BULLÉE CONSULTING LTD.

WATERWORKS SYSTEM ASSESSMENT FOR THE TOWN OF PILOT BUTTE

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TOWN OF PILOT BUTTE
WATERWORKS SYSTEM ASSESSMENT

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APPENDICES

TOWN OF PILOT BUTTE

WATERWORKS SYSTEM ASSESSMENT

1. BACKGROUND

The purpose of this *Waterworks System Assessment* for the Town of Pilot Butte is to review the community's water supply, treatment, storage and distribution facilities in accordance with the Government of Saskatchewan's 2002 Water Regulations. These regulations require all waterworks supplying water intended for human consumption to obtain an independent engineering assessment every 5 years. This assessment is intended to identify, analyze and mitigate any potential adverse risks and environmental impacts related to the waterworks.

The Town of Pilot Butte is a community with a population of approximately 2,200, located in the south central Saskatchewan, approximately 20 km east of the City of Regina on Highway 46, a few kilometres north of the Trans-Canada Highway. Bullée Consulting conducted a site inspection of the Town's water facilities on March 6th, 2017.

The Pilot Butte waterworks system is supplied with groundwater from the Zehner Aquifer. Three groundwater wells located approximately 4 kilometres northwest of the Town supply raw water to the water treatment plant through a raw water main. The water treatment plant houses four membrane treatment units (MTU), which use reverse osmosis membranes to treat the raw water. Once water flows through the membrane, it is dosed with sodium hydroxide to increase the pH of the water, and by chlorine to disinfect the water. The treated water is stored in an underground concrete storage reservoir, under the water treatment plant building. An array of distribution pumps pump treated water to the community through a network of distribution water mains.

2. Existing Infrastructure

2.1 Raw Water Supply

The water source for the community is groundwater (not under the influence of surface water) from the Zehner Aquifer. The Town was granted an allocation of 1,000 dams (cubic decametres), apportioned 700 dams for Pilot Butte and 300 dams for Balgonie. Three groundwater wells were drilled in 2010, approximately 4 km northwest of the Town. The wells are pitless adaptor style wells with their own dedicated raw water main from the well to a common well booster pumphouse. Each well head is protected by steel bollards. There are no source water concerns identified for the wells.

Well PW1-2010 is the north most of the three wells located on NW¼ - Sec 6 - Twp 18 - Rge 18 - W2. The well is 66.4 m deep, with a 300 mm diameter steel casing. The well was completed with electrical servicing, pump and pitless adaptor installation in 2011. The pump is a Grundfos Model 625-S-600-3A, rated at 37.8 L/s (600 USgpm) at 85 m (280 ft.) TDH, with a 60 hp, 600 volt, 3 phase, 3450 rpm motor. The well pump is set at approximately 29 m below ground.

Well PW2 - 2010 is located 15 m west of the booster pumphouse on NW¼ - Sec 6 - Twp 18 - Rge 18 - W2. The well is 70.1 m deep, with a 300 mm diameter steel casing. The well was completed with electrical servicing, and the pump and pitless adaptor were installed in 2011. The pump is a Grundfos model 625-S-600-3A, rated at 37.8 L/s (600 USgpm) at 85 m (280 ft.) TDH, with a 60 hp, 600 volt, 3 phase, 3450 rpm motor. The well pump is set approximately 29 m below ground.

Well PW3 - 2010 is located 400 m south of the booster pumphouse on SW¼ - Sec 6 - Twp 18 - Rge 18 - W2. The well is 67.97 m deep, with a 300 mm diameter steel casing. The well was completed with electrical servicing, pump, and pitless adaptor installation in 2015. The pump is a Grundfos model 625-S-600-3A, rated at 37.8 L/s (600 USgpm) at 85 m (280 ft.) TDH, with a 60 hp, 600 volt, 3 phase, 3450 rpm motor. It was reported that the pump is set approximately 29 m below ground.

A single well operating can adequately supply more than the average day raw water consumption rate, but cannot meet peak day raw water consumption needs. More information on capacity requirements can be found in Section 3.3.

It was reported that with all three wells operating simultaneously, the raw water flow rate is 106 L/s due to head loss in the raw water main. Static water levels in all three wells were noted on October 17th of each year from 2014 to 2017, and compared with original static levels from the original well drilling in October 2010, as shown in Table 2-1.

Static water levels have remained relatively consistent over the past four years. Static levels do tend to drop during periods of high usage, but return to 2014 levels once usage returns to average. In 2017, static water levels dropped during summer months due to the City of Regina temporarily using a groundwater well, drawing water from the Zehner aquifer to increase water supply to the City. Static water levels in all three wells dropped by as much as 4 m during this period. As noted in Table 2-1, the static water levels were stabilizing by October 2017, when the City well was no longer in use.

Table 2-1: Static Water Level (below casing)

Well	Oct. 2010 (m)	Oct. 17/14 (m)	Oct. 17/15 (m)	Oct. 17/16 (m)	Oct. 17/17 (m)
PW1-2010	4.26	5.81	5.36	5.65	6.18
PW2-2010	4.28	5.78	5.35	5.68	6.18
PW3-2010	7.14	7.84	7.38	7.73	8.22

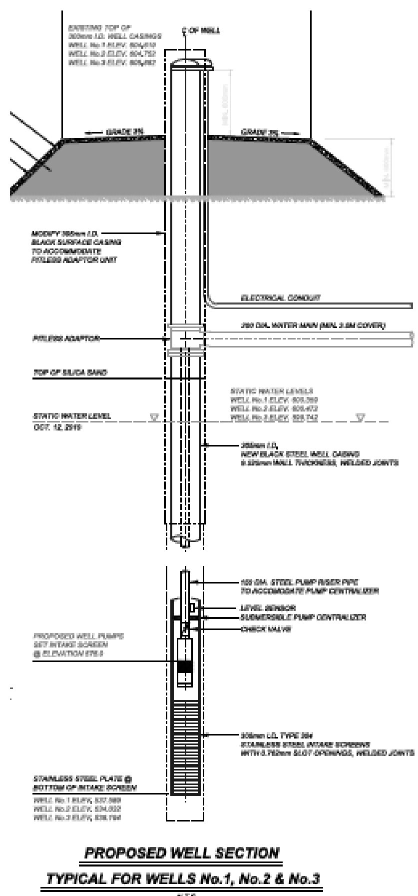


Figure 2-1: Typical Well Section

The three wells feed three separate 200 mm diameter HDPE raw water mains from the well heads to the booster pumphouse. The three mains are metered separately in the booster pumphouse prior to combining into a common header which feeds a single 400 mm diameter HDPE raw water main from the booster pumphouse to the water treatment plant. The 400 mm diameter main is approximately 4,400 m in length, and is equipped with isolation gate valves and a raw water flush out at the water treatment plant.

The booster pumphouse is a 47 m^2 timber frame structure on a thickened edge concrete foundation slab. The building is clad with concrete pre-finished siding (Hardiboard) and a pre-finished metal roof. Interior walls are finished with fibreglass panelling. The building is lit with fluorescent lighting and is well ventilated. The pumphouse also houses the electrical equipment required for the wells, including variable frequency drives (VFDs) and power conditioning equipment.

2.2 Treatment

The water treatment plant was constructed in 2013 and was upgraded (additional treatment unit) in 2015. The treatment process consists of reverse osmosis membrane treatment, with chlorine disinfection. Upon entering the water treatment plant, the raw water is dosed with an anti-scalant prior to flowing through membrane pre-filters which remove any large particulate in the raw water. The pre-filters are Shelco model 22FOS-3, with 5 micron stainless steel cartridges. After pre-filtration, the water flows through one of four MTUs. The units are model R-0255, manufactured by Sapphire Water. Each MTU can be operated separately, and flushed or cleaned individually. Each MTU is rated at 16.25 L/s (255 USgpm), for a total treatment capacity of 65 L/s (1030 USgpm). Each MTU is equipped with sample ports after each membrane stage, as well as pressure gauges and membrane contactors to remove dissolved CO^2.

There are eight in-line booster pumps which provide pressure to the raw water prior to entering the membrane pressure vessels. The booster pumps are Goulds model 9RCLC vertical turbine pumps (canned), 8 stage, capable of pumping 18.9 L/s at 106.7 m TDH. The motors are 40 hp, 3 phase, 600 volt electric motors, with VFDs.

Prior to disinfection, membrane permeate water is stored in a dedicated concrete 'flushing chamber' to use in the flushing and backwash processes. Each MTU is flushed with clean permeate water once it goes into standby mode, to help preserve the integrity of the membranes. The flushing water is provided by a vertical turbine pump. The two pumps are Goulds model 10WALC vertical turbine pump, 3 stage, capable of pumping 18.9 L/s at 42.7 m TDH. The motors are 15 hp, 3 phase, 600 volt electric motors, with VFDs. The second flushing pump was added as part of the 2015 water treatment plant upgrades.

The pre-filter backwash pump also uses permeate water from the flushing chamber to backwash the Shelco pre-filters. The pump is a Goulds model 10RJLC vertical turbine pump, 3 stage, capable of pumping 28.4 L/s at 35.4 m TDH. The motor is a 20 hp, 3 phase, 600 volt electric motor, with a VFD.

2.2.1 Chemical Feed Systems

As mentioned, the raw water is dosed with an anti-scalant to prevent iron fouling of the membranes, and sodium hydroxide and chlorine is injected into the membrane permeate to adjust the pH of the water and to provide primary disinfection of the treated water and secondary disinfection in the distribution system. The chemical feed system is housed in a separate room in the water treatment plant, equipped with an overhead loading door and separate ventilation systems. Floor weigh scales are in place to facilitate chemical feed from large totes, or to use mixing barrels until the chemical consumption increases to justify totes. The electronic scales are used to track chemical consumption rates and can also cause notification alarm if a chemical volume is too low. There are spill containment sumps for each chemical feed area.

