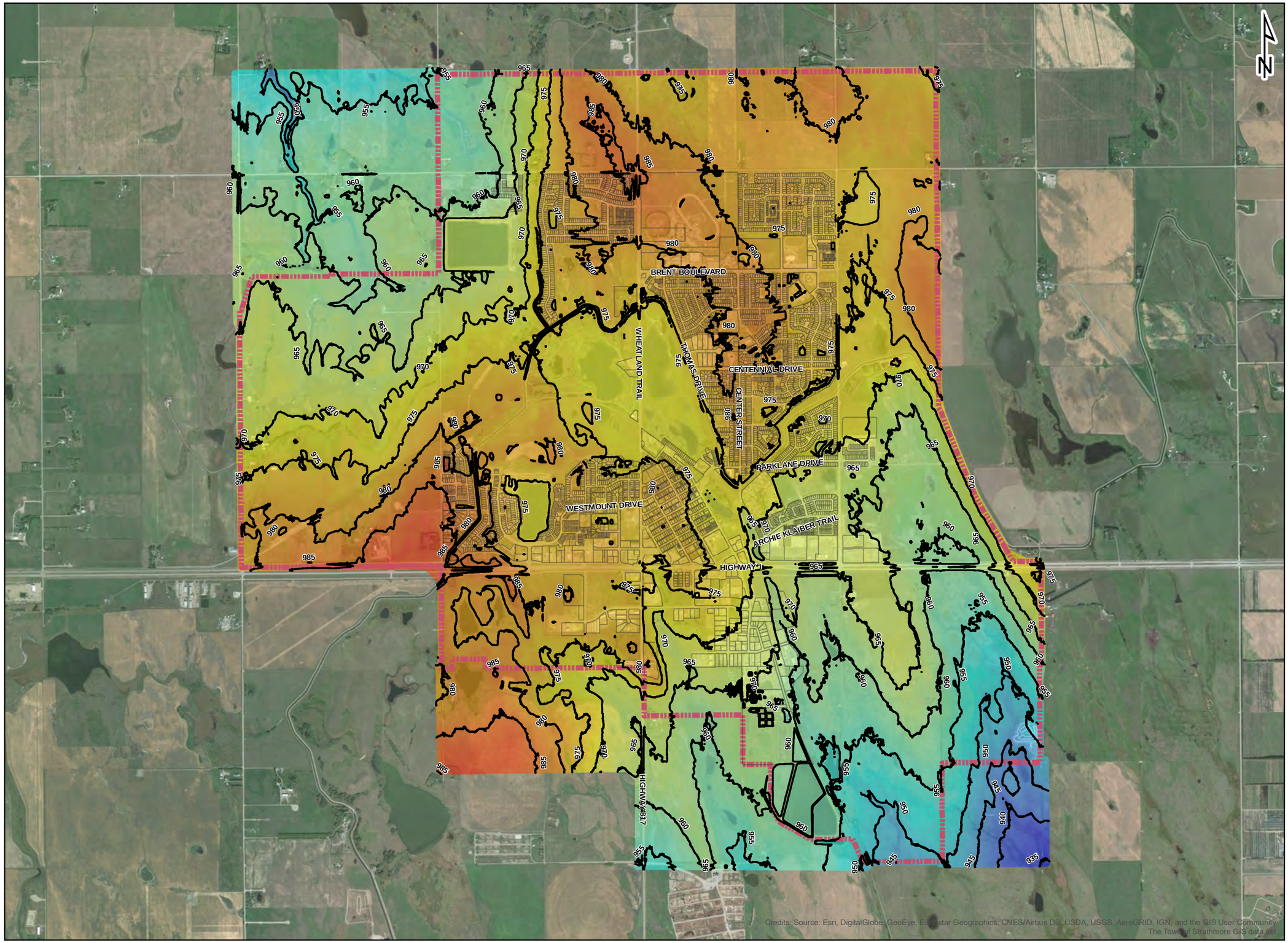
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 2.1
STUDY AREA
WATER MASTER SERVICING STUDY

Date: 11/7/2019 Document: I:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 2.1_Study Area.mxd

Integrated Expertise. Locally Delivered.



Legend

- Contours - 5m Interval
- Legal
- Town Boundary

Elevation (m)

High : 989.98

Low : 934.14

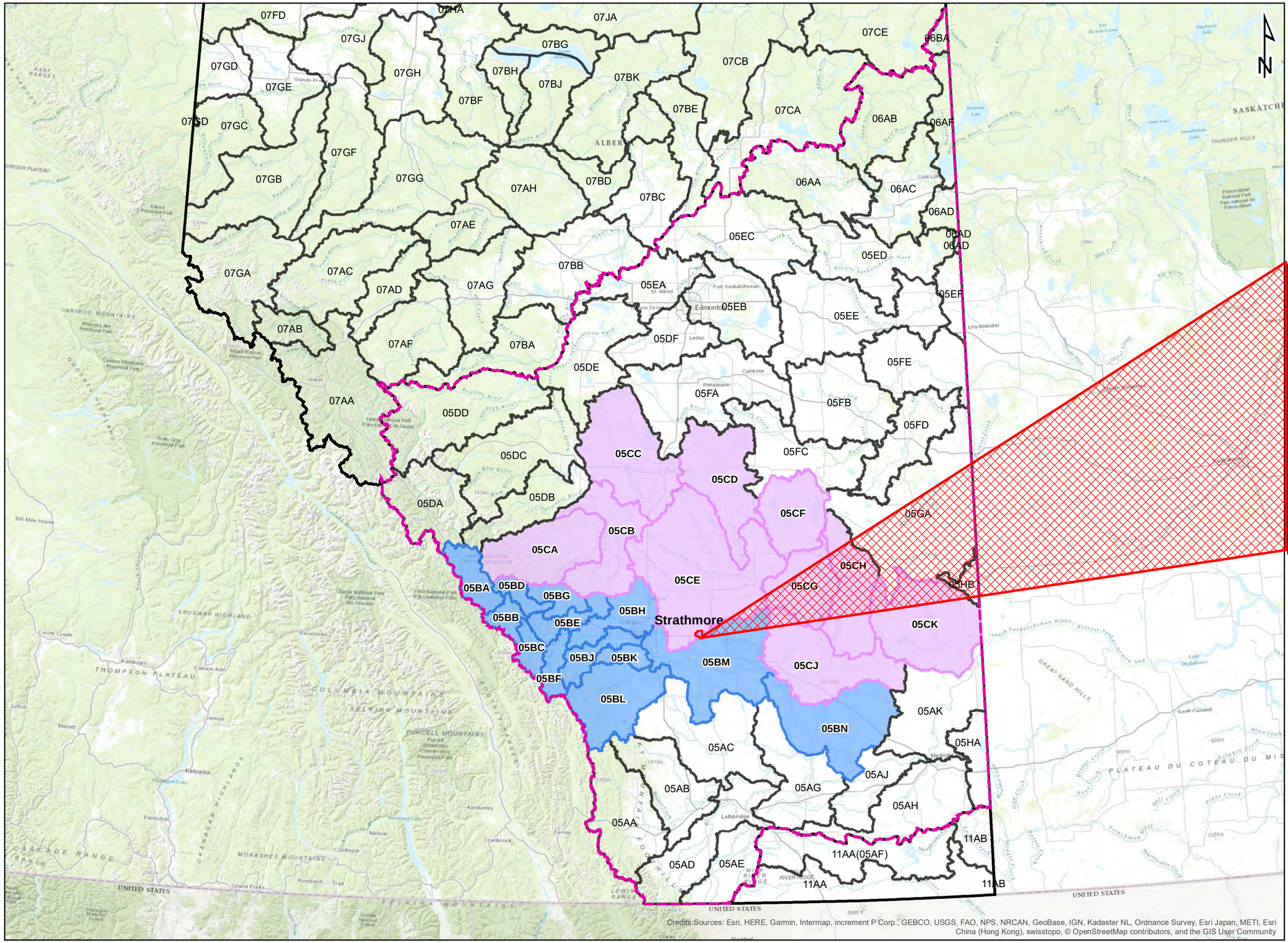
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 2.2
TOPOGRAPHY
WATER MASTER SERVICING STUDY

Date: 11/7/2019 Document: I:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 2.2_Topography.mxd

Integrated Expertise. Locally Delivered.



Legend

Study Area

Continental Drainage Basins

Nelson-Churchill (Hudson Bay)
Mackenzie (Arctic Ocean)
Mississippi (Gulf of Mexico)

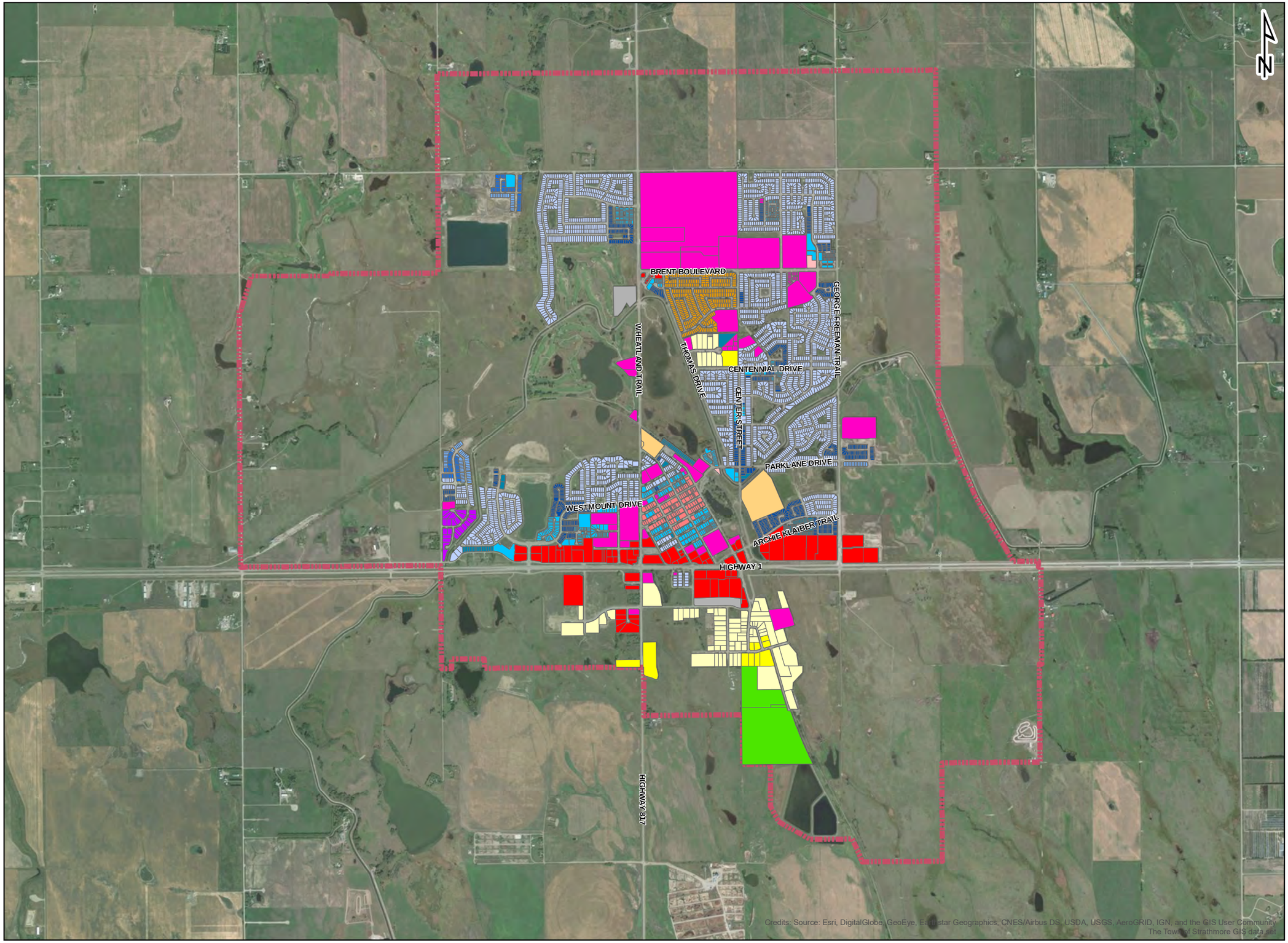
Watersheds Of Alberta

Bow River
Red Deer River
Remaining Watershed Regions

0 38,000 76,000 152,000 m

1:3,100,000 NAD 1983 3TM 114

FIGURE 2.3
WATERSHED BOUNDARIES
WATER MASTER SERVICING STUDY



Legend

- Legal
- Town Boundary

Land Use District

- AG
- C1
- CB
- CHWY
- CR1
- M1
- M2
- MHP
- MHS
- P1
- R1
- R1N
- R1S
- R2
- R2X
- R3
- R3M
- UR

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

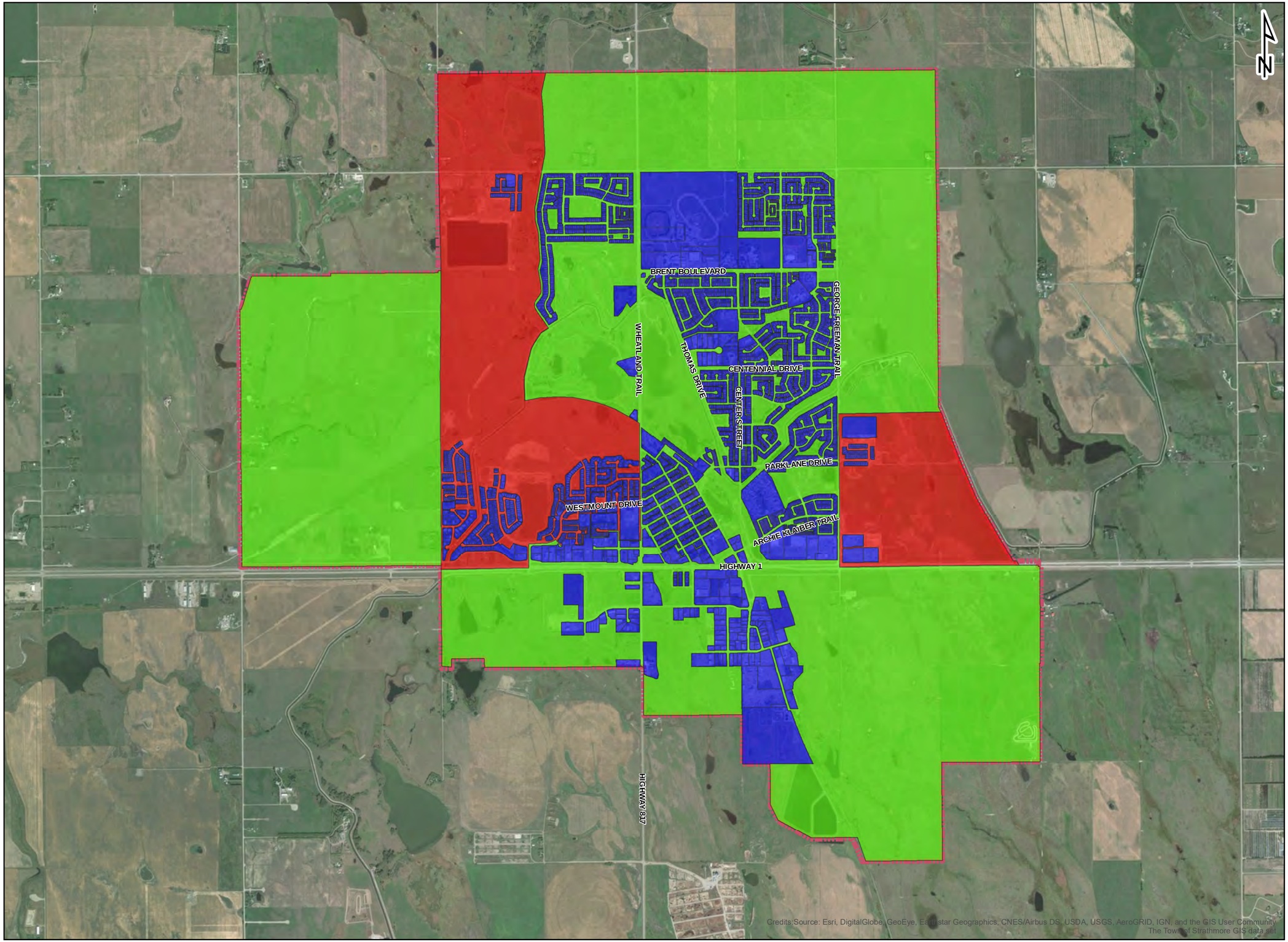
FIGURE 2.4
EXISTING LAND USE DISTRICTS
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 11/15/2019 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 2.4_Land Use Districts.mxd



Legend

- Legal
- Town Boundary

Population Horizons

- Existing Conditions (13,515)
- Interim Growth to 2052 (30,703)
- Full Build-out of the Town (70,506)

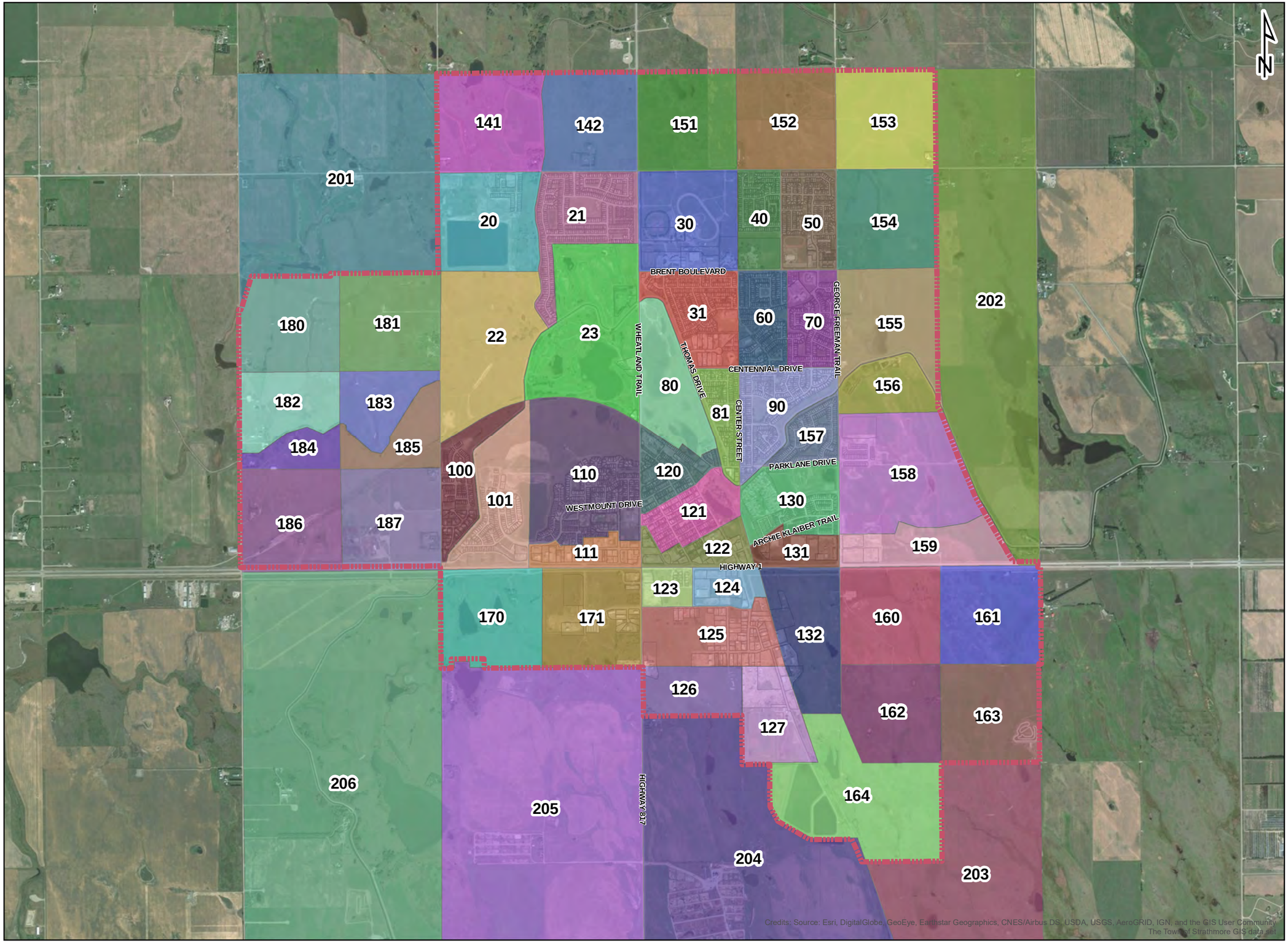
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 2.5
POPULATION HORIZONS
WATER MASTER SERVICING STUDY

Integrated Expertise. Locally Delivered.

Date: 4/23/2020 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 2.5_Population Horizons.mxd



Legend

- Legal
- Town Boundary

Zone Number

20, 21, 22, 23, 30, 31, 40, 50, 60, 70, 80, 81, 90, 100, 101, 110, 111, 120, 121, 122, 123, 124, 125, 126, 127, 130, 131, 132, 141, 142, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 170, 171, 180, 181, 182, 183, 184, 185, 186, 187, 201, 202, 203, 204, 205, 206

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 2.6
TRANSPORTATION ZONES
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 11/7/2019 Document: I:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 2.6_Transportation Zones.mxd

3.0 Design Criteria

The design criteria used to assess the Town's water distribution system was derived from past Water Servicing Studies, typical municipal servicing standards in the Province of Alberta, and fire flow requirements from the Fire Underwriters Survey. In addition, water demands were determined based on the Town's population rates and service areas as stated below in Section 5.2.

3.1 Existing System Consumption Rates

The existing system consumption rates utilized in this analysis were derived through historic production and consumption data provided by the Town. Rates for residential, commercial, irrigation, and unaccounted for water (UFW) were determined, in addition to the application of high water users throughout the Town. The derivation of these rates is described in the subsequent sections, and summarized below. It is noted that the commercial consumption rates were applied for industrial and institutional areas as well.

- Residential Consumption Rate – 155 L/p/d
- Commercial Consumption Rate – 255 L/p/d
- High Water User Demand – Varies per High Water User
- Irrigation Consumption Rate – 0.12 L/s/ha
- UFW Rate – 0.013 L/s/ha

3.1.1 Residential Consumption Rate Derivation

Residential consumption data was provided by the Town on a monthly basis for 2016 to 2018. On an annual average, the residential consumption ranged from 23.86 L/s to 25.17 L/s. These demands were divided by the populations in each year, to determine the consumption rate per year. The 2018 population was obtained from census data, while the 2016 and 2017 population was interpolated between the 2015 and 2018 census years. Based on the three years of annual consumption data, an average rate of 157.40 L/p/d was derived, and rounded to 155 L/p/d. This is summarized in Table 3.1.

Table 3.1: Residential Consumption Rate Derivation

Year	Residential Population	Average Residential Consumption	Residential Consumption Rate
	Persons	L/s	L/p/d
2016	13,390	23.86	153.97
2017	13,453	25.17	161.67
2018	13,438	24.35	156.57
Average	13,427	24.46	157.40

3.1.2 Commercial Consumption Rate Derivation

The commercial consumption data was provided by the Town on a monthly basis from 2016 to 2018. However, only 2017 and 2018 were utilized for the rate derivation as the high water users were deducted from the average rate, and this data was only provided for 2017 to 2019. On an annual average, the commercial consumption including the high water users was 12.08 L/s and 10.28 L/s for 2017 and 2018 respectively. The high water users accounted for 3.95 L/s and 4.12 L/s of the overall commercial demands for 2017 and 2018, respectively. The employment population data was derived as part of the TMP, and due to limited information regarding data from previous years, the employment population was kept constant between 2017 and 2018 at 2,413. Based on this, an average rate of 255.83 L/p/d was derived, and rounded to 255 L/p/d. This is summarized in Table 3.2.

Table 3.2: Commercial Consumption Rate Derivation

Year	Commercial Population	Average Commercial Consumption	Average High Water User Consumption	Commercial Consumption Rate
	Persons	L/s	L/s	L/p/d
2017	2,413	12.08	3.95	291.28
2018	2,413	10.28	4.12	220.37
Average	2,413	11.18	4.04	255.83

3.1.3 High Water Users Consumption

The average high water user demands are summarized in Section 3.1.2, and represent approximately a third of the overall commercial demand. Monthly consumption data for the Top 24 water users throughout the Town was provided by the Town for 2017 to 2019. The locations of these Top 24 water users are shown in Figure 3.1. To better represent the non-residential demands, as mentioned above these high water users were deducted from the general commercial consumption rate derivation. Instead, the consumption was assigned to the model individually through fixed demands at the nearest nodes to each property. This was completed to ensure proper demand allocations throughout the network, so that areas such as the water park and Wheatland Lodge were receiving a larger portion of the flows.

3.1.4 Irrigation Consumption Rate Derivation

Irrigation consumption data was provided by the Town from 2016 to 2018 between the months of May to October. These demands average between 1.13 L/s to 2.38 L/s over the course of these six months. The irrigated area was obtained through the TOS_Parks shapefile provided by the Town. In this shapefile, there is a field labelled as “Irrigated”. The total sum of the area of the features marked “YES” in this field was determined for the purposes of deriving a per area rate. This area was assumed to remain constant between years. Based on this, an average rate of 0.12 L/s/ha was derived. This is summarized in Table 3.3 below. It is noted that the irrigation demand was only applied under MDD and MDD + FF.

Table 3.3: Irrigation Consumption Rate Derivation

Year	Irrigation Area	Average Irrigation Consumption	Irrigation Consumption Rate
	ha	L/s	L/s/ha
2016	14	1.13	0.08
2017	14	1.24	0.09
2018	14	2.38	0.17
Average	14	1.58	0.12

It is noted that the irrigation consumption rate is an average of the irrigation volumes provided between 2016 and 2018, therefore does not differentiate between wet and dry years. Typically, wet years would result in lower irrigation volumes, while dry years would result in higher volumes. This holds true for residential watering applications as well as parks. An averaged irrigation rate in practice would only be applicable if the Town is willing to regulate the irrigation consumption in dry years. Regulation could be accomplished by ensuring that the cost of park irrigation water is charged separately to the Parks Service on a volume basis. That said, accounting for these enhanced irrigation periods is generally represented through the MDD scenario, as the MDD generally will occur on a dry summer day when lawn watering is expected.

3.1.5 UFW Rate Derivation

A UFW rate was also determined and applied uniformly across the model to account for potable water leaving the reservoirs, but not being metered, thus not accounted for in the consumption demands. It is noted that the larger dataset from 2014 to 2018 was available for this calculation, as UFW is not dependent on separated residential and commercial demands (provided as an overall combined demand for 2014 and 2015). To derive this rate, the overall production demands between 2014 and 2018 were multiplied by 0.16, based on the assumption that 16% of the Town is unmetered or lost throughout the system through leaks. The service area was based on those that were delineated during the development of the hydraulic model, as discussed in Section 5.2. This totalled 533.55 ha, and was assumed to remain constant between years. Based on this an average rate of 0.013 L/s/ha was derived, as summarized below in Table 3.4.

Table 3.4: UFW Rate Derivation

Year	UFW Area	Average UFW Demand	UFW Rate
	ha	L/s	L/s/ha
2014	533.55	7.11	0.013
2015	533.55	7.45	0.014
2016	533.55	6.90	0.013
2017	533.55	6.95	0.013
2018	533.55	6.74	0.013
Average	533.55	7.03	0.013

3.2 Future System Consumption Rates

For future developments, the following per capita consumption rates were applied:

- Future Residential Consumption Rate – 263 L/p/d
- Future Non-Residential Consumption Rate – 200 L/p/d

The residential rate of 263 L/p/d is consistent with the rate applied in the 2012 Master Servicing Study Update document. The document stipulates a water conservation of 1% from 2011 to 2040 (rate beginning at 375 L/p/d in 2011 and decreasing by 1% per year ultimately to 263 L/p/d by 2041, see Table 4.2 of the 2012 Master Servicing Study Update document), while a fixed rate of 263 L/p/d was applied from 2041 to 2061. As both growth horizons considered in this document are after 2041 (2052 and 2086), the fixed rate was selected.

In terms of non-residential development types, previous studies did not differentiate between residential and employment populations. Instead, the rate selected was chosen to be in line with rates used in other nearby municipalities. For example, the Airdrie UMP applied an employment rate of 193.75 L/p/d while the High River UMP applied a rate of 203 L/p/d.

3.3 Peaking Factors

The following factors were used to establish MDD and PHD for both the existing and future scenarios:

- MDD – 1.85 x ADD
- PHD – 3.70 x ADD

These peaking factors were applied in order to remain consistent with the ECRWL, and are sufficient based on Alberta Environment and Parks' (AEP) guidelines.

3.4 Assessment Scenarios

Model runs to analyze the water distribution system under existing and future conditions were undertaken. Scenarios reviewed included:

- Average day demand (ADD)
- Maximum daily demand (MDD)
- Peak hour demand (PHD)
- Maximum day demand plus fire flow (MDD + FF)
- Average day demand plus reservoir filling (ADD + RF)
- Maximum day demand plus reservoir filling (MDD + RF)

3.5 Operating Pressure Criteria

Strathmore's water system was assessed using the following criteria based on a variety of standards, including those stipulated by AEP:

1. Normal pressure range in the system under ADD of 350 kPa to 550 kPa (50.76 psi to 79.77 psi)
2. Minimum residual pressure in the system under PHD of 275 kPa (39.89 psi)
3. Minimum residual pressure in the system under MDD + FF of 140 kPa (20.31 psi)

3.6 Fire Flow Criteria

Fire flow criteria was based on the Fire Underwriters Survey recommendations (formerly the Insurer's Advisory Organization). Fire flow requirements can be reduced by up to 50% for facilities equipped with sprinkler systems. Below are the fire flow rates for various development types:

1. Single Family Residential – 76 L/s
2. Multi-Family Residential / Institutional – 114 – 227 L/s
3. Industrial – 227 L/s
4. Commercial – 265 L/s

Also for consideration is the fire flow criteria stipulated in the Fire Flow Assessment Report, with rates as follows:

1. Single Family Residential – 60 L/s
2. Multi-Family Residential – 120 L/s
3. School – 190 L/s
4. Commercial/Industrial – 200 L/s

As the Fire Underwriters Survey criteria is more stringent, these fire flow criteria take precedence within this document. However, noting that depending on the Town's tolerance for risk, there is the option to provide some leniency to the required fire flow criteria.

3.7 Reservoir Storage

Reservoir storage volumes were calculated in three manners for comparison purposes: the formula recommended by AEP, the formula recommended by the ECRWL and the formula recommended by The City of Calgary (COC).

Alberta Environment and Parks (Standards and Guidelines for Municipal Waterworks, Wastewater and Stormwater Drainage Systems):

$$S = A + B + (the\ greater\ of\ C\ or\ D)$$

Where,

S = Total storage requirement, m^3
A = Fire storage, m^3
B = Equalization storage (25% of MDD), m^3
C = Emergency storage (minimum of 15% of ADD), m^3
D = Disinfection contact time storage to meet CT requirements, m^3

In terms of fire storage, the fire flow rate of 200 L/s for 3 hours was selected. The rate and duration are consistent with the previous 2006 and 2012 Master Servicing Studies, and are in agreement with the Strathmore Fire Flow Assessment Report.

East Calgary Regional Water Line:

Storage volume shall be equivalent to twice the average per capita per day demand for the regional system.

City of Calgary (Water Long Range Plan):

Storage volume shall be the greater of:

- Sufficient Active Storage to balance out the instantaneous projected MDD without depleting total storage by more than half
- Sufficient to supply the ADD for one day without pumping to the zone
- Sufficient to meet the Canadian Fire Underwriters recommendations

3.8 Design Standards and Procedures for Development and Subdivision Infrastructure Policy Review/Comparison

In large, the Town of Strathmore's Design Standards and Procedures adhere to the "Design Guidelines for Subdivisions Servicing", "Standard Specifications", "Standard Block Profile Specifications", and "Stormwater Management Design Manual" documents published by The City of Calgary. The Town's Design Standards and Procedures document stipulates the differences from the above-mentioned City of Calgary specifications. In terms of water distribution system planning, little criteria is noted, thus The City of Calgary's specifications govern. A number of key discussion items regarding the design criteria for water distribution are noted below.

3.8.1 Future Consumption Rates

The City of Calgary stipulates a future total system demand of 300 L/p/d (not differentiated between residential and commercial areas). The residential rate is roughly 35 L/p/d less in this Study. As mentioned above, the residential rate was selected to be consistent with the previous study.

3.8.2 Reservoir Storage

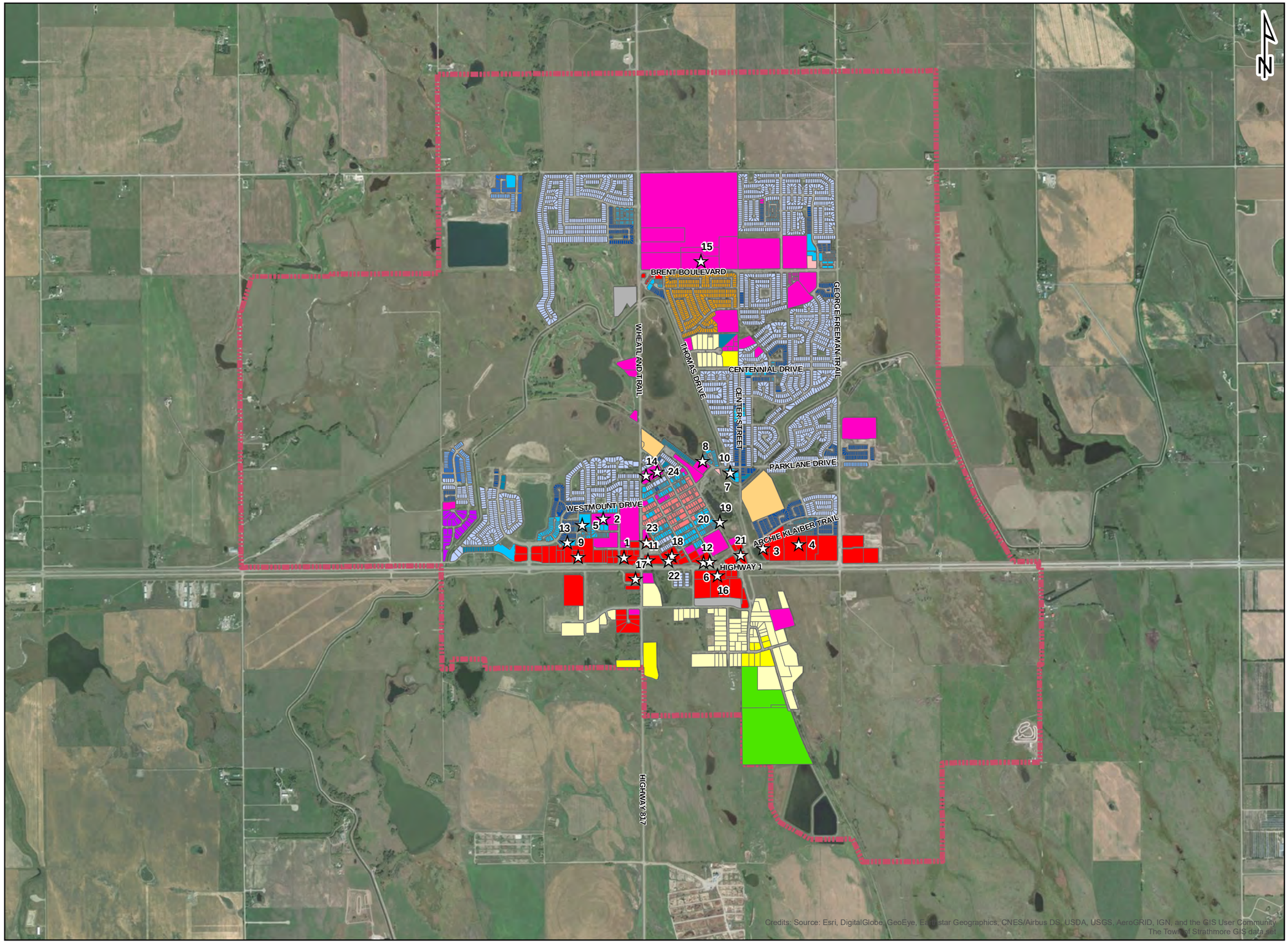
In this Study, reservoir storage was stipulated for AEP, COC, and ECRWL's storage criteria. That said, to ensure congruence between this report and the ECRWL, that criteria was chosen for design, while the other two formulas provided a basis for comparison. In addition to this, the ECRWL criteria is the most conservative of the three. This results in a storage criteria that is twice the criteria stipulated by The City of Calgary.

3.8.3 Watermain Sizing and Layout

For the future distribution network, The City of Calgary recommends a baseline grid network. That said, at a more detailed level of the design of a subdivision the grid network can be altered to better align with the layout subdivision. This would include adding in watermains along the roads within the subdivision, and is not limited to the gridded schematic. Sizing must generally follow that which is proposed in this Study, and the design is subject to approval by the Town. The layout of watermains should also be designed to avoid dead-end mains wherever possible.

In terms of general sizing requirements, the following criteria, consistent with The City of Calgary, should be adhered to:

- 200 mm minimum size in future residential areas
- 250 mm minimum size in future non-residential areas
- 150 mm watermains allowed within small cul-de-sacs, provided there are no hydrants within the cul-de-sac



Legend

- Top Water Users
- Legal
- Town Boundary

Land Use District

- AG
- C1
- CB
- CHWY
- CR1
- M1
- M2
- MHP
- MHS
- P1
- R1
- R1N
- R1S
- R2
- R2X
- R3
- R3M
- UR

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 3.1
TOP WATER USERS
WATER MASTER SERVICING STUDY

Date: 11/7/2019 Document: I:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 3.1_Top Water Users.mxd

Integrated Expertise. Locally Delivered.

4.0 Existing Water System

4.1 Water Distribution System

The Town of Strathmore's population is currently serviced by 64.5 km of water distribution mains. The water distribution system detailed with regards to diameter, material, and installation year are shown in Figures 4.1, 4.2 and 4.3, respectively. The watermains are predominantly polyvinyl chloride (PVC), with the central portion being primarily ductile iron (DI). Pipe sizes range from 50 mm to 450 mm. The majority of the distribution mains vary between 150 mm to 300 mm. Table 4.1 below summarizes the water distribution system based on diameter, material, and installation year.

Table 4.1: Water Distribution System Summary

Diameter	Total Length	Material	Total Length	Installation Year	Total Length
mm	m		m		m
Unknown	44	Unknown	940	Unknown	1,672
50	182	Asbestos Cement (AC)	585	1950 - 1959	2,593
100	3,063	Cast Iron (CI)	2,919	1960 - 1969	339
150	17,942	Copper (CU)	51	1970 - 1979	8,344
200	18,879	Ductile Iron (DI)	8,821	1980 - 1989	5,509
250	13,831	High Density Polyethylene (HDPE)	508	1990 - 1999	13,879
300	9,452	Polyethylene (PE)	251	2000 - 2009	21,252
350	547	Polyvinyl Chloride (PVC)	50,447	2010 - 2019	10,934
400	570				
450	11				
Total	**64,523**	**Total**	**64,523**	**Total**	**64,523**

Water is stored in the Wildflower and Brentwood Reservoirs, that cumulatively have a capacity of 17,500 m^3 of potable water. It is noted that the Brentwood reservoir is not filled full due to the condition of the reservoir. Between the two reservoirs, there are a total of seven distribution pumps and one fire pump. There are four distribution pumps at the Wildflower Reservoir, and three distribution pumps plus the fire pump at the Brentwood Reservoir. Reservoir characteristics are summarized below in Table 4.2, while pump characteristics are included in Table 4.3. It is noted that in lieu of detailed information pertaining to the reservoirs and pressure reducing valves (PRVs), a number of assumptions were made. These are described as notes in Table 4.2.

Table 4.2: Reservoir Characteristics

Reservoir		Wildflower	Brentwood
Capacity	**m^3**	11,500	6,000
Reservoir Slab Elevation[1]	**m**	986.52	981.00
Normal Operating Pressure[2]	**kPa**	311	365
Hydraulic Grade Line[3]	**m**	1018.29	1018.29
Pumping Capacity	**L/s**	234	316
Firm Capacity	**L/s**	166	189

[1] Reservoir slab elevation extracted from LiDAR data provided by the Town
[2] Normal operating pressure calculated by taking the difference between the hydraulic grade line and the reservoir slab elevation
[3] Hydraulic grade line represents the average of the two loggers that were monitored during hydrant testing

Table 4.3: Pump Characteristics

Pump	Type	Design Point[1]			
		Flow		Head	
		US gpm	L/s	ft	m
Wildflower Reservoir					
P1	Goulds 10RJLC	476	30.0	151	46.0
P2, P3 and P4	Goulds 12CMC	1078	68.0	151	46.0
Brentwood Reservoir					
P1 and P2	5060-Split Case	2013	127.0	165	50.3
P3	5060-Split Case	983	62.0	165	50.3

[1] *Pump information obtained from pump curves provided by EPCOR.*

The rated pumping capacity equates to 550 L/s, and the distribution pumps have a firm capacity of 355 L/s. The firm capacity is the total pumping capacity assuming that the largest pump at each reservoir has been taken offline (noting this is more conservative than having just the largest pump on a global scale offline), and is used to assess the pumps under a more redundant scenario resulting in a more resilient system.

4.2 Water Supply System

The Town receives potable water from The City of Calgary via the ECRWL, installed in 2010. The ECRWL consists of a partnership between the Town of Strathmore, The City of Calgary, and the City of Chestermere in which The City of Calgary supplies water to meet the current and future needs of these municipalities until 2031.

The ECRWL connects to The City of Calgary's feedermain system at the intersection of 52 Street SE and 50 Avenue SE. At the connection point the ECWRL is a 900 mm main and heads east on 50 Avenue SE (Township Road 240). At the west end of Chestermere the main is reduced to 750 mm, and is reduced again to 600 mm at the east end of Chestermere. At the west end of Cheadle, the main is reduced from 600 mm to 500 mm and continues heading east on Township Road 240. Around Range Road 260, the ECRWL begins to head northeast, where it ultimately ties into the Wildflower Reservoir. The material varies between concrete, PVC, and HDPE. The alignment of the ECRWL is illustrated in Figure 4.4.

At the Wildflower Reservoir the potable water is re-chlorinated. From this reservoir, there is a direct fill line to the Brentwood Reservoir and a line to the Town's distribution network. The fill line to the Brentwood Reservoir consists of sections of 500 mm pipes and 350 mm pipes, with a material varying between PVC, HDPE, and DI.

The ECRWL was designed as a gravity pressure main with a capacity to service approximately 100,000 people by supplying 561 L/s. Additional capacity is also available through the implementation of a future pump station at the connection point in The City of Calgary. Though the ECRWL currently only services Strathmore and Chestermere, there is sufficient capacity to service neighbouring regions as well. Table 4.4 summarizes these regions, and their associated water supply allocations.

Table 4.4: ECRWL Service Regions

Region	Allocated Supply
	L/s
Strathmore	201
Chestermere	190
MD of Rocky View	85
Wheatland County	85

4.3 Water Consumption and Production

As mentioned above in Section 3.1, historic water consumption and production data was provided in a spreadsheet format from the Town. The data was provided on a monthly basis for the past five years (2014 to 2018). Figure 4.5 below illustrates the historic volumes for both production and consumption. It is noted that the production volumes represent the total volume entering the Town from the ECRWL while the consumption volume represents the combined residential/commercial volume.

