

# **Swan Lake Watershed Integrated Watershed Management Plan - Water Quality Report**

**Prepared by:**

**Manitoba Water Stewardship  
160 - 123 Main Street.  
Winnipeg, Manitoba, Canada**

**March 2011**

**Water Quality Investigations and Routine Monitoring:**

This report provides an overview of the studies and routine monitoring which have been undertaken by Manitoba Water Stewardship's Water Quality Management Section within the Swan Lake Watershed. There are two long term water quality monitoring stations (1974 – 2010) within the Swan Lake Watershed. These include the Swan River at PR 268 and the Woody River at PR 268. Historic data from other stations in this watershed were sparse, and so were not included in this report.

The Swan Lake watershed area is primarily characterized by agricultural land both crop and livestock, as well as urban and rural centres, and three provincial parks. All these land uses have the potential to negatively impact water quality, if not managed appropriately. Cropland can present water quality concerns in terms of fertilizer and pesticide runoff entering surface water. Livestock can present water quality concerns in terms of nutrient and pathogen runoff from feces, especially if they have direct access to surface water bodies. Urban and rural municipalities present water quality concerns in terms of wastewater treatment and effluent discharge. Provincial parks present similar water quality concerns in terms of wastewater treatment and disposal.

The tributaries of most concern in the Swan Lake watershed are the Swan and Woody Rivers, as these are the major tributaries in the watershed. Currently, these are the two long term water quality monitoring stations in the watershed, and are sampled on a quarterly basis for general chemistry, nutrients, metals, bacteria, and pesticides.

**Water Quality Index Calculations:**

The Canadian Council of Ministers of the Environment (CCME) Water Quality Index is used to summarize large amounts of water quality data into simple terms (e.g., good) for reporting in a consistent manner (CCME, 2001). Twenty-five variables are included in the Water Quality Index (Table 1) and are compared with water quality objectives and guidelines contained in the Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson 2002 and Table 1).

The Water Quality Index combines three different aspects of water quality: the 'scope,' which is the percentage of water quality variables with observations exceeding guidelines; the 'frequency,' which is the percentage of total observations exceeding guidelines; and the 'amplitude,' which is the amount by which observations exceed the guidelines. The basic premise of the Water Quality Index is that water quality is excellent when all guidelines or objectives set to protect water uses are met virtually all the time. When guidelines or

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objectives are not met, water quality becomes progressively poorer. Thus, the Index logically and mathematically incorporates information on water quality based on comparisons to guidelines or objectives to protect important water uses. The Water Quality Index ranges from 0 to 100 and is used to rank water quality in categories ranging from poor to excellent.

- Excellent (95-100) - Water quality never or very rarely exceeds guidelines
- Good (80-94) - Water quality rarely exceeds water quality guidelines
- Fair (60-79) - Water quality sometimes exceeds guidelines and possibly by a large margin
- Marginal (45-59) - Water quality often exceeds guidelines and/or by a considerable margin
- Poor (0-44) - Water quality usually exceeds guidelines and/or by a large margin

Table 1: Water quality variables and objectives or guidelines (Williamson 2002) used to calculate Water Quality Index (CCME 2001).

<b>Variables</b>	<b>Units</b>	<b>Objective Value</b>	<b>Objective Use</b>
Fecal Coliform MF	Bacteria/100mL	200	Recreation
pH	pH Units	6.5-9.0	Aquatic Life Greenhouse Irrigation
Specific Conductivity	uS/cm	1000	Aquatic Life
Total Suspended Solids	mg/L	25 (mid range)	Aquatic Life
Dissolved Oxygen	mg/L	5 (mid range)	Aquatic Life
Total or Extractable Cadmium*	mg/L	Calculation based on Hardness (7Q10)	Aquatic Life
Total or Extractable Copper*	mg/L	Calculation based on Hardness (7Q10)	Aquatic Life Drinking Water, Health
Total Arsenic	mg/L	0.025	Aquatic Life
Total or Extractable Lead*	mg/L	Calculation based on Hardness (7Q10)	Aquatic Life
Dissolved Aluminum	mg/L	0.1 for pH >6.5	Aquatic Life
Total or Extractable Nickel*	mg/L	Calculation based on Hardness (7Q10)	Aquatic Life
Total or Extractable Zinc*	mg/L	Calculation based on Hardness (7Q10)	Aquatic Life Drinking Water, Aesthetic
Total or Extractable Manganese	mg/L	0.05	Drinking Water, Aesthetic
Total or Extractable Iron	mg/L	0.3	Drinking Water, Aesthetic
Total Ammonia as N	mg/L	Calculation based pH	Aquatic Life
Soluble or Dissolved Nitrate-Nitrite	mg/L	10	Drinking Water, Health
Total Phosphorus	mg/L	0.05 in Rivers or 0.025 in Lakes	Nuisance Plant Growth
Dicamba	ug/L	0.006 where detectable	Irrigation
Bromoxynil	ug/L	0.33	Irrigation
Simazine	ug/L	0.5	Irrigation
2,4 D	ug/L	4	Aquatic Life
Lindane	ug/L	0.08	Aquatic Life
Atrazine	ug/L	1.8	Aquatic Life
MCPA	ug/L	0.025 where detectable	Irrigation
Trifluralin	ug/L	0.2	Aquatic Life

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The Water Quality Index for the Swan River typically fell between the categories of 'Fair' to 'Good' (Figure 1). The Water Quality Index for the Woody River was typically 'Good', with the exception of 1994, 1997, 2006 and 2007 where the Water Quality Index was 'Fair', and 1996 where the Water Quality Index was poor (Figure 2). This indicates water quality occasionally exceeded water quality guidelines for some variables. While numerous variables are used to calculate the overall Water Quality Index, the percentage of variables that exceeded their objective for the Swan River from 1992 to 2008 ranged from 13 to 26 per cent, while the Woody River ranged from 4 to 22 percent. Total phosphorus is typically responsible for driving down the Water Quality Index (to be discussed in greater detail below). While some water bodies contain naturally elevated concentrations of nutrients due to watershed characteristics, many human alterations impact nutrient loading to the Swan Lake watershed.

