

Introduction:

In the early 90's, a number of municipalities in south central Manitoba joined to form the Pembina Valley Water Cooperative Inc. (PVWC). The purpose was to develop a regional approach to supplying potable water in an area which lacked wide distribution of good, plentiful water resources, but which also exhibited the highest rate of economic growth of any region in Manitoba. Municipalities that were members of the cooperative as of December, 2017 include:

Town of Altona	City of Winkler
R.M. of Dufferin	Town of Carman
R.M. of Grey	Municipality of Emerson - Franklin
R.M. of Montcalm	R.M. of Morris
Town of Morris	Municipality of Rhineland
R.M. of Roland	City of Morden
R.M. of Stanley	R.M. of Thompson

The mandate of the PVWC is to provide treated/potable water that meets all of the Canadian Drinking Water standards to its municipal members. It is governed by a board of 14 members, one representative from each municipal member.

The PVWC is a wholesaler of water which is distributed through its pipelines to its municipal customers. The municipalities then sell this water to the end user, their customers, which is then delivered through their own distribution system. The service area covers 9,000 square kilometers with a population base of approximately 50,000. The existing water supply system is shown in Figure 1.

Existing Water Supply

The Letellier water treatment plant (WTP) withdraws water from the Red River, pumps it into an oxbow with an approximate storage of two (2) months and has the ability to produce up to 96 litres per second (lps) of treated water. From there, treated water is provided to the Towns of Altona, and to the City of Winkler and Morden. Treated water is also provided from this plant to the Municipalities of Emerson-Franklin, Rhineland, Montcalm, Stanley, and the Roseau River First Nation.

