Town of Okotoks

Zone 3S Reservoir Feasibility – Phase 1

Technical Memorandum

CIMA+ file number: C04-00459
April 28, 2022 – Review FINAL

Town of Okotoks

Zone 3S Reservoir Feasibility – Phase 1

Technical Memorandum

Prepared by: Jamie Purdy
Lead Technician, CET

PROFESSIONAL ENGINEER ALBERTA
STEVEN P DAWE
ID 85297
April 29 2022

Verified by: Steven Dawe
Lead Engineer, P. Eng.

CIMA+

#300 6815 8 St NE, Calgary, AB
Canada T2E 7H7

CIMA+ file number: C04-00459
April 28, 2022 – Review FINAL

Review and submission register			
Review No.	Reviewed by	Date	Description of the change or submission
DRAFT	JP/SD	Oct 29 2021	Draft report
DRAFT V2	JP/SD	Dec 13, 2021	Revised draft addressing Town comments
FINAL	JP/SD	April 28, 2022	Final report

Executive Summary

This report is Phase 1 of the Zone 3S Reservoir Feasibility Study. The intent of a phased study was to expedite the initial stages of the feasibility study. This was to support the review and approval process of the West Okotoks ASP, which contains a lot set aside for the proposed reservoir.

Phase 1 had the following objectives:

+ Review and confirm the proposed pressure zone boundaries
+ Investigate and verify whether a new south reservoir is required and justified
+ Investigate and verify the proposed location of the south reservoir in the West Okotoks ASP
+ Investigate and verify the reservoir lot size in the West Okotoks ASP

Pressure Zones

The result of the pressure zone review is that they can remain largely unchanged, with several exceptions:

+ The Zone 1S pressure zone has been increased by 60 kPa (9 psi) at the beginning of September 2021. This can be maintained and used to supply the proposed reservoir
+ The 2S pressure zone is currently considered to be two separate pressure zones, Zone 2S-1 and Zone 2S-2, in order to service the portion of development that currently resides in the Zone 3S boundary. Once the new reservoir is constructed the Zone 2S can be merged back into a single zone. This would involve opening the isolation valves, opening or decommissioning the PRVs, and reducing the discharge pressure at Westmount booster to be in line with the 1128 m HGL.
+ Zone 3S Should have its north boundary where it meets with Zone 2S-1 extended to Big Rock trail, in order to have adequate service pressure of the high elevation area that was in Zone 2S-1. This could be extended further to incorporate the existing development at Sheep River Heights. This would require reducing the lower elevation of the pressure zone by 12 m, resulting in potential service pressures above 103 psi.

New Reservoir Justification

There are currently no reservoir storage volume constraints at the South Reservoir, according to the Alberta Environment storage reservoir calculations or the Max Day Demand storage calculation, however with the Max Day Demand calculation the existing reservoir only has approximately 50 m^3 of remaining capacity. When assessing the system against the Max Day Demand storage calculation, a storage expansion would be needed to support any additional development. Constructing a new reservoir that can supply all of the Zone 1S, 2S and 3S demands for a full day at Max Day Demand will effectively provide resiliency to the Town's water infrastructure to the effects of future climate change, such as floods or water insecurity.

When looking at the South Reservoir pump station and the Big Rock and Westmount booster stations, there are currently no constraints in their peak pumping capacity, with the exception that Big Rock can't provide fire flows. It is assumed that Westmount can provide those flows through the PRVs. However, by the Short Term scenario, Westmount will be out of capacity with regards to Peak Hourly Demand. Operators also stated that the Westmount fire pump turns on during high demand periods, which may mean the pumping capacity of Westmount is lower than expected, or the peak demands are higher than estimated. Additionally, by the Short Term scenario, the South Reservoir pump station and both booster stations will require additional capacity for the Max Day Demand + Fire Flow scenario. This is due to the expectation of industrial development in both the 1S and 2S zones, which would necessitate an available fire flow of 225 L/s.

Considering that upgrades will be required to the Westmount/Big Rock boosters and the South Reservoir pump station in the short term, and an additional booster station would be required to service Zone 3S if no reservoir were constructed, it would be justified to instead construct a new reservoir and pump station, and decommission the existing booster station.

Verification of Reservoir Lot Size

The full buildout volume for the storage reservoir is approximately 22,000 m^3. We investigated several similarly sized reservoirs and pump stations from nearby communities, and determined that a minimum lot size of 0.9 ha would be required.

Verification of Reservoir Location

The available hydraulic grade line that the Zone 1S could supply to the proposed reservoir location at full buildout is approximately 1106 m. Ideally the reservoir would be located at the same elevation as the HGL, in order to maximize the efficiency of the supply and distribution of water. The proposed location does not meet the elevation requirements, and instead a new location should be selected.

Instead, it is recommended that the reservoir location be changed to the parcels south of the multifamily land use site in the centre of the NASP area. This area has an overall elevation of approximately 1107 m, is relatively flat, and has favourable bedrock contours below it.

Reservoir Staging

The proposed reservoir can be staged in order to minimize upfront costs, and support future development as it is being planned.

Initial development of the West Okotoks NASP area could be supplied by Zone 2S, bounded roughly by the environmental reserve to the west and Westridge Dr to the south. However, development would quickly result in the South Reservoir being over capacity under the Max Day Demand storage calculation.

The initial phase of the reservoir should be approximately 8,000 m^3, in order to support the Max Day Demand of the existing Zone 1S and 2S area, and the estimated demands of the West Okotoks NASP area.

Future phases would be determined as development timelines become clearer, with one possibility being two additional 7,000 m^3 cells constructed as needed to meet the eventual 22,000 m^3 storage requirement.

Table of Contents

List of Tables

List of Figures

1. Introduction

In September 2021 the Town of Okotoks retained CIMA+ to prepare a feasibility study for a proposed new reservoir servicing the southern portion of Okotoks. This study is to be delivered in two phases.

This first phase will address the immediate needs of the Town, such as whether the reservoir is required, how large it needs to be, and where it should be built. The second phase with take a deeper investigation into the hydraulic and financial feasibility of the reservoir.

1.1 Background

A reservoir in the southern side of Okotoks has been considered for a number of years. This project has been proposed it previous Master Plans, and the Town has been collecting levies for it.

As of September 2021, the West Okotoks NASP is in active development. It Is located on NW ¼ 20-20-29-W4. As it is located in one of the highest elevation areas in the southern portion of Okotoks, it had been determined by the Town that this was a probable location for the proposed reservoir. The Town made it a requirement to set aside land for the reservoir in the NASP. As such, a 3 acre parcel was set aside in the southeast corner of the NASP area for the reservoir in the preliminary land use concept.

Phase 1 of this report will serve largely to verify the proposed location and parcel size, in order to expedite the NASP approval process.

1.2 Objectives

The stated objectives of this study are as follows:

- Review and confirm the proposed pressure zone boundaries, pressure/HGL range and HGL using LiDAR and pressure measurements
- Investigate and verify whether a new south reservoir is required and justified, considering:
  - Storage requirements across south Okotoks and emergency storage considerations
  - Peak flow capabilities of south reservoir
  - Peak flow capabilities of Big Rock and Westmount booster stations
- Investigate and verify the proposed location of the south reservoir in the West Okotoks NASP land use concept plan, with a priority on supplying the south reservoir without a booster station
- Investigate and verify the reservoir lot size in the West Okotoks NASP land use concept plan, considering the ultimate buildout reservoir size

2. Pressure Zones

South Okotoks currently consists of three pressure zones:

+ Zone 1S – supplied from the South Reservoir
+ Zone 2S – supplied from Westmount and Big Rock booster stations
    - These should be considered two separate zones, as the two booster stations have different distribution set points, and are separated by PRVs
+ Zone 3S – Portion of the West Okotoks NASP falls in this zone. No separate supply is in place for this zone, a new reservoir or booster station would be needed to support development

2.1 Current Pressure Zone Boundaries

The following table shows the current pressure zone set points, including highest elevation, lowest elevation, highest service pressure, lowest service pressure, and Hydraulic Grade Line (HGL), as noted by Okotoks staff. These values will be reviewed through fields measurements and SCADA data.

Zone	Low Elevation (m)	High Elevation(m)	Low Service Pressure (psi)	High Service Pressure (psi)	HGL (m)
1S	1040	1070	47	90	1103
2S	1062	1098	57	108	1138
3S	1096	1122	49	86	1156

The current boundaries of the established pressure zones are as shown in the figure below.

