2012-2013

East Interlake Conservation District

City of Selkirk Storm Water Quality Assessment

Produced by the East Interlake Conservation District in partnership with the City of Selkirk

Executive Summary

The East Interlake Conservation District (EICD) partnered with the City of Selkirk to conduct an assessment of Selkirk's urban storm water drains. The purpose of the project was to investigate the quality of storm water from an urban environment and determine what, if any, pollutants are entering the Red River. With an understanding of what is entering the river, the EICD and the City of Selkirk will be better prepared to take appropriate mitigation measures.

The study was designed to capture spring snowmelt and a summer and fall storm event. However, a dry summer in 2012 and a dry fall in 2013 prevented these samples from being taken. Samples were acquired on March 13, 2012; October 4, 2012; April 25, 2013; and July 25, 2013. Each time, samples were collected from six sites.

Samples were analyzed for 30 different parameters. Of these parameters, 15 water quality guidelines were derived to use for data analysis. Therefore, a total of 360 results had an associated guideline for analysis. Of these, 91 (25%) failed water quality guidelines.

Each parameter had a total of 24 results for analysis. 15 tests (63%) exceeded the water quality guideline for bacteria. e.coli was exceedingly high (>110,000) on five separate occasions. For those guidelines of concern for wastewater effluent; total phosphorous was exceeded four times (16%), total nitrogen was exceeded twice (8%), and suspended solids was exceeded 19 times (79%).

Scope, frequency and amplitude of sample failures were taken into account by processing results into a Water Quality Index (WQI). The lowest WQI was derived for the sampling period of July 25, 2013, which was preceded by a large rainfall event. The site with the lowest WQI score was Brittania and Eveline.

Based on the findings of this study, several recommended actions have been provided to decreasing the quantity and improve the quality of the water entering the storm water system. This will consequently improve the health of the Red River and Lake Winnipeg. The EICD will continue to work with the City of Selkirk and its citizens to meet its goals.

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Introduction

The City of Selkirk approached the EICD about implementing an urban storm water runoff monitoring program after hearing about a similar program carried out by the EICD in Gimli in 2008/09. The City hoped to determine the quality of their urban storm water runoff and if it would negatively affect the Red River, and ultimately Lake Winnipeg downstream.

The primary goal of the program was to determine the general quality of the water entering the Red River from the urban area. With this information the City of Selkirk and the EICD would be better positioned to make informed decisions regarding the urban water quality programming needs of the city as well as the other urban centres within the Conservation District.

Study Site

Six storm water drains were selected for testing within the City of Selkirk (Figure 1). Each location was selected in consultation with public works employees based on their knowledge of Selkirk's drainage system.

Five of the sites included runoff from the city's core region. One site, Young & Main, was a catchment for runoff from the industrial park and outer areas of the city (including the Wal-Mart/Canadian Tire region). Locations were named for the intersections at which they were located:

- Cocleugh & Eveline
- Rosser & Eveline
- Brittania & Eveline
- Morris & Eveline
- Queen & Main
- Young & Main

GPS coordinates of sampling locations are provided in Appendix 2.

Figure 1: Storm Water Sampling Locations

Methods

The EICD attempted to collect runoff samples representative of the seasonal variation within one year. To accomplish this, samples from a spring snowmelt, a mid-summer storm, and a late rain event were targeted. Dates were not predetermined. Samples were only collected if a number of suitable conditions were met, including:

- Rain/snowmelt event of sufficient magnitude to produce storm water flow at all sampling locations
- Runoff event occurred at appropriate time (i.e. snowmelt, mid-summer, late fall)
- EICD and City of Selkirk staff were available to capture the initial flush of storm water (i.e. event occurred during a weekday)
- The Red River water level was low enough to allow storm water to flow out of the drainage system. (Outlets are routinely shut to prevent back flow)

Due to safety concerns posed by high river levels, all samples were taken directly out of the downstream portion of storm drains using manholes as the access point. Samples were labelled and immediately placed in a cooler to maintain an appropriate temperature. A chain of custody was completed and samples were either shipped or delivered directly to the laboratory following collection. All samples were analyzed for 30 parameters at ALS Environmental, an accredited laboratory commonly used by the EICD and the Province of Manitoba for water quality testing.

Sampling Periods

EICD personnel captured storm water runoff on March 13, 2012; October 4, 2012; and April 25, 2013, and July 25, 2013. Each time, samples were collected from six sites.

Weather information for each day was gathered from the closest Government of Canada Weather station (Winnipeg at The Forks).