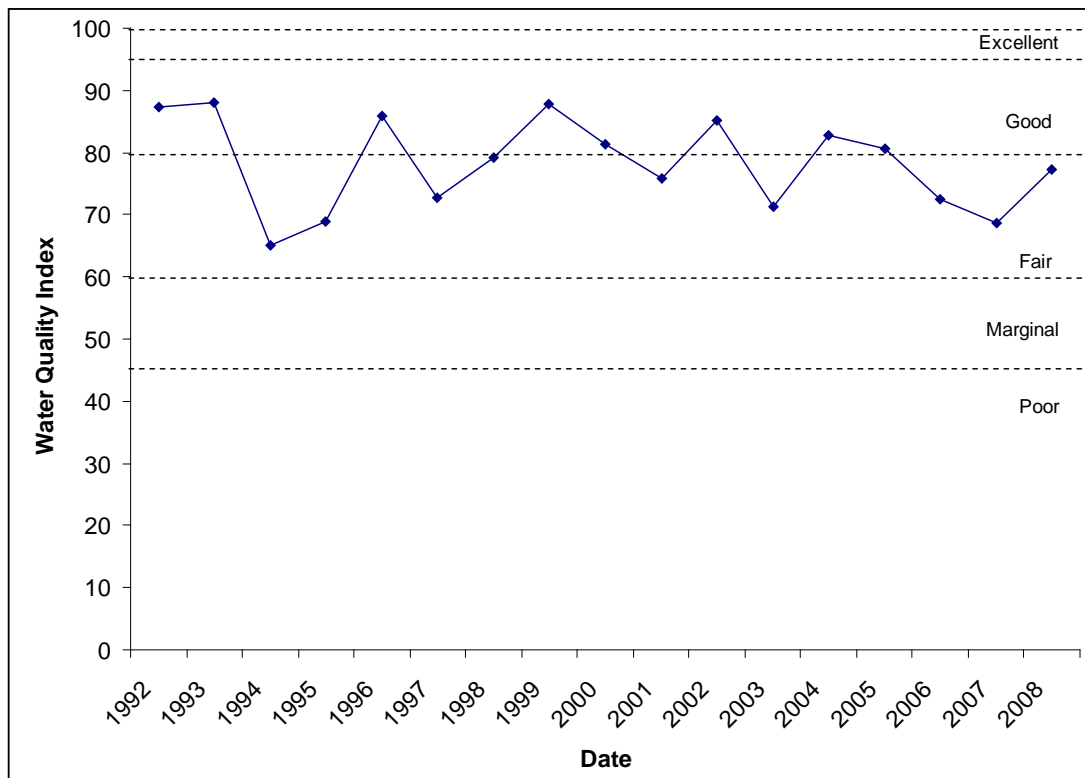


Figure 1: Water Quality Index calculated from 1992 to 2008 for the Swan River at PR 268.

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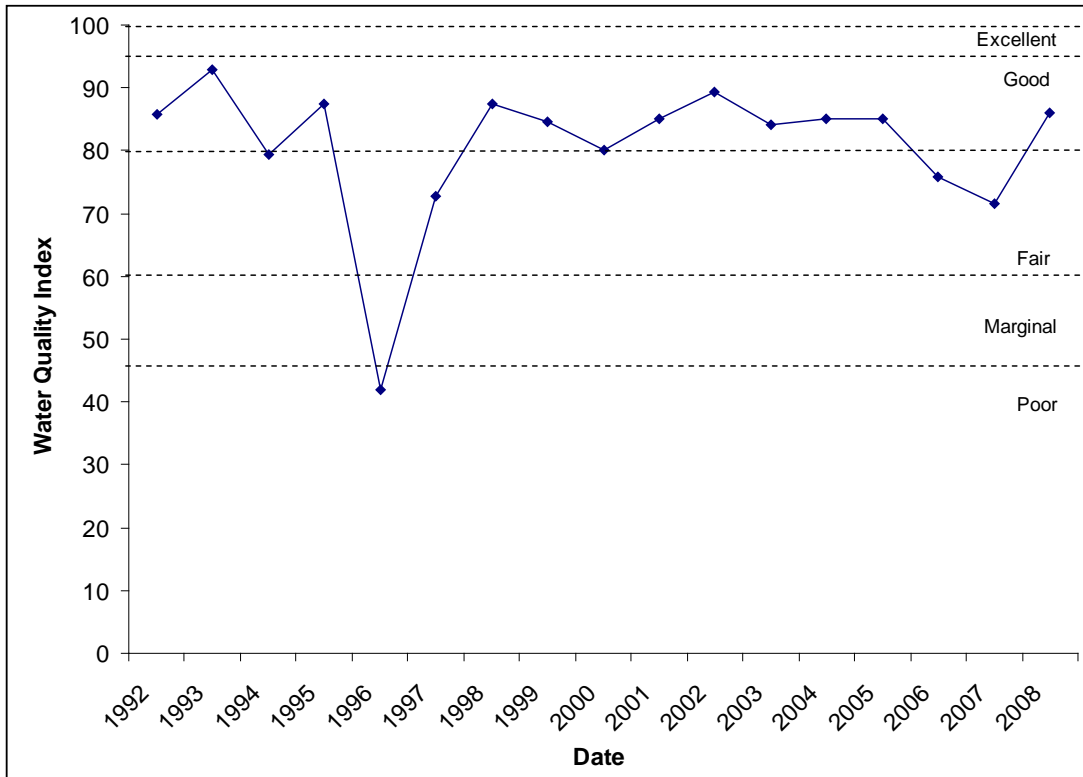


Figure 2: Water Quality Index calculated from 1992 to 2008 for the Woody River at PR 268.