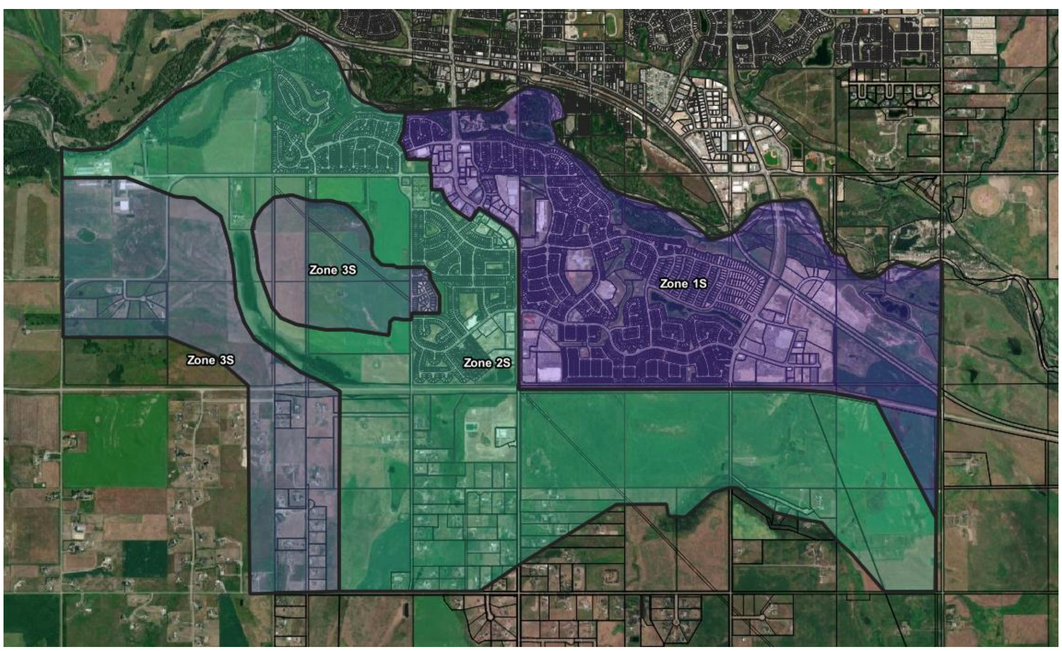

Figure 2-1 Existing Pressure Zone Boundaries

2.2 Pressure Zone Review

The existing pressure zones HGL in south Okotoks are established through the pump station distribution pressures, and maintained by PRV setpoints. The distribution pressures of the South Reservoir, Westmount Booster Station, and Big Rock Booster Station have been reviewed to determine HGL from each. Additionally, hydrant pressure measurements taken during hydrant flow tests were reviewed for HGL. Finally, the high and low elevations of the pressure zones were checked against LiDAR data using the pressure zone boundaries.

Currently pressure Zone 2S is operating as two separate pressure zones, as they are fully separated through PRVs and closed valves, and have different supply pressures. The northern portion, supplied by Big Rock, will be considered pressure Zone 2S-1, and the southern portion, supplied by Westmount, will be considered Zone 2S-2.

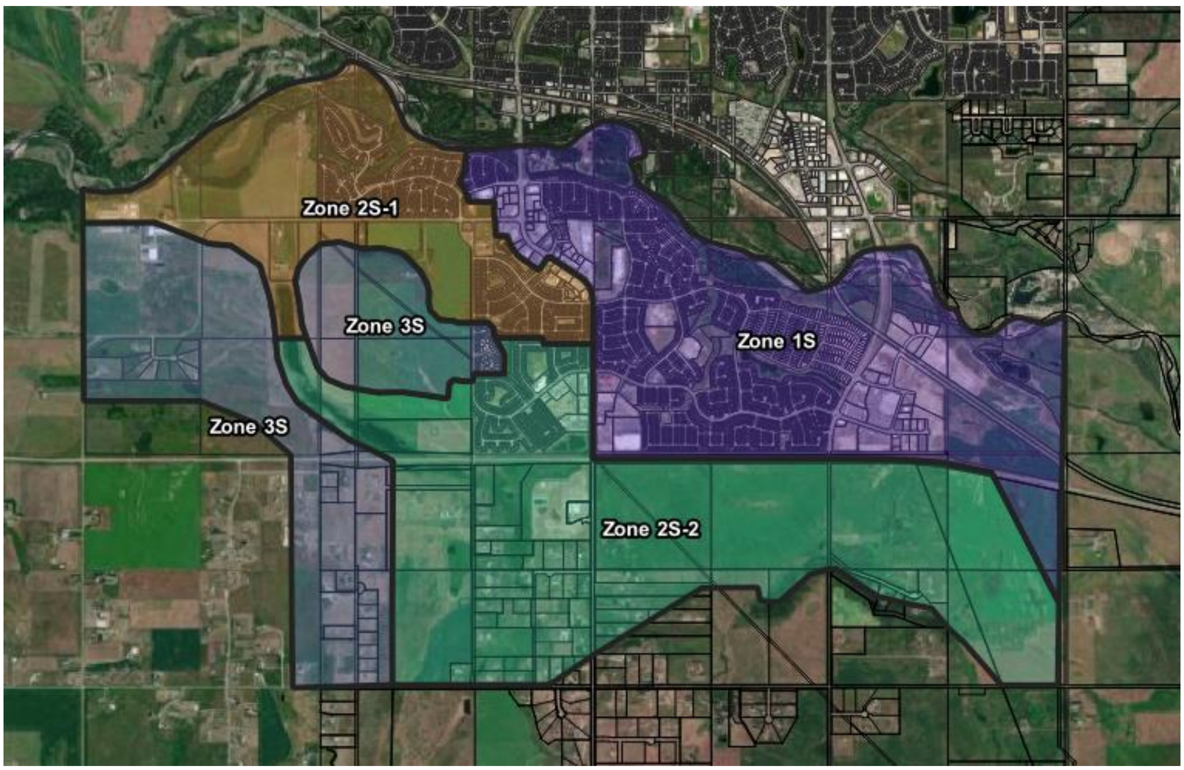

Figure 2-2 Updated Zone 2S

Distribution Pressures

Distribution pressures out of South Reservoir, Big Rock Booster, and Westmount Booster were pulled from the SCADA data. The distribution pressure was averaged across the full data set, this value was used for the calculations. However, the South Reservoir appears to have altered its discharge setpoint from 500 kPa (73 psi), to 560 kPa (81 psi) in September 2021. For the purpose of this report, the increased pressure set point will be used.

The height of the pressure sensor at each location was accounted for, relative to floor elevation, in order to get the most accurate HGL value.

Table 2-1 Pump Station Distribution Pressures

Pump Station	Average Distribution Pressure (psi)	Pressure Head (m)	Floor Elevation (m)	Height of Pressure Sensor (m)	HGL (m)
South Reservoir	81.2	56.7	1053.2	1.24	1111.1
Westmount	101.2	71.4	1063.0	2.5	1136.9
Big Rock	77.7	54.7	1071.9	1.9	1128.5

Using the HGL calculated above, the distribution pressures for the high and low areas of the pressure zones can be calculated.

Table 2-2 Pressure Zone Service Pressures

Zone	Low Elevation (m)	High Elevation(m)	Low Service Pressure (psi)	High Service Pressure (psi)	HGL (m)
1S	1040	1070	59	102	1111.1
2S-1	1062	1098	44	95	1128.5
2S-2	1062	1098	56	107	1136.9
3S	1096	1122	49	86	1156.0

Hydrant Pressures

Hydrant pressures were taken from hydrant flow tests performed in 2016, 2017 and 2018. Hydrants were located using GIS, and ground elevation at each hydrant was taken from LiDAR in order to calculate the HGL.