The anti-scalant is Pre-Treat Plus 100 and is fed at an estimated rate of 3.4 mg/L by a Grundfos DDA pump. The typical feed rate for anti-scalant is 1 - 10 mg/L, with a NSF / ANSi 60 maximum use limit of 19 mg/L.

Chlorine is fed using a 12% liquid sodium hypochlorite solution. The chlorine pump is a Grundfos DDA dosing pump, which is in good condition. The chlorine is injected immediately prior to filtered water entering the underground storage reservoir, to act as a disinfecting agent. The chlorine is fed at a rate of 1.2 - 1.5 mg/L to meet the target free chlorine residual of 0.5 to 0.7 mg/L. A review of the daily testing records indicates that the majority of the total chlorine is in a 'free' state, indicating that there is very little in the treated water to react with chlorine. The typical total chlorine concentration is in the range of 0.6 - 0.8 mg/L, with approximately 90% of the chlorine in the 'free' state. The feed rate is much lower than the maximum usage level of 72 mg/L, as per NSF 60 requirements, and lower than the typical usage level of 10 mg/L, as per the Water Security Agency's' *EPB432 - Use of Chemicals in Drinking Water Treatment*.

Sodium hydroxide is injected post-membrane by a Grundfos DDA pump to raise the pH of the treated water. The Operator uses a manual pH reading to determine the pH level of the treated water and adjusts the sodium hydroxide feed rate to target a pH of 8.3 - 8.8. The dosage rate varies from approximately 5 - 10 mg/L, with an average dosage rate of 7 mg/L. The maximum use limit for the product is 100 mg/L.

2.2.2 Contact Time Disinfection

To ensure effective disinfection, the treated water free chlorine residual must be maintained and given adequate contact time. The effectiveness is determined by a contact time (CT) value (residual disinfectant concentration multiplied by the contact time), which is determined for a specific temperature and pH.

The CT of the system is calculated based on the reservoir size and peak hour flow rate. In addition to the size of the reservoir, a baffling factor is applied based on the flow path and mixing occurring in the reservoir. The baffling factor for the community's reservoir is estimated to be 0.7, as there is good baffling provided by the multiple chambers and connecting piping that the water flows through prior to entering the distribution system.

Typically groundwater treatment facilities require adequate disinfection to provide equal to or greater than 4 log removal (99.99%) of viruses. Reverse osmosis treatment systems are capable of providing greater than 6 log removal (99.9999%) of viruses. For calculation purposes, 4 log removal will be used.

Example CT Calculation on October 8th, 2017:

Total Reservoir Volume	3,185,000 L
Effective Volume (assume 50% full)	1,592,500 L
Baffling Factor 'Good'	0.7
Average Distribution Flow Rate (estimated)	7.03 L/s
Peak Hour Flow Rate (estimated)	28.1 L/s
Assume Balgonie distribution pump on	+ 37 L/s
Total Peak Hour Flow (estimated)	65.1 L/s
Theoretical Detention Time (TDT) (equal to Effective Volume/Peak Hour Flow)	24,462 seconds = 408 minutes
Time for 10% of water to pass (T_{10}) (equal to TDT x Baffling Factor)	285.6 minutes
Free Chlorine Residual Oct. 8, 2017	0.51 mg/L
CT actual (equal to T_{10} x Chlorine Residual)	**145.6 mg/L x min**

Table 2-2 illustrates the CT values required for 4.0 log inactivation of viruses at the worst case temperature of 0.5 degrees Celsius versus the actual distribution chlorine residual samples from the past few years and the resulting CT value.

Table 2-2: CT Calculation

Date of Distribution System Test Results	Free Chlorine (mg/L)	CT Requirement (mg/L x min)	CT actual (mg/L x min)
October 8, 2017	0.51	12	145.6
January 5, 2015	0.33	12	94.2
September 22, 2013	0.41	12	117.1

*Required CT values taken from Table 7 of *Waterworks Design Standard EPB 501 - 2012*.

The Operator typically maintains free chlorine concentrations between 0.5 to 0.7 mg/L. There are occasionally lower chlorine residuals below the lower target of 0.5 mg/L. It should be noted that the operating permit for the system requires a minimum residual of 0.1 mg/L at all points of the distribution system. At the minimum concentration of 0.1 mg/L, the resulting CT value will be 14.6 mg/L x min., which does exceed the minimum required of 12 mg/L x min.

There are no recommended changes to the current disinfection practices.

2.2.3 Water Quality

A summary of the raw and treated water quality for Pilot Butte is appended. The raw water is classified as very hard, highly mineralized water, with excessive concentrations of iron and manganese, as well as elevated concentrations of bicarbonate, sulphate, alkalinity and total dissolved solids, which define the raw water. Metals are present in levels consistent with true groundwater, with only iron and manganese concentrations exceeding guidelines.

The reverse osmosis treatment process is effectively removing particulate and dissolved metals from the raw water to levels far below guidelines. After chlorination and pH balancing, the treated water is very soft and classified as a water of excellent quality. There are no parameters of concern present in the treated water. All metal concentrations are reduced to levels far below guidelines. The turbidity of the treated water is recorded twice daily at the water treatment plant. The turbidity typically ranges from 0.05 - 0.15 NTU, with an average level of 0.08 NTU. The treatment process is effectively lowering the turbidity of the treated water.

A brief summary of constituents of interest for the raw and treated water is summarized in Table 2-3. A full summary of water quality results is appended.

Table 2-3: Summary of Water Quality

Constituent	Raw			Treated		SK Guideline
	Well No. 1 Oct. 4/10	Well No. 2 Oct. 4/10	Well No. 3 Oct. 4/10	Jan. 24/17	Jan. 25/17	
Iron (mg/L)	0.6	0.5	0.62	<0.1	<0.1	<0.3
Manganese (mg/L)	0.72	0.69	0.72	<0.1	<0.01	<0.05
Sulphate (mg/L)	220	160	180	2.5	2.2	-
TDS (mg/L)	652	566	606	40	77	<1,500
Bicarbonate (mg/L)	405	373	376	25	53	-
Alkalinity (mg/L)	332	306	308	20.2	43.1	500

A description of each of the raw and treated water constituents in excess of the Canadian or Saskatchewan Drinking Water Standards are as follows (write ups are from *SRC Analytical - Water Analysis Information Sheet*):

Iron
At levels above 0.3 mg/L, iron stains laundry and plumbing fixtures and causes undesirable taste. The precipitation of excessive iron causes a reddish brown colour in the water. It may also promote the growth of iron bacteria, leaving a sliming coating in piping. The presence of iron bacteria can also cause a 'rotten egg' odour in the water and a sheen on the surface of the water. The aesthetic objective is set at a maximum of 0.3 mg/L. Iron levels in the raw water at Pilot Butte are in the order of 0.6 mg/L. The current treatment system removes most of the iron, as levels are consistently <0.1 mg/L in the distributed water.

Manganese
Manganese can cause staining to plumbing and laundry and undesirable tastes in beverages. Also, it may lead to the accumulation of bacterial growth in the piping. The manganese concentration in the raw water is very high, in the order of 0.7 mg/L. The aesthetic objective of both Canada and Saskatchewan is set at a maximum of 0.05 mg/L. The treatment process is effectively removing manganese to concentrations <0.01 mg/L.

Sulphate
Sulphate occurs naturally in water and may be present in natural waters in concentrations ranging from a few to several thousand mg/L. Concentrations in excess of 500 mg/L, especially if the magnesium content is also high, may have a laxative effect, or cause gastrointestinal irritation. It may also result in a noticeable taste. The aesthetic objective is set at a maximum of 500 mg/L. Raw water concentrations are elevated, in the range of 160 - 220 mg/L. The treatment process is effectively removing sulphate to <3 mg/L.

Total Dissolved Solids or Specific Conductivity
Specific conductivity is a measure of the ability of water to carry an electric current. This ability depends on the presence of ions and therefore is an indication of the concentration of ions (ie: dissolved solids) in the water. Waters with high dissolved solids generally are of inferior palatability and also may leave a white film on dishes, etc. The aesthetic objective for total dissolved solids in Saskatchewan is 1,500 mg/L and 500 mg/L federally. The raw water TDS is typically >600 mg/L, with treated concentrations lowered to <100 mg/L.

Bicarbonate
Bicarbonate is the major form of alkalinity. In excessive amounts, bicarbonates, in conjunction with calcium, may cause scale formation in heated waters. The raw water bicarbonate concentration is approximately 400 mg/L, which is considered moderately high. The process effectively removes bicarbonate to <60 mg/L.

Alkalinity
Alkalinity is a water's acid-neutralizing capacity and is primarily a function of carbonate, bicarbonate and hydroxide content. Excessive alkalinity levels may cause scale formation. The aesthetic objective is set at a maximum of 500 mg/L. Pilot Butte's raw water is slightly alkaline, with concentrations ranging from 300 - 325 mg/L. The finished alkalinity of the treated water is <50 mg/L.

2.3 Water Storage

Treated water storage capacity is provided by a cast-in-place concrete underground reservoir, divided into two large chambers and two pump wells. The reservoir was constructed in 2012. The reservoir chambers were designed so that either large reservoir can be isolated for maintenance and the two pump wells can be isolated, with all of the pumping occurring out of a single pump well during maintenance periods. The total effective storage capacity of the four chambers is estimated to be 3,185,000 L.