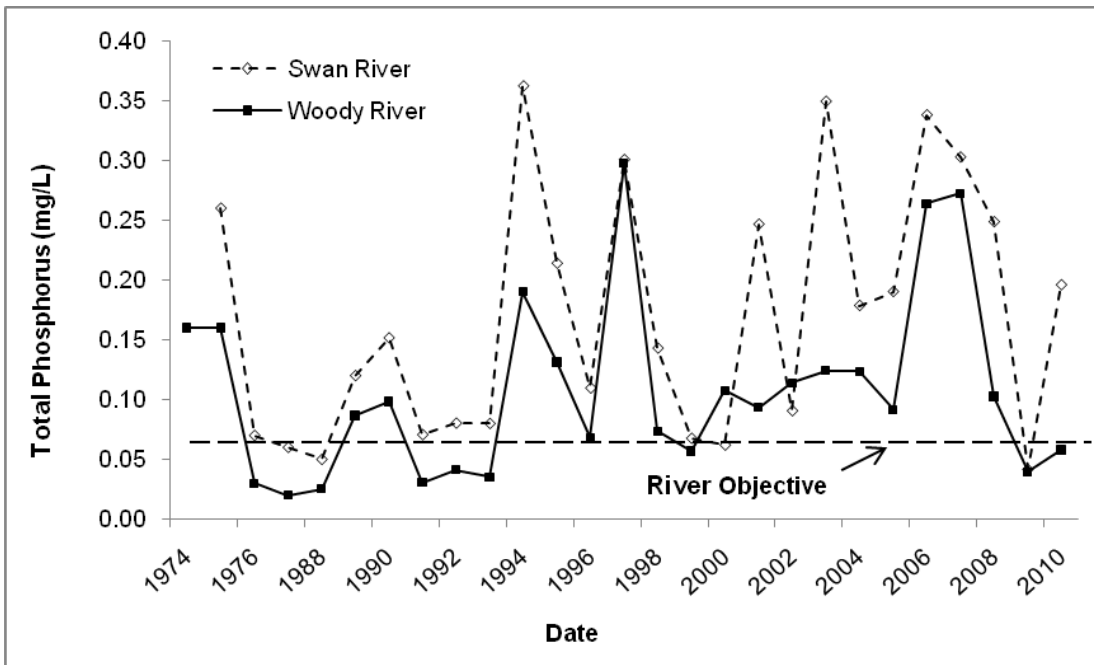


Figure 3: Yearly total phosphorus (mg/L) concentrations from two long term water quality monitoring stations in the Swan Lake watershed between 1974 and 2010.

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Figure 3 illustrates yearly means of total phosphorus concentrations in the Swan Lake watershed. Typically, total phosphorus concentrations were well above the Manitoba Water Quality Guideline for rivers of 0.05 mg/L (Williamson 2002). Total phosphorus concentrations between 1994 and 2010 were significantly greater than historic levels between 1974 and 1993. As part of the Lake Winnipeg Action Plan, Manitoba is implementing several strategies to better manage plant nutrients. Part of this Action Plan includes the development of more appropriate site-specific or regional-specific water quality objectives or guidelines for nutrients. In the meantime, the narrative guidelines will be retained for nutrients such as nitrogen and phosphorus until more site specific objectives are developed. It is generally recognized, however, that narrative guidelines for phosphorus likely do not apply to many streams in the Canadian prairie region since other factors such as turbidity, stream velocity, nitrogen, and other conditions most often limit algal growth. As well, relatively high levels of phosphorus in excess of the narrative guidelines may arise naturally from the rich prairie soils. It should be noted that most streams and rivers in southern Manitoba exceed this guideline, in some cases due to the natural soil characteristics in the watershed and/ or due to inputs from human activities and land-use practices.