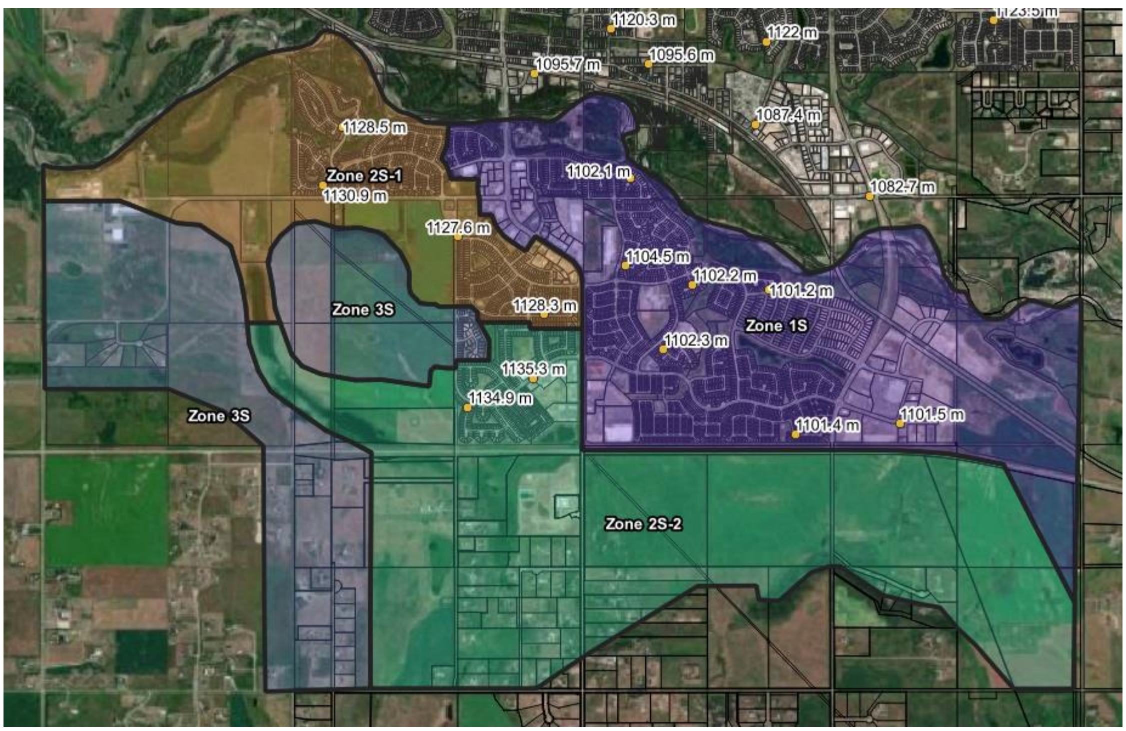

Figure 2-3 Pressure Zone HGL From Hydrants

Table 2-3 Pressure Zone Hydrant HGL

Zone	Average Hydrant HGL (m)
1S	1102.2
2S-1	1128.8
2S-2	1135.1

The HGL measured from hydrants are very similar to those calculated from the distribution points. The Zone 1S hydrant readings would have been taken when the lower (500 kPa) set point was in place.

Pressure Zone Boundaries

Each pressure zone was investigated using LiDAR, where the liar was clipped at the high and low elevations, and checked against the pressure zone boundaries.

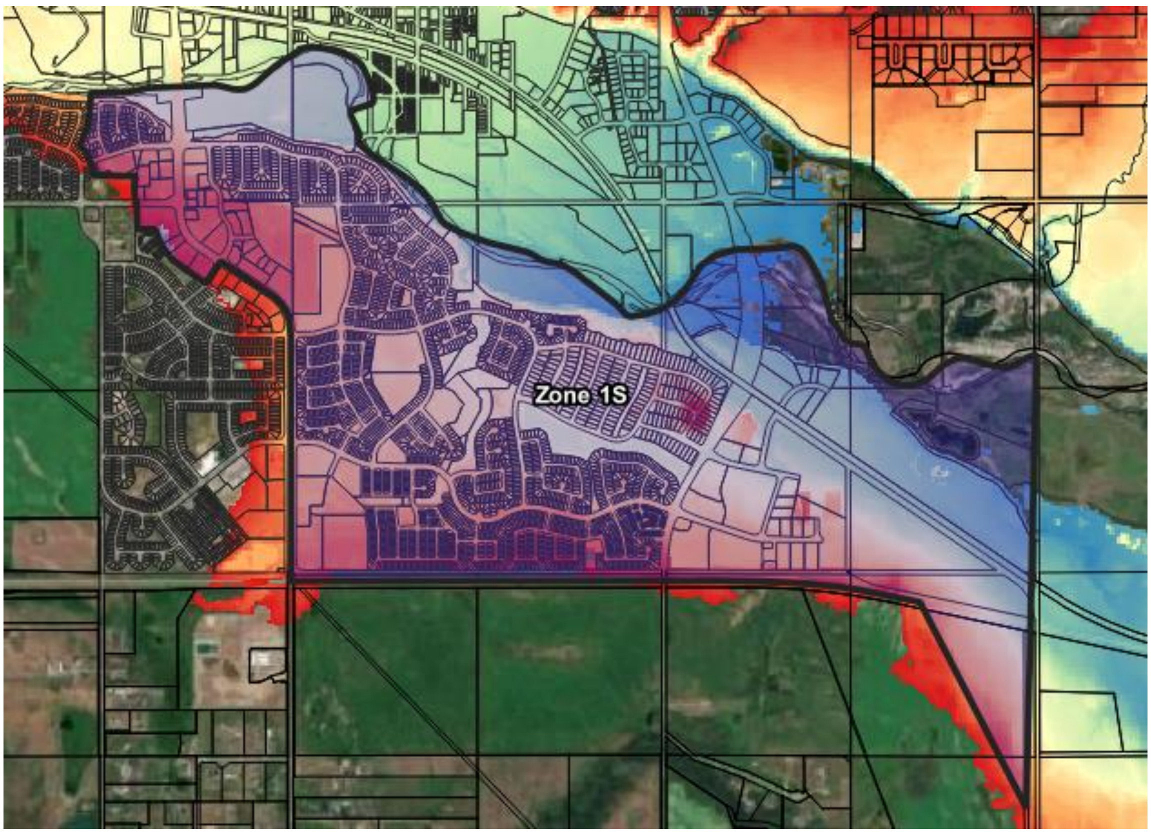

Figure 2-4 Pressure Zone 1S Boundaries

Pressure Zone 1S has boundaries that align with the proposed high and low elevations, and is otherwise defined on the west side through closed valves and PRVs. The current boundaries do extend beyond the low side on the north end, however that boundary is defined by the Sheep River.

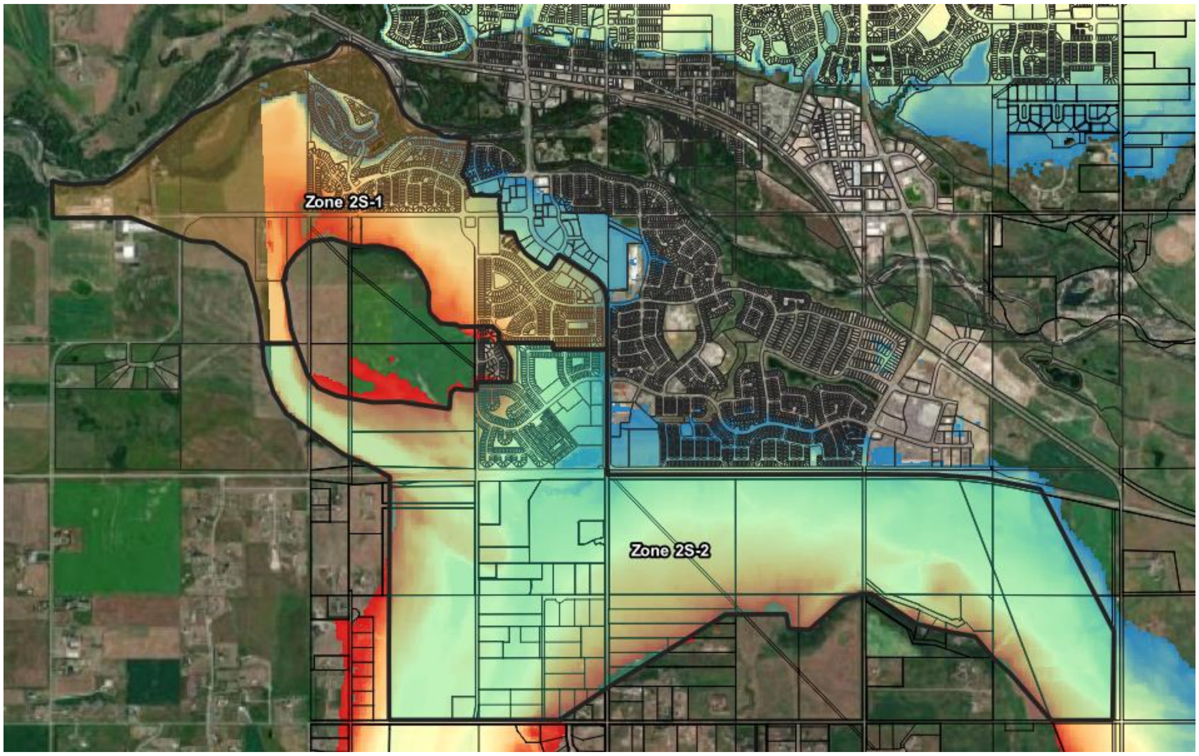

Figure 2-5 Pressure Zone 2S Boundaries

Pressure Zone 2S has boundaries that largely line up with the proposed high and low elevations. Zone 2S-1 does have some areas that are outside of range. The LiDAR cuts off on the west side of Zone 2S-1, so that portion could not be assessed.