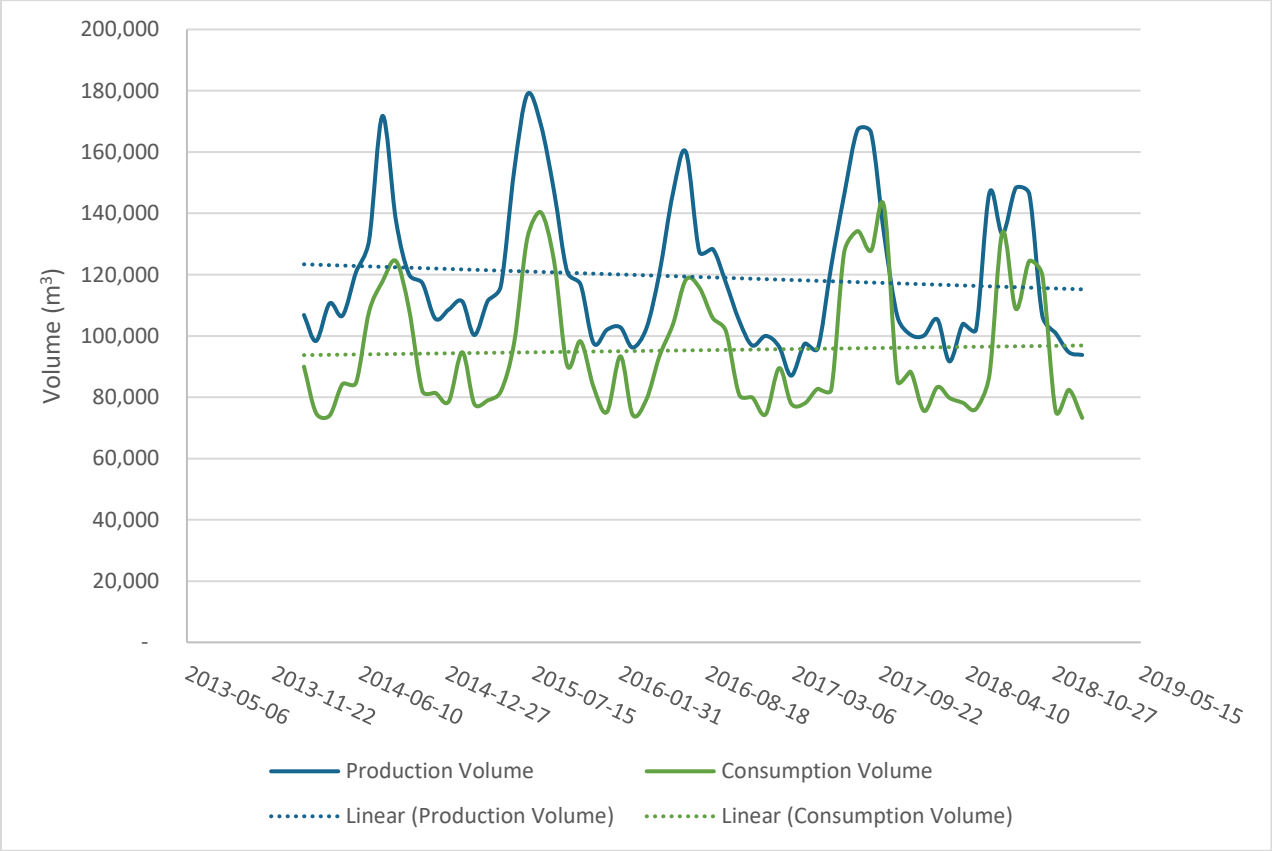
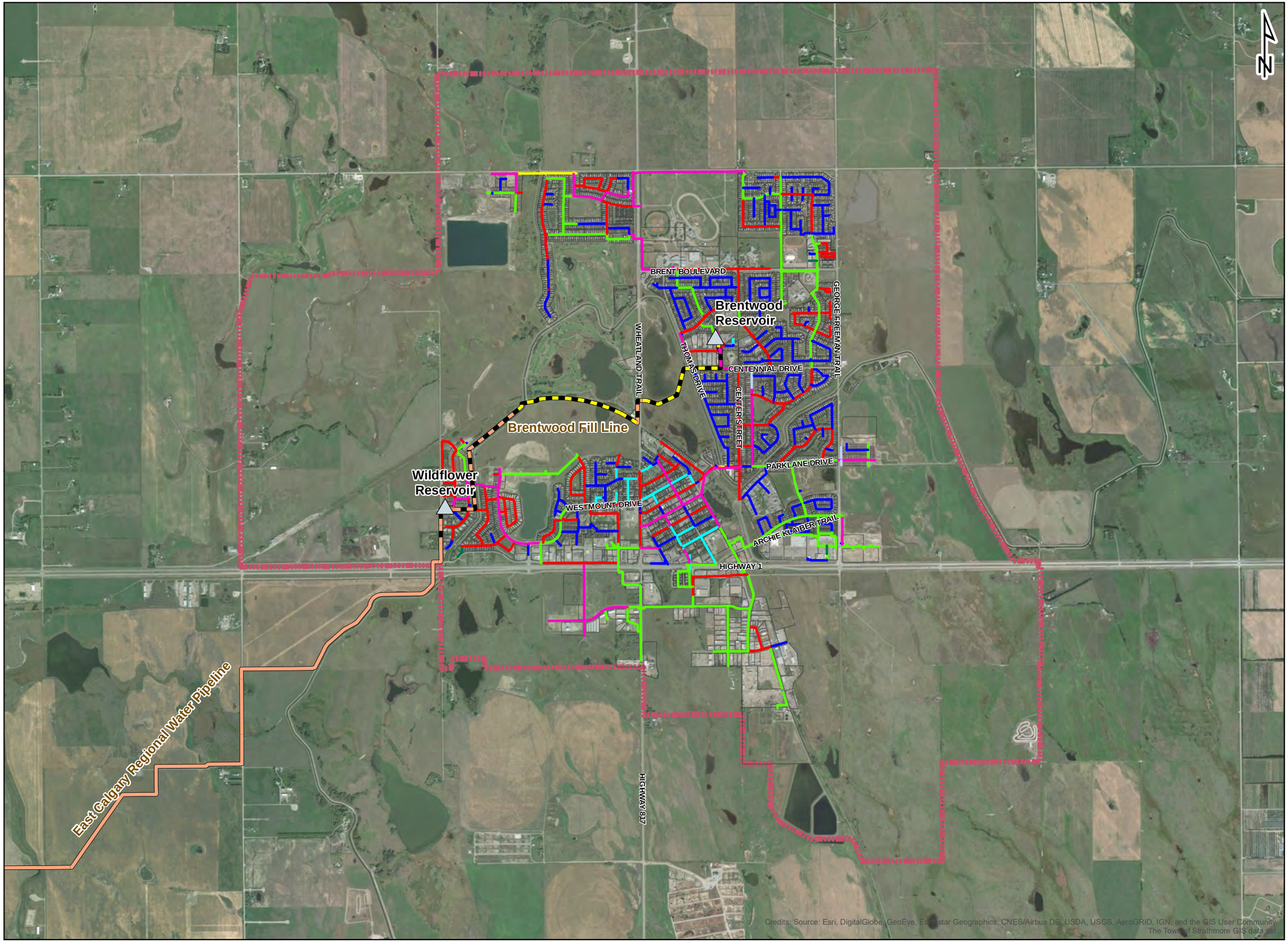


Figure 4.5: Historic Production and Consumption Volumes

Generally speaking, the production volume has declined while the consumption volume indicates a slight upward trend. The increase in the consumption volume is likely attributed to the growing population and associated larger demand. As the production volume has been decreasing over the past number of years, it is likely that the Town has been experiencing a lesser degree of leakage throughout the network.

This page has been left blank intentionally.



Legend

- Reservoir
- Legal
- Town Boundary

Distribution - Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Fill Line - Pipe Diameter

- 300mm
- 350mm
- 450mm
- 500mm

Supply Line - Pipe Diameter

- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

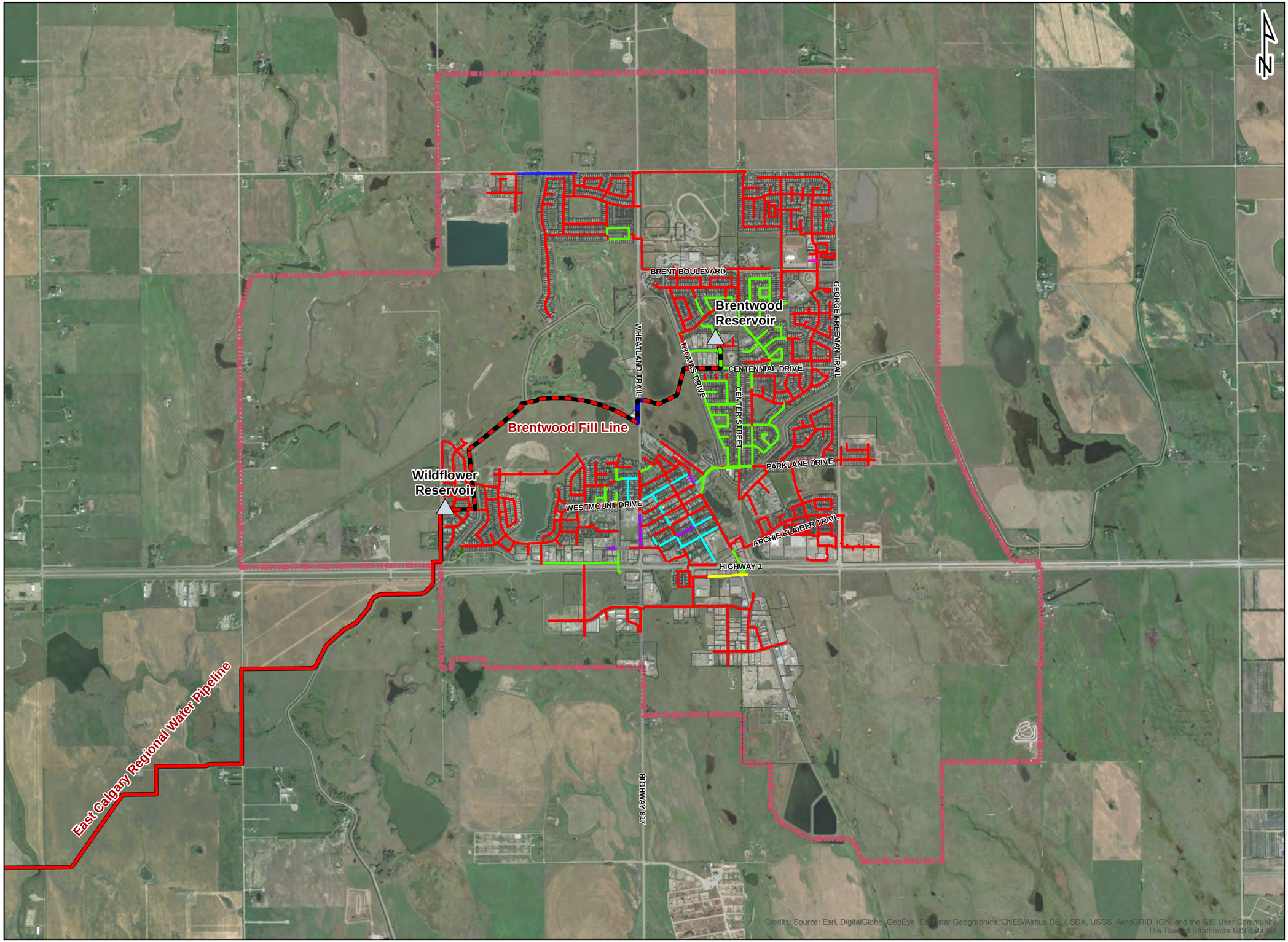
FIGURE 4.1
PIPE DIAMETER
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 1/21/2020 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 4.1_Pipe Diameter.mxd



Legend

- Reservoir
- Legal
- Town Boundary

Distribution - Pipe Material

- Unknown
- AC
- CI
- CON
- CU
- DI
- HDPE
- PE
- PEX
- PVC
- S

Fill Line - Pipe Material

- DI
- HDPE
- PVC
- S

Supply Line - Pipe Material

- Unknown
- CON
- HDPE
- PVC

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

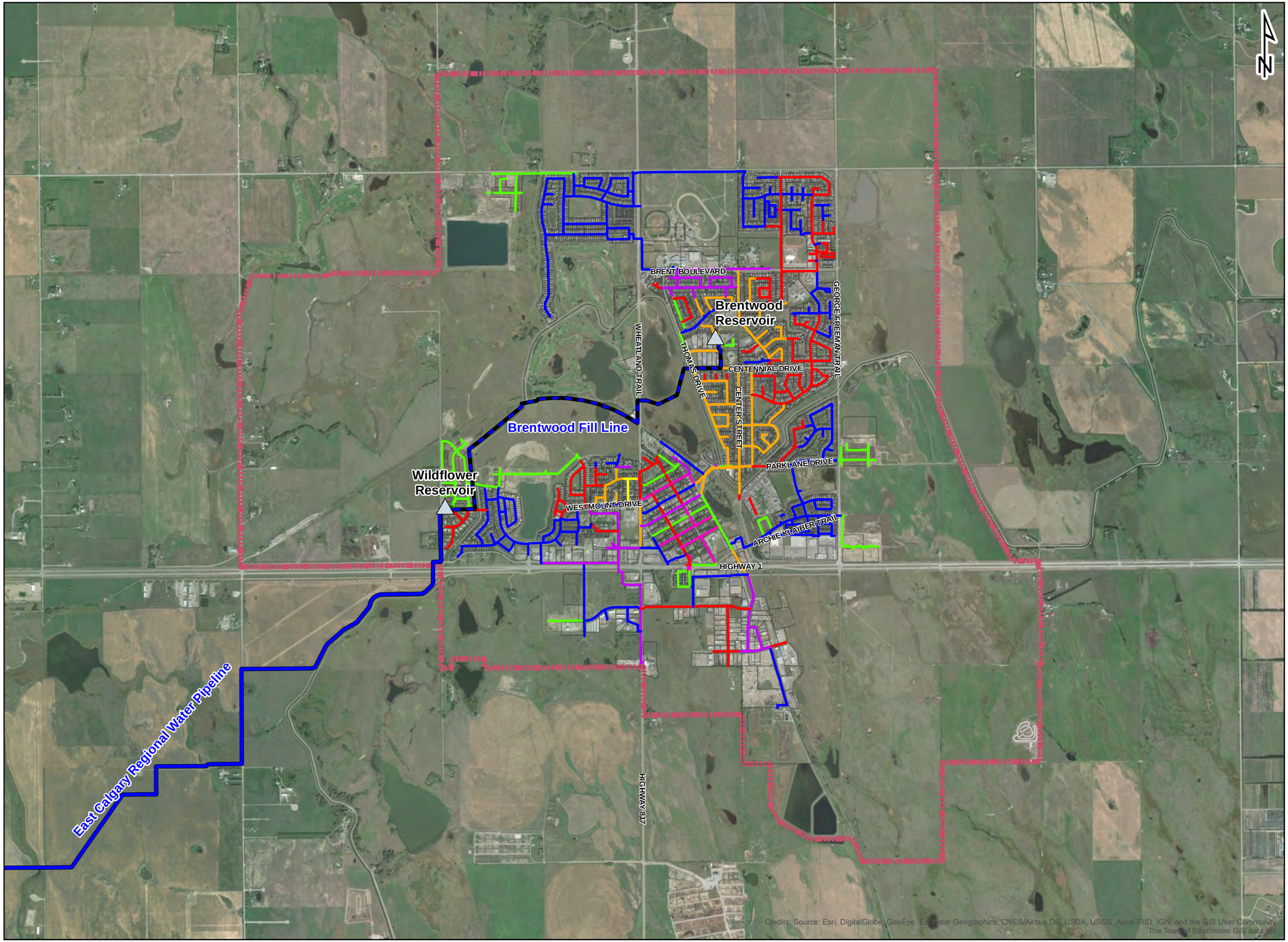
FIGURE 4.2
PIPE MATERIAL
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 2/13/2020 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 4.2_Pipe Material.mxd



Legend

- Reservoir
- Legal
- Town Boundary

Distribution - Pipe Installation Year

- Unknown
- 1950 to 1959
- 1960 to 1969
- 1970 to 1979
- 1980 to 1989
- 1990 to 1999
- 2000 to 2009
- 2010 to Present

Fill Line - Pipe Installation Year

- 2000 to 2009
- 2010 to Present

Supply Line - Pipe Installation Year

- 2000 to 2009

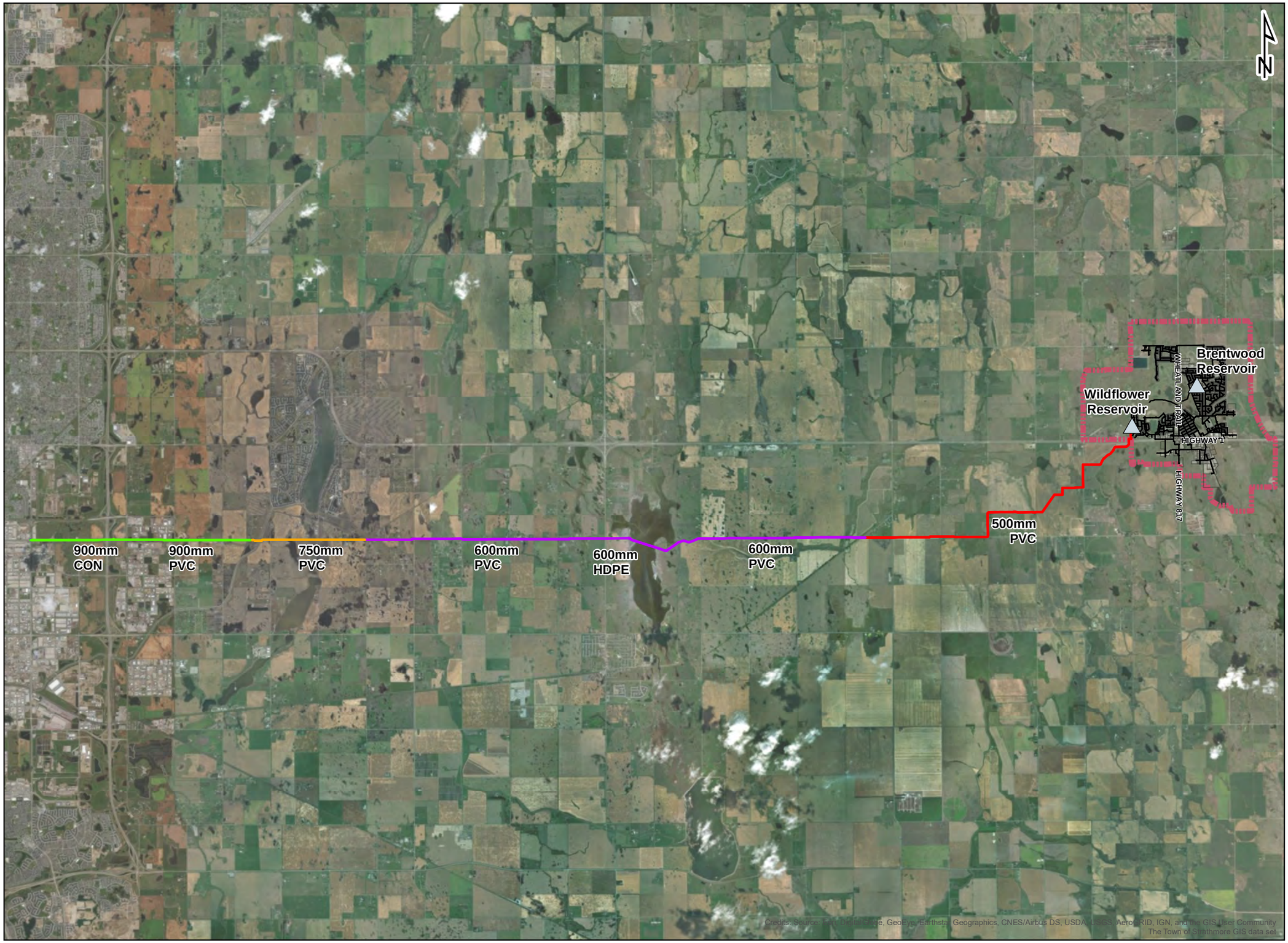
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 4.3
PIPE INSTALLATION YEAR
WATER MASTER SERVICING STUDY

Integrated Expertise. Locally Delivered.

Date: 2/13/2020 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 4.3_Pipe Installation Year.mxd



Legend

- Reservoir
- Legal
- Town Boundary
- Distribution Main

East Calgary Regional Waterline

- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

0 1,550 3,100 6,200 m

1:125,000 NAD 1983 3TM 114

FIGURE 4.4
EAST CALGARY REGIONAL
WATERLINE ALIGNMENT
WATER MASTER SERVICING STUDY

Integrated Expertise. Locally Delivered.

Date: 11/7/2019 Document: I:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 4.4_ECRWL.mxd

5.0 Hydraulic Model Development

5.1 Model Set-up

Bentley WaterCAD CONNECT Edition Update 1 was used in order to assess the Town's water distribution system. WaterCAD is a powerful analysis tool that utilizes pump curve data and routes flows through the physical distribution system. In this manner, pressure results are obtained, and available fire flow at any location in the water distribution system can be estimated. All WaterCAD model files developed as part of this project can be found in Appendix A.

To develop the model, all available GIS data relevant to the water system in the study area received from the Town was reviewed in detail. Mains and junctions were then imported into the WaterCAD model using the provided shapefiles. Junctions consist of fittings, manholes, plugs, PRVs, reduces, tees, valves, and valve chambers. Once the data was imported it was inspected to ensure proper connectivity. PRVs and reservoir locations, elevations and settings were inputted based on the reservoir characteristics noted in Section 4.0.

Junction surface elevations were populated using the light detection and ranging (LiDAR) data that was obtained from the Town. This was accomplished by employing a powerful spatial analyst tool, which extracted the elevation from the LiDAR data at each targeted junction and assigned it as the surface elevation. The model was inspected one last time by performing a series of quality assurance/quality control (QA/QC) tasks to ensure that all data was detailed and accurate.

5.2 Service Area Delineation

5.2.1 Existing Service Areas

Following the set-up of the physical water distribution system model, it was necessary to delineate the study area into service areas for the purpose of deriving populations and thus system demands. The service areas were delineated based on individual lots and the development type classifications mentioned in Section 2.2, including residential, commercial, industrial, and institutional. Parks labelled as being irrigated were also included for this purpose.

The shapefile that was produced as part of the TMP was utilized for the distribution of the existing populations, including single and multi-family, retail, non-retail, and industrial applications. These classifications were converted to development types as follows:

- Single and Multi-family – Residential
- Retail – Commercial
- Non-retail – Institutional
- Industrial – Industrial

These populations were then spatially allocated to the individual lots using ArcGIS. Each lot was assigned to the nearest node in ArcGIS, and lots sharing the same node were merged together to formulate the final service area polygons. The populations associated with each development type on a per lot basis were summated during the merging process. A summary of the individual service areas is found in Table 5.1 below, while the merged service area polygons are illustrated in Figure 5.1.

Table 5.1: Summary of Existing Service Areas

Land Use Type	Number of Lots	Total Population		Total Area
		Residential	Non-Residential	ha
Residential	4,648	13,515	-	261
Commercial	182	-	829	65
Industrial	102	-	924	87
Institutional	81	-	660	123
Irrigation	21	-	-	14
Total	**5,034**	**13,515**	**2,413**	**551**

Following delineation of service areas, unit demands (populations for residential and non-residential developments; areas for irrigation and UFW) were imported to the model. The unit demands associated with the highest water users were deleted, and straight demands were added in their place. Model construction proceeded to hydrant testing, which formulated the data input for the calibration process.

5.2.2 Build-out Service Areas

The TMP zones were primarily used to derive the service areas for the build-out population horizon of 70,500. Populations were assigned utilizing the methodology discussed in Section 2.3. In summary, areas with ASPs were assigned populations based on the populations stipulated in the ASPs and areas without ASPs were assigned populations based on densities of 44.3 and 34.0 persons per gross hectare (residential and non-residential, respectively). The TMP classification to development type conversion that was used for the development of the existing service areas was also applied for build-out conditions.

Once populations were assigned, the TMP zones were further discretized into service areas. To accomplish this, the zones were split in halves or quarters, and populations were prorated accordingly. Each service area was then assigned to a node. A summary of the service area populations is found in Table 5.2 below, while the service area polygons are illustrated in Figure 5.2.

Table 5.2: Summary of Build-out Service Areas

Land Use Type	Total Population	
	Residential	Non-Residential
Residential	54,288	-
Commercial	-	7,197
Industrial	-	5,199
Institutional	-	1,453
Existing	13,515	2,413
Densification	2,703	897
Total	**70,506**	**17,159**

Note: In ASP areas, multiple development types were aggregated into single service areas, thus areas are not included as it would duplicate some of the service areas.

5.2.3 Interim Service Areas

The interim service areas were derived from the build-out service areas, but discretized to only include the areas flagged for development under the interim growth horizon. This includes the development of five ASPs, and consists of TMP zones 20, 22, 100, 101, 110, 141, 158, and 159. Densification of the existing system was also included. A summary of the interim populations is found below in Table 5.3, and shown in Figure 5.3.

Table 5.3: Summary of Interim Service Areas

Land Use Type	Total Population	
	Residential	Non-Residential
Residential	14,430	-
Commercial	-	798
Industrial	-	-
Institutional	-	69
Existing	13,515	2,413
Densification	2,703	897
Total	**30,648**	**4,177**

5.3 Hydrant Testing

In order to produce a model that is on par with actual system performance, hydrant testing was performed. SFE Global was requisitioned by ISL to complete hydrant tests at five locations. Additionally, two residual monitoring stations (loggers) were installed to supplement hydrant flow test locations. The overall fire flow test reports can be found in Appendix B, and a map of the flow hydrants, residual hydrants and logger locations is illustrated in Figure 5.4.

The results of the hydrant testing are summarized below in Table 5.4. Observed pressures from hydrant testing were used to calibrate the water model, subsequently obtaining more accurate scenario results.

Table 5.4: Hydrant Flow Test Results

Hydrant Test	Time of Test	Test Type	Flow at Hydrant	Residual Hydrant Pressure		Logger No. 1 Pressure[2]		Logger No. 2 Pressure[2]	
			L/s	psi[1]	kPa	psi	kPa	psi	kPa
1		Static		53	365	50.7	349.7	55.2	380.4
	14:48	1 Port	72.54	42	290	50.2	346.2	53.8	371.2
2		Static		58	400	50.7	349.7	55.2	380.4
	15:19	1 Port	78.76	47	324	50.4	347.6	55.0	379.5
3		Static		56	386	50.7	349.7	55.2	380.4
	15:45	1 Port	72.54	48	331	49.8	343.3	55.1	379.8
4		Static		72	496	50.7	349.7	55.2	380.4
	16:34	1 Port	91.95	55	379	50.1	345.1	55.0	379.1
5		Static		58	400	50.7	349.7	55.2	380.4
	16:12	1 Port	82.24	48	331	49.9	344.0	55.0	379.1

[1] Static pressures are based on original statics before fire pump, per the notes recorded in the Fire Flow Test Report (included in Appendix B).
[2] Static pressures at each logger were calculated by taking the averages of the overall logger data.

5.4 Calibration

For the purpose of calibrating the WaterCAD model, the five hydrant test locations were utilized. These hydrant test locations represent multiple physical locations and elevations within the Town, as well as various development types and installation periods. The locations are shown in Figure 5.4.

Model calibration was performed by using the resultant pressures and associated flow rates obtained from the hydrant testing. This was done in order to ensure proper Hazen-Williams 'C' values were used in the WaterCAD model to simulate pipe roughness and aging. The preliminary 'C' values represented common practice roughness values of the various materials seen throughout Town.

The flows monitored at the reservoirs during hydrant testing (obtained from SCADA data provided by EPCOR for the day hydrant testing was performed) were higher than ADD flows. Thus, the modelled system under ADD was peaked by 1.45 to match the flows. This peaking factor applies solely to calibration and was removed for all subsequent analyses.

In adjusting the 'C' values, it was determined that very good static pressure calibration could be achieved. All pressure errors in this case are within ±10 kPa. In attempting to match the system pressures for the flowed tests, it was determined that the majority of the sites (Sites 1, 2, 4) could be reasonable matched and are within ±15 kPa. Sites 3 and 5 have pressure errors that are around the 40 kPa mark. After reviewing their locations in the system, compared to the pressure errors at the loggers and the roughness coefficients in the model, it was determined that there is likely a closed valve somewhere in the southwest quadrant of the Town. As well, all piping between Site 5 and the Wildflower Reservoir is PVC, which is at a relatively low 'C' value (high roughness) making it difficult to improve the calibration at this site without jeopardizing the results throughout the rest of town. At this point it was deemed that reasonable calibration was achieved, allowing for system assessments. The Hazen-Williams 'C' values in Table 5.5 were determined for model calibration.

Table 5.5: Hazen-Williams 'C' Values

Material	Percentage of all Pipes (Distribution)	Roughness Coefficient
Unknown	1.46%	100
AC	0.91%	120
CI	4.52%	70
CU	0.08%	130
DI	13.67%	60
HDPE	0.79%	130
PE	0.39%	130
PVC	78.18%	120
Steel[1]	N/A	100

[1] Not included/adjusted in the calibration process as it represents only a portion of the fill line from the Wildflower Reservoir to the Brentwood Reservoir, which was not modelled under this scenario.

Table 5.6 and Figures 5.5 and 5.6 show the model calibration results obtained from using the aforementioned 'C' values.

Hydrant Test	Test Type	Flow at Hydrant	Residual Hydrant			Logger 1			Logger 2		
			Field Pressure	Model Pressure	Model Error	Field Pressure	Model Pressure	Model Error	Field Pressure	Model Pressure	Model Error
		L/s	kPa	kPa	kPa	kPa	kPa	kPa	kPa	kPa	kPa
1	Static		365	371	6	350	350	0	380	379	-1
	Flow	72.54	290	299	9	346	349	3	371	374	3
2	Static		400	402	2	350	350	0	380	379	-1
	Flow	78.76	324	338	14	348	349	1	379	373	-6
3	Static		386	394	8	350	350	0	380	379	-1
	Flow	72.54	331	370	39	343	347	4	380	369	-11
4	Static		496	493	-3	350	350	0	380	379	-1
	Flow	91.95	379	389	10	345	341	-4	379	371	-8
5	Static		400	407	7	350	350	0	380	379	-1
	Flow	82.24	331	374	43	344	341	-3	379	373	-6

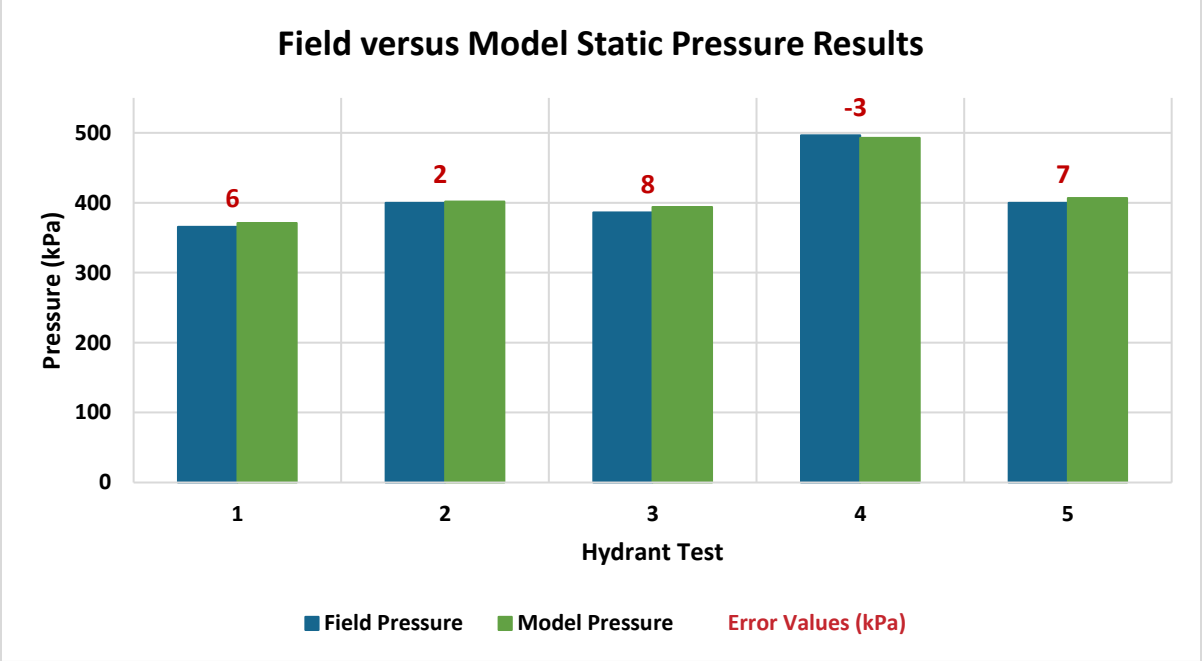


Figure 5.5: Static Pressure Calibration Results at Residual Hydrant

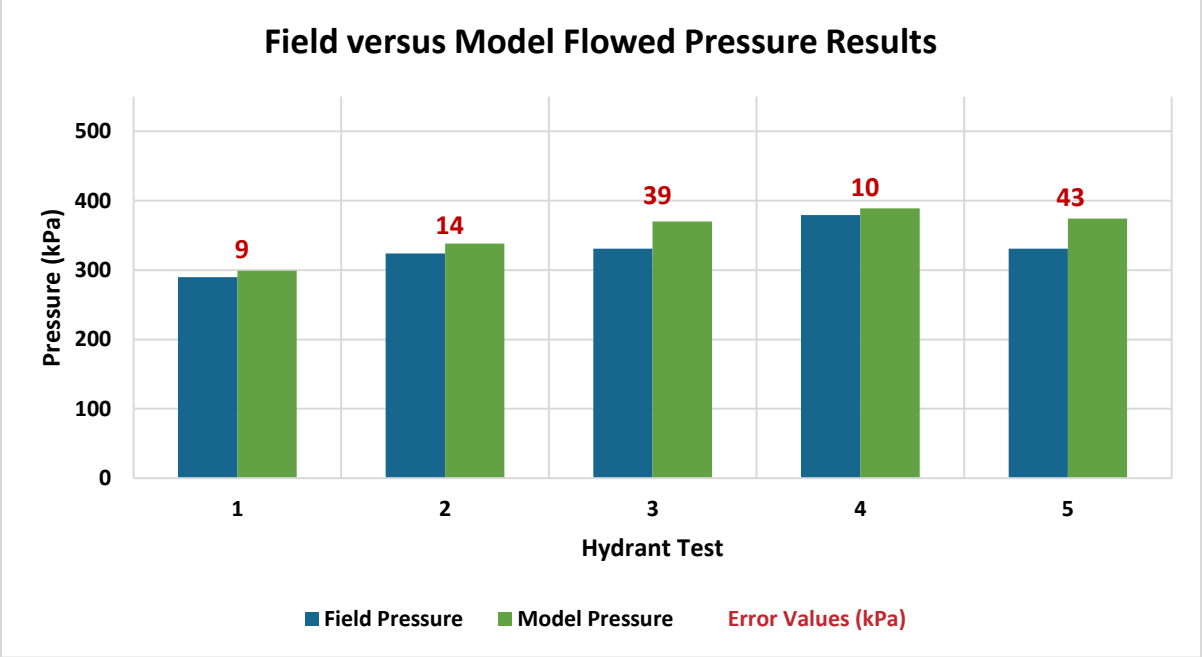
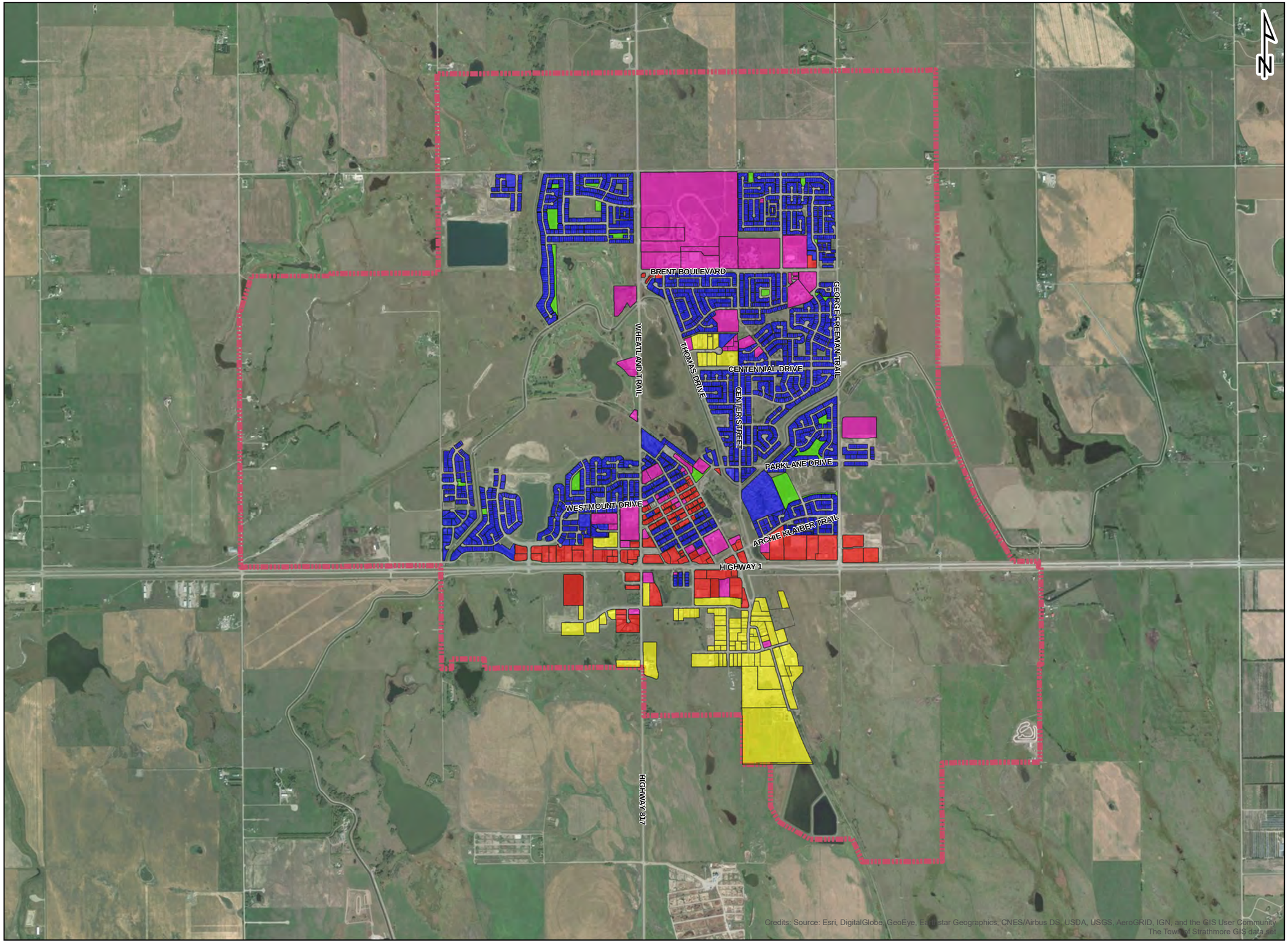


Figure 5.6: Flowed Pressure Calibration Results at Residual Hydrant

This page has been left blank intentionally.



Legend

- Legal
- Town Boundary

Service Area Land Use Type

- Commercial
- Industrial
- Institutional
- Irrigation
- Residential

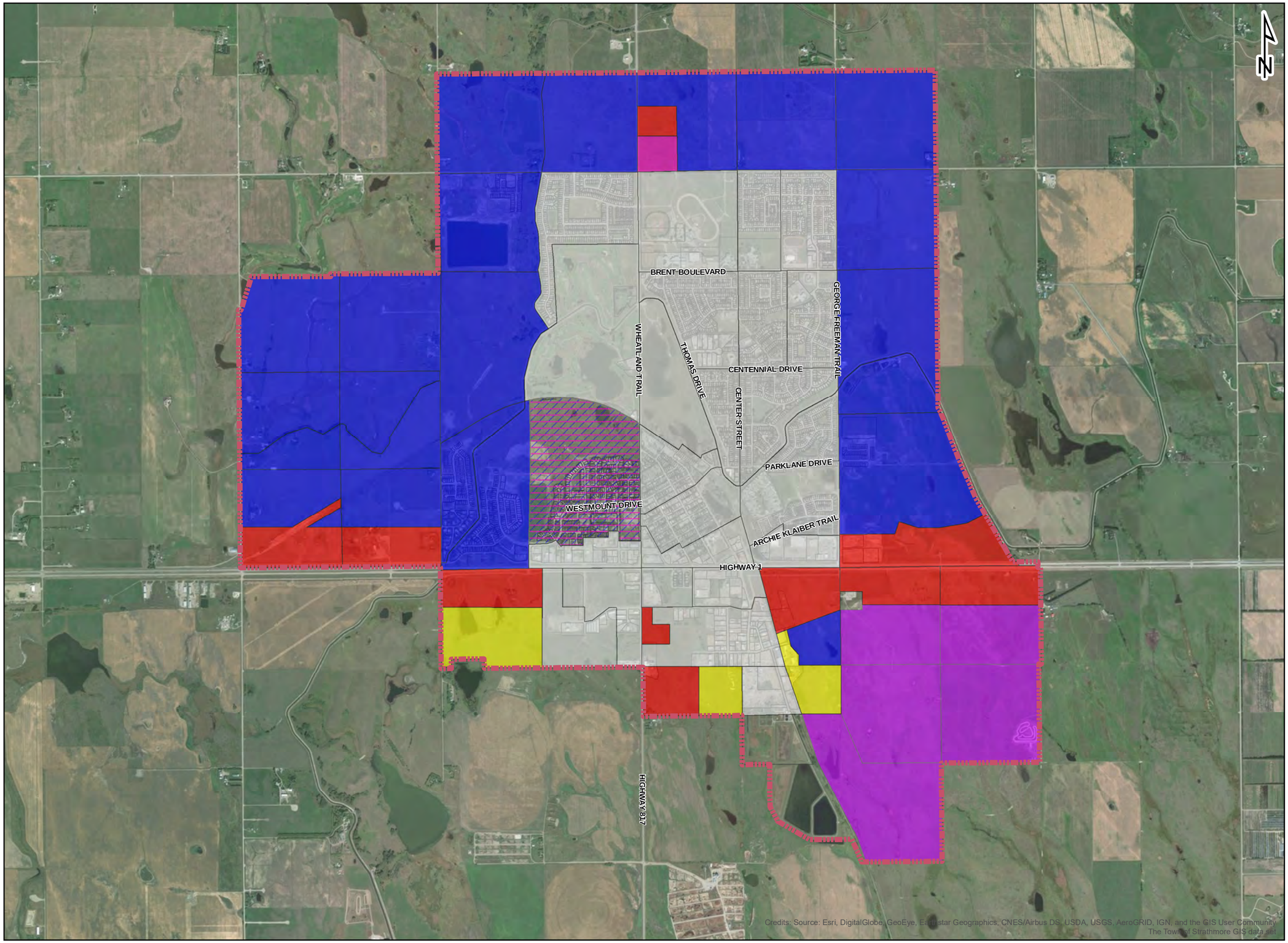
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 5.1
EXISTING SERVICE AREAS
WATER MASTER SERVICING STUDY

Date: 11/7/2019 Document: I:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 5.1_Existing Service Areas.mxd

Integrated Expertise. Locally Delivered.



Legend

- Legal
- Town Boundary

Service Area Land Use Type

- Existing
- Commercial
- Industrial
- Institutional
- Residential
- Residential / Institutional
- No Water Service Required

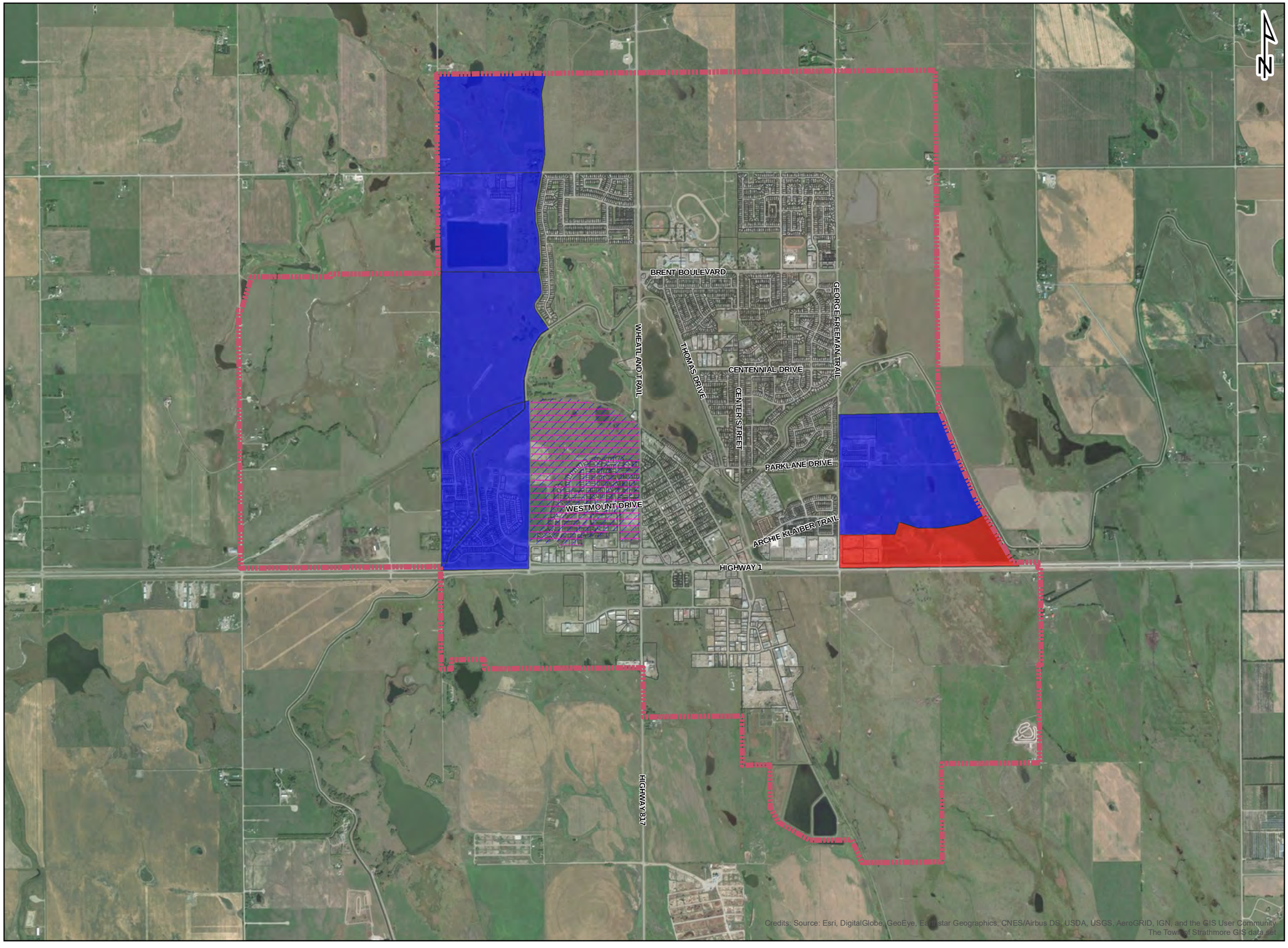
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 5.2
BUILD-OUT SERVICE AREAS
WATER MASTER SERVICING STUDY

Date: 11/7/2019 Document: I:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 5.2_Build-out Service Areas.mxd

Integrated Expertise. Locally Delivered.