The level of water in the reservoirs is measured by a pressure sensor, which is tracked by the control software. The system is setup to initiate producing water when the reservoir level drops to a set point. If the reservoir level drops to a lower set point, the rate at which water is produced is increased (additional treatment units are started). The Operator reported that the current operation strategy is to not produce water overnight when Operators are not present. The Operators start making treated water each morning and base the treatment rate on how much the reservoir level has dropped. Typically the reservoir level drops 0.4 m if treated water has not been pumped to Balgonie. Balgonie's system has treated storage in a reservoir in Balgonie. When the reservoir level in Balgonie drops to a set point, a control valve on the water supply line from Pilot Butte to Balgonie opens and starts filling the Balgonie reservoir. The dedicated Balgonie pumps typically run for 4 - 6 hours at a rate of 37 L/s to fill the Balgonie reservoir. When Balgonie's reservoir is filled it drops the Pilot Butte reservoir level by an additional 0.6 m (typical). If this occurs the Operators produce water at an increase rate by starting two MTUs, until the treated storage reservoir level reaches the full set point.

2.4 Distribution

There are two distribution headers in a separate distribution pump room, which provide the distribution pressure to the community of Pilot Butte. The pumps on each header draw water from one of two pump chambers, which can be isolated by control valves to facilitate cleaning of the chambers, while water can still be distributed from the other chamber. Each header is equipped to operate individually, with two distribution pumps on each header. In 2015, two dedicated distribution pumps for the Balgonie system were added, which feed a separate 200 mm diameter Balgonie water supply main. These pumps are controlled separately by the Balgonie water supply system. They are reported to each have a capacity of 37 L/s at 70.4 m TDH.

Distribution pumps 1 and 2 are Goulds model 6x9RCHC vertical turbine pumps, 3 stage, capable of pumping 34.7 L/s at 36.6 m TDH, with a 25 horsepower, 600 volt, 3 phase electric motor.

Distribution pumps 3 and 4 are Goulds model 8x12RJMC vertical turbine pumps, 3 stage, capable of pumping 68.1 L/s at 43.3 m TDH, with a 50 horsepower, 600 volt, 3 phase electric motor.

The distribution system is operated to maintain a set pressure target of 50 psi. Variable speed drives control the speed of each pump to try and maintain the pressure set point. If the pressure drops significantly the pumps are started in sequence to maintain the pressure on the system.

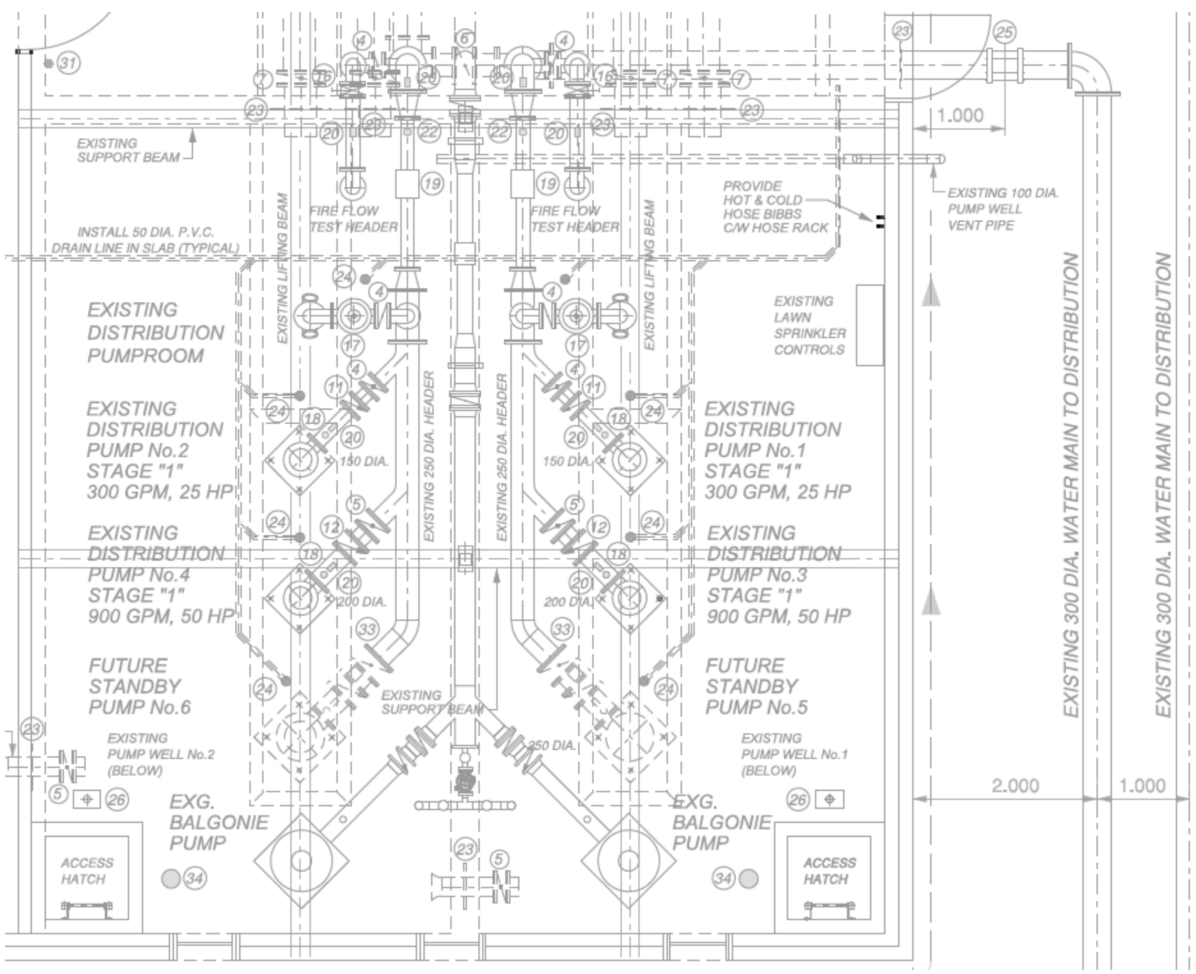


Figure 2-2: Distribution Pump Configuration

The pumps distribute water to the community through a network of distribution mains. The mains were installed in 2012 - 2013. The mains are predominantly 150 and 200 mm in diameter, with a larger 300 mm diameter main installed along Fifth Avenue (east - west) from the water treatment plant, east to Fifth Street, where it reduces to 250 mm diameter. The pipe material is PVC C-900 piping, rated at 160 psi. The system is equipped with isolation gate valves and hydrants are regular intervals. It is reported that the distribution system is in excellent condition, due to its relatively new age.

Bacti testing is completed weekly from one of several sampling locations on the distribution system. In the past four years there has not been a single verified sample which tested positive.

The Operator also records free and total chlorine concentrations, as well as turbidity from the weekly distribution samples (samples taken at least once per week). In 2017, the average free chlorine residual was 0.6 mg/L and the total chlorine average concentration was 0.7 mg/L. The range of free chlorine concentrations is very consistent, from 0.5 to 0.7 mg/L, indicating that there is no material present in the distribution network interfering with chlorine disinfection. The turbidity results are similarly consistent with average readings of 0.09 NTU.

2.5 PLC and Controls

The electrical components in the water treatment plant were installed in the 2013 construction and are in excellent condition. The facility is supplied by a 1600 amp, 3 phase, 600 volt service, with harmonic filters, and transient voltage surge suppression on the power supply. A separate electrical room in the water treatment plant houses the majority of the electrical equipment including the main breaker, two breaker panels, transformer, pump starters, TVSS, variable speed drives, transfer switch, etc. The room is separately ventilated, and has space for future expansion. The water treatment plant controls are operated from a single PLC in the office/lab space. The Operator can view flow rates, pump status, reservoir level, distribution pressures in real time, and track consumption data, meter readings, etc., as well as control most major operations of the plant.

The system is equipped with alarm conditions which notify the Operators in the event of:

- low reservoir level;
- high reservoir level;
- low distribution pressure;
- low temperature (building);
- low temperature (well pumphouse);
- low flow distribution;
- loss of power supply.

There is a backup generator fuelled by natural gas that can power the entire facility during a disruption to the power supply. The generator is a Cummins model GFEB, 330 kilowatt unit. The genset is in a separate room with dedicated ventilation systems and space to add an additional future genset. An automatic transfer switch in the electrical room transfers power supply to the genset power, if the grid power supply is interrupted.

There are on-line instruments in the facility that can measure water quality parameters continuously and allow for the Operator to view trends over specific timeframes on the PLC. The instruments include:

- each MTU is equipped with a GLI International pH analyzer, a temperature probe, and a Hach 1720D turbidity monitor;
- a Hach 1720E turbidity meter on the distribution header;
- a Hach CL17 on-line chlorine analyzer on the distribution header.

2.6 Wastewater Disposal

The treatment process creates a waste stream of concentrate water when the water is being produced, of approximately 20 - 25% of the raw water flow rate. There is a concrete concentrate/backwash chamber at the west end of the water treatment plant, where all of the floor drains, sumps and wastewater is collected. This chamber allows for surcharging if a high flow rate of wastewater is created during a membrane flushing or other maintenance practice. The chamber drains using a 200 mm diameter pipe with a gate valve to control the flow rate, to a sanitary manhole outside of the water treatment plant. This manhole drains by a 250 mm diameter sewer main, east along Fifth Avenue, eventually to the Butte Street Sewage Pumping Station. The station was designed to receive the wastewater from the water treatment plant, along with other domestic sanitary sewage, and pump it to the Town's treatment lagoon.

2.7 Water Treatment Facility

The water treatment plant building was constructed in 2013 and is a timber framed structure with the concrete reservoir acting as the building's foundation. The building exterior is finished with split faced brick and a painted metal roof. The building is in excellent condition.

The interior of the building is divided into several rooms, including the main treatment room, electrical, generator, chemical feed, booster pump, laboratory, storage, and bathroom spaces. The interior flooring is painted concrete (reservoir top slab) for the majority of the plant, with porcelain tile in the laboratory and bathroom area. Ceiling height is generally 4.4 m, providing excellent overhead space for maintenance of pumps, etc. The interior walls are a combination of painted plywood and lascoboard finish.

