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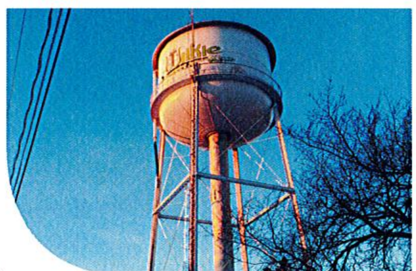
May 9, 2016

WATERWORKS SYSTEM ASSESSMENT FOR THE

TOWN OF WILKIE



DECEMBER 2015
JOB NO.: 177.42

TOWN OF WILKIE
WATERWORKS SYSTEM ASSESSMENT

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TOWN OF WILKIE
WATERWORKS SYSTEM ASSESSMENT

1. BACKGROUND

The purpose of this Waterworks System Assessment for the Town of Wilkie is to review the community's water supply, treatment, storage and distribution facilities in accordance with the Government of Saskatchewan's *2002 Water Regulations* and the Water Security Agency's *2015 New Waterworks and Sewage Works 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 associated with the waterworks, evaluate progress made since the previous assessment, and evaluate the current performance and sustainability of the waterworks.

The Town of Wilkie is a community with a population of approximately 1,301, located approximately 60 kilometers southwest of the City of North Battleford along Highway 14. Bullée Consulting conducted a site inspection on November 27th, 2015.

The water system consists of two wells supplying raw water to the water treatment plant. Once the raw water enters the water treatment plant it is injected with potassium permanganate (oxidizing agent) prior to being filtered by a manganese greensand gravity filter unit. The filtered water is chlorinated and then stored in an underground concrete storage reservoir with two chambers. The water is distributed to the community by three distribution pumps through underground water mains. There is an elevated water storage tower on the distribution system.

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2. EXISTING INFRASTRUCTURE

2.1 RAW WATER SUPPLY

The source of raw water for the Town of Wilkie is two true groundwater wells. The wells are located west and northwest of the community. The land surrounding each well is utilized primarily for crop production. There is no fencing enclosing either site.

Well #3 is located on section SE 1-Twp 40-Rge 20-W3. The pitless adaptor and 30 horsepower (hp) submersible pump are located approximately 15 metres (m) from the metal clad building which houses the electrical components and unit heater. Since the previous Waterworks System Assessment (2011), well #3 has received a new pump and motor. The interior of the building, metal piping and controls are in fair condition. The well driller's report indicates that the well was constructed in 1998 and is approximately 36.6 m (120 ft.) deep. The water audit report completed in 2002 by Pinter and Associates indicated that the well has a typical flow rate of 15.9 litres per second (L/s) or 210 imperial gallons per minute (Igpm).

Well #4 is located approximately 1.0 kilometres (km) north of well #3. Since the previous Waterworks System Assessment, the pump at well #4 was pulled and replaced with a new submersible pump and pitless adapter. There is a small metal clad building approximately 15 m from the well head, which houses electrical components and a propane unit heater. The well drillers report indicated that the well was constructed in 1981 and is approximately 26.5 m (87 ft.) deep. The water audit report completed in 2002 by Pinter and Associates indicated that the typical flow rate from the well is 16.3 L/s (215 Igpm).

Well #3 supplies water through a 150 mm (6 inch) diameter raw water main to a 'T' connection, where it connects to a 250 mm (10 inch) diameter PVC pipeline from well #4. The wells share the 250 mm diameter PVC raw water main from the pipe intersection to the water treatment plant. There was a service connection off of the 150 mm raw water main from well #3 to a private residence, which was disconnected in 2009.

Two guidelines define water quality, categorized into aesthetic objectives and maximum acceptable concentrations, according to the Canadian Drinking Water Quality Guidelines and the Saskatchewan Drinking Water Quality Guidelines. Aesthetic objectives are used to assess taste, odour, and palatability of the water, while maximum acceptable concentrations define potential safety and health issues.

The quality of raw water supplied by the wells is of a reasonable quality, with concentrations of iron, manganese and turbidity above the Saskatchewan Drinking Water Quality Guidelines. These parameters are aesthetic issues and not health concerns. The raw water also contains concentrations of bicarbonate, total alkalinity, sulphates, elevated hardness, and total dissolved solids, which are below Saskatchewan Guidelines, but qualify the water as aesthetically marginal.

2.2 TREATMENT

2.2.1 Filters

The filter unit in the water treatment plant was installed in 1985 and is a BCA model F-IR-2-660. There are two halves to the filter unit (A and B). The media in the filter unit is manganese greensand, which is typical for iron and manganese removal. The operation and maintenance manual indicates that there is a total detention time of 22.6 minutes provided by the filter tanks. It also indicates that each filter half is capable of filtering at a rate of 20.8 L/s (330 USgpm), for a total filtration rate of 41.6 L/s (660 USgpm). The filters are set up to backwash based on the pressure differential across each filter, however, the operator initiates the process manually, as the filter units are not connected to the programmable logic controller (PLC). Typically the filters are each backwashed once per day. Aeration is not used in the backwash process. Each filter is backwashed for approximately 7 minutes at a rate of approximately 69.4 L/s (1,100 USgpm). The wastewater flows into the backwash water chamber and then via a pipe to the gravity sewer system. Filter to waste piping is installed to prevent turbidity issues immediately following backwash, once filters are put back into operation.

Static mixers were recently added to the influent piping on both sides of the filter unit in an effort to increase oxidization effectiveness. Replacement valves for the filter effluent lines have been purchased and are to be installed shortly. The valves on the influent piping are also intended to be replaced in the near future.

Presently, aeration is not used in the backwash process. An air scour system would improve the effectiveness of the backwash process and decrease water consumption.

