Associated Engineering

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

REPORT

Town of Bon Accord

Water Master Plan Update

OCTOBER 2019

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1 INTRODUCTION

1.1 Background

Recent interest in new development within the Town of Bon Accord has triggered a need for the Town to update their current municipal utility and transportation information. The Town would like the ability to provide potential developers a framework in which to plan their developments while meeting the Town's vision for growth. As such, The Town has engaged Associated Engineering (AE) to develop Water, Sanitary, Storm and Transportation Master Plans for the Town.

1.2 Study Area

The Study Area, presented on **Figure 1-1**, is comprised of a little over six quarter sections, with undeveloped lands located north, east and west of the current development area. Future development is anticipated to include commercial land to the southwest, industrial land to the northeast and future residential development to the north, east and west. For the most part, the topography is generally flat, with low ridge lines occurring throughout the future development areas. A large low area is located in the southeast corner of the Town and there are additional isolated local low areas throughout the future development areas.

1.3 Scope and Objectives

The primary objective of this project is to develop Water, Sanitary, Storm and Transportation Master Plans for the Town of Bon Accord. The Master Plans are intended to provide guidance for system planning and operation, to identify and prioritize capital upgrading requirements, and to establish high level servicing concepts to help guide future development.

In general, the scope of work for each utility will involve the following major tasks:

- Review background information
- Establish design criteria
- Evaluate the existing system
- Propose recommended upgrades to the existing system
- Develop an ultimate development servicing concept
- Establish high level capital cost estimates
- Prepare a comprehensive report complete with conclusions and recommendations

1.4 References

In the preparation of this Water Master Plan, we reviewed the following documents:

- Town of Bon Accord Servicing Master Plan (AECOM, 2010);
- Town of Bon Accord Annexation Servicing Study (MPE Engineering, 2016);
- Re-imagine. Plan. Build. Edmonton Metropolitan Region Growth Plan (Edmonton Metropolitan Region Board, 2017);
- Town of Bon Accord Minimum Design Standards for Design of Local Improvements (2003);
- Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems (Alberta Environment and Parks, 2013);
- Town of Bon Accord Annual Water Reports (2013 through April 2019);

- Municipal Affairs Population Lists (Government of Alberta, 2013 through 2018); and
- Available Record Drawings.

1.5 Acknowledgments

Associated Engineering gratefully recognizes the contribution from the Town of Bon Accord in the development of this Master Plan. Special thanks to Joyce Pierce, Ken Reil, and Dianne Allen who collaborated on this project.

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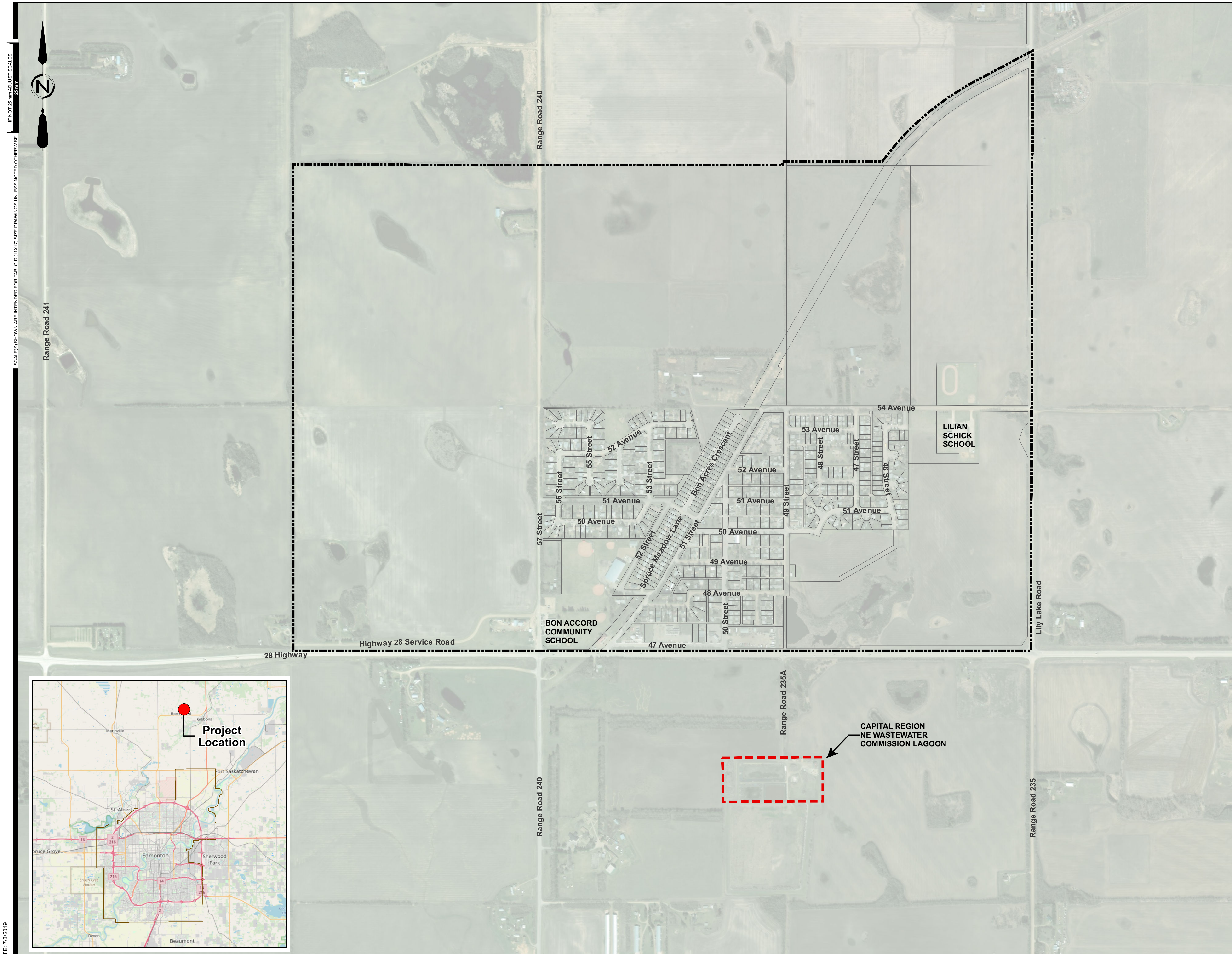
IF NOT 25 mm ADJUST SCALES 25 mm

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE



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Legend:

Lagoon

Town Boundary

Town of Bon Accord
building for tomorrow

FIGURE No. 1-1

TOWN OF BON ACCORD
WATER MASTER PLAN UPDATE

STUDY AREA AND KEY PLAN

AE PROJECT No.	2019-3459
SCALE	1:12,000
COORD. SYSTEM	NAD 1983 3TM 114
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

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DATE: 7/3/2019;

2 DESIGN CRITERIA

2.1 General

2.1.1 Population

One of the main variables in assessing a community's municipal servicing components is the population. The population will provide a measure of the quantity of water required and will have an impact on the distribution and collection systems based on population density.

Table 2-1 presents the historical population for the Town of Bon Accord, from 1996 onward, obtained from federal census data. Based on the data, the average annual growth rate was 0.12% from 1996 through 2016.

Table 2-1
Historical Population Statistics

Year	Population	5 Year Annual Growth Rate
1996	1,493	
2001	1,532	+0.5%
2006	1,534	+0.03%
2011	1,488	-0.6%
2016	1,529	+0.6%

The Edmonton Metropolitan Region Board (EMRB) published "Re-imagine. Plan. Build. Edmonton Metropolitan Region Growth Plan" in 2017. In this document, the EMRB projects that the Town will have a population ranging from 2,700 to 3,300 by the year 2044. This results in an average annual growth rate ranging from 2.1% per year to 2.8% per year.

The Annexation Servicing Study (MPE Engineering, 2016) applied a growth rate of 2%.

Based on a meeting with the Town on March 22, 2019, the Town proposed an annual growth rate of 0.5% to 1.0%; therefore, our analysis has applied an annual growth rate of 1.0%. A population of 1,575 people has been established for 2019, using the 2016 historical population and an annual growth rate of 1.0%.

Table 2-2 below presents the projected population for the next 25 years, in 5 year increments.

Table 2-2
Projected Population (25 Years)

Year	Population
2019	1,575
2024	1,656
2029	1,740
2034	1,829
2039	1,922
2044	2,020

2.1.2 Population Density

Population densities are used to estimate the population or equivalent population for different land use areas. These values are used in conjunction with the per capita daily consumption / sewage generation rates to estimate the demands on the water system and flows within the sewer system.