Weather information for each sampling period:

- March 13, 2012 – A mean temperature of 5.8°C was recorded. For five days leading up to this date, the weather had warmed up from a previous mean temperature of -8.9°C. There was also a small amount of 0.5mm of rain recorded this day.
- October 4, 2012 – A significant rain/snowfall event occurred, with 18.4mm of total precipitation. A mixture of snow and sleet was experienced during sample collection in the afternoon.
- April 25, 2013 – Warmer temperatures arrived much later than the prior year, resulting in runoff samples being collected more than a month later than they were in 2012. Although the mean temperature was recorded as 5.4°C the day of sampling, the mean temperatures the two days prior were 13.1 °C and 13.3°C. These warmer days allowed enough snow to melt for adequate runoff.
- July 25, 2013 – A significant rainfall event occurred. 12.4mm of total precipitation was recorded

Water Quality Guidelines

To analyze the data, EICD compiled water quality guidelines from three sources. No one set of guidelines was found that could be applied in this situation. The three sources used were: *Manitoba Water Quality Standards, Objectives and Guidelines* (2011), *the Canadian Water Quality Guidelines for the protection of aquatic life* (2010, 2011), and the *Guidelines for Canadian Recreational Water Quality* (2012). When multiple guidelines were available for a parameter the most appropriate guideline was applied.

Manitoba Water Quality Standards, Objectives, and Guidelines that fell under Tier 1-Water Quality Standard for Industrial & Municipal Wastewater Effluents Discharged to a Water Body were given priority. Water quality guidelines and/or objectives for the protection of aquatic life were given the next priority, followed by those for irrigation, livestock, and recreation. A total of 15 relevant guidelines were found to use for data analysis. The water quality guidelines used in analysis are listed in Appendix I.

Results

A total of 360 results corresponded to a water quality guideline. Of these, 91 (25%) failed a guideline. Full tables of the storm water quality results are in Appendix 2.

Manitoba Water Quality Standards, Objectives, and Guidelines: Tier 1

When determining which guideline to apply, this set was considered the most relevant and was given the highest priority. Four guidelines were applied Tier 1-Water Quality Standard for Industrial and Municipal Wastewater Effluents Discharged to a Water Body.

e.coli (200 MPN/100ml)

15 out of 24 tests exceeded this guideline (63%). It is interesting to note that all locations failed e.coli guidelines during the July 25, 2013 sampling period. The amount of e.coli was exceedingly high (>110,000) on five separate occasions.

Phosphorus (1 mg/L)

Four out of 24 tests (17%) exceeded the guideline for total phosphorus.

Nitrogen (15 mg/L)

Two out of 24 tests (8%) exceeded the guideline for total nitrogen.

Suspended Solids (25 mg/L)

19 out of 24 (79%) tests exceeded the guideline for total suspended solids.

Water Quality Guidelines for the Protection of Aquatic Life

Manitoba or Canadian guidelines for the protection of aquatic life were considered the second-highest priority in the determination of applicable guidelines. The most noteworthy result associated with this guideline is the failure of the chloride guideline during the March 22, 2012 period. It may be speculated that the fast snowmelt could have flushed road salts into the drainage system. More consultation with public works is required to confirm this. All sampling locations failed this parameter during the rapid melt associated with this sampling period.

The guideline for calcium and nitrate was not exceeded in any of the samples. Dissolved oxygen was below (therefore failed) the guideline only once. pH levels were found to be within an acceptable range in all samples.

Water Quality Index

A water quality index (WQI) was compiled to provide a convenient means of summarizing the complex water quality data and facilitate its communication to a general audience.

The Canadian Council of Ministers of the Environment (CCME) Water Quality Index (WQI) was used to display these storm water results. A Microsoft Excel macro was used to automate the process. This Index has an advantage over a traditional pass/fail means of analyzing water quality data, as it incorporates the following three elements in its derivation:

1. scope- the number of variables not meeting water quality objectives
2. frequency- the number of times these objectives are not met
3. amplitude- the amount by which the objectives are not met

The water quality data and 15 relevant guidelines were entered into the CCME Excel macro to produce the final WQI. The index produced a number between 0 (worst water quality) and 100 (best water quality).

The numbers are then divided into 5 descriptive categories:

- Excellent (95-100)
- Good (80-94)
- Fair (65-79)
- Marginal (45-64)
- Poor (0-44)

Two charts were created to illustrate the Water Quality Index results for the Selkirk Storm Water Quality data. One was grouped by sampling period to compare water quality changes across the different sampling periods. The second was grouped by site for comparison of water quality between sampling sites.