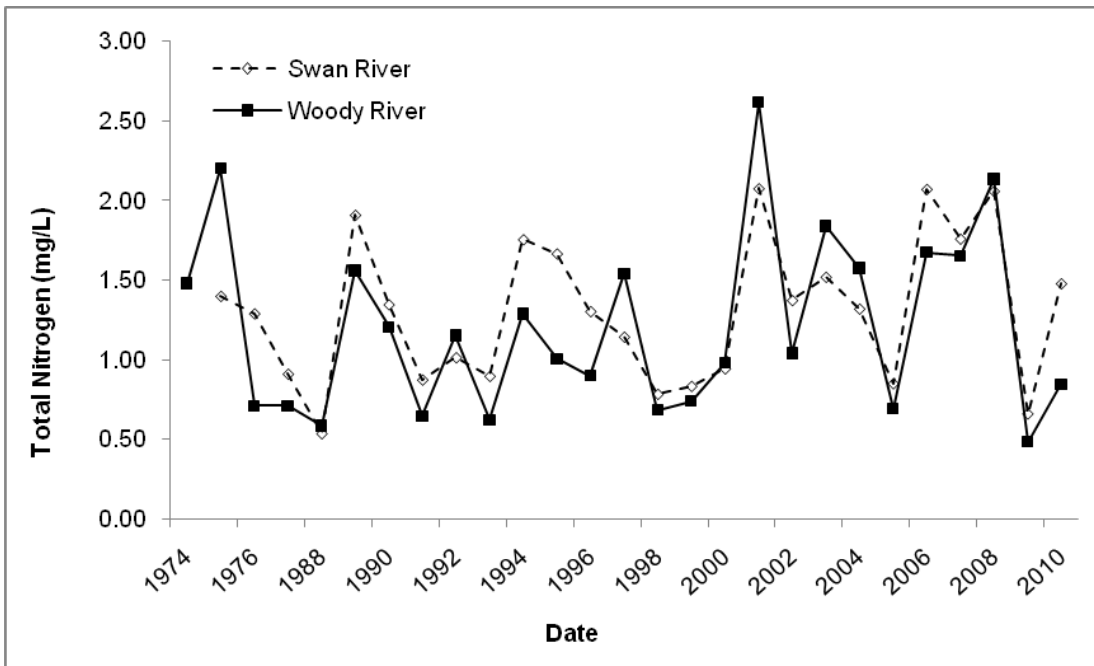


Figure 4: Yearly total nitrogen (mg/L) concentrations from two long term water quality monitoring stations in the Swan Lake watershed between 1974 and 2010.

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The narrative objective for total nitrogen states nitrogen should be limited to the extent necessary to prevent nuisance growth and reproduction of aquatic rooted, attached and floating plants, fungi, or bacteria, or to otherwise render the water unsuitable for other beneficial uses (Williamson 2002). Nitrogen and phosphorus are two essential nutrients which stimulate algal growth in Lake Manitoba and its watershed. Figure 4 illustrates yearly means for total nitrogen concentrations in the Swan Lake watershed. Total nitrogen concentrations from the Swan and Woody Rivers have remained relatively constant, but show an overall increase between 1974 and 2010.

Maintenance of adequate dissolved oxygen levels is essential to the health of aquatic life inhabiting rivers and streams. The monitoring conducted in the Swan Lake watershed (Figure 5) demonstrates that typically dissolved oxygen levels are well above the 5.0 mg/ L Manitoba objective (Williamson 2002). Overall, dissolved oxygen levels have slightly declined between 1974 and 2010. This is with the exception of a significant drop in dissolved oxygen concentration between 1999 and 2000. Low oxygen levels under ice conditions are not uncommon in small prairie rivers, as the decomposition of plant material consumes oxygen from the water. As well, low oxygen levels are not uncommon after a summer of intense algal blooms consuming oxygen from the water column. Overall, there is typically adequate dissolved oxygen in this watershed to support healthy aquatic life.

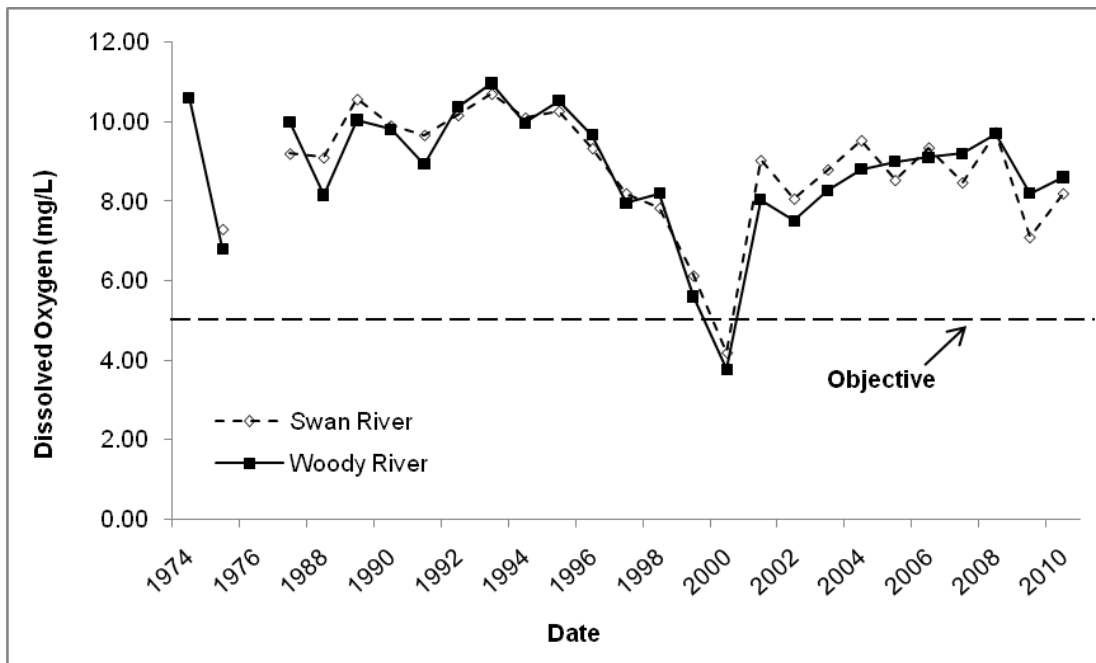


Figure 5: Yearly dissolved oxygen (mg/L) concentrations from two long term water quality monitoring stations in the Swan Lake watershed between 1974 and 2010.