Population densities for several communities have been reviewed, compared, and discussed with the Town; our analyses used the following population densities:

Existing Development Areas

- Single Family Residential / Low Density Residential — 30 people / ha
- Multi-Family Residential / Medium Density Residential — 75 people / ha (2.5 times the density of Single Family Residential)
- High Density Residential (walk-up apartments) — 150 people / ha (5 times the density of Single Family Residential)
- Commercial / Institutional (equivalent population, ep) — 30 ep / ha
- Industrial (equivalent population, ep) — 25 ep / ha

Future Development Areas

- Single Family Residential — 40 people / ha
- Commercial / Institutional (equivalent population, ep) — 30 ep / ha
- Industrial (equivalent population, ep) — 25 ep / ha

2.1.3 Land Use

Figure 2-1 presents the Land Use Map, developed for use on this project. The figure is a compilation of the land use map presented in the 2016 Town of Bon Accord Land Use Bylaw, the “Meadows of Bon Accord Servicing Study” (Stantec, 2007) and the “Annexation Servicing Study” (MPE Engineering, 2016). Some adjustments have been made to the various existing and proposed land use designations as appropriate for the current project.

2.2 Water System

2.2.1 Water Demand

Water demand is critical in determining the distribution network, pumping capability, and storage required for a water system. Three critical rates of demand are normally used: average day, peak day, and peak hour demand. Fire flows, in conjunction with the peak day flows are also used to test the water system's capability to deliver water and meet system demands.

The following briefly describes each of the critical flow conditions:

2.2.1.1 Average Day

The average day demand is determined by dividing the total annual consumption by 365 days. By dividing this rate by the population served, the per capita per day demand is derived. This rate is used primarily as a basis for the projection of the total water demand.

2.2.1.2 Peak Day

The peak day demand is determined by the single day of maximum consumption observed in the distribution system over one year. In using the single day of maximum flow, one must ensure that the record is not distorted by fire fighting demand, equipment malfunction, or watermain breaks. The peaking factor is determined by comparing the peak day demand to the average day demand. The peak day demand is used in determining the delivery capacity required of supply mains, treatment facilities, storage facilities, and pumping facilities. In conjunction with the fire flow, it is used to test the water system's capacity to supply the fire and peak day demand.

2.2.1.3 Peak Hour

The peak hour demand is the expected maximum demand observed during a short period of the day. Most facilities are not equipped to record peak hour demands in such detail; therefore, the rate is established based on experience and judgment. The peak hour rate is used in determining pumping requirements.

2.2.1.4 Historical Water Usage

The Town of Bon Accord has provided water consumption records for the past six years. A summary is provided in **Table 2-3.**

Table 2-3
Historical Water Usage

	2013	2014	2015	2016	2017	2018	2019[4]
Total Water Usage (m^3/year – Excluding Truck Fill Usage)	152,901	146,056	147,058	105,340	102,213	106,696	35,074
Average Day (m^3/day)	419	400	403	289	280	292	331
Average Day Demand (L/s)	4.85	4.63	4.66	3.34	3.24	3.38	3.83
Average Day Per Capita (L/c/d)	279	265	265	189	181	187	210
Population	1,504[1]	1,512[1]	1,521[1]	1,529[2]	1,544[3]	1,560[3]	1,575[3]

Notes:

[1] The growth rate from 2011 to 2016 (Table 2-1) was used to interpolate the populations in 2013 - 2015.

[2] 2016 census population.

[3] The design population growth rate of 1.0% was used to estimate the population in 2017 through 2019.

[4] Only data for the months of January through mid-April were available for 2019.

As shown in Table 2-3, the per capita water consumption ranged from 181 to 279 L/c/d; these are relatively low values compared to many other communities in Alberta.

The Town of Bon Accord indicated that a major leak in the distribution system was repaired in 2016, which could help explain the sudden drop in water usage from 2013 – 2015 to 2016 – 2019.

2.2.1.5 Proposed Design Demands

Based on the recent water usage data, the following water demands have been applied in the model:

- Average Day Demand 220 L/c/d
- Peak Day Demand 440 L/c/d (Peaking Factor of 2.0)
- Peak Hour Demand 660 L/c/d (Peaking Factor of 3.0)

The recommended average day demand of 220 L/c/d is approximately 15% higher than the current water usage and should allow for conservatism in future water demand calculations. A peak day factor of 2.0 was used, based on experience in similar communities. The existing facilities do not measure peak hour flows. From experience in similar communities, a peak hour factor of 3.0 was used.

The proposed water demands and demand criteria for the next 25 years are outline in Table 2-4 below.

Table 2-4
Projected Water Demands

	2019	2024	2029	2034	2039	2044
Population	1,575	1,656	1,740	1,829	1,922	2,020
Average Day Per Capita (L/c/d)	220	220	220	220	220	220
Peak Day Factor	2	2	2	2	2	2
Peak Hour Factor	3	3	3	3	3	3
Average Day Demand (L/s)	4.0	4.2	4.4	4.7	4.9	5.1
Average Day Demand (m^3/day)	347	364	383	402	423	444
Peak Day Demand (L/s)	8.0	8.4	8.9	9.3	9.8	10.3
Peak Day Demand (m^3/day)	693	729	766	805	846	889
Peak Hour Demand (L/s)	12.0	12.7	13.3	14.0	14.7	15.4

2.2.1.6 Recommended Fire Flows

Table 2-5 presents the recommended fire flows derived from the Fire Underwriters Survey.

Table 2-5
Fire Flows (Fire Underwriters Survey)

Description		Recommended Fire Flow (L/min)
Single Family Residential Wood frame construction, two stories or less 100 m^2 to 150 m^2 150 m^2 to 275 m^2		 5,000 (83 L/s) 6,000 (100 L/s)
Multi-Family Residential Wood frame construction c/w fire separator Four units up to 100 m^2 each		 8,000 (133 L/s)
Walk-up Apartments Ordinary construction up to 3,200 m^2	 (10 – 20 m separation)	 12,000 (200 L/s)
Schools Non-combustible construction Up to 3,300 m^2 Up to 4,000 m^2 Up to 12,000 m^2		 10,000 (167 L/s) 11,000 (183 L/s) 19,000 (317 L/s)
Institutional, Churches Ordinary construction (15% exposure)	 up to 850 m^2	 6,000 (100 L/s)
Commercial Non-combustible construction (50% exposure) Up to 2,900 m^2 Up to 4,200 m^2		 11,000 (183 L/s) 14,000 (233 L/s)
Light Industrial Non-combustible construction Up to 2,900 m^2 (25% exposure) Up to 2,900 m^2 (50% exposure)		 9,000 (150 L/s) 11,000 (183 L/s)
Low Density Rural Residential 2 storeys or less; over 30 m separation		 2,000 (33 L/s)
High Density Rural Residential 2 storeys or less; 10.1 to 30 m separation		 3,000 (50 L/s)

The preceding flows, based on Fire Underwriters Survey guidelines, are determined as follows:

F	=	$220*C\sqrt{A}$, where
F	=	required fire flow (L/min)
C	=	1.5 for wood frame construction
	=	1.0 for ordinary construction
	=	0.8 for non-combustible construction
	=	0.6 for fire-resistant construction (fully protected frame, floors, roof)
A	=	total floor area in square metres (including all storeys)

Other considerations when determining fire flow requirements include:

- Occupancy hazard;
- Automatic sprinkler protection; and
- Exposure within 45 m.

The fire flows in **Table 2-6** have been adopted by the Town for this study.

Table 2-6
Recommended Fire Flows

Land Use	Type of Development	Required Fire Flow
Residential		
	Single Family	83 L/s
	Multi-Family	133 L/s
	High Density (walk-up apartments)	200 L/s
Commercial		
	Standard	183 L/s
	Up to 2.900 m^2 – strip mall, health centre, etc.	233 L/s
Industrial		183 L/s
Schools		
	Elementary	167 L/s
	High School	183 L/s
Institutional		
	Churches	100 L/s

In general, the higher value of 200 L/s will be applied to all new residential locations (in the ultimate scenario). This will consider the potential for high density neighbourhood development (walk-up apartments) and will provide for additional fire flow flexibility in these locations.

2.2.2 Operating Pressures

The recommended normal operating system pressures are:

- Absolute minimum pressure at peak demand — 280 kPa (40 psi)
- Target minimum pressure — 345 kPa (50 psi)
- Target maximum pressure — 550 kPa (80 psi)

The minimum recommended system pressure during a fire event is 140 kPa (20 psi).

2.2.3 Pipe Roughness Coefficient ("C" Value)

The following "C" values for various pipe materials have been used within the model:

- PVC / HDPE — 130
- Asbestos Cement (AC) — 110
- Cast Iron — 100
- Ductile Iron — 120
- Steel — 120

Proposed watermains will be assumed to have a "C" value of 130.

2.2.4 Minimum Pipe Size

The following recommended minimum pipe sizes have been applied in the model:

- Single family residential (including semi-detached housing) — 200 mm
- Medium density residential (row housing) — 250 mm
- High density residential (walk-up apartment buildings) — 250 mm
- Commercial / industrial / institutional — 250 mm

Proposed pipe sizes were based on the results of the hydraulic network analysis.