2.2.2 Chemical Feed System

The potassium permanganate chemical feed pump is a Grundfos DDI pump in good condition, rated at 720 litres per day (Lpd) (158 Igpd). The potassium permanganate is injected into the raw water piping as it enters the water treatment plant. Potassium permanganate is used to begin the oxidization of iron and manganese. The operator feeds potassium at an approximate feed rate of 3.1 mg/L. The iron and manganese concentration of the raw water requires a feed rate of approximately 2.8 mg/L but does not account for other particles in the water which may also interact with potassium permanganate. Therefore the feed rate of 3.1 mg/L appears to be in the proper range. The maximum use limit for potassium permanganate is 50 mg/L, with the typical use limit approximately 15 mg/L.

The potassium permanganate chemical feed pump is activated based on the well start / stop condition. This could lead to a possible overfeeding of potassium permanganate if the well fails to supply water to the water treatment plant as chemical feed pumps will continue to operate.

Chlorine gas is fed into the water prior to entering the treated water reservoir. There is an automatic switch between gas cylinders once a cylinder is emptied. A gas detection alarm is also present and sends an alarm to the main PLC if a gas leak is detected. An autodialler telephones the operator's cell phone to notify him of the alarm. The plant has a separate chlorine room with its own ventilation system and exterior access to house the chlorine gas cylinders. Chlorine gas is fed at a concentration of approximately 3.1 mg/L, which is below the typical use limit and maximum use limit of 10 mg/L and 30 mg/L, respectively.

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

Groundwater treatment facilities typically require adequate disinfection to provide equal to or greater than 4 log removal (99.99%) of viruses.

The contact time of the system is calculated based on the reservoir volume at low level and peak hour flow rate. In addition to the volume of the reservoir, a baffling factor is applied based on the flow path and mixing occurring in the reservoir. The baffling factor for the Town's reservoir is 0.3. Assuming the reservoir is half full, the effective time required for 10% of the water to pass through the reservoir (T_{10}) is equal to 179.4 minutes.

The table below illustrates the CT values required for 4 log inactivation of viruses versus the actual distribution chlorine residual samples and the resulting CT value.

Example CT calculation:

2015 Average Day Consumption Rate	= 7.12 L/s
Assume Peak Hour = 4.0 x Average Day =4.0 x 7.12	= 28.5 L/s
Total Reservoir Volume (excluding tower)	= 2,045,700 L
50% Reservoir Volume	= 1,022,800 L
Apply baffling factor of 0.3 = 1,022,800 L x 0.3	= 306,855 L

Time for 10% of water to pass through reservoirs (T_{10})
306,855 L ÷ 28.5 L/s = 10,766 seconds = 179.4 min.

CT (November 2, 2015) = 1.13 mg/L x 179.4 = 202.8 mg/L x min.

Virus inactivation by disinfection - 4.0 log

Date of Community Test Results	Free Chlorine Residual (mg/L)	Required CT * at 0.5°C (mg/L x min)	Required CT * at 5°C (mg/L x min)	Required CT * at 20°C (mg/L x min)	Actual Calculated CT (mg/L x min)
June 8, 2015	1.23	12.0	8.0	3.0	220.9
July 28, 2015	0.96	12.0	8.0	3.0	172.
Aug. 17, 2015	1.04	12.0	8.0	3.0	186.8
Sept. 14, 2015	0.91	12.0	8.0	3.0	163.4
Oct. 5, 2015	0.93	12.0	8.0	3.0	167.0
Nov. 2, 2015	1.13	12.0	8.0	3.0	202.9

*values established in the Water Security Agency's *EPB 501 Waterworks Design Standards*

The Operator typically maintains free chlorine concentrations of approximately 0.9 - 1.5 mg/L, which is adequate for 4.0 log virus inactivation.

2.2.3 Treated Water Quality

The quality of the treated water is acceptable, as there is no health risk associated with the quality of the treated water. The process is effective in removing iron and manganese particles from the treated water. The system has no ability to reduce the total dissolved solids, total alkalinity concentration or hardness of the water; therefore the quality of the treated water could be improved aesthetically. The total dissolved solids concentration of approximately 900 mg/L present in the treated water is higher than the Canadian aesthetic objective of 500 mg/L, but lower than the Saskatchewan guideline of 1500 mg/L.

A description of each pertinent constituent follows (provided by SRC's *Analytical Chemical Health & Toxicity Package*):

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.

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 aesthetic objective is set at a maximum of 0.05 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 is 1500 mg/L and is approximately equivalent to a conductivity of 1500 uS/cm.

Total Hardness

Water hardness is mainly caused by the presence of calcium and magnesium and is expressed as the equivalent quantity of calcium carbonate. Scale formation and excessive soap consumption are the main concerns with hardness. When heated, hard waters have a tendency to form scale deposits. Depending on the interaction of other factors, such as pH and alkalinity, hardness levels between 80 and 100 mg/L are considered to provide an acceptable balance between corrosion and incrustation. Water supplies with a hardness greater than 200 mg/L are considered poor, but tolerable; those in excess of 500 mg/L are unacceptable for most domestic purposes. As water softening may introduce undesirably high quantities of sodium into drinking water, it is recommended that a separate unsoftened supply be used for drinking and cooking. (The aesthetic objective in Saskatchewan is 800 mg/L.)

Calcium

The presence of calcium in water supplies results from passage through or over limestone, dolomite and other calcium containing deposits. Small concentrations of calcium carbonate combat corrosion of metal pipes by laying down a protective coating. Higher levels of calcium salts can precipitate when heated to form scale in boilers, pipes and cooking utensils. Calcium contributes to the total hardness of water.

2.3 WATER STORAGE

The underground concrete chambers were constructed at the time of the water treatment plant construction in 1983. The two chambers are connected by a 300 mm (12") diameter valved transfer pipe. Treated water can be discharged from the filter unit into either reservoir. Similarly, distribution pumping can be drawn from either reservoir. Additional storage is provided by the water tower, which is connected by the distribution network.