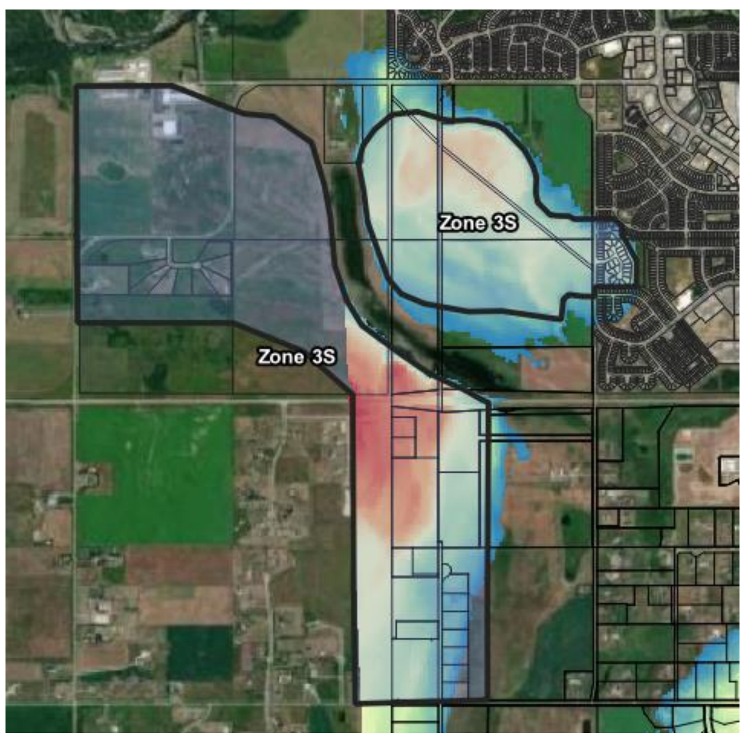

Figure 2-6 Pressure Zone 3S Boundaries

Pressure Zone 3S has boundaries that largely align with the proposed low and high elevations. The northern portion bounding Zone 2S-1 may need to be extended, as that would be a lower pressure area, and could be captured in Zone 3S. The western portion of Zone 3S could not be assessed due to the LiDAR.

2.3 Recommendations

Due to the portion of existing development that sits in Zone 3S, the Westmount booster station has needed to operate at a higher distribution pressure. As such, Zone 2S was divided into two separate zones. Once Zone 3S is operational, this will no longer be required, and Zone 2S can be revised back into a single zone. This would require lowering the distribution pressure at Westmount to match that of Big Rock, and opening the isolation valves and PRVs that currently separate the zones.

Zone	Low Elevation (m)	High Elevation (m)	Low Service Pressure (psi)	High Service Pressure (psi)	HGL (m)
2S	1062	1098	43	94	1128

A portion of Zone 3S should be extended towards Big Rock Trail, as it is currently in Zone 2S-1 and is outside of the service elevation.

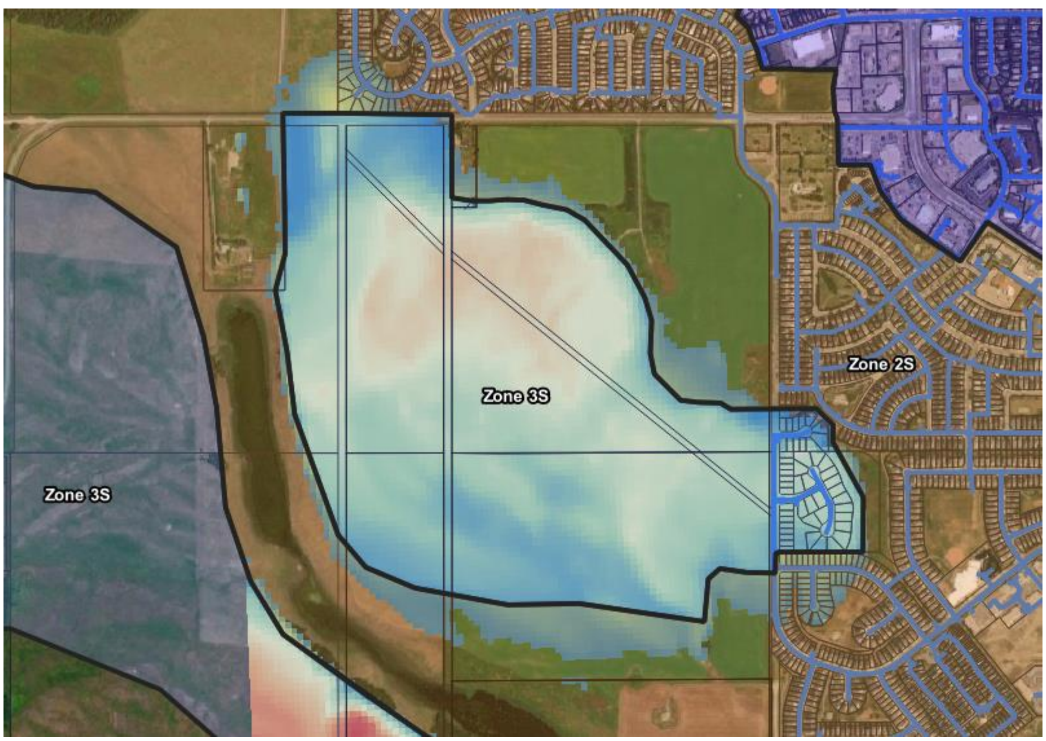

Figure 2-7 Updated Zone 2S/Zone 3S

This could be extended further to include the portion of existing development of Sheep River Heights, as that area experiences low service pressures. This would require installing PRVs in existing infrastructure. An expansion of the lower elevation ranges would be required to service this additional area, and could result in service pressures higher than the recommended 90 psi in the lowest portions. This could also allow for Zone 3S to service down to Highway 7.

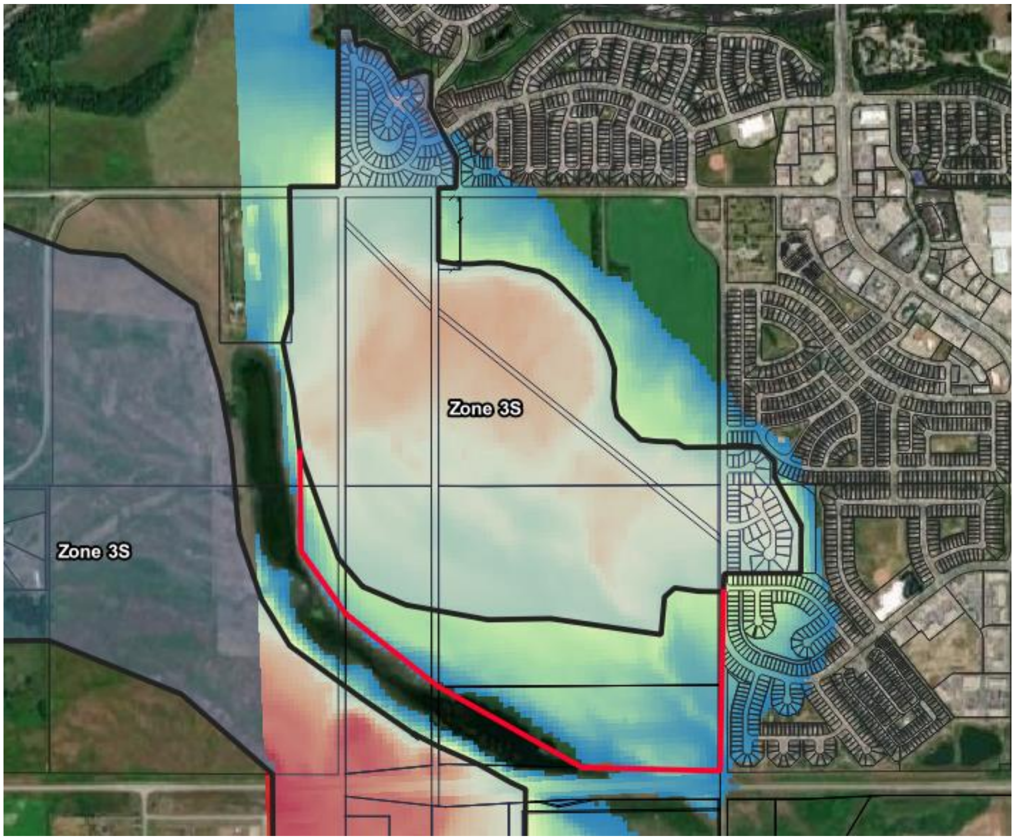

Figure 2-8 Alternative Zone 3S

Table 2-4 Alternative Zone 3S Service Pressures

Zone	Low Elevation (m)	High Elevation(m)	Low Service Pressure (psi)	High Service Pressure (psi)	TWL (m)
3S	1084	1122	49	103	1156.0

3. New Reservoir Justification

Need for a new reservoir will be shown by investigating the performance of the existing water storage and distribution system for south Okotoks, including the following:

- Storage requirements across south Okotoks and emergency storage considerations
- Peak flow capabilities of the South Reservoir
- Peak flow capabilities of Big Rock and Westmount booster stations

3.1 Storage Requirements

Currently the South Reservoir provides storage for all of Zone 1S and Zone 2S, and has a total storage volume of 6,390 m^3. Storage requirements will be assessed for both the existing system, the various scenarios in the Water Master Plan, and a Full Buildout scenario that encompasses the development of the full annexation boundary. The Full Buildout service area can be seen in Figure 3.1 in the next page.