2.2.5 Velocity

It is recommended that the maximum velocity not exceed 1.5 m/s during normal system operation, increasing to a maximum of 3.0 m/s during fire flow scenarios.

2.2.6 Water Storage

It is good practice to provide adequate storage in a water system for operational needs (peak hour), supply interruption, and fire flow demand. There are two methods, described below, which are generally used to calculate water storage requirements. Alberta Environment and Parks (AEP) guidelines require:

Method 1:

- Equalization Storage (peak hour demand): 25% of Peak Day flow; and
- Fire Storage; and
- The greater of:
    - Emergency Storage (in the event of supply interruption): 15% of Average Day flow; or
    - Disinfection contact time (T_{10}) storage.

Method 2:

- 1 Peak Day; and
- Fire Storage

Water storage requirements for systems with long supply lines, or where storage is located at long distances from the water source, (i.e., regional pipelines) are at higher risk of supply interruption. In these cases, the recommended storage is calculated based on Method 2; however, specific situations could warrant even higher storage recommendations.

As the Town of Bon Accord is serviced via the Capital Region Northeast Water Services Commission (CRNWSC), the second method of calculating storage requirements has been used in our analyses.

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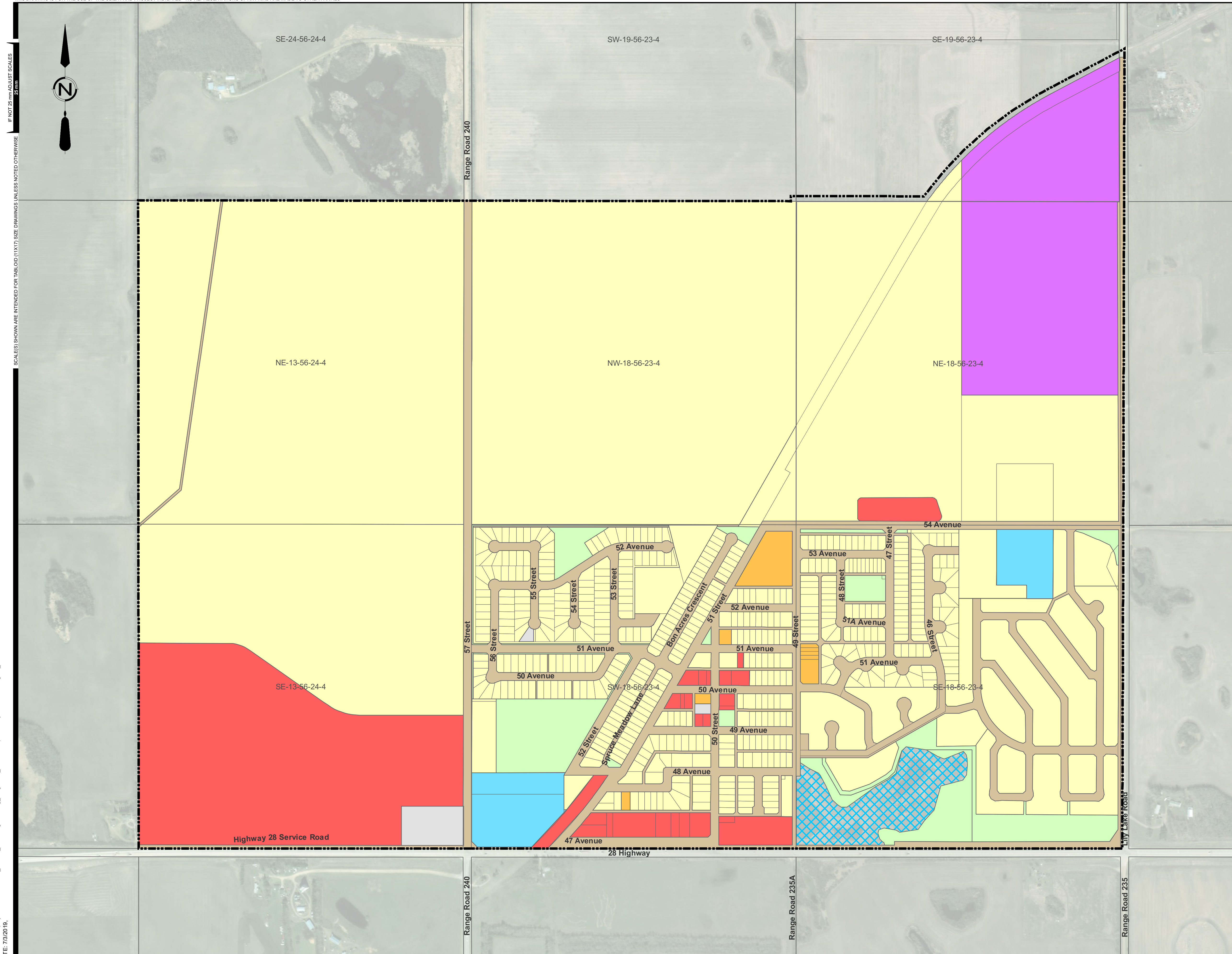

Legend:

- Low Density Residential
- Medium Density Residential
- Commercial
- Industrial
- Institutional
- Public Utility
- Park/Open Space/ER
- Roadways
- Stormwater Retention Area
- Town Boundary

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FIGURE No. 2-1

TOWN OF BON ACCORD
WATER MASTER PLAN UPDATE

LAND USE MAP

AE PROJECT No.	2019-3459
SCALE	1:9,000
COORD. SYSTEM	NAD 1983 3TM 114
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

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DATE: 7/3/2019.

3 EXISTING SYSTEM

3.1 Existing Water Distribution System

3.1.1 Existing Facilities

The existing water system within the Town of Bon Accord consists of:

- A Treated Water Supply Line;
- A Reservoir and Pumphouse;
- A Water Distribution System; and
- A Truck Fill Station.

3.1.1.1 Treated Water Supply Line

The Capital Region Northeast Water Services Commission (CRNWSC) supplies treated water from the City of Edmonton to the Town of Bon Accord via a 200 mm diameter supply main.

3.1.1.2 Reservoir and Pumphouse

There is one Reservoir and Pumphouse which serves the Town of Bon Accord water distribution system. An expansion was recently undertaken at the reservoir, which increased the total storage capacity to approximately 5,000 m^3. There is a separate truck fill building which is located directly north of the Reservoir and Pumphouse. The existing pumphouse supplies the distribution system only and is equipped with three distribution pumps and two standby pumps. Table 3-1 summarizes the existing reservoir storage and pumping capacities.

Table 3-1
Pumping and Reservoir Capacity

Reservoir and Pumphouse	Pump Designation	Pumping Capacity
Pumphouse Capacity:		
Distribution Pump (VFD)	P-101	25 L/s 44.5 m head
Distribution Pump (VFD)	P-102	25 L/s 44.5 m head
Distribution Pump (VFD)	P-103	55 L/s 49.2 m head
Fire / Standby Pump	P-104	110 L/s 49.2 m head
Fire / Standby Pump	P-105	110 L/s 49.2 m head
Truck Fill Pump:	P-106	25.2 L/s 10.7 m head
Reservoir Capacity:	5,000 m^3	

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Distribution Pump 103 and Fire / Standby Pumps 104 and 105 were replaced in 2007, while Pumps 101 and 102 were re-installed with new motors. The three Distribution Pumps (101, 102 and 103) are all variable speed pumps, while Fire / Standby Pumps 104 and 105 are constant speed pumps. It is understood that currently Pump 103 (the largest of the distribution pumps) operates as the lead pump, with Pumps 101 and 102 operating as lag.

The pump setpoints identified above are based on pump curves enclosed in the Operating and Maintenance Manual for the Pumphouse Upgrades and Truck Fill Station Project, which occurred in 2006. It should be noted that the setpoints do not match what is identified on the Record Drawing Set or in the Town of Bon Accord Servicing Master Plan (AECOM, 2010). As Pumps 101 and 102 were not replaced in the 2006 project, the setpoints identified in the 2010 Servicing Master Plan are assumed to be correct.

The variable speed pumps are currently programmed to operate at approximately 735.7 m HGL (50 psi) at the Pumphouse. There is a pressure relief valve (PRV) located on the header which will operate at 746.3 m HGL (65 psi) to relieve high pressures including operation of the fire / standby pump.

3.1.1.3 Distribution System

Based on the water model provided, the existing distribution system is comprised of AC, PVC, HDPE and steel pipes (at the pumphouse). The majority of the older parts of Town have AC watermains, with the majority of the newer piping comprised of PVC or HDPE pipes. Pipes range in size from 150 mm in diameter to 400 mm in diameter. **Figure 3-1** indicates the pipe sizes of the existing water distribution system.

It should be noted that the watermain identified as 350 mm in diameter is comprised of a DR11 HDPE main, and has been modelled using its internal diameter of 287 mm. The model does not otherwise reflect internal pipe diameters, as they are generally much closer to the nominal pipe diameter.