PVWC Distribution

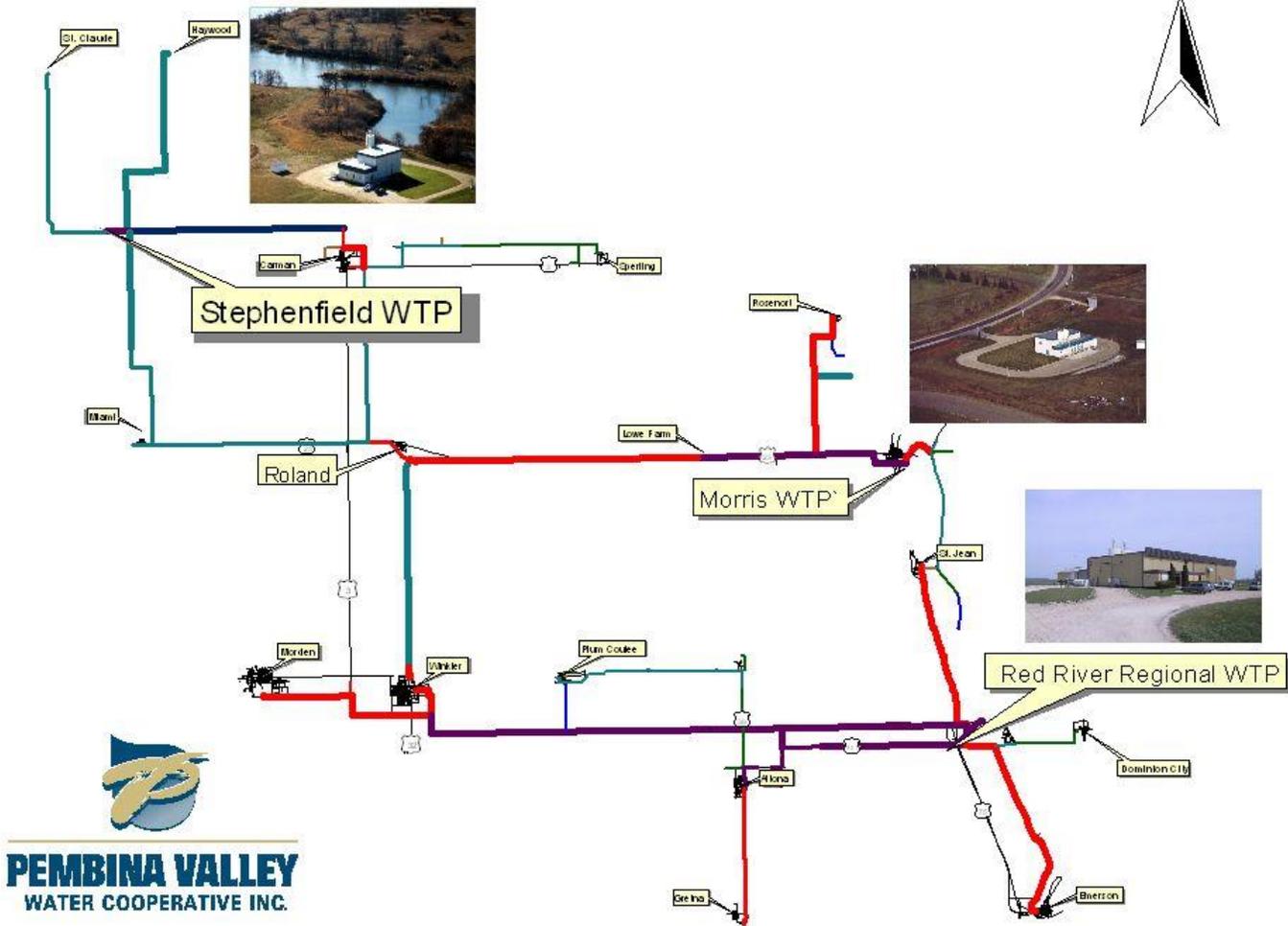


Figure 1 is a model of the PVWC distribution system, including the three water treatment plants.

The water treatment plant at Morris also withdraws water from the Red River and pumps it into a large holding pond of 1,000 acre feet. It currently has the capacity to produce up to 67 lps of treated water. From there, treated water is provided to the Town of Morris, the R.M.s of Morris, Montcalm, Roland, Thompson, and Dufferin and a partial supply to the City of Winkler and the R.M. of Stanley.

The Stephenfield water treatment plant withdraws water from the Stephenfield Lake and has a capacity to produce up to 40 lps of treated water. This plant provides water to St. Claude and Haywood and to the R.M.s of Dufferin, Grey, Thompson and a partial supply to the R.M.s of Roland, Morris and the Town of Carman.

By the licensing requirements of the existing system and as a matter of best management practice, all of the regions' existing supplies are utilized to their sustainable yield with the exception of the expanded water treatment plant in Morris. The expansion will allow for growth and some drought resistance in the future. The City of Morden receives

approximately 5% of their water supply from the PVWC with the remainder coming from Lake Minnewasta. The City of Winkler receives approximately 35% of their supply from the PVWC and the remainder is withdrawn from the Winkler Aquifer. The Town of Carman receives 25% of their water supply from the PVWC and the rest of their supply comes from the Boyne River.

The PVWC is a user-pay water supply system. The price includes the cost of production, operation and maintenance, principal and interest. There is no decreasing scale or other discounting in the pricing system. The price charged to deliver the water to the municipal system in 2017 was \$8.00 per thousand gallons.

Red River Regional Water Treatment Plant - Letellier

- Red River used as water source
- Raw water storage of approx 250 acre-feet
- Rated for 96 litres per second
- Storage capacity 2,450,000 litres or 540,000 gallons
- Senior plant operator- Trevor Hodgins
- Drinking Water Officer- Kale Black



The following is a description of the major treatment process for the Red River Regional Water Treatment Plant: This lime softening plant, which is typical of those commonly found throughout the Manitoba prairies, is used to treat the water from the Red River.

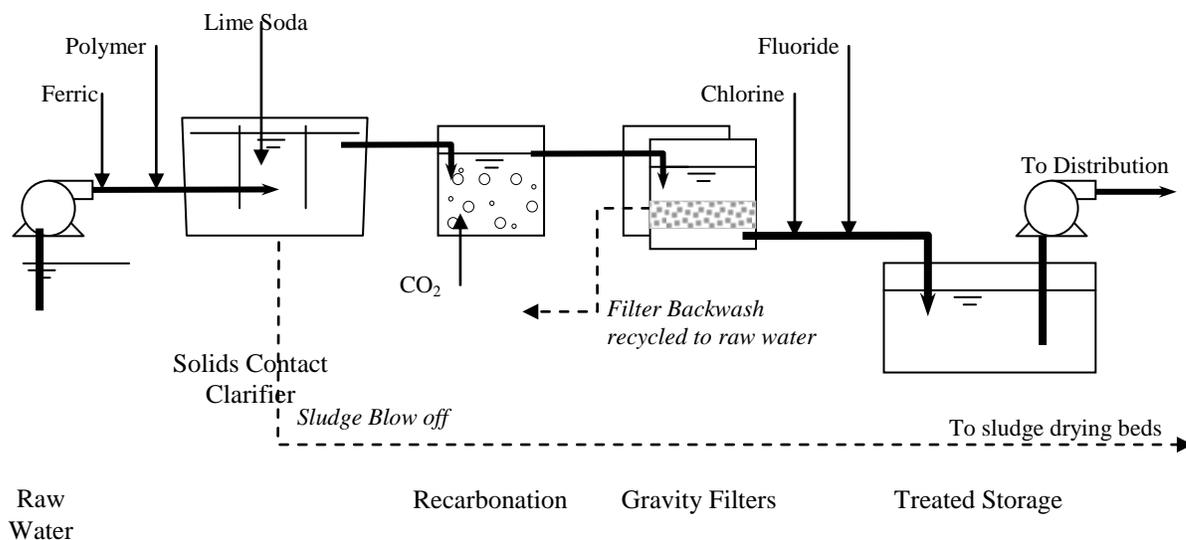


Figure 2 is a schematic of the existing process.