The Water Master Plan scenarios were labelled 2029, 2044, and 2069, however due to variable growth rates these scenarios will be referred to as Short Term, Mid Term, and Long Term, respectively. The storage requirements will be assessed against two metrics, the first being the Alberta Environment recommended storage calculation, which utilizes the following formula:

Volume = A + B + C where:

- A = Fire storage (As per fire flow requirements)
- B = Equalization storage (25% of MDD)
- C = Contingency storage (15% of ADD)

The second metric to assess storage requirements will be storage volume for one day at Max Day Demand. This metric was determined through discussions with Town Staff, in consideration of the potential insecurity of the water supply and treatment system. The water treatment plant is located at the low point in Okotoks, near the Sheep River. In the 2013 floods, water levels nearly reached the main floor of the water treatment plant and South Reservoir pump station. Climate change could create more severe floods and create an emergency at the water treatment plant, or impact the raw water supply.

Water Demands

For the Existing scenario, the Average Daily Demand (ADD) and Maximum Daily Demand (MDD) out of the South Reservoir were pulled from the SCADA data. ADD was the average daily volume leaving the reservoir over the data set. MDD was the maximum recorded daily volume across the data set. They are as follows:

- ADD = 3,361 m^3 / day
- MDD = 6,340 m^3 / day

Residential land uses have a unit density of 30 units per ha, as per the Municipal Development Plan. Water consumption data for the south zones indicate a yearly average consumption of 170 m^3 per unit. With an average of 25% of total water consumption being unmetered, the adjusted yearly consumption is 212.5 m^3 per unit. For the purpose of this report, 215 m^3 per unit will be used.

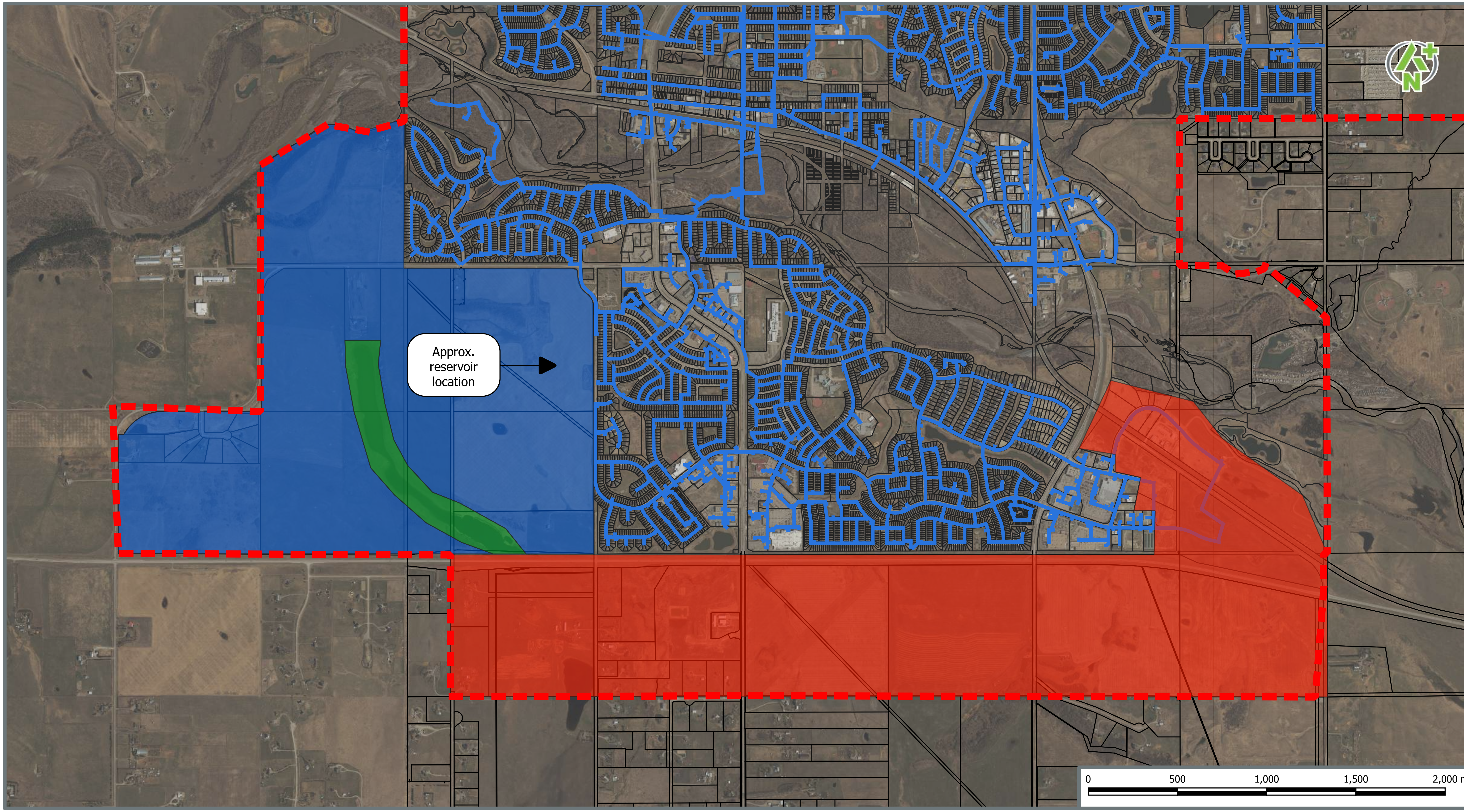

Figure 3.1 - Full Buildout Service Area

Scale 1:20,000

CIMA+

Annexation Boundary
Future ICI Land Use
Future Residential Land UseRes
Green Space / Wetland

PREPARED FOR TOWN OF OKOTOKS
SOUTH RESERVOIR FEASIBILITY STUDY
DECEMBER 2021

ICI land uses are noted in the Water Master Plan as having area based water consumption ranging from 4 m^3/ha per day to 12 m^3/ha per day, with 7 m^3/ha per day noted for industrial. As the primary land use in that area will be industrial, 7 m^3/ha per day water consumption will be used.

A peaking factor of 1.5 will be used for the max day demand, in accordance with the Water Master Plan.

For the future scenarios from the Water Master Plan, the ADD and MDD demands were pulled from the WaterCAD model. The WO NASP area was assumed to be fully built out, and demands were updated according to the residential density and consumption rates outlined above.

All demands in Zones 1S, 2S and 3S were summed together to get the ADD and MDD. They are as follows:

Table 3-1 Future Scenario Demands

Scenario	ADD (m^3)	MDD (m^3)
Existing + WO NASP	5,241	8,040
Mid Term	6,539	9,531
Long Term	7,831	12,460

The full buildout scenario water demands were estimated through land use type. There are two main land uses in the buildout area; residential and ICI (industrial, commercial, and institutional.

- Residential – Approximately 6 quarter sections of developable area, for a total of 400 ha, located west of Westland Rd and north of Highway 7
- ICI – Approximately 7 quarter sections of developable area, for a total of 470 ha, located primarily south of Highway 7

Table 3-2 Full Buildout Area Water Demands

Land Use	Area	Units	Demand	ADD (m^3)	MDD (m^3)
Existing	-	-	-	3,361	6,340
Residential	400	12000	215 m^3/unit/year	7,068	10,603
ICI	470	-	7 m^3/ha/day	3,290	4,935
Total				**13,719**	**21,878**

Alberta Environment Storage Calculation

According to the Water Master Plan, the required fire storage by the Short Term scenario for the South Reservoir is 2,430 m^3, due to industrial land uses being projected to come online. This is the equivalent of a required fire flow of 225 L/s for 3 hours.

For each scenario after existing, the fire storage volume remains the same. The following table shows the required reservoir storage volume for each scenario.

Table 3-3 Alberta Environment Reservoir Storage Calculations

Scenario	A – Fire Storage (m^3)	B - Equalization Storage (m^3)	C - Contingency Storage (m^3)	Storage Needed (m^3)	Storage Available (m^3)	Remaining Capacity (m^3)
Existing	1,620	1,585	504	3,709	6,390	**2,681**
Existing + WO NASP	2,430	1,912	786	5,128	6,390	**1,262**
Mid Term	2,430	2,405	981	5,815	6,390	**575**
Long Term	2,430	2,916	1,175	6,520	6,390	**-130**
Full Buildout	2,430	5,469	2,058	9,957	6,390	**-3,567**

As the reservoir storage calculations show, the South Reservoir will be nearing capacity by the Mid Term horizon, and be out of capacity before the Long Term horizon.

Max Day Demand Storage Calculation

While the existing reservoir can support development past the year Mid Term development horizon according to the Alberta Environment storage reservoir calculations, there are additional considerations, such as emergencies at the water treatment plant, or raw water supply constraints that may result in a need for additional storage. Discussions with the Town determined that using a storage volume of one day at Max Day Demand would be a reasonable metric to assess potable water security in the event of an emergency.