3.1.1.4 Truck Fill Station

A truck fill station was constructed immediately north of the Reservoir and Pumphouse in 2006. A 100 mm PVC main supplies water to the truck fill station from the Pumphouse. The truck fill pump is located on a separate header within the pumphouse and does not affect distribution system pumping.

3.1.2 Existing Model Update

The Town's previous WaterCAD model was updated for use on this project. The following tasks were undertaken to update the model:

- Input upgrades to the piped distribution system.
- Input lidar ground elevations.
- Update water demands to reflect current water use and land use.
- Update fire flow requirements to reflect current land use.
- Update the pumps and pumphouse setpoints.
- Review record drawings of existing system and update pipe diameter and material where necessary.

3.1.3 Existing System Assessment

Following model updating, the existing distribution system was analyzed to determine the average day pressures, peak hour pressures and peak day plus fire flow capabilities. The following describes each scenario in detail:

3.1.3.1 Average Day Scenario

The Average Day Demand scenario was run to assess the maximum system pressures within the system. During the average day demand, the highest system pressure was 689 kPa (54 psi) at the south end of the 54 Street cul-de-sac, and the lowest was 293 kPa (43 psi) located adjacent to Lilian Schick School. All locations experience pressures greater than 40 psi; however, only half of the Town has pressures which exceed 345 kPa (50 psi), which is a common target pressure for typical operating scenarios (and as recommended by Alberta Environment and Parks). The results are based on Pump P-103 operating at the Pumphouse.

3.1.3.2 Peak Hour Scenario

During the Peak Hour scenario, the modelled pressures range from 291 kPa (42 psi) to 368 kPa (53 psi), with the lowest pressures located adjacent to Lilian Schick School. Once again, much of the Town experiences pressures below the target minimum pressure of 345 kPa (50 psi). This pressure range is considered acceptable as the pressures remains above 280 kPa (40 psi) which is the absolute minimum allowable pressure during the peak hour demand.

Figure 3-1 identifies the Peak Hour pressures for the existing system and is based on operation of Pump 103 at the Pumphouse. The results are based on an outgoing pressure of 50 psi (345 kPa, 735.7 m HGL) at the pumphouse.

3.1.3.3 Peak Day plus Fire Scenario

A number of locations within Bon Accord did not fully satisfy the Peak Day plus Fire Flow criteria. Those areas which did not meet the criteria include: the downtown area, highway commercial area, residential development east of 49 Street, Lilian Schick School, medium density development located at 51 Street and 54 Avenue and residential cul-de-sacs and dead ends.

Figure 3-2 identifies the locations which did not meet the recommended criteria. Although these locations may not fully meet the target fire flow criteria due to a reduced flowrate, there will be water available for fighting fire. The figure identifies the percent of recommended fire flow which can be delivered to each location. This scenario was run with both fire / standby pumps operating. The results are based on an outgoing pressure of 448 kPa (65 psi, 746.3 m HGL) at the pumphouse.

3.1.3.4 Pump Capacity

Table 3-2 presents the pumping capacity analysis. The analysis is based on:

- Operating distribution Pump 103;
- Reserving distribution Pumps 101 and 102 as combined backup capacity (total combined capacity is similar to Pump 103).

Table 3-2
Pumping Capacity Analysis

Year	2019	2024	2029	2034	2039	2044
Population	1,575	1,656	1,740	1,829	1,922	2,020
Average Day (L/s)	4.0	4.2	4.4	4.7	4.9	5.1
Peak Day (L/s)	8.0	8.4	8.8	9.4	9.8	10.2
Peak Hour Analysis						
Peak Hour (L/s)	12.0	12.6	13.2	14.1	14.7	15.3
Distribution Pumping Capacity [1,2] (L/s)	55.0	55.0	55.0	55.0	55.0	55.0
Surplus (L/s)	43.0	42.4	41.8	40.9	40.3	39.7
Peak Day + Fire Flow Analysis						
Peak Day plus Fire Flow (L/s)	208.0	208.4	208.8	209.4	209.8	210.2
Fire Pump Capacity [2,3] (L/s)	220	220	220	220	220	220
Surplus (L/s)	12.0	11.6	11.2	10.6	10.2	9.8

Notes:

[1] Distribution pumping capacity is based on maintaining 100% backup (Pumps 101/102 or 103).

[2] All pump capacity totals are based on the rated design flow and do not account for combined headloss or operating at a lower head.

[3] Fire pump capacity is based on utilizing both Pumps 104 / 105.

As shown in the **Table 3-2**, there is currently 43.0 L/s surplus pumping capacity available after meeting the 2019 peak hour demands (if reserving the two smaller distribution pumps as backup). Ideally, there is full distribution pumping backup to allow for pump maintenance and repair so as not to cause system disruption. As shown in the table, there is ample surplus distribution pumping capacity to beyond 2044.

As well, there is sufficient fire / standby pump capacity to meet the projected peak day plus fire flow demand beyond 2044. It should be noted that the design fire flow has been assumed as 200 L/s, which is intended to service a four-storey walk-up apartment building. Although this type of development does not currently exist in Bon Accord, it is possible that one could be constructed as the Town grows.

3.1.3.5 Water Storage

It is recommended that the required storage volume for Bon Accord be calculated based on 1 Peak Day plus Fire Storage, as outlined in Section 3 of this report. As presented in **Table 3-3** below, the total storage requirement for 2019 is 2,691 m^3 which results in a storage surplus of 2,309 m^3 to meet the current needs. As shown in the table, it is estimated that the current storage volume will support a population of 6,818, anticipated to occur in the year 2166 based on a 1% growth rate.

It is understood that the Town is currently operating the reservoir at 70% capacity, reducing the effective storage volume from 5,000 m^3 to 3,500 m^3. Considering the reduction in effective storage, there will still be remaining surplus storage capacity through 2044.

The recommended fire flow is the largest demand allowed for in a water distribution system. Based on the design criteria adopted, the largest recommended fire flow used in this study is 200 L/s for a four-storey walk-up (for future allowance). A fire flow of 200 L/s is required to be maintained for 2.5 hours, in accordance with Fire Underwriters survey. This results in a fire flow storage requirement of 1,800 m^3.

The truck fill storage requirement has been estimated based on the peak monthly volume recorded from 2013 through 2018. It is acknowledged that a truck fill storage volume of 200 m^3 is an average over the peak month, and that the actual peak day is likely to be higher. As there is currently ample storage within the facility, this is not considered to be of significant consequence.

Table 3-3
Storage Capacity Analysis

	Existing Storage [1] (m^3)	Projected Population	Peak Day Flow (L/s)	Peak Day Flow (m^3/day)	Peak Truck Fill [2] (m^3/day)	Fire Flow [3] (200 L/s for 2.5 hours) (m^3)	Total Required Storage (m^3)	Remaining Storage (Surplus) (m^3)
Existing (2019)	5,000	1,575	8.0	691	200	1,800	2,691	2,309
2024	5,000	1,656	8.4	726	200	1,800	2,726	2,274
2029	5,000	1,740	8.9	769	200	1,800	2,769	2,231
2034	5,000	1,829	9.3	804	200	1,800	2,804	2,196
2039	5,000	1,922	9.8	847	200	1,800	2,847	2,153
2044	5,000	2,020	10.3	890	200	1,800	2,890	2,110
2166	5,000	6,818	34.7	3,000	200	1,800	5,000	0
Ultimate	5,000	11,200	57.0	4,928	200	1,800	6,928	-1,928

Notes:

[1] The existing storage volume is estimated to be in the order of 5,000 m^3.