The current process consists of a screened raw water intake located off the Red River that pumps to an off stream storage reservoir beside the plant which is then pumped directly to

the solids contact clarifier. The cold lime softening clarifier then reduces hardness and turbidity. The subsequent re-carbonation step stabilizes the clarifier effluent and the gravity filters polish the water for final turbidity and pathogen reduction.

The filtered water is then dosed with chlorine for disinfection and fluoride for dental maintenance. The fluoridation program is monitored by Manitoba Health.

Disinfection Monitoring and Reporting

The treated water leaving the water plant is tested continuously for a level of chlorine that is high enough for proper disinfection in the distribution system and leaving a minimum chlorine residual of greater than 0.1 mg/l.

These values are closely monitored by the operators along with bacterial test results. Changes in any of these factors can result in lower chlorine residuals. No incidents were reported.

Bacteriological Monitoring and Reporting

The raw and treated water is tested on a weekly basis at four locations, for the presence of total coliform and E. coli bacteria. If these bacteria are present in the water it is an indication that disease causing organisms may also be present. No incidents were reported.

Turbidity Monitoring and Reporting

Turbidity is a measurement of the clarity of water. Turbidity is used to tell us if the treatment process and filtration is working to remove particles and other contaminants from the water. A high turbidity can cause the water to look cloudy and affect the disinfection process. Turbidity is continuously tested after the filtering process and before disinfection.

Turbidity, which is measured and reported in nephelometric turbidity units (NTU), is an optical measurement of water’s ability to scatter and absorb light rather than transmit it in straight lines.

	Requirement
Chemically assisted, rapid gravity filtration process for water treatment	≤ 0.3 NTU in at least 95% of the samples taken per month
	Not to exceed 0.3 NTU for more than 12 continuous hours
	Not to exceed 1.0 NTU at any time

There were 6 incidents throughout the year that exceeded 1.0 NTU. Four of the incidents were due to maintenance on the meters and 2 of these were clarifier upset issues.

Corrective action forms were submitted. PVWC has installed a filter to waste system that will help eliminate these events. There were 3 incidents of record keeping due to procedural changes.

Disinfection By-products Monitoring and Reporting

Trihalomethanes (THMs) are formed when chlorine reacts with naturally occurring organic matter in the water. Studies have shown a link between high levels of THMs and cancer. The province has set a standard for THMs of 100 micrograms per litre of water. The THM standard is based on an average of four samples per year. Our water from the Letellier plant is tested at four locations in the distribution system - Emerson, St. Jean Baptiste, Gretna and Morden.

Trihalomethane quarterly sampling

Locations	Requirement	Test Results
Emerson	Less than or equal to 100 µg/L as an annual average of quarterly samples	116 µg/L
St. Jean Baptiste		115 µg/L
Gretna		126 µg/L
Morden		121 µg/L

One factor in the increase in THM's is the regulatory requirements to maintain greater than 0.1 mg/l of chlorine residual in the water distribution system. This has made it necessary to increase the chlorine concentration leaving the water treatment plant which has the direct result of increasing the THM's. New treatment methods and operational methods are being investigated to reduce the disinfection by-products created by chlorine. The PVWC and U of M are doing research to investigate how to reduce THM levels.

Major Expenses for the Red River Regional Water Treatment Plant in 2017

A filter to waste system was installed eliminating high turbid water in the distribution system. The process controllers were upgraded to improve electronics. A generator was installed at the Stanley Booster Station. The sludge ponds were upgraded to provide improved drainage.

Future Projects for the Red River Regional Water Treatment Plant

A regional assessment of the plant and distribution systems, including a drought preparedness plan is being completed. Depending on availability of Government funding, this could result in additional pipeline and storage projects.