Record information pertaining to the water storage system is very limited. From the 2002 *Water System Audit* prepared by Pinter and Associates, the water reservoirs are sized as follows:

Small underground concrete chamber	227,300 L
Large underground concrete chamber	1,818,400 L
Elevated water tower	363,700 L
Total Estimated Storage Capacity	**~2,409,000 L**

Access to the smaller chamber is through an access hatch located in the water treatment building. The hatch sits on top of 100 mm raised concrete curbing. The exterior access for the larger reservoir chamber is a steel lid on top of a raised concrete curb. This access is always padlocked.

The reservoir appeared clean and the Operator commented it was last cleaned in 2014. The Operator intends to clean the reservoir every other year. Reservoir cleaning can be completed without shutting down the distribution system. During the cleaning operation of one chamber, treated water can be pumped from the other chamber to provide continuous water supply. The reservoir reportedly had a leak, which was sealed by excavation and application of a blueskin membrane to the west wall in 2015.

The water tower received maintenance in 2015, which included painting of the exterior and spray foam insulation to the riser piping enclosure. A new compressor and access hatch were also added during the renovation.

2.4 Distribution

Treated water is distributed to the community by three vertical turbine pumps, pumping water through underground distribution mains ranging from 150 mm to 300 mm in diameter. The total length of water main is estimated to be approximately 12,000 m.

Distribution pumps #1 and #2 are Aurora Vertiline type 7RH, 15 hp, 1770 rpm, 8 stage, 3 phase pumps, each capable of pumping 20.8 L/s (330 USgpm) at 35.1 m (115 ft.) TDH. Pump #2 was replaced in 2014. Distribution pump #3 is an Aurora Vertiline 30 hp, 1770 rpm, 2 stage, 3 phase pump rated at 44.2 L/s (700 USgpm) at 35.1 m (115 ft.) TDH.

The standby pump is an Aurora Vertiline type 14RH, 1770 rpm, 2 stage pump capable of pumping 151.4 L/s (2,400 USgpm) at 53.3 m (175 ft) TDH. The pump is driven by a John Deere diesel standby engine. The operator reported that the engine is started at least once per month. In the event of a power outage, the water tower also provides system pressure until power is restored or the standby pump is manually engaged.

The Operator indicated that the distribution system operates well and that there are no stagnant lines in the network. The Operator typically flushes the system twice annually. The network experiences two to three water main breaks each year, mainly due to the age of the system. Extensive water main and hydrant replacement programs have been completed since 2009 to replace all cast iron mains in the Town, including service connections, valves, and hydrants. Historical issues experienced by the network included heavy corrosion. All replacement valves have been installed with cathodic protection to combat this issue. The system is equipped with meters at each residence and building in Town. Water quality within the distribution system is good, with residual free chlorine levels between 0.58 - 1.67 mg/L.

There is a coin operated truck fill line located at the fire hall. The truck fill line is supplied directly off of the distribution piping and is equipped with a backflow prevention device.

2.5 PLC and Controls

The electrical controls in the facility were installed in 1983. Components were upgraded in 1997, including the installation of a programmable logic controller (PLC) in the filter control panel. Since the previous Waterworks System Assessment, controls have been upgraded further, with the installation of a new PLC controlling the wells, distribution, storage levels, and system monitoring. The filter unit is intended to be tied into the new PLC in the near future. The old Healy Ruff level sensors were replaced with new ultrasonic sensors in both reservoirs as part of the upgrade. The PLC operates the well pumps based on reservoir levels and the distribution pumps based on the level in the water tower. Communication between the wells, plant and tower is now wireless. Other upgrades include the installation of a new magnetic flow meter on the raw water influent line.

The water treatment plant is equipped with an autodialer, with monitored conditions of high and low reservoir levels, chlorine leak detection in the chlorine room, and low building temperature at the wells. If the alarm conditions are reached, a phone call is placed to the Operator's cell phone, via the autodialer.

The power supply to the building is a 3 phase electrical service. There is no electrical surge protection equipment or backup power supply.

2.6 Water Treatment Facility

The building was constructed in 1983 and has an area of 156 m2 (1680 ft2). The building has metal walls, a concrete floor and metal roofing. The plant has a separate chlorine gas room, with an exterior access door and separate ventilation system.

The building is heated by a natural gas unit heater, as well as a radiant heater. Fluorescent lights and natural light from windows light the building well. Space in the building is adequate, with ample room for chemical storage, maintenance and lab testing space. The mechanical piping in the facility is in good condition.

Since the previous Waterworks System Assessment, the natural gas piping in the plant has been re-routed to run overhead, rather than through the reservoir space as originally configured. The diesel storage tank for the standby engine has been replaced with a new double walled tank. The Operator indicated that the domestic water feed line to the chemical room freezes periodically due to its location within an exterior masonry wall.

This line should be re-routed to prevent this issue.

2.7 New Components and Upgrades

As detailed herein, new components and upgrades to the plant include the following:

- new well pumps for both wells and new pitiless adapter for well no. 4;
- static mixers added to the filter influent piping;
- new paint and spray foam insulation to the water tower riser pipe enclosure;
- new compressor and access hatch for the water tower;
- completion of water main replacement programs to replace all cast iron water mains in the Town, including valves, service connections, and hydrants;
- replacement of distribution pump #2;
- upgrade of water plant controls including a new PLC and ultrasonic level sensors;
- new double walled diesel fuel tank in the plant;
- new communications system between the wells, water treatment plant, and water tower, using radio frequency.

3. COMPONENT SIZING

3.1 POPULATION

The population statistics available from Statistics Canada indicate that the Town of Wilkie has experienced a slight increase in population over the five year period from 2006 to 2011. The population for 2011 was 1,301. Population growth rates are required to predict future populations and related water consumption. For the purposes of this report, a growth rate of 1.26% per annum will be used, resulting in the following population predictions.