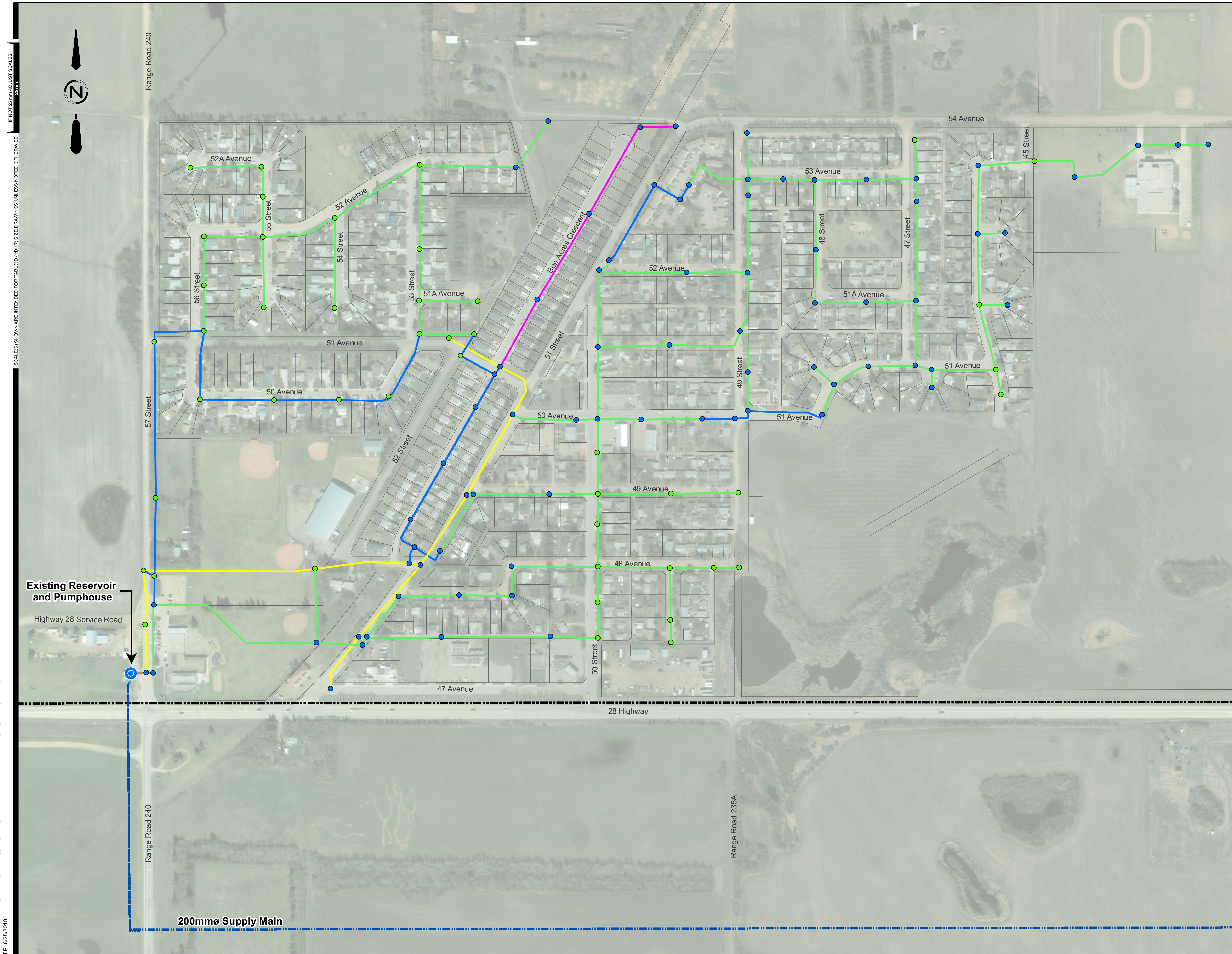
[2] The Peak Truck Fill storage volume is based on historical peak month usage provided. Actual peak day values may exceed that shown above.

[3] The Design Fire Flow is based on a four-storey walk-up, should one be constructed.

3.1.3.6 Hydrant Coverage

Figure 3-3 indicates the current level of hydrant coverage within the Town. The coverage is based on a 75 m radius for hydrants within single family residential areas and 50 m for commercial / industrial locations. The hydrant locations were identified based on GIS data provided by the Town of Bon Accord. The information was then checked against mapping provided by the Town and verified using aerial imagery to identify missing GIS data. It is recommended that the Town verify all locations to ensure that they remain accurate.

Figure 3-3 also recommends locations for future hydrants in areas without sufficient coverage. Most of the areas which require additional hydrants can be easily serviced from existing watermains, although additional hydrants could be required to protect the far side of large buildings such as schools and commercial / industrial buildings.



Legend:

- Existing Reservoir and Pumphouse

Peak Hour Pressure

- 40 - 50 psi (280 kPa - 345 kPa)
- 50 - 80 psi (345 kPa - 550 kPa)
- 80 - 90 psi (550 kPa - 620 kPa)

Distribution System

- Existing 150 mmø
- Existing 200 mmø
- Existing 250 mmø
- Existing 300 mmø
- Existing 350 mmø
- Existing 400 mmø
- Supply Main
- Town Boundary

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FIGURE No. 3.1

TOWN OF BON ACCORD
WATER MASTER PLAN UPDATE

EXISTING WATER SYSTEM
PEAK HOUR PRESSURE

AE PROJECT No.	2019-3459
SCALE	1:5,000
COORD. SYSTEM	NAD 1983 UTM ZONE 12N
DATE	2019 JUNE
REV	
DESCRIPTION	ISSUED FOR DRAFT

IF NOT 25 mm ADJUST SCALES 25 mm

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

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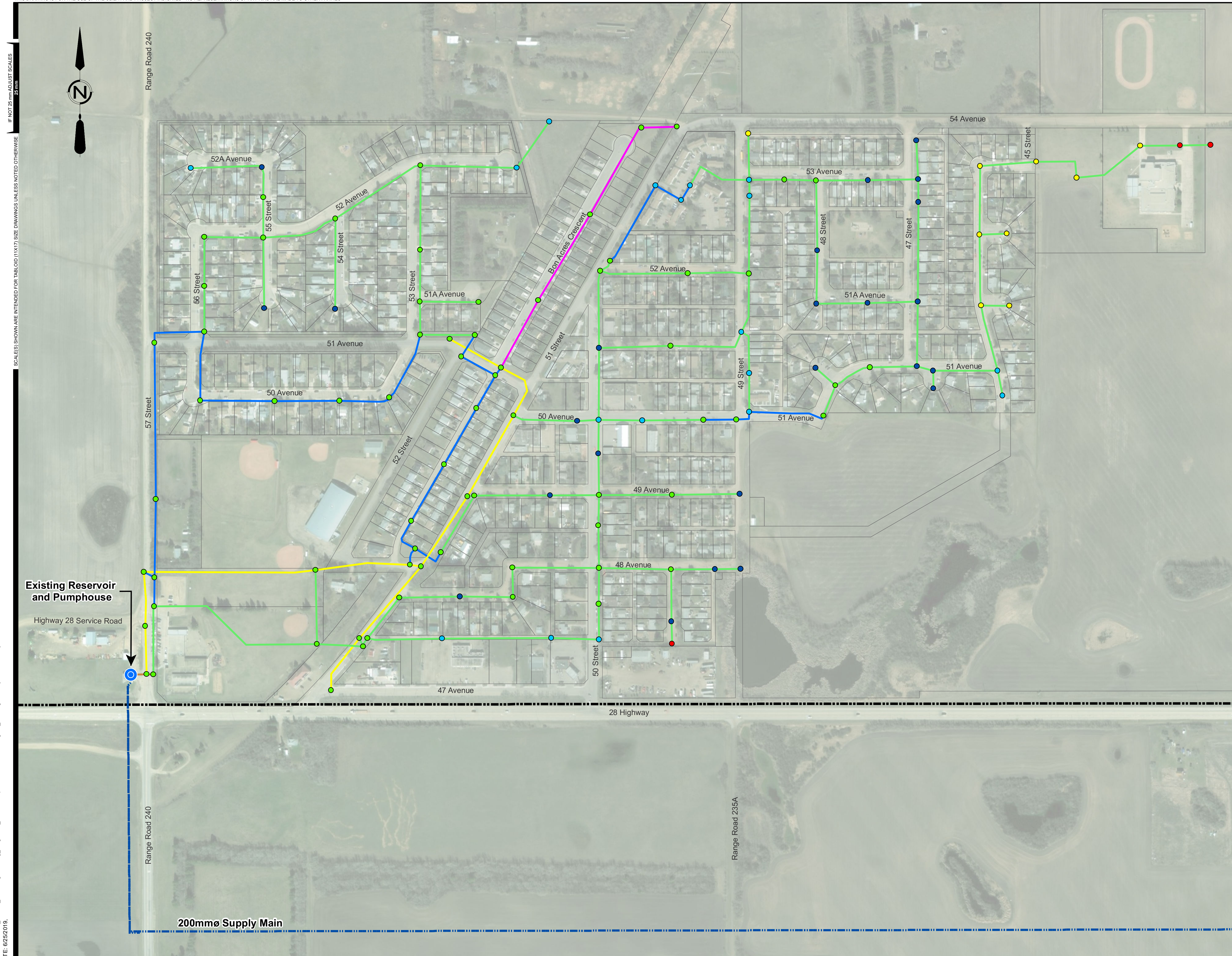
DATE: 6/25/2019,



Associated Engineering

Legend:

- Existing Reservoir and Pumphouse

Fire Flow Availability

- Exceeds Fire Flow Requirements
- 80% - 99%
- 60% - 80%
- 40% - 60%
- 0% - 40%

Distribution System

- Existing 150 mmø
- Existing 200 mmø
- Existing 250 mmø
- Existing 300 mmø
- Existing 350 mmø
- Existing 400 mmø
- Supply Main
- Town Boundary

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FIGURE No. 3.2

TOWN OF BON ACCORD
WATER MASTER PLAN UPDATE

EXISTING WATER SYSTEM
PEAK DAY PLUS FIRE FLOW

AE PROJECT No.	2019-3459
SCALE	1:5,000
COORD. SYSTEM	NAD 1983 UTM ZONE 12N
DATE	2019 JUNE
REV	
DESCRIPTION	ISSUED FOR DRAFT