Red River Regional Water Treatment Plant Water Analysis

RRRWTP Chemistry		Aesthetic	Raw	Treated	Raw	Treated
Analyte	Units	Objective	February	February	September	September
Colour, True	CU	15	15.2	<5.0	22.5	<5.0
Conductivity	umhos/cm		1090	870	1030	829
Hardness (as CaCO ₃)	mg/L		428 *	212 *	397 *	149 *
Langelier Index (4 C)			0.42	-0.36	1.3	-0.64
Langelier Index (60 C)			1.2	0.4	2.1	0.12
pH	pH units	6.8-8.5	7.79	7.61	8.77	7.72
Total Dissolved Solids	mg/L	500	739	561	732	553
Transmittance, UV (254 nm)	% T		58.9	85.5	57.4	84.7
Turbidity	NTU		2.92	<0.10	21.3	0.1
Alkalinity, Total (as CaCO ₃)	mg/L		298	94.6	262	55.6
Ammonia, Total (as N)	mg/L		0.269	0.017	0.017	<0.010
Bicarbonate (HCO ₃)	mg/L		363	115	275	67.8
Bromide (Br)	mg/L		0.12	<0.10	0.151	0.052
Carbonate (CO ₃)	mg/L		<0.60	<0.60	22.3	<0.60
Chloride (Cl)	mg/L		56.2	62.1	58.2	63.1
Fluoride (F)	mg/L	0.6	0.183	0.764	0.219	0.303
Hydroxide (OH)	mg/L		<0.34	<0.34	<0.34	<0.34
Nitrate (as N)	mg/L		0.795	0.889	<0.010 *	0.051
Nitrite (as N)	mg/L		0.0101	<0.0010	<0.0020 *	<0.0020 *
Sulfate (SO ₄)	mg/L		226	231	261	267
Dissolved Organic Carbon	mg/L		10.9	6.28	12.7	7.45
Total Organic Carbon	mg/L		11	6.11	13	7.02
Aluminum (Al)-Total	mg/L		0.0523	<0.0050	0.383	0.0033
Arsenic (As)-Total	mg/L		<0.00020	<0.00020	0.00067	0.00064
Barium (Ba)-Total	mg/L		0.00215	0.00076	0.00605	0.00091
Boron (B)-Total	mg/L		0.0619	0.0108	0.0828	0.0187
Cadmium (Cd)-Total	mg/L		0.1	0.058	0.139	0.114
Calcium (Ca)-Total	mg/L		0.000016	<0.000010	0.0000302	<0.0000050
Copper (Cu)-Total	mg/L		84	59.5	75.9	41.1
Iron (Fe)-Total	mg/L		0.00159	0.0132	0.00319	0.00653
Lead (Pb)-Total	mg/L		0.099	<0.010	0.495	<0.010
Lithium (Li)-Total	mg/L		<0.000090	<0.000090	0.000666	0.000063
Magnesium (Mg)-Total	mg/L		0.0555	0.054	0.0696	0.0669
Manganese (Mn)-Total	mg/L	0.05	53	15.3	50.3	11.3
Phosphorus (P)-Total	mg/L		0.131	0.00047	0.14	0.00033
Potassium (K)-Total	mg/L		0.14	<0.10	0.175	<0.050
Silicon (Si)-Total	mg/L		9	10.1	13.2	12.3
Sodium (Na)-Total	mg/L		8.59	4.24	3.25	1.29
Strontium (Sr)-Total	mg/L		71	100	91.2	113
Uranium (U)-Total	mg/L		0.316	0.178	0.34	0.185
Zinc (Zn)-Total	mg/L		0.00433	0.00011	0.00485	0.000098

Morris Regional Water Treatment Plant

- Red River used as water source
- Raw water storage of 1,000 acre feet
- Rated for 67 litres per second
- Storage capacity 2,800,000 litres or 616,000 gallons
- Senior plant operator- Byron Klassen
- Drinking Water Officer- Kale Black



The following is a description of the major treatment process for the Morris Regional Water Treatment Plant which was commissioned on March 17, 2010.

The plant is a microfiltration and membrane plant. Figure 4.2 is a schematic of the process.