The building is well lit using fluorescent fixtures and natural light from exterior windows. Ventilation is provided by intake louvres and exhaust fans for each separate room. Genset exhaust and air supply requirements are met by dedicated ventilation equipment, which is connected to the operations of the generator.

Building heat is provided by a pair of Viessman Vitodens 200 natural gas high efficiency boilers, which heat glycol distributed to unit heaters spread throughout the plant that distribute the heat. The heating system is an energy efficient method to heat a larger building. There are small backup electrical wall heaters located in the various rooms of the facility to provide emergency heat in the event of a boiler failure.

2.8 NEW COMPONENTS AND UPGRADES

As noted, the original water treatment plant was constructed in 2013, with a capacity upgrade occurring in 2015 to provide treated water to the Town of Balgonie. The upgrade generally consisted of the addition of two new MTUs, four booster pumps and pre-filters, a second flushing pump, and related mechanical components to accommodate the new equipment. The community also completed the mechanical and electrical installation of Well PW3 - 2010 in 2015.

3. COMPONENT SIZING

3.1 POPULATION

A key factor in predicting future water consumption rates is estimating the population growth that will contribute to the consumption rate. Population growth rates are required to predict future populations and related water consumption. The population statistics available from Statistics Canada and the Saskatchewan Ministry of Health indicate that the Town of Pilot Butte's population has steadily increased over the past 20+ years. Canadian census data is known to be consistently lower than reported physical population counts, so SaskHealth counts (persons receiving health services noting residence as Pilot Butte) are often also considered. Since the Town is also responsible for providing treated water to Balgonie, their population data will also be considered. Table 3-1 summarizes the population data available for the Towns of Pilot Butte and Balgonie.

Table 3-1: Population Data

Year	Pilot Butte			Balgonie		
	StatCan Census		SaskHealth Population	StatCan Census		SaskHealth Population
	Population	# of Dwellings		Population	# of Dwellings	
2016	2,137	791		1,765	611	
2015			2,615			2,231
2011	1,843	624	2,279	1,630	575	2,223
2006	1,867	622	2,177	1,384	474	1,732
2001	1,850	588	2,045	1,239	426	1,471
1996	1,481			1,132		

A review of this data indicates a steady growth trend in the number of dwellings occupied by residents and the overall population, whether considering the census or SaskHealth estimates. Pilot Butte reports a physical count of approximately 2,300 in 2017, slightly higher than the census estimate. Although the population numbers vary, it should be noted that growth has occurred at a higher rate over the past 5 -10 years than in the previous 10 year period. This trend is confirmed by the number of housing starts increasing significantly over the past 5 - 10 years.

The following trends were noted for Pilot Butte:

- StatCan growth rate of 1.85% over 20 year period (1996 to 2016);
- SaskHealth growth rate of 1.77% over 14 year period (2001 to 2015);
- StatCan growth rate of 2.95% over 5 year period (2011 to 2016);
- SaskHealth growth rate of 3.50% over 4 year period (2011 to 2015).

In order to project future population estimates for Pilot Butte, we must apply a growth rate to the existing population. Based on the trends noted, a growth rate of 3.0% was applied to the existing population to project estimated populations for the 20 year period.

Balgonie has also seen growth over the past 20 year period, with a declining rate of growth over the past five years, although still experiencing positive growth. A summary of the Balgonie population trends are:

- StatCan growth rate of 2.25% over 20 year period (1996 to 2016);
- SaskHealth growth rate of 3.02% over 14 year period (2001 to 2015);
- StatCan growth rate of 1.60% over 5 year period (2011 to 2016);
- SaskHealth growth rate of 0.09% over 4 year period (2011 to 2015).

A conservative growth rate of 2.25% for Balgonie was used to project growth over the next 20 years, which is the StatCan rate over the past 20 years.

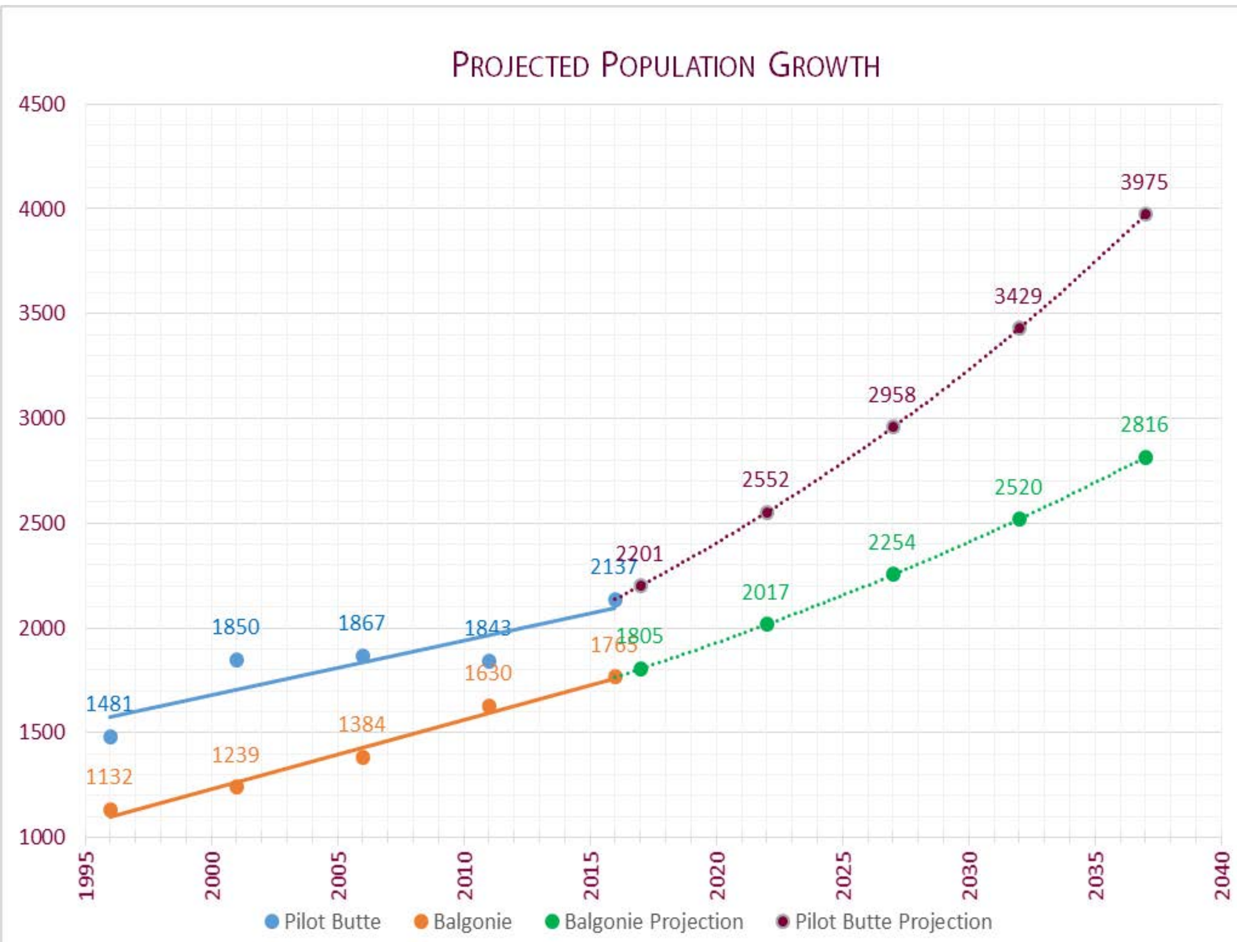


Figure 3-1: Projected Population Growth

Table 3-2: Project Population Growth

Year	2017	2022	2027	2032	2037
Pilot Butte	2,201	2,552	2,958	3,429	3,975
Balgonie	1,805	2,017	2,254	2,520	2,816
Total	**4,006**	**4,569**	**5,212**	**5,949**	**6,791**

3.2 WATER CONSUMPTION

The water treatment plant is equipped with water meters which record raw water, treated, and distributed quantities, for the Pilot Butte distribution system and the Balgonie system. The facility was commissioned in 2013, with Balgonie connecting in March of 2014. The data reviewed from 2013 to 2017 is a small sample set, but the trend of increasing water consumption due to population growth is evident. A summary of annual water consumption from 2013 to 2017 is appended. Based on the records kept at the water treatment plant, water use since 2013 is as follows:

Table 3-3: Water Consumption Summary

Year	Raw Water (m^3)				Treated Water (m^3)			
	Total	Avg. Day	Peak Day	Peak Factor	Total	Avg. Day	Peak Day	Peak Factor
2014	376,560	1,032	3,678	3.57	296,440	812	2,986	3.68
2015	450,514	1,234	3,559	2.88	350,467	960	2,872	2.99
2016	438,536	1,201	2,292	1.91	330,907	907	1,870	2.06
2017*	529,598	1,451	3,176	2.19	403,202	1105	2,492	2.26

*Pro-rated data

The rate of water consumption varies over a wide range during different periods of the year and hours of the day. However, two characteristic demand periods are normally recognized as being critical factors in the design and operation of a water system. These are the peak day and peak hour demand. The Peak Day consumption is the highest day of consumption in any one year. In 2014 the Peak Day factor (Peak Consumption divided by the Average Day consumption) was above 3.0 for raw and treated consumption, but has trended down in recent years. This may be due to a large amount of water use in 2014, as the system was being put into operation and mains were being flushed frequently. The more recent peak factors are in the typical range (2.25 - 2.75) using the Harmon formula and the population of the two communities. For the purposes of this report, a Peak Day Factor of 2.5 will be used to estimate peak consumption rates. A Peak Hour consumption rate of 3.5 times the average rate will be used to determine pumping requirements, since peak hour pumping rates are not recorded.