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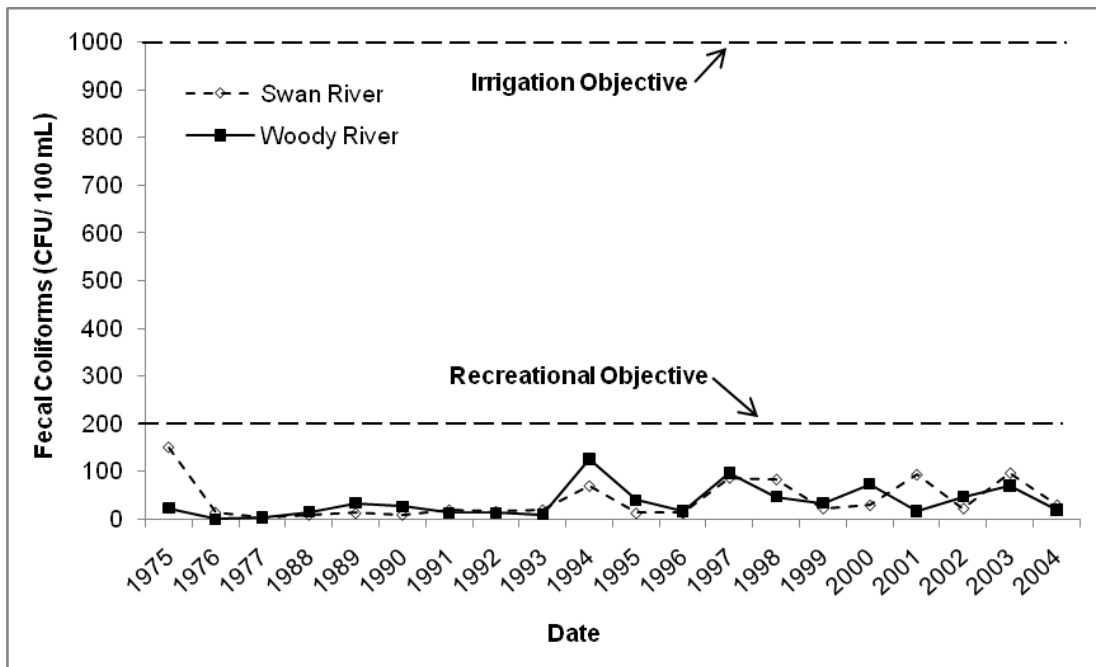


Figure 6: Yearly fecal coliform densities (CFU/ 100 mL) from two long term water quality monitoring stations in the Swan Lake watershed between 1974 and 2010.

*Escherichia coli* (*E. coli*) is one type of fecal coliform, which is a bacteria commonly found all warm-blooded animals including humans, livestock, wildlife, and birds. *E. coli* itself does not generally cause illness, but when present in large numbers the risk of becoming ill from other organisms is elevated. The most common illnesses contracted by bathers are infections of the eyes, ears, nose, and throat as well as stomach upsets. Typical symptoms include mild fever, vomiting, diarrhea and stomach cramps. Extensive studies were undertaken by Manitoba Water Stewardship in 2003 to determine the source of occasionally high *E. coli* counts and the mechanism of transfer to Lake Winnipeg beaches. Studies have shown large numbers of *E. coli* present in the wet sand of beaches. During periods of high winds, when water levels are rising in the south basin, these bacteria can be washed out of the sand and into the swimming area of the lake. Research shows less than 10% of *E. coli* found at Lake Winnipeg beaches is from human sources, with the remaining percentage from birds and animals.

Figure 6 illustrates yearly means of fecal coliform densities from two long term water quality monitoring station in the Swan Lake watershed. In all cases fecal coliform densities were well below both the irrigation objective of 1000 MPN/ 100 mL, and the recreational objective of 200 MPN/ 100 mL (Williamson 2002).



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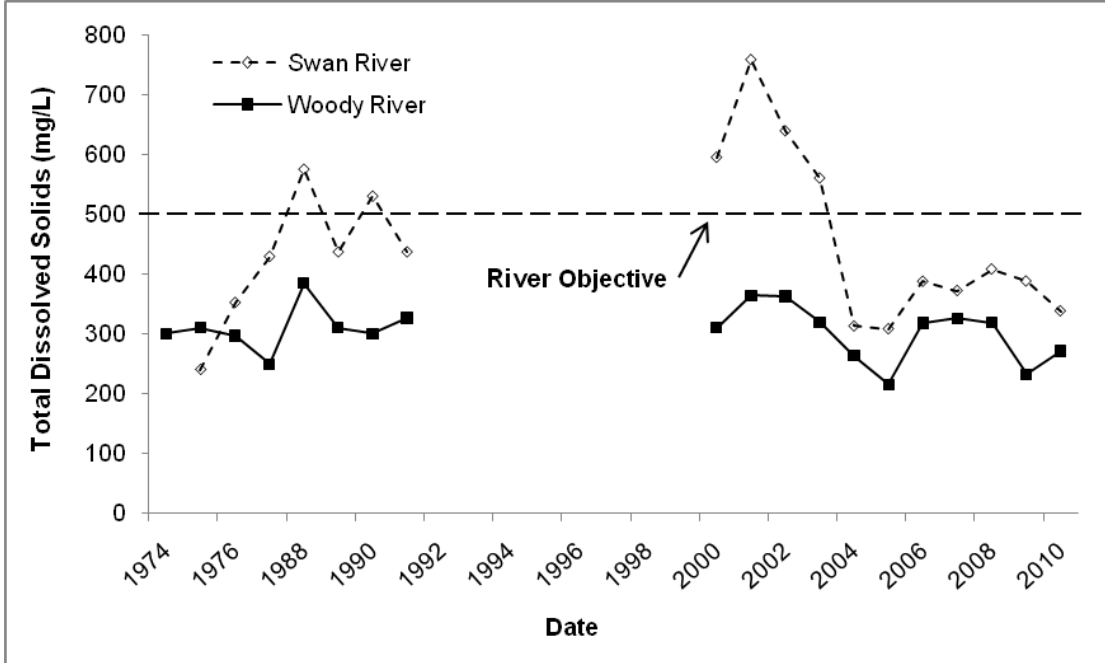


Figure 7: Yearly total dissolved solids (mg/L) from two long term water quality monitoring stations in the Swan Lake watershed between 1974 and 2010.

