State of the Watershed Report
Seine River Watershed - Water Quality Component - Wendy Ralley

Surface water quality data have been collected by the Water Quality Management Section, Manitoba Water Stewardship, to address various issues within the Seine River watershed. Surface water quality data are collected primarily to: 1) assess long-term, ambient water quality trends at routinely monitored sites, and 2) assess ambient water quality through short-term, intensive studies and activities. Results of water chemistry collected from the Seine River watershed represent data that were generated from both the long-term water quality site, and from short-term, issue-driven studies. While sporadic data exists for sites within the Seine River watershed, these data are very limited in scope and will not be presented in this report. Similarly, water chemistry data from smaller watercourses within the watershed have not been routinely monitored and thus, are not represented in this report.

The Seine River drains 1650 square kilometres of mostly agricultural land and meanders through crop lands, range lands, wetlands, and two golf courses (at Lorette and La Broquerie). Once the river reaches the City of Winnipeg, it flows through residential areas, the Niakwa, Windsor, and St. Boniface golf courses, and enters the Archibald Industrial District. Finally, the Seine flows through a series of parks, and then into the Red River near historic Fort Gibraltar in Whittier Park.

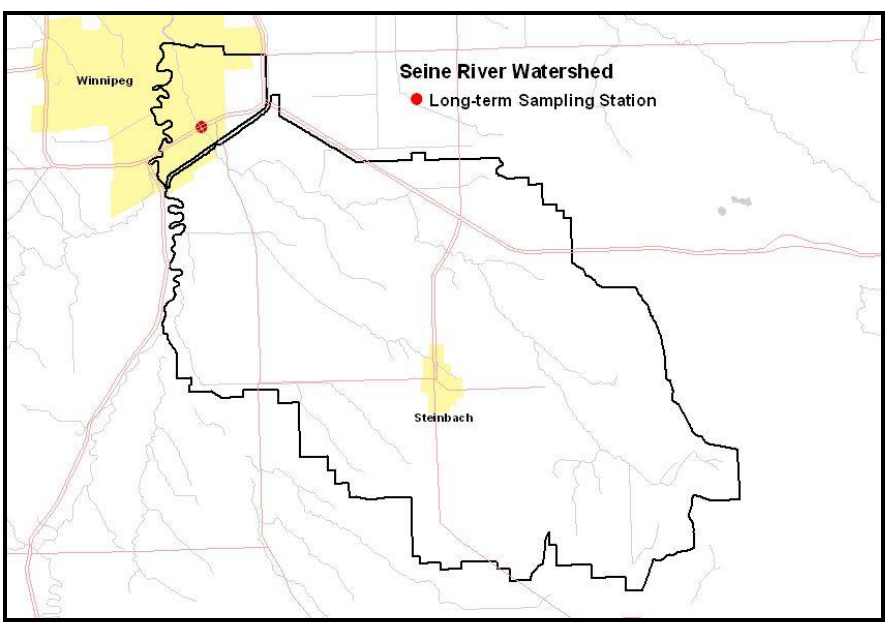
Long-Term Surface Water Quality

The Seine River watershed has one long-term water quality station located on the east side of the Perimeter Highway (Table 1, Figure 1). While sampling at this location began in 1973 at a frequency of one sample every 3 months, there is a 10-year data gap from 1978 to 1988. The frequency of sampling reflects the purpose of monitoring water chemistry for

Table 1. Long term surface water quality monitoring stations within the watershed area.

Station	Location	EMS	Period	Frequency
Seine River	S. Perimeter Hwy.	MB05OHS003	1973 to 2006	4 times/yr