WQI by Site

The Water Quality Index graph grouped by sampling site is shown in Figure 2.

The average WQI score of each site (in descending order of quality)

1. Queen & Main (69)
2. Young & Main (68)
3. Rosser & Eveline (64)
4. Cocleugh & Eveline (57)
5. Morris & Eveline (49)
6. Brittania & Eveline (44)

The largest range in WQI was observed at Morris & Eveline, which fluctuated between 25 and 100. Brittania & Eveline varied the least, scoring 29-56 throughout sampling periods.

A possible reason for Morris & Eveline and Brittania & Eveline's low WQI averages is a change in sampling site during the collection of samples in April 2013. This is discussed in more detail in the next section.

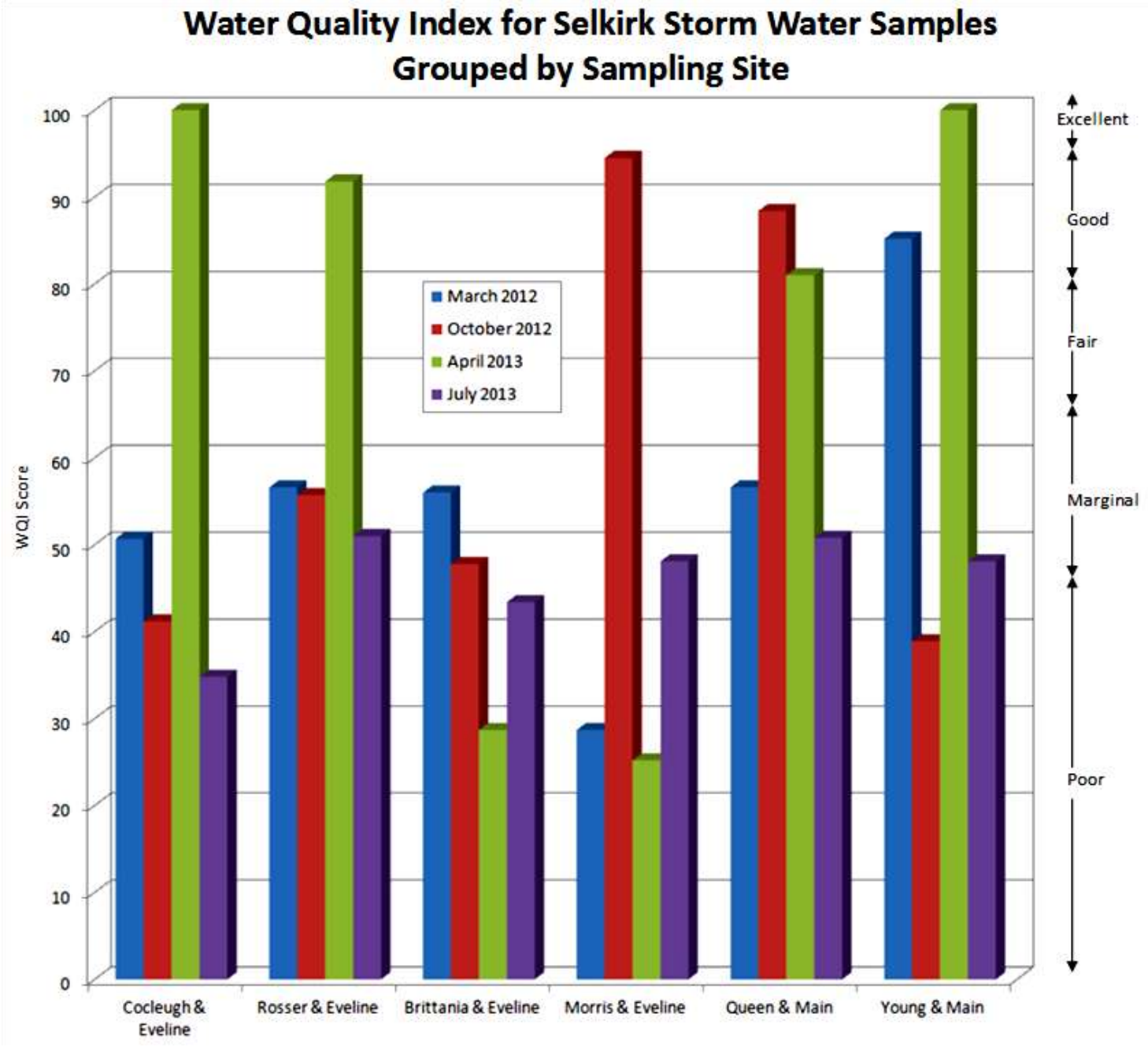

Figure 2: Water Quality Index for Selkirk Storm Water Samples Grouped by Sampling Site