Drinking water variables of greatest concern are typically nitrates (objective value = 10 mg/L), arsenic (objective value = 0.025 mg/L), barium (objective value = 1 mg/L), boron (objective value = 5 mg/L), fluoride (objective value = 1.5 mg/L), uranium (objective value = 0.020 mg/L) and total dissolved solids (objective value = <500 mg/L) (Williamson 2002). It should be noted that the above stated drinking water objectives and guidelines only apply to treated, potable water. The data presented in this report however, are ambient natural untreated water quality samples, presented only for comparative purposes. At no time should raw untreated surface water be consumed for drinking water purposes, due to potential health concerns.

Drinking water variables for the two long term stations were always well below the objectives, with the exception of total dissolved solids (Figure 7). Total dissolved solids typically were below the drinking water objective of 500 mg/L for both long term stations. This was with the exception of the Swan River in 1988, 1990, 2000 – 2003. The Woody River never exceeded the guidelines for total dissolved solids. Total dissolved solids are a secondary drinking water objective, meaning they are primarily an aesthetic concern, rather than an immediate health concern. Total dissolved solids are related to ‘hard’ water which can cause problems and increased costs to drinking water and hot water systems. In addition, high concentrations of total dissolved solids can be an indication of elevated concentrations of potentially harmful ions such as nitrates, arsenic, aluminum, lead, copper, etc. which can be detrimental to health if ingested.

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Pesticide concentrations for both the Swan and Woody Rivers were almost always below the level of detection, or very close to that limit, and typically did not exceed water quality objectives. The pesticides Dicamba, Simazine and MCPA occasionally exceeded the irrigation objectives of 0.006 µg/L, 0.05 µg/L, and 0.025 µg/L, respectively, at both locations. However, the aquatic life objective for Dicamba of 10 µg/L, Simazine of 10 µg/L, and MCPA of 2.6 µg/L were never exceeded at either location.

### **Discussion**

Nutrient enrichment or eutrophication is one of the most important water quality issues in Manitoba. Excessive levels of phosphorus and nitrogen fuel the production of algae and aquatic plants. Extensive algal blooms can cause changes to aquatic life habitat, reduce essential levels of oxygen, clog fisher's commercial nets, interfere with drinking water treatment facilities, and cause taste and odour problems in drinking water. In addition, some forms of blue-green algae can produce highly potent toxins.

Studies have shown that since the early 1970s, phosphorus loading has increased by about 10% to Lake Winnipeg and nitrogen loading has increased by about 13%. A similar phenomenon has also occurred in many other Manitoba streams, rivers, and lakes.

Manitobans, including those in the Swan Lake watershed, contribute about 47% of the phosphorus and 44% of the nitrogen to Lake Winnipeg (Bourne *et al.* 2002, updated in 2006). About 15% of the phosphorus and 6% of the nitrogen entering Lake Winnipeg is contributed by agricultural activities within Manitoba. In contrast, about 9% of the phosphorus and 6% of the nitrogen entering Lake Winnipeg from Manitoba is contributed by wastewater treatment facilities such as lagoons and sewage treatments plants.

As part of Lake Winnipeg Action Plan, the Province of Manitoba is committed to reducing nutrient loading to Lake Winnipeg to those levels that existed prior to the 1970s. The Lake Winnipeg Action Plan recognizes that nutrients are contributed by most activities occurring within the drainage basin and that reductions will need to occur across all sectors. Reductions in nutrient loads across the Lake Winnipeg watershed will benefit not only Lake Winnipeg but also improve water quality in the many rivers and streams that are part of the watershed, including the Swan Lake watershed. The Lake Winnipeg Stewardship Board's 2006 report "Reducing Nutrient Loading to Lake Winnipeg and its watershed: Our Collective Responsibility and Commitment to Action" (LWSB 2006) provides 135 recommendations on actions needed to reduce nutrient loading to the Lake Winnipeg watershed. However, reducing nutrients loading to the Lake Winnipeg watershed, including the Swan Lake

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watershed, is a challenge that will require the participation and co-operation of all levels of government and all watershed residents. Ensuring good water quality in the Swan Lake watershed and downstream is a collective responsibility among all living in the watershed.

### **Water Quality Management Zones**

In June 2005 *The Water Protection Act* received royal ascension. This Act is intended to enable regulations to be developed for strengthening adherence to water quality standards, for protecting water, aquatic ecosystems or drinking water sources, and to provide a framework for integrated watershed management planning. The first regulation under *The Water Protection Act* — the *Nutrient Management Regulation* (see: [www.gov.mb.ca/waterstewardship/wqmz/index.html](http://www.gov.mb.ca/waterstewardship/wqmz/index.html)) — defines five Water Quality Management Zones for Nutrients to protect water from excess nutrients that may arise from the over-application of fertilizer, manure, and municipal waste sludge on land beyond the amounts reasonably required for crops and other plants during the growing season.

As of January 1, 2009, substances containing nitrogen or phosphorus cannot be applied to areas within the Nutrient Buffer Zone or land within Nutrient Management Zone N4 (Canada Land Inventory Soil Capability Classification for Agriculture Class 6 and 7, and unimproved organic soils). The width of the Nutrient Buffer Zone varies depending upon the nature of the body of water and is generally consistent with those contained in the Livestock Manure and Mortalities Management Regulation (42/98).

The *Nutrient Management Regulation* (MR 62/2008) prohibits the construction, modification, or expansion of manure storage facilities, confined livestock areas, sewage treatment facilities, and wastewater lagoons on land in the Nutrient Management Zone N4 or land in the Nutrient Buffer Zone. Further, the construction, installation, or replacement of an on-site wastewater management system (other than a composting toilet system or holding tank) within Nutrient Management Zone N4 or land in the Nutrient Buffer Zone is prohibited (Part 4: Section 14(1): f).