Legend:

- Existing Reservoir and Pumphouse
- Water Hydrant
- Existing Hydrant Coverage in Residential Area (75m Radius)
- Existing Hydrant Coverage in Other Area (50m Radius)
- Proposed Hydrant Coverage in Residential Area (75m Radius)
- Proposed Hydrant Coverage in Other Area (50m Radius)
- Existing Watermain
- Supply Main
- Town Boundary

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FIGURE No. 3-3

TOWN OF BON ACCORD
WATER MASTER PLAN UPDATE

EXISTING WATER SYSTEM
HYDRANT COVERAGE

AE PROJECT No.	2019-3459
SCALE	1:5,000
COORD. SYSTEM	NAD 1983 UTM ZONE 12N
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

4 UPGRADES TO EXISTING SYSTEM

4.1 Distribution System

Upgrades to the distribution system are presented on Figure 4-1 and are recommended to satisfy fire flow criteria. The proposed upgrades are as follows:

- New watermains are recommended as shown:
  - A 250 mm diameter watermain along 47 Avenue to service the highway commercial area
  - A 250 mm diameter watermain along 49 Street to loop dead end watermains and improve fire flows in the downtown area
  - A 200 mm diameter watermain along 52 Avenue to support the northwest residential area
  - A 300 mm diameter watermain along 54 Avenue to improve fire flows:
    - In the medium density development located along 51 Street and 54 Avenue
    - In the northeast residential area
    - At Lilian Schick School

Some dead ends / cul-de-sacs will require future adjacent development and watermain looping to fully satisfy the fire flow criteria. Watermain extensions may or may not be identified for these locations at this time.

As well, it is recommended that the outgoing pressure from the Pumphouse be increased to 57 psi (from 50 psi) to provide a minimum pressure of 50 psi throughout the community (during the average day demand scenario). It is acknowledged that the pressure had been lowered to reduce potential leakage in the system (which increases with pressure). Should the Town feel that there is general user satisfaction within the distribution system at the current pressure, then this recommendation can be held until deemed necessary.

Should the Town wish to increase the operating pressure to provide a minimum of 50 psi throughout, the VFD setpoint should then be revised to 393 kPa (57 psi, 741 m HGL). It is recommended that the current fire / standby PRV setpoint be maintained at 448 kPa (65 psi, 746.3 m HGL).

The upgrades indicated on Figure 4-1 are those required to meet the recommended fire flow criteria. However, it is recommended that mains be upsized to the minimum recommended diameter when the opportunity arises, such as during neighbourhood upgrading or renewal projects. It is recommended that a minimum of 200 mm diameter pipes be installed in all residential areas and a minimum of 250 mm diameter pipes be installed in all multi-family and commercial / industrial areas.

Following the proposed upgrades, there are a few isolated locations which are not anticipated to meet the recommended fire flow criteria (the locations are identified on Figure 4-1). A brief discussion on each location is provided below:

Medium Density location on 48 Avenue east of 51 Street
Although this location is identified as medium density development on the land use plan, it does not appear that anything greater than a duplex is currently constructed (requiring typical residential fire flows of 83 L/s). As well, the Available Fire Flow is only minimally short of the target flow of 133 L/s, at 129 L/s.

Northwest Residential Cul-de-Sacs
Fire Flows in the cul-de-sacs located along 54 Street and 52A Avenue are somewhat deficient in fire flow, with available fire flows ranging between 64 L/s to 78 L/s (out of a target of 83 L/s). It is recommended that the Town consult with the local fire department to determine if the hydrants located within these dead-end locations would be used to fight fire prior to considering an upgrade.

Lilian Schick School
An available fire flow of 143 L/s is achieved at Lillian Schick School, which is less than the target fire flow of 167 L/s.

In addition to the watermain upgrades identified above, seven new hydrants are recommended to improve hydrant coverage throughout the Town, as shown on **Figure 3-3**.

4.2 Pumping

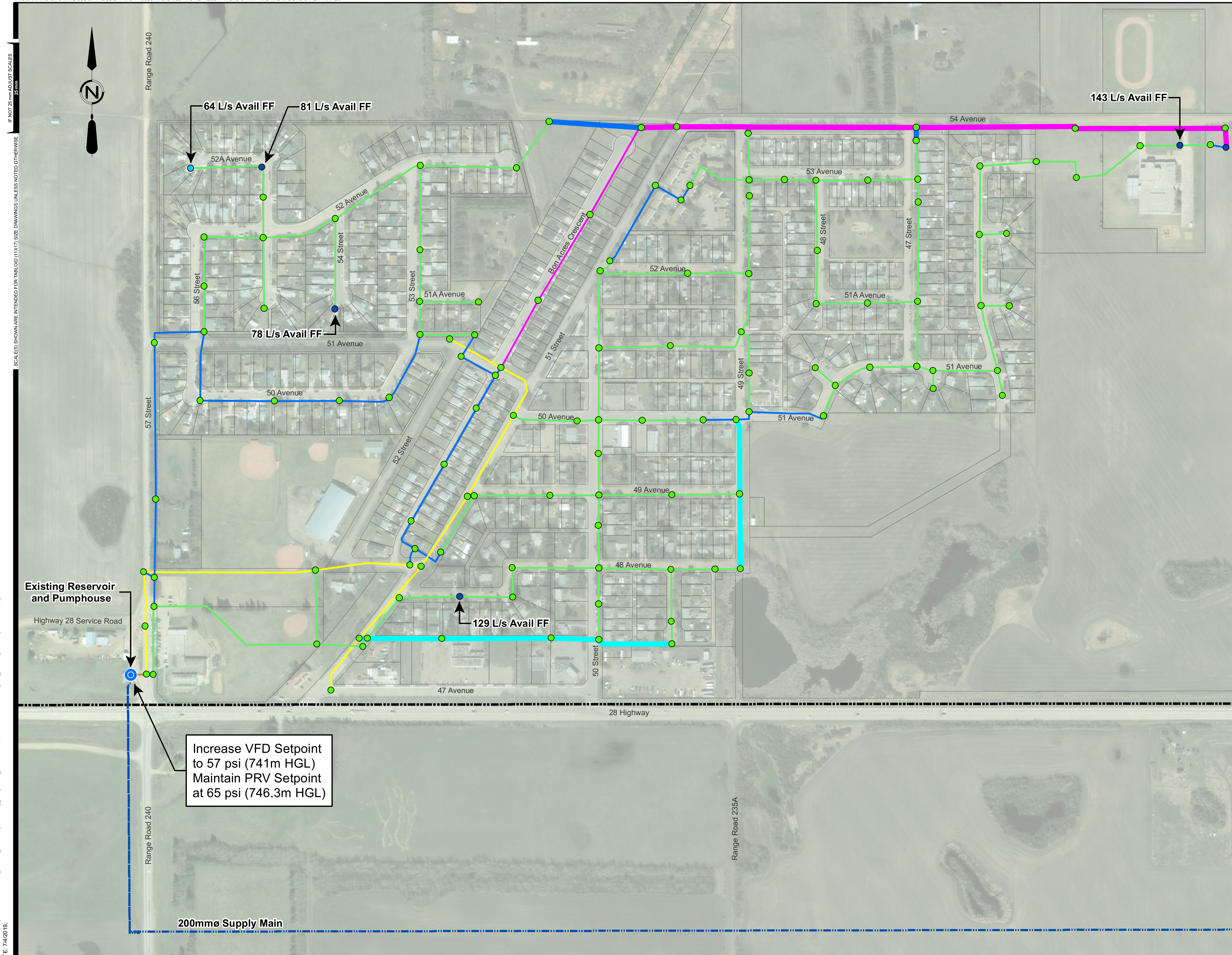
Table 3-2 identifies that there is ample pumping capacity available beyond 2044. This is true whether Pumps 101 and 102 are retained as backup, or if Pump 103 is retained as backup. The table also identifies that there is sufficient fire / standby pump capacity to meet the projected peak day plus fire flow demand beyond 2044.

It is recommended that the Town consider revising the current operating philosophy such that Pump 101 or 102 (25 L/s) operate as the lead pump, as Pump 103 (55 L/s) is significantly oversized for the Town's average day flow (4 L/s).

It is proposed that the distribution pump VFD setpoint be increased to 393 kPa (57 psi, 741 m HGL) as identified in Section 4.1.

4.3 Storage

Table 3-3 identifies that there is sufficient storage to service the projected population beyond 2044.