Legend

- Legal
- Town Boundary

Service Area Land Use Type

- Commercial
- Residential
- Residential / Institutional

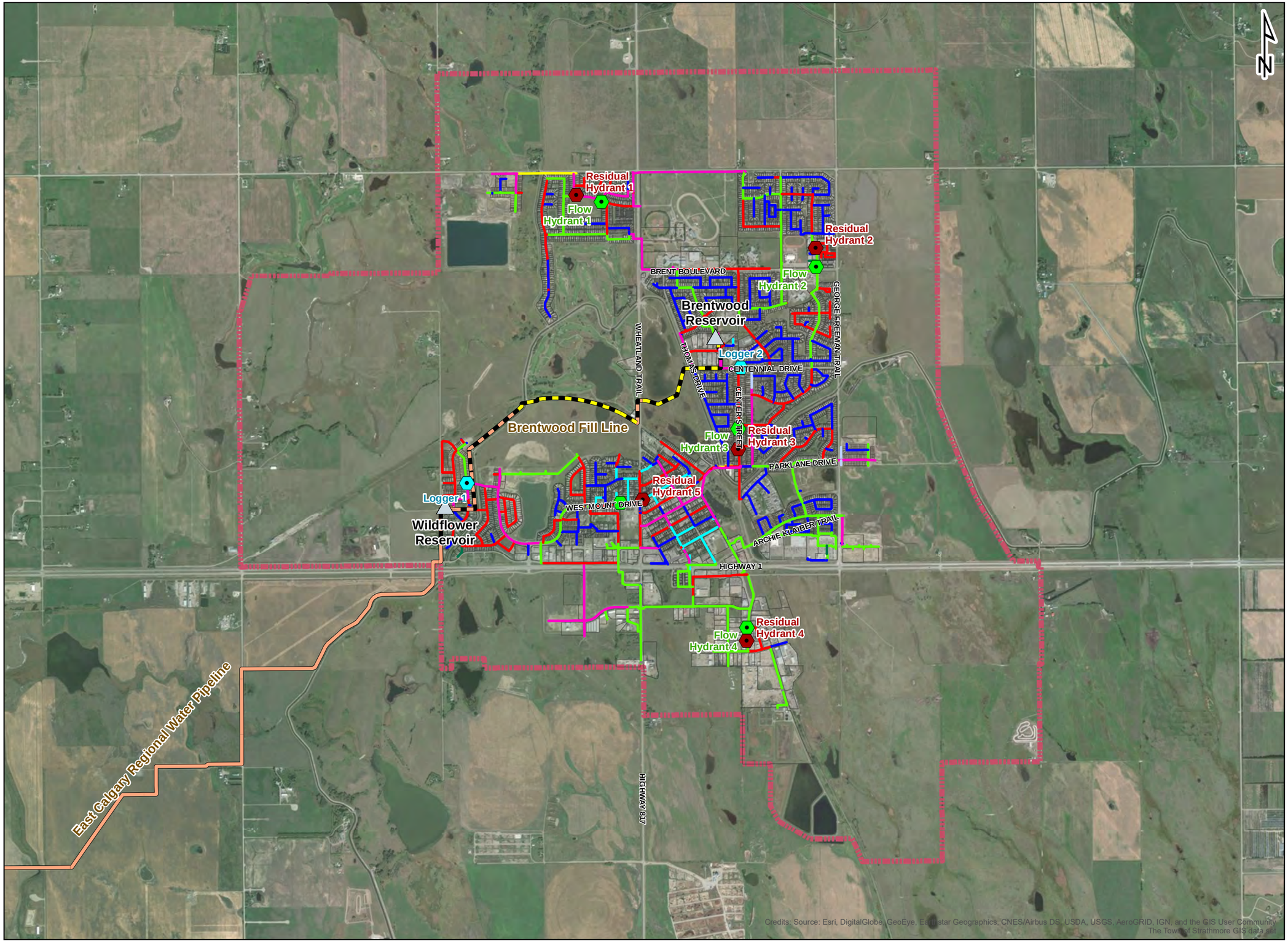
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 5.3
INTERIM SERVICE AREAS
WATER MASTER SERVICING STUDY

Date: 11/7/2019 Document: I:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 5.3_Interim Service Areas.mxd

Integrated Expertise. Locally Delivered.



Legend

- Reservoir
- Legal
- Town Boundary

Hydrant Test Location

- Flow Hydrant
- Residual Hydrant
- Logger

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Fill Line - Pipe Diameter

- 300mm
- 350mm
- 450mm
- 500mm

Supply Line - Pipe Diameter

- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 5.4
HYDRANT TEST LOCATIONS
WATER MASTER SERVICING STUDY

Integrated Expertise. Locally Delivered.

6.0 Existing System Assessment and Upgrades

The existing distribution system was analyzed under six different scenarios in order to determine system conditions. As mentioned in Section 3.4, these scenarios included:

- ADD
- MDD
- PHD
- MDD + FF
- ADD + RF
- MDD + RF

Additionally, the reservoirs were assessed in terms of reservoir storage and pumping capacity under the existing system. Table 6.1 summarizes the demands that were used for input in the above mentioned assessments.

Table 6.1: Existing System Demands

Scenario	Demand	
	L/s	m^3
ADD	43.28	3,739
MDD	75.67	6,538
PHD	141.15	12,195

6.1 Pressure Assessment

The highest and lowest pressures in addition to the locations at which these pressures occur are shown below in Table 6.2, for the ADD, MDD, and PHD scenarios.

Table 6.2: Existing System Pressure Ranges

Scenario	Figure	Highest Pressure		Location	Lowest Pressure		Location
		kPa	psi		kPa	psi	
ADD	6.1	581	84.27	Township Road 244 between Wheatland Trail and Range Road 253	307	44.53	West of the Wildflower Reservoir
MDD	6.2	577	83.69		307	44.53	
PHD	6.3	562	81.51		297	43.08	Intersection of Wheatland Trail and Township Road 244

The results suggest that the existing system performs rather well under ADD, MDD, and PHD. Under ADD, the pressures are slightly on the low side near the Wildflower Reservoir, and are below the minimum ADD pressure criteria of 350 kPa. There is also a small area of higher pressures in the top northwest corner of the system, which marginally fails to meet the maximum pressure criteria of 550 kPa. These pockets of lower and higher pressures are both quite isolated, and the requirements are nominally insufficient. Under PHD, all junctions meet the stipulated pressure criteria of a minimum of 275 kPa. The range between highest and lowest pressures suggests that the Town, operating on a single pressure zone, is at the limits on both ends. This does not necessarily mean there is a need for upgrades, but it does suggest that servicing outside the current elevation band would require the addition of new pressure zones.

6.2 Fire Flow Assessment

Results of the MDD + FF scenario are shown in Figure 6.4. In the northwest, available fire flows drop to around the 125 L/s range and in the northeast flows range from a high of around 150 L/s to a low of about 70 L/s. These are more residential in nature so are likely sufficient, noting that the lower flows in the 70 L/s range are at dead-end watermains with hydrants right at the end of the main. The pockets of lower fire flows to the east and south of the Brentwood Reservoir are looped, but consist of 150 mm DI watermains. Flows here are in the 60 to 80 L/s range, which is on the low end, to slightly below the requirement for residential. The more central pocket along the TCH near the Travelodge also shows some lower fire flows, watermains here are 100 mm CI. 100 mm watermains tend to be bad for fire flow, and with the CI/DI pipes there could be quite a bit of calcification causing the size to be even smaller.

A condition assessment would be valuable to determine the extent of calcification, and a cast/ductile iron replacement program might be beneficial. The smaller iron watermains, when replaced, should be upsized to a minimum of 200 mm to meet current standards. This will largely deal with any issue areas. A more in depth condition assessment could include performing a CCTV inspection of watermains (though this can be very costly), prioritizing those in older areas that have exhibited concerns in the past. Alternatively, additional hydrant testing could be performed in areas with significant amounts of iron, providing more findings to further calibrate the model (beyond the five test locations used for this Study). Pipes with poor roughness values as a result of the refined calibration could be flagged for replacement. Another more simplified version of condition assessment could be prioritizing replacements based on break history, correlated with installation year. A figure of previous watermain break locations, utilizing data provided in the provided shapefiles, is shown in Figure 6.5.

A number of institutional developments such as schools, the hospital, churches and recreation centres are in areas where the fire flows drop below the fire flow requirements of institutional areas (up to 227 L/s). That said, fire flow requirements are reduced by 50% when a building is sprinklered. Fire flows near these facilities are in the 130 L/s to 175 L/s range, thus are adequate as long as sprinklers are installed.

6.3 Reservoir and Pumping Capacity Assessment

The volume of water storage required in the Town under existing conditions was determined using the formulas for storage criteria provided by AEP, ECRWL, and The City of Calgary. Please refer to Section 3.7 for a summary of the storage calculation requirement methodologies.

In terms of AEP's calculation criteria, the fire flow rate was chosen as 200 L/s for 3 hours, as specified in the Town's standards. The ECRWL criteria states that the required storage shall be equal to twice the average per capita per day demand, thus the ADD was multiplied by two to achieve the storage value. The City of Calgary's criteria states that reservoir size shall be the greater of the Sufficient Active Storage to balance out the instantaneous projected MDD without depleting total storage by more than half or the ADD. In this case, half the MDD is less than the ADD, thus, the ADD was assumed.

Any analysis on storage capacity was completed using the ECRWL formula. However, if the Town wishes to pursue a less conservative approach to any upgrades, they may choose to consider implementing either AEP or The City of Calgary's storage requirements. Table 6.3 summarizes the storage requirements for all criteria.

Table 6.3: Existing Reservoir Storage Requirements

Parameter	Unit	Wildflower Reservoir	Brentwood Reservoir	Both Reservoirs in Aggregate
ADD[1]	m^3	1,870	1,870	3,739
MDD[1]	m^3	3,269	3,269	6,538
Available Storage	m^3	11,500	6,000	17,500
Required Storage (AEP)[2]	m^3	3,258	3,258	4,355
Meets Requirements?		Yes	Yes	Yes
Required Storage (ECRWL)	m^3	3,739	3,739	7,478
Meets Requirements?		Yes	Yes	Yes
Required Storage (COC)	m^3	1,870	1,870	3,739
Meets Requirements?		Yes	Yes	Yes

[1] *Based on the provided consumption data for 2018, each reservoir distributes approximately equivalent volumes of water throughout the system, thus the ADD and MDD were divided evenly between Wildflower and Brentwood.*
[2] *Generally, fire storage is required once per pressure zone, instead of once per reservoir. This is reflected in the 'Both Reservoirs' column, whereas the individual reservoir storage calculations both assume their own fire storage.*

When considering the ECRWL formulation, the required cumulative storage capacity between the two existing reservoirs (i.e., Wildflower and Brentwood) is 7,478 m^3. There is a current cumulative storage capacity of 17,500 m^3 between Wildflower and Brentwood, and as such no water storage upgrading is required at this time.

To achieve the required pumping capacity at the reservoirs under existing conditions, a pumping capacity of 276 L/s is required. The required pumping capacity was determined using the greater of either the MDD + FF scenario or the PHD scenario. Under these conditions, the MDD of 76 L/s plus a fire flow of 200 L/s governed over the PHD scenario of 141 L/s. As the firm capacity of 355 L/s is greater than the required pumping capacity of 276 L/s, the current pumping configuration is sufficient for existing conditions.

6.4 Reservoir Filling Assessment

A reservoir filling scenario was run in order to simulate the Brentwood Reservoir being filled under ADD and MDD conditions for a total of eight hours from the Wildflower Reservoir. This scenario was completed in order to ensure that the system was able to meet the reservoir filling requirements, without depleting pressures throughout the remainder of the system. It is noted that ADD and MDD analyses are conservative approaches to reservoir filling, as the Brentwood Reservoir will likely be filled at night, over an eight hour period, when the water demand in the Town is significantly less than during daytime hours. The total storage requirement was equal to 130 L/s, considering ECRWL's storage requirements. Thus, the total system demands were 173 L/s and 206 L/s for ADD and MDD, respectively.

Results from the ADD and MDD filling scenarios are illustrated in Figures 6.6 and 6.7. As seen, in the distribution system pressures range from 299 kPa to 580 kPa for ADD and 284 kPa to 573 kPa for MDD, with the minimum and maximum nodes being consistent with those stated above in Section 6.1. There is positive pressure at the fill location under both scenarios. There are few instances where the pressures within the distribution system are below the operating pressure requirements noted in Section 3.5. However, reservoir filling will likely occur during the night time when demands are much lower, thus these scenarios are considered conservative. That said, no upgrades or changes to the existing system are recommended to ensure the Brentwood Reservoir is sufficiently filled. As well, since no major deficiencies were noted additional pumping capacity/dedicated pumps would be not be required.

6.5 Decommissioning Brentwood Reservoir

The Brentwood Reservoir is intended to be decommissioned within the short term, and ultimately be replaced with the East Reservoir. As the East Reservoir is not to be built in the short term, an analysis was required to determine if the Brentwood Reservoir can be taken offline without depleting fire flows or pressure requirements in the existing system.

A preliminary assessment was undertaken such that the Brentwood Reservoir was removed from service, and no alterations to the existing system were applied. These results are illustrated in Figures 6.8 to 6.10 for ADD, PHD, and MDD + FF, respectively. Results suggest that there is a significant lack in fire flow throughout the Town, as low as an available fire flow of 5 L/s in the north portion. As well, the PHD criteria is not met in a large portion of the Town.

Noted by EPCOR, the fill line that feeds the Brentwood Reservoir from the Wildflower Reservoir has an interconnection to the distribution system on Centennial Drive between Thomas Drive and Centre Street. Currently, this interconnection has been disconnected through a closed valve, however the intent is that this valve is to be opened in the future in order to take the Brentwood Reservoir offline, and for the Wildflower Reservoir to feed that portion of the distribution system. An additional scenario was conducted in order to determine the impacts to the system with this interconnection activated. These results are shown in Figures 6.11 to 6.13 for ADD, PHD, and MDD + FF, respectively. The difference in fire flows between this scenario and existing conditions is illustrated in Figure 6.14.

These results are independent of any other recommended existing system upgrades, as discussed below in Section 6.6. The results from this scenario suggest that there are significant improvements to the available fire flow and pressures under PHD when compared to the scenario with the fill line valve closed and Brentwood Reservoir offline. Minimal changes in pressure are observed under ADD and PHD when compared to the existing system analysis. For MDD + FF, there are noted drops in available fire flow in the north, however flows are generally in the 75 L/s to 100 L/s range, so generally acceptable for the predominantly residential area. That said, in both scenarios with the Brentwood Reservoir offline, the system does experience a drop in fire flow whether or not the valve is open or closed. Of specific concern are the institutional developments such as the hospital, recreation centre, schools, and churches in the north. Among these facilities, the largest difference in fire flow from the scenario with Brentwood Reservoir online is approximately 70 L/s, occurring at the Brentwood Elementary School. This results in a fire flow of 121 L/s at the school. The lowest fire flow in the area is 64 L/s, occurring at two churches along Maplewood Drive. This is below fire flow criteria even if sprinklers are installed.

In terms of reservoir storage, under ECRWL's criteria the required storage is 7,478 m^3, while the Wildflower Reservoir has a capacity of 11,500 m^3. This suggests storage requirements would be fine if taking Brentwood Reservoir offline. Full and firm pumping capacities at Wildflower are 234 L/s and 166 L/s, respectively. The required pumping capacity is 276 L/s; the MDD of 76 L/s plus a fire flow of 200 L/s governed over the PHD scenario of 141 L/s. Accordingly, the current pumping capacity at the Wildflower Reservoir would be insufficient with the Brentwood Reservoir offline. This can be resolved by increasing the current firm capacity at the Wildflower Reservoir of 166 L/s by 110 L/s to 276 L/s. The as-builts of the Wildflower Reservoir indicate that there is space in the pump room for a future domestic pump. Note that to meet the criteria under the interim growth horizon, the Wildflower Reservoir's pumping capacity must be increased to 378 L/s (an additional 102 L/s from this scenario).

This indicates that decommissioning the existing Brentwood Reservoir in the short term prior to the implementation of the new East Reservoir can be accomplished without causing significant pressure deficiencies, given that the fill line is connected into the distribution system and the pumping capacity at the Wildflower Reservoir increased. That said, fire flow deficiencies are noted for institutional facilities, which adds a significant level of risk to the system. Thus, decommissioning the Brentwood Reservoir under existing system conditions could have severe implications in the event of a fire at one of these facilities. Also in terms of serviceability, there may be concerns regarding the scheduled maintenance and cleaning for the Wildflower

Reservoir if the Brentwood Reservoir is decommissioned. This option should only be considered if there is a way to service the town during the routine/preventative maintenance, such as the ability of the ECRWL to bypass the Wildflower Reservoir straight to the pumps. The timing of when the new East Reservoir will be needed is discussed further below in Section 7.0.

6.6 Emergency Management Assessment

An additional assessment was performed on the existing system to analyze the potential for supply interruption, in the event that the ECRWL was closed for an indefinite period. If this was to occur, the Town would be dependent on its reservoir storage capacity alone to supply water throughout the network. At present, the Town's combined reservoir storage capacity is 17,500 m^3 between the Wildflower and Brentwood Reservoirs. Note that if the Brentwood Reservoir is decommissioned, the capacity drops to 11,500 m^3 prior to the development of the East Reservoir. Table 6.4 summarizes the duration the Town could manage if the ECRWL were to go unexpectedly offline.

Table 6.4: Emergency Management of an ECRWL Closure

Reservoir	Available Storage	Duration under ADD[1]		Duration under MDD[2]	
	m^3	days	hours	days	hours
Wildflower + Brentwood	17,500	4.68	112.33	2.68	64.24
Wildflower	11,500	3.08	73.81	1.76	42.22

[1] *An existing ADD of 43.28 L/s has been applied for these calculations.*

[2] *An existing MDD of 75.67 L/s has been applied for these calculations.*

In the event of a failure to the ECRWL, the Town's water reserves should be restricted to essential use only. This would aid in extending the availability of potable water. Activities that are considered non-essential, in agreement with The City of Calgary's Stage 4 Outdoor Water Restrictions excerpt from the Water Utility Bylaw 40M2006, Schedule "E" document, are summarized below.

- Residential/Commercial Restrictions
  - Watering of lawns, gardens, trees, shrubs, and planters
  - Watering of new, unestablished, lawns
  - Filling of fountains or ponds
  - Filling of swimming pools or hot tubs
  - Washing outdoor surfaces, unless required for health and safety reasons
  - Washing of vehicles outdoors
  - Watering for construction purposes (grading, compaction, dust control)
- Town Restrictions
  - Unessential hydrant and main flushing (noting that essential flushing is permitted)
  - Unessential street cleaning and bridge washing (noting that essential cleaning is permitted)
  - Washing of fleet vehicles outdoors
  - Watering Town parks through sprinkler/irrigation systems

It is also suggested that residents are equipped with emergency preparedness kits in the event that the available potable water becomes depleted. The kit should include the following:

- Sealed containers of drinking water
- A household bucket
  - Can be used to flush toilets, by filling bathtubs if given advance notice of an interruption (i.e., indication that the reservoirs are close to being dry) and flushing only if absolutely necessary
- Anti-bacterial hand sanitizer as an alternative to water and soap for hand washing

Potable water trucks can also be dispatched throughout neighbourhoods to help reduce the demands on the reservoirs during the water shortage. The trucks will become essential if the reservoirs become fully depleted. With the water trucks, residents will be able to bring jugs to fill up with potable water for household uses and as drinking water.

During the water shortage, the Town should send out regular updates to residents informing them of critical information. This could include the status of the ECRWL repairs, ways to reduce water consumption, what to include in the emergency preparedness kits, and emergency water truck locations. Once the water is restored, it is recommended that water taps are run cold for a minimum of five minutes prior to using as stagnation could lead to impurities. Residents should also be notified of the recommended steps once there is water again.

To provide substantial resiliency to the ECRWL, a twinned line would be needed. Due to the extent of construction and capital that would be needed to accomplish this, twinning does not seem like a feasible option at this time. Alternatively, additional reservoir storage in Strathmore would extend the duration the Town could go without an operational ECRWL. This will come from the implementation of the East Reservoir and extension of the Wildflower Reservoir, as discussed in further detail below.

6.7 Existing System Recommendations

Generally speaking, the Town's current water distribution system performs adequately under ADD, PHD and MDD + FF. Very minor pressure constraints were noted in the far northwest corner for higher pressures, and near the Wildflower Reservoir for lower pressures. Fire flow deficiencies were noted in the northwest and northeast portions of the Town, and throughout the downtown core.

Recommendations to the existing system are as follows, and are independent of the decommissioning of the Brentwood Reservoir. The following recommendations are largely in line with the upgrades previously proposed in the 2012 MSS Update.

- To pinpoint critical locations in the system that are limited by fire flows, it is suggested that the Town implements a cast/ductile iron replacement program and consider conducting a condition assessment.
- Consideration for upgrading areas with small fire flow deficiencies could be made during roadworks programs. The recommendation in this case would be to replace 100 mm to 150 mm watermains with 200 mm to 300 mm mains, respectively, to improve fire flows in Town. That said, this would only make sense in conjunction with roadworks programs, given minor deficiencies in fire flow would make it difficult to justify larger capital expenditures. This will improve fire flows to meet standards over time. These programs should also contemplate replacement of any iron or AC pipes with safer and less problematic PVC piping. This would offer a solution to improve the low roughness coefficients derived through the calibration process for AC, CI, and DI.
- To improve the fire flows south of the TCH and through portions of the center of Town, install a 300 mm trunk watermain from west to east. This has been proposed through the Westmount subdivision; consisting of an upsized 300 mm PVC pipe from the intersection of Westmount Road and Westmount Drive down to Westridge Road, ultimately tying into the intersection of Wheatland and 3rd Avenue.
- Localized fire flow improvements can be made along 5th Avenue, by upsizing the existing watermains to 300 mm.

The proposed upgrades to the existing system focusing on the improvements in the Westmount subdivision and along 5th Avenue are illustrated in Figure 6.15. Associated ADD, PHD, and MDD + FF results are shown in Figures 6.16 to 6.18, respectively. The difference in fire flows between this scenario and existing conditions is illustrated in Figure 6.19. It is noted that Brentwood Reservoir is online in these assessments, and the fill line from the Wildflower Reservoir to the Brentwood Reservoir remains isolated from the distribution system.

6.8 Existing System Upgrades Cost Estimates

To address the slightly inadequate fire flows in the Town, numerous upgrades would be required. Given the nominal improvement required to meet standards, the cost of upgrading watermains under existing streets, at a cost that could readily exceed $2,000 per metre, may not be justifiable. That said, it is recommended that watermains that are 100 mm or 150 mm be upgraded to 200 mm to 300 mm at the time of future roadworks programs, when upgrading costs would be relatively nominal, comparatively speaking. Alternatively, upgrades can also occur at the end of the pipe's service life, depending on the global timing of the roadworks programs and remaining life of the infrastructure. Exact sizing upgrades should be in line with those stipulated in Section 3.8, dependent on land use type.

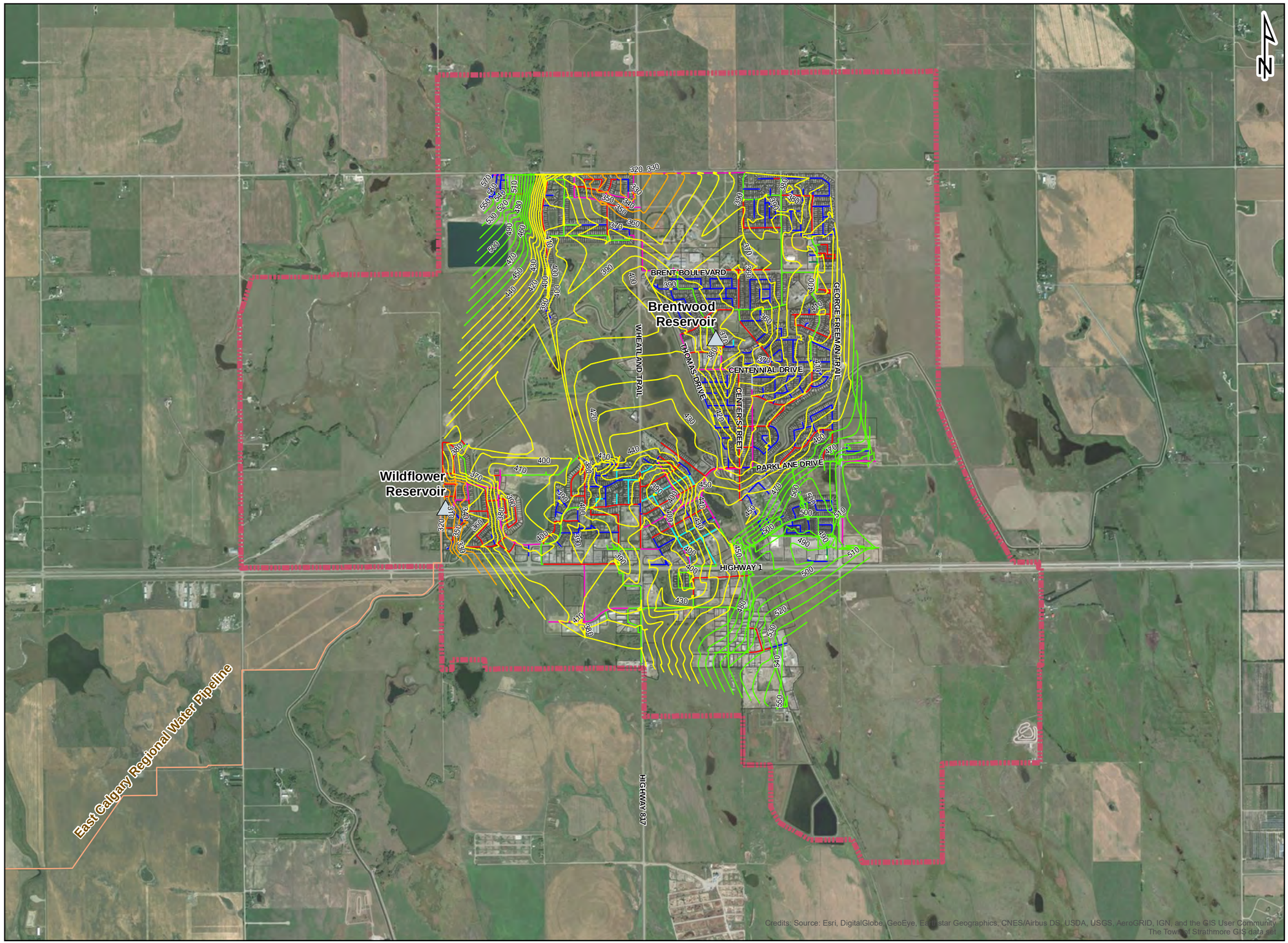
A summary of the costs associated with the remaining recommended existing system upgrades are detailed below in Table 6.5. A full breakdown of the costs has been provided in Appendix C.

Table 6.5: Class D Cost Estimates for Recommended Upgrades to the Existing System

Item Number	Upgrade	Total Cost
EX Upgrade 1	300mm trunk main through the Westmount Subdivision	$2,410,000
EX Upgrade 2	Localized fire flow improvements along 5th Avenue	$950,000
EX Upgrade 3	Decommission Brentwood Reservoir and supply main valve to distribution system[1]	$2,550,000
	Grand Total:	**$5,910,000**

[1] *Costs stipulated are to meet the pump upgrades required for existing conditions only (additional 110 L/s).*

This page has been left blank intentionally.



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Average Day Pressure

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

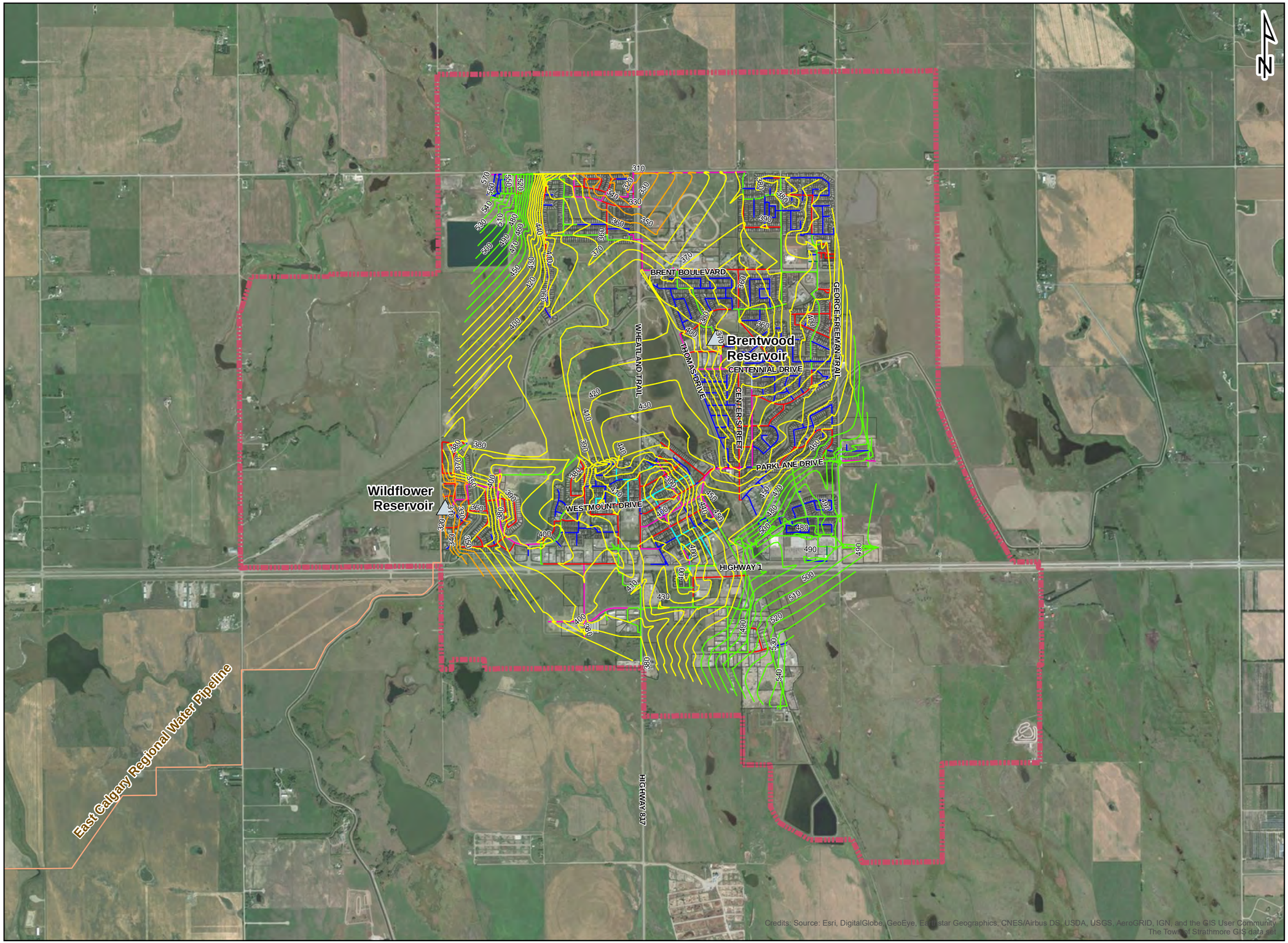
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 6.1
EXISTING SYSTEM ANALYSIS
AVERAGE DAY DEMAND
WATER MASTER SERVICING STUDY

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 6.1_Existing System_ADD.mxd

Integrated Expertise. Locally Delivered.



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Maximum Day Pressure

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

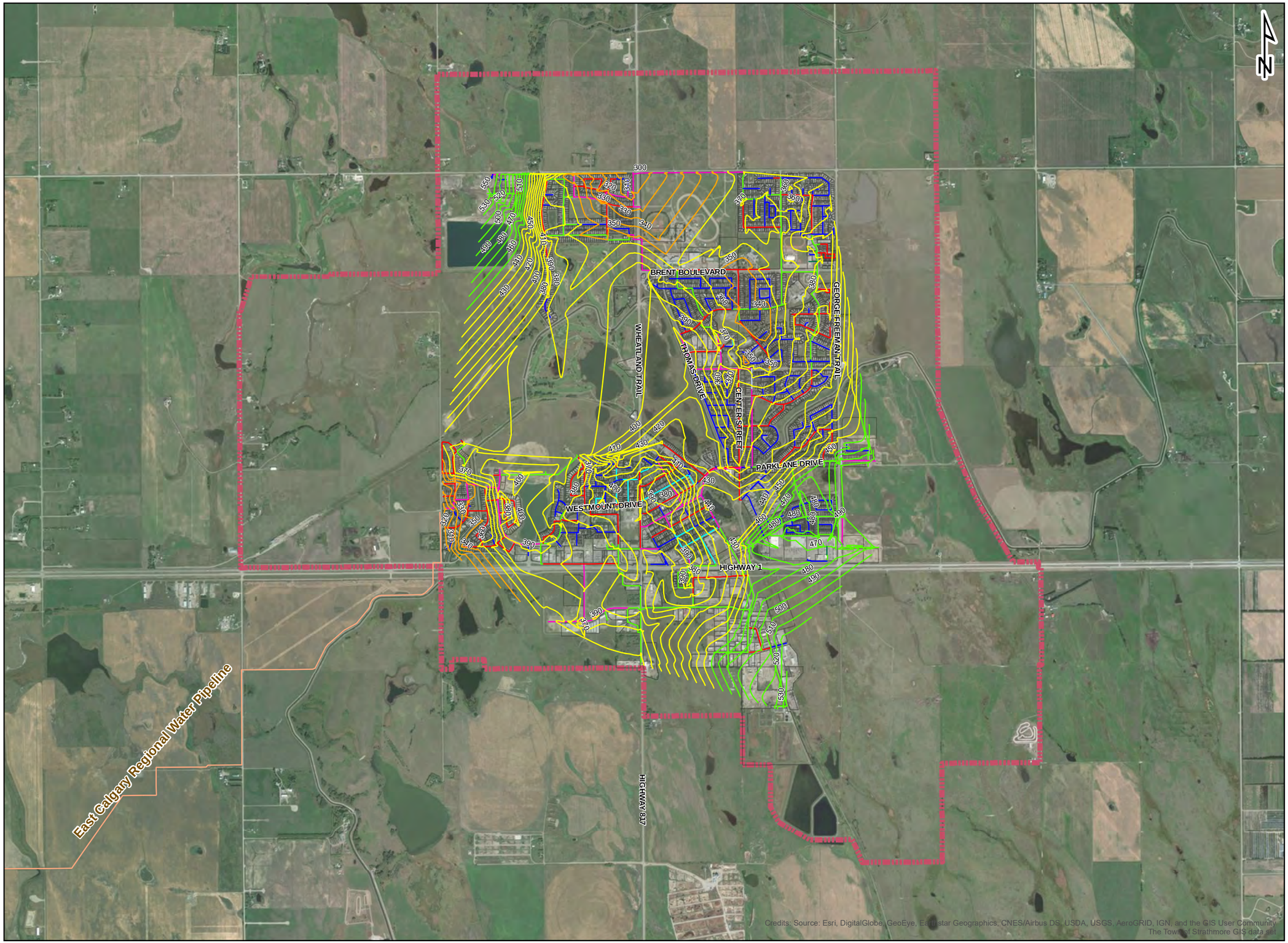
FIGURE 6.2
EXISTING SYSTEM ANALYSIS
MAXIMUM DAY DEMAND
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 6.2_Existing System_MDD.mxd



Legend

- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Peak Hour Pressure

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

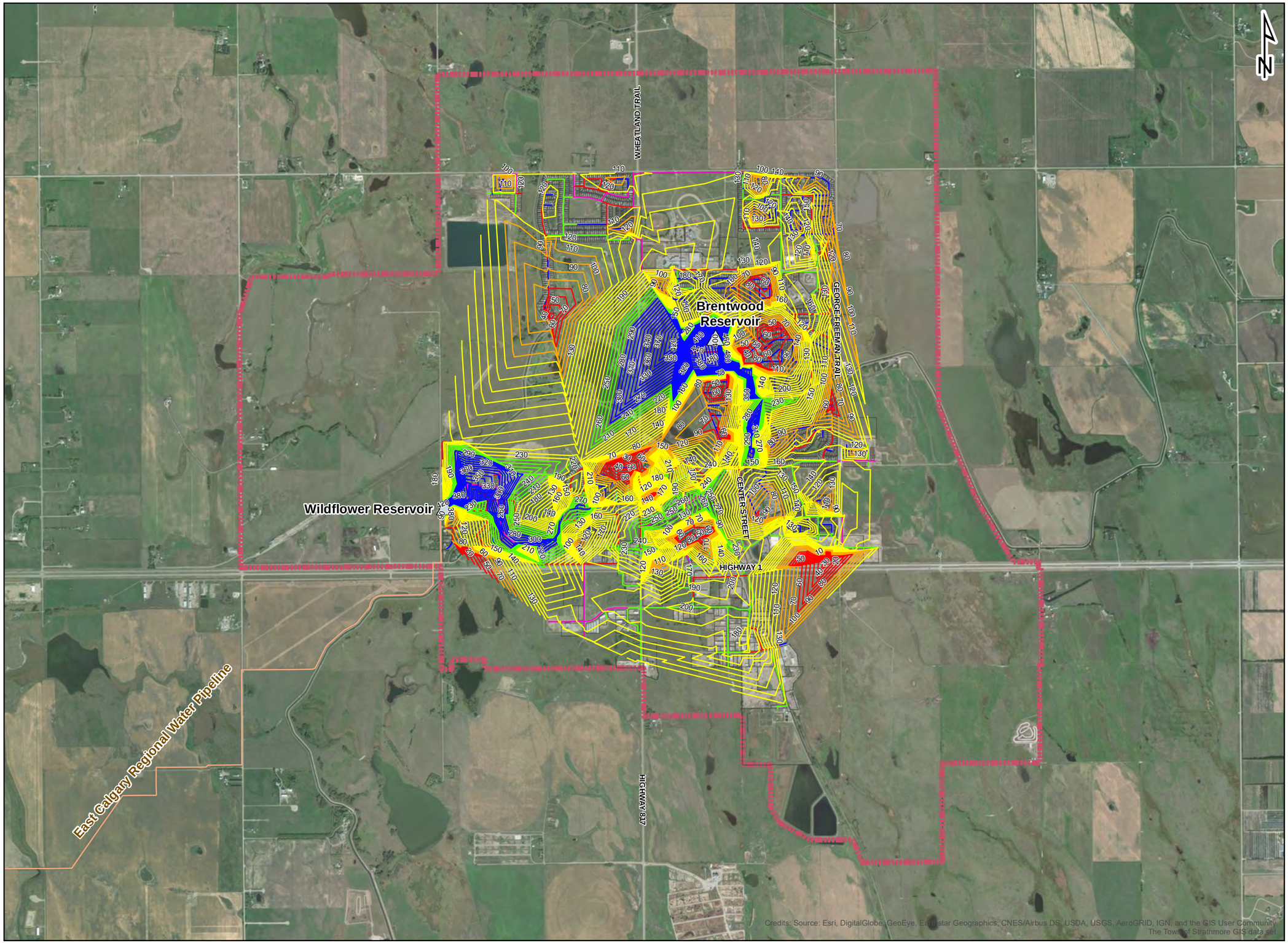
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 6.3
EXISTING SYSTEM ANALYSIS
PEAK HOUR DEMAND
WATER MASTER SERVICING STUDY

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 6.3_Existing System_PHD.mxd

Integrated Expertise. Locally Delivered.



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Available Fire Flow

- Less than 76L/s (Fails All Criteria)
- 76 to 114L/s (Single Family Residential)
- 114 to 227L/s (Multi-Family Residential / Institutional)
- 227 to 265L/s (Industrial)
- Greater than 265L/s (Commercial)

Based on Fire Underwriters Survey recommendations.