WQI by Sampling Period

The Water Quality Index graph grouped by sampling period is shown in Figure 3. There appears to be a great amount of variation in results between the sites for the different time periods

The average WQI score of each sampling period (in descending order of quality):

1. April 25, 2013 (71)
2. October 4, 2012 (61)
3. March 2012 (56)
4. July 2013 (46)

The lowest WQI was derived during a large rain storm which may have washed many contaminants into the storm water system

The most variation in WQI was observed in April 2013. Two sites, Brittania & Eveline and Morris & Eveline scored quite low (25 and 29, respectively) compared to the rest of the sites sampled during that time. At the intersection of Morris & Eveline, there are three manhole covers. The middle one was sampled during all but one of the sampling periods. On April 25, 2013, the usual sampling spot had no water diverted into it; so the sample was taken at the manhole to the west. The samples obtained at this time had a large amount of toilet paper and debris in it. At Brittania & Eveline, the sampling spot was also moved on April 25, 2013 because water had not been diverted into the normal spot. The water at this station was stagnant during this sampling period. The total coliforms and e.coli results for these samples taken at these two intersections were both >110,000 MPN/100mL.

in this manhole was stagnant and low volume, which could explain the low water quality observed

The least amount of variation was seen in July 25, 2013; with all sampling sites having poor to marginal water quality (35-51).