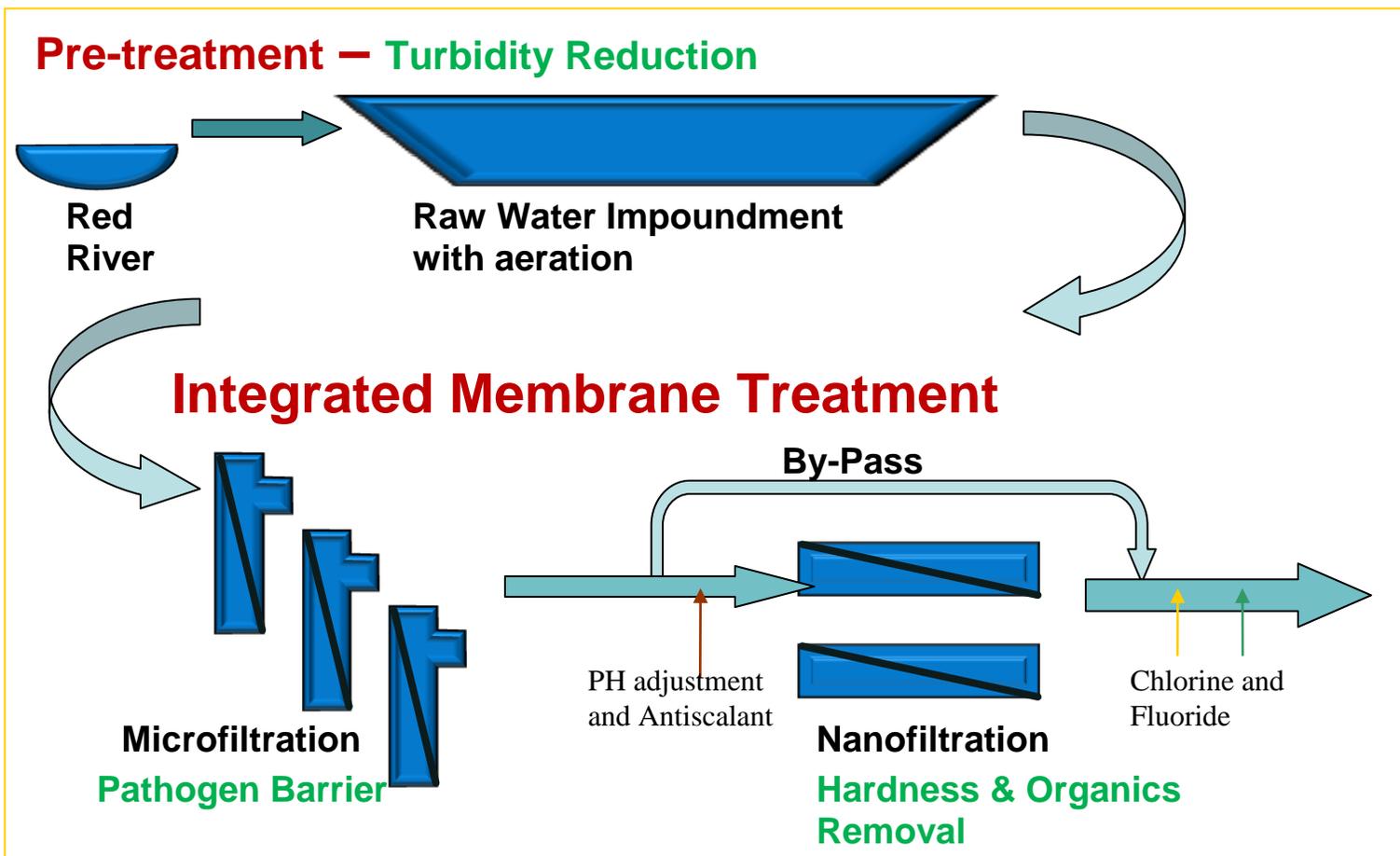


Figure 4.2

The process consists of a screened raw water intake located off of the Red River that pumps into a raw water impound for off stream storage and settling. The microfiltration removes the pathogens and reduces the turbidity to a point where it is potable. A partial percentage

of the water is bypassed and put into the distribution system. The subsequent nano membrane step removes the hardness and the organics so that when the water is blended it meets all of the Manitoba Drinking Water guidelines. The blended water is then dosed with chlorine for disinfection and fluoride for dental maintenance. The fluoridation program is monitored by Manitoba Health.

Disinfection Monitoring and Reporting

The treated water leaving the water plant is tested continuously for a level of chlorine that is high enough for proper disinfection in the distribution system.

Bacteriological Monitoring and Reporting

The raw and treated water is tested on a weekly basis for the presence of Total Coliform and E. coli bacteria. If these bacteria are present in the water it is an indication that disease causing organisms may also be present.

A copy of the water test results are kept at the water treatment plant and at the main office in Altona.

Turbidity Monitoring and Reporting

Turbidity is a measurement of the clarity of water. Turbidity is used to tell us if the treatment process and filtration is working to remove particles and other contaminants from the water. A high turbidity can cause the water to look cloudy and affect the disinfection process. Turbidity is continuously tested after the microfiltration process and before disinfection.

Turbidity, which is measured and reported in nephelometric turbidity units (NTU), is an optical measurement of water's ability to scatter and absorb light rather than transmit it in straight lines. There was one incident of exceeding 0.3 NTU due to a recording method. Program changes are in progress to prevent this issue in the future.

	Requirement
Continuous sampling of the effluent from each of the microfiltration skids.	≤ 0.1 NTU in at least 99% of the samples taken per month
	Not to exceed 0.3 NTU for any continuous time
Frequency of testing	Continuous
Report submissions	Monthly