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

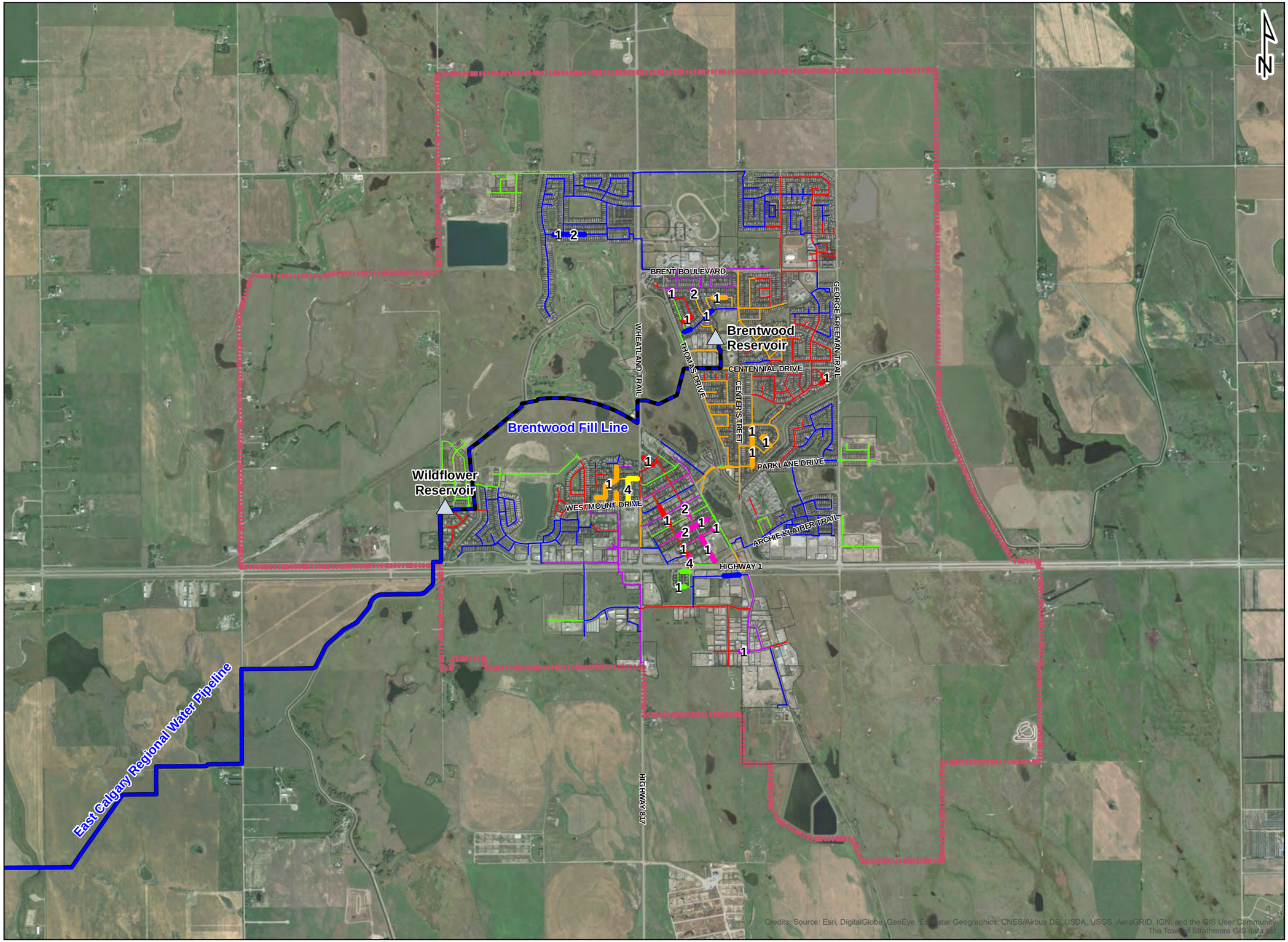
FIGURE 6.4
EXISTING SYSTEM ANALYSIS
MAXIMUM DAY DEMAND PLUS FIRE FLOW
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 6.4_Existing System_MDD+FF.mxd



Legend

- Reservoir
- Legal
- Town Boundary

Watermain with Past Breaks

Distribution - Pipe Installation Year

- 1950 to 1959
- 1960 to 1969
- 1970 to 1979
- 1980 to 1989
- 1990 to 1999
- 2000 to 2009
- 2010 to Present

Distribution - Pipe Installation Year

- Unknown
- 1950 to 1959
- 1960 to 1969
- 1970 to 1979
- 1980 to 1989
- 1990 to 1999
- 2000 to 2009
- 2010 to Present

Fill Line - Pipe Installation Year

- 2000 to 2009
- 2010 to Present

Supply Line - Pipe Installation Year

- 2000 to 2009

**Number of breaks labelled at on each break location.*

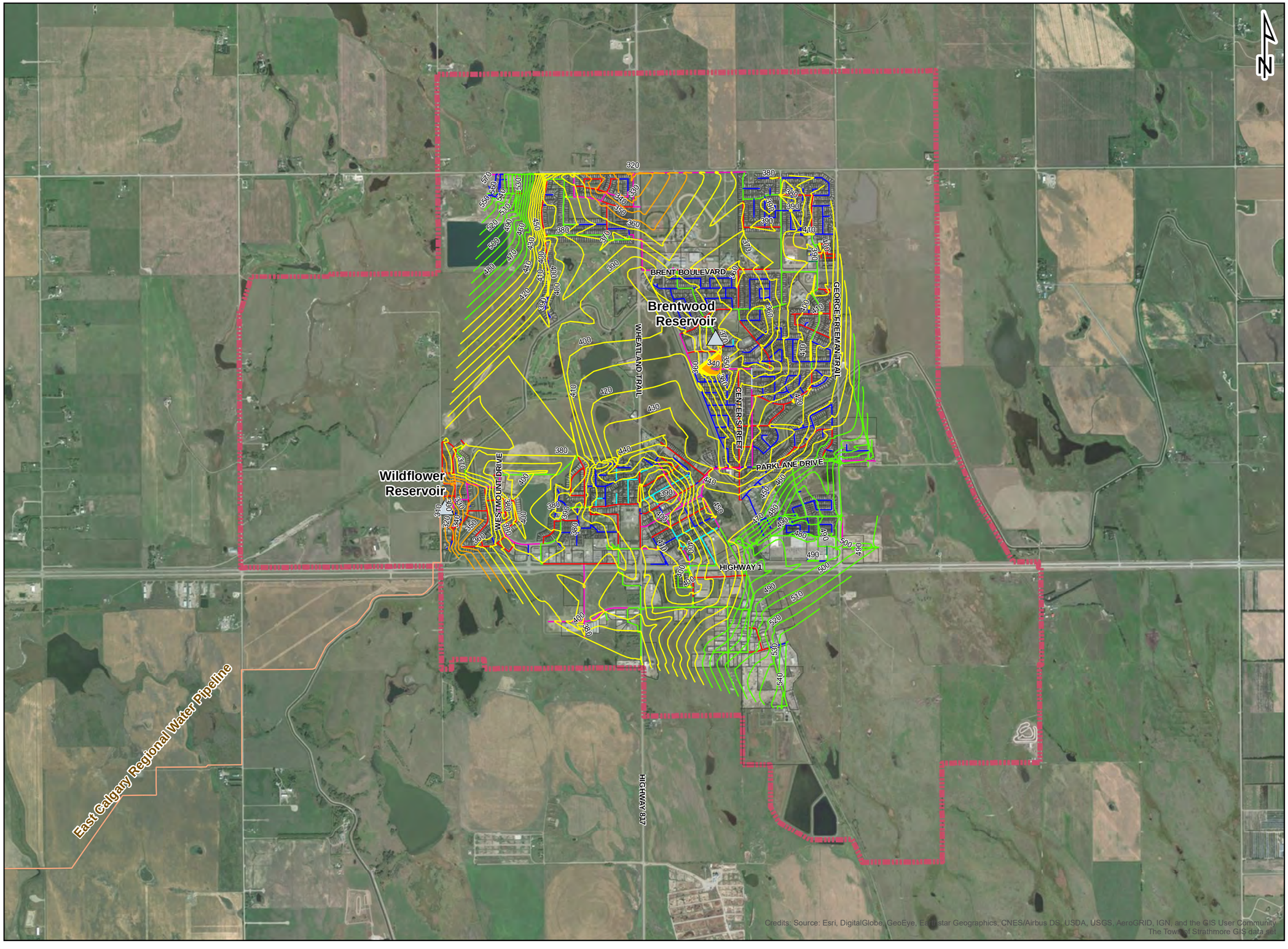
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 6.5
WATERMAIN BREAK HISTORY
WATER MASTER SERVICING STUDY

Date: 2/13/2020 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 6.5_Watermain Break History.mxd

Integrated Expertise. Locally Delivered.



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Average Day Pressure

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

0 375 750 1,500 m

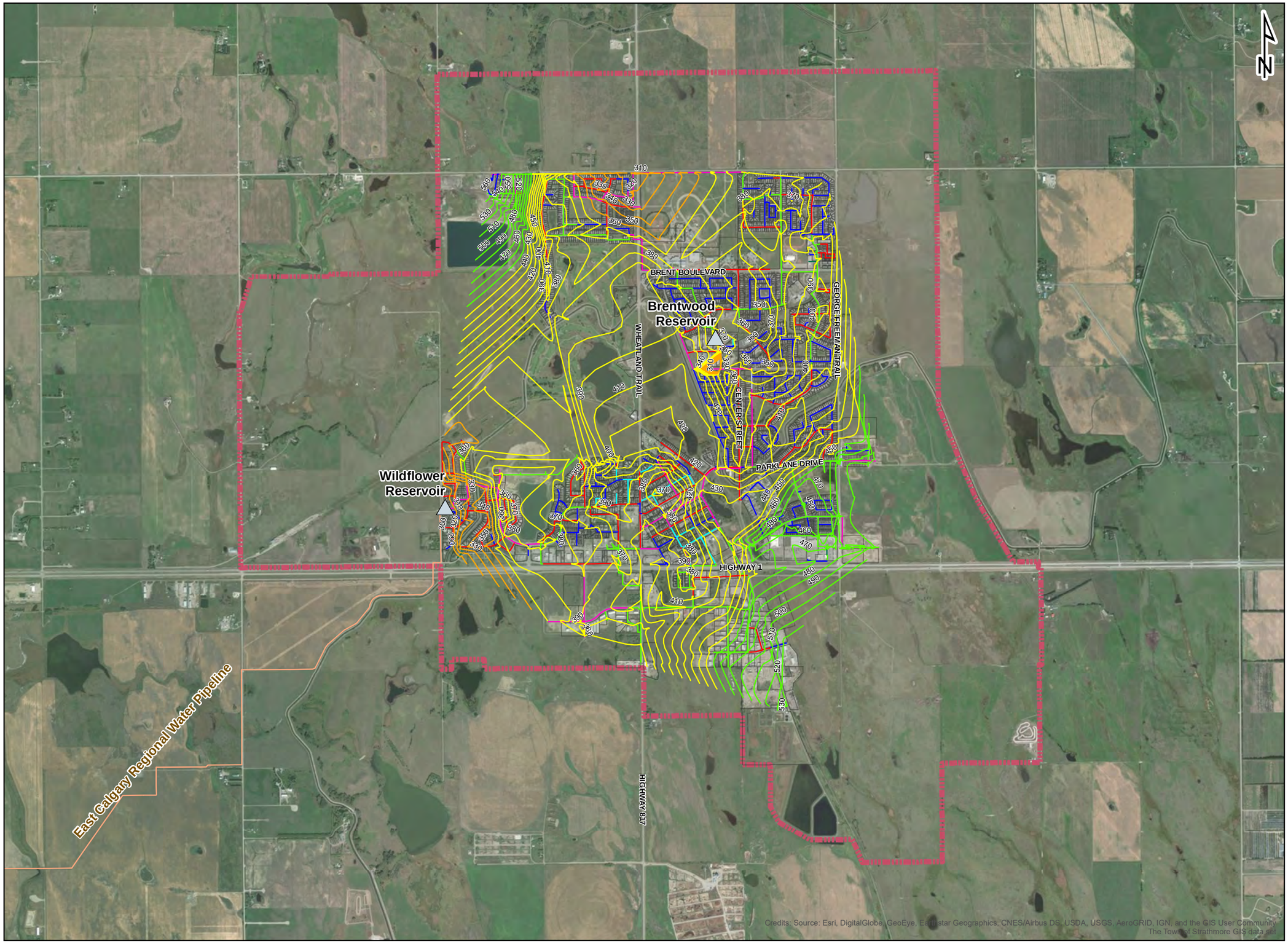
1:30,000 NAD 1983 3TM 114

FIGURE 6.6
EXISTING SYSTEM ANALYSIS
AVERAGE DAY DEMAND
PLUS BRENTWOOD RESERVOIR FILLING
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Maximum Day Pressure

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

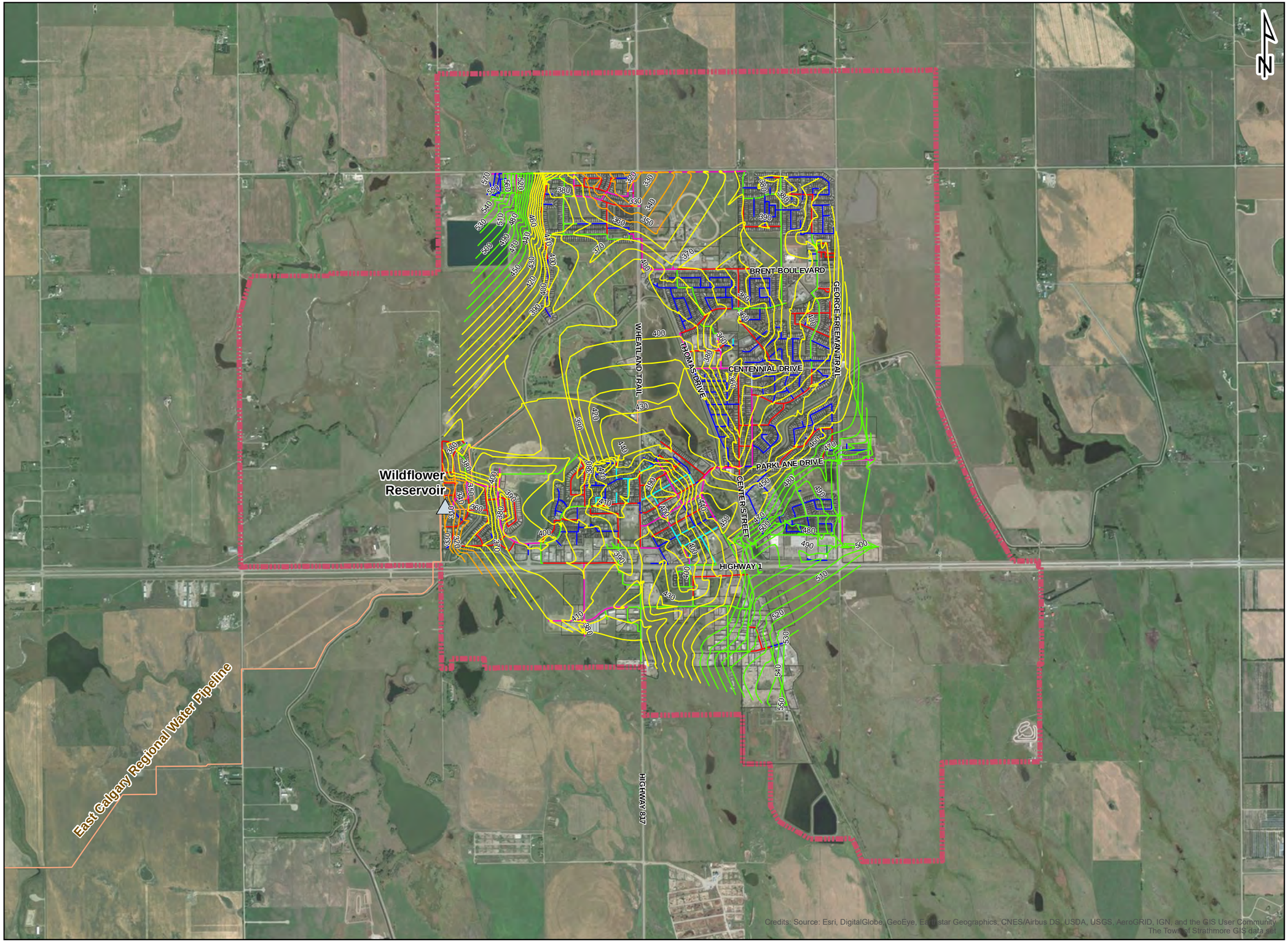
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 6.7
EXISTING SYSTEM ANALYSIS
MAXIMUM DAY DEMAND
PLUS BRENTWOOD RESERVOIR FILLING
WATER MASTER SERVICING STUDY

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 6.7_Existing System_MDD + RF.mxd

Integrated Expertise. Locally Delivered.



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Average Day Pressure

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

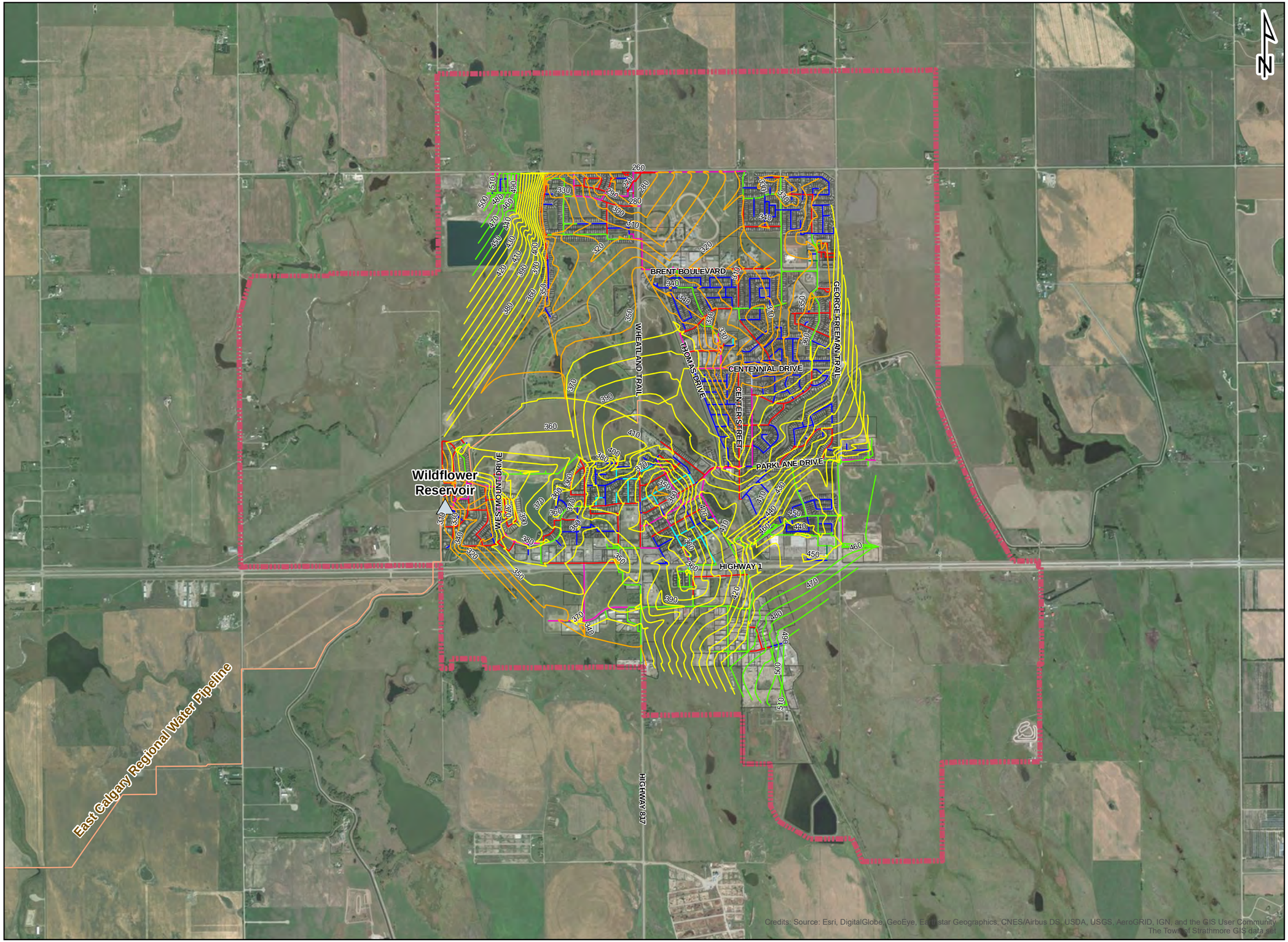
FIGURE 6.8
EXISTING SYSTEM ANALYSIS
BRENTWOOD RESERVOIR OFFLINE
AVERAGE DAY DEMAND
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 6.8_Existing System_ADD - Brentwood Offline.mxd



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Peak Hour Demand

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

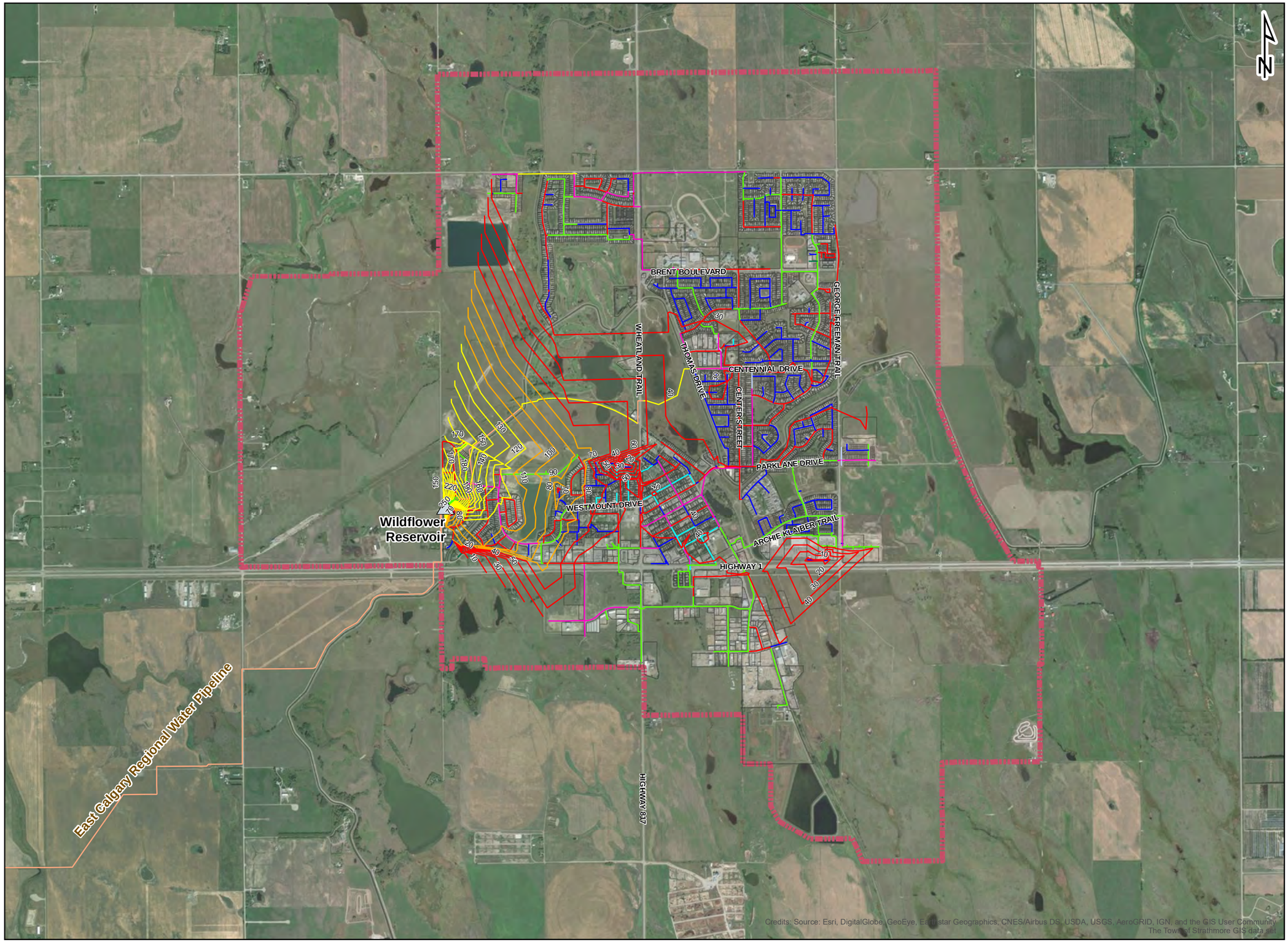
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 6.9
EXISTING SYSTEM ANALYSIS
BRENTWOOD RESERVOIR OFFLINE
PEAK HOUR DEMAND
WATER MASTER SERVICING STUDY

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 6.9_Existing System_PHD - Brentwood Offline.mxd

Integrated Expertise. Locally Delivered.



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Available Fire Flow

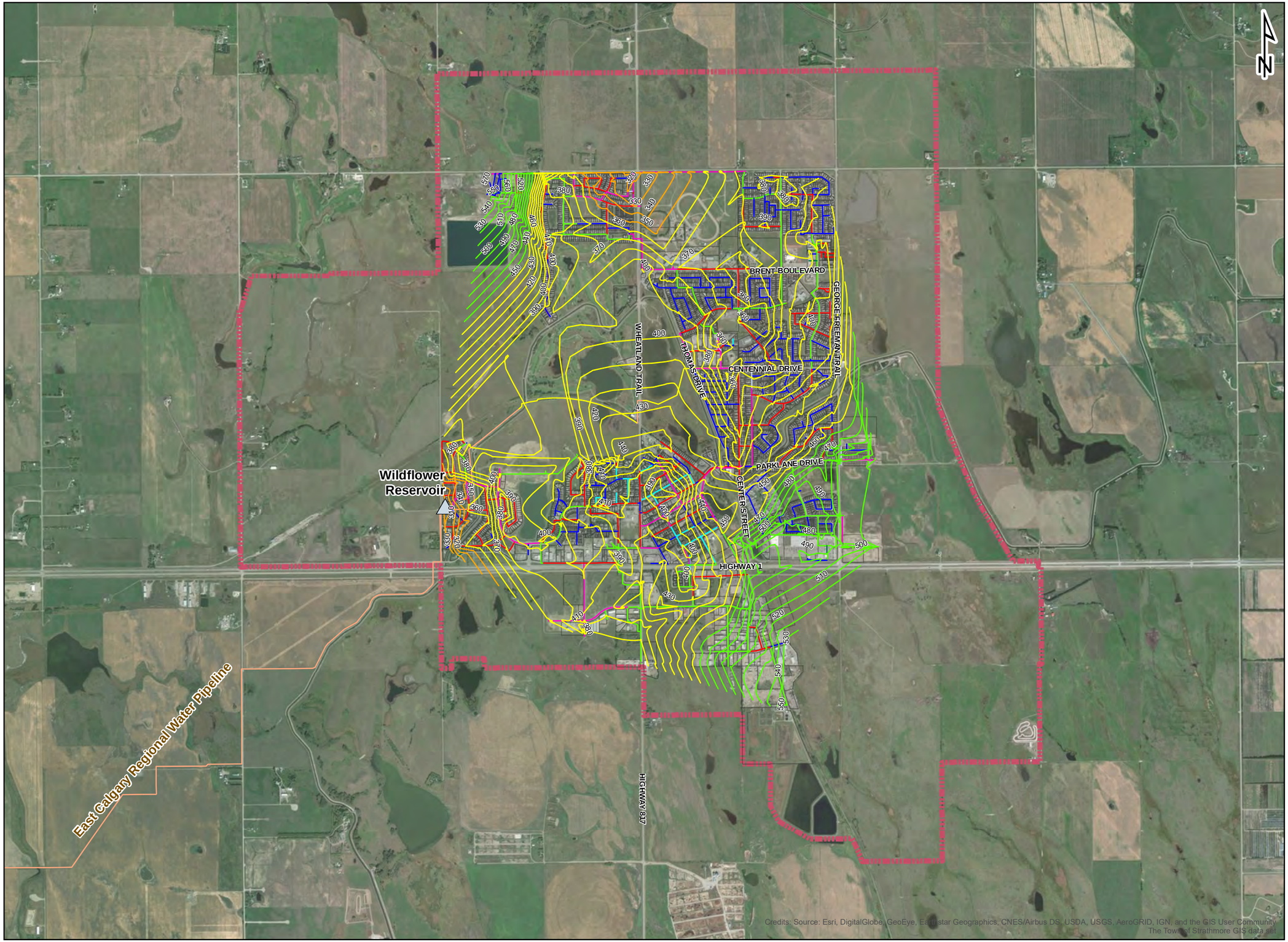
- Less than 76L/s (Fails All Criteria)
- 76 to 114L/s (Single Family Residential)
- 114 to 227L/s (Multi-Family Residential / Institutional)
- 227 to 265L/s (Industrial)
- Greater than 265L/s (Commercial)

Based on Fire Underwriters Survey recommendations.

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 6.10
EXISTING SYSTEM ANALYSIS
BRENTWOOD RESERVOIR OFFLINE
MAXIMUM DAY DEMAND PLUS FIRE FLOW
WATER MASTER SERVICING STUDY



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Average Day Pressure

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

0 375 750 1,500 m

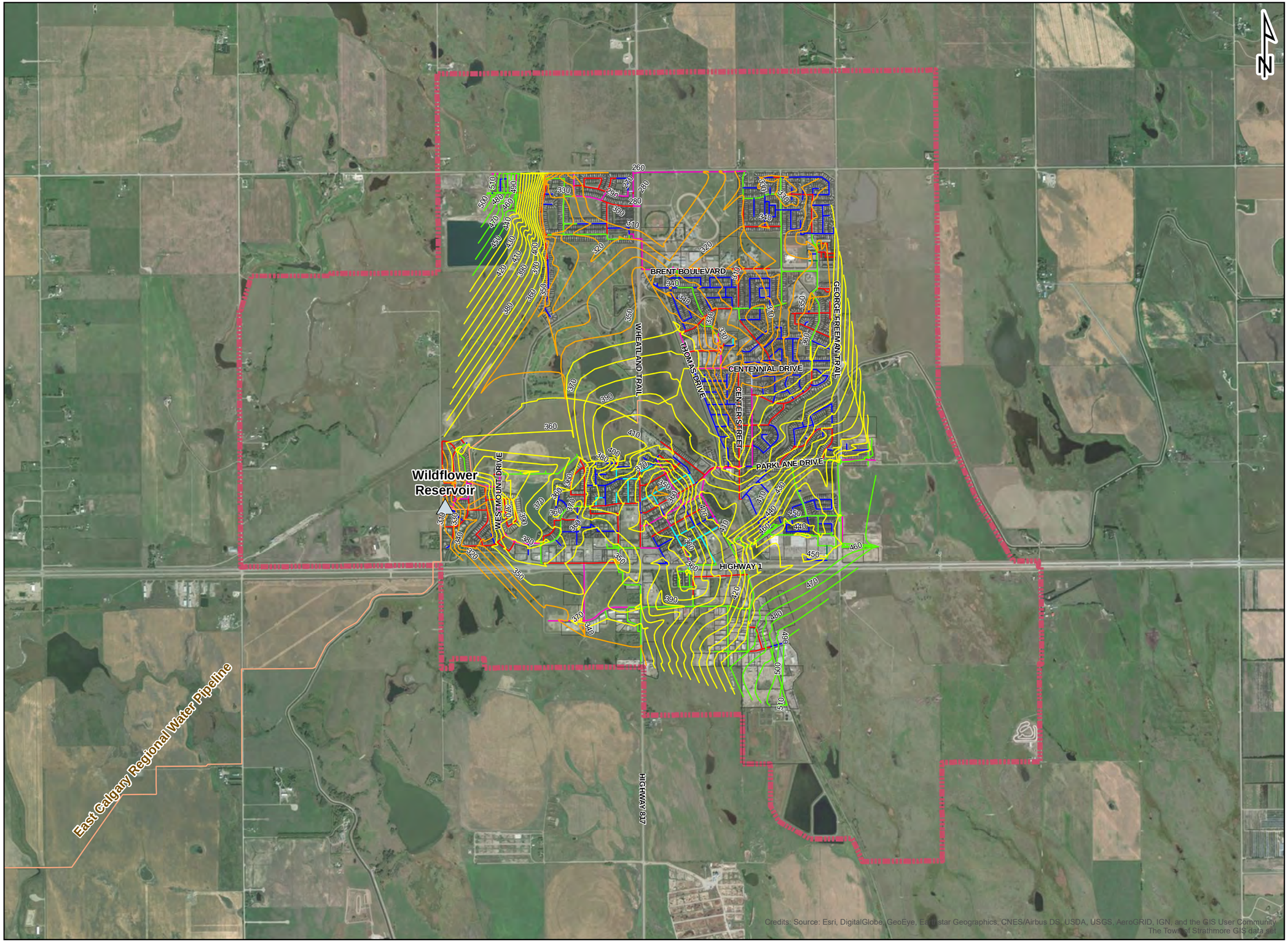
1:30,000 NAD 1983 3TM 114

FIGURE 6.11
EXISTING SYSTEM ANALYSIS
BRENTWOOD RESERVOIR OFFLINE - UPGRADES
AVERAGE DAY DEMAND
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Peak Hour Pressure

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

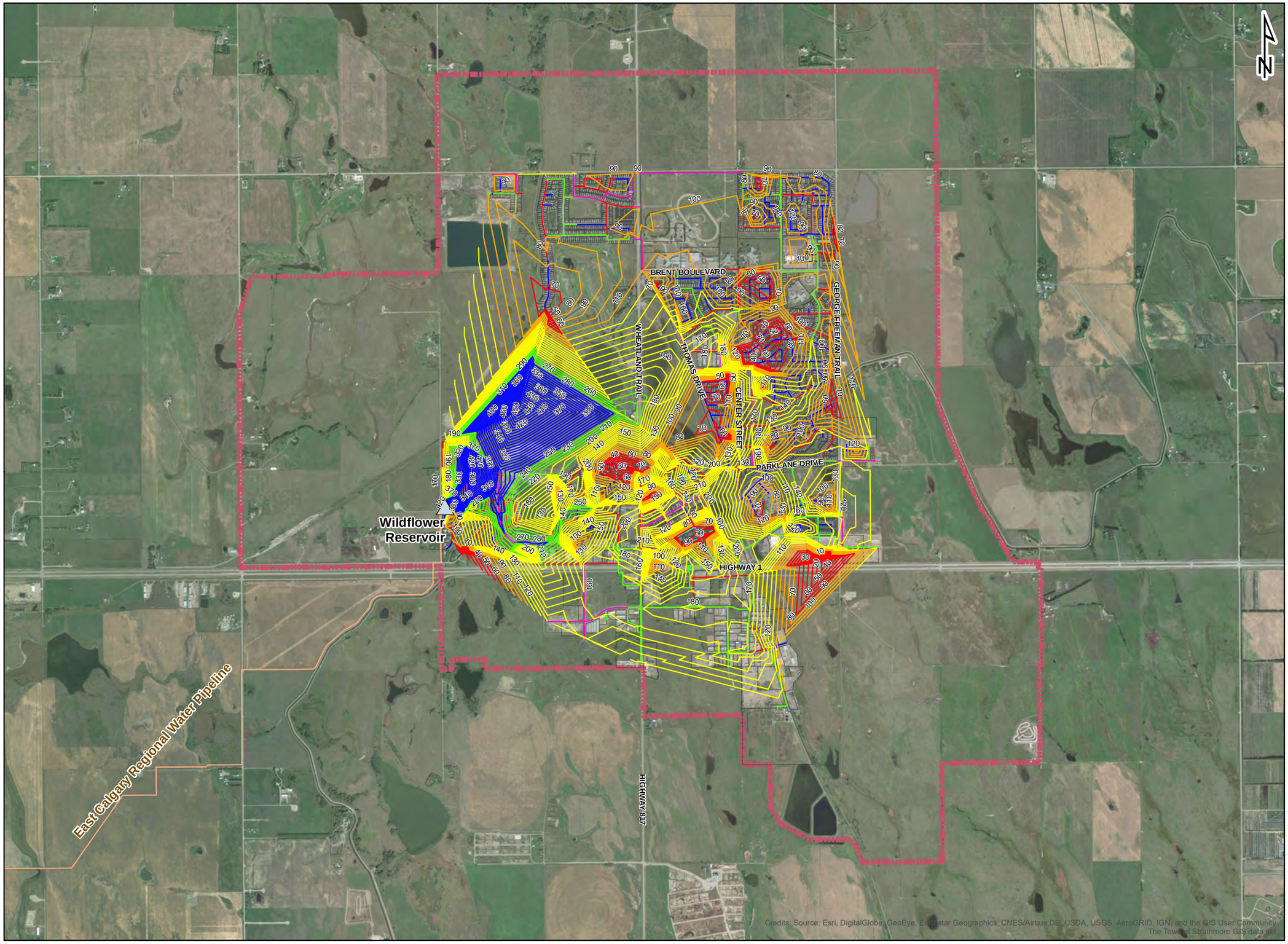
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 6.12
EXISTING SYSTEM ANALYSIS
BRENTWOOD RESERVOIR OFFLINE - UPGRADES
PEAK HOUR DEMAND
WATER MASTER SERVICING STUDY

Integrated Expertise. Locally Delivered.

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 6.12_Existing System_PHD - Brentwood Offline - Upgrades.mxd



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Available Fire Flow

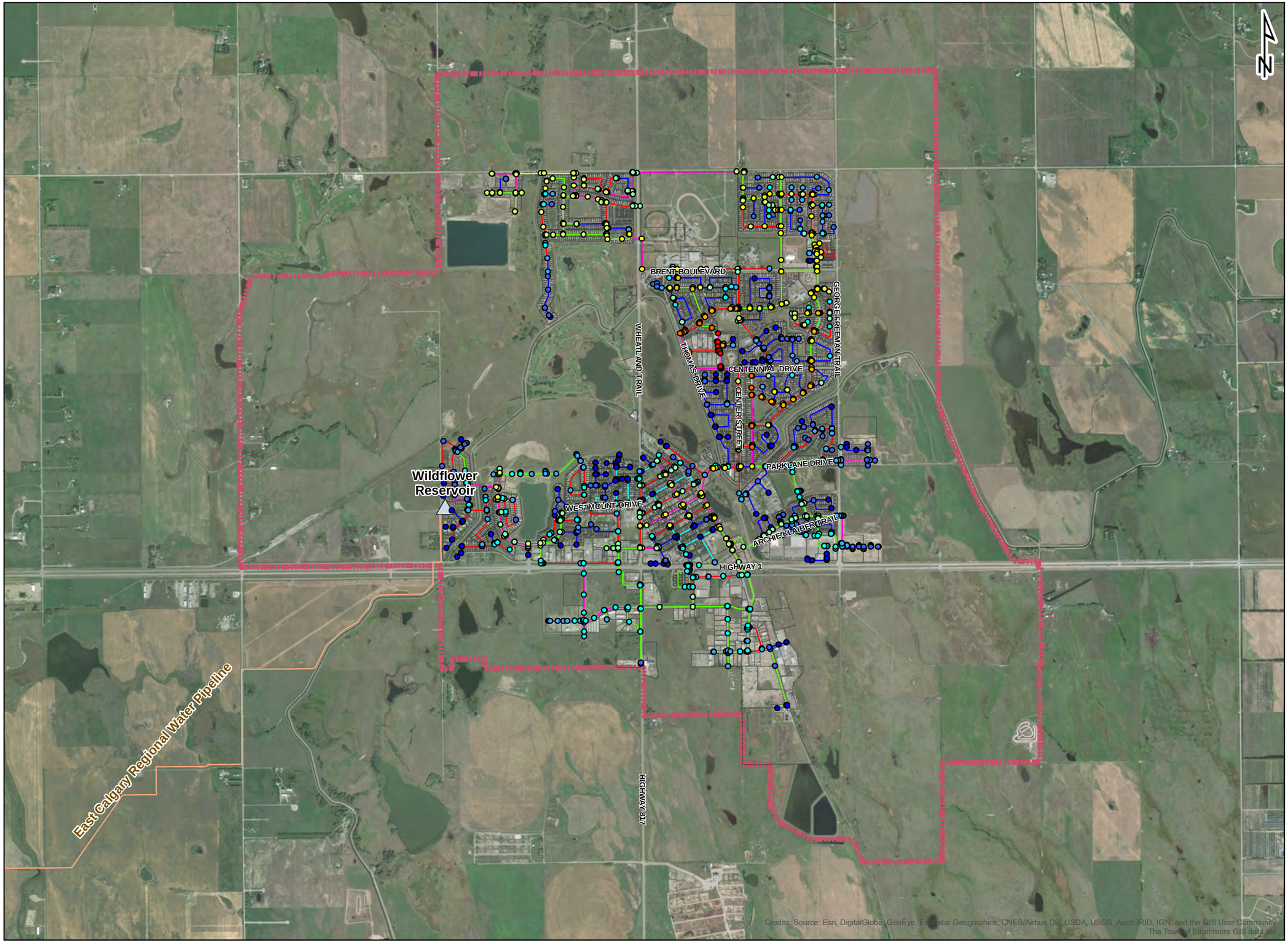
- Less than 76L/s (Fails All Criteria)
- 76 to 114L/s (Single Family Residential)
- 114 to 227L/s (Multi-Family Residential / Institutional)
- 227 to 265L/s (Industrial)
- Greater than 265L/s (Commercial)

Based on Fire Underwriters Survey recommendations.

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 6.13
EXISTING SYSTEM ANALYSIS
BRENTWOOD RESERVOIR OFFLINE - UPGRADES
MAXIMUM DAY DEMAND PLUS FIRE FLOW
WATER MASTER SERVICING STUDY



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Reduction in Fire Flow

- Less than 5L/s
- 5 to 10L/s
- 10 to 15L/s
- 15 to 20L/s
- 20 to 30L/s
- 30 to 40L/s
- 40 to 60L/s
- 60 to 100L/s
- 100 to 250L/s
- Greater than 250L/s

Difference represents reduction in fire flow from existing conditions.

0 375 750 1,500 m

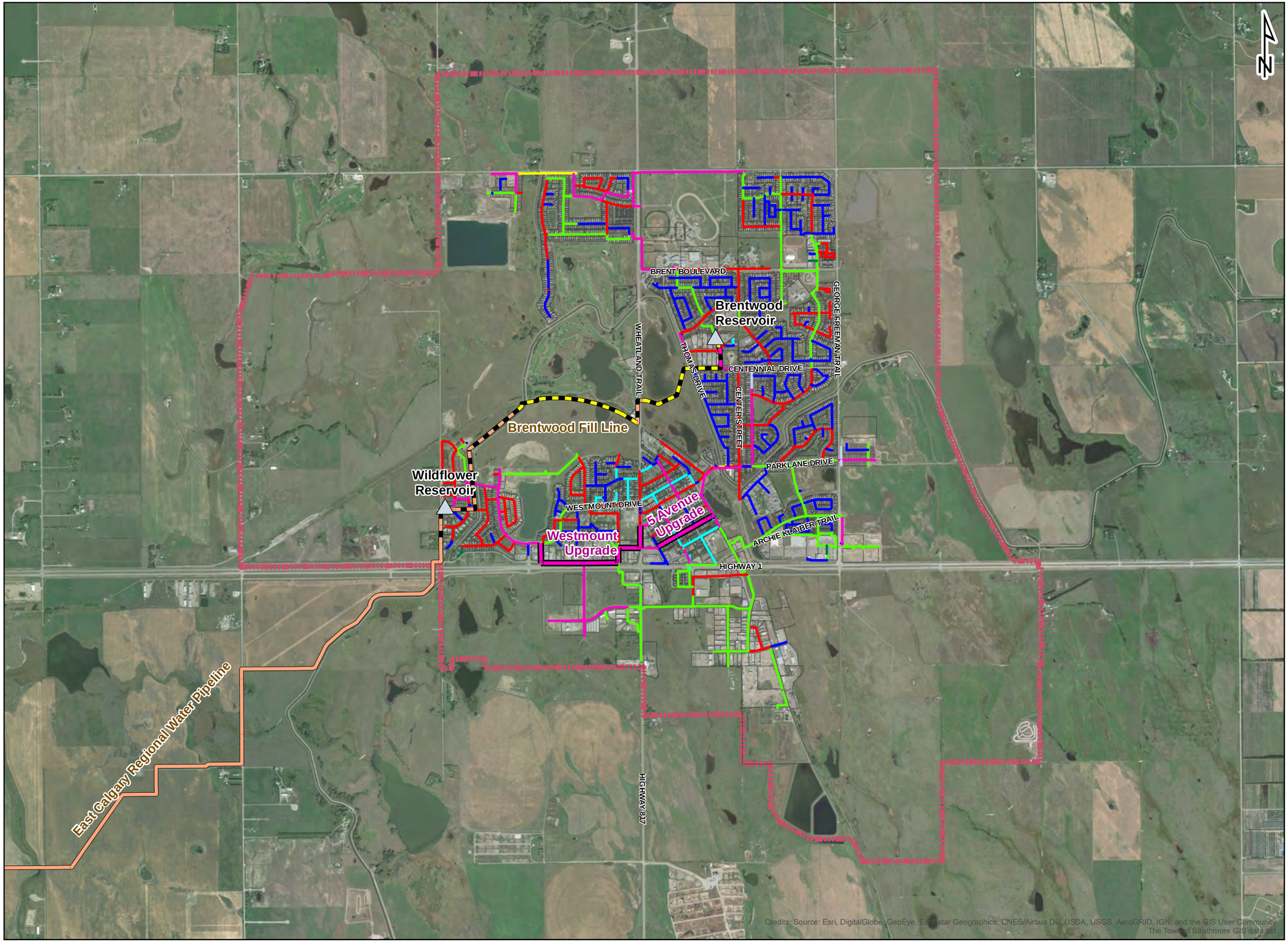
1:30,000 NAD 1983 3TM 114

FIGURE 6.14
EXISTING SYSTEM ANALYSIS
BRENTWOOD RESERVOIR OFFLINE - UPGRADES
MAXIMUM DAY DEMAND PLUS FIRE FLOW
COMPARISON TO EXISTING CONDITIONS
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.