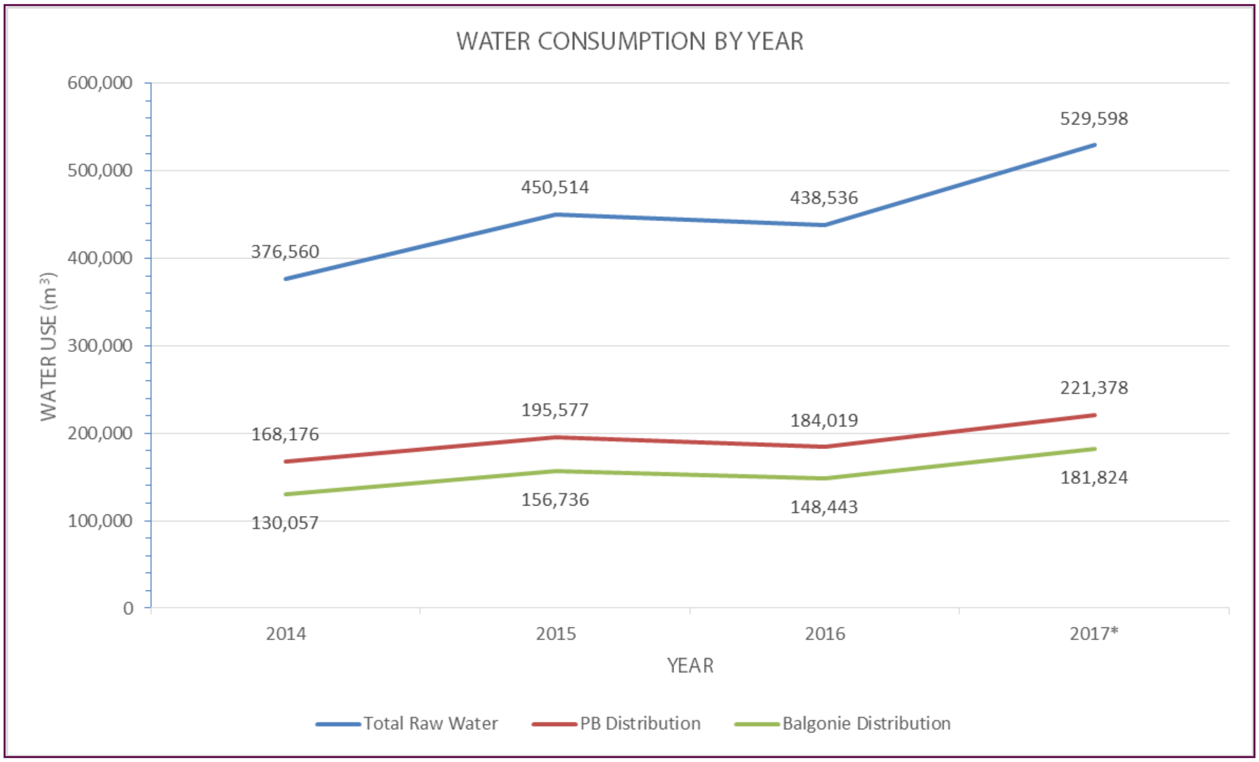


Figure 3-2: Water Consumption by Year

Applying the peaking factors and assumptions described above, Table 3-3 summarizes the average day, peak day and peak hour rates for the system, estimated for the 20 year design period.

Table 3-4: Estimated Flow Rates

	Population			Average Day (L/s)		Peak Day (L/s)		Peak Hour (L/s) Treated
Year	Pilot Butte	Balgonie	Total	Raw	Treated	Raw	Treated	
2017	2,201	1,805	4,006	16.79	12.79	41.98	31.98	44.77
2022	2,552	2,017	4,569	19.15	14.58	47.88	36.46	51.05
2027	2,958	2,254	5,212	21.85	16.64	54.62	41.59	58.23
2032	3,429	2,520	5,949	24.94	18.99	62.35	47.47	66.46
2037	3,975	2,816	6,791	28.47	21.68	71.17	54.19	75.87

3.3 SYSTEM COMPONENTS

Typical design standards indicate that a system's raw water supply and treatment capacity should be capable of providing peak day demand, the treated water storage should be a minimum of 2 times the average day demand to meet minimum firefighting and maintenance requirements, and the distribution pumping should be able to meet the peak hour demand. Balgonie's water use will affect the raw water supply and treatment rates, but will not affect the pumping capacity requirements.

Based on these conditions, the components sizing requirements are summarized below:

Table 3-5: Component Sizing

	Existing Capacity	Required Infrastructure 20 Year Horizon				
Year		**2017**	**2022**	**2027**	**2032**	**2037**
Population		4006	4569	5212	5949	6791
Water Consumption						
Per Capita (Lcd)		276	276	276	276	276
Demand (L/s)		12.79	14.58	16.64	18.99	21.68
Raw Water Supply (L/s)	106	41.98	47.88	54.62	62.35	71.17
Water Treatment (L/s)	65	31.98	36.46	41.59	47.47	54.19
Treated Storage (m^3)	3,185	1,215	1,409	1,633	1,893	2,194
Distribution Pumping (L/s)	76.2	28.1	32.6	37.8	43.8	50.8

Based on the projected population and water consumption rates, all of the existing major components related to the water supply, treatment, storage and pumping are adequately sized to accommodate the growth of the community. The estimated population capacity of each major component, based on current consumption rates, can be summarized as follows:

- raw water supply - 10,100 population;
- water treatment - 8,100 population;
- treated storage reservoir - 5,800 population;
- distribution pumping - 6,000 population.

4. OPERATION AND MAINTENANCE

4.1 TESTING AND RECORDS

The water quality testing is completed daily using Hach DR890 and 2100Q portable testing units, as well as on-line instrumentation. The equipment is quite new and appeared to be in excellent condition. A General Chemical, Health and Toxicity Analysis of the water is completed by an accredited lab once every two years. The Operator reported there is a significant array of testing that is performed each day. The items that are monitored daily include:

- anti-scalant dosage rate and consumption;
- sodium hydroxide dosage rate and consumption;
- chlorine dosage rate and consumption;
- raw water use;
- flushing water use;
- treated water distributed - Pilot Butte and Balgonie;
- conductivity on each vessel of each stage of the MTU in use;
- combined permeate testing of pH and conductivity, and concentrate conductivity;
- raw water flow;
- static water levels in wells.

Daily maintenance rounds also include recording reservoir depths and meter readings, visual inspection of all pumps and motors, chemical feed equipment, and the electrical and controls equipment. Daily water quality testing performed at the water treatment plant includes:

- free and total chlorine;
- pH (used to adjust sodium hydroxide feed rate daily);
- turbidity;
- iron;
- manganese.

A distribution system sample is collected daily in the winter and at least once per week in the summer from one of 6-7 rotating locations in the community. The distribution sample is tested for the following constituents:

- bacti (weekly);
- free and total chlorine;
- turbidity;
- copper;
- pH;
- temperature.

The records kept by the Operators are completed each day and are exemplary. The information collected and recorded is valuable to establish trends in the performance of the system, and will help in detecting when conditions change or an upset condition occurs. The Operator adjusts chemical feed dosage rates to target a free chlorine residual of 0.5 mg/L to 0.7 mg/L. The sodium hydroxide feed rate is also adjusted daily to target a finished pH of 8.3 to 8.8.

4.2 Maintenance and Operation

The Operator reports that the water treatment facility is in good operating condition. The Operators have developed a thorough maintenance program that will keep the system operating well and extend the lifespan of its major components.

Monthly maintenance practices include:

- check pumps for grease;
- service on-line chlorine analyzer;
- calibrate lab testing equipment;
- check static water levels in wells by hand;
- clean on-line pH probes;
- boiler maintenance and filters;
- clean air filters on VFDs;
- test genset start (weekly);
- clean flow meters (raw water flow meters cleaned every 6 months).

Longer term maintenance programs in place for the water system include:

- flushing of water mains (annual);
- exercise water main gate valves, including a valve body pressure test;
- hydrant inspections (semi-annual);
- lab instruments calibrated (annual);
- well servicing (estimate every 7 years);
- treated reservoir cleaning (anticipate every 5 years);
- turbine pumps full maintenance (every 5 years);
- genset servicing and test (semi-annual).

4.3 Review of Pertinent Documents

There are complete record drawings and operation and maintenance manuals for the water system. The Operators' "Daily Plant Rounds" log of meter readings, dosage rates, etc. were reviewed in the preparation of this report, and the information recorded is well above the standard for the amount of information recorded.

5. WATERWORKS COST AND SUSTAINABILITY

5.1 INTRODUCTION

All waterworks and wastewater systems should be operated as a self-sustaining utility. Water and sewer rates should be sufficient to off-set all operating costs, debt retirement, and to provide a surplus for future capital investment. The American Waterworks Association has a policy statement regarding the economic principles of operating a water utility that is widely accepted in North America. The statement can be found at www.awwa.org and is summarized as follows:

1. Water utilities' revenues from water service charges, user rates, and capital charges (e.g. impact fees and system development charges) should be sufficient to enable utilities to provide for:

   - annual operation and maintenance expenses;
   - capital costs (e.g. debt service and other capital outlays); and
   - adequate working capital and required reserves.

2. Water utilities should account for and maintain their funds in separate accounts from other governmental or owning entity operations.

3. Water utilities should adopt a uniform system of accounts based on generally accepted accounting principles.

4. Water rate schedules should be designed to distribute the cost of water service equitably among each type and class of service.

5. Water utilities should maintain asset records that detail sufficient information to provide for the monitoring and management of the physical condition of infrastructure.

The community should consult with the Saskatchewan Municipal Board if it requires assistance in determining an equitable rate. The Municipal Board has adopted the above noted principles in its assessment of water and sewer utility rates.