It is recommended that measures are taken to prevent the watering of livestock in any watercourses to prevent bank erosion, siltation, and to protect water quality by preventing nutrients from entering surface water.

No development should occur within the 99 foot Crown Reserve from the edge of any surface water within the rural municipalities. Permanent vegetation should be encouraged on lands within the 99 foot crown reserve to prevent erosion, siltation, and reduce the amount of nutrients entering surface water.

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The Nutrient Management Regulation under *The Water Protection Act*, prohibits the application of a fertilizer containing more than 1% phosphorus by weight, expressed as P<sub>2</sub>O<sub>5</sub>, to turf within Nutrient Management Zone N5 (built-up area such as towns, subdivisions, cottage developments, etc.) except during the year in which the turf is first established and the following year. In residential and commercial applications, a phosphorus containing fertilizer may be used if soil test phosphorus (using the Olsen-P test method) is less than 18 ppm.

The Nutrient Management Regulation (MR 62/2008) under *The Water Protection Act*, requires Nutrient Buffer Zones (set-back distances from the water's edge) be applied to all rivers, streams, creeks, wetlands, ditches, and groundwater features located across Manitoba including within urban and rural residential areas and within agricultural regions (Table A2 in Appendix 2).

### **Drainage**

Although it is recognized that drainage in Manitoba is necessary to support sustainable agriculture, it is also recognized that drainage works can impact water quality and fish habitat. Types of drainage include the placement of new culverts or larger culverts to move more water, the construction of a new drainage channels to drain low lying areas, the draining of potholes or sloughs to increase land availability for cultivation and the installation of tile drainage. Artificial drainage can sometimes result in increased nutrient (nitrogen and phosphorus), sediment and pesticide load to receiving drains, creeks and rivers. All types of drainage should be constructed so that there is no net increase in nutrients (nitrogen and phosphorus) to waterways. To ensure that drainage maintenance, construction, and reconstruction occurs in an environmentally friendly manner, the following best available technologies, and best management practices aimed at reducing impacts to water quality and fish habitat are recommended.

The following recommendations are being made to all drainage works proposals during the approval process under *The Water Rights Act*:

- There must be no net increase in nutrients (nitrogen and phosphorus) to waterways as a result of drainage activities. Placement of culverts, artificial drainage and construction and operation of tile drains can sometimes result in increased nutrient (nitrogen and phosphorus), sediment and pesticide loads to receiving drains, creeks and rivers.
- Synthetic fertilizer, animal manure, and municipal wastewater sludge must not be applied within drains.

**Culverts**

- Removal of vegetation and soil should be kept to a minimum during the construction and the placement of culverts.
- Erosion control methodologies should be used on both sides of culverts according to the Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat.
- A strip of vegetation 1 to 3 metres wide should be maintained along drainage channels as a buffer. This will reduce erosion of channels and aid in nutrient removal.
- The proponent should revegetate exposed areas along drainage channels.

**Surface Drainage**

- Surface drainage should be constructed as shallow depressions and removal of vegetation and soil should be minimized during construction.
- Based on Canada Land Inventory Soil Capability Classification for Agriculture (1965), Class 6 and 7 soils should not be drained.
- There should be no net loss of semi-permanent or permanent sloughs, wetlands, potholes or other similar bodies of water in the sub-watershed within which drainage is occurring.
- Erosion control methodologies outlined in Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat should be used where the surface drain intersects with another water body.
- A strip of vegetation 1 to 3 metres wide should be maintained along surface drainage channels as buffers. These will reduce erosion of channels and aid in nutrient removal.
- The proponent should revegetate exposed areas along banks of surface drainage channels.

**Tile Drainage**

- Discharge from tile drainage should enter a holding pond or wetland prior to discharging into a drain, creek or river.

Manitoba Water Stewardship is working towards the development of an environmentally friendly drainage manual that will provide additional guidance regarding best management practices for drainage in Manitoba.

**Conclusions and Recommendations:**

1. The Water Quality Index for the Swan Lake watershed is typically of 'Fair' to 'Good' quality. The majority of total phosphorus concentrations exceeded objectives, thus impacting the Water Quality Index.
2. Total phosphorus and nitrogen data indicate a steady increase in concentrations from 1974 to 2010. Therefore, management decisions should focus on nutrient reductions to the Swan Lake watershed to ensure the reduction of phosphorus and nitrogen loading to the Swan Lake watershed, and ultimately to Lakes Manitoba and Winnipeg.
3. Although fecal coliform densities were always below irrigation and body contact objectives, management decisions should ensure cattle are excluded direct access to water bodies. This will continue to minimize bacterial contamination and nutrient loading to surface waters in the Swan Lake watershed.
4. Overall, strategies need to be implemented to protect and enhance the water quality and habitat in the Swan Lake watershed. Best Management Practices should be adopted to reduce nutrient loading to the watershed, and ultimately Lake Manitoba. Consistent with the interim water quality targets set out in the Lake Winnipeg Action Plan, the Swan Lake watershed could consider setting a nutrient reduction goal of 10%.
5. Many steps can be taken to protect the Swan Lake watershed and its downstream environment. These include:
  - Maintain a natural, riparian buffer along waterways. Natural vegetation slows erosion and helps reduce the amount of nitrogen and phosphorus entering lakes, rivers and streams.
  - Where feasible, "naturalize" drainage systems to reduce streambed and stream bank erosion, and allowing opportunities for nutrients to be assimilated and settled out of the stream.
  - Value and maintain wetlands. Similar to riparian buffers along waterways, wetlands slow erosion and help reduce nutrient inputs to lakes, rivers, and streams. Wetlands also provide flood protection by trapping and slowly releasing excess water while providing valuable habitat for animals and plants.