Legend

- Reservoir
- Legal
- Town Boundary

Distribution - Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm
- 300mm Upgrade

Fill Line - Pipe Diameter

- 300mm
- 350mm
- 450mm
- 500mm

Supply Line - Pipe Diameter

- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

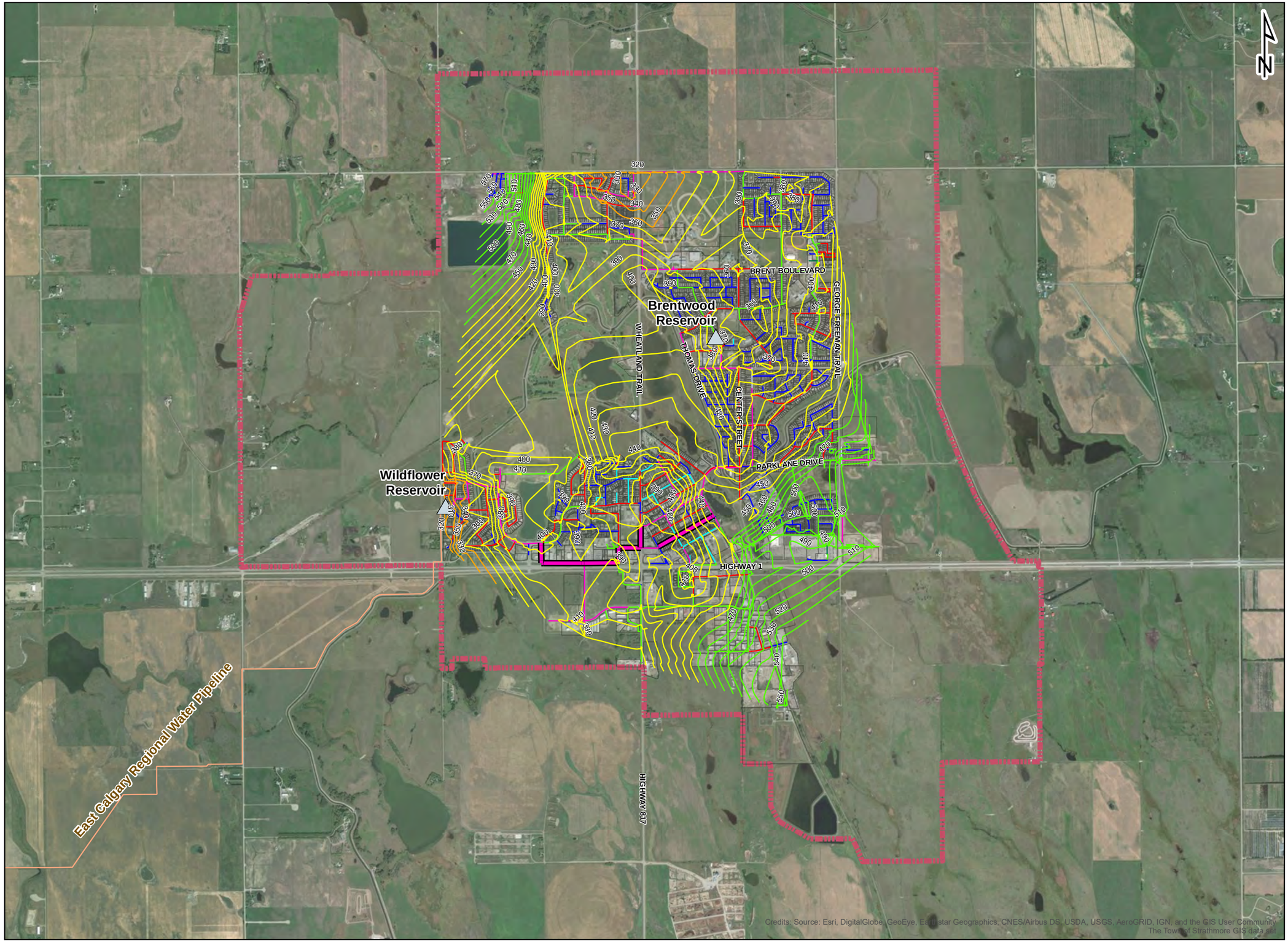
FIGURE 6.15
EXISTING SYSTEM UPGRADES
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 1/21/2020 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 6.13_Existing System Upgrades.mxd



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm
- 300mm Upgrade

Average Day Pressure

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

0 375 750 1,500 m

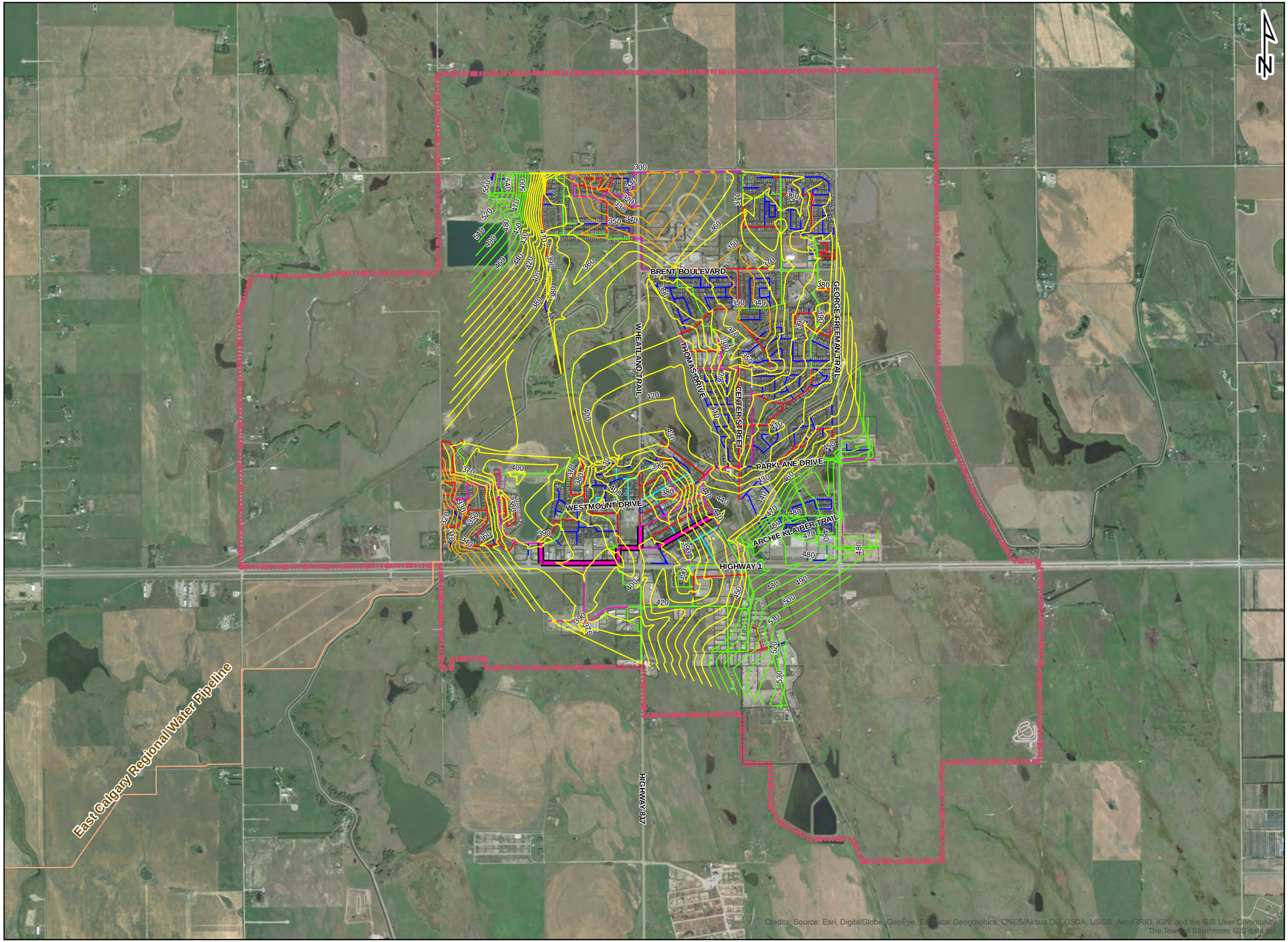
1:30,000 NAD 1983 3TM 114

FIGURE 6.16
EXISTING SYSTEM UPGRADE ANALYSIS
AVERAGE DAY DEMAND
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.



Legend

- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm
- 300mm Upgrade

Peak Hour Pressure

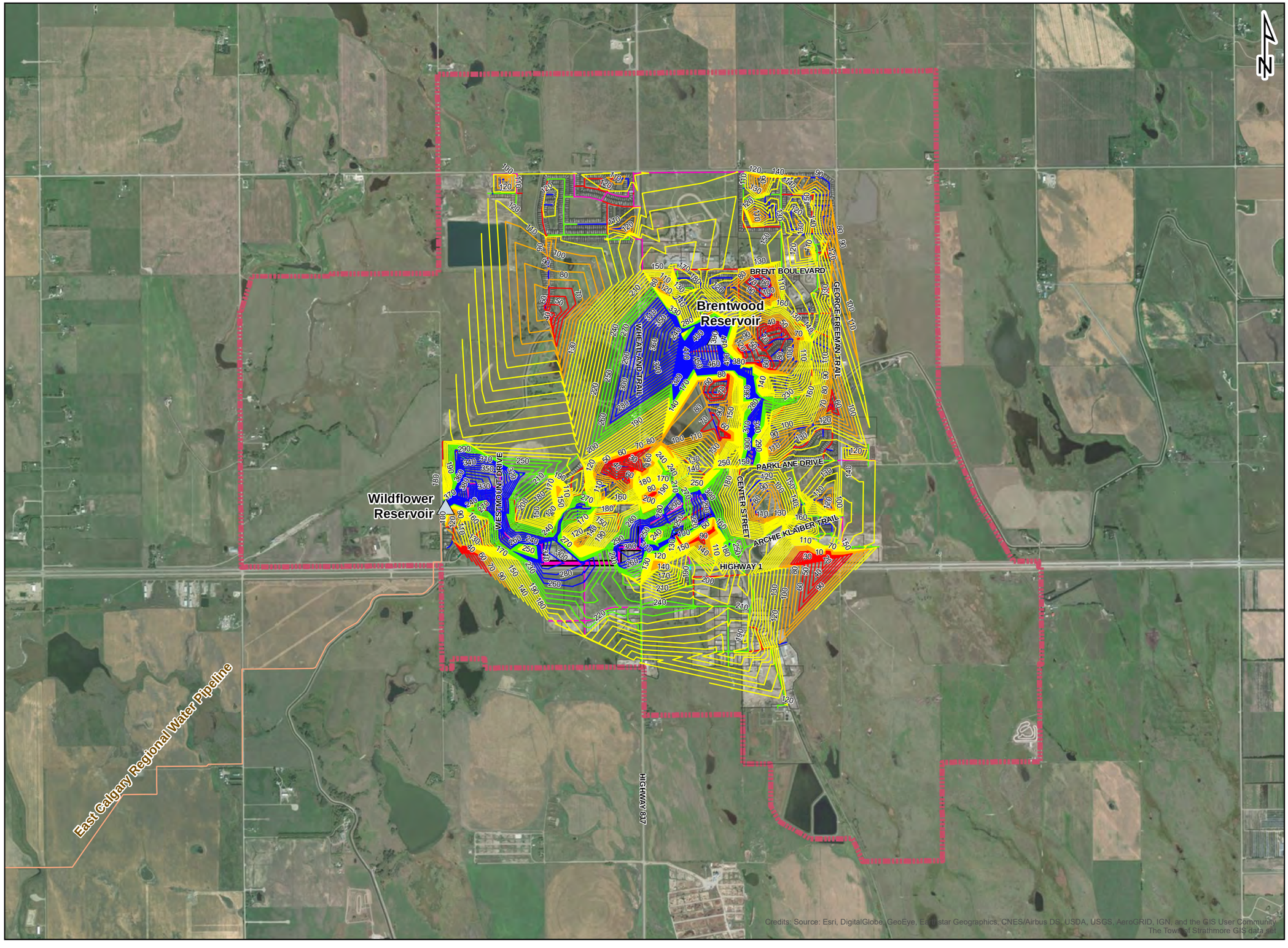
- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 6.17
EXISTING SYSTEM UPGRADE ANALYSIS
PEAK HOUR DEMAND
WATER MASTER SERVICING STUDY

Integrated Expertise. Locally Delivered.



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm
- 300mm Upgrade

Available Fire Flow

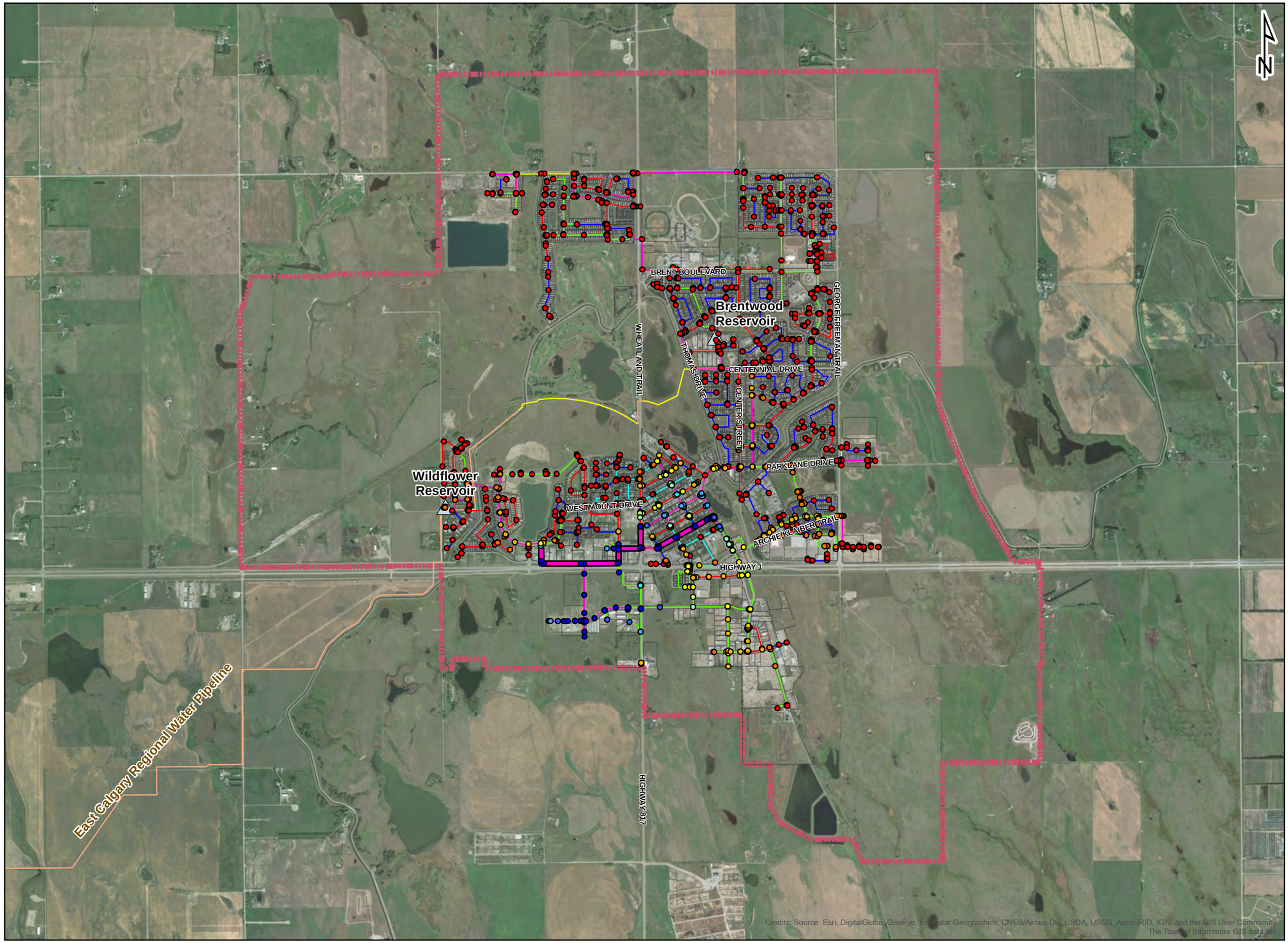
- Less than 76L/s (Fails All Criteria)
- 76 to 114L/s (Single Family Residential)
- 114 to 227L/s (Multi-Family Residential / Institutional)
- 227 to 265L/s (Industrial)
- Greater than 265L/s (Commercial)

Based on Fire Underwriters Survey recommendations.

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 6.18
EXISTING SYSTEM UPGRADE ANALYSIS
MAXIMUM DAY DEMAND PLUS FIRE FLOW
WATER MASTER SERVICING STUDY



Legend

- Reservoir
- Legal
- Town Boundary

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm
- 300mm Upgrade

Increase in Fire Flow

- Less than 5L/s
- 5 to 10L/s
- 10 to 15L/s
- 15 to 20L/s
- 20 to 25L/s
- 25 to 30L/s
- 30 to 35L/s
- 35 to 40L/s
- 40 to 45L/s
- Greater than 45L/s

Difference represents improvement in fire flow from existing conditions.

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 6.19
EXISTING SYSTEM UPGRADE ANALYSIS
MAXIMUM DAY DEMAND PLUS FIRE FLOW
COMARISON TO EXISTING CONDITIONS
WATER MASTER SERVICING STUDY

Date: 2/10/2020 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 6.19_Existing System Upgrades_MDD+FF_Node Comparison.mxd

Integrated Expertise. Locally Delivered.

7.0 Future System Assessment and Upgrades

The future system analysis consists of two population horizons: interim growth to 2052 with a population of 30,703, and full build-out of the Town with a population of approximately 70,506. The proposed concept was derived for the full build-out scenario, and subsequently scaled back for the interim growth horizon such that only the required infrastructure for the developable areas to 2052 were included. This ensures that appropriate staging can be implemented between 2052 and full build-out to guarantee the final servicing concept can be efficiently and economically realized. The proposed servicing concept is described in Section 7.1 below.

The full build-out of the Town growth horizon analysis includes a servicing concept that has been proposed for the area, and an assessment of that servicing concept. The assessment consists of ensuring the proposed servicing concept is adequate, and the impact of the servicing concept on the existing system. This analysis is described in Section 7.2 below.

Under the interim growth horizon, the existing system is assessed assuming that all service areas included in this scenario have been developed. This horizon assesses what (if any) upgrades would be required to the existing system to accommodate this future growth. This analysis is described in Section 7.3.

7.1 Water Servicing Concept

The proposed network is shown in Figure 7.1. A standard 300 mm grid network was assumed along quarter section boundaries, with a 400 mm trunk encompassing the extents of the current water distribution system. The grid network is a baseline City of Calgary requirement, noting that the actual water alignment can be tailored to each subdivision to follow the subdivision layout. The actual water alignment should be designed to avoid dead-end mains, following the general concept proposed in this Study. The selected concept must be approved by the Town prior to implementation.

The proposed watermains were connected to the Town's existing network at key junction points. The looped distribution network was only considered in quarter sections with residential or employment populations in the given growth scenario. That said, the full build-out scenario provides a full overview of the distribution mains that are be necessary under both horizons, while the interim growth looping was limited to only specific quarter sections with growth to 2052. All proposed watermains have been assumed to be PVC, with a 'C' value of 140.

The intent is that the Brentwood Reservoir will be decommissioned in the short term, thus requiring a new reservoir to accommodate future growth. The East Reservoir has been proposed, also within the Main Pressure Zone. This reservoir has been proposed for the southeast corner of the intersection of Centennial Drive and George Freeman Trail. The location of this reservoir is meant to be flexible along the east corridor. Adjustments along the east corridor should not impact the performance of the network significant, but would have cost implications associated with constructing a longer fill line to the reservoir.

New Northwest and Southeast Pressure Zones were created for this concept to reduce pressures in the lower lying areas within the Town's boundary, as shown in Figure 7.2. The new pressure zones are connected to the Main Pressure Zone with PRVs. Alternatively, localized PRVs can be installed on each lot if there is to be limited development in these pressure zones. In this concept, as both the Northwest and Southeast Pressure Zones are in a lower elevation area when compared to the Main Pressure Zone, they are fed via the Wildflower and East Reservoirs. The Town may wish to introduce further system resiliency by implementing reservoirs and pump stations for each pressure zone. This would be a more costly venture, however it would reduce the risk of complete system failure in the event of issues in the Main Pressure Zone. It is noted that providing system resiliency in the Main Pressure Zone (i.e., in the long-term once the Wildflower and East Reservoirs are both online) also provides resiliency in the Northwest and Southeast Pressure Zones, given there are multiple connection points into each zone.

As mentioned in Section 5.2.2, each quarter section was further discretized into either two or four service areas, to improve the spatial allocation of the demands in the models. Populations were evenly distributed between the service areas. Junctions were added at all corners and intersections of the service areas, and also at changes in ground slope to detail low and high points. Service areas were connected to the nearest junction in the model.

7.2 Full Build-out Horizon Concept Analysis

In order to address the adequacy of the existing water distribution system to handle expansion of the Town, the hypothetical looped network around the Town was set up in the WaterCAD model. The following scenarios, mentioned in Section 3.4, were modelled to analyze the capacities of the system with the additional future growth:

- ADD – Figure 7.3
- MDD – Figure 7.4
- PHD – Figure 7.5
- MDD + FF – Figure 7.6
- ADD + RF – Figure 7.7
- MDD + RF – Figure 7.8

Additionally, the reservoirs were assessed in terms of reservoir storage and pumping capacity under the existing system. Table 7.1 summarizes the demands that were used for input in the above mentioned assessments.

Table 7.1: Build-out System Demands

Scenario	Total Demand		Wildflower Reservoir Demand		East Reservoir Demand	
	L/s	m^3	L/s	m^3	L/s	m^3
ADD	222.55	19,228	102.30	8,839	120.26	10,390
MDD	407.32	35,192	184.64	15,953	222.69	19,240
PHD	804.47	69,506	363.29	31,388	441.16	38,116

7.2.1 Pressure Assessment

The highest and lowest pressures in addition to the locations at which these pressures occur are shown below in Table 7.2, for the ADD, MDD, and PHD scenarios.

Table 7.2: Future System Pressure Ranges

Scenario	Figure	Highest Pressure		Location	Lowest Pressure		Location
		kPa	psi		kPa	psi	
ADD	7.3	572	82.96	South end of system, centered between Wheatland Trail and Orchard Way	300	43.51	Southeast corner of TCH and George Freeman Trail
MDD	7.4	569	82.38		300	43.51	
PHD	7.5	559	81.08		300	43.51	

There are two locations in the build-out concept where the pressures are above 550 kPa under ADD, thus do not meet the stipulated requirements. The first is at the south end of the system, directly west of the Southeast Pressure Zone. There are three modelled nodes in this location that are above the criteria. The second is in the northwest, directly east of the Northwest Pressure Zone along Lakewood Circle. Incorporating these locations into the lower pressure zones would impact existing watermains, thus were left in the Main Pressure Zone. High pressures at these locations should be monitored once the East Reservoir is implemented, and localized pressure reducing valves installed if significant leakage is observed.

Under PHD, additional pumping capacity was required in order to achieve the PHD demands. The total demand is 804 L/s, while Wildflower has a firm capacity of 166 L/s. The flow being distributed through the East Reservoir is 441 L/s, thus Wildflower would require an additional pumping capacity of 197 L/s (noting that 110 L/s of this 197 L/s would be implemented for the decommissioning of the Brentwood Reservoir). This additional pumping capacity is represented in the results stipulated above.

7.2.2 Fire Flow Assessment

Results of the MDD + FF scenario are shown in Figure 7.6. In the proposed system, there is sufficient fire flow throughout to meet the stipulated development types. That said, in the Main Pressure Zone directly on the upstream end of the Northeast Pressure Zone, due to available fire flows between 185 L/s and 263 L/s additional diagonal looping was implemented in the Main Pressure Zone. This was done to increase the available fire flow in this area, in the event that the land use designation changes from residential to another type with a higher fire flow requirement. Alternatively in this event, instead of this additional looping, the Town could ensure that buildings are equipped with sprinklers, thus reducing the fire flow criteria. For the purposes of this Study, additional looping will be applied.

In the Main Pressure Zone directly on the upstream end of the Southeast Pressure Zone, lower available fire flows were also noted. Here, the diagonal watermains adjacent to the Western Irrigation District Canal A were increased from 300 mm watermains to 400 mm watermains to improve the fire flows.

Two additional ties to the existing distribution system were added to the proposed concept to introduce looping where there are currently dead-ends. This was only done in locations where fire flows would be improved solely by the looping, therefore dead-end mains that are also undersized were not flagged for further looping. As noted in Section 6.7, fire flow improvements at these locations can be accomplished in conjunction with local roadworks programs. All the additional fire flow improvement efforts are represented in the results figures herein.

7.2.3 Reservoir and Pumping Capacity Assessment

The volume of water storage required at each reservoir was determined using the formulas for storage criteria provided by AEP, ECRWL, and The City of Calgary, as noted in Section 3.7. Table 7.3 summarizes the storage requirements in each reservoir for all criteria.

Table 7.3: Proposed Reservoir Storage Requirements

Parameter	Unit	Wildflower Reservoir	East Reservoir	Both Reservoirs
ADD	m^3	8,839	10,390	19,228
MDD	m^3	15,953	19,240	35,192
Available Storage	m^3	11,500	-	11,500
Required Storage (AEP)	m^3	7,474	8,529	13,842
Additional Storage	m^3	N/A	8,529	N/A
Required Storage (ECRWL)	m^3	17,677	20,781	38,457
Additional Storage	m^3	6,177	20,781	26,957
Required Storage (COC)	m^3	8,839	10,390	19,228
Additional Storage	m^3	N/A	10,390	7,728

When considering the ECRWL formulation, the required cumulative storage capacity between the two reservoirs is 38,457 m^3. There is a current storage of 11,500 m^3, thus the additional storage requirement is 26,957 m^3. From the required storage, at full build-out the Wildflower Reservoir would need an additional 6,177 m^3 of storage while the East Reservoir storage requirement would be 20,781 m^3.

To achieve the required pressures and demands in the system under the full build-out growth horizon, the following reservoir/pumping specifications in Table 7.4 are recommended.

Table 7.4: Proposed Reservoir/Pump Station Specifications under the Full Build-out Growth Horizon

Parameter	Unit	Wildflower Reservoir	East Reservoir	Both Reservoirs
MDD	L/s	185	223	407
MDD + FF	L/s	N/A	N/A	607
PHD	L/s	363	441	804
Governing Pumping Capacity[1]	L/s	363	441	804
Current Pumping Capacity[2]	L/s	166	-	166
Pumping Deficiency[2]	L/s	197	441	638
Total Head	m	46	45	N/A
Normal Operating Pressure	kPa	311	437	N/A
Reservoir Slab Elevation	m	987	973.76	N/A
Hydraulic Grade Line	m	1,018.29	1,018.29	1,018.29

[1] *Governing pumping capacity was determined using the greater of the PHD and MDD + FF (MDD + 200 L/s).*

[2] *Based on the current pumps' cumulative firm capacity.*

It is important to note that the reservoir slab elevation and normal operating pressure of the East Reservoir is based off of the current proposed location of the reservoir. The location by no means is final, and is dependent on where the Town believes the reservoir is best suited. The location will be influenced by the development plans for each quarter section, topography, and public/stakeholder engagement. The normal operating pressures should be adjusted such that the hydraulic grade line is achieved at the proposed reservoir elevation.

Under the full build-out horizon, the PHD demand governs over the MDD + FF demand. At the Wildflower Reservoir, as mentioned above the required additional pumping capacity is 197 L/s, noting that the required pumping capacity (212 L/s) under the interim growth horizon ultimately governs, as described below in Section 7.3. The East Reservoir must be designed to have a pumping capacity of 441 L/s. This will result in a total system pumping capacity of 804 L/s.

7.2.4 Reservoir Filling Assessment

A reservoir filling scenario was run in order to simulate the East Reservoir being filled under ADD and MDD conditions for a total of eight hours, resulting in a reservoir fill of 722 L/s, considering ECRWL's storage requirements. This scenario was completed in order to ensure that the system was able to meet the reservoir filling requirements, without depleting pressures throughout the remainder of the system. The results of these scenarios are shown in Figures 7.7 and 7.8.

It is noted that the ADD and MDD analyses are conservative approaches to reservoir filling, as the East Reservoir will likely be filled at night, over an eight hour period, when the water demand in the Town is significantly less than during daytime hours. That said, pressure deficiencies in both scenarios are evident in the southwest, especially near the Wildflower Reservoir.

The intent is that the fill line from the Wildflower Reservoir to the Brentwood Reservoir gets repurposed as a fill line to the new East Reservoir. This line was therefore extended in the model as a 500 mm PVC watermain to the new East Reservoir location. Under both ADD and MDD, this fill line fails at providing the required demand of 722 L/s according to ECRWL's criteria, as negative pressure at the East Reservoir is observed. This holds true as well when considering the COC and AEP's criteria, which would result in reservoir fill demands of 361 L/s and 296 L/s, respectively. To achieve positive pressures at the reservoir under ECRWL's criteria, the entire fill line would require upsizing to 600 mm.

7.2.5 Build-out Horizon Concept Cost Estimates

A summary of the costs associated with developing the proposed build-out concept are detailed below in Table 7.5. A full breakdown of the costs has been provided in Appendix C.

Table 7.5: Class D Cost Estimates for Proposed Build-out Concept

Item	Servicing Location			Cost Per Item Type (Rounded)	Grand-Total[2] (Rounded)
	Main	Northwest	Southeast		
Watermains	$47,959,000	$3,943,000	$3,870,000	**$55,770,000**	**$119,800,000**
Fill Line[1]	$4,894,000	$0	$0	**$4,890,000**	
Reservoir Storage	$51,784,000	$0	$0	**$51,780,000**	
Reservoir Pump Station	$6,489,000	$0	$0	**$6,490,000**	
Pressure Reducing Valves	$0	$435,000	$435,000	**$870,000**	
Cost Per Servicing Location (Rounded)	**$111,130,000**	**$4,380,000**	**$4,310,000**		

[1] *Assumes ECRWL's criteria for reservoir storage.*

[2] *Costs represent to the total cost from existing conditions to full build-out, thus include upgrades required under the interim growth horizon.*

Life-Cycle Costing

Consideration of the ongoing operation and maintenance costs have also been included in this analysis, to ensure long-term costing requirements are contemplated and known. This will ensure that the Town, including the municipal departments and residents, is fully aware of the additional costs of operating these new facilities.

It is noted that operational cost allowances have not been provided for the distribution system, but solely the new facilities. The costs associated with distribution main flushing and other network activities are considered to be a fraction of the costs of operating and maintaining the reservoirs and pump stations, thus are considered to have a nominal impact on the overall operational expenditures.

The costs associated with operating and maintaining reservoirs is assumed to be 2% of the capital value of the reservoir. Likewise, the costs associated with operating and maintaining pump stations is assumed to be 4%. These assumptions are in line with approaches taken in similar studies for neighbouring municipalities, primarily in the Airdrie Utility Master Plan (ISL and AE, 2016). The annual operation and maintenance costs associated with the proposed servicing concept are summarized in Table 7.6 below.

Table 7.6: Annual Operation and Maintenance Costs for the Proposed Servicing Concept

Items	Capital Cost	Percentage of Capital	Annual Operation and Maintenance Costs
Wildflower Reservoir Storage	$11,859,000	2%	$237,000
East Reservoir Storage	$39,925,000	2%	$799,000
Wildflower Reservoir Pumping Capacity (212 L/s)[1]	$5,053,000	4%	$202,000
East Reservoir Pumping Capacity (441 L/s)	$3,843,000	4%	$154,000
Total	**$60,680,000**		**$1,392,000**

[1] *Pumping capacity reflective of governing required flow rates, which occur in the interim growth horizon discussed below.*

Funding Sources

The required servicing infrastructure and the upgrades to the existing system have been compiled to provide seamless integration with the Off-Site Levy (OSL) Update (ISL, 2020), or otherwise provide alternate funding sources. The purpose here is to ensure that the capital costs of infrastructure improvements that support and benefit growing areas should be borne by those growing areas. The following assumptions with regards to water infrastructure upgrades have been applied in the OSL Update:

- Replacement of existing distribution mains at the same size as the existing pipe is considered the responsibility of the Town and has not been included in the levy calculations.
  - For example, any upgrades made for the cast/ductile iron replacement program would be borne by the Town.
- Replacement and upsizing of existing distribution mains is expected to be cost-shared between the Town and the Developers via the Off-Site Levy. The Off-Site Levy Update will define this exact split.
- Decommissioning of the Brentwood Reservoir and construction of the future East Reservoir are considered to be cost shared between the Town and Developers via the Off-Site Levy. As before the Off-Site Levy Update will define this exact split.
- Distribution mains of 300 mm diameter or smaller are considered to be the responsibility of the Developer.

Potential grant funding of infrastructure should also be considered. Possible grants include Building Canada, AMWWP, and GMF. It will be at the discretion of the Town to include and apply for these municipal infrastructure grants.

The apportionment of costs associated with the required servicing infrastructure and upgrades to the existing system are provided in the detailed costing tables in Appendix C for Tables 1 and 2. Additional details regarding theses costs can be referenced in the OSL Update.

7.3 Interim Growth Horizon Concept Analysis

As mentioned above, the interim growth horizon concept is based on the full build-out concept, but focusses on the piping required only for the lands considered to be developable in this horizon. The demands are based on a growth to a population of 30,703. The proposed concept is illustrated in Figure 7.9, with results shown in Figures 7.10, 7.11, 7.12 and 7.13 for ADD, MDD, PHD, and MDD + FF, respectively. No reservoir filling scenarios are needed under this concept as Wildflower Reservoir is the only active reservoir, further discussed below. Table 7.7 summarizes the demands that were used for input in the assessments.

Table 7.7: Interim System Demands

Scenario	Total Demand	
	L/s	m^3
ADD	98.70	8,528
MDD	178.18	15,395
PHD	346.17	29,909

With some upgrades to the Wildflower Reservoir, the interim water distribution system can be serviced entirely by this reservoir. This is assuming that the Brentwood Reservoir will be decommissioned in the short term, and that the East Reservoir is not yet built. That said, having a single reservoir does not allow for system resiliency, which should be considered when decommissioning the Brentwood Reservoir prior to bringing the East Reservoir online. The degree of risk that the Town is willing to tolerate should be discussed internally prior to decommissioning the Brentwood Reservoir. With the Brentwood and East Reservoirs offline, the Wildflower Reservoir is currently incapable of meeting the demands of the system under the interim growth horizon. The following discussion is provided in order to maintain the single reservoir at this stage.

In terms of reservoir storage, consider the following:

- The spare capacity under existing conditions is 4,022 m^3, assuming the Brentwood Reservoir is offline. This spare capacity can service the Town until a population of roughly 20,000 is reached, projecting to 2034.
- Under the full build-out concept, an additional storage of 6,177 m^3 is required at the Wildflower Reservoir.
- Between the spare capacity under existing conditions plus the additional storage required under the full build-out concept, there would be a total spare capacity of 10,199 m^3. This is equivalent to approximately 59 L/s under ADD, assuming ECRWL's criteria.
- The difference in ADD between existing conditions and the interim concept is 55 L/s. Thus upgrading the storage by 6,177 m^3 for an overall spare storage of 10,199 m^3 would be sufficient in accommodating the storage required for the interim concept.
- It is therefore recommended that the storage capacity of the Wildflower Reservoir is increased by implementing an adjacent reservoir to meet the full build-out criteria (additional 6,177 m^3) prior to reaching the interim growth horizon.
- There is potential to place this new facility directly east of the current Wildflower Reservoir in the green space. This would ensure sufficient storage at the Wildflower Reservoir for the entire distribution system under the interim growth horizon.

Pumping capacity requirements are as follows:

- Additional pumping capacity would also be needed in the interim at the Wildflower Reservoir.
- To meet existing system conditions with Brentwood Reservoir offline, the pumping capacity must be increased by 110 L/s to 276 L/s.
- Under the full build-out horizon, with East Reservoir online, the pumping capacity must be increased by 197 L/s to 363 L/s.
- Under the interim horizon, which consists of solely the Wildflower Reservoir online (i.e., no Brentwood or East Reservoirs), the governing pumping capacity is 378 L/s (MDD + FF governs over PHD in this case).
- Thus, with Wildflower being the only active reservoir in this scenario an additional pumping capacity of 212 L/s is needed. This pumping capacity (required for the interim horizon) governs over the existing and full build-out horizons.
- The 110 L/s required with Brentwood Reservoir offline under existing conditions will be added to the existing pump room in the form of a fifth domestic pump; it is noted that the pump room has been sized as such. Thus, an additional 102 L/s will be needed for the interim growth horizon by upgrading the existing pumps. To meet firm capacity, implementation of the pump upgrades would be required as soon as the Brentwood Reservoir is decommissioned, assuming growth will be increasing at a relatively steady rate from existing conditions.

7.3.1 Interim Horizon Concept Cost Estimates

A summary of the costs associated with developing the proposed interim concept are detailed below in Table 7.8. A full breakdown of the costs has been provided in Appendix C.

Table 7.8: Class D Cost Estimates for Proposed Interim Concept

Item	Servicing Location			Cost Per Item Type	Grand-Total
	Main	Northwest	Southeast		
Watermains	$14,000,000	$3,090,000	$960,000	$18,050,000	$33,010,000
Reservoir Storage	$11,870,000	$0	$0	$11,870,000	
Reservoir Pump Station	$2,646,000	$0	$0	$2,650,000	
Pressure Reducing Valves	$0	$290,000	$150,000	$440,000	
Cost Per Servicing Location	**$28,520,000**	**$3,380,000**	**$1,110,000**		

7.4 Timing of the East Reservoir

With the upgrades noted above to the Wildflower Reservoir, implementation of the East Reservoir can be deferred to when the Town reaches its interim growth horizon of a population of 30,703 based on densification and build-out of Lakewood Meadows, Wildflower Ranch, Westcreek, Edgefield and, Coldwell Ranch, assuming the Town is comfortable with the lower system resiliency of having a single reservoir. This consists of complete development of the communities noted above, illustrated in Figure 2.5. With a 2.5% growth rate, the Town would reach this interim growth horizon in 2052. Any development occurring outside of the interim growth horizon boundary would require the new East Reservoir. Parameters of the East Reservoir are stipulated above in Table 7.4.

7.5 Evaluation of ECRWL Capacity

The Calgary Metropolitan Region Board (CMRB) consists of a collaborative network of ten municipalities to ensure sustainable growth in the Calgary region. As a regional member, the Town of Strathmore has an intergovernmental agreement with The City of Calgary in place to receive potable water servicing to accommodate the existing development and anticipated future growth within the Town's limits.

The Master Servicing Study Update (AECOM, 2012) stipulates that Strathmore's ECRWL contribution is 201 L/s, which is expected to be sufficient to provide the Town with potable water until 2022. The ECRWL was designed for a 2031 build-out horizon, meaning that Strathmore's water supply will be deplete prior to further expansion. Since the 2012 Study, adjustments were made to the parameters (including employment consumption rate and populations) used for the existing and future water system. This has resulted in an updated estimate on when additional potable water is required, discussed below.

This analysis has been completed based on the Standards and Guidelines for Municipal Waterworks, Wastewater, and Storm Drainage Systems (Alberta Environment, 2006) document. The document stipulates that water supply shall be designed for MDD plus 10%. The spare capacity available in the ECRWL under each growth horizon is shown below in Table 7.9.

Table 7.9: ECRWL Contributions per Growth Horizon

Horizon	MDD	MDD + 10%	Spare ECRWL Capacity (MDD)[1]	Spare ECRWL Capacity (ADD)[1]
	L/s			
Existing	75.70	83.27	107.02	57.85
Interim (2052)	178.22	196.04	4.51	2.44
Build-out (2086)	407.32	448.05	-224.59	-121.40

[1] *Based on Strathmore's ECRWL contribution of 201 L/s.*

Based on these spare capacities, the associated population increases were derived. Residential to non-residential ratios were derived based on full development of each growth horizon to ensure proper splits of the additional population available. This is summarized in Table 7.10 below.

Table 7.10: Additional Population Growth Available based on Spare Capacity in the ECRWL

Scenario	Parameter	Existing	Interim	Build-out
N/A	Residential Allocation	82%	86%	76%
	Non-Residential Allocation	18%	14%	24%
MDD + 10%	Residential Increase	15,612	692	N/A
	Non-Residential Increase	4,462	143	N/A

This indicates that prior to reaching the full build-out growth horizon, the Town will require additional contribution of the ECRWL. Based on an MDD deficiency of 224.59 L/s and accounting for a 10% increase, 247.05 L/s is needed. There is the potential for Strathmore to acquire Wheatland County's contribution if the County decides not to connect into the system, forming a portion of the required additional contribution. Alternatively, a booster station or potentially a new supply line may be required to produce the demand deficiency.

7.6 Consideration for Additional Quarter Sections

After discussions with the Town, it was noted that two additional quarter sections in the northwest may be annexed at some point in the future, contributing to the Town's residential base. As these quarter sections are not yet annexed, they were excluded from the full build-out concept discussed above in the event the annexation does not progress. That said, a full build-out concept has also been developed to include these two quarter sections as detailed below.

The two quarter sections in question are shown in Figure 7.14, while the revised servicing concept is illustrated in Figure 7.15. Note that these quarter sections are assumed to be included for the full build-out growth horizon only, to keep the interim growth horizon consistent with the TMP. Results in terms of ADD, MDD, PHD, and MDD + FF are shown in Figures 7.16, 7.17, 7.18, and 7.19, respectively.

The quarter sections were assumed to be entirely residential, with a density of 44.3 persons per gross hectare. This results in an additional residential population of 5,748. The associated demands are summarized in Table 7.11, utilizing the future residential consumption rate of 263 L/p/d. The revised reservoir storage and pumping specifications are summarized below in Table 7.12 for this scenario.

Table 7.11: Additional Demands Associated with Potential Annexation of Quarter Sections

Scenario	Additional Demand	
	L/s	m^3
ADD	17.50	1,512
MDD	32.37	2,797
PHD	64.74	5,593

Table 7.12: Updated Reservoir Storage/Pump Station Specifications with the Two Additional Quarter Sections

Parameter	Unit	Wildflower Reservoir	East Reservoir	Both Reservoirs
MDD	L/s	207	233	440
MDD + FF	L/s	N/A	N/A	640
PHD	L/s	407	462	869
Governing Pumping Capacity[1]	L/s	407	462	869
Current Pumping Capacity[2]	L/s	166	-	166
Pumping Deficiency[2]	L/s	241	462	703
ADD	m^3	9,880	10,860	20,740
MDD	m^3	17,868	20,130	37,989
Available Storage	m^3	11,500	-	11,500
Required Storage (AEP)	m^3	8,109	8,822	14,768
Additional Storage	m^3	N/A	8,822	N/A
Required Storage (ECRWL)	m^3	19,760	21,721	41,481
Additional Storage	m^3	8,260	21,721	29,981
Required Storage (COC)	m^3	9,880	10,860	20,740
Additional Storage	m^3	N/A	10,860	9,240

[1] *Governing pumping capacity was determined using the greater of the PHD and MDD + FF (MDD + 200 L/s).*

[2] *Based on the current pumps' cumulative firm capacity.*

In summary, the required pumping capacity at the Wildflower Reservoir would increase to 241 L/s from 197 L/s, resulting in a 44 L/s pumping capacity increase at the Wildflower Reservoir. The total storage required at the Wildflower Reservoir is 19,760 m^3, which is 8,260 m^3 more than the current available storage, and 2,083 m^3 more than the full build-out concept without the two additional quarter sections.

At the East Reservoir, when compared to the original full build-out concept the pumping capacity would increase from by 21 L/s from 441 L/s to 462 L/s while the reservoir storage would increase by 940 m^3 from 20,781 m^3 to 21,721 m^3. As this reservoir is not built, this change has a minimal impact on the system. At both reservoirs, consideration is needed for these additional quarter sections prior to conducting upgrades or implementing a new reservoir.

The following table (Table 7.13) summarizes the additional infrastructure that would be needed as a result of the two additional quarter sections.

Table 7.13: Summary of Required Additional Infrastructure

Item Number	Upgrade	Total Cost
Addition 1	300 mm PVC watermain looping	$4,670,000
Addition 2	One additional PRV to separate the Northeast Pressure Zone from the Main Pressure Zone	$70,000
Addition 3	Increase pumping capacity at the Wildflower Reservoir by 44 L/s	$380,000
Addition 4	Increase reservoir storage at the Wildflower Reservoir by 2,083 m^3	$4,000,000
Addition 5	Increase pumping capacity at the East Reservoir by 21 L/s[1]	$20,000
Addition 6	Increase reservoir storage at the East Reservoir by 940 m^3	$1,810,000
	Grand Total:	**$10,950,000**

[1] *Minimal cost implications are noted associated with increasing the pumping capacity at the East Reservoir as this reservoir is not built, thus upgrades to piping and the pump house are not needed.*

7.7 Staging Plan

The timing of development will progress as stipulated by the Town, and is consistent with both the TMP and the Off-site Levies (ISL, 2019) that are under development. The development timeline, shown in Figure 7.20, has been divided into three periods:

- Short-Term (2020 to 2039; population of 13,853 to 22,146)
- Medium-Term (2040 to 2059; population of 22,700 to 36,289)
- Long-Term (2060 to Full Build-out; population of 37,196 to 70,506)

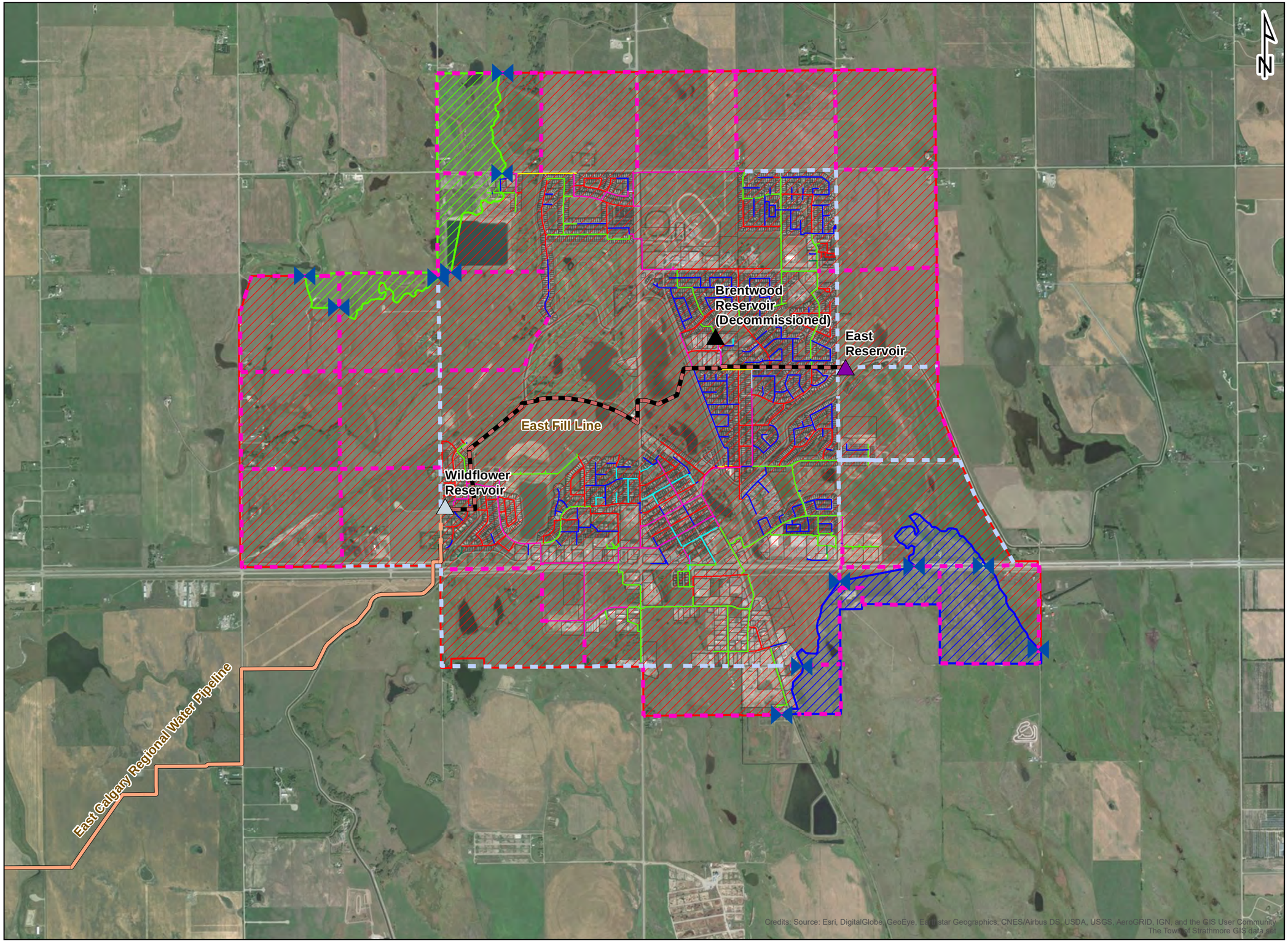
The interim growth horizon occurs in 2052 (population of 30,703), thus is considered medium-term growth. That said, there are a number of service areas within the interim growth horizon that are more imminent and will be developed in the short-term.