Year	2006	2011	2015	2020	2025	2030	2035
Stats Canada	1,222	1,301					
1.26% Growth			1,368	1,456	1,550	1,650	1,757

3.2 WATER CONSUMPTION

The community of Wilkie consumed water at an average daily rate of 6.5 L/s in 2011 and 6.1 L/s in 2012. However, the rate of water consumption varies over a wide range during different periods of the year and hours of the day. There are two characteristic demand periods that are normally recognized as being critical factors in the design and operation of a water system. These critical periods are the peak day (the day of highest consumption during any one year) and the peak hour (the hour of highest consumption during any one year). Historically, Wilkie has experienced an average peak day factor of 2.75 times the average day flow. Based on the peak day and the population of the community a peaking factor of 4.0 was used for the peak hourly flow and 2.75 for the peak day flow to develop a twenty year projection of water consumption.

The community installed water meters in every home in 2007 and started billing for usage in 2009, subsequently experiencing a significant reduction in water usage. Prior to metering, average daily use per person was estimated to be 570 L/d. Once meters were installed, the average daily per capita use has steadily decreased to levels of 433 Lcd in 2011 and 402 Lcd in 2012. This decrease may be partially weather dependant, as it coincides with several years of higher precipitation. For this report, a per capita consumption figure of 450 L/d was used.

Year	Population	Average Day (L/s)	Peak Day (L/s)	Peak Hour (L/s)
2015	1,368	7.12	19.59	28.50
2020	1,456	7.58	20.86	30.34
2025	1,550	8.07	22.20	32.30
2030	1,650	8.60	23.64	34.38
2035	1,757	9.15	25.17	36.61

3.3 SYSTEM COMPONENTS

Based on the projected populations and water consumption rates, each major component of the water system was evaluated to determine its ability to satisfy future water demand. 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 twice the average day demand to meet minimum firefighting requirements and the distribution pumping should be able to meet the peak hour demand.

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

Component	Existing Capacity	Required Capacity				
		2015	2020	2025	2030	2035
Raw Water Supply (L/s)	15.9	**19.59**	**20.86**	**22.20**	**23.64**	**25.17**
Water Treatment (L/s)	41.6	19.59	20.86	22.20	23.64	25.17
Treated Water Storage (L)	2,409,000	1,231,038	1,310,573	1,395,246	1,485,389	1,581,357
Distribution Pumping (L/s)	44.2	28.50	30.34	32.30	34.38	36.61

Although raw water supply is marginally undersized, operation of both wells in tandem provides a raw water supply rate of 38.9 L/s during high use periods and excess storage capacity acts as a buffer to ensure treated water availability.

4. OPERATION AND MAINTENANCE

4.1 TESTING AND RECORDS

The water quality testing is completed daily using the Hach DR 890 Colorimeter and 2100P portable testing units. The DR 890 colorimeter and 2100P turbidimeter are in good condition. The Operator reported that the daily testing practice was to test for free and total chlorine levels, iron and manganese concentrations, and turbidity of the treated water.

The testing records track water consumption, chemical consumption, chlorine, iron, manganese, and turbidity levels. The records appear complete for water usage and chlorine levels with typical chlorine residual levels of 0.9 to 1.5 mg/L.

Bacteriological sampling is completed weekly, as directed by the Water Security Agency. The Operator reported that samples are collected from the extreme ends of the distribution system at random points and are sent to a provincial testing lab for analysis. A general chemical water quality testing is completed annually.

4.2 MAINTENANCE AND OPERATION

The Operator reports that the water treatment facility is generally in good operating condition. Daily maintenance practices include testing, filter backwashing, visual inspection of chemical feed systems and general cleaning in the water treatment plant. Testing equipment is calibrated monthly and professionally inspected annually.

It was reported that the raw water supply main is swabbed annually and that the distribution system is flushed twice each year. However, there is currently no valve exercising program in place for the distribution system.

The building is clean and the painting on the piping is well maintained. The reservoir was last cleaned in 2014, and is intended to be cleaned every other year. The generator set is tested monthly and has not experience any issues to date. The Operator also mentioned that an electrical inspection is completed each year.

There are few spare parts on-site other than those for chemical feed pumps. Spare parts are readily available in Saskatoon and North Battleford. Pump servicing is typically provided by Anderson Pump House in North Battleford.

The water treatment plant does not have a complete set of operation and maintenance manuals present; however, a procedural operations manual was being completed at the time of inspection.

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4.3 Review of Pertinent Information

The water treatment plant is lacking adequate operation and maintenance manuals, and drawings for the use of the Operator.

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 requires 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 following table summarizes the Town's expenditures for the past four years.

Item	2011	2012	2013	2014
Water Revenue	$251,434	$277,775	$320,642	$317,414
Sewer Revenue	69,461	69,140	69,482	69,242
Total Revenue	**$320,895**	**$346,915**	**$390,124**	**$386,656**
Utility Expenditures	$296,305	$297,580	$353,777	$366,054
Total Expenditure	**$296,305**	**$297,580**	**$353,777**	**$366,054**
Surplus / (Deficit)	**$24,590**	**$49,335**	**$36,347**	**$20,602**

As indicated by the table, the Town is consistently running a surplus. The financial statements received from the Town indicate debt retirement paid for by water and sewer income. The surplus generated should allow the Town to save for future capital expenditure as necessary. Water and sewer rates were reviewed by Council in 2011, with additional review to occur in 2016. It should be noted that the grants received from the Building Canada Fund in 2011 and 2012 have not been included in this summary.

6. RECOMMENDATIONS AND COST ESTIMATES

6.1 IMMEDIATE ISSUES AND RISKS

An issue was identified with regard to the domestic feed line freezing within the storage area wall. This line provides the water for mixing the potassium permanganate oxidizing solution and chlorine gas for disinfection, and is critical for the treatment process. Re-routing of the line should be completed to avoid future disruptions due to frozen lines.

6.2 RECOMMENDATIONS

6.2.1 Raw Water Supply Main

It is recommended that the Town consider installing a second raw water supply main in the future. The current raw water main is a 250 mm diameter, with adequate capacity, but the Town's water supply is reliant on this single pipeline. Adding a second raw water main at some time in the future would add redundancy to the system. Installing a new raw water supply main would cost approximately $250,000 - $300,000.