The following table shows the Max Day Demand for each scenario against the available capacity in the South Reservoir.

Table 3-4 Max Day Demand Storage Calculations

Scenario	Max Day Demand (m^3)	Storage Available (m^3)	Remaining Capacity (m^3)
Existing	6,340	6,390	**50**
Short Term	7,649	6,390	**-1,259**
Mid Term	9,618	6,390	**-3,228**
Long Term	11,662	6,390	**-5,272**
Full Buildout	21,878	6,390	**-15,488**

As the storage calculations show, the South Reservoir can only support one full day at Max Day Demand during the existing scenario, with minimal spare capacity. Under this metric additional storage volume would be required before the Short Term horizon.

3.2 Pumping Capacity

The South Reservoir pumps water to Zones 1S, 2S-1 and 2S-2. Westmount Booster and Big Rock Booster individually supply water to their respective zones from Zone 1S. Each pump station should be capable of providing flows during peak demands, particularly during Max Day Demand + Fire Flow, and Peak Hour Demand.

For the existing system, demands were pulled from the SCADA data set. For future scenarios, demands were divided evenly between the two booster stations. Firm pumping capacity of each pump station was retrieved from the Water Master Plan and compared against the documented pump curves and observed pumping capacity through the SCADA data.

Table 3-5 PHD Pumping Capacity

Pump Station	Pumping Capacity	Existing PHD (L/s)	Short Term PHD (L/s)	Mid Term PHD (L/s)	Long Term PHD (L/s)	Full Buildout PHD (L/s)
South Reservoir	285	170	182	227	272	506
Big Rock	84	31	46	68	86	211
Westmount	36	30	42	75	82	210

As the above table shows, the South Reservoir and the Big Rock booster can accommodate future scenarios up to the Mid Term scenario, after which the Big Rock booster is over capacity. The Westmount booster, on the other hand, is out of capacity at the Short Term scenario. According to statements from operations staff, and review of the SCADA data, the fire pump at Westmount can turn on during high demand periods. which may mean the noted capacity is less than expected or demands are higher than calculated.

For MDD+FF, the reservoir and booster stations all have a fire flow requirement of 150 L/s. Once the Short Term scenario is reached, there is ICI development expected in Zone 1S and 2S, according to the Water Master Plan. As such, the South Reservoir and boosters will have a fire flow requirement of 225 L/s.

Table 3-6 MDD+FF Pumping Capacity

Pump Station	Pumping Capacity	Existing MDD+FF (L/s)	Short Term MDD+FF (L/s)	Mid Term MDD+FF (L/s)	Long Term MDD+FF (L/s)	Full Buildout MDD+FF (L/s)
South Reservoir	285	189	314	336	360	478
Big Rock	84	163	248	259	266	405
Westmount	183	164	246	262	266	405

As the above table shows, the Big Rock booster does not have sufficient pumping capacity to accommodate fire flows during existing demands, and the South Reservoir and Westmount Booster are over capacity by the Short Term scenario. This is mainly due to industrial land uses with high fire flow requirements coming on line at that horizon.

In order to support future development, significant upgrades to the pumping capacity of the South Reservoir, Big Rock booster and Westmount booster would likely be required. In addition, another booster station would be required to supply the Zone 3S areas.

3.3 Reservoir Justification Conclusion

Currently the existing South Reservoir has sufficient capacity to support growth in South Okotoks beyond the Mid Term horizon when assessed under the Alberta Environment storage requirements. However, this requires the continued operation of the raw water delivery and the water treatment plant. South Okotoks is particularly sensitive to emergencies that impact treated water delivery, with the reservoir only having enough capacity to supply one day of demands at MDD today. Under the Max Day Demand storage calculations, there is insufficient storage capacity after the Existing scenario. An additional reservoir capable of servicing all of South Okotoks would significantly improve the resiliency of the water distribution system. This could be a foundational contributor to the Town's goal of creating a more resilient water supply infrastructure as outlined in their Climate Action Plan.

Along with creating a more resilient water infrastructure, construction of a new reservoir and pump station could minimize needed upgrades at the south Okotoks pump and booster stations, as the reservoir could distribute water to Zones 2S-1 and 2S-2, and supplement Zone 1S, and allow for the eventual consolidation of Zone 2S. This could delay the need for pump upgrades at the South Reservoir, and potentially eliminate the need for either booster station. Otherwise, significant upgrades to the pumping capacity of the existing booster stations will be needed.

Additional infrastructure will be required to service Zone 3S through a new booster station if a reservoir is not constructed. This added demand would hasten the needed upgrades to the booster stations and the South Reservoir pumps, as they will have to provide peak flows, such as PHD and MDD+FF. A new reservoir and pump station, on the other hand, would only require MDD flows from the downstream supply, which would be provided directly from the existing South Reservoir.

By providing system resiliency, potentially eliminating booster stations, and minimizing future upgrades, the proposed reservoir is well justified as a beneficial improvement to the Town of Okotoks's treated water infrastructure.

4. Verification of Reservoir Lot Size

The proposed lot size for the new reservoir is 1.21 ha (3.00 ac). In order to ensure that the lot set aside for this purpose is adequate, a total land area required for the reservoir and pump station will have to be estimated. This will include a high level estimate of the total reservoir volume at full buildout and a subsequent land area projection, and an investigation of the land area of similar infrastructure.

4.1 Reservoir Volume

The ideal sizing for the proposed reservoir would be to act as a full redundant reservoir to the existing South Reservoir. This would mean providing capacity for the entirety of Zones 1S, 2S and 3S. Providing this level of redundancy would maximize the resiliency of the water distribution system, and should be used for planning purposes.

The storage volume calculations used were Max Day Demand of Zone 1S, 2S and 3S, as described in 3.1. This ensures that the reservoir can support a maximum day of demands to all of south Okotoks in the event of an emergency to critical infrastructure such as the raw water supply or the water treatment facility.

Table 4-1 Future Reservoir Storage Calculations

Scenario	Max Day Demand (m^3)	Recommended Volume (m^3)
Existing	6,340	6,500
Short Term	7,649	8,000
Mid Term	9,618	10,000
Long Term	11,662	12,000
Full Buildout	21,878	22,000

As the storage calculations show, the full buildout storage volume would be 22,000 m^3. With this new reservoir, alongside the existing South Reservoir, the total storage for south Okotoks would be approximately 28,340 m^3.

4.2 Similar Lot Sizes

Several water reservoirs and pump stations, similar in scope and size to the proposed reservoir, were investigated to obtain approximate land area needed.

Airdrie Windsong Reservoir

The Airdrie Windsong reservoir has a storage volume of 10,000 m^3. The reservoir was designed to minimize land area, with the pump station building sitting on top of the reservoir. The total land area of the reservoir and pump station is approximately 0.4 ha.

Canmore Benchlands Reservoir

The Canmore Benchlands reservoir has a storage volume of approximately 11,000 m^3. The total land area is approximately 0.5 ha.

Chestermere Water Transfer Station

The Chestermere Water Transfer Station has a reservoir with a storage volume of approximately 13,000 m^3. The total land area is approximately 0.8 ha.

4.3 Recommended Lot Size

Similar Lot Sizes

The three reservoirs investigated have an average volume of approximately 11,300 m^3, and an average land area of approximately 0.57 ha. Extrapolating to the recommended full buildout volume of 22,000 m^3, results in a land area of 1.1 ha.

Estimated Land Area

The land area can be estimated using the volume of the reservoir, an assumed depth, and a multiplier of the reservoir area.

+ Volume – 22,000 m^3
+ Assumed depth – 4 m
+ Reservoir area – 5,500 m^2 (75 m x 75 m)
+ Setback – assumed 10 m setback on all side (95 m x 95 m footprint)

Using these values, an estimated land area of 0.9 ha would be needed.

Between the two methods of estimating required lot size, a land area of 0.9 ha -1.1 ha is required.

5. Verification of Reservoir Location

The proposed new reservoir would ideally be located such that it can be supplied from the South Reservoir through Zone 1S, bypassing the booster stations. It would also be beneficial for the reservoir to be able to back feed back into Zone 1S in the event of emergencies, such as the raw water supply, water treatment plant or South Reservoir pump station going offline.

The primary driver of the reservoir location will be the ground elevation of the lot it is set on. This will have to consider the HGL that Zone 1S can supply to the reservoir, along with considerations such as ground cover and overall site grading.

5.1 Available Supply Hydraulic Grade Line

The HGL of Zone 1S is 1111m, as per the pressure zone review previously performed. However, due to system head losses, the HGL near the delivery point would be lower. To obtain another data point, the supply side pressures at Big Rock booster and Westmount booster were checked.