The full build-out growth horizon occurs in 2086, thus is considered long-term growth. As the medium-term growth covers from 2040 to 2059, a portion of this growth will occur in the full build-out growth horizon as well (development expected to occur after 2052).

With the development timeline and growth horizons assessed within this Study in mind, upgrades to the existing system and the implementation of new infrastructure is anticipated to progress as summarized in Table 7.14 and illustrated in Figures 7.21 to 7.23 for short-, medium-, and long-term growth, respectively. Detailed cost estimates are provided in Table 5 of Appendix C.

Table 7.14: Staging Plan

ID	Approximate Date	Approximate Population	Description	Cost
Short-Term (2020 to 2039)				
STG 1A	Ongoing	N/A	Upgrade smaller diameter CI and DI watermains in conjunction with the Town's road works program. This will be an ongoing effort, with timing or implementation varying based on the program.	Varies
STG 1B	2020	13,853	Westmount Road upsizing to 300 mm to provide a west to east trunk in the south.	$2,408,000
STG 1C	2021	14,199	Upsize the existing watermains on 5th Avenue to 300 mm for localized improvements to fire flows.	$953,000
STG 1D	2023	14,918	Upgrade the Wildflower Reservoir to provide a pumping capacity of 378 L/s (additional capacity of 212 L/s) to ensure existing/ultimate condition flows can be achieved.	$5,053,000
STG 1E	2024	15,291	Connect the Brentwood Reservoir fill line to the distribution system, and decommission the Brentwood Reservoir.	$146,000
STG 1F	2034	19,574	Implement an adjacent Wildflower Reservoir to increase storage to meet the ECRWL requirements under full build-out, which is equivalent to an additional storage of 6,177 m^3 (total storage of 17,677 m^3). This storage is sufficient under the interim growth horizon when Wildflower Reservoir is the only active reservoir (required storage in terms of ECRWL's criteria of 17,055 m^3).	$11,859,000
STG 1G	To precede development of Edgefield Community	N/A	Upsize the 300 mm watermain along Centennial Drive to a 350 mm watermain, and the 300 mm watermain along Edgefield Gate to a 400 mm watermain.	$1,117,000
STG 1H	2020 to 2039	13,853 to 22,146	Implement the looped networks within the short-term developments based on timing of these developments.	$19,008,000
Medium-Term (2040 to 2059)				
STG 2A	2040	22,700	Implement the looped networks within the medium-term developments based on timing of these developments.	$8,073,000
STG 2B	2050	29,057	Increase the Town's ECRWL contribution by 247 L/s (MDD + 10%).	Varies Depending on Method Selected
STG 2C	2052	30,703	Implement a 600 mm fill line from the Wildflower Reservoir to the East Reservoir by either building a new fill line, or upsizing the existing fill line to the Brentwood Reservoir.	$4,895,000
STG 2D	2052	30,703	Build the East Reservoir prior to any development beyond the interim growth horizon being implemented.	$43,768,000
Long-Term (2060 to Full Build-out)				
STG 3A	2060 to 2086	37,196 to 70,506	Continue growth within the full build-out horizon such that it is in line with the development timeline. This includes the implementation of all looped watermains and PRVs needed to maintain the Southeast and Northwest Pressure Zones.	$28,445,000



Legend

- Proposed PRV
- East Fill Line (600mm)
- Legal

Decommissioned Reservoir

- Brentwood Reservoir

Active Reservoir

- Wildflower Reservoir

Proposed Reservoir

- East Reservoir

Distribution - Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Supply Line - Pipe Diameter

- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Pressure Zone

- Main Pressure Zone
- Northwest Pressure Zone
- Southeast Pressure Zone

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.1
PROPOSED BUILD-OUT CONCEPT
WATER MASTER SERVICING STUDY

Date: 1/21/2020 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.1_Proposed Build-out Network.mxd

Integrated Expertise. Locally Delivered.

Brentwood Reservoir (Decommissioned)

East Reservoir

East Fill Line

Wildflower Reservoir

East Calgary Regional Water Pipeline

N

Legend

Proposed PRV

Existing Watermains

Proposed Upgrades

Proposed Concept

Legal

Decommissioned Reservoir

Brentwood Reservoir

Active Reservoir

Wildflower Reservoir

Proposed Reservoir

East Reservoir

Pressure Zone

Main Pressure Zone

Northwest Pressure Zone

Southeast Pressure Zone

Elevation (m)

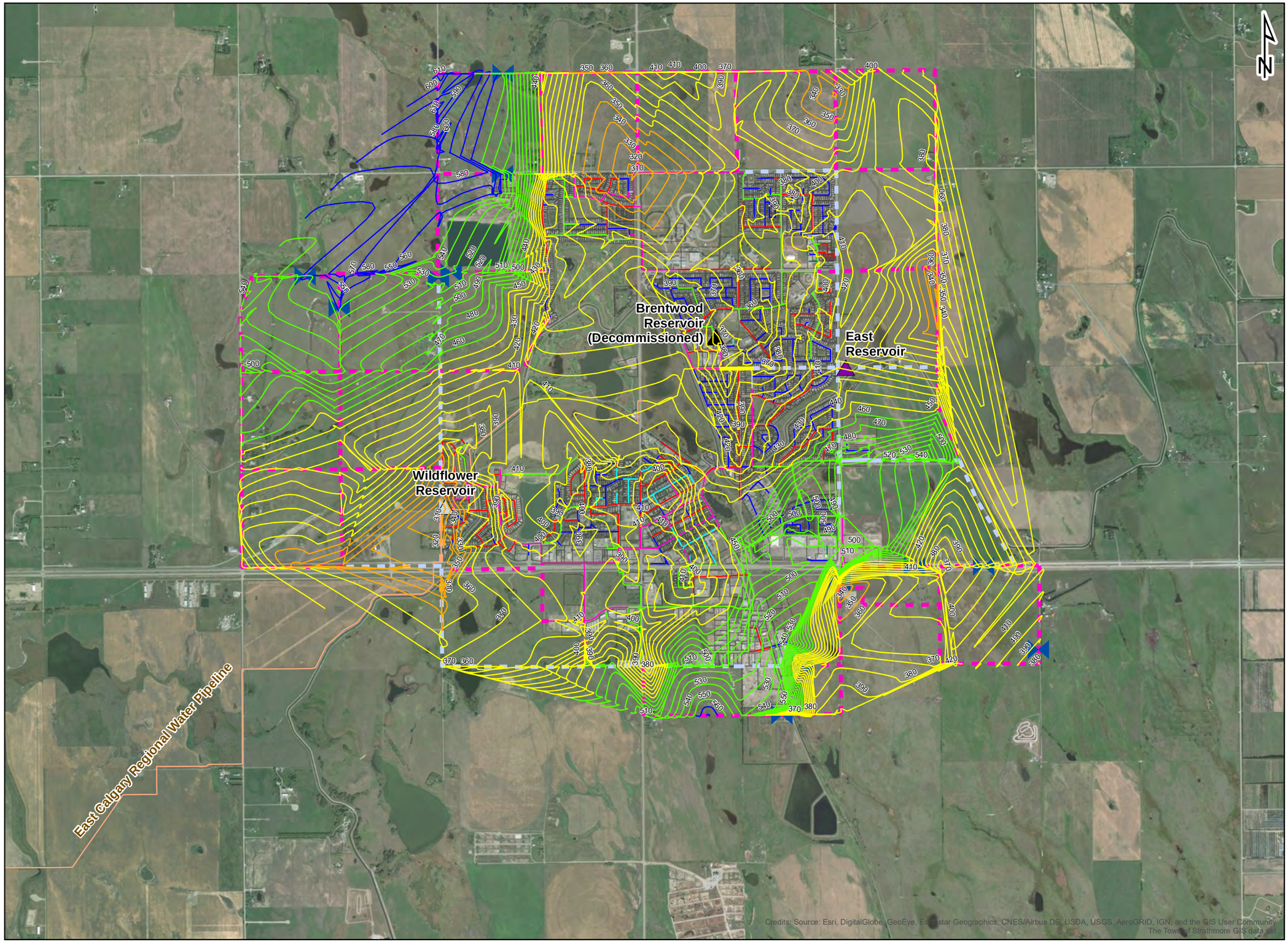
High : 989.98

Low : 934.14

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.2
FUTURE PRESSSURE ZONES
WATER MASTER SERVICING STUDY



Legend

Proposed PRV

Legal

Decommissioned Reservoir

Brentwood Reservoir

Active Reservoir

Wildflower Reservoir

Proposed Reservoir

East Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

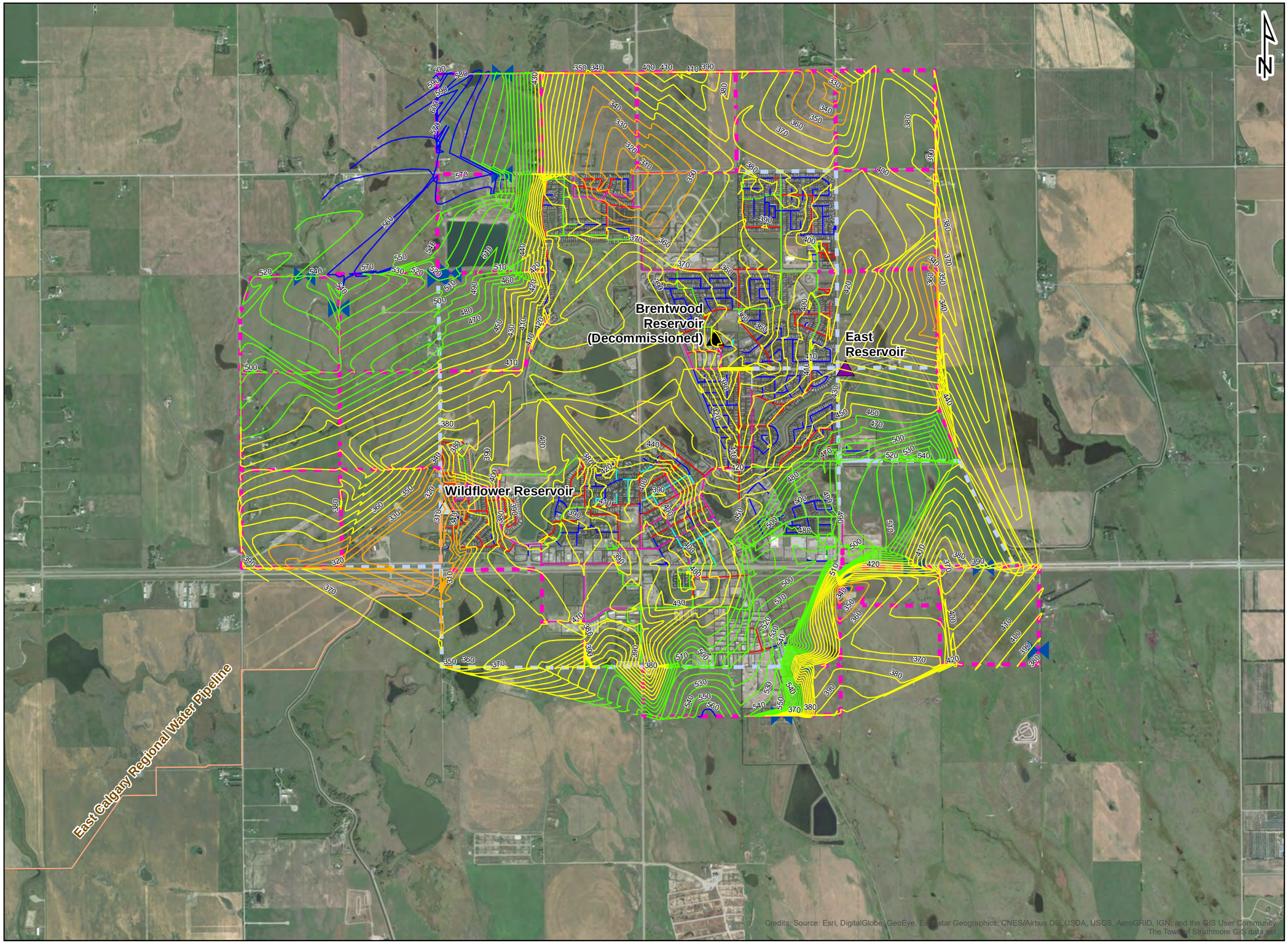
Average Day Demand

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.3
PROPOSED BUILD-OUT ANALYSIS
AVERAGE DAY DEMAND
WATER MASTER SERVICING STUDY



Legend

Proposed PRV

Legal

Decommissioned Reservoir

Brentwood Reservoir

Active Reservoir

Wildflower Reservoir

Proposed Reservoir

East Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Maximum Day Demand

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

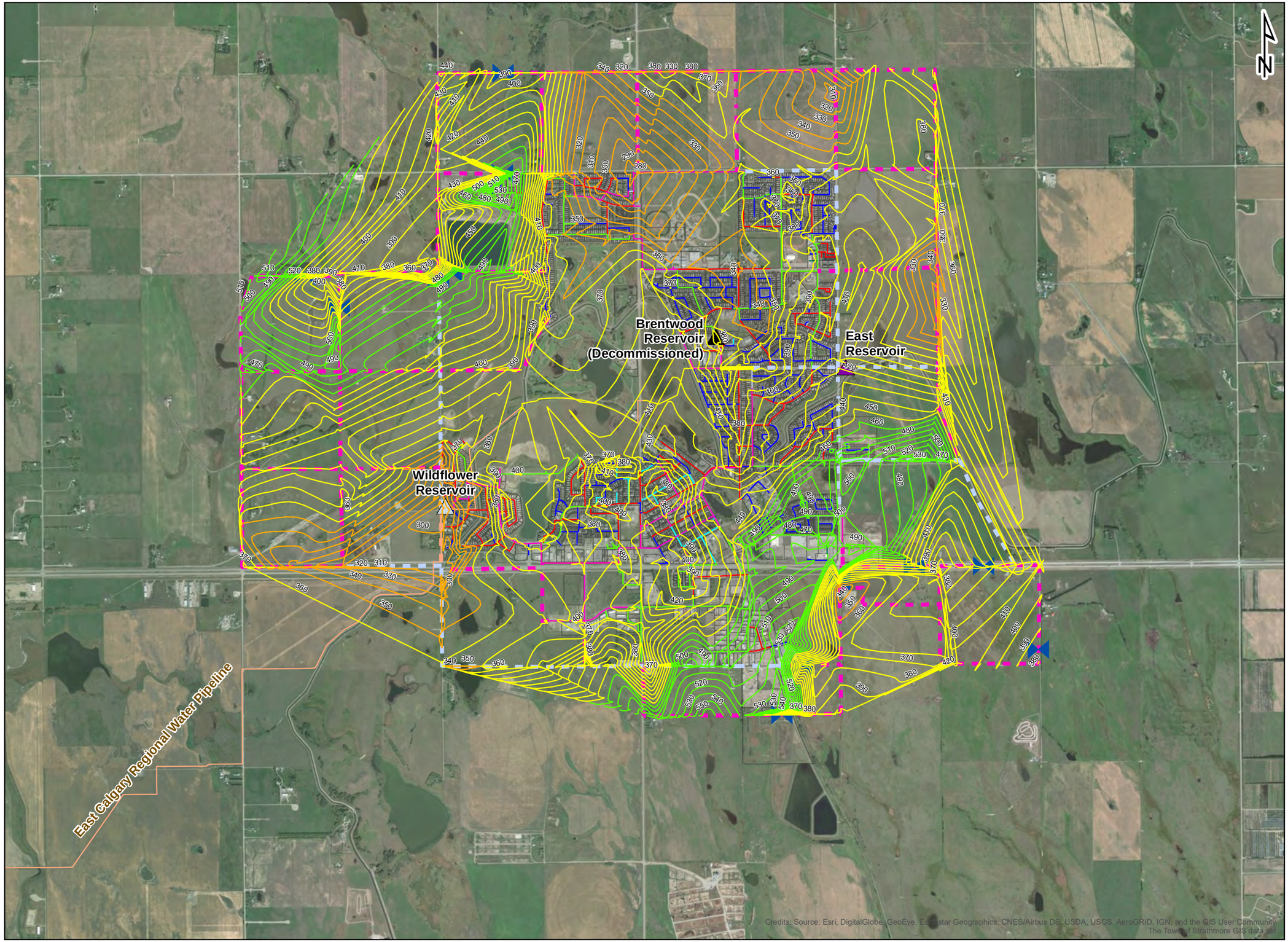
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.4
PROPOSED BUILD-OUT ANALYSIS
MAXIMUM DAY DEMAND
WATER MASTER SERVICING STUDY

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.4_Build-out_MDD.mxd

Integrated Expertise. Locally Delivered.



Legend

Proposed PRV

Legal

Decommissioned Reservoir

Brentwood Reservoir

Active Reservoir

Wildflower Reservoir

Proposed Reservoir

East Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Peak Hour Demand

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

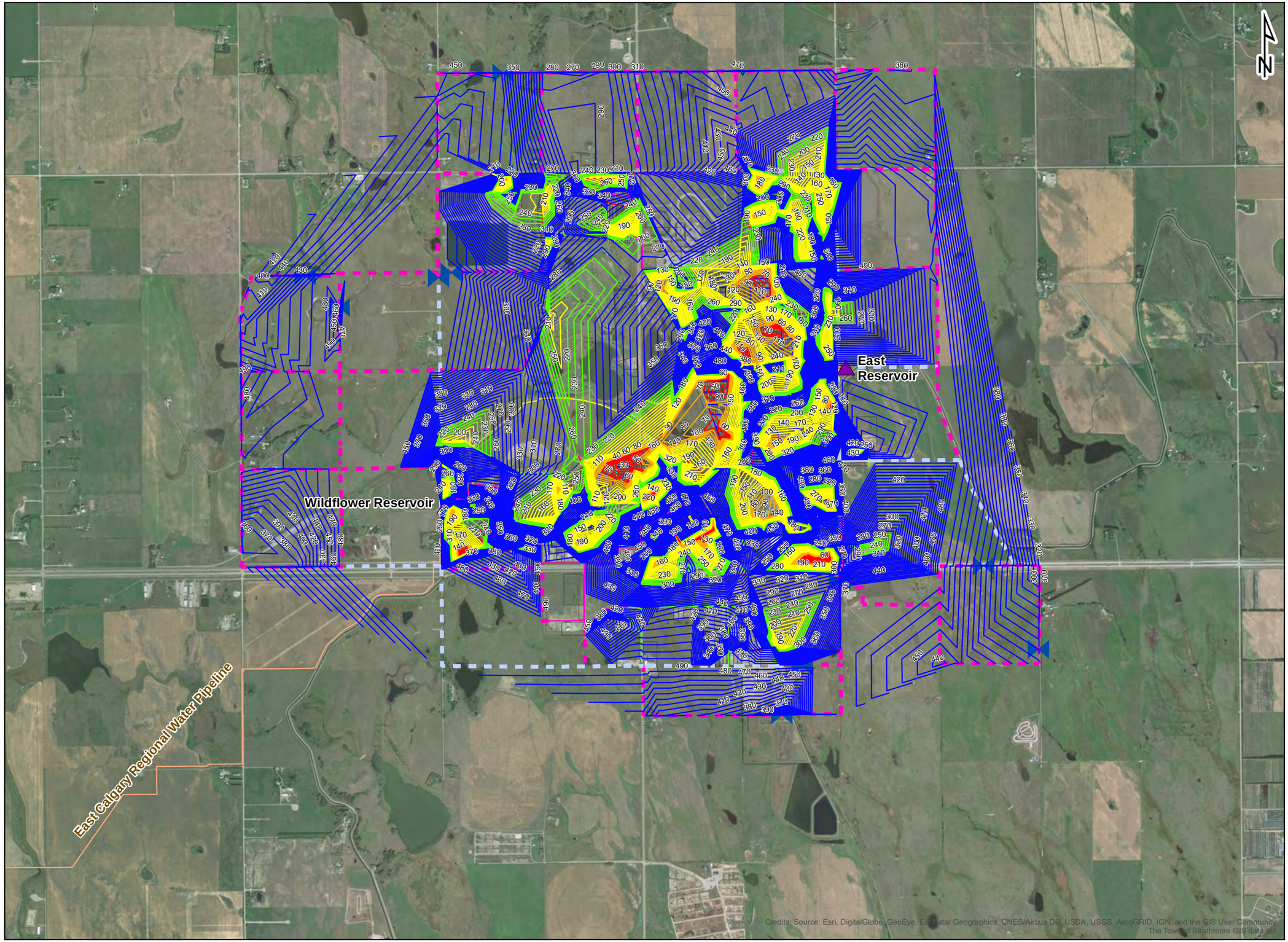
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.5
PROPOSED BUILD-OUT ANALYSIS
PEAK HOUR DEMAND
WATER MASTER SERVICING STUDY

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.5_Build-out_PHD.mxd

Integrated Expertise. Locally Delivered.



Legend

- Proposed PRV
- Legal

Decommissioned Reservoir

- Brentwood Reservoir

Active Reservoir

- Wildflower Reservoir

Proposed Reservoir

- East Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Available Fire Flow

- Less than 76L/s (Fails All Criteria)
- 76 to 114L/s (Single Family Residential)
- 114 to 227L/s (Multi-Family Residential / Institutional)
- 227 to 265L/s (Industrial)
- Greater than 265L/s (Commercial)

Based on Fire Underwriters Survey recommendations.

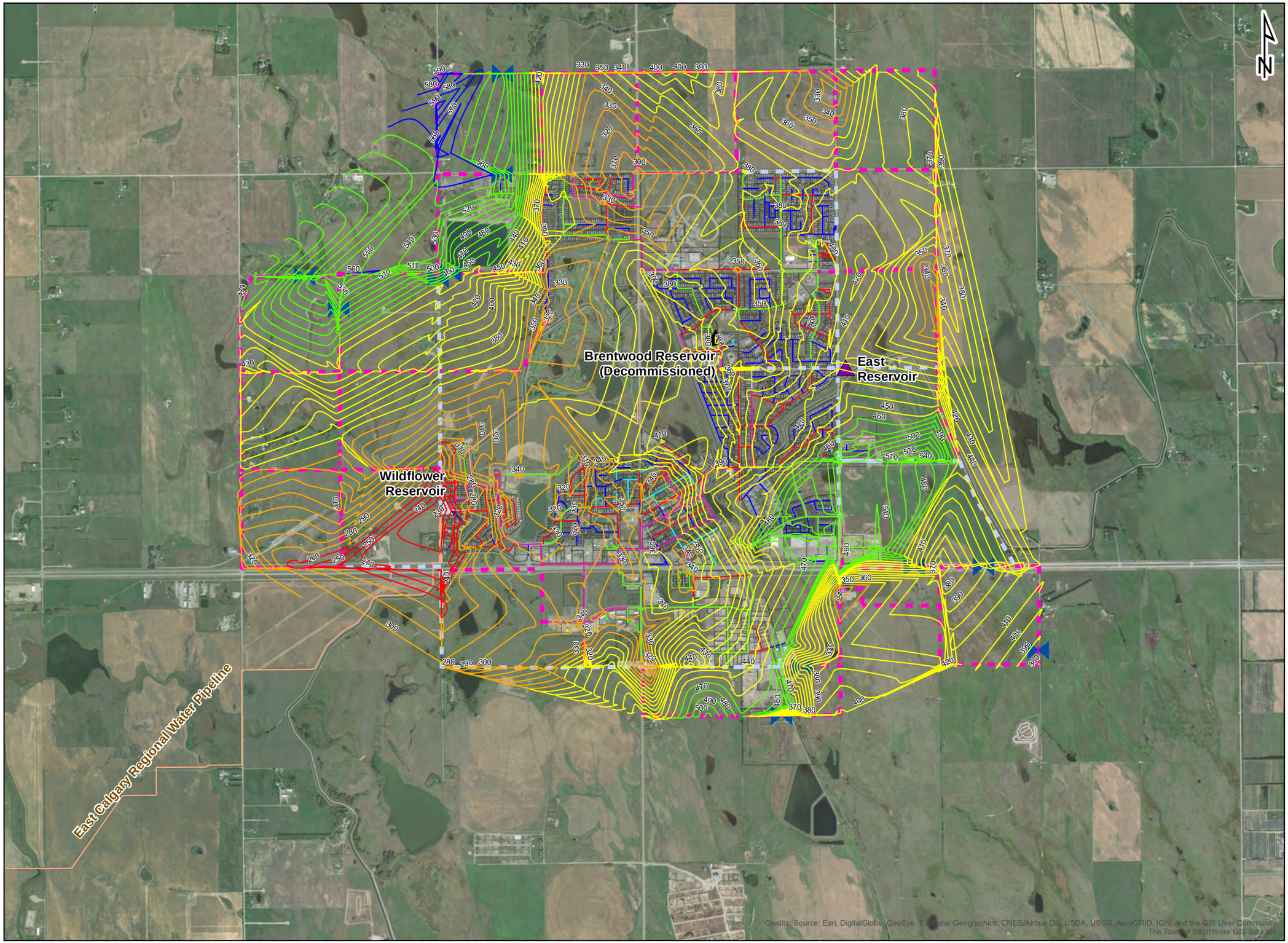
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.6
PROPOSED BUILD-OUT ANALYSIS
MAXIMUM DAY DEMAND PLUS FIRE FLOW
WATER MASTER SERVICING STUDY

Integrated Expertise. Locally Delivered.

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.6_Build-out_MDD + FF.mxd



Legend

Proposed PRV

Legal

Decommissioned Reservoir

Brentwood Reservoir

Active Reservoir

Wildflower Reservoir

Proposed Reservoir

East Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Average Day Demand

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

0 375 750 1,500 m

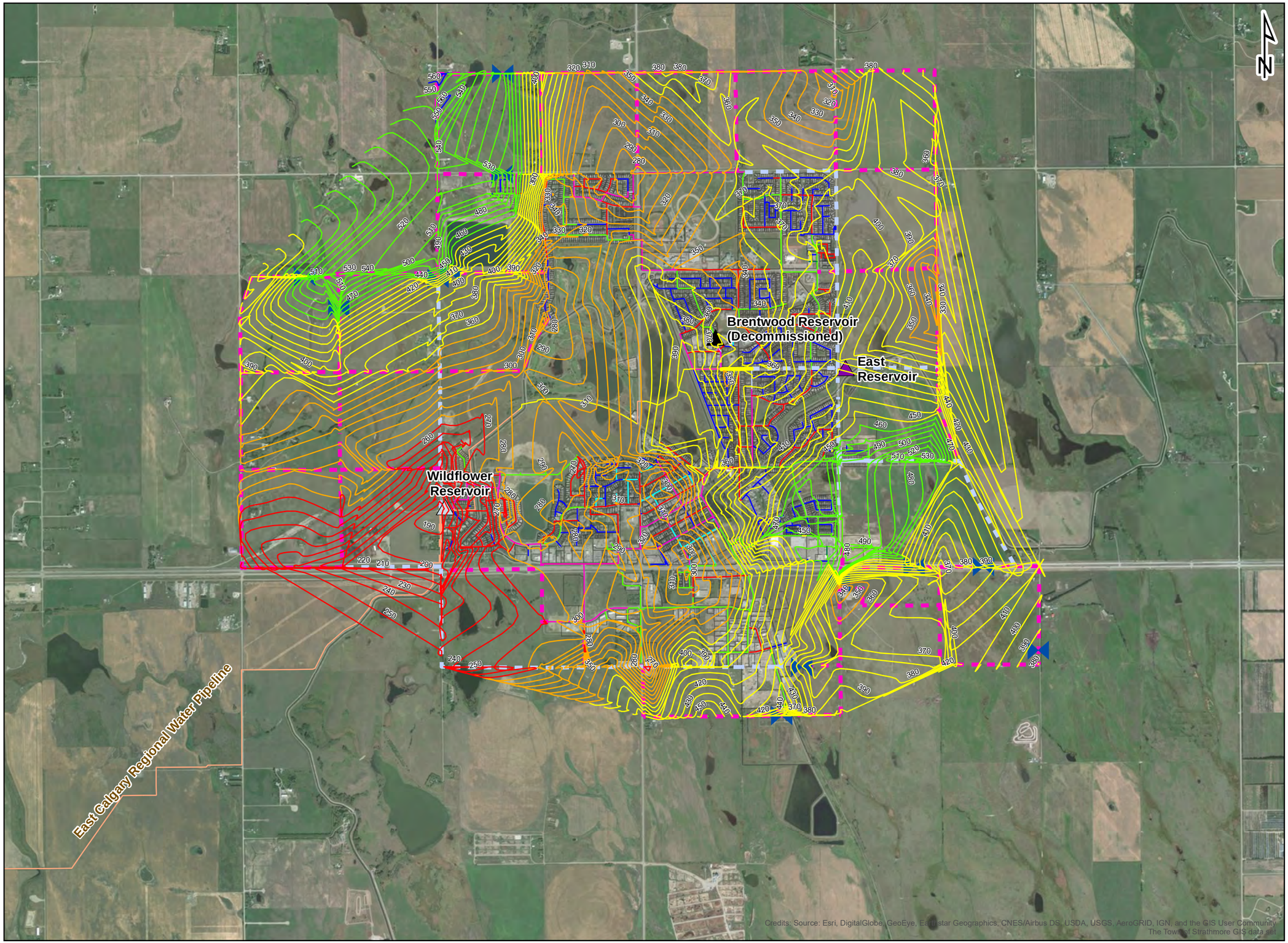
1:30,000 NAD 1983 3TM 114

FIGURE 7.7
PROPOSED BUILD-OUT ANALYSIS
AVERAGE DAY DEMAND
PLUS EAST RESERVOIR FILLING
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.



Legend

Proposed PRV

Legal

Decommissioned Reservoir

Brentwood Reservoir

Active Reservoir

Wildflower Reservoir

Proposed Reservoir

East Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Maximum Day Demand

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

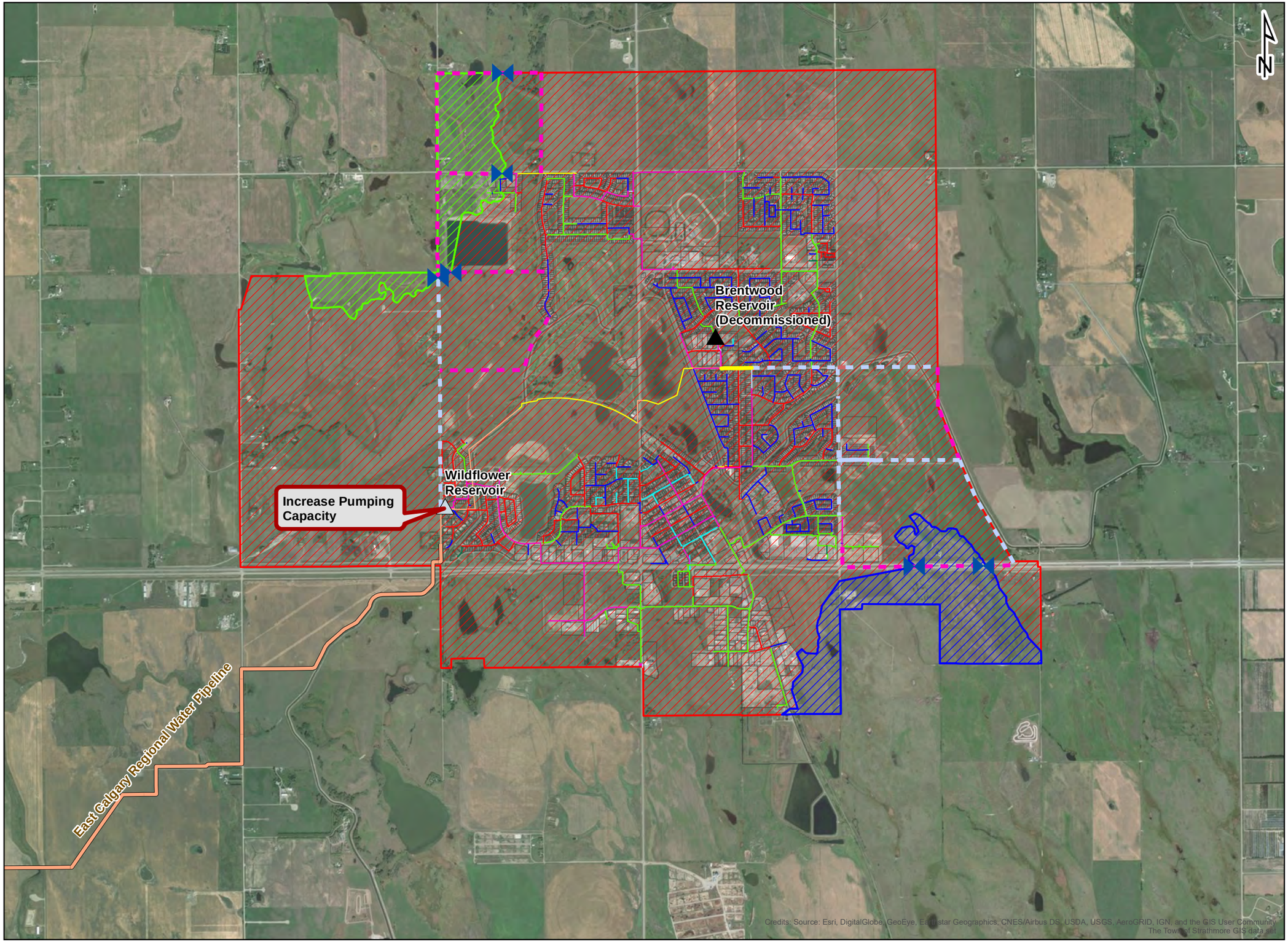
FIGURE 7.8
PROPOSED BUILD-OUT ANALYSIS
MAXIMUM DAY DEMAND
PLUS EAST RESERVOIR FILLING
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.8_Build-out_MDD + RF.mxd



Legend

Proposed PRV

Legal

Decommissioned Reservoir

Brentwood Reservoir

Active Reservoir

Wildflower Reservoir

Distribution - Pipe Diameter

Unknown
50mm
100mm
150mm
200mm
250mm
300mm
350mm
400mm
450mm
500mm
600mm
750mm
900mm
1200mm

Supply Line - Pipe Diameter

500mm
600mm
750mm
900mm
1200mm

Proposed Upgrades

Upsized to 350mm
Upsized to 400mm

Proposed Concept

150mm
300mm
400mm
500mm
600mm

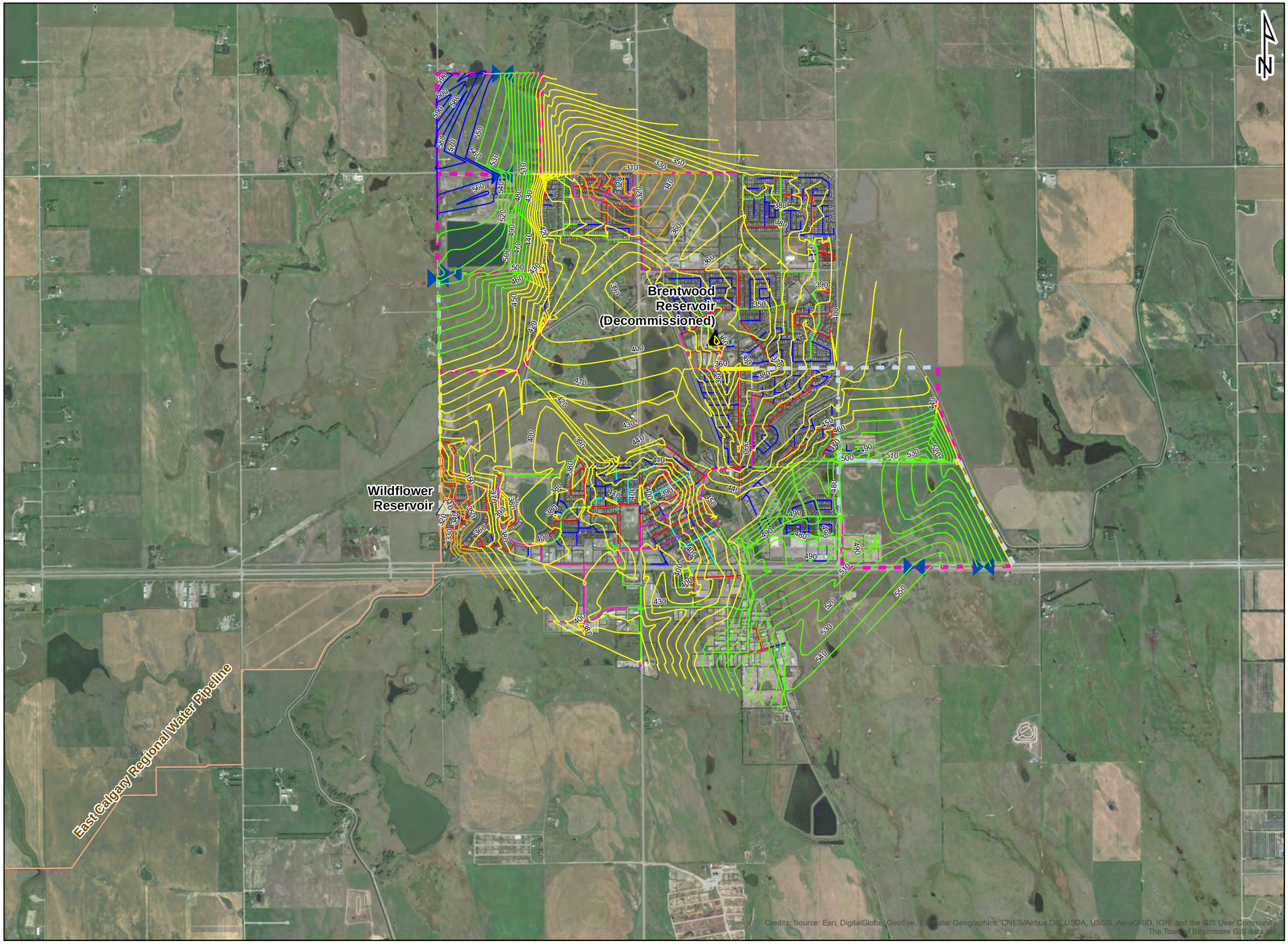
Pressure Zone

Main Pressure Zone
Northwest Pressure Zone
Southeast Pressure Zone

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.9
PROPOSED INTERIM CONCEPT
WATER MASTER SERVICING STUDY



Legend

Proposed PRV

Legal

Decommissioned Reservoir

Brentwood Reservoir

Active Reservoir

Wildflower Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Average Day Demand

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

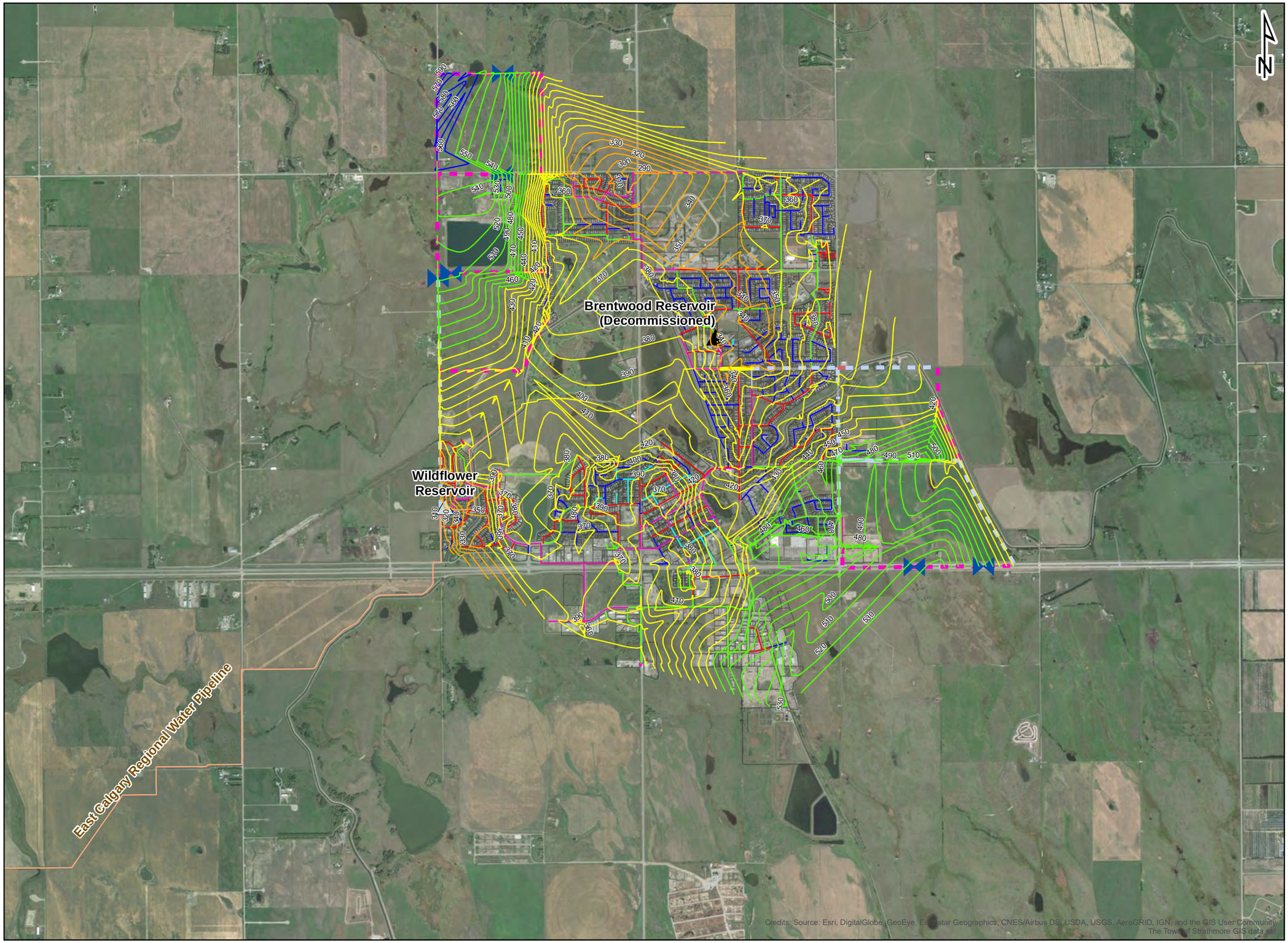
FIGURE 7.10
PROPOSED INTERIM ANALYSIS
AVERAGE DAY DEMAND
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.10_Interim_ADD.mxd



Legend

Proposed PRV

Legal

Decommissioned Reservoir

Brentwood Reservoir

Active Reservoir

Wildflower Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Maximum Day Demand

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

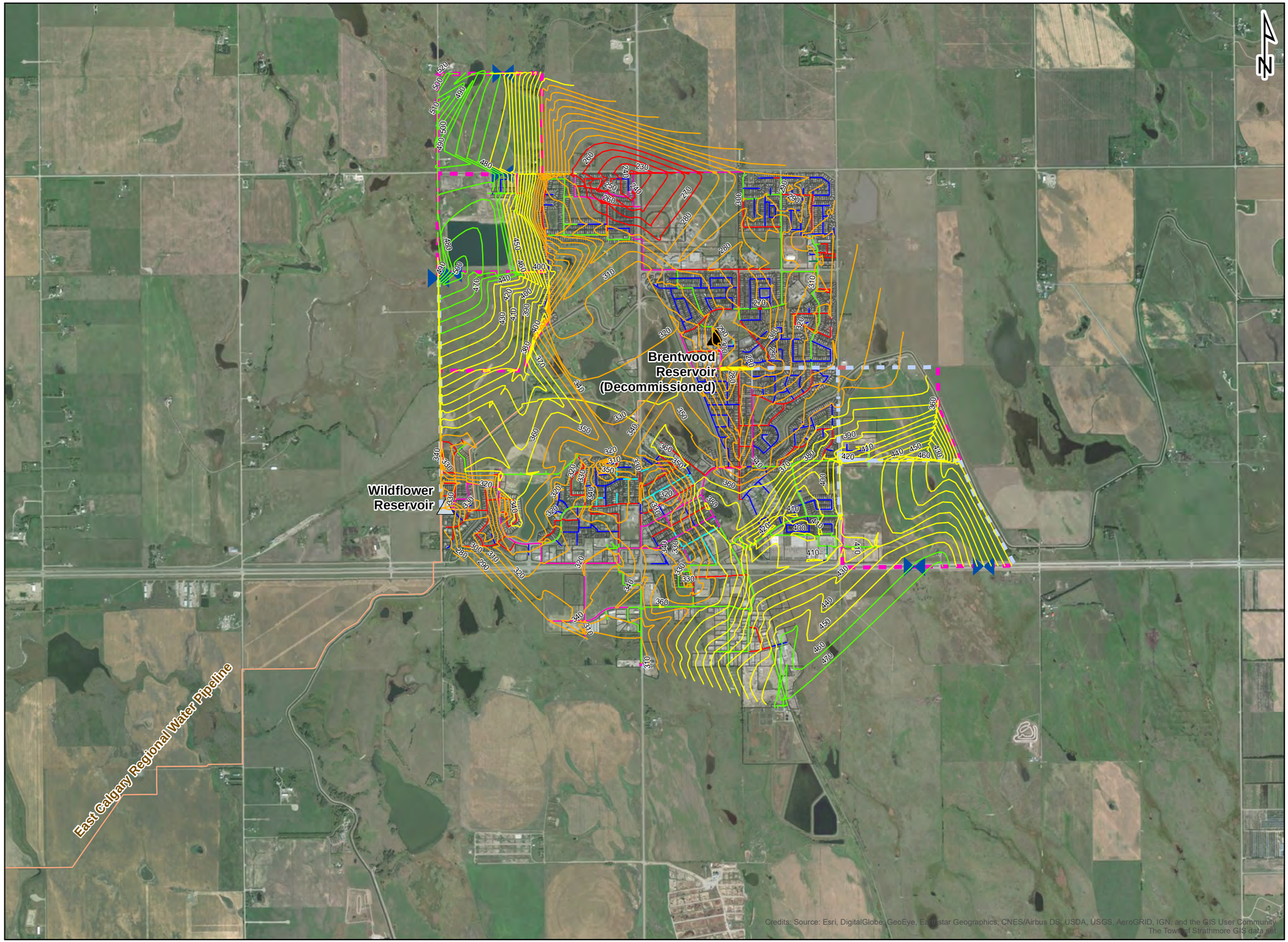
FIGURE 7.11
PROPOSED INTERIM ANALYSIS
MAXIMUM DAY DEMAND
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.11_Interim_MDD.mxd



Legend

Proposed PRV

Legal

Decommissioned Reservoir

Brentwood Reservoir

Active Reservoir

Wildflower Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Peak Hour Demand

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

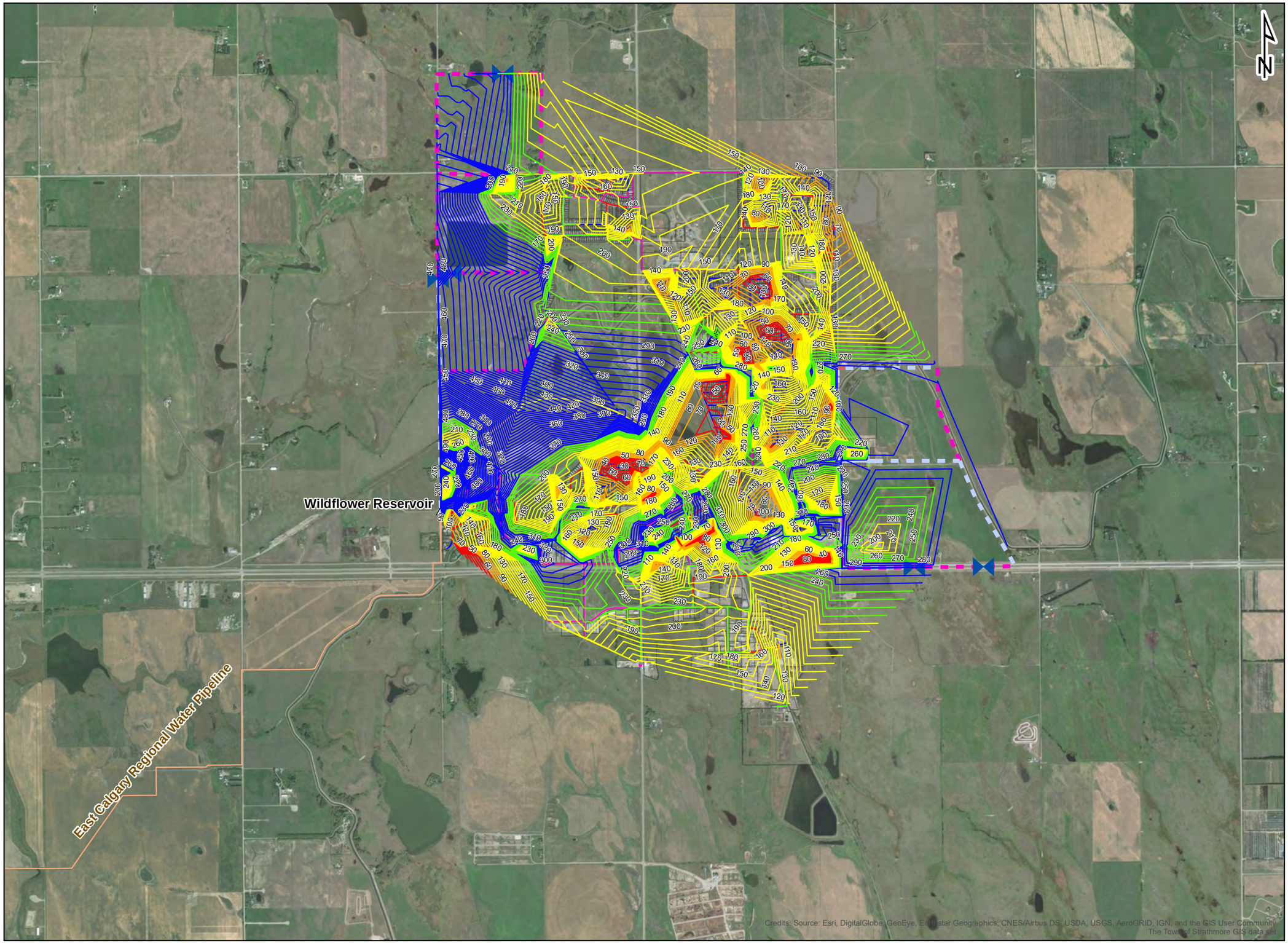
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.12
PROPOSED INTERIM ANALYSIS
PEAK HOUR DEMAND
WATER MASTER SERVICING STUDY

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.12_Interim_PHD.mxd

Integrated Expertise. Locally Delivered.