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Legend:

- Existing Reservoir and Pumphouse

Fire Flow

- Exceeds Fire Flow Requirements
- 80% - 99%
- 60% - 80%
- 40% - 60%
- 0% - 40%

Distribution System

- Existing 150 mmø
- Existing 200 mmø
- Existing 250 mmø
- Existing 300 mmø
- Existing 350 mmø
- Existing 400 mmø
- Proposed 200 mmø
- Proposed 250 mmø
- Proposed 300 mmø
- Supply Main
- Town Boundary

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FIGURE No. 4-1

TOWN OF BON ACCORD
WATER MASTER PLAN UPDATE

EXISTING WATER SYSTEM
WITH UPGRADES

AE PROJECT No.	2019-3459
SCALE	1:5,000
COORD. SYSTEM	NAD 1983 UTM ZONE 12N
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

IF NOT 25 mm ADJUST SCALES 25 mm
SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

\\ae-edm-fs-01\projects\20193459\00_Master_Servicing\Working_Dwgs\010_GIS\ArcMap\WaterMasterPlan\Fig4-1_ExistingWaterSystemwithUpgrades.mxd
DATE: 7/4/2019.

5 SYSTEM EXPANSION

5.1 Ultimate Water Distribution System

The proposed Ultimate Water System Concept is presented on **Figure 5-1**. In general, a fire flow of 200 L/s has been assumed in each future residential area to allow for high density development (walk-up apartments). A fire flow of 183 L/s has been allowed for in all future non-residential developments.

Generally, only major watermains (250 mm and above) have been identified in the expansion areas. It is anticipated that additional watermains will be installed and will be suitably sized based on adjacent development. In typical single family residential development areas, looped 200 mm mains will generally be sufficient.

The Meadows of Bon Accord ASP was reviewed and incorporated into the development concept, with some minor revisions made to reflect the proposed transportation system.

5.1.1 Distribution System

Figure 5-1 presents the proposed distribution system for the Ultimate System. This figure presents the overall peak hour pressure rather than insufficient fire flow as all expansion areas will achieve full fire flow (unless otherwise noted on the figure). It provides an overview of the lowest anticipated pressures at full development.

As shown in **Figure 5-1**, it is proposed that each quarter section be serviced with two major watermains running east/west, and that several north/south watermain connections also be installed. This has been proposed to facilitate relatively small development pockets, with the goal of constructing a significant watermain in close proximity to existing development. The intent is to support expansion in all directions, which may encourage smaller pocket development, while reinforcing the existing distribution system. Should a major development occur, a single 300 mm watermain running through the quarter section may be sufficient. Once again, local looped watermains will need to be sized in accordance with the adjacent land use.

It has been assumed that the pumphouse will be operated at the proposed distribution system pressure of 393 kPa (57 psi, 741 m HGL) in the ultimate development scenario. No new pressure zones are required as the pumphouse can adequately accommodate the topography of the expansion areas. The pressures will range from 344 - 420 kPa (50 - 61 psi) in the average day scenario, and from 49 - 60 psi (338 - 416 kPa) in the peak hour scenario. Based on the proposed HGL of 741 m at the Reservoir and Pumphouse, all pressures will be within the target limits during the average day scenario, with pressure falling to 49 psi at Lilian Schick School during the peak hour scenario.

Fire Flows are fully met in all new development lands. As shown in **Figure 5-1**, 52A Avenue cul-de-sac will continue to fall somewhat short of the target fire flows. The Town could choose to upsize the watermain to a 200 mm pipe, should they wish to address this shortfall.

5.1.2 Pumping and Storage

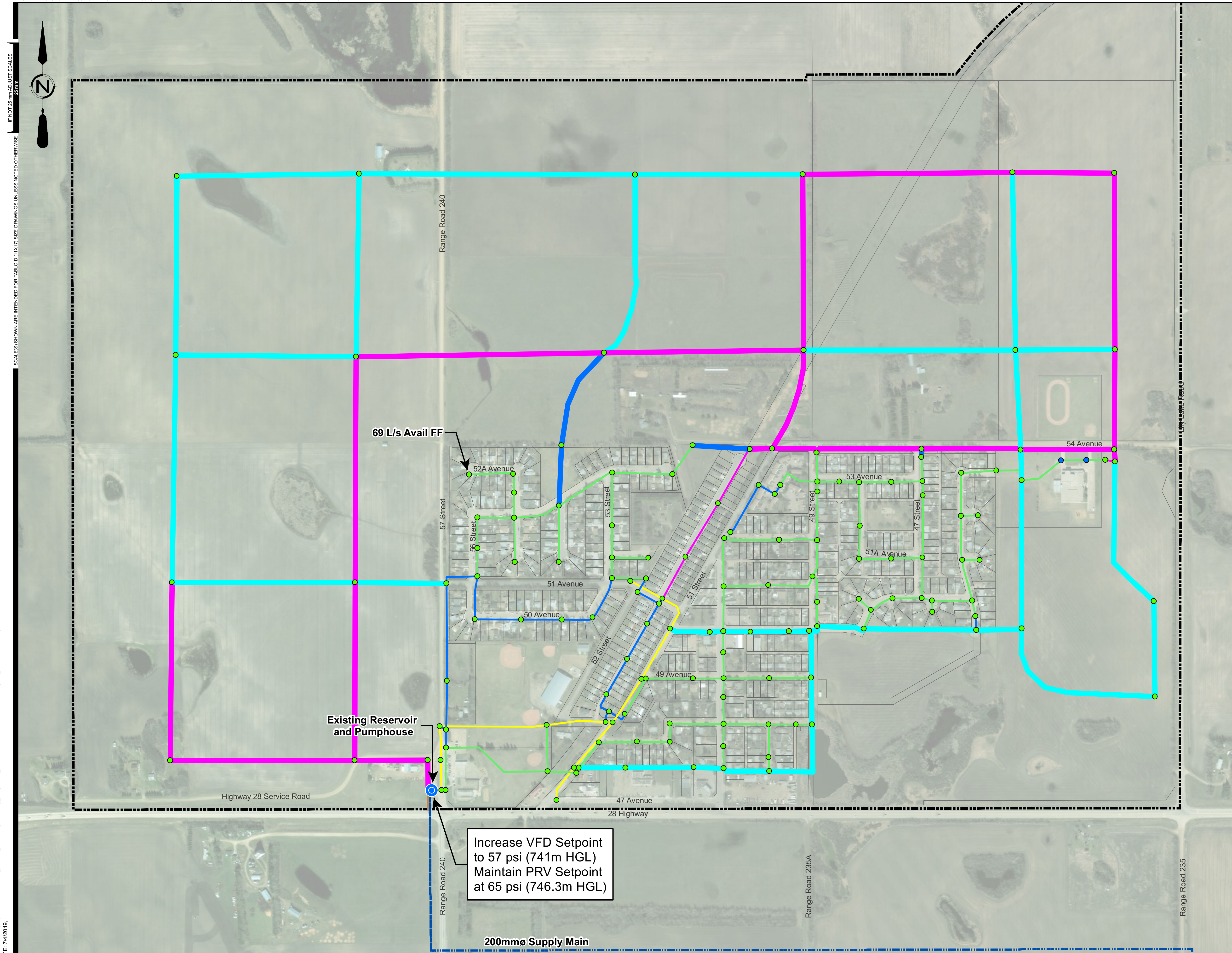
As presented in **Table 3-2**, pumping upgrades are not anticipated in the next 25 years (based on capacity). It is recommended that pumps be regularly inspected and maintained to prolong their lifespan. It should be anticipated that pumps may need to be replaced every 10 - 15 years based on condition.

As presented in **Table 3-3**, there is ample available storage to meet the Town's projected growth and an expansion is not anticipated to be required within the next 25 years. It is estimated that an expansion of approximately 2,000 m^3 will be required to service the ultimate development area at full buildout.

5.2 Regional Supply

The capacity of the CRNWSC supply main to Bon Accord has not been assessed as it is not within the scope of this study.

THIS DRAWING IS FOR THE USE OF THE CLIENT AND PROJECT INDICATED - NO REPRESENTATIONS OF ANY KIND ARE MADE TO OTHER PARTIES



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Legend:

- Existing Reservoir and Pumphouse

Peak Hour Pressure

- 40 - 50 psi (280 kPa - 345 kPa)
- 50 - 80 psi (345 kPa - 550 kPa)
- 80 - 90 psi (550 kPa - 620 kPa)

Distribution System

- Existing 150 mmø
- Existing 200 mmø
- Existing 300 mmø
- Existing 350 mmø
- Existing 400 mmø
- Proposed 150 mmø
- Proposed 200 mmø
- Proposed 250 mmø
- Proposed 300 mmø
- Supply Main
- Town Boundary

Town of Bon Accord
building for tomorrow

FIGURE No. 5-1

TOWN OF BON ACCORD
WATER MASTER PLAN UPDATE

ULTIMATE WATER SYSTEM

AE PROJECT No.	2019-3459
SCALE	1:8,000
COORD. SYSTEM	NAD 1983 UTM ZONE 12N
DATE	2019 JULY
REV	
DESCRIPTION	ISSUED FOR DRAFT

IF NOT 25 mm ADJUST SCALES 25 mm

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

DATE: 7/4/2019.