6.2.2 Water Tower

The Town should have a long term plan in place for decommissioning the aging water tower. To accommodate the loss of constant pressure the tower provides to the distribution system, changes would be required to the distribution pumping system at the water treatment plant, which may require backup power generation.

6.2.3 Filter Unit

It is recommended that the Town have the filter unit connected to and controlled by the new PLC for improved control and monitoring purposes. The cost to complete this is approximately $45,000.

6.2.4 Distribution Pumps

The distribution pumps are currently operational, but aging, as indicated by the recent replacement of pump #2. It is recommended that the Town budget for the replacement of the remaining pumps in the near future at a cost of approximately $20,000.

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:				
Wells	1981-1998	20-50 years	0-20 years	$200,000
Pumps and Motors	2013-2014	20 years	0-20 years	$25,000
Supply Pipeline: 600 m of 150 mm dia. 2,400 m of 250 mm dia.	-	40-60 years	0-20 years	$490,000
Water Treatment Plant:				$3,700,000
Filters	1985	20-30 years	0-10 years	
Building	1983	40-50 years	15-25 years	
Mechanical	1983	20-30 years	5-10 years	
Pump and Motors	1983	20 years	5-10 years	
Electrical	1983/2013	20-30 years	20-30 years	
Reservoirs:				
Underground Treated Water Storage Reservoir (2,045,700 L) - combined	1983	50-70 years	25-45 years	$1,950,000
Elevated Treated Water Storage Reservoir (363,700 L)	1947	50-70 years	0-10 years	$425,000
Distribution System*:				
150 - 300 mm dia. (12,000 m)	1950-1985; 2009-2012	40-60 years	50-60 years	$6,500,000
Total Estimated Replacement Cost:				**$13,290,000**

*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. Ledding, P. Eng.