Morris Regional Water Treatment Plant Water Analysis

MWTP Chemistry		Aesthetic	Raw	Treated
Analytes	Units	Objective	August	August
Colour, True	CU	15	12.1	<5.0
Conductivity	umhos/cm		872	227
Hardness (as CaCO ₃)	mg/L		394	75.8
Langelier Index (4 C)			1.1	-1.3
Langelier Index (60 C)			1.9	-0.49
pH	pH units	6.8-8.5	8.63	7.52
Total Dissolved Solids	mg/L	500	598	127
Transmittance, UV (254 nm)	% T		60.3	92.7
Turbidity	NTU		3.57	0.2
Alkalinity, Total (as CaCO ₃)	mg/L		223	48.3
Ammonia, Total (as N)	mg/L		0.068	<0.010
Bicarbonate (HCO ₃)	mg/L		243	58.9
Bromide (Br)	mg/L		0.106	<0.010
Carbonate (CO ₃)	mg/L		14.4	<0.60
Chloride	mg/L	250	45.8	14.5
Fluoride	mg/L		0.191	0.619
Hydroxide (OH)	mg/L		<0.34	<0.34
Nitrate-N	mg/L		0.0635	0.0377
Nitrite-N	mg/L		0.0034	<0.0010
Sulfate	mg/L	500	211	42.7
Dissolved Organic Carbon	mg/L		10	2.05
Total Organic Carbon	mg/L		10.1	1.95
Aluminum (Al)-Total	mg/L		0.0807	<0.0030
Arsenic (As)-Total	mg/L		0.00874	0.00186
Barium (Ba)-Total	mg/L		0.0551	0.0107
Boron (B)-Total	mg/L		0.123	0.115
Cadmium (Cd)-Total	mg/L		<0.0000050	<0.0000050
Calcium (Ca)-Total	mg/L		74.2	14
Copper (Cu)-Total	mg/L	1	0.00792	0.0134
Iron (Fe)-Total	mg/L	0.3	0.119	<0.010
Lead (Pb)-Total	mg/L		0.000427	<0.000050
Lithium (Li)-Total	mg/L		0.0756	0.0196
Magnesium (Mg)-Total	mg/L		50.7	9.94
Manganese (Mn)-Total	mg/L	0.05	0.243	0.0342
Phosphorus (P)-Total	mg/L		0.151	1.03
Potassium (K)-Total	mg/L		9.16	2.39
Silicon (Si)-Total	mg/L		2.87	0.92
Sodium (Na)-Total	mg/L	200	65.8	18.9
Strontium (Sr)-Total	mg/L		0.298	0.0562
Uranium (U)-Total	mg/L		0.00409	0.000744
Zinc (Zn)-Total	mg/L	5	0.0119	<0.0030

Disinfection By-products Monitoring and Reporting

Trihalomethane (THMs) are formed when chlorine reacts with naturally occurring organic matter in the water. Studies have shown a link between high levels of THMs and cancer. The province has set a standard for THMs of 100 micrograms per litre of water. The THM standard is based on an average of four samples per year. Our water is tested at two locations in the distribution system - Miami and Rosenort.

	Requirement	Performance
Trihalomethane sampling requirements	2 sample locations 4 times a year	100%
Miami	<100 µg/L as an annual average of quarterly samples	62 µg/L
Rosenort		47 µg/L

Major Expenses for the Morris Regional Water Treatment Plant in 2017

Zebra mussels have been discovered on the river and pond intake screens. We are in the process of developing a plan to reduce the effects of zebra mussels. The distribution system has expanded on the east side of the Red River feeding into the Municipality of Emerson-Franklin.

Future Expenses for the Morris Regional Water Treatment Plant

A growth, drought and regulatory study will be completed shortly. A plan to reduce the manganese in the treated water has been developed and this will help reduce the discolouration of the water. Other improvements include an upgrade to the aeration system in the pond.

Stephenfield Regional Water Treatment Plant

- Stephenfield Lake used as water source
- Rated for 40 litres per second
- Storage capacity 2,350,000 litres or 1,068,000 gallons
- Senior plant operator- Paul Termeer
- Drinking Water Officer- Kale Black



The following is a description of the newly upgraded treatment process for the Stephenfield Regional Water Treatment Plant. The new plant is a membrane technology with a micro filtration followed by a nano filtration. Figure 4.3 is a schematic of the new process.