6 COST ESTIMATES

6.1 Capital Cost Estimates

A summary of capital cost estimates is provided in Table 6-1 below for upgrades which are recommended for the existing water system, as well as for the ultimate development scenario. The estimates presented include an allowance for engineering (15%) and contingency (15%), but do not include GST. The costs are based on 2019 construction dollars. Unit costs and detailed estimates are provided in Appendix A.

No costs are presented for the ultimate development scenario in new development areas as costs for watermains 300 mm and smaller are anticipated to be covered by developers. Costs for offsite watermains within the existing developed section of the Town have been included in the ultimate development scenario costs.

Table 6-1
Summary of Capital Cost Estimates

Upgrades to Existing System	
Watermains	$2,374,000
Hydrants	$140,000
TOTAL UPGRADES TO EXISTING SYSTEM	**$2,514,000**
Ultimate Development Scenario	
Watermains	$1,281,000
Ultimate Reservoir Expansion	$2,000,000
TOTAL ULTIMATE DEVELOPMENT SCENARIO	**$3,281,000**

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

- The current outgoing pumphouse pressure of 345 kPa (50 psi) results in a minimum distribution system pressure of 293 kPa (43 psi) at Lilian Schick School during the average day demand scenario. Over half of the Town experiences pressure lower than 345 kPa (50 psi), which is lower than recommended during the average day scenario.
- Although many peak hour pressures also fell below 345 kPa (50 psi), this is considered acceptable during peak demand periods.
- A number of locations within Bon Accord did not fully satisfy the Peak Day plus Fire Flow criteria. Although these locations may not fully meet the target fire flow criteria at the reduced flowrates, there will be water available for fighting fire.
- The largest distribution pump (P-103) currently operates as the lead pump.
- There is ample pumping capacity to meet the 25 year projected water demands and fire flow requirements.
- There is ample storage capacity to meet the 25 year projected water demands and fire flow requirements.
- The majority of Town has adequate fire hydrant coverage.
- Upgrades to the distribution system will be required to meet the recommended fire flows throughout the Town. Upgrades were not recommended to all deficient areas, as some will be rectified over time as adjacent areas develop.
- No additional pressure zones will be required in the ultimate development scenario as the pumphouse can adequately accommodate the topography of the expansion areas.

7.2 Recommendations

- Install seven additional hydrants as per **Figure 3-3.**
- Increase the outgoing pumphouse pressure to 393 kPa (57 psi, 741 m HGL) to increase minimum distribution pressures to 50 psi during the average day scenario.
- Operate one of the small distribution pumps as the lead pump (P-101 or P-102).
- Undertake the proposed upgrades identified in **Figure 4-1**.
- Implement the proposed ultimate servicing plan identified in **Figure 5-1**.
- Install minimum recommended pipe sizes when undertaking neighbourhood rehabilitation projects.

CLOSURE

This report was prepared for the Town of Bon Accord to provide a Water Master Plan Update.

The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering Alberta Ltd.

2019-10-03
Candice Gottstein, P.Eng.
Project Engineer

2019-10-07
Diego Mejia, P.Eng.
Project Manager

ASSOCIATED ENGINEERING
QUALITY MANAGEMENT SIGN-OFF
Signature:
Date: October 4, 2019

APEGA Permit to Practice P 3979

APPENDIX A - DETAILED COST ESTIMATES

Table A-1
Cost Breakdown

Town of Bon Accord Water Master Plan

Upgrades to Existing System

Watermains

Location	From	Start Node	To	Stop Node	Length (m)	Diameter (mm)	Unit Cost ($/m)	Pipe Cost	Type
54 Avenue	Bon Acres Crescent	J-516	Lilian Schick School	J-508	850	300	$1,530	$1,300,500	Gravel/Rural
54 Avenue	Bon Acres Crescent	J-516	52 Avenue Extension	J-49	130	200	$950	$123,500	Undeveloped
47 Street	End of Watermain	J-206	54 Avenue	J-514	20	200	$1,350	$27,000	Gravel/Rural
49 Street	48 Avenue	J-142	51 Avenue	J-156	210	250	$1,420	$298,200	Gravel/Rural
Back of Commercial	51 Street	J-106	49A Street	J-144	440	250	$1,420	$624,800	Gravel/Rural
							Total Watermains	**$2,374,000**	

Hydrants

Hydrants	Quantity	Unit Cost (each)	Total Cost
New Hydrant Installation	7	$20,000	**$140,000**

Ultimate Development

Watermains

Location	From	Start Node	To	Stop Node	Length (m)	Diameter (mm)	Unit Cost ($/m)	Pipe Cost	Type
50 Avenue	51 Street	J-78	51 Avenue	J-208	450	250	$2,300	$1,035,000	Developed
49 Street	48 Avenue	J-142	South of 48 Ave	J-556	105	250	$1,420	$149,100	Gravel/Rural
Back of Commercial	50 Street	J-144	49 Street	J-556	95	250	$1,020	$96,900	Undeveloped
							Total Watermains	**$1,281,000**	

Reservoir Expansion

Reservoir and Pumphouse	Volume (m^3)	Unit Cost ($/$m^3$)	Total Cost
Reservoir Expansion	2,000	$1,000	**$2,000,000**

Table A-2
Watermain Unit Costs ($/m)

Town of Bon Accord Water Master Plan

Undeveloped Lands

Item	200mm	250mm	300mm	350mm	400 mm	450 mm	500 mm	600 mm
Topsoil Stripping and Stockpiling (assuming depth of 0.4 m)	$21	$21	$21	$21	$23	$23	$23	$23
Trenching and Backfilling	$305	$305	$305	$305	$357	$357	$357	$357
Pipe Zone Material	$32	$32	$32	$32	$58	$58	$58	$58
Supply and Install DR18 PVC Pipe	$95	$125	$180	$240	$315	$405	$500	$695
Place Topsoil, Compact, and Seed	$42	$42	$42	$42	$47	$47	$47	$47
Fire Hydrant (1 every 90 m)	$116	$116	$116	$116	$116	$116	$116	$116
Gate valve (1 per 100 m 300 mm dia. and smaller, 1 per 200 m 400 mm dia. and larger)	$37	$58	$79	$105	$68	$89	$116	$147
Fittings (Tees, Bends, Reducers, Plugs)	$13	$15	$17	$18	$23	$27	$32	$36
Miscellaneous (Mob/De-Mob, Survey, Signage) (10%)	$66	$71	$79	$88	$101	$112	$125	$148
Total Construction	$727	$785	$871	$967	$1,108	$1,234	$1,374	$1,627
Contingency (15%)	$109	$118	$131	$145	$166	$185	$206	$244
Engineering (15%)	$109	$118	$131	$145	$166	$185	$206	$244
Total (rounded)	**$950**	**$1,020**	**$1,130**	**$1,260**	**$1,440**	**$1,600**	**$1,790**	**$2,110**

An additional $400/m has been included in the detailed cost estimate for partial rural/gravel roadway repair where necessary.

Developed Lands

Item	200mm	250mm	300mm	350mm	400mm	450 mm	500 mm	600 mm
Asphalt Pavement Removal	$52	$52	$52	$52	$79	$79	$79	$79
Granular Base Removal and Disposal	$37	$37	$37	$37	$53	$53	$53	$53
Curb, Gutter, and Sidewalk Removal	$58	$58	$58	$58	$58	$58	$58	$58
Trenching and Backfilling	$420	$420	$420	$420	$473	$473	$473	$473
Pipe Zone Material	$32	$32	$32	$32	$58	$58	$58	$58
Supply and Install DR18 PVC Pipe	$95	$125	$180	$240	$315	$405	$500	$695
Existing Pavement Repair	$231	$231	$231	$231	$347	$347	$347	$347
New Monolithic Curb, Gutter, and Sidewalk	$221	$221	$221	$221	$221	$221	$221	$221
Fire Hydrant (1 every 90 m)	$116	$116	$116	$116	$116	$116	$116	$116
Gate valve (1 per 100 m 300 mm dia. and smaller, 1 per 200 m 400 mm dia. and larger)	$37	$58	$79	$105	$68	$89	$116	$147
Fittings (Tees, Bends, Reducers, Plugs)	$13	$15	$17	$18	$23	$27	$32	$36
Reconnect Services	$231	$231	$231	$231	$0	$0	$0	$0
Manhole / Valve / Catch Basin Adjustments	$11	$11	$11	$11	$11	$11	$11	$11
Miscellaneous (Mob/De-Mob, Survey, Signage) (10%)	$155	$161	$169	$177	$182	$194	$206	$229
Total Construction	$1,709	$1,768	$1,854	$1,949	$2,004	$2,131	$2,270	$2,523
Contingency (15%)	$256	$265	$278	$292	$301	$320	$341	$379
Engineering (15%)	$256	$265	$278	$292	$301	$320	$341	$379
Total (rounded)	**$2,220**	**$2,300**	**$2,410**	**$2,530**	**$2,610**	**$2,770**	**$2,950**	**$3,280**