Legend

Proposed PRV

Legal

Decommissioned Reservoir

Brentwood Reservoir

Active Reservoir

Wildflower Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Available Fire Flow

- Less than 76L/s (Fails All Criteria)
- 76 to 114L/s (Single Family Residential)
- 114 to 227L/s (Multi-Family Residential / Institutional)
- 227 to 265L/s (Industrial)
- Greater than 265L/s (Commercial)

Based on Fire Underwriters Survey recommendations.

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

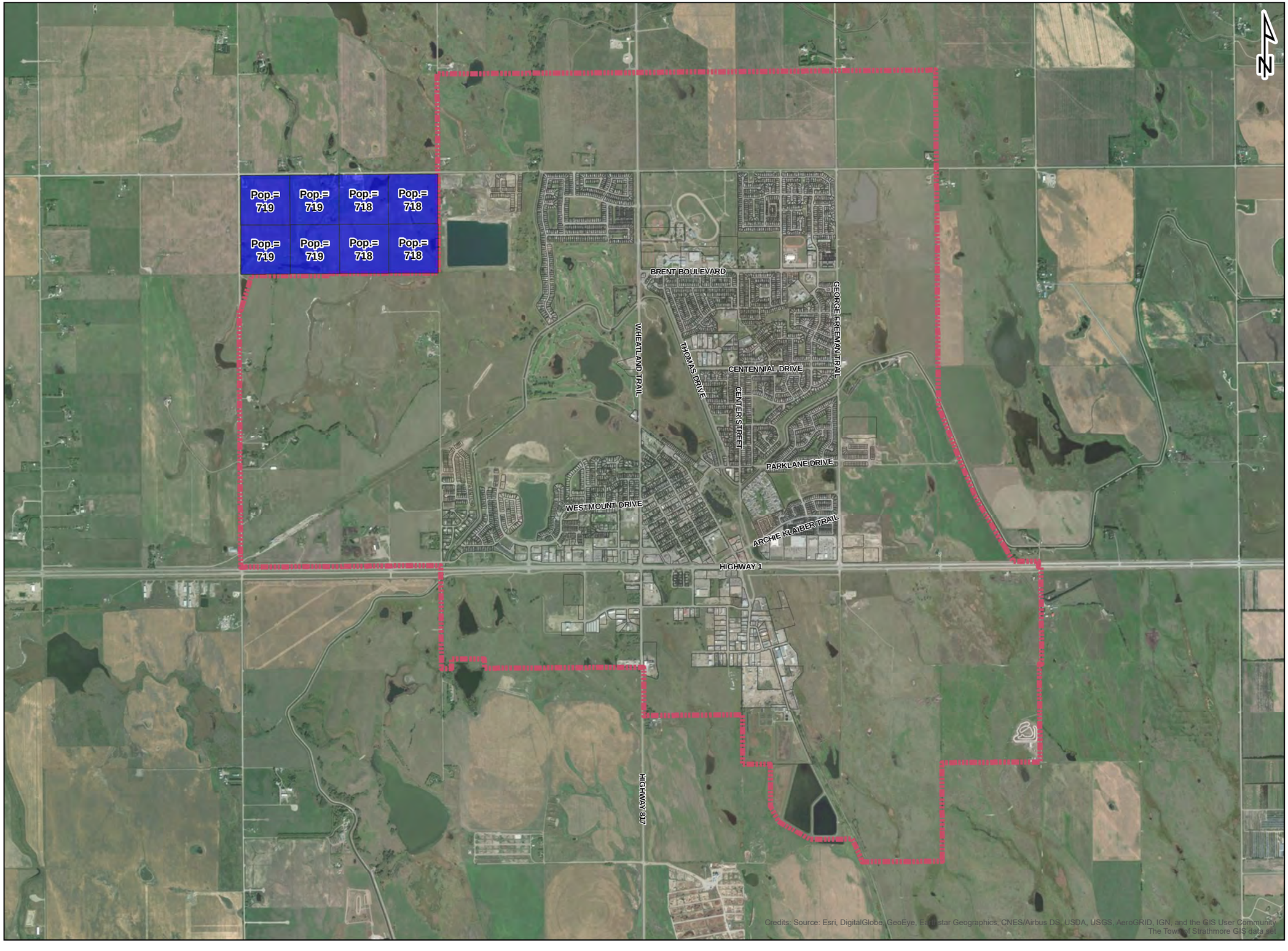
FIGURE 7.13
PROPOSED INTERIM ANALYSIS
MAXIMUM DAY DEMAND PLUS FIRE FLOW
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.13_Interim_MDD + FF.mxd



Legend

Legal

Town Boundary

Additional Quarter Sections

Residential

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.14
ADDITIONAL QUARTER SECTIONS
SERVICE AREAS
WATER MASTER SERVICING STUDY

Date: 1/21/2020 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.14_Additional Quarter Sections.mxd

Integrated Expertise. Locally Delivered.

Brentwood Reservoir (Decommissioned)

East Reservoir

East Fill Line

Wildflower Reservoir

Increase Pumping Capacity

East Calgary Regional Water Pipeline

Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
The Town of Strathmore GIS data set

Legend

- Proposed PRV
- East Fill Line (600mm)
- Legal

Decommissioned Reservoir

- Brentwood Reservoir

Active Reservoir

- Wildflower Reservoir

Proposed Reservoir

- East Reservoir

Distribution - Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Supply Line - Pipe Diameter

- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Pressure Zone

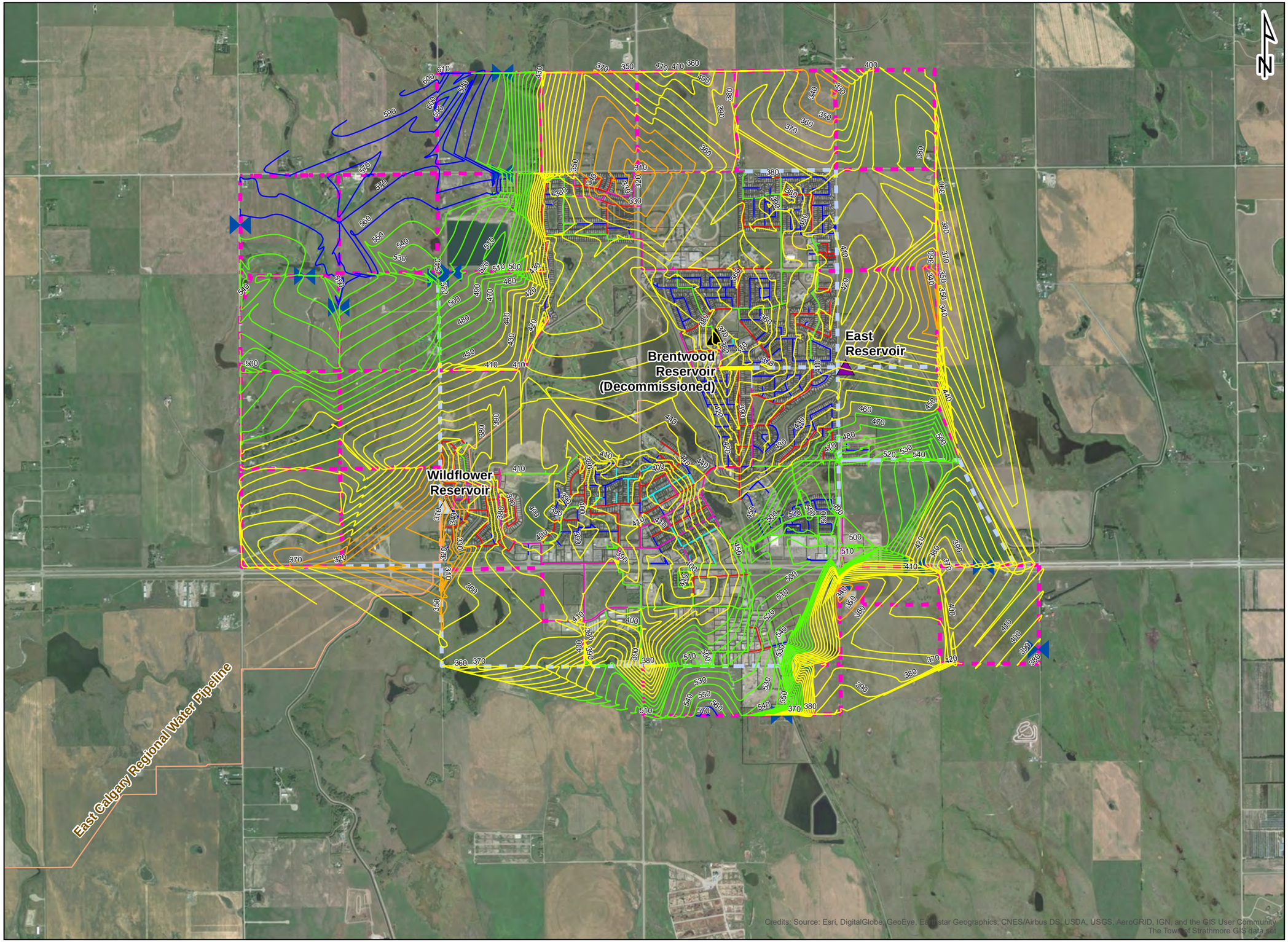
- Main Pressure Zone
- Northwest Pressure Zone
- Southeast Pressure Zone

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.15
PROPOSED BUILD-OUT CONCEPT
WITH ADDITIONAL QUARTER SECTIONS
WATER MASTER SERVICING STUDY

Date: 1/21/2020 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.15_Proposed Build-out Network_Added Quarters.mxd



Legend

- Proposed PRV
- Legal

Decommissioned Reservoir

- Brentwood Reservoir

Active Reservoir

- Wildflower Reservoir

Proposed Reservoir

- East Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Average Day Demand

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

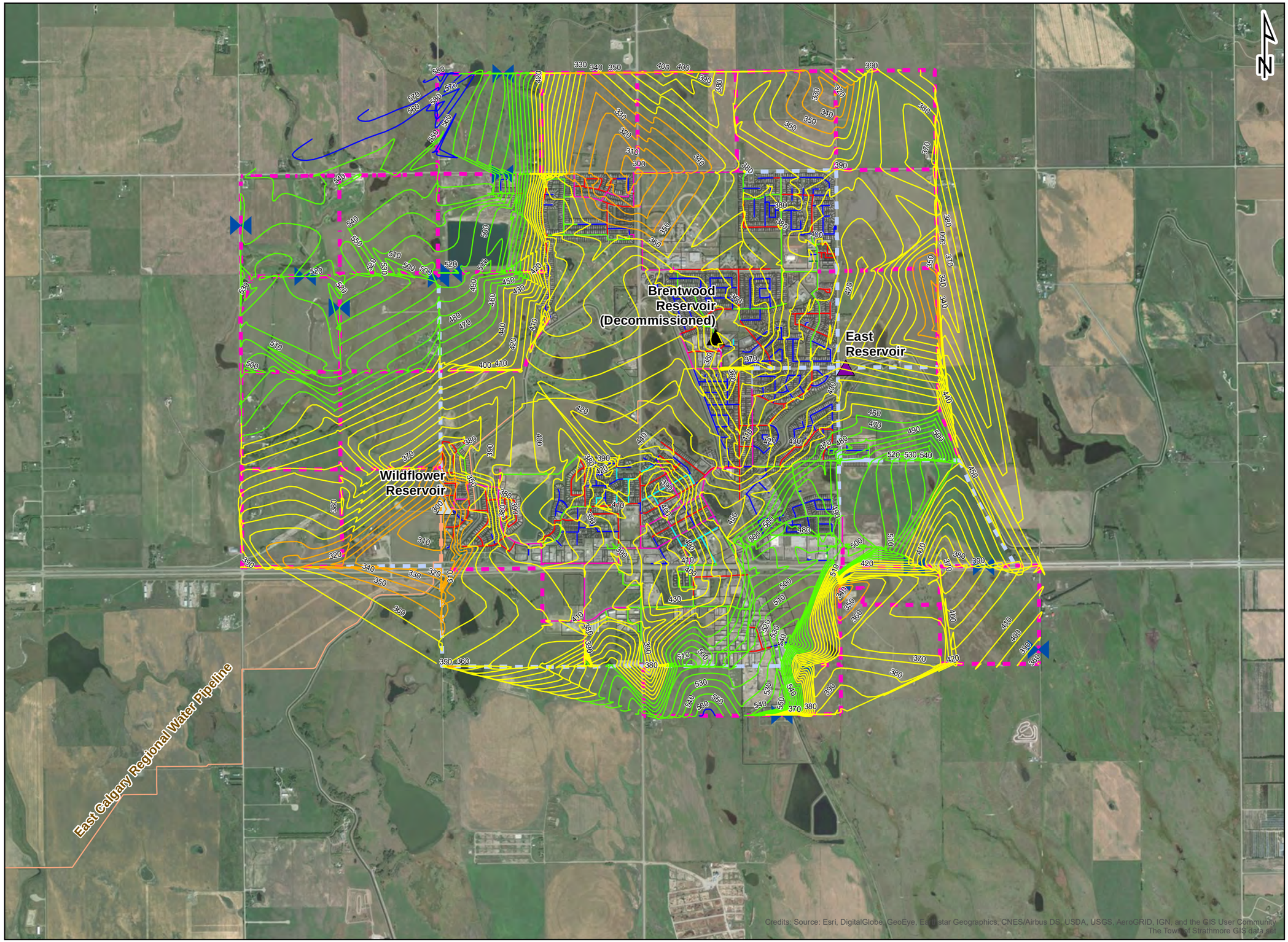
FIGURE 7.16
PROPOSED BUILD-OUT ANALYSIS
WITH ADDITIONAL QUARTER SECTIONS
AVERAGE DAY DEMAND
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.16_Build-out_Added Quarters_ADD.mxd



Legend

Proposed PRV

Legal

Decommissioned Reservoir

Brentwood Reservoir

Active Reservoir

Wildflower Reservoir

Proposed Reservoir

East Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Maximum Day Demand

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

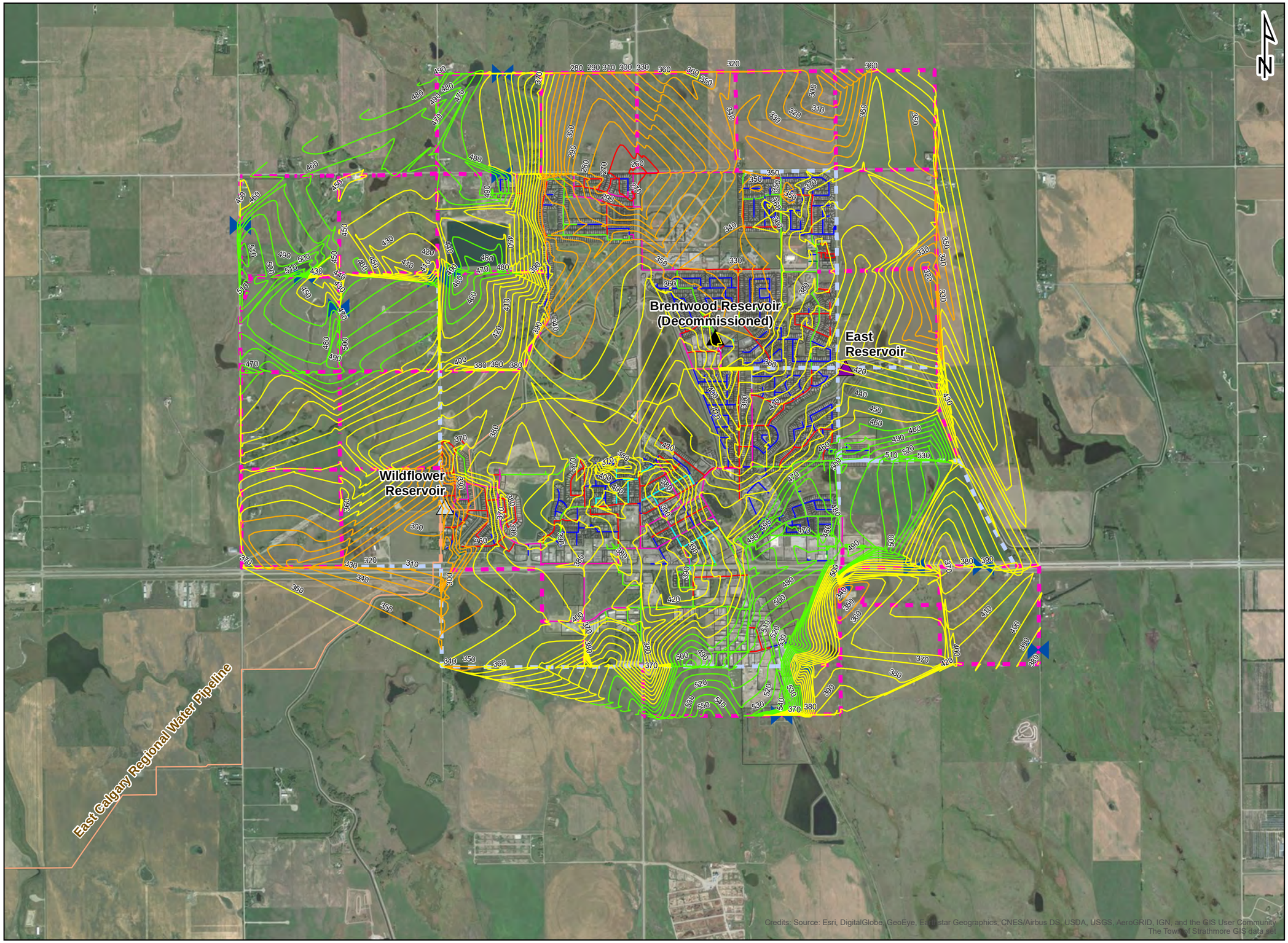
FIGURE 7.17
PROPOSED BUILD-OUT ANALYSIS
WITH ADDITIONAL QUARTER SECTIONS
MAXIMUM DAY DEMAND
WATER MASTER SERVICING STUDY

ISL

Strathmore
Where Quality of Life is a Way of Life

Integrated Expertise. Locally Delivered.

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.17_Build-out_Added Quarters_MDD.mxd



Legend

- Proposed PRV
- Legal

Decommissioned Reservoir

- Brentwood Reservoir

Active Reservoir

- Wildflower Reservoir

Proposed Reservoir

- East Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Peak Hour Demand

- Less than 275kPa (40psi)
- 275 to 350kPa (40psi to 50psi)
- 350 to 450kPa (50psi to 65psi)
- 450 to 550kPa (65psi to 80psi)
- 550 to 700kPa (80psi to 100psi)
- Greater than 700kPa (100psi)

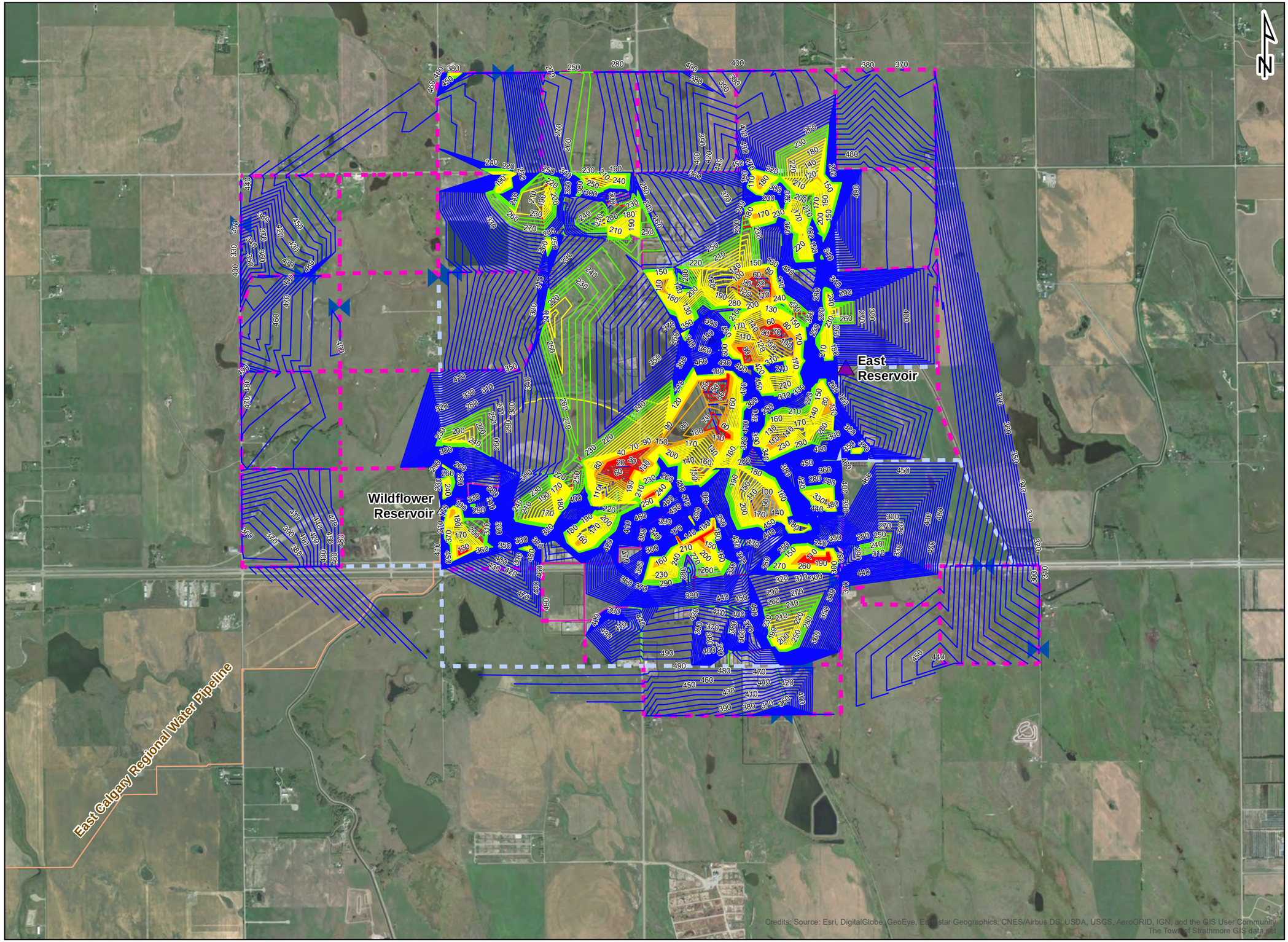
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.18
PROPOSED BUILD-OUT ANALYSIS
WITH ADDITIONAL QUARTER SECTIONS
PEAK HOUR DEMAND
WATER MASTER SERVICING STUDY

Date: 2020-02-20 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.18_Build-out_Added Quarters_PHD.mxd

Integrated Expertise. Locally Delivered.



Legend

Proposed PRV

Legal

Decommissioned Reservoir

Brentwood Reservoir

Active Reservoir

Wildflower Reservoir

Proposed Reservoir

East Reservoir

Pipe Diameter

- Unknown
- 50mm
- 100mm
- 150mm
- 200mm
- 250mm
- 300mm
- 350mm
- 400mm
- 450mm
- 500mm
- 600mm
- 750mm
- 900mm
- 1200mm

Proposed Upgrades

- Upsized to 350mm
- Upsized to 400mm

Proposed Concept

- 150mm
- 300mm
- 400mm
- 500mm
- 600mm

Available Fire Flow

- Less than 76L/s (Fails All Criteria)
- 76 to 114L/s (Single Family Residential)
- 114 to 227L/s (Multi-Family Residential / Institutional)
- 227 to 265L/s (Industrial)
- Greater than 265L/s (Commercial)

Based on Fire Underwriters Survey recommendations.

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.19
PROPOSED BUILD-OUT ANALYSIS
WITH ADDITIONAL QUARTER SECTIONS
MAXIMUM DAY DEMAND PLUS FIRE FLOW
WATER MASTER SERVICING STUDY

Legend

Legal

Town Boundary

Development Timeline

Short-Term (2020-2039)

Medium-Term (2040-2059)

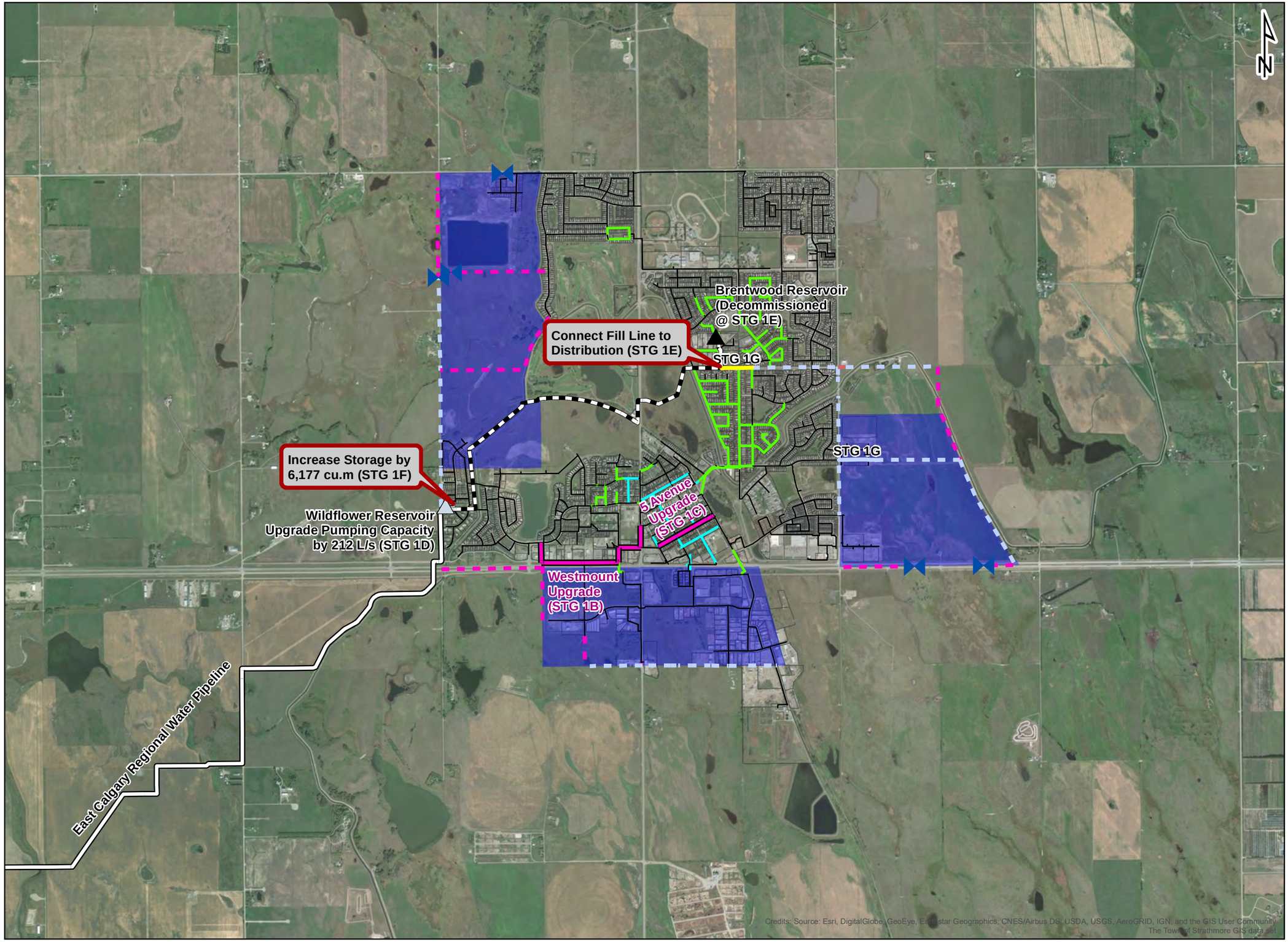
Long-Term (2060 to Full Build-Out)

N

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.20
DEVELOPMENT TIMELINE
WATER MASTER SERVICING STUDY



Legend

- Proposed PRV
- Legal
- Supply Line
- Fill Line
- Existing Watermain
- Cast Iron Replacement (STG 1A)
- Ductile Iron Replacement (STG 1A)
- Upsized to 300mm (STG 1B/1C)
- Upsized to 350mm (STG 1G)
- Upsized to 400mm (STG 1G)

Proposed Concept (STG 1H)

- 300mm
- 400mm
- 600mm

Decommissioned Reservoir

- Brentwood Reservoir (STG 1E)

Active Reservoir

- Wildflower Reservoir

Development Timeline

- Short-Term (2020-2039)

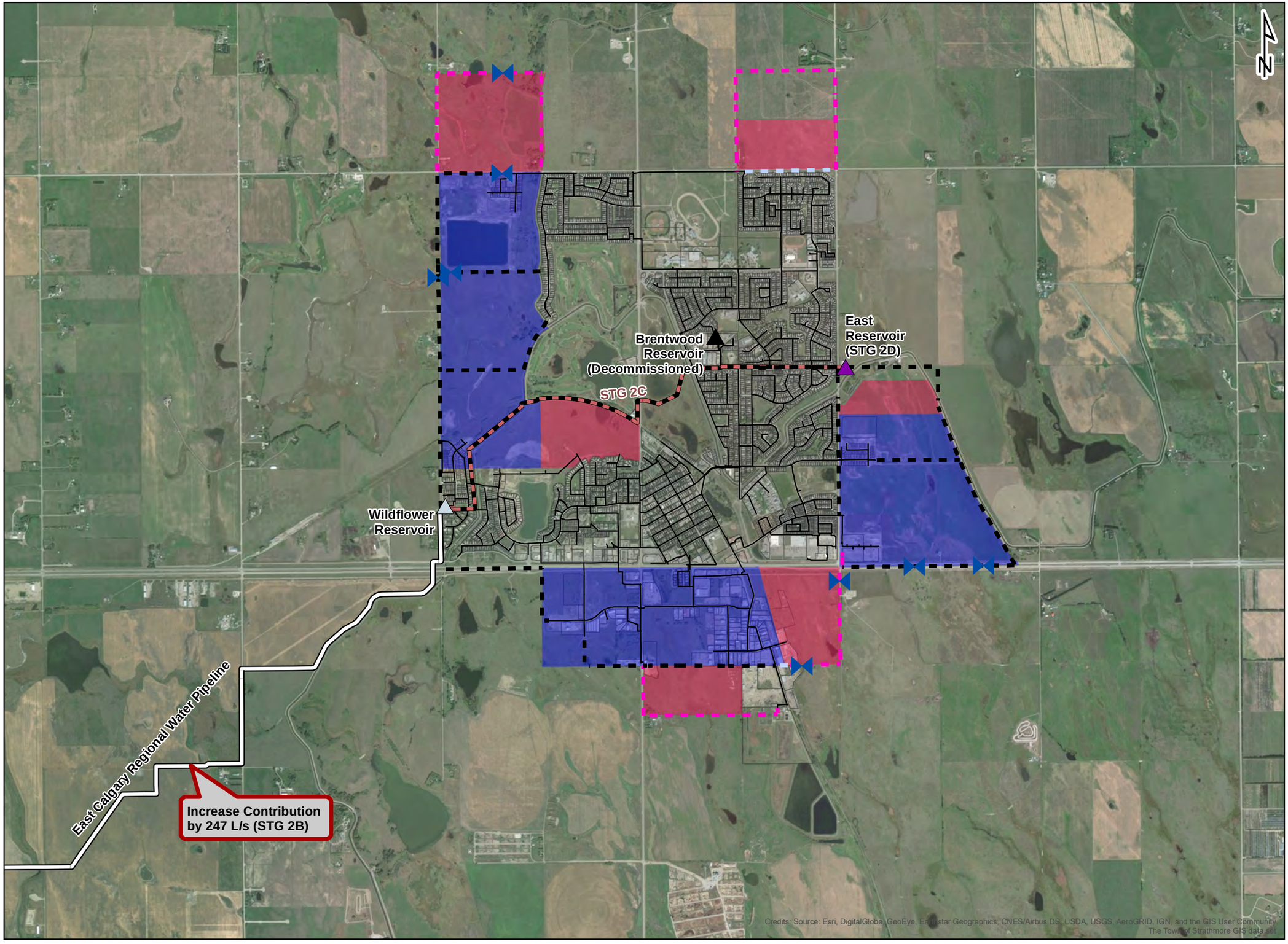
0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.21
STAGING PLAN - SHORT-TERM
2020 TO 2039
WATER MASTER SERVICING STUDY

Integrated Expertise. Locally Delivered.

Date: 2/7/2020 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.21_Proposed Build-out Network_Staged_Short Term.mxd



Legend

- Proposed PRV
- Legal
- Supply Line
- Existing Watermain
- 600mm Fill Line (STG 2C)

Proposed Concept (Coloured are STG 2A)

- Short-term Concept
- 300mm
- 400mm

Decommissioned Reservoir

- Brentwood Reservoir

Active Reservoir

- Wildflower Reservoir

Proposed Reservoir

- East Reservoir (STG 2D)

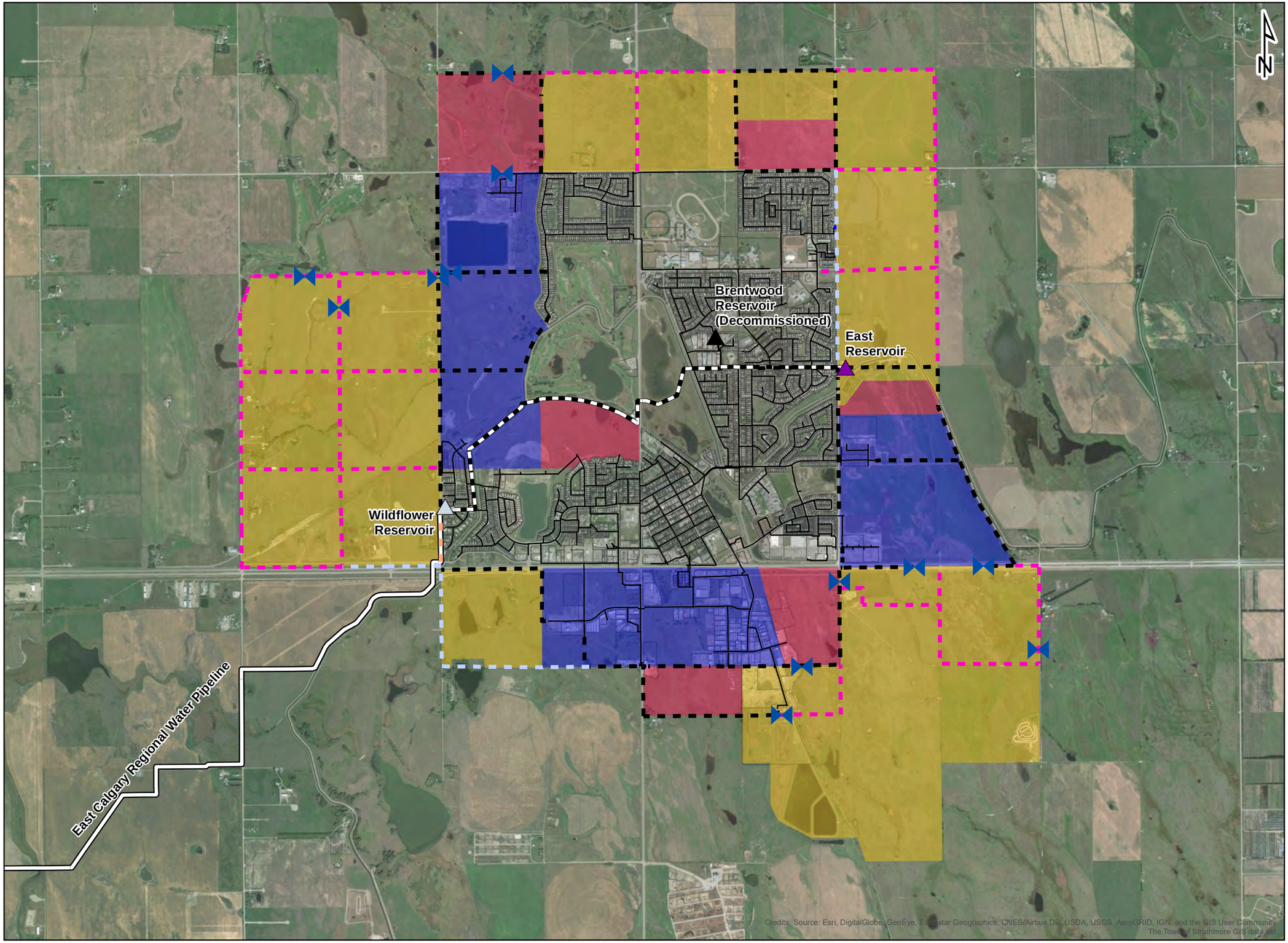
Development Timeline

- Short-Term (2020-2039)
- Medium-Term (2040-2059)

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.22
STAGING PLAN - MEDIUM-TERM
2040 TO 2059
WATER MASTER SERVICING STUDY



Legend

- Proposed PRV
- Legal
- Existing Watermain
- Supply Line
- East Fill Line (600mm)

Proposed Concept (Coloured are STG 3A)

- Short- and Medium-term Concepts
- 150mm
- 300mm
- 400mm
- 500mm

Decommissioned Reservoir

- Brentwood Reservoir

Active Reservoir

- Wildflower Reservoir

Proposed Reservoir

- East Reservoir

Development Timeline

- Short-Term (2020-2039)
- Medium-Term (2040-2059)
- Long-Term (2060 to Full Build-Out)

0 375 750 1,500 m

1:30,000 NAD 1983 3TM 114

FIGURE 7.23
STAGING PLAN - LONG-TERM
2060 TO FULL BUILD-OUT
WATER MASTER SERVICING STUDY

Date: 2/7/2020 Document: Q:\Projects\27399_Strathmore WMSS\251_Figures\Report Figures\Figure 7.23_Proposed Build-out Network_Staged_Long Term.mxd

Integrated Expertise. Locally Delivered.

8.0 Conclusions and Recommendations

The Study was prepared to achieve the following objectives:

- Compilation and assessment of the existing water data.
  - Development of a WaterCAD model for the water distribution system.
  - GIS compatible files.
  - Water calibration to accurately represent the performance of the Town's existing water distribution system.
- Analysis of infrastructure under existing and future growth horizons.
  - Five demand scenarios for the water distribution system:
    - Average Day Demand (ADD)
    - Peak Hour Demand (PHD)
    - Maximum Day Demand plus Fire Flows (MDD + FF)
    - Reservoir Filling under Average Day Demand (RF + ADD)
    - Reservoir Filling under Maximum Day Demand (RF + MDD)
- Identification of the required upgrades to the infrastructure to meet existing and future needs.
  - Rehabilitation of existing pipes.
  - Constructing additional infrastructure to improve flows and pressures within the existing system.
  - Implementing additional infrastructure to accommodate future developments in two phases:
    - To the interim growth horizon
    - To the ultimate build-out development horizon for the annexation lands
- Detailed evaluation of servicing alternatives analysis, based on the 70,500 population threshold.
  - Ranking of alternatives
  - Recommended servicing options
  - Funding strategies
- Development of cost estimates for recommended upgrades for existing and future horizons.
- Complete an analysis of the Design Standards and Procedures for Development and Subdivision Infrastructure Policy document.
- Evaluate the capacity of the ECRWL to meet current and future demands.
- Development of a staging plan for implementing infrastructure upgrades in terms of short term and long term needs.