Station	Supply Pressure (psi)	Pressure Head (m)	Floor Elevation (m)	Height of Pressure Sensor (m)	HGL (m)
Big Rock	52	36.4	1071.9	1.0	1109.3
Westmount	63	44.4	1063.0	1.2	1108.6

Using this information, it is assumed that a hydraulic grade line of 1109 m can be delivered from the supply side of the Big Rock booster station. Hydraulic modelling indicated that this value stays consistent through various demand scenarios.

Approximate head losses through the supply pipe also need to be considered. Worst case scenario would be supplying the proposed reservoir from the current Big Rock booster location, which is approximately 1,200 m of pipe. Assuming a maximum day demand of 180 L/s (the approximate full buildout MDD of Zones 2S and 3S), and a pipe diameter of 450 mm, the total head losses are approximately 2.8 m.

This means that the maximum HGL Zone 1S can supply to the proposed reservoir is 1106 m. The grade of the site location should be at a minimum this elevation.

5.2 Proposed Reservoir Water Levels

As per discussions with the Town, it was determined that it would be in the Town's best interest to be able to provide sufficient flows and pressures to Pressure Zone 1S from the proposed reservoir directly by gravity. This ensures optimal energy usage, and minimal operational and maintenance demand.

To facilitate this, the new reservoir's Top Water Level would have to be higher, to ensure the high ends of Zone 1S still receive an adequate level of service. The existing HGL of Zone 1S prior to the pressure increase (1102 m) should be the minimum that the new reservoir can provide, to ensure this level of service can be maintained. As such, a 4 m deep reservoir with a TWL of 1106 m and a bottom of 1102 m would be ideal for this purpose. At the top elevation of 1070 m, this results is an minimum operating pressure of 45 psi to 51 psi, dependent on reservoir level.

5.3 Proposed Supply Line Alignment

The supply line to the proposed reservoir location should consist of two redundant lines from different connection points, both of which tie directly to Zone 1S. One supply line would connect at the existing Big Rock booster location, and the other would connect at Big Rock Trail and Westland Rd. Both lines should be 450 mm diameter. Redundant supply lines would ensure that the reservoir can continue to be filled in the event of maintenance or an emergency on one of the lines.

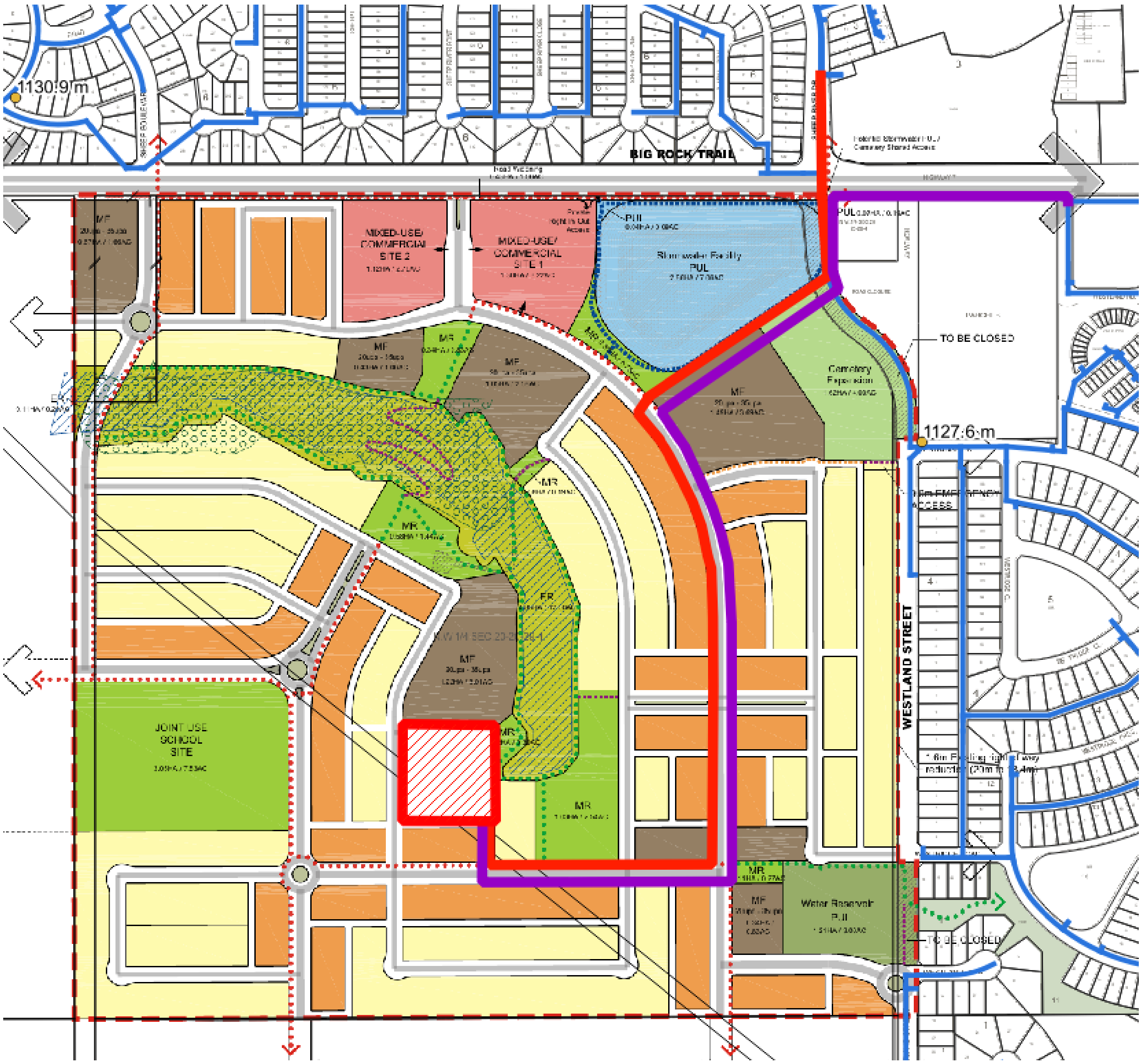

Figure 5-1 Proposed Supply Line Alignments

5.4 Proposed Location and Site Grading

The reservoir is currently proposed to be in the southeast corner of the NASP area. Figure 5-2 shows the location, and proposed site grading.

The highest point of the proposed location is the southwest corner, with an elevation of 1101.55 m. This is below the minimum HGL that would allow for the supply of Zone 1S, and well below the recommended Top Water Level.

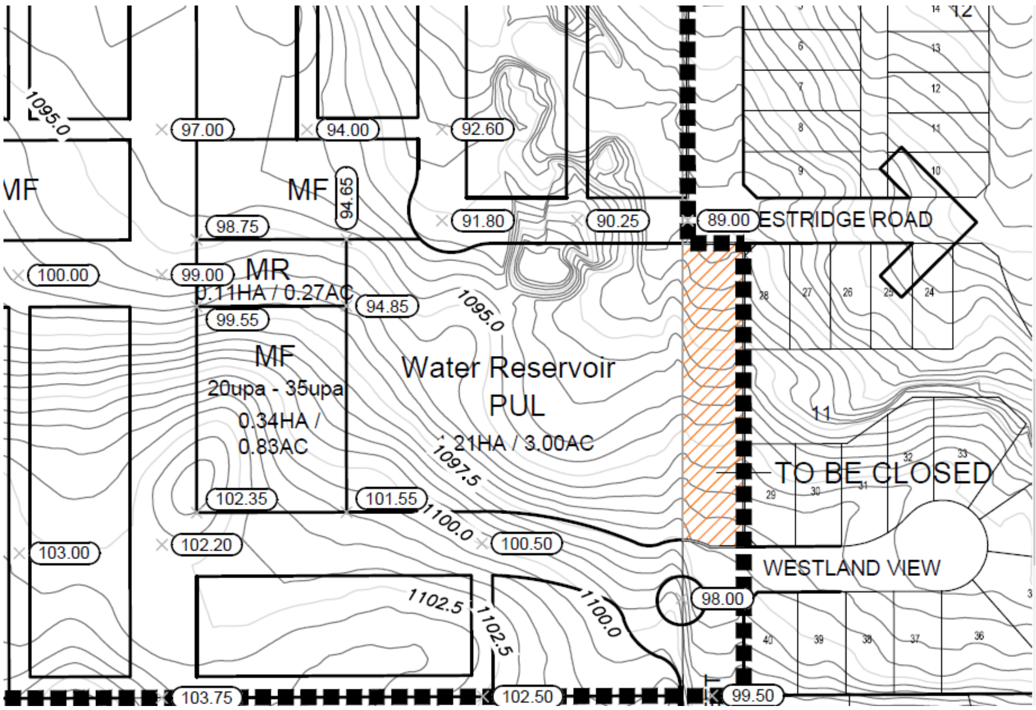

Figure 5-2 Current Proposed Reservoir Location and Site Grading

5.5 Alternative Reservoir Location

Due to site elevation limitations, an alternative location for the proposed reservoir will likely be required. A potential alternative would south of the multifamily land use site in the centre of the NASP area.