We have prepared the following cursory review of the Town's operating costs and revenue.

5.2 HISTORICAL EXPENDITURES

The Town of Pilot Butte provided historical expenditure and revenue statements for the years 2014 to 2016. This included unaudited and audited information, as well as internal annual reporting prepared by the Town's Water Department. It is difficult to accurately determine the true annual revenues and costs when you include the capital borrowing costs, debt retirement, and amortization of existing infrastructure, as there are significant expenditures related to these items, as the infrastructure is all relatively new. There are also revenue mechanisms from development levies to offset these expenditures. BCL reviewed the available data and prepared a cursory summary for the operating expenditures versus revenues for the Pilot Butte Utility (Balgonie costs and revenues removed), as well as a review of the entire utility for the year 2015.

Table 5-1: Expenditures and Revenues

Item	2014	2015
Pilot Butte Revenue	$317,463	$479,247
Pilot Butte Operating Expenses	$233,672	$220,573
Surplus / (Deficit)	$83,791	$258,674

The 2015 financial statements for the Water Utility, including capital debt expenditures and distribution of water to Balgonie, were reviewed and the following key points noted:

- total revenues from utility rates and connection fees were approximately $963,267;
- total expenditures, including amortization of assets and debt retirements costs were $915,814;
- the Department generated a surplus of $47,813 in 2015, without including revenue from development levies;
- the utility rates charged appear to be adequately funding the utility and generating adequate surplus;
- a portion of surplus should be dedicated to accelerated debt retirement or a dedicated surplus fund for future expenditures;
- the current arrangement with Balgonie appears to generate a surplus;
- the facility appears to be operated efficiently, no cost saving measures were identified.

6. RECOMMENDATIONS AND COST ESTIMATES

6.1 IMMEDIATE ISSUES AND RISKS

There are no immediate concerns with the water quality operation condition, or capacity of the Pilot Butte water system. The facility is positioned to handle significant growth in the region without requiring significant upgrades. No risk to public health of the environment was identified.

The static water level of the aquifer at the well site should be monitored and reviewed annually by Operations staff, to note if any long term changes occur. The emergency use of the City of Regina's groundwater well in proximity to Pilot Butte's wells caused static levels to fall in 2017, but it is unlikely to cause any lasting problems unless a major shift in Regina's water supply strategy occurs and the well(s) are used consistently.

6.2 RECOMMENDATIONS

There are no short term recommendations made at this time.

Longer term recommendations include planning for the following future expenditures:

- Drilling and development of a fourth groundwater well, once average daily consumption exceeds 20 L/s or Peak Day consumption exceeds approximately 50 L/s. This is anticipated to occur with a total population served of near 6,000. Order-of-magnitude cost is estimated to be $300,000;

- Twinning of the raw water main from the raw water booster pumphouse to the water treatment plant to provide system redundancy. The order-of-magnitude cost is estimated to be $1.75M.

6.3 ESTIMATED CAPITAL REPLACEMENT COSTS AND REMAINING SERVICE LIFE

It is very difficult to estimate the remaining service life of most major components, as many factors are involved, including age, environment, maintenance procedures, quality of workmanship, etc. It is particularly difficult for those components that are buried underground. However, in compliance with the Water System Assessment requirements, our assessment of capital replacement costs and remaining service life is as follows:

Component	Year of Construction / Installation	Typical Service Life	Estimated Remaining Service Life	Estimated Replacement Cost
Raw Water Supply:				
Raw Water Wells (3)	2013 / 2015	30-50 years	25-35 years	$750,000
Raw Water Booster Pumphouse	2013	30-40 years	25-35 years	$750,000
Raw Water Supply Pipeline (250 mm - 400 mm dia.)	2013	40-60 years	35-50 years	$1,900,000
Water Treatment Plant:				
Process Equipment	2013 / 2015	20-30 years	15-25 years	$4,200,000
Building	2013	40-50 years	35-45 years	$1,000,000
Mechanical	2013	20-30 years	15-25 years	$1,100,000
Pump and Motors	2013 / 2015	20-30 years	15-25 years	$400,000
Electrical	2013	20-30 years	15-25 years	$1,300,000
Subtotal:				$8,000,000
Reservoirs:				
Treated Storage Reservoir (3,185 m^3)	2013	50-70 years	45-65 years	$3,500,000
Distribution System:				
Pipe (150 mm - 300 mm dia.)	2013 / 2017	40-60 years	35-60 years	$5,200,000
Total Estimated Replacement Cost:				**$20,100,000**

* Estimated replacement costs include 25% for engineering and contingency.

7. CONCLUSION

We trust that this report fulfills the requirements for this *Waterworks System Assessment*. Should you require additional information, please do not hesitate to contact our office.

"I, the undersigned, declare that the information contained within this submission is, to the best of my knowledge, completed and accurate, and has been prepared in accordance with the standard for this submission as published by the Saskatchewan Water Security Agency."

Respectfully Submitted,

BULLÉE CONSULTING LTD.

T. J. Magus, P.Eng.

Constituents	Unit	WTP Jan. 24, 2017	WTP Jan. 19, 2016	WTP Jan. 25, 2015	WTP Jan. 13, 2014	Wells 1 & 2 Jan. 17, 2013	Well #1 Oct. 4, 2010	Well #2 Oct. 4, 2010	Well #3 Oct. 4, 2010	Saskatchewan Drinking Water Quality Guidelines		Canadian Drinking Water Quality Guidelines	
METALS												MAC	AO
Arsenic, As	mg/L	0.0014		0.0013	0.0016	0.0032	0.0036	0.0037	0.0022	0.01		0.01	
Aluminum, Al	mg/L	0.008		0.0097	19.1	0.0033	0.0021	<0.0005	<0.0005				
Barium, Ba	mg/L	0.0008		<0.00231	<0.00231	0.0233	0.025	0.027	0.019	1		1.0	
Boron, B	mg/L	0.1		0.1	0.1	0.2	0.15	0.12	0.12			5	
Cadmium, Cd	mg/L	<0.00015		<0.00056	<0.00056	<0.00056	<0.00001	<0.00001	<0.00001	0.005		0.005	
Chromium, Cr	mg/L	<0.00019		<0.00011	<0.00011	<0.00011	<0.0005	<0.0005	<0.0005	0.05		0.05	
Copper, Cu	mg/L	<0.00829		0.0029	0.0131	<0.00271	0.0011	0.0035	<0.0002		1		≤1.0
Iron, Fe	mg/L	<0.1	<0.1	<0.1	<0.1	**0.6**	**0.6**	**0.5**	**0.62**	0.3			≤0.3
Lead, Pb	mg/L	<0.00007		<0.00009	0.0001	<0.00009	<0.0001	0.0003	<0.0001	0.01		0.01	
Manganese, Mn	mg/L	<0.01	<0.01	<0.01	<0.01	**0.7**	**0.72**	**0.69**	**0.72**		0.05		≤0.05
Selenium, Se	mg/L	<0.00113		<0.00096	<0.00096	<0.00096	0.0003	0.0002	0.0003	0.001		0.001	
Uranium, U	mg/L	<0.00011		0.0001	<0.00010	0.0094	0.01	0.0093	0.011	0.01		0.01	
Zinc, Zn	mg/L	<0.004		<0.00362	0.0058	<0.00062	0.0012	<0.0005	<0.0005		5		≤5.0
Routine Analysis													
Bicarbonate, HCO3	mg/L	25	26	53	58	397	405	373	376				
Calcium, Ca	mg/L	1	<1	<1	2	109	104	90	97				
Carbonate, CO3	mg/L	0	0	0	0	0	<1	<1	<1				
Chloride, Cl	mg/L	1.1	1.1	1	1.8	3.2	4	5	4		250		≤250
Fluoride, F	mg/L	<0.05	<0.05	<0.05	<0.05	0.28	0.36	0.36	0.38	1.5		1.5	
Hardness	mg/L	7	7	7	9	478	448	389	423		800		
Hydroxide, OH	mg/L	0	0		0	0	<1	<1	<1				
Magnesium, Mg	mg/L	<1	<1	<1	<1	50	46.0	40.0	44.0		200		
Nitrate	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.04	<0.04	<0.04	45		45	
Phenols	mg/L	0	0	0									
pH in Water	pH	8.1	7.9	8.3	8	7.4	7.97	7.99	7.96		6.5-9.0		7.0-10.5
Potassium, K	mg/L	<1	<1	<1	<1	6	5.8	5.2	5.3				
Sodium, Na	mg/L	8	8	18	19	35	35	29	29		300		≤200
Sulphate, S04	mg/L	2.5	2.9	2.2	1.2	188	220	160	180				
Total Alkalinity	mg/L	20.2	21.4	43.1	47.9	325	332	306	308		500		
Turbidity	NTU						<0.1	<0.1	<0.1			≤0.3/≤1.0/≤0.1	
Total Organic Carbon	mg/L						1.1	1	1.2				
Total Organic Carbon, dis.	mg/L						1.2	1.1	1.6				
Sum of Ions	mg/L						800	702	735				
Specific Conductivity	uS/cm	47	51	85			938	833	874				
Computed Conductivity	uS/cm				97	904							
Total Suspended Solids	mg/L						2	1	1				
TDS (Calculated)	mg/L	40	41	77	84	**788**	**652**	**566**	**606**		1500		≤500