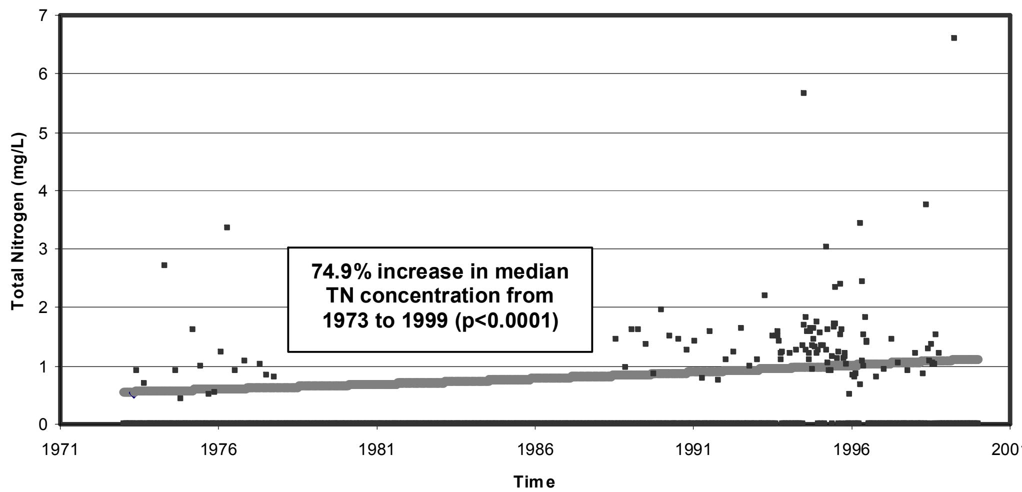
Figure 1. Location of the long-term water quality station on the Seine River at the South Perimeter Highway.

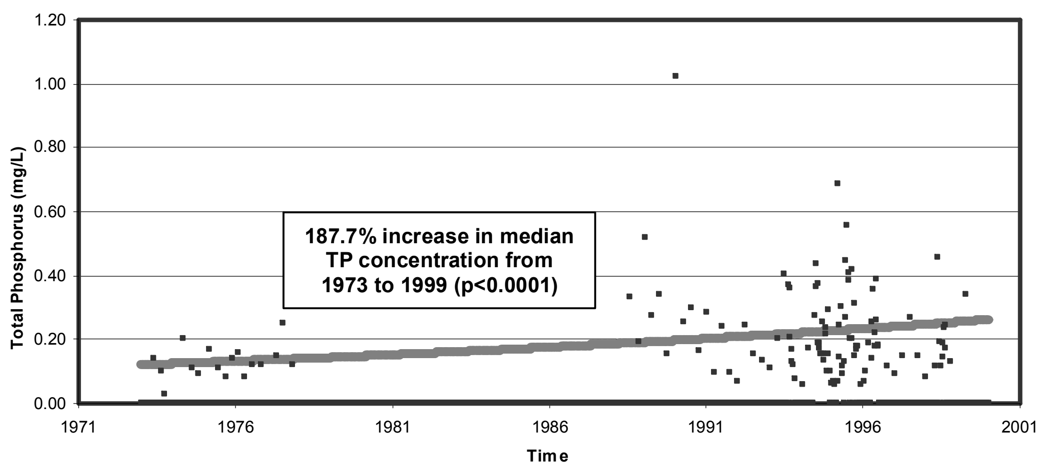


long-term changes and trends over the period of record. Water samples were collected and analyzed for a wide range of water chemistry variables at the long-term monitoring station; these included pesticides, metals, nutrients, general chemistry and bacteria.

In 2001, total phosphorus (TP) and total nitrogen (TN) from the long-term water quality station were analyzed for trends using a relatively complex statistical model (Jones and Armstrong 2001). The model identified trends in concentrations of TP and TN after accounting for variations due to river flow. Both TP and TN showed statistically significant increasing trends ($p<0.0001$) in concentration from 1973 to 1999 (Figure 2).

Figure 2. Total Nitrogen (TN) and Total Phosphorus (TP) at the south Perimeter Highway, Winnipeg, MB (WQ0166) (after Jones and Armstrong 2001). The % change in median concentration refers to the median concentration of the flow-adjusted trend line.





Total nitrogen increased 74.9 per cent from 1973 to 1999, and total phosphorus increased 187.7 per cent, or almost 4 per cent per year since 1973 (Jones and Armstrong, 2001).

A positive trend at a water quality monitoring station could be attributed to an increase in nutrient additions to the waterway. However, the potential source of nutrient addition (*i.e.* point or non-point source, anthropogenic or natural) could not be identified in this study. Also, assessment of the potential impact of an increase in nutrients on an aquatic system depends on the magnitude of the increase and the actual recorded concentrations present. In addition, monitoring stations where trends were not detected may still be subject to anthropogenic nutrient additions leading to eutrophication.

Water Quality Index:
Data from the long-term water quality station can be used to calculate a Water Quality Index for the Seine River. 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. Twenty-five variables are included in the Water Quality Index (Table 2) and are compared with water quality objectives and guidelines contained in the Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson 2002 and Table 2).

Table 2. Water quality variables and objectives or guidelines (Williamson 2000, Williamson 1988) used to calculate Water Quality Index (CCME 2000).