APPENDIX A

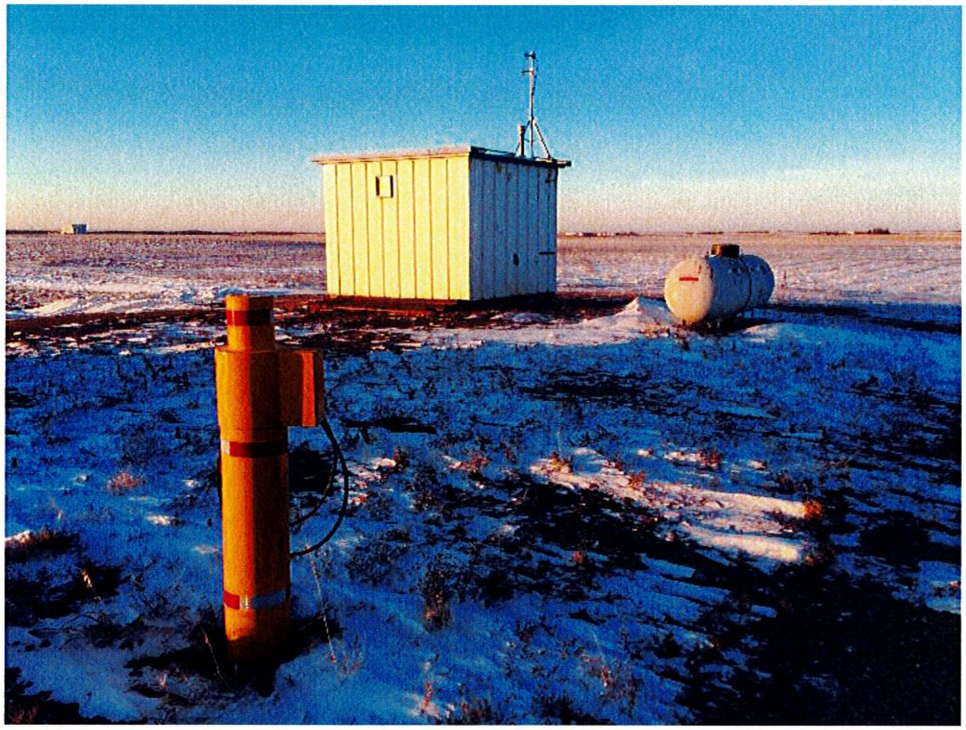
WATER QUALITY SUMMARY

APPENDIX B

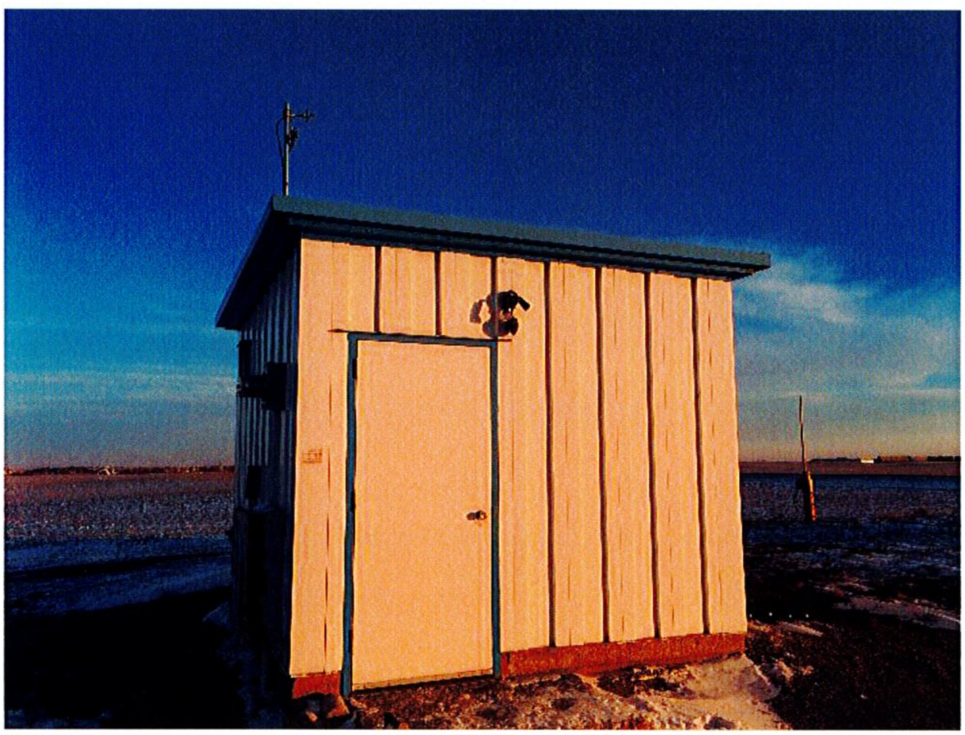
PHOTOGRAPHS

Well #3 Well Head

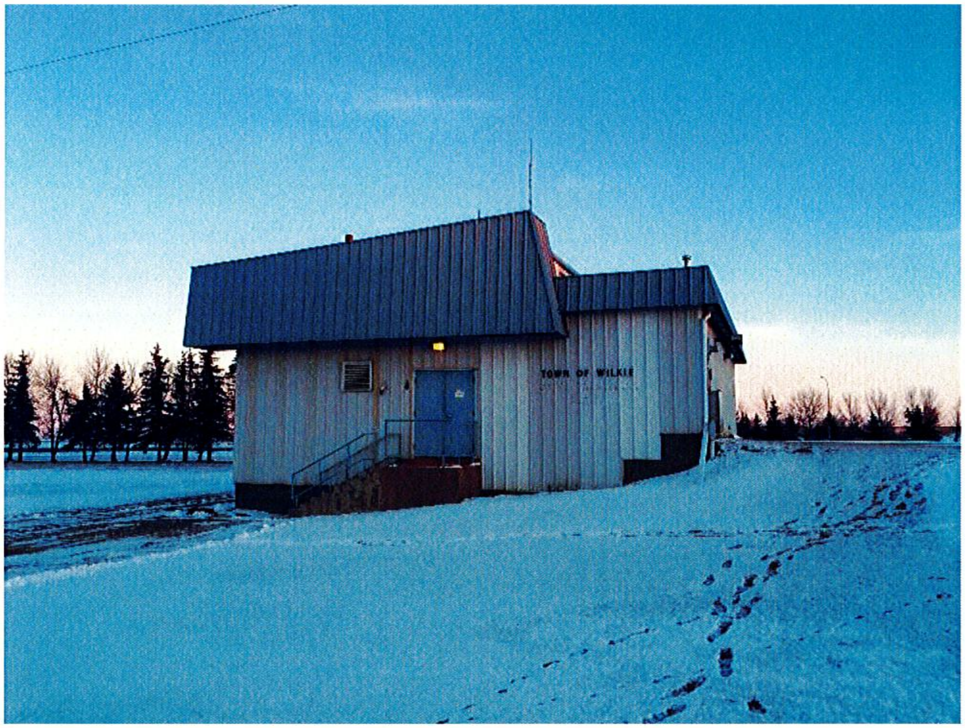
Well #3 Controls Housing



Well Site #4



Well #4 Controls Housing



Water Treatment Plant Building

Water Treatment Plant Building

Water Treatment Plant Building, Underground Reservoir in Foreground

Plant Interior

Raw Water Influent Piping

Manganese Greensand Gravity Filter Unit

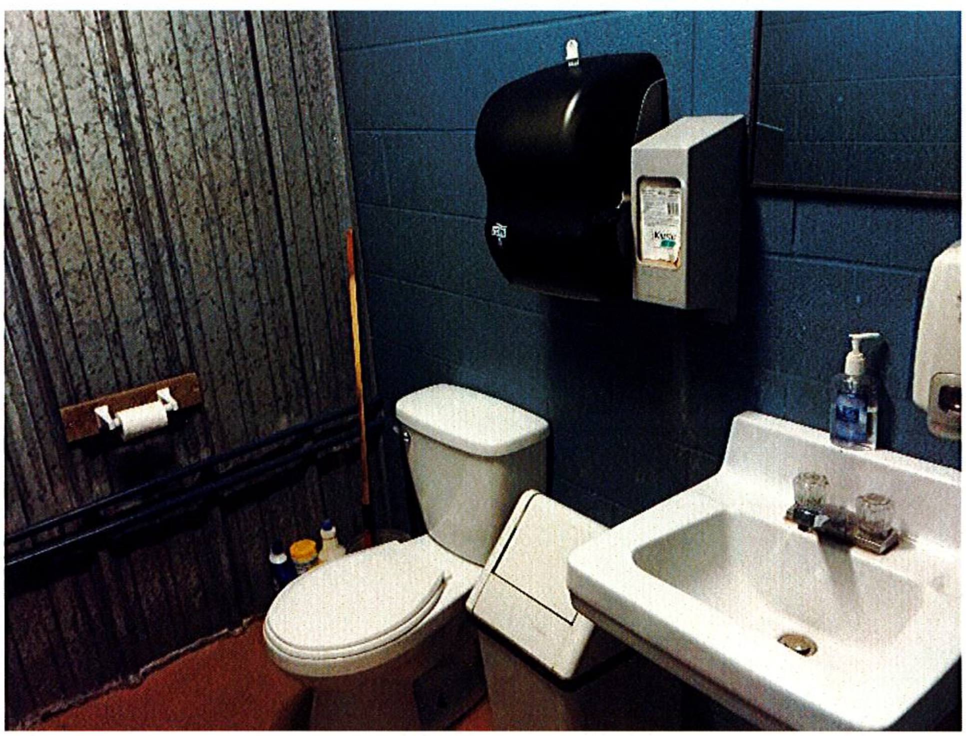
Manganese Greensand Gravity Filter Unit

Filter Process Piping

$KMnO_4$ Feed Station

Separated Chemical Room

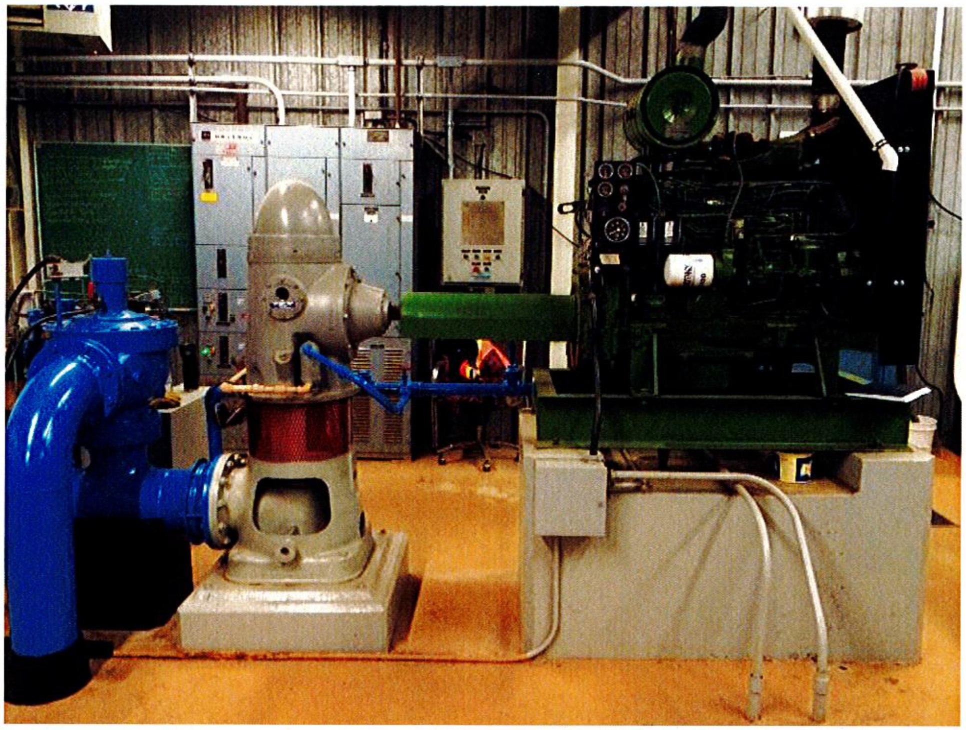
Plant Storage Room



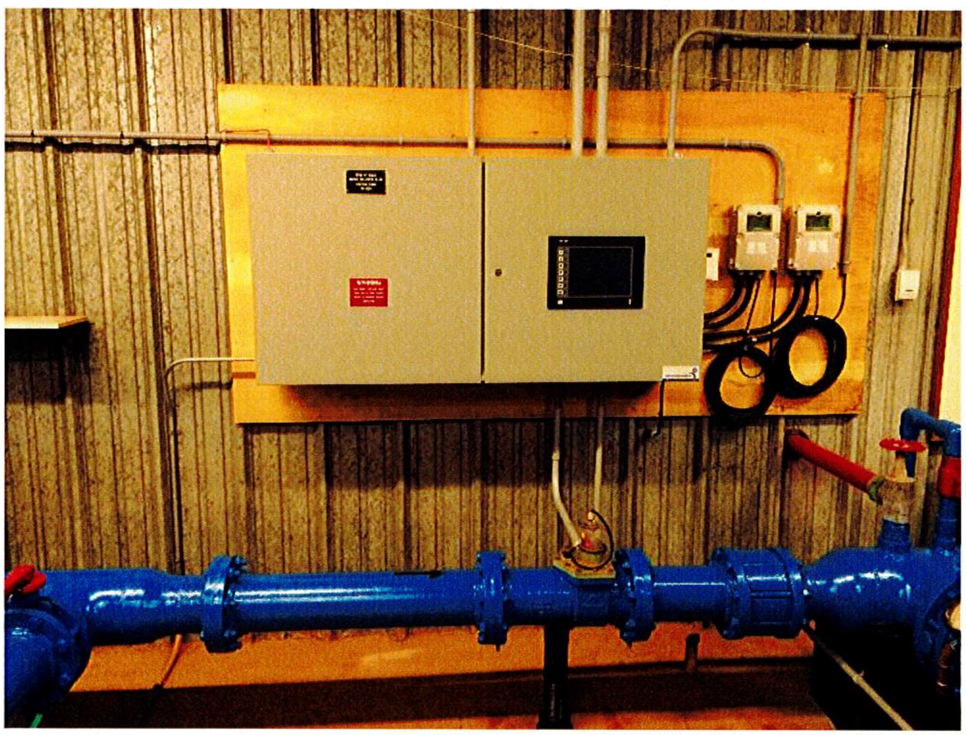
Plant Washroom

Workspace and Testing Area

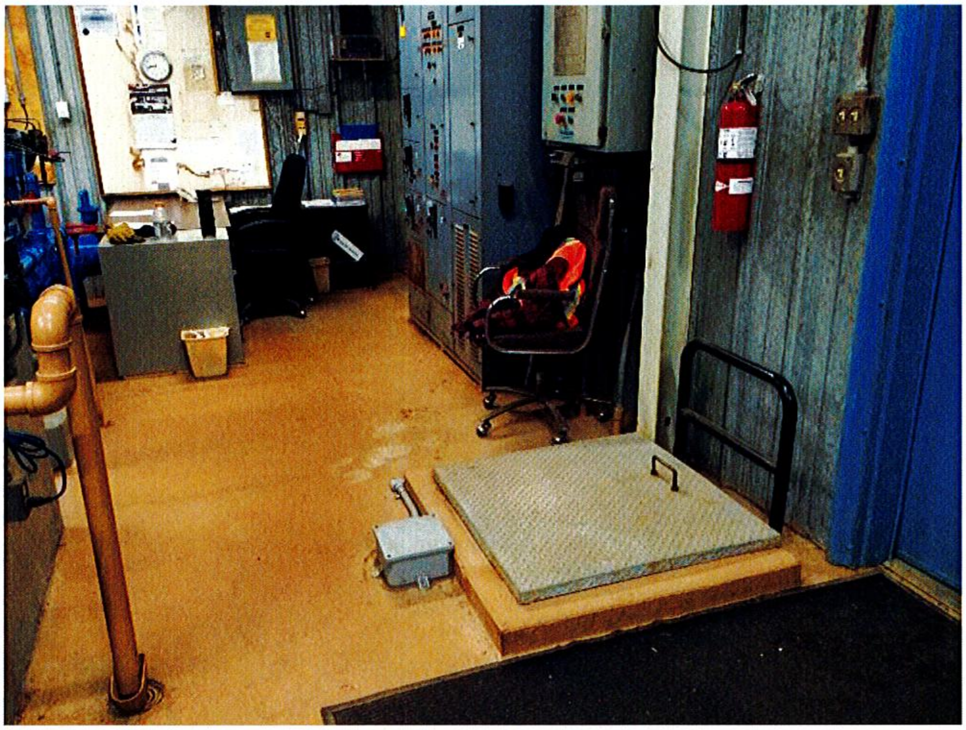
Distribution Pumps and Header



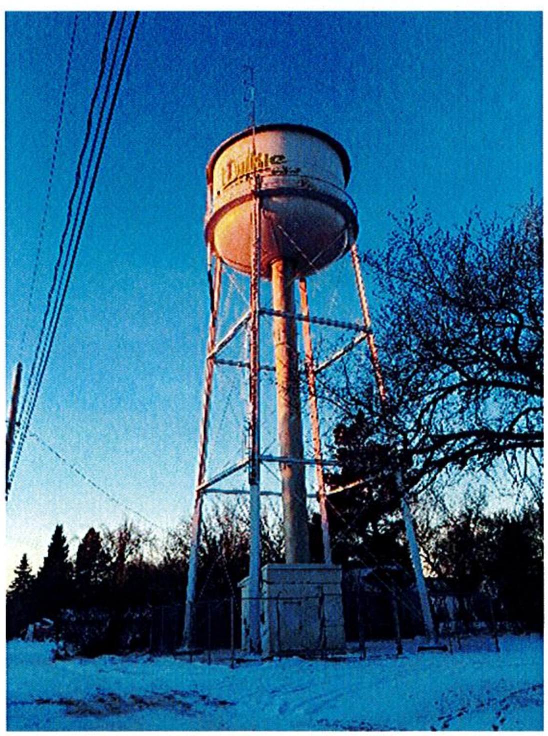
Standby Pump and Diesel Generator



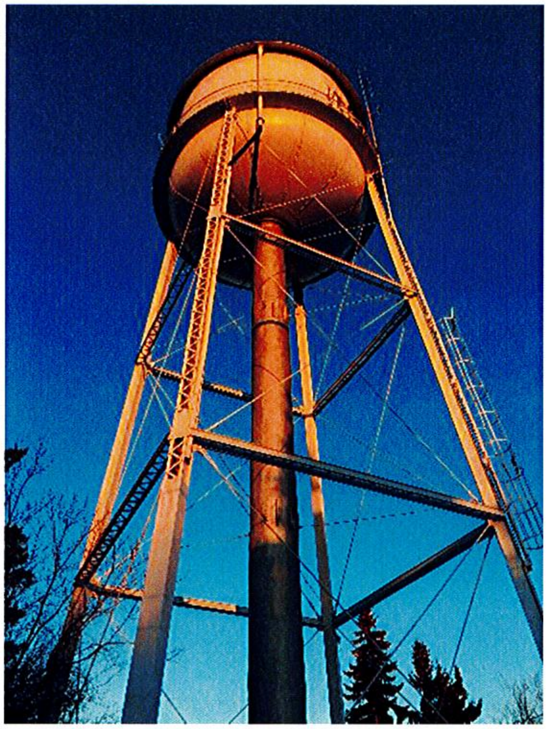
Upgraded PLC



Reservoir Access Hatch



Water Tower



Water Tower

Truck Fill Line

APPENDIX C

WATERWORKS SYSTEM ASSESSMENT SUMMARY