Town of Pilot Butte
Water Consumption Summary
October 25th, 2017
2013-2017

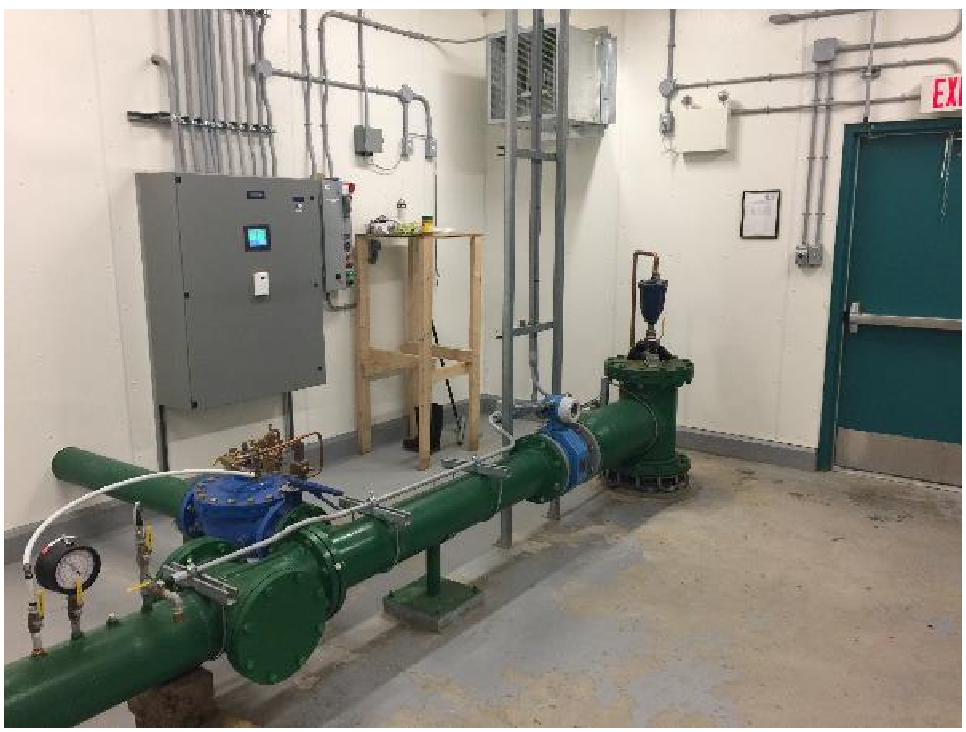
	2013			2014				2015				2016				2017			
Month	Raw Total (m^3)	Treated Total (m^3)	Pilot Butte Distribution (m^3)	Raw Total (m^3)	Treated Total (m^3)	Pilot Butte Distribution (m^3)	Balgonie Distribution (m3)	Raw Total (m^3)	Treated Total (m^3)	Pilot Butte Distribution (m^3)	Balgonie Distribution (m3)	Raw Total (m^3)	Treated Total (m^3)	Pilot Butte Distribution (m^3)	Balgonie Distribution (m3)	Raw Total (m^3)	Treated Total (m^3)	Pilot Butte Distribution (m^3)	Balgonie Distribution (m3)
January	-	-	-	6,635	6,686	5,937	-	32,831	25,902	15,356	10,770	32,763	24,219	14,238	10,726	35,931	27,302	15,407	12,066
February	-	-	-	7,254	6,949	6,810	-	30,038	23,616	14,299	9,245	29,773	22,091	12,121	9,408	32,115	24,457	14,309	10,413
March	-	-	-	28,794	21,237	14,180	7,386	34,266	26,981	16,322	11,385	31,449	23,407	13,006	11,052	35,280	26,594	14,964	11,590
April	-	-	-	37,467	29,418	16,893	12,708	31,581	24,863	14,228	10,696	32,385	24,219	13,387	11,081	35,393	26,792	15,195	11,780
May	-	-	-	40,534	32,054	16,544	16,053	43,993	34,914	17,805	17,118	47,597	36,021	18,627	17,402	50,164	38,212	20,834	16,991
June	-	-	-	39,050	30,389	15,494	15,060	53,151	42,251	21,905	20,404	44,415	33,573	18,351	15,444	53,666	40,765	22,088	19,021
July	-	-	-	46,785	36,529	19,285	18,020	45,333	35,530	18,655	17,331	40,852	31,044	17,676	12,997	73,788	56,422	29,273	27,304
August	-	-	-	38,158	29,780	16,468	12,997	44,273	34,156	18,970	14,958	40,705	30,988	17,506	13,559	59,918	45,978	24,523	21,068
September	5,630	4,254	3,589	38,191	29,850	14,296	15,573	35,798	27,541	15,639	12,426	36,583	27,825	15,401	12,393	48,343	36,797	20,721	16,009
October	6,889	5,582	4,946	32,038	25,131	14,223	11,014	34,227	25,828	14,584	11,026	34,391	26,136	14,510	11,824	-	-	-	-
November	3,649	3,929	3,991	30,294	23,748	13,921	10,912	32,269	24,128	13,783	11,106	32,682	24,937	13,898	10,856	-	-	-	-
December	5,399	5,778	4,892	31,361	24,669	14,123	10,335	32,754	24,757	14,029	10,269	34,941	26,447	15,299	11,702	-	-	-	-
Total (m^3)	**21,566**	**19,543**	**17,417**	**376,560**	**296,440**	**168,176**	**130,057**	**450,514**	**350,467**	**195,577**	**156,736**	**438,536**	**330,907**	**184,019**	**148,443**	**424,598**	**323,319**	**177,315**	**146,241**
Yearly Avg Day (m^3)	**177**	**160**	**143**	**1,032**	**812**	**461**	**425**	**1,234**	**960**	**536**	**429**	**1,201**	**907**	**504**	**407**	**1,555**	**1,184**	**650**	**536**
Peak Day (m^3)	**799**	**733**	**574**	**3,678**	**2,986**	**923**	**2,760**	**3,559**	**2,872**	**1,135**	**1,436**	**2,292**	**1,870**	**804**	**864**	**3,176**	**2,492**	**1,186**	**1,364**
	Oct. 29	**Nov. 21**	**Oct. 29**	**Sept. 7**	**Sept. 7**	**July 16**	**Sept. 7**	**June 9**	**June 9**	**June 10**	**May 24**	**May 5**	**May 5**	**Aug. 30**	**May 4**	**July 28**	**May 31**	**July 16**	**July 16**
Peak Factor	**4.52**	**4.58**	**4.02**	**3.57**	**3.68**	**2.00**	**6.49**	**2.88**	**2.99**	**2.12**	**3.34**	**1.91**	**2.06**	**1.59**	**2.12**	**2.04**	**2.10**	**1.83**	**2.55**

***Notes: Distribution of treated water to Balgonie began on March 6, 2014**

Groundwater well (typical of 3).

Well pumphouse exterior.

Raw water main header from each well.



Raw water main header, PRV, and flow meter.

Well pumphouse electrical MCC.

Raw water main entering WTP, turbidity meter.

Booster pumps and pre-filters.

Flushing chamber access hatch and level sensor.

Transfer pumps and backwash pump.

Electric hoist in booster pump room.

Membrane treatment unit controller, turbidimeter.

Membrane treatment unit.

MTU turbidimeters.

MTU de-gas membrane.

MTU sampling sink.

MTU logic controller screen.

Overhead door into chemical feed room.

Exterior overhead door into chemical feed room.

Treated water discharge to reservoir, magmeter.

Clean-In-Place tank, pre-filter, and pump.

Chemical feed, in-floor scales, feed pumps.

Chemical feed pump and weigh scale interface.

Chemical feed set-up.

Emergency shower and eyewash.

Chemical feed room ventilation.

Chemical feed room radiant heater and ventilation fan.

Reservoir access hatches and level sensor.

Distribution header, magmeter, pH meter, and chlorine analyzer.

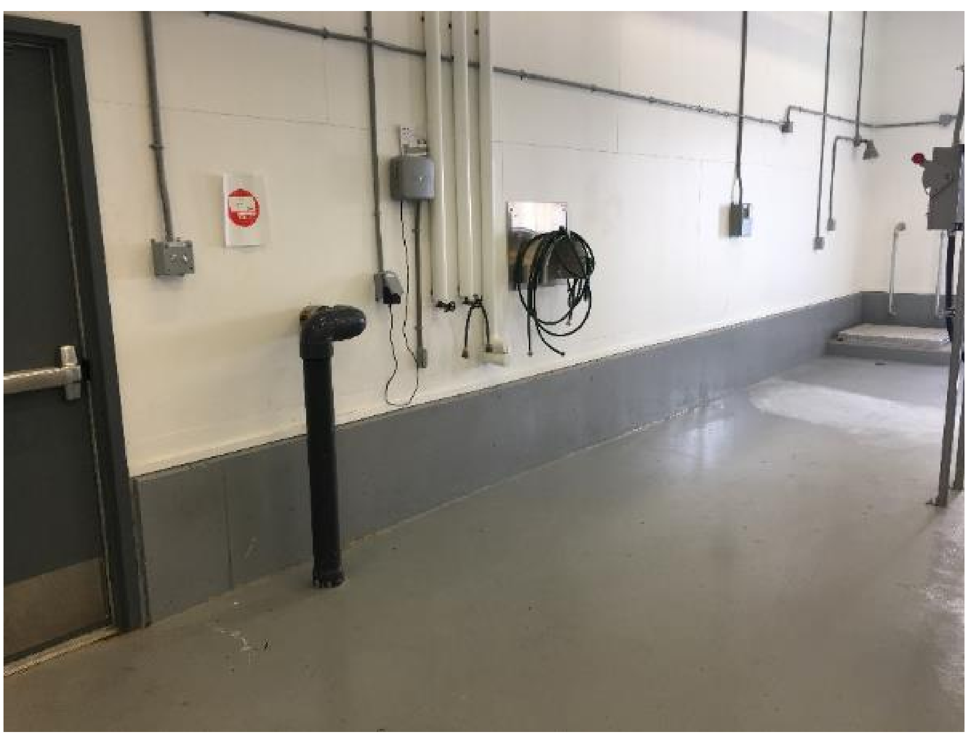
Distribution piping, PRV valve.