Variables	Units	Objective Value	Objective Use
Fecal Coliform MF	Bacteria/100mL	200	Recreation
Ph	Ph Units	6.5-9.0	Aquatic Life Greenhouse
Specific Conductivity	uS/cm	1000	Irrigation
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
Total Arsenic	mg/L	0.025	Drinking Water, Health
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
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

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.

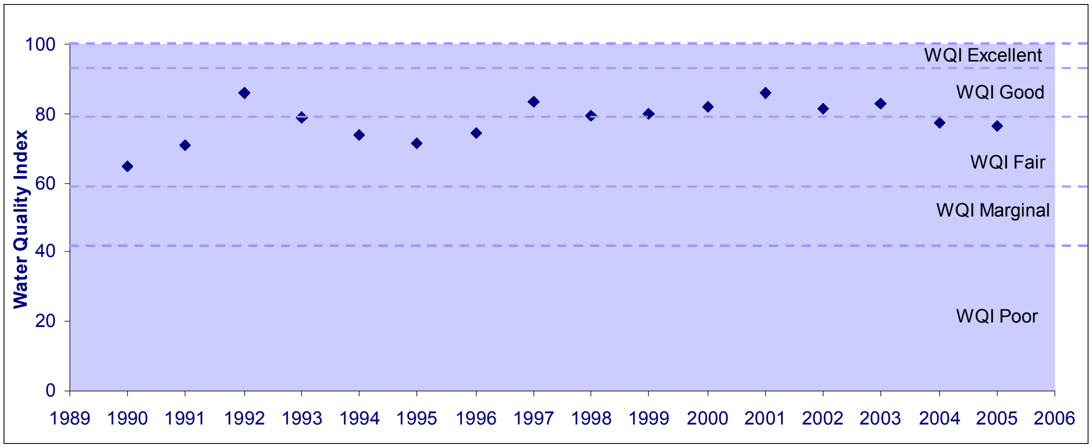
The basic premise of the Water Quality Index is that water quality is excellent when all guidelines or objectives set to protect water uses are met virtually all the time. When guidelines or objectives are not met, water quality becomes progressively poorer. Thus, the Index logically and mathematically 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

While water chemistry has been monitored at this site since 1973, certain pesticides that are required to calculate the WQI were not monitored prior to 1990. Therefore, the WQI has been calculated from 1990 to present and these indices are represented on Figure 3.

Figure 3. Water Quality Index calculated from 1990 to 2005 for the Seine River at the South Perimeter Highway.