8.1 Conclusions

Conclusions for the Study are as follows:

1. The existing water servicing network generally performs adequately under existing conditions in terms of pressure and fire flow requirements.
2. The range between highest and lowest pressures suggests that servicing outside the current elevation band would require the addition of new pressure zones.
3. The existing distribution system generally appears to meet fire flow requirements, with some deficiencies in older areas with predominantly iron watermains. Deficiencies are also noted in the north, near some institutional facilities such as schools, the hospital, churches, and recreation centres, although if sprinklered these facilities have sufficient fire flows.
4. Under existing conditions, the Wildflower and Brentwood Reservoirs are sufficient in terms of storage and pumping capacity.
5. The Brentwood Reservoir is sufficiently filled under ADD and MDD reservoir filling scenarios.

6. To service the distribution system only with the Wildflower Reservoir for the interim growth horizon, an expansion to the Wildflower Reservoir is needed both for storage and pumping capacity. This is proposed to be expanded in the adjacent green space to the east.
7. A servicing concept has been developed to provide water distribution considering full build-out of the Town's boundary.
8. Expansion of the system to the northwest and southeast will require two additional pressure zones. It is noted that as these pressure zones are lower in elevation compared to the Main Pressure Zone, new reservoirs are not required, unless the Town wishes to introduce further system redundancy.
9. A new reservoir, the East Reservoir, is required for the Main Pressure Zone to effectively service the east and north. A 600 mm fill line from the Wildflower Reservoir is needed, which can be accomplished either by upsizing the existing Brentwood fill line and expanding east, or implementing a new line altogether. The East Reservoir is required prior to any growth outside of the interim growth horizon.
10. An analysis of the ECRWL suggests that there is capacity in the supply line to accommodate growth beyond the interim growth horizon. That said, additional capacity is required prior to complete development of the full build-out horizon.
11. Consideration for two additional residential quarter sections in the northwest was analyzed, resulting in minor implications to the developed servicing concept (apart from additional storage and pumping capacity to meet these additional demands, plus further watermain looping).
12. A staging plan considering the existing conditions plus the two growth horizons over short-, medium-, and long-term growth was made.

8.2 Recommendations

Recommendations for the Study are as follows:

1. To pinpoint critical locations in the system that are limited fire flows, it is suggested that the Town implements a cast/ductile iron replacement program and consider conducting a condition assessment.
2. Consideration for upgrading areas with small fire flow deficiencies could be made during roadworks programs. The recommendation in this case would be to replace 100 mm to 150 mm watermains with 200 mm to 300 mm mains, respectively, to improve fire flows in Town. That said, this would only make sense in conjunction with roadworks programs, given minor deficiencies in fire flow would make it difficult to justify larger capital expenditures. This will improve fire flows to meet standards over time. These programs should also contemplate replacement of any iron or asbestos cement pipes with safer and less problematic PVC piping. This would offer a solution to improve the low roughness coefficients derived through the calibration process for AC, CI, and DI.
3. To improve the fire flows south of the TCH and through portions of the center of Town, install a 300 mm trunk watermain from west to east. This has been proposed through the Westmount subdivision; consisting of an upsized 300 mm PVC pipe from the intersection of Westmount Road and Westmount Drive down to Westridge Road, ultimately tying into the intersection of Wheatland and 3rd Avenue.
4. Localized fire flow improvements can be made along 5th Avenue, by upsizing the existing watermains to 300 mm.
5. Increase the pumping capacity of Wildflower Reservoir by 110 L/s by adding a fifth pump in order to decommission the Brentwood Reservoir and meet required flows. Note here that decommissioning the Brentwood Reservoir decreases the available fire flow in the north further, adding a degree of risk to the institutional facilities in the north. It also reduces the system's resiliency, and presents potential challenges regarding the operation and maintenance of the Wildflower Reservoir.
6. Connect the Brentwood Reservoir fill line to the distribution system, and decommission the Brentwood Reservoir.
7. Implement an adjacent Wildflower Reservoir to increase storage to meet the ECRWL requirements under full build-out, which is equivalent to an additional storage of 6,177 m^3 (total storage of 17,677 m^3). This storage is sufficient under the interim growth horizon when Wildflower Reservoir is the only active reservoir (required storage in terms of ECRWL's criteria of 17,055 m^3).

8. Implement 102 L/s of additional pumping capacity at the Wildflower Reservoir to ensure required flows under the interim and full build-out growth horizons are met. It is noted that these upgrades can be performed simultaneously with Recommendation #5 to avoid multiple upgrade projects at the same reservoir.
9. Upsize the 300 mm watermain along Centennial Drive to a 350 mm watermain, and the 300 mm watermain along Edgefield Gate to a 400 mm watermain.
10. Implement the looped networks within the short-term developments based on timing of these developments.
11. Implement the looped network within the medium-term developments based on timing of these developments.
12. Implement a 600 mm fill line from the Wildflower Reservoir to the East Reservoir by either building a new fill line, or upsizing the existing fill line to the Brentwood Reservoir.
13. Build the East Reservoir prior to any development beyond the interim growth horizon being implemented.
14. Increase the Town's ECRWL contribution by 247 L/s (MDD + 10%).
15. Continue growth within the full build-out horizon such that it is in line with the development timeline. This includes the implementation of all looped watermains and PRVs needed to maintain the Southeast and Northwest Pressure Zones.

This page has been left blank intentionally.

9.0 References

Alberta Environment. 2006. Standards and Guidelines for Municipal Waterworks, Wastewater, and Storm Drainage Systems.

AECOM. January, 2013. Town of Strathmore Master Servicing Study Update 2012 Water and Sanitary.

Allnorth. May 2017. Town of Strathmore Master Servicing Study – 2017 Update Sanitary System.

City of Calgary. November, 2019. The Water Utility Bylaw 40M2006.

Fire Underwriters Survey. 1995. A Guide to Public Fire Protection.

ISL Engineering and Land Services Ltd. September 2019. Transportation Master Plan Update Draft Report.

ISL Engineering and Land Services Ltd. and Associated Engineering. October 2016. Airdrie Utility Master Plan.

Town of Strathmore. July 2003. Design Standards and Procedures for Development and Subdivision Infrastructure Policy.

Town of Strathmore. April 2014. Municipal Development Plan.

UMA Engineering Ltd. May 2007. Town of Strathmore Master Servicing Study – Annexation 2006.

UMA Engineering Ltd. October 2006. Town of Strathmore Fire Flow Assessment Report.

APPENDIX A
WaterCAD Model Files (Provided on a USB)

APPENDIX B
Fire Flow Test Reports

Final Report for

ISL Engineering and Land Services Ltd.

Attn: **Geoffrey Schulmeister, P.Eng., SCPM**

Strathmore, Alberta

Fire Hydrant Flow Testing

June 2019

Prepared and submitted by:

SFE Global

10707 - 181th Street

Edmonton, Alberta T5S 1N3

Phone (780) 461-0171 Fax (780) 443-4613

Toll Free: 1-877-293-0173

Alberta Head Office
10707-181 Street
Edmonton, Alberta T5S 1N3
Ph (780) 461-0171 *Fx* (780) 443-4613

British Columbia Head Office
#201 – 26641 Fraser Hwy
Aldergrove, British Columbia V4W 3L1
Ph (604) 856-2220 *Fx* (604) 856-3003

June 27, 2019

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

ISL Engineering and Land Services Ltd.
#1, 6325 – 12 Street NE
Calgary, Alberta
T2H 2K1

FINAL REPORT: 2019 Fire Hydrant Flow Testing, Strathmore, Alberta

Dear Mr. Schulmeister;

Please find enclosed SFE's Final Report for the above mentioned project. If you have any questions, comments or concerns, please do not hesitate to contact us at your earliest convenience.

Thank you for having SFE conduct this work on your behalf. We are appreciative of the opportunity to work with you and your team on this project. We look forward to working together again in the near future.

Sincerely,
SFE Global

Kevin McMillan
Vice President
(780) 461-0171
Kevin.McMillan@sfeglobal.com
www.sfeglobal.com

1. Executive Summary

This report provides details of the hydrant fire flow testing conducted in Strathmore, Alberta. SFE Global was retained by ISL Engineering, under the direction of Ms. Sarah Barbosa. Kevin McMillan represented SFE Global as Project Manager during this project.

As requested, SFE conducted five fire hydrant fire flow tests on June 11, 2019. The flow hydrants and test hydrants were indicated to SFE by maps supplied by the client. The fire flow tests were conducted according to National Fire Protection Association (NFPA) 291 standards.

2. Summary of Testing

SFE Technicians met representatives of Epcor on-site to perform testing. The testing plan was discussed, and safety reviewed by all participants.

Testing Equipment

Testing was performed on flow hydrants utilizing a Hydro Flow Products 4-inch Hose Monster system with integral de-chlorinator. These are fixed pitot devices to measure flow, de-chlorinate and diffuse in one process. The benefit of this system is the ability to provide repeatable results and manage discharge water conditions.

Residual pressure was measured with a liquid filled Bourdon tube type pressure gauge, and/or a Telog HPR digital pressure recorder. Pitot pressure readings were obtained from liquid filled, Bourdon tube pressure gauges.

The configuration for the Hose Monster System consisted of one four-inch hose monster on the Flow hydrant pumper port. A pressure recording gauge was installed on the designated residual pressure hydrant.

To digitally log pressure on the residual hydrant SFE Technicians installed two (2) Telog HPR hydrant pressure loggers. This device was set to one-minute logging intervals and one second sampling intervals. Each one minute interval logs the minimum, maximum and average pressure for that interval.

Testing Procedure

The client selected all flow, residual and digital logging hydrants. SFE Technicians installed flow testing equipment on each flow hydrant and residual pressure measurement equipment on the residual hydrant.

The tests were performed by recording system static pressure then flowing the four-inch port on the flow hydrant. Once fire pumps activated and the pressure and flow stabilized all flow and residual pressures were recorded. Total flow and extrapolated flow to 20 psi residual pressure are calculated from this test on the flow testing summary sheets.

Flow testing summary sheets are included in Appendix I.

3. Data

Residual pressure graphs are included in Appendix I. The testing reports included in Appendix II contain all test results and photos. All pressure readings are in psi and all flow values are reported in IGPM. All hydrants were returned to as found condition upon completion of testing.

4. Safety

A pre-job safety inspection and meeting was conducted by SFE personnel, and the following potential hazards were identified:

- Need for Personal Protective Equipment
- Working with water under pressure
- Pedestrian and vehicular traffic conditions
- Safe operation and shut down of fire hydrants

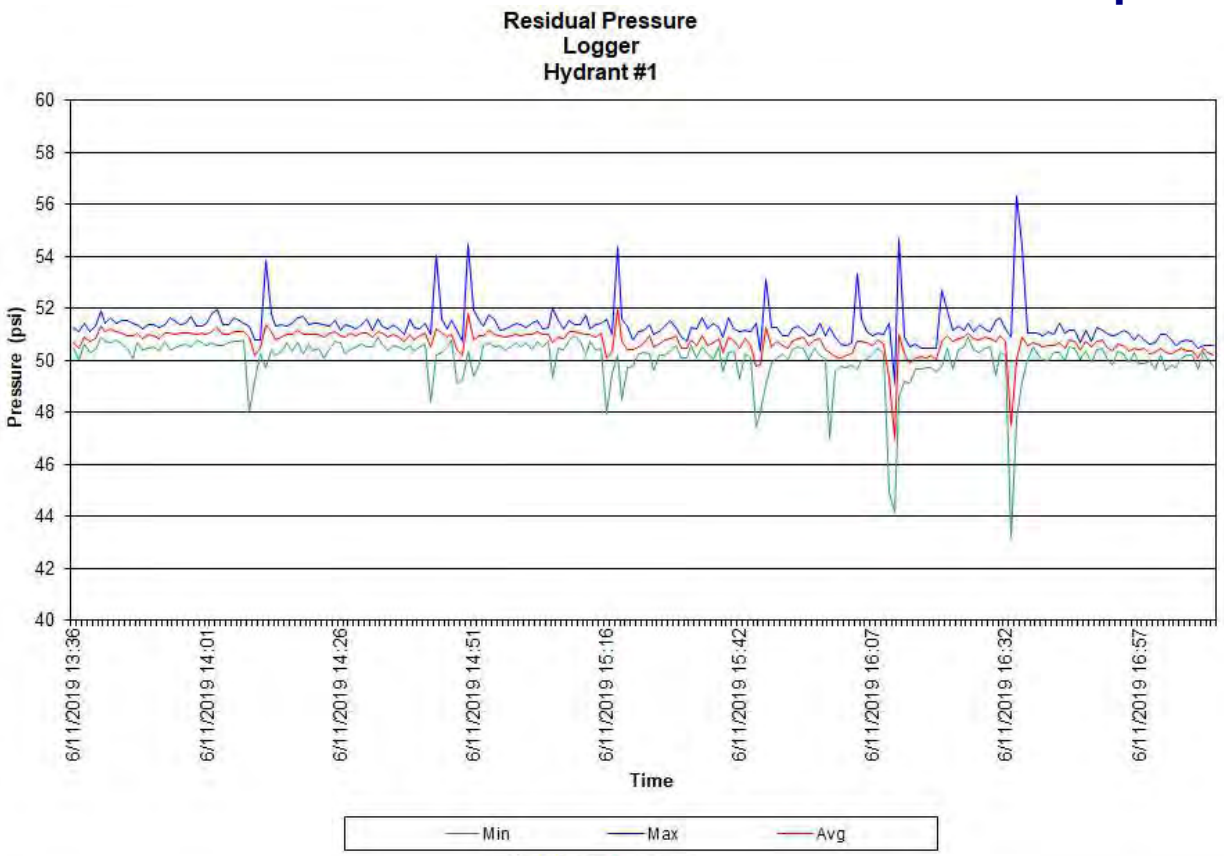
This project was conducted in accordance with the WCB and OSHA safety standards as documented in SFE's Safety Procedures Manual. The SFE crew reviewed the work to be completed and safety requirements at a tail-gate safety meeting held prior to commencing work.

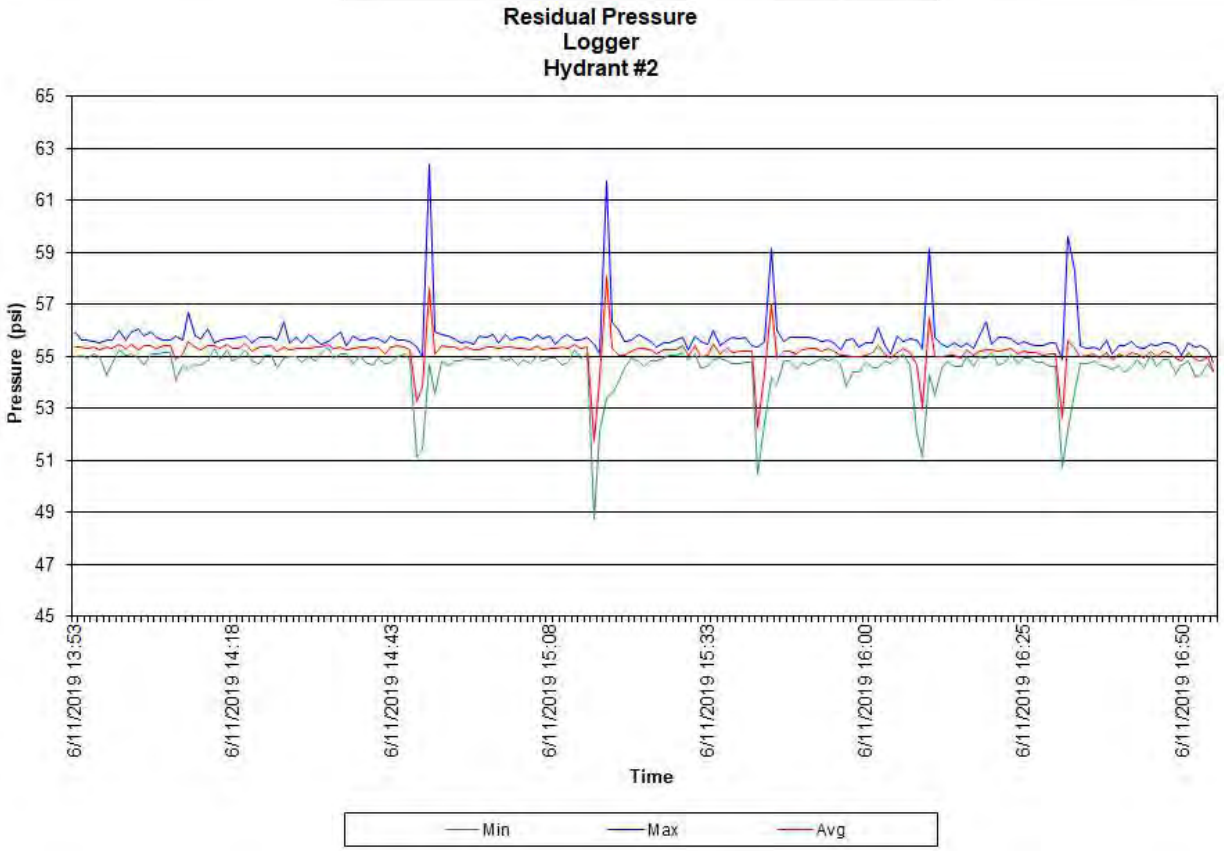
Report End
June 2019

SFE Global
Project A19-015

Appendix I

Residual Pressure


Residual Pressure
Logger
Hydrant #1
Pressure (psi)
60
58
56
54
52
50
48
46
44
42
40
6/11/2019 13:36
6/11/2019 14:01
6/11/2019 14:26
6/11/2019 14:51
6/11/2019 15:16
6/11/2019 15:42
6/11/2019 16:07
6/11/2019 16:32
6/11/2019 16:57
Time
Min
Max
Avg


Residual Pressure
Logger
Hydrant #2
Pressure (psi)
65
63
61
59
57
55
53
51
49
47
45
6/11/2019 13:53
6/11/2019 14:18
6/11/2019 14:43
6/11/2019 15:08
6/11/2019 15:33
6/11/2019 16:00
6/11/2019 16:25
6/11/2019 16:50
Time
Min
Max
Avg

Appendix II

Test Results

SFE GLOBAL

Fire Flow Test Report

Client Name:	ISL	Hyd 1 - #/Port Size	4" STORZ	Flow Hyd 1 Addr	64 Hillview Dr.
Project Location:	Strathmore, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr	
SFE Project #:	A19-015	Hyd 1 - Pito Types	4" Hose Monster	Resid Hyd Addr.	505 Hillview Dr.
SFE Technicians:	KM/JM	Hyd 2 - Pito Types		Fire Pump Status	Auto
		Test Procedure	NFPA 291	(circle one)	Force On

Test ID: 1 Test : 1 of 5 Date: 11-Jun-19

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
14:48	14:51	9				68	42	68

Notes: Original static before fire pump, 53 psi.

Flow Summary (igpm)	
Flow 1-1	957
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	957
Flow @ 20 psi	1333

Flow Hydrant 1

GPS 51.0652 -113.4075

Flow Hydrant 2

GPS

Residual Hydrant

GPS 51.0647 -113.4045

Fire Flow Test Report

Client Name:	ISL	Hyd 1 - #/Port Size	4" STORZ	Flow Hyd 1 Addr	Strathhaven Dr. / Brent Blvd.
Project Location:	Strathmore, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr	
SFE Project #:	A19-015	Hyd 1 - Pito Types	4" Hose Monster	Resid Hyd Addr.	125 Strathaven Dr.
SFE Technicians:	KM/JM	Hyd 2 - Pito Types		Fire Pump Status	Auto
		Test Procedure	NFPA 291	(circle one)	Force On

Test ID: 1 Test : 2 of 5 Date: 11-Jun-19

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
15:19	15:20	14				70	47	70

Notes: Original static before fire pump, 58 psi.

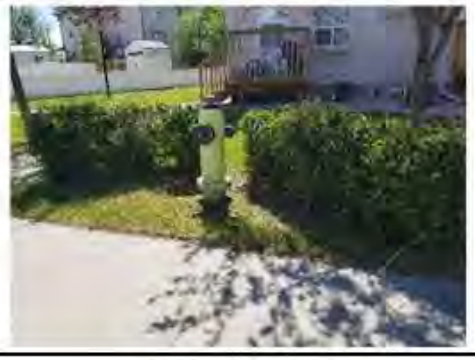
Flow Summary (igpm)	
Flow 1-1	1039
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	1039
Flow @ 20 psi	1580

Flow Hydrant 1

GPS 51.0598 -113.3795

Flow Hydrant 2

GPS



Residual Hydrant

GPS 51.0612 -113.3796

SFE GLOBAL

Fire Flow Test Report

Client Name:	ISL	Hyd 1 - #/Port Size	4" STORZ	Flow Hyd 1 Addr	128 Center Street
Project Location:	Strathmore, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr	
SFE Project #:	A19-015	Hyd 1 - Pito Types	4" Hose Monster	Resid Hyd Addr.	22 Center Street
SFE Technicians:	KM/JM	Hyd 2 - Pito Types		Fire Pump Status	Auto
		Test Procedure	NFPA 291	(circle one)	Force On

Test ID: 1 Test : 3 of 5 Date: 11-Jun-19

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
15:45	15:48	9				60	48	60

Notes: Original static before fire pump, 56 psi.

Flow Summary (igpm)	
Flow 1-1	957
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	957
Flow @ 20 psi	1833

Flow Hydrant 1

GPS 51.0480 -113.3888

Flow Hydrant 2

GPS

Residual Hydrant

GPS 51.0464 -113.3888

Fire Flow Test Report

Client Name:	ISL	Hyd 1 - #/Port Size	4" STORZ12	Flow Hyd 1 Addr	26 Spruce Park Dr.
Project Location:	Strathmore, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr	
SFE Project #:	A19-015	Hyd 1 - Pito Types	4" Hose Monster	Resid Hyd Addr.	44a Struce Park Dr.
SFE Technicians:	KM/JM	Hyd 2 - Pito Types		Fire Pump Status	Auto
		Test Procedure	NFPA 291	(circle one)	Force On

Test ID: 1 Test : 4 of 5 Date: 11-Jun-19

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
16:34	16:35	15				70	55	70

Flow Summary (igpm)	
Flow 1-1	1213
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	1213
Flow @ 20 psi	2324

Notes: Original static before fire pump, 72 psi.

Flow Hydrant 1

GPS 51.0333 -113.3880

Flow Hydrant 2

GPS

Residual Hydrant

GPS 51.0323 -113.3880

SFE GLOBAL

Fire Flow Test Report

Client Name:	ISL	Hyd 1 - #/Port Size	4" STORZ	Flow Hyd 1 Addr	514 Westmount Dr.
Project Location:	Strathmore, AB	Hyd 2 - #/Port Size		Flow Hyd 2 Addr	
SFE Project #:	A19-015	Hyd 1 - Pito Types	4" Hose Monster	Resid Hyd Addr.	324 1 Ave.
SFE Technicians:	KM/JM	Hyd 2 - Pito Types		Fire Pump Status	Auto
		Test Procedure	NFPA 291	(circle one)	Force On

Test ID: 1 Test : 5 of 5 Date: 11-Jun-19

		Flow Hyd 1		Flow Hyd 2		Residual Hydrant		
Start Time	End Time	Port 1-1 psi	Port 1-2 psi	Port 2-1 psi	Port 2-2 psi	Static psi	Residual psi	Static psi
16:12	16:13	12				65	48	65

Notes: Original static before fire pump, 58 psi.

Flow Summary (igpm)	
Flow 1-1	1085
Flow 1-2	
Flow 2-1	
Flow 2-2	
Total Flow	1085
Flow @ 20 psi	1835

Flow Hydrant 1

GPS 51.0426 -113.4026

Flow Hydrant 2

GPS

Residual Hydrant

GPS 51.0428 -113.4000

APPENDIX C
Detailed Cost Estimates

Table 1: Cost Estimates - Existing System Upgrades
Water Master Servicing Study
Town of Strathmore

Item Number	Upgrade	Items	Apportionment	Material	Quantity	Units	Unit Cost	Sub-Total	Contingency 30%	Engineering 15%	Total Cost
EX Upgrade 1	300mm backbone through the Westmount Subdivision	300mm Distribution Main	Town	PVC	1284	Metres	$ 425	$ 545,700	$ 163,710	$ 81,855	$ 791,000
		Pavement Rehabilitation	Town	N/A	1284	Metres	$ 750	$ 963,000	$ 288,900	$ 144,450	$ 1,396,000
		200mm Watermain Removal	Town	AC/DI	792	Metres	$ 115	$ 91,080	$ 27,324	$ 13,662	$ 132,000
		250mm Watermain Removal	Town	PVC/AC/DI	492	Metres	$ 125	$ 61,500	$ 18,450	$ 9,225	$ 89,000
							EX Upgrade 1 Sub-Total:	**$ 1,661,280**	**$ 498,384**	**$ 249,192**	**$ 2,408,000**
EX Upgrade 2	Localized fire flow improvements along 5th Avenue	300mm Distribution Main	Town	PVC	518	Metres	$ 425	$ 220,150	$ 66,045	$ 33,023	$ 319,000
		Pavement Rehabilitation	Town	N/A	518	Metres	$ 750	$ 388,500	$ 116,550	$ 58,275	$ 563,000
		100mm Watermain Removal	Town	AC	174	Metres	$ 85	$ 14,790	$ 4,437	$ 2,219	$ 21,000
		150mm Watermain Removal	Town	PVC/CI	327	Metres	$ 100	$ 32,700	$ 9,810	$ 4,905	$ 47,000
		200mm Watermain Removal	Town	PVC	17	Metres	$ 115	$ 1,955	$ 587	$ 293	$ 3,000
							EX Upgrade 2 Sub-Total:	**$ 658,095**	**$ 197,429**	**$ 98,714**	**$ 953,000**
EX Upgrade 3	Decommission Brentwood Reservoir and supply main valve to distribution system	Decommission Reservoir	Levy (80%)	N/A	1	Item	$ 100,000	$ 100,000	$ 30,000	$ 15,000	$ 145,000
		Open Valve	Levy (80%)	N/A	1	Item	$ 1,000	$ 1,000	$ 300	$ 150	$ 1,000
		Wildflower Pumping Capacity (Additional 110L/s)[1]	Levy (100%)	N/A	1	Item	$ 1,660,000	$ 1,660,000	$ 498,000	$ 249,000	$ 2,407,000
							EX Upgrade 3 Sub-Total:	**$ 1,761,000**	**$ 528,300**	**$ 264,150**	**$ 2,553,000**
							Grand Total:	**$ 4,080,375**	**$ 1,224,113**	**$ 612,056**	**$ 5,914,000**

[1] *Costs stipulated are to meet the pump upgrades required for existing conditions only (additional 110 L/s).*

Table 2: Cost Estimates - Proposed Build-out Concept
Water Master Servicing Study
Town of Strathmore

	Items	Apportionment	Material	Quantity	Units	Unit Cost	Sub-Total	Contingency 30%	Engineering 15%	Total Cost[2]
Main Pressure Zone	150mm Distribution Main	Developer	PVC	22	Metres	$ 300	$ 6,600	$ 1,980	$ 990	$ 10,000
	300mm Distribution Main	Developer	PVC	28,698	Metres	$ 425	$ 12,196,650	$ 3,658,995	$ 1,829,498	$ 17,685,000
	350mm Distribution Main	Levy (80%)	PVC	247	Metres	$ 480	$ 118,560	$ 35,568	$ 17,784	$ 172,000
	400mm Distribution Main	Levy (80%/100%; Upgraded/New)	PVC	13,367	Metres	$ 530	$ 7,084,510	$ 2,125,353	$ 1,062,677	$ 10,273,000
	500mm Distribution Main	Levy (100%)	PVC	513	Metres	$ 640	$ 328,320	$ 98,496	$ 49,248	$ 476,000
	600mm Distribution Main	Levy (100%)	PVC	64	Metres	$ 750	$ 48,000	$ 14,400	$ 7,200	$ 70,000
	300mm Watermain Removal	Town	DI/PVC	551	Metres	$ 140	$ 77,140	$ 23,142	$ 11,571	$ 112,000
	Pavement Rehabilitation	Developer/Levy (Watermain Size Dependent)	N/A	17,619	Metres	$ 750	$ 13,214,250	$ 3,964,275	$ 1,982,138	$ 19,161,000
	600mm Fill Line to East Reservoir[1]	Levy (80%)	PVC	4,500	Metres	$ 750	$ 3,375,000	$ 1,012,500	$ 506,250	$ 4,894,000
	Close Valve	Levy (80%)	N/A	1	Item	$ 1,000	$ 1,000	$ 300	$ 150	$ 1,000
	Wildflower Reservoir Storage[2]	Levy (100%)	N/A	6,177	Cubic Metres	$ 1,324	$ 8,178,348	$ 2,453,504	$ 1,226,752	$ 11,859,000
	East Reservoir Storage	Levy (80%)	N/A	20,781	Cubic Metres	$ 1,325	$ 27,534,825	$ 8,260,448	$ 4,130,224	$ 39,925,000
	Wildflower Reservoir Pumping Capacity (102 L/s)	Levy (100%)	N/A	1	Item	$ 1,825,000	$ 1,825,000	$ 547,500	$ 273,750	$ 2,646,000
	East Reservoir Pumping Capacity (441 L/s)	Levy (80%)	N/A	1	Item	$ 2,650,000	$ 2,650,000	$ 795,000	$ 397,500	$ 3,843,000
						Sub-Total:	**$ 76,638,203**	**$ 22,991,461**	**$ 11,495,730**	**$ 111,127,000**
Northwest Pressure Zone	300mm Distribution Main	Developer	PVC	4,163	Metres	$ 425	$ 1,769,275	$ 530,783	$ 265,391	$ 2,565,000
	Pavement Rehabilitation	Developer	N/A	1,267	Metres	$ 750	$ 950,250	$ 285,075	$ 142,538	$ 1,378,000
	Pressure Reducing Valves	Levy (100%)	N/A	6	Items	$ 50,000	$ 300,000	$ 90,000	$ 45,000	$ 435,000
						Sub-Total:	**$ 3,019,525**	**$ 905,858**	**$ 452,929**	**$ 4,378,000**
Southeast Pressure Zone	300mm Distribution Main	Developer	PVC	5,283	Metres	$ 425	$ 2,245,275	$ 673,583	$ 336,791	$ 3,256,000
	Pavement Rehabilitation	Developer	N/A	565	Metres	$ 750	$ 423,750	$ 127,125	$ 63,563	$ 614,000
	Pressure Reducing Valves	Levy (100%)	N/A	6	Items	$ 50,000	$ 300,000	$ 90,000	$ 45,000	$ 435,000
						Sub-Total:	**$ 2,969,025**	**$ 890,708**	**$ 445,354**	**$ 4,305,000**
						Grand Total:	**$ 82,626,753**	**$ 24,788,026**	**$ 12,394,013**	**$ 119,810,000**

[1] *Assumes ECRWL's criteria for reservoir storage.*

[2] *Costs represent to the total cost from existing conditions to full build-out, thus include upgrades required under the interim growth horizon.*

Table 3: Cost Estimates - Proposed Interim Concept
Water Master Servicing Study
Town of Strathmore

	Items	Material	Quantity	Units	Unit Cost	Sub-Total	Contingency 30%	Engineering 15%	Total Cost
Main Pressure Zone	300mm Distribution Main	PVC	5,292	Metres	$ 425	$ 2,249,100	$ 674,730	$ 337,365	$ 3,261,000
	350mm Distribution Main	PVC	247	Metres	$ 480	$ 118,560	$ 35,568	$ 17,784	$ 172,000
	400mm Distribution Main	PVC	6,569	Metres	$ 530	$ 3,481,570	$ 1,044,471	$ 522,236	$ 5,048,000
	500mm Distribution Main	PVC	35	Metres	$ 640	$ 22,400	$ 6,720	$ 3,360	$ 32,000
	600mm Distribution Main	PVC	64	Metres	$ 750	$ 48,000	$ 14,400	$ 7,200	$ 70,000
	300mm Watermain Removal	DI/PVC	551	Metres	$ 140	$ 77,140	$ 23,142	$ 11,571	$ 112,000
	Pavement Rehabilitation	N/A	4,882	Metres	$ 750	$ 3,661,500	$ 1,098,450	$ 549,225	$ 5,309,000
	Wildflower Reservoir Storage	N/A	6,177	Cubic Metres	$ 1,325	$ 8,184,525	$ 2,455,358	$ 1,227,679	$ 11,868,000
	Wildflower Reservoir Pumping Capacity (102 L/s)	N/A	1	Item	$ 1,825,000	$ 1,825,000	$ 547,500	$ 273,750	$ 2,646,000
						$ 19,667,795	**$ 5,900,339**	**$ 2,950,169**	**$ 28,518,000**
Northwest Pressure Zone	300mm Distribution Main	PVC	2,771	Metres	$ 425	$ 1,177,675	$ 353,303	$ 176,651	$ 1,708,000
	Pavement Rehabilitation	N/A	1,267	Metres	$ 750	$ 950,250	$ 285,075	$ 142,538	$ 1,378,000
	Pressure Reducing Valves	N/A	4	Items	$ 50,000	$ 200,000	$ 60,000	$ 30,000	$ 290,000
						$ 2,327,925	**$ 698,378**	**$ 349,189**	**$ 3,376,000**
Southeast Pressure Zone	300mm Distribution Main	PVC	565	Metres	$ 425	$ 240,125	$ 72,038	$ 36,019	$ 348,000
	Pavement Rehabilitation	N/A	565	Metres	$ 750	$ 423,750	$ 127,125	$ 63,563	$ 614,000
	Pressure Reducing Valves	N/A	2	Items	$ 50,000	$ 100,000	$ 30,000	$ 15,000	$ 145,000
						$ 763,875	**$ 229,163**	**$ 114,581**	**$ 1,107,000**
						$ 22,759,595	**$ 6,827,879**	**$ 3,413,939**	**$ 33,001,000**

Table 4: Cost Estimates - Proposed Build-out Concept - Additional Quarter Sections
Water Master Servicing Study
Town of Strathmore

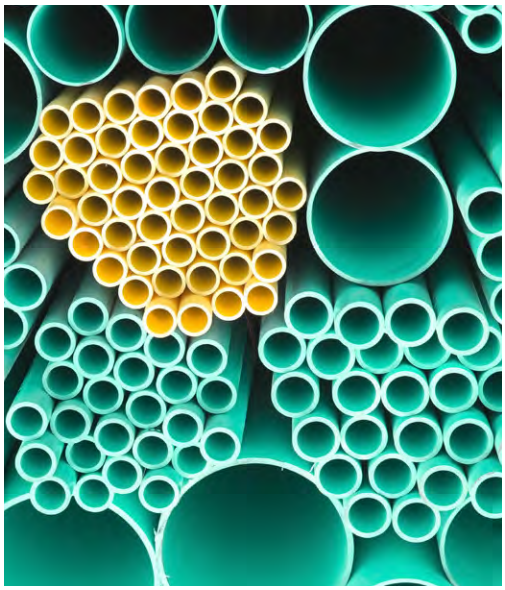
	Items	Material	Quantity	Units	Unit Cost	Sub-Total	Contingency 30%	Engineering 15%	Total Cost
Main Pressure Zone	300mm Distribution Main	PVC	491	Metres	$ 425	$ 208,675	$ 62,603	$ 31,301	$ 303,000
	Pavement Rehabilitation	N/A	402	Metres	$ 750	$ 301,500	$ 90,450	$ 45,225	$ 437,000
	Wildflower Reservoir Storage	N/A	2,083	Cubic Metres	$ 1,325	$ 2,759,975	$ 827,993	$ 413,996	$ 4,002,000
	East Reservoir Storage	N/A	940	Cubic Metres	$ 1,325	$ 1,245,500	$ 373,650	$ 186,825	$ 1,806,000
	Wildflower Reservoir Pumping Capacity Increase (44 L/s)	N/A	1	Item	$ 265,000	$ 265,000	$ 79,500	$ 39,750	$ 384,000
	East Reservoir Pumping Capacity Increase (21 L/s)	N/A	1	Item	$ 10,000	$ 10,000	$ 3,000	$ 1,500	$ 15,000
						$ 4,790,650	**$ 1,437,195**	**$ 718,598**	**$ 6,947,000**
Northwest Pressure Zone	300mm Distribution Main	PVC	2,820	Metres	$ 425	$ 1,198,500	$ 359,550	$ 179,775	$ 1,738,000
	Pavement Rehabilitation	N/A	2,015	Metres	$ 750	$ 1,511,250	$ 453,375	$ 226,688	$ 2,191,000
	Pressure Reducing Valves	N/A	1	Items	$ 50,000	$ 50,000	$ 15,000	$ 7,500	$ 73,000
						$ 2,759,750	**$ 827,925**	**$ 413,963**	**$ 4,002,000**
						$ 7,550,400	**$ 2,265,120**	**$ 1,132,560**	**$ 10,949,000**

Table 5: Cost Estimates - Staging
Water Master Servicing Study
Town of Strathmore

	Stage	Items	Material	Quantity	Units	Unit Cost	Sub-Total	Contingency 30%	Engineering 15%	Total Cost
Short-Term	1A	Cast/Ductile Iron Replacement Program	Varies depending on timing of Road Works Program.							
	1B	300mm Distribution Main	PVC	1,284	Metres	$ 425	$ 545,700	$ 163,710	$ 81,855	$ 791,000
		Pavement Rehabilitation	N/A	1,284	Metres	$ 750	$ 963,000	$ 288,900	$ 144,450	$ 1,396,000
		200mm Watermain Removal	AC/DI	792	Metres	$ 115	$ 91,080	$ 27,324	$ 13,662	$ 132,000
		250mm Watermain Removal	PVC/AC/DI	492	Metres	$ 125	$ 61,500	$ 18,450	$ 9,225	$ 89,000
						Sub-Total:	**$ 1,661,280**	**$ 498,384**	**$ 249,192**	**$ 2,408,000**
	1C	300mm Distribution Main	PVC	518	Metres	$ 425	$ 220,150	$ 66,045	$ 33,023	$ 319,000
		Pavement Rehabilitation	N/A	518	Metres	$ 750	$ 388,500	$ 116,550	$ 58,275	$ 563,000
		100mm Watermain Removal	AC	174	Metres	$ 85	$ 14,790	$ 4,437	$ 2,219	$ 21,000
		150mm Watermain Removal	PVC/CI	327	Metres	$ 100	$ 32,700	$ 9,810	$ 4,905	$ 47,000
		200mm Watermain Removal	PVC	17	Metres	$ 115	$ 1,955	$ 587	$ 293	$ 3,000
						Sub-Total:	**$ 658,095**	**$ 197,429**	**$ 98,714**	**$ 953,000**
	1D	Wildflower Reservoir Pumping Capacity (212 L/s)	N/A	1	Item	$ 3,485,000	$ 3,485,000	$ 1,045,500	$ 522,750	$ 5,053,000
						Sub-Total:	**$ 3,485,000**	**$ 1,045,500**	**$ 522,750**	**$ 5,053,000**
	1E	Decommission Reservoir	N/A	1	Item	$ 100,000	$ 100,000	$ 30,000	$ 15,000	$ 145,000
		Open Valve	N/A	1	Item	$ 1,000	$ 1,000	$ 300	$ 150	$ 1,000
						Sub-Total:	**$ 101,000**	**$ 30,300**	**$ 15,150**	**$ 146,000**
	1F	Wildflower Reservoir Storage	N/A	6,177	Cubic Metres	$ 1,324	$ 8,178,348	$ 2,453,504	$ 1,226,752	$ 11,859,000
						Sub-Total:	**$ 8,178,348**	**$ 2,453,504**	**$ 1,226,752**	**$ 11,859,000**
	1G	350mm Distribution Main	PVC	247	Metres	$ 480	$ 118,560	$ 35,568	$ 17,784	$ 172,000
		400mm Distribution Main	PVC	304	Metres	$ 530	$ 161,120	$ 48,336	$ 24,168	$ 234,000
		300mm Watermain Removal	DI/PVC	551	Metres	$ 140	$ 77,140	$ 23,142	$ 11,571	$ 112,000
		Pavement Rehabilitation	N/A	551	Metres	$ 750	$ 413,250	$ 123,975	$ 61,988	$ 599,000
						Sub-Total:	**$ 770,070**	**$ 231,021**	**$ 115,511**	**$ 1,117,000**
	1H	300mm Distribution Main	PVC	7,545	Metres	$ 425	$ 3,206,625	$ 961,988	$ 480,994	$ 4,650,000
		400mm Distribution Main	PVC	7,780	Metres	$ 530	$ 4,123,400	$ 1,237,020	$ 618,510	$ 5,979,000
		600mm Distribution Main	PVC	64	Metres	$ 750	$ 48,000	$ 14,400	$ 7,200	$ 70,000
		Pavement Rehabilitation	N/A	7,307	Metres	$ 750	$ 5,480,250	$ 1,644,075	$ 822,038	$ 7,946,000
		Pressure Reducing Valves	N/A	5	Items	$ 50,000	$ 250,000	$ 75,000	$ 37,500	$ 363,000
						Sub-Total:	**$ 13,108,275**	**$ 3,932,483**	**$ 1,966,241**	**$ 19,008,000**
						Short-Term Total:	**$ 27,962,068**	**$ 8,388,620**	**$ 4,194,310**	**$ 40,544,000**
Medium-Term	2A	300mm Distribution Main	PVC	7,904	Metres	$ 425	$ 3,359,200	$ 1,007,760	$ 503,880	$ 4,871,000
		400mm Distribution Main	PVC	826	Metres	$ 530	$ 437,780	$ 131,334	$ 65,667	$ 635,000
		Pavement Rehabilitation	N/A	2,160	Metres	$ 750	$ 1,620,000	$ 486,000	$ 243,000	$ 2,349,000
		Pressure Reducing Valves	N/A	3	Items	$ 50,000	$ 150,000	$ 45,000	$ 22,500	$ 218,000
						Sub-Total:	**$ 5,566,980**	**$ 1,670,094**	**$ 835,047**	**$ 8,073,000**
	2B	Increase ECRWL Contribution	Varies Depending on Method Selected.							
	2C	600mm Fill Line to East Reservoir	PVC	4,500	Metres	$ 750	$ 3,375,000	$ 1,012,500	$ 506,250	$ 4,894,000
		Close Valve	N/A	1	Item	$ 1,000	$ 1,000	$ 300	$ 150	$ 1,000
						Sub-Total:	**$ 3,376,000**	**$ 1,012,800**	**$ 506,400**	**$ 4,895,000**
	2D	East Reservoir Storage	N/A	20,781	Cubic Metres	$ 1,325	$ 27,534,825	$ 8,260,448	$ 4,130,224	$ 39,925,000
		East Reservoir Pumping Capacity (441 L/s)	N/A	1	Item	$ 2,650,000	$ 2,650,000	$ 795,000	$ 397,500	$ 3,843,000
						Sub-Total:	**$ 30,184,825**	**$ 9,055,448**	**$ 4,527,724**	**$ 43,768,000**
						Medium-Term Total:	**$ 39,127,805**	**$ 11,738,342**	**$ 5,869,171**	**$ 56,736,000**
Long-Term	3A	150mm Distribution Main	PVC	22	Metres	$ 300	$ 6,600	$ 1,980	$ 990	$ 10,000
		300mm Distribution Main	PVC	22,695	Metres	$ 425	$ 9,645,375	$ 2,893,613	$ 1,446,806	$ 13,986,000
		400mm Distribution Main	PVC	4,457	Metres	$ 530	$ 2,362,210	$ 708,663	$ 354,332	$ 3,425,000
		500mm Distribution Main	PVC	513	Metres	$ 640	$ 328,320	$ 98,496	$ 49,248	$ 476,000
		Pavement Rehabilitation	N/A	9,433	Metres	$ 750	$ 7,074,750	$ 2,122,425	$ 1,061,213	$ 10,258,000
		Pressure Reducing Valves	N/A	4	Items	$ 50,000	$ 200,000	$ 60,000	$ 30,000	$ 290,000
						Sub-Total:	**$ 19,617,255**	**$ 5,885,177**	**$ 2,942,588**	**$ 28,445,000**
						Long-Term Total:	**$ 19,617,255**	**$ 5,885,177**	**$ 2,942,588**	**$ 28,445,000**

[1] *Assumes ECRWL's criteria for reservoir storage.*

[2] *Costs represent to the total cost from existing conditions to full build-out, thus include upgrades required under the interim growth horizon.*



Integrated Expertise. Locally Delivered.

islengineering.com