Distribution pumps and header.

Overhead electric hoist in distribution pump room.

Distribution pump room.

Dedicated Balgonie distribution pumps and piping.



Reservoir ventilation pipe.

Distribution piping in valve chamber.

Electrical room ventilation equipment.

Natural gas boilers (heating system).

Electrical equipment.

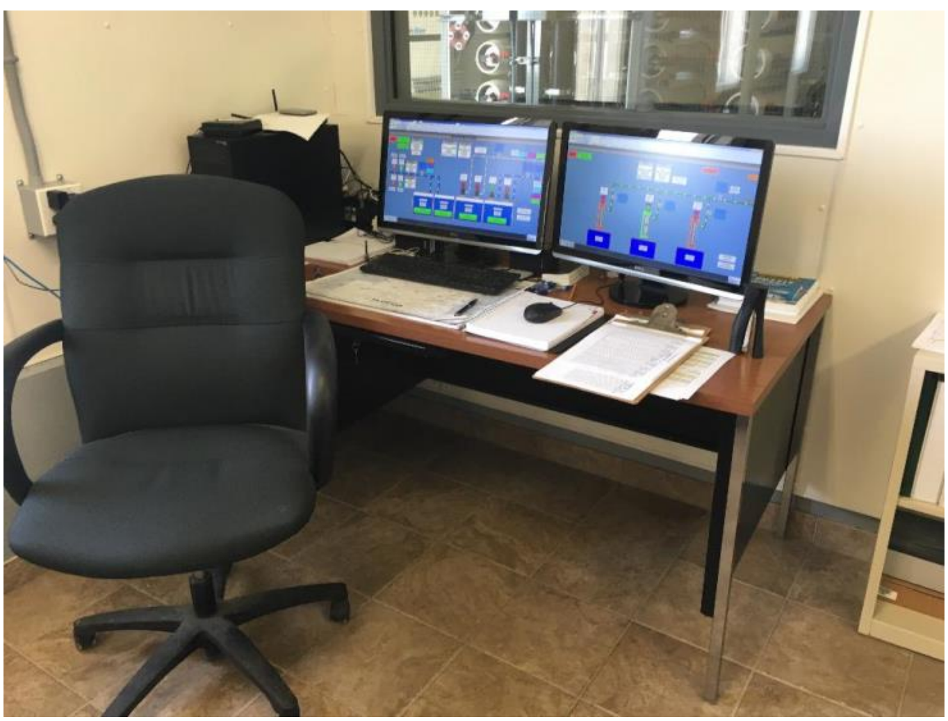
Variable frequency drives in electrical room.

Electrical MCC.

Power conditioning equipment.

Electrical components.

Natural gas standby genset.



Operator PLC control interface.

Office and lab space.

Testing area in office / lab.

Handheld testing equipment.

Washroom.

Exterior of water treatment plant.

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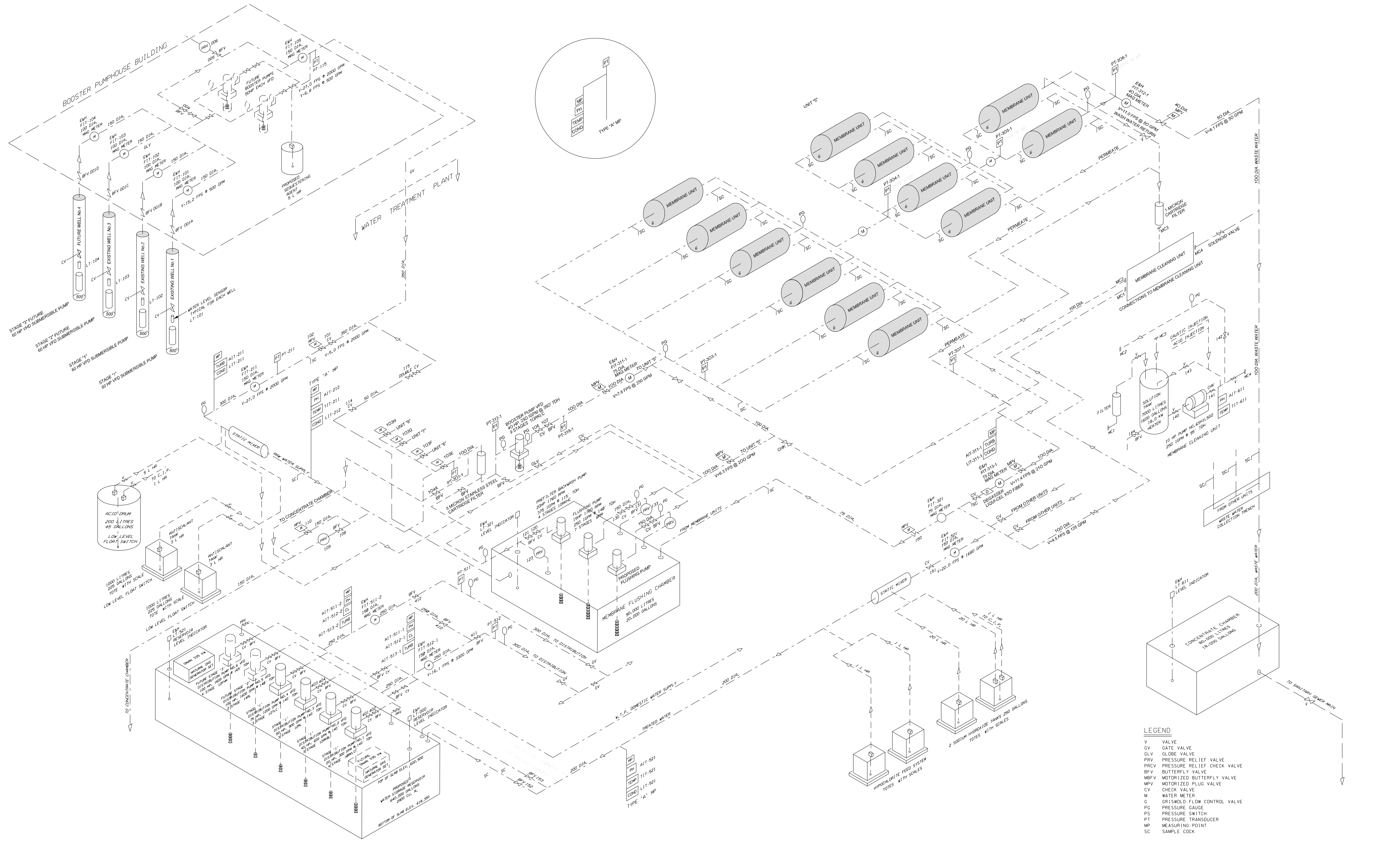
Appendix D
Figures and Drawings



LEGEND

V	VALVE
GV	GATE VALVE
GLV	GLOBE VALVE
PRV	PRESSURE RELIEF VALVE
PRCV	PRESSURE RELIEF CHECK VALVE
BFV	BUTTERFLY VALVE
MBFV	MOTORIZED BUTTERFLY VALVE
MPV	MOTORIZED PLUG VALVE
CV	CHECK VALVE
M	WATER METER
G	GRISWOLD FLOW CONTROL VALVE
PG	PRESSURE GAUGE
PS	PRESSURE SWITCH
PT	PRESSURE TRANSDUCER
MP	MEASURING POINT
SC	SAMPLE COCK

BCL
BULLÉE CONSULTING LTD.

JOB No. 181.00	TOWN OF PILOT BUTTE
DATE: 2018/04/27	WATER TREATMENT PLANT SCHEMATIC FLOW DIAGRAM
DRAWN: L.J.K.	
CHECKED: L.F.L.	
DESIGNED: T.J.M.	SCALE: N.T.S. / REV. No. / DRAWING No. / SHEET: 1 OF 1

Round 3 Waterworks System Assessment Summary

Waterworks: Town of Pilot Butte

Owner(s): Town of Pilot Butte

Env. Project Officer: Don Turner

Summary Completion Date: Dec. 15, 2017

Population: Full Time: 4006 Seasonal:

Source: Groundwater: [x] Surface Water: [ ] GUDI (groundwater under direct influence): [ ]
Treated Groundwater: [ ] Treated Surface Water: [ ] Treated GUDI: [ ]

Sourcewater Protection Concerns: Capacity concern of aquifer if City of Regina wells are operated in an emergency situation

Source/Raw Water Quality Issues that May Affect Treatment/Treated Water Quality:

Parameter:	Level:	Parameter:	Level:
Iron	.36 - .62 mg/L		
TDS	566 - 788 mg/L		
Manganese	.62 - .72 mg/L		

Raw water capacity/allocation: 1000 dams (700 Pilot Butte, 300 Balgonie)

Treated/Distributed Water Quality Issues (any that exceed Standards and Objectives after treatment):

Parameter:	Level:	Parameter:	Level:

List of Chemicals Used: 1) Anti-scalant 2) Sodium Hypochlorite 3) Sodium Hydroxide

Description of Treatment Processes in Place:

Three groundwater wells supply raw water to the WTP. Raw water enters the plant, is injected with an anti-scalant, flows through 5 micron pre-filters, and then through reverse osmosis membrane treatment units. Membrane permeate water is dosed with Sodium Hydroxide to raise the pH of the water and sodium hypochlorite to disinfect the water. Treated water is stored in an underground concrete storage reservoir under the WTP.

Treatment Processes with existing issues (including capacity issues):

None of the treatment equipment has operational issues. It is all in good working order.

Other issues identified within the waterworks:

None.

Major Recommendations:

Monitor static water levels at well site.

Any Recommendations that may pose an Immediate Health Concern:

None at this time.

Total Cost of Recommended Upgrades: $0

Other Comments:

None at this time.

*Please submit electronic copy to WSA. If more space is required, a longer summary sheet may be requested.