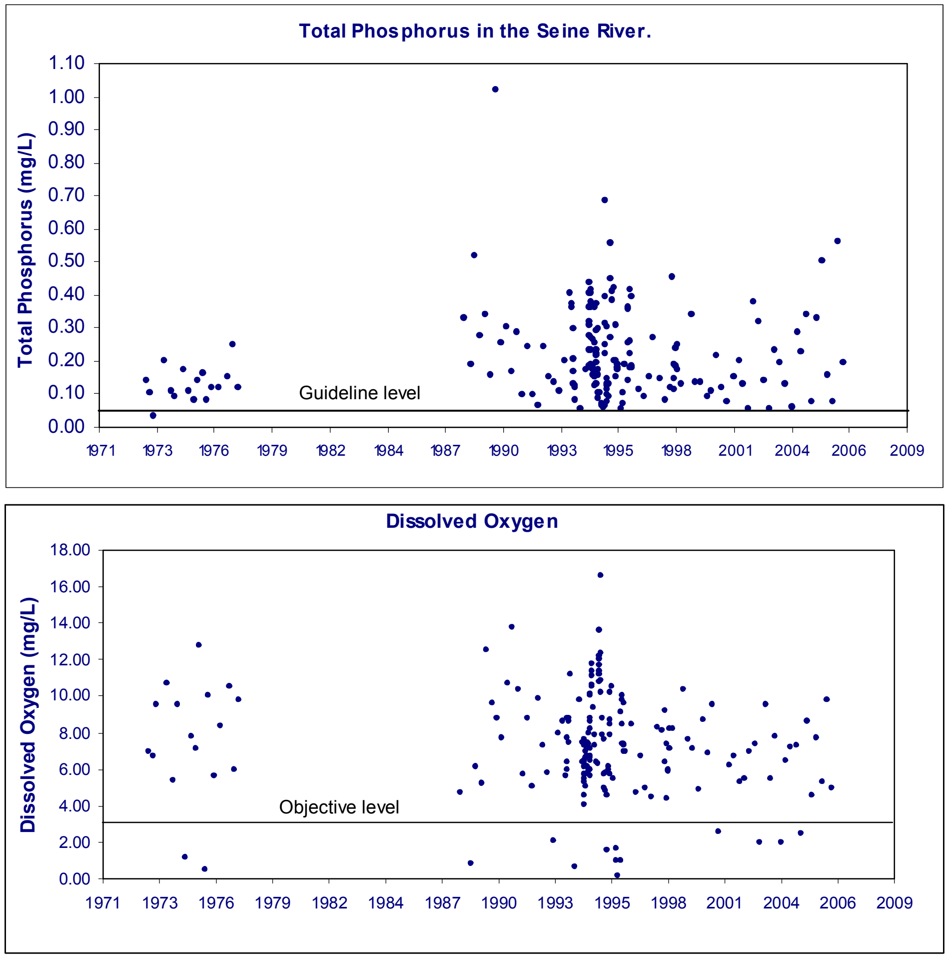


In general, the WQI in the Seine River fell within the categories of 'Fair' and 'Good' (Figure 3) indicating that water quality sometimes exceeded water quality guidelines for some variables.

While numerous variables are used to calculate the overall Water Quality Index, the percentage of variables that exceeded their objective in the Seine River from 1990 to 2005 ranged from 17 per cent to 29 per cent. Total phosphorus consistently exceeded the narrative guideline of 0.05 mg/L (Figure 4). The province-wide narrative phosphorus guideline of 0.05 mg/L provides general guidance on phosphorus concentrations but will need to be replaced with more ecologically-relevant objectives (See below in Nutrient Section). Other nutrients (ammonia and nitrate/nitrite nitrogen) were within guidelines for the entire period of record. While some water bodies contain naturally elevated concentrations of nutrients due to watershed characteristics, many human alterations impact nutrient loading to the Seine River.

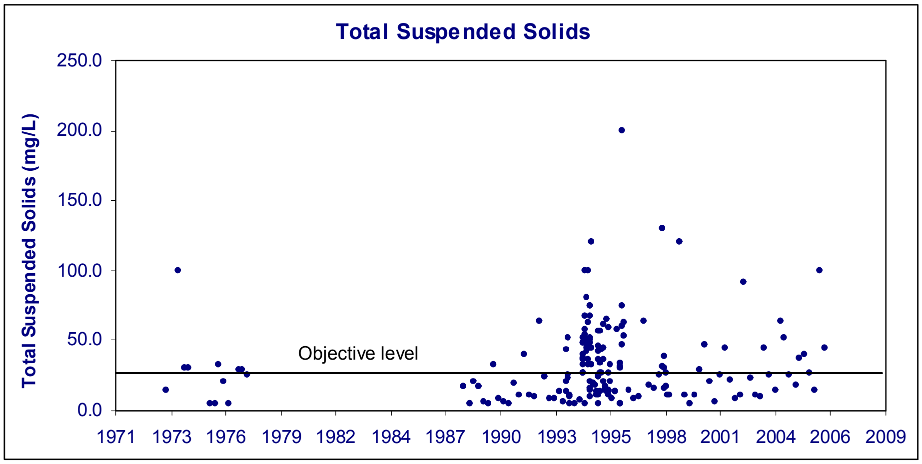
There was a consistent pattern of low dissolved oxygen in those samples collected during ice-covered months (Figure 4). Low oxygen can result from the decomposition of organic material such as algae and plants and is exacerbated by ice cover, a time when dissolved oxygen concentrations are less likely to be replenished. Critically low concentrations of dissolved oxygen can result in fish kills and foul smelling water.

Figure 4. Total phosphorus (mg/L) and Dissolved Oxygen (mg/L) concentrations from 1973 to 2005 collected from the Seine River at the South Perimeter Highway.