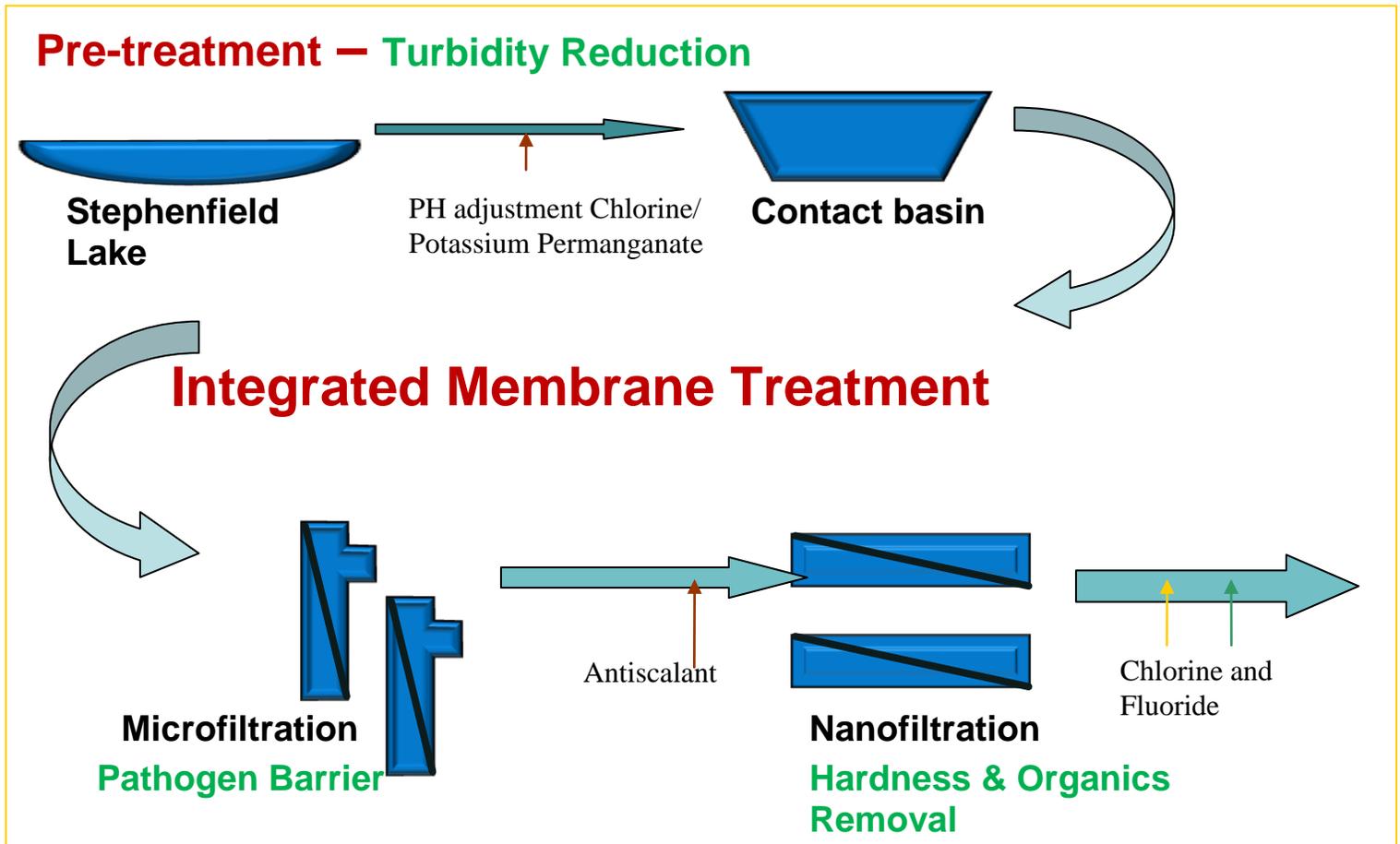


Figure 4.3

The current process consists of a screened raw water intake located in Stephenfield Lake that feeds water directly to the pumps in the water treatment plant. The pumps supply water to the contact basin (clarifier) which provides contact time with oxidants. The subsequent microfiltration removes the pathogens and reduces the turbidity to a point where it is potable. The nano membrane step then removes most of the hardness and organics. The filtered water is then dosed with chlorine for disinfection and fluoride for dental maintenance. The fluoridation program is monitored by Manitoba Health.

Disinfection Monitoring and Reporting

The treated water leaving the water plant is tested continuously for a level of chlorine that is high enough for proper disinfection in the distribution system.

Free chlorine at the end of a distribution system is dependent on the initial chlorine injected at the source, the rate of flow in the distribution system and the time spent in the distribution system. These parameters are closely monitored by the operators along with bacterial test results. Changes in any of these factors can result in lower chlorine residuals.

The daily log reporting requirements were not met 6 times due to an error with the new computer software and once due to the analyzer being taken offline for maintenance. The software issue has been resolved. Continuous chlorine values were still monitored by the PLC. This is a reporting issue and at no time was the quality of the water affected.

Bacteriological Monitoring and Reporting

The raw and treated water is tested on a bi-weekly basis for the presence of Total Coliform and E. coli bacteria. If this bacteria is present in the water it is an indication that disease causing organisms may also be present.

A copy of the water test results is kept at the water treatment plant and at the main office in Altona.

Turbidity Monitoring and Reporting

Turbidity is a measurement of the clarity of water. Turbidity is used to tell us if the treatment process and filtration is working to remove particles and other contaminants from the water. A high turbidity can cause the water to look cloudy and affect the disinfection process. Turbidity is continuously tested after the microfilters and before disinfection. Turbidity, which is measured and reported in nephelometric turbidity units (NTU), is an optical measurement of water's ability to scatter and absorb light rather than transmit it in straight lines.