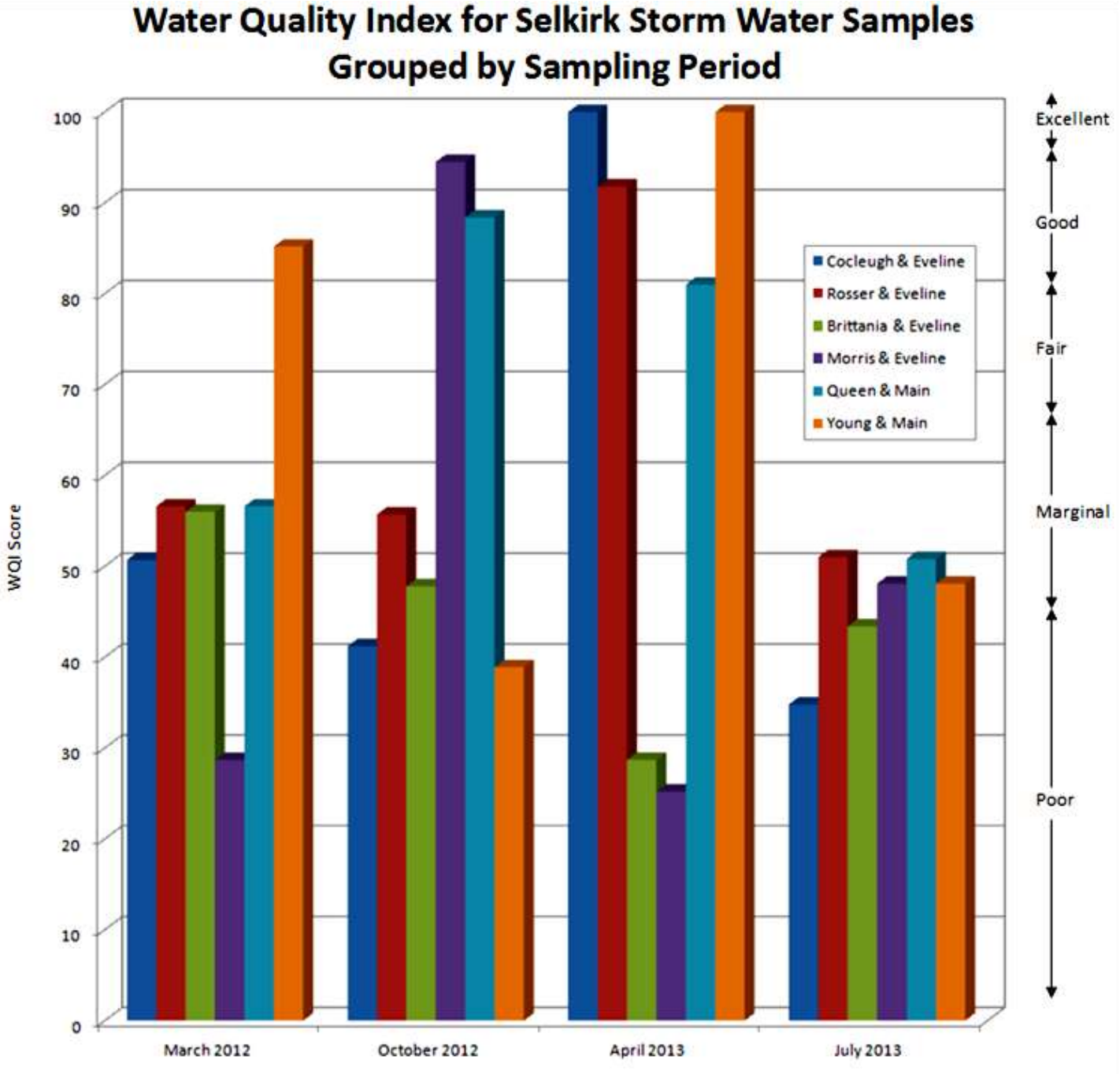

Figure 3: Water Quality Index for Selkirk Storm Water Samples Grouped by Sampling Period

Recommendations

Although these four sampling periods do not supply sufficient data on which to base major policy recommendation upon, it was the goal of this project to use the findings to help direct general urban initiatives to promote watershed and human health. In recognition of this, the following is a list of possible initiatives to be undertaken by the EICD and/or other watershed stakeholders

- Consult existing maps of drain system to identify obvious sources of bacteria
- Continue with plans to separate existing combined sanity and storm sewers
- Inspection of storm drains during dry times in an attempt to detect any non-storm flows that may indicate problems
- Establishment of a 'hotline' for citizens to report any suspicious or illegal activities that may impact the drainage system
- Provision of pet waste bags and receptacles in parks and other public spaces
- Painting fish along the existing sewer system as a part of a public awareness campaign (Yellow Fish Road initiative http://www.yellowfishroad.org/)
- Work on soft water path solutions to decrease water consumption, consequently decreasing the amount of water in the storm water system
- Educational campaign regarding the responsible use of household fertilizers
- Promote organic lawn care techniques
- Creation of vegetated buffer zones or vegetative swales around ditches and storm water collection areas, wherever possible
- Support water retention on land for storage and reuse. (encourage residents to manage their property's runoff through the establishment of rain gardens and using rain barrels)
- Develop a Municipal Storm Water Management Plan
- Consider expanding testing to include metals and/or pesticides in order to assess the full spectrum of risks
- Follow-up with further sampling to monitor progress

Appendix 1: Water Quality Guidelines

Parameter	Unit	Passed if:	
Ammonia	mg/L	Variable, pH & Temperature Dependent	Canadian Water Quality Guideline for the protection of aquatic life (freshwater organisms)
Calcium	mg/L	< 1000	Manitoba Water Quality Standards, Objectives, and Guidelines. Tier III – Water Quality Guideline Surface and Ground Water: Livestock
Chloride	mg/L	< 120	Canadian Water Quality Guideline for the protection of aquatic life (freshwater organisms)
Coliforms	MPN/ 100ml	< 1000	Manitoba Water Quality Standards, Objectives, and Guidelines. Tier III – Water Quality Guideline Surface and Ground Water: Irrigation
Conductivity	uS/cm	< 1500	Manitoba Water Quality Standards, Objectives, and Guidelines. Tier II – Water Quality Objective Surface & Ground Water: Field, Park, & Garden Irrigation.
Dissolved Oxygen	mg/L	> 4	Manitoba Water Quality Standards, Objectives, and Guidelines. Tier II – Water Quality Objective Surface Water: Cold Water Aquatic Life and Wildlife
Dissolved Solids	mg/L	< 2000	Manitoba Water Quality Standards, Objectives, and Guidelines. Tier II – Water Quality Objective Surface & Ground Water: Field, Park, Garden Irrigation. Guideline crop dependent; median value derived
e.coli	MPN/ 100ml	< 200	Manitoba Water Quality Standards, Objectives, and Guidelines. Tier I – Water Quality Standard Industrial and Municipal Wastewater Effluents Discharged to a Water Body
Nitrate	mg/L	< 13	Manitoba Water Quality Standards, Objectives, and Guidelines. Tier III – Water Quality Guideline Surface Water: Freshwater Aquatic Life
Nitrate and Nitrite N	mg/L	< 10	Manitoba Water Quality Standards, Objectives, and Guidelines. Tier III – Water Quality Guideline Surface and Ground Water: Livestock
Nitrogen	mg/L	< 15	Manitoba Water Quality Standards, Objectives, and Guidelines. Tier I – Water Quality Standard Industrial and Municipal Wastewater Effluents Discharged to a Water Body
pH		6.5-9	Manitoba Water Quality Standards, Objectives, and Guidelines. Tier III – Water Quality Guideline Surface Water: Freshwater Aquatic Life
Phosphorous	mg/L	< 1	Manitoba Water Quality Standards, Objectives, and Guidelines. Tier I – Water Quality Standard Industrial and Municipal Wastewater Effluents Discharged to a Water Body
Suspended Solids	mg/L	< 25	Manitoba Water Quality Standards, Objectives, and Guidelines. Tier I – Water Quality Standard Industrial & Municipal Wastewater Effluents Discharged to a Water Body
Turbidity	NTU	< 50	Guideline for Canadian Recreational Water Quality, Health Canada. Aesthetic objective. (*NOTE* related to suspended solids; a concern for wastewater effluent discharge)