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- Reduce or eliminate the use of phosphorus-based fertilizers on lawns, gardens, and at the cottage.
- Choose low phosphorus or phosphorus-free cleaning products.
- Prevent soil from eroding off urban and rural properties and reaching storm drains or municipal ditches.
- Ensure that septic systems are operating properly and are serviced on a regular basis. It's important that septic systems are pumped out regularly and that disposal fields are checked on a regular basis to ensure that they are not leaking or showing signs of saturation.
- Evaluate options for potential reduction of nutrients from municipal wastewater treatment systems. Consider options such as effluent irrigation, trickle discharge, constructed wetland treatment, or chemical treatment to reduce nutrient load to the watershed.
- Review the recommendations in the Lake Winnipeg Stewardship Board 2006 report "Reducing Nutrient Loading to Lake Winnipeg and its Watershed: Our Collective Responsibility and Commitment to Action" with the intent of implementing those that are relevant to the Swan Lake watershed.

#### **Contact Information**

For more information, please contact:

Water Quality Management Section  
Manitoba Water Stewardship  
Suite 160, 123 Main St  
Winnipeg, Manitoba R3C 1A5  
Phone: 204-945-7100  
Fax: 204-948-2357

And visit the Department's web site: <http://www.gov.mb.ca/waterstewardship>

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**Appendix 1:**

Table A1: Total phosphorus (mg/L), total nitrogen (mg/L), dissolved oxygen (mg/L), fecal coliforms (CFU/ 100 mL) and total dissolved solid (TDS mg/L) concentrations collected from the Swan and Woody Rivers between 1974 and 2010.

Date	Total Phosphorus (mg/L)		Total Nitrogen (mg/L)		Dissolved Oxygen (mg/L)		Fecal Coliforms (CFU/ 100mL)		Total Dissolved Solids (mg/L)	
	Swan River	Woody River	Swan River	Woody River	Swan River	Woody River	Swan River	Woody River	Swan River	Woody River
1974	-	0.16	-	1.48	-	10.60	-	-	-	300
1975	0.26	0.16	1.40	2.20	7.30	6.80	150.00	23.00	240	310
1976	0.07	0.03	1.29	0.71	-	-	15.00	0.00	352	297
1977	0.06	0.02	0.91	0.71	9.20	10.00	4.00	4.00	429	249
1988	0.05	0.03	0.54	0.59	9.10	8.15	10.00	15.00	575	385
1989	0.12	0.09	1.91	1.56	10.57	10.03	13.33	33.33	437	310
1990	0.15	0.10	1.35	1.21	9.90	9.80	10.00	26.67	530	300
1991	0.07	0.03	0.87	0.65	9.67	8.93	20.00	13.33	437	327
1992	0.08	0.04	1.01	1.15	10.17	10.37	16.67	13.33	-	-
1993	0.08	0.04	0.90	0.62	10.70	10.97	20.00	10.00	-	-
1994	0.36	0.19	1.76	1.29	10.10	9.96	70.00	126.00	-	-
1995	0.21	0.13	1.67	1.01	10.27	10.53	13.33	40.00	-	-
1996	0.11	0.07	1.30	0.90	9.33	9.67	13.33	16.67	-	-
1997	0.30	0.30	1.14	1.54	8.20	7.95	86.67	96.67	-	-
1998	0.14	0.07	0.78	0.68	7.83	8.20	83.33	46.67	-	-
1999	0.07	0.06	0.83	0.74	6.13	5.60	23.33	33.33	-	-
2000	0.06	0.11	0.94	0.98	4.20	3.77	30.00	73.33	595	310
2001	0.25	0.09	2.08	2.62	9.03	8.03	93.33	16.67	759	364
2002	0.09	0.11	1.37	1.04	8.07	7.50	23.33	46.67	639	363
2003	0.35	0.12	1.52	1.84	8.80	8.27	96.67	70.00	560	319
2004	0.18	0.12	1.32	1.58	9.53	8.80	30.00	20.00	313	263
2005	0.19	0.09	0.85	0.69	8.53	9.00	-	-	308	215
2006	0.34	0.26	2.07	1.68	9.35	9.10	-	-	388	318
2007	0.30	0.27	1.76	1.65	8.48	9.20	-	-	372	326
2008	0.25	0.10	2.06	2.13	9.73	9.70	-	-	408	319
2009	0.04	0.04	0.66	0.49	7.10	8.20	-	-	388	232
2010	0.20	0.06	1.48	0.85	8.20	8.60	-	-	338	271

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**Appendix 2:**

Table A2. The Nutrient Buffer Zone widths as outlined in the Nutrient Management Regulation (MR 62/2008) under *The Water Protection Act*.

<b>Water Body</b>	<b>A <sup>(1)</sup></b>	<b>B <sup>(1)</sup></b>
o a lake or reservoir designated as vulnerable	30 m	35 m
o a lake or reservoir (not including a constructed stormwater retention pond) not designated as vulnerable	15 m	20 m
o a river, creek or stream designated as vulnerable		
o a river, creek or stream not designated as vulnerable	3 m	8 m
o an order 3, 4, 5, or 6 drain or higher		
o a major wetland, bog, swamp or marsh		
o a constructed stormwater retention pond		

(<sup>1</sup>) Use column A if the applicable area is covered in permanent vegetation. Otherwise, use column B.

A healthy riparian zone is critical to river ecosystem health providing shade, organic inputs, filtering of nutrients and habitat creation (falling trees). Preserving space along rivers gives the river freedom to naturally meander across the landscape and buffers the community from flooding impacts. Reference to the Nutrient Buffer Zone and its significance can be coupled with **Section 3.1.8 – Environmental Policies** which identifies the goals of enhancing surface water and riverbank stability, and the importance of respecting setbacks.