Upon further review of the existing ground contours, and the recently provided bedrock contours, we are confident that the square parcel south of the large multifamily site, and west of the MR site, would be an ideal location.

The existing grade is relatively flat, with ground elevations near that of what the final design elevation of the reservoir will be (approximately 1107 m.) In addition, the existing bedrock at that location is all slightly higher than what the design reservoir base elevation will be. This provides an excellent foundation for the reservoir, which should minimize some of the construction risks that had been discussed surrounding building on engineered fill

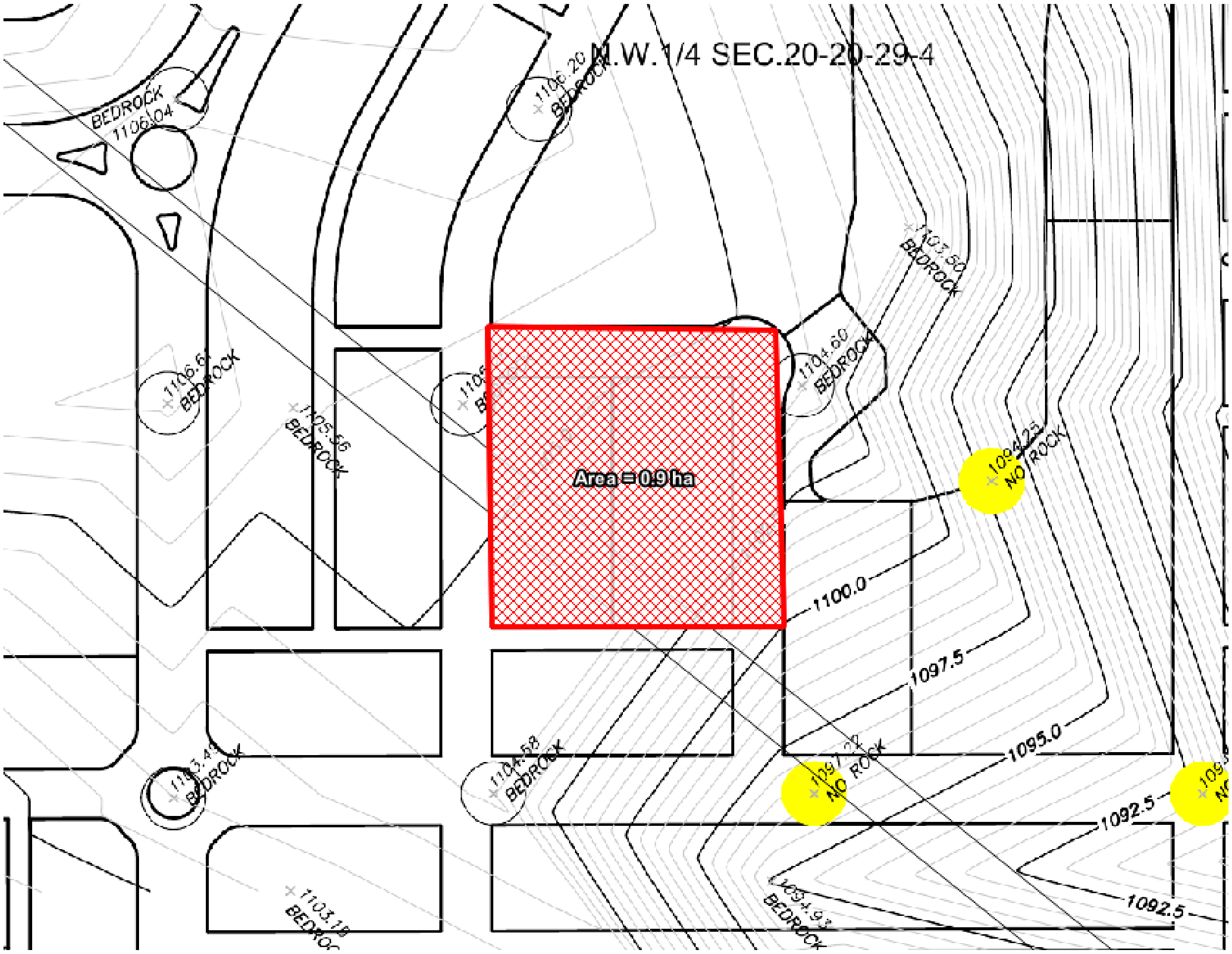

Figure 5-3 Proposed Alternative Reservoir Location

6. Reservoir Staging

The full buildout storage volume for the proposed reservoir is 22,000 m^3, however that buildout scenario is very far in the future. In the interim, the reservoir can be staged to support development as required.

6.1 Development with No Reservoir

Prior to the proposed reservoir being constructed, it is possible to service a portion of the West Okotoks NASP area off of Zone 2S. This portion would be the northeast portion of the quarter section, roughly bounded by the environmental reserve to the west and Westridge Rd to the south. However, this development would likely result in the existing South Reservoir going beyond its required storage capacity under the Max Day Demand volume calculation, as there is only approximately 50 m^3 of remaining capacity. As such, it would be reasonable for the Town to require the construction of the first phase of the reservoir before development were allowed to proceed.

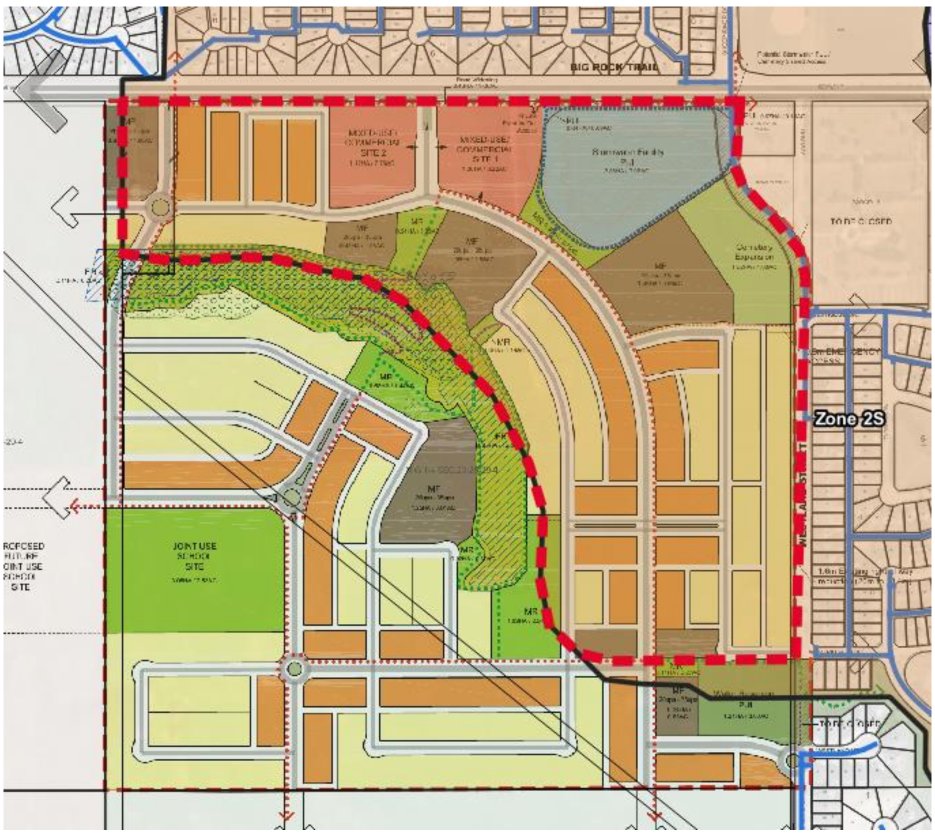

Figure 6-1 Serviceable Area from Zone 2S

6.2 Initial Reservoir Stage

The proposed reservoir can be constructed in phases in order to minimize upfront costs while still supporting the proposed development. The first phase of the reservoir should, at a minimum, support the existing demands of south Okotoks and the full buildout of the West Okotoks NASP area.

Using the assumed unit density of 30 units per ha, and a water consumption of 215 m^3 per unit per year, the West Okotoks NASP area has an ADD of 1,130 m^3, and an MDD of 1,700 m^3.

Scenario	Max Day Demand (m^3)	Recommended Volume (m^3)
Existing	6,340	**~8,000**
WO NASP	1,700	
Total	**8,040**	

An initial reservoir cell of ~8,000 m^3 would be sufficient to support the full buildout of the NASP area, along with the existing demands of the 1S and 2S zones.

6.3 Future Reservoir Stages

Future stages to the reservoir would be planned as the development horizons and timelines are better understood. With 14,000 m^3 remaining to support the full buildout of the service area, one possible option would be two additional 7,000 m^3 cells.