Appendix 2: Data

The following tables list the results from all 30 parameters that were tested. Any red parameters are ones that have failed to meet the selected water quality guideline (where one exists)

March 13, 2012

Sample Info		Cocleugh & Eveline	Rosser & Eveline	Brittania & Eveline	Morris & Eveline	Queen & Main	Young & Main
Easting		650896	651910	651943	652345	652372	652344
Northing		5554988	5556177	5556348	5556935	5557248	5558028
Sample Results	**Units**						
Hardness (as CaCO3)	mg/L	478	506	273	366	579	151
Nitrite	mg/L	<0.25	<0.25	<0.050	0.073	<0.050	<0.050
Sulfate	mg/L	32.2	7.4	3.79	54.6	13.7	21.8
Total Organic Carbon	mg/L	9.1	19.9	46.9	20.3	19.1	17.1
Total Inorganic Carbon	mg/L	73.5	17.7	31.3	13.2	15.1	15.8
Total Carbon	mg/L	82.6	37.6	78.2	33.5	34.2	32.9
Total Kjeldahl Nitrogen	mg/L	1.37	3.61	2.41	15.4	2.52	1.31
Total Particulate Phosphorus	mg/L	0.144	0.412	0.342	1.25	0.39	0.047
Total Dissolved Phosphorus	mg/L	0.16	0.251	0.278	1.28	0.324	0.305
Colour, True	CU	30.6	36.5	29.6	61.8	37.8	47.6
Total Alkalinity (as CaCo3)	mg/L	311	100	76	127	88	73
Bicarbonate (HCO3)	mg/L	379	122	93	155	108	89
Carbonate (CO3)	mg/L	<12	<12	<12	<12	<12	<12
Hydroxide (OH)	mg/L	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8
Total Magnesium (Mg)	mg/L	62.4	40.9	22.2	34.1	42.9	19.9
Results with an associated Guideline							
Total Ammonia (as N)	mg/L	0.289	0.64	0.82	8.1	0.63	0.337
Total Calcium (Ca)	mg/L	88.6	135	72.8	90.5	161	27.6
Chloride	mg/L	280	426	331	320	273	341
Total Coliforms	MPN/100mL	9300	2300	1500	>110000	2300	2300
Conductivity	uS/cm	1300	1390	1160	1300	1000	1210
Dissolved Oxygen	mg/L	10.2	8.5	9.8	6	9.6	9.1
Total Dissolved Solids	mg/L	800	792	638	762	560	700
Escherichia Coli	MPN/100mL	4300	93	230	>110000	93	93
Nitrate	mg/L	3.11	0.37	0.137	<0.050	0.359	0.589
Nitrate and Nitrite N	mg/L	3.11	0.37	0.137	0.073	0.359	0.589
Total Nitrogen	mg/L	4.48	3.98	2.547	15.473	2.879	1.899
pH	pH units	8.25	8.09	8.16	7.67	8.28	8.06
Total Phosphorus	mg/L	0.304	0.663	0.62	2.53	0.714	0.352
Total Suspended Solids	mg/L	162	488	418	586	566	11
Turbidity	NTU	119	321	259	260	230	21.2