Round 3 Waterworks System Assessment Summary

Waterworks: Town of Wilkie Waterworks — Owner(s): Town of Wilkie

Env. Project Officer: Kris Dushire — Summary Completion Date: Nov. 27, 2015

Population: Full Time: Est. 1,370 — Seasonal: Est. 1,370

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

Sourcewater Protection Concerns: None

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

Parameter:	Level:	Parameter:	Level:
Iron	0.75-3.20 mg/L	Hardness	443-452 mg/L
Manganese	0.42-0.53 mg/L		
Turbidity	3.96-6.65 NTU		
Total Dissolved Solids	>900 mg/L		
Total Alkalinity	>350 mg/L		

Raw water capacity/allocation: 300,000 Cu.M.

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

Parameter:	Level:	Parameter:	Level:

List of Chemicals Used:
Potassium Permanganate ($KMnO_4$)
Chlorine Gas (Cl_2)

Description of Treatment Processes in Place:

Raw water from two groundwater wells is pumped to the plant and dosed with an oxidizing agent ($KMnO_4$) before being directed to a manganese greensand gravity filter unit. Filtered water effluent is mixed with chlorine gas and deposited into a concrete underground storage reservoir.

Treatment Processes with existing issues (including capacity issues):

There were no issues identified with the treatment process or treated water quality. Aesthetically, the treated water has elevated levels of alkalinity, hardness, and total dissolved solids but is still within Saskatchewan guidelines for each of these constituents.

Other issues identified within the waterworks:

There is no secondary raw water supply main. In the event of a break or obstruction of the existing main, the plant would be incapable of producing water. The existing water feed line to the chlorine gas room has issues with freezing during winter.

Major Recommendations:

Consider installation of a secondary raw water main, perhaps directly from well #4 to the treatment plant. The water feed line to the chlorine gas room should be rerouted to mitigate freezing issues.

Any Recommendations that may pose an Immediate Health Concern:

None

Total Cost of Recommended Upgrades: $365,000

Other Comments: None

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