Two incidents of failing to maintain less than 1.0 NTU occurred in January and April with the old process. Corrective actions were taken with the new plant helping to resolve this issue. The upgraded computer software, failed to meet 7 incidences for the daily log reporting requirements. Continuous turbidity values were still monitored by the PLC. This is a reporting issue and at no time was the quality of the water affected.

Disinfection By-products Monitoring and Reporting

Trihalomethane (THMs) are formed when chlorine reacts with naturally occurring organic matter in the water. Studies have shown a link between high levels of THMs and cancer. The province has set a standard for THMs of 100 micrograms per litre of water. The THM standard is based on an average of four samples per year. Our water is tested at two locations in the distribution system, St. Claude and the Dufferin Booster north of Carman.

	Requirement	Performance
Trihalomethane sampling requirements	2 sample locations	
Location	4 times a year	
St. Claude	≤100 µg/L as annual average of quarterly samples	52.5µg/L
Dufferin Booster		64.2 µg/L

Major Expenses for the Stephenfield Regional Water Treatment Plant in 2017

The Stephenfield WTP was upgraded from 20 l/s to 40 l/s with an option to upgrade to 60 l/s. The commissioning date was June 26, 2017. The total cost of the upgrade was \$6.1million

Additional water meters and a pipeline were installed to help understand and reduce water losses in the R.M. of Dufferin. The R.M. of Dufferin and PVWC have worked together to resolve this issue. PVWC is working with Carman on their plan to build a larger reservoir with several days storage.

Future Projects for the Stephenfield Regional Water Treatment Plant

The intake screen will be upgraded to meet future water demands. The La Salle Red Boyne Conservation District and PVWC are working together to utilize the aeration system during the winter in order to improve water quality for drinking and the ecosystem.

PVWC is working with Carman on their plan to build a larger reservoir with several days' storage.

Stephenfield Regional WTP Water Analysis

SWTP Chemistry New Plant		Aesthetic	Raw	Treated
Analytes	Units	Objective	May	May
Colour, True	CU	5	24.5	<5.0
Conductivity	umhos/cm	20	748	297
Hardness (as CaCO3)	mg/L	0.3	385 *	114 *
Langelier Index (4 C)		n/a	1.2	-0.58
Langelier Index (60 C)		n/a	2	0.19
pH	pH units	0.1	8.46	7.51
Total Dissolved Solids	mg/L	5	475	168
Transmittance, UV (254 nm)	% T	1	49.3	97.5
Turbidity	NTU	0.1	11	<0.10
Alkalinity, Total (as CaCO3)	mg/L	20	319	122
Ammonia, Total (as N)	mg/L	0.01	0.016	<0.010
Bicarbonate (HCO3)	mg/L	24	369	149
Bromide (Br)	mg/L	0.1	0.021	<0.010
Carbonate (CO3)	mg/L	12	9.84	<0.60
Chloride	mg/L	0.2	14.1	26.6
Fluoride	mg/L	0.1	0.262	0.088
Hydroxide (OH)	mg/L	6.8	<0.34	<0.34
Nitrate-N	mg/L	0.005	0.0053	<0.0050
Nitrite-N	mg/L	0.001	<0.0010	<0.0010
Sulfate	mg/L	0.5	111	0.6
Dissolved Organic Carbon	mg/L	1	10.1	<0.50
Total Organic Carbon	mg/L	1	10.8	<0.50
Aluminum (Al)-Total	mg/L	0.005	0.196	<0.0050
Arsenic (As)-Total	mg/L	0.0002	0.00262	<0.00020
Barium (Ba)-Total	mg/L	0.0002	0.0775	0.0209
Boron (B)-Total	mg/L	0.01	0.086	0.081
Cadmium (Cd)-Total	mg/L	0.00001	0.000031	<0.000010
Calcium (Ca)-Total	mg/L	0.1	92.6	28.4
Copper (Cu)-Total	mg/L	0.0002	0.00182	<0.00020
Iron (Fe)-Total	mg/L	0.1	0.305	<0.010
Lead (Pb)-Total	mg/L	0.00009	0.000219	<0.000090
Lithium (Li)-Total	mg/L	0.002	0.0425	0.0249
Magnesium (Mg)-Total	mg/L	0.01	37.4	10.5
Manganese (Mn)-Total	mg/L	0.0003	0.392	0.0228
Phosphorus (P)-Total	mg/L	0.1	<0.10	<0.10
Potassium (K)-Total	mg/L	0.02	6.46	3.86
Silicon (Si)-Total	mg/L	0.1	3.63	2.11
Sodium (Na)-Total	mg/L	0.03	27.2	18.1
Strontium (Sr)-Total	mg/L	0.0001	0.373	0.111
Uranium (U)-Total	mg/L	0.0001	0.0106	<0.00010
Zinc (Zn)-Total	mg/L	0.002	0.0022	<0.0020

Organizational Resources