October 4, 2012

Sample Info		Cocleugh & Eveline	Rosser & Eveline	Brittania & Eveline	Morris & Eveline	Queen & Main	Young & Main
Easting		650896	651910	651943	652345	652372	652344
Northing		5554988	5556177	5556348	5556935	5557248	5558028
Sample Results	**Units**						
Hardness (as CaCO3)	mg/L	205	106	88.4	489	145	569
Nitrite	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.25
Sulfate	mg/L	16.7	3.24	8.64	266	8.64	109
Total Organic Carbon	mg/L	16.7	10.1	32.1	14.5	8	20.7
Total Inorganic Carbon	mg/L	19.8	7.8	4	44.6	11	20.5
Total Carbon	mg/L	36.4	17.9	36.1	59.1	19.1	41.2
Total Kjeldahl Nitrogen	mg/L	0.92	0.74	2.34	1.74	0.62	1.14
Total Particulate Phosphorus	mg/L	0.138	0.092	0.132	0.095	0.061	0.189
Total Dissolved Phosphorus	mg/L	0.215	0.149	0.544	0.163	0.146	0.375
Colour, True	CU	35.6	31.6	77.8	18.7	30.3	32.3
Total Alkalinity (as CaCo3)	mg/L	153	40	64	311	41	152
Bicarbonate (HCO3)	mg/L	187	49	78	376	45	186
Carbonate (CO3)	mg/L	<12	<12	<12	<12	<12	<12
Hydroxide (OH)	mg/L	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8
Total Magnesium (Mg)	mg/L	26	8.86	8.18	59.2	12.6	91.2
Results with an associated Guideline							
Total Ammonia (as N)	mg/L	0.104	0.148	0.378	0.445	0.137	0.169
Total Calcium (Ca)	mg/L	39.1	27.8	21.9	98.4	37.3	77.6
Chloride	mg/L	20.9	12.7	12.6	42.9	16.1	819
Total Coliforms	MPN/100mL	110000	24000	46000	230	930	>110000
Conductivity	uS/cm	381	130	191	1140	150	2950
Dissolved Oxygen	mg/L	10.1	9.9	8.4	7.9	10.8	8.6
Total Dissolved Solids	mg/L	244	100	102	726	88	1580
Escherichia Coli	MPN/100mL	110000	1500	9300	90	<30	2300
Nitrate	mg/L	0.758	0.108	<0.050	0.852	0.199	0.53
Nitrate and Nitrite N	mg/L	0.758	0.108	0.071	0.852	0.199	0.53
Total Nitrogen	mg/L	1.678	0.848	2.411	2.592	0.819	1.67
pH	pH units	7.72	7.59	7.03	8.3	8.46	7.55
Total Phosphorus	mg/L	0.353	0.241	0.676	0.258	0.207	0.564
Total Suspended Solids	mg/L	19	30	33	14	34	48
Turbidity	NTU	70	69.4	47.5	10.1	87.6	93.6

April 5, 2013

Sample Info		Cocleugh & Eveline	Rosser & Eveline	Brittania & Eveline	Morris & Eveline	Queen & Main	Young & Main
Easting		650896	651910	651943	682345	652372	652344
Northing		5554988	5556177	5556348	5556935	5557248	5558028
Sample Results	**Units**						
Hardness (as CaCO3)	mg/L	545	128	187	238	228	130
Nitrite	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Sulfate	mg/L	61.6	4.65	91.2	116	15.5	12.4
Total Organic Carbon	mg/L	4.2	10.8	40.8	57.3	19.8	12.9
Total Inorganic Carbon	mg/L	105	24.7	44.5	58.3	46.9	26.5
Total Carbon	mg/L	109	35.5	85.3	116	66.7	39.4
Total Kjeldahl Nitrogen	mg/L	0.72	1.33	22.9	27.0	4.7	3.2
Total Particulate Phosphorus	mg/L	0.027	0.123	1.25	0.9	0.18	0.029
Total Dissolved Phosphorus	mg/L	0.067	0.343	1.73	2.39	0.494	0.294
Colour, True	CU	9.5	56.7	49.8	56.6	37.4	71.2
Total Alkalinity (as CaCo3)	mg/L	436	101	8.8	243	189	113
Bicarbonate (HCO3)	mg/L	532	123	212	296	230	137
Carbonate (CO3)	mg/L	436	<12	<12	<12	<12	<12
Hydroxide (OH)	mg/L	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8
Total Magnesium (Mg)	mg/L	36.9	9.76	20.7	37.1	17.9	11.8
Results with an associated Guideline							
Total Ammonia (as N)	mg/L	0.054	0.241	8.8	11.9	2.54	0.334
Total Calcium (Ca)	mg/L	57.2	20	33.3	49.4	35.7	29.2
Chloride	mg/L	67.7	27.6	199	164	52.9	52.9
Total Coliforms	MPN/100mL	93	93	>110000	>110000	430	43
Conductivity	uS/cm	1050	296	1180	1230	553	424
Dissolved Oxygen	mg/L	9.1	10.9	5.4	2.5	9.1	10.9
Total Dissolved Solids	mg/L	570	157	590	629	274	213
Escherichia Coli	MPN/100mL	23	15	>110000	>110000	230	4
Nitrate	mg/L	3.42	0.145	<0.050	<0.050	0.39	0.858
Nitrate and Nitrite N	mg/L	3.42	0.145	0.071	0.071	0.39	0.858
Total Nitrogen	mg/L	4.14	1.475	22.971	27.1	5.09	4.058
pH	pH units	8.18	7.65	7.6	7.36	7.8	8.13
Total Phosphorus	mg/L	0.094	0.466	2.98	3.29	0.674	0.323
Total Suspended Solids	mg/L	25	70	136	160	90	10
Turbidity	NTU	10.8	39.8	97.2	93.1	44	6.83

July 25, 2013

Sample Info		Cocleugh & Eveline	Rosser & Eveline	Brittania & Eveline	Morris & Eveline	Queen & Main	Young & Main
Easting		650896	651910	651943	652345	652372	652344
Northing		5554988	5556177	5556348	5556935	5557248	5558028
Sample Results	**Units**						
Hardness (as CaCO3)	mg/L	295	90.1	169	276	163	122
Nitrite	mg/L	0.25	0.065	<0.050	<0.050	<0.050	<0.050
Sulfate	mg/L	83	7.1	12	15.9	23.3	13
Total Organic Carbon	mg/L	41.9	5.6	8.6	10.5	10.7	9.5
Total Inorganic Carbon	mg/L	41.2	12	20.9	11.5	16.7	9.2
Total Carbon	mg/L	83.1	17.6	29.5	22	27.4	18.7
Total Kjeldahl Nitrogen	mg/L	9.5	1.46	0.75	0.73	1.18	1.59
Total Particulate Phosphorus	mg/L	0.73	0.194	0.079	0.104	0.175	0.056
Total Dissolved Phosphorus	mg/L	0.73	0.091	0.107	0.129	0.236	0.277
Colour, True	CU	52.3	8.1	28.2	37.9	47.7	48.6
Total Alkalinity (as CaCo3)	mg/L	231	66	113	79	113	86
Bicarbonate (HCO3)	mg/L	282	80	137	96	133	105
Carbonate (CO3)	mg/L	<12	<12	<12	<12	<12	<12
Hydroxide (OH)	mg/L	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8
Total Magnesium (Mg)	mg/L	88	13.4	18.6	28.8	23.9	14.3
Results with an associated Guideline							
Total Ammonia (as N)	mg/L	2.66	0.169	<0.010	<0.010	0.01	0.339
Total Calcium (Ca)	mg/L	73.1	29	44.5	48	52.2	28.6
Chloride	mg/L	90.9	7.53	15.8	153	23.7	25.1
Total Coliforms	MPN/100mL	>110000	24000	24000	46000	24000	46000
Conductivity	uS/cm	869	155	271	666	316	270
Dissolved Oxygen	mg/L	8.1	8.9	8.9	8.8	8.5	8.1
Total Dissolved Solids	mg/L	499	82.5	161	416	191	166
Escherichia Coli	MPN/100mL	>110000	4300	24000	4300	4300	4300
Nitrate	mg/L	0.12	0.24	0.608	0.222	0.707	1.39
Nitrate and Nitrite N	mg/L	0.37	0.305	0.608	0.222	0.707	1.39
Total Nitrogen	mg/L	9.87	1.765	1.358	0.952	1.887	2.98
pH	pH units	7.53	8.25	8.25	7.95	8.34	8.05
Total Phosphorus	mg/L	1.46	0.285	0.186	0.233	0.411	0.333
Total Suspended Solids	mg/L	110	86	66	44	114	40
Turbidity	NTU	57.7	124	58.8	34.9	128	51.2

References

Canadian Council of Ministers of the Environment. 2001. Canadian water quality guidelines for the protection of aquatic life: CCME Water Quality Index 1.0, User's Manual. http://www.ccme.ca/assets/pdf/wqi_usermanualfctsht_e.pdf

Canadian Environmental Quality Guidelines. CEQG Online Database http://www.ccme.ca/publications/ceqg_rcqe.html

Federal-Provincial-Territorial Working Group on Recreational Water Quality of the Federal -Provincial-Territorial Committee on Health and the Environment. Guidelines for Canadian Recreational Water Quality 2012. http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/guide_water-2012-guide_eau/index-eng.php

Manitoba Water Stewardship, Water Science and Management Branch. 2011. Manitoba Water Quality Standards, Objectives, and Guidelines. http://www.gov.mb.ca/waterstewardship/water_quality/quality/pdf/mb_water_quality_standard_final.pdf