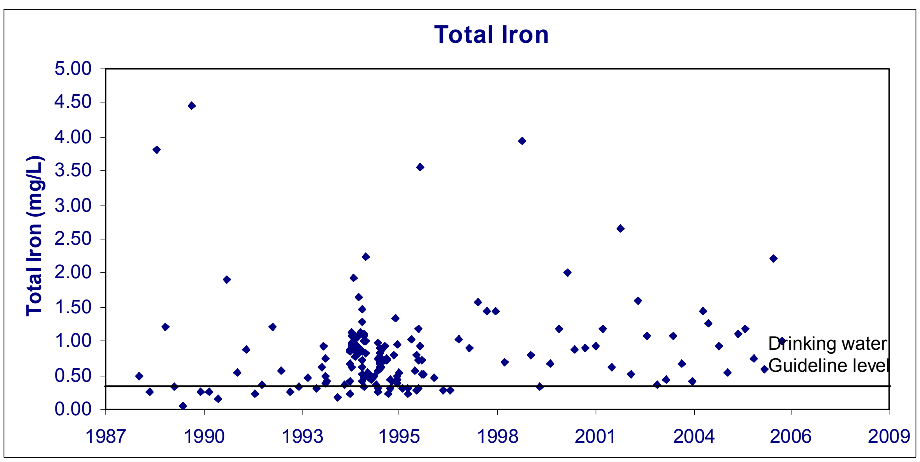
The pesticides simizine and MCPA exceeded their water quality guideline once during the period of record. All other pesticides were not detected in any sample collected during the period of record. Total suspended solids exceeded the objective approximately 50 % of the time and typically during the spring and summer months (Figure 5). Total suspended sediments increase after spring runoff, and after summer precipitation events. Overland runoff carries soil, silt, and organic debris all of which will increase the concentration of suspended sediments. Bank erosion will also contribute to increased suspended sediments. Poor land-use practices such as removing vegetated buffer strips from along rivers and smaller tributaries will also increase the overland movement of soil and other debris into the river.

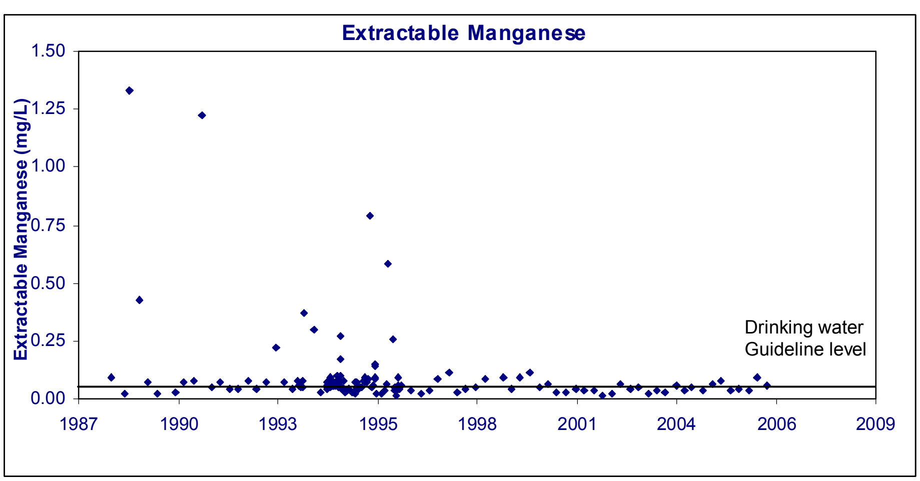
Figure 5. Total suspended solids (mg/L) from 1973 to 2005 collected from the Seine River at the South Perimeter Highway. Line indicates the Manitoba Water Quality objective.



Most of the metals either rarely, or did not, exceed their water quality objectives or guidelines. In contrast, iron and manganese exceeded the guidelines in numerous samples over the period of record (Figure 6). Iron is naturally released to surface waters through weathering of iron-bearing minerals but significant amounts are also released through industrial processes, corrosion of iron and steel, and discharges from mining operations. Iron can impart a metallic taste and produce a yellow participate in water. Manganese is strongly associated with iron in water and is also naturally found in water from weathering of minerals. High concentrations of manganese can impart an unpleasant taste.

Figure 6. Total iron (mg/L) and extractable manganese (mg/L) from 1973 to 2005 collected from the Seine River at the South Perimeter Highway.





Other Water Quality Studies

Manitoba Water Stewardship collected water quality data from 15 sites along the Seine River between 1994 to 1996 (Figure 7). These data were used to assess water quality conditions along the entire reach of the Seine River including the reach within the City of Winnipeg. Samples were analyzed for numerous variables including: general chemistry, nutrients, dissolved salts and minerals, chlorophyll-a and bacteria. In general, the downstream sites were statistically higher in concentrations of nutrients, general chemistry, and dissolved salts and minerals when compared to the upstream sites (Figure 8).

Figure 7. Location of the water quality stations on the Seine River sampled during 1994 to 1996 and the wastewater treatment facilities located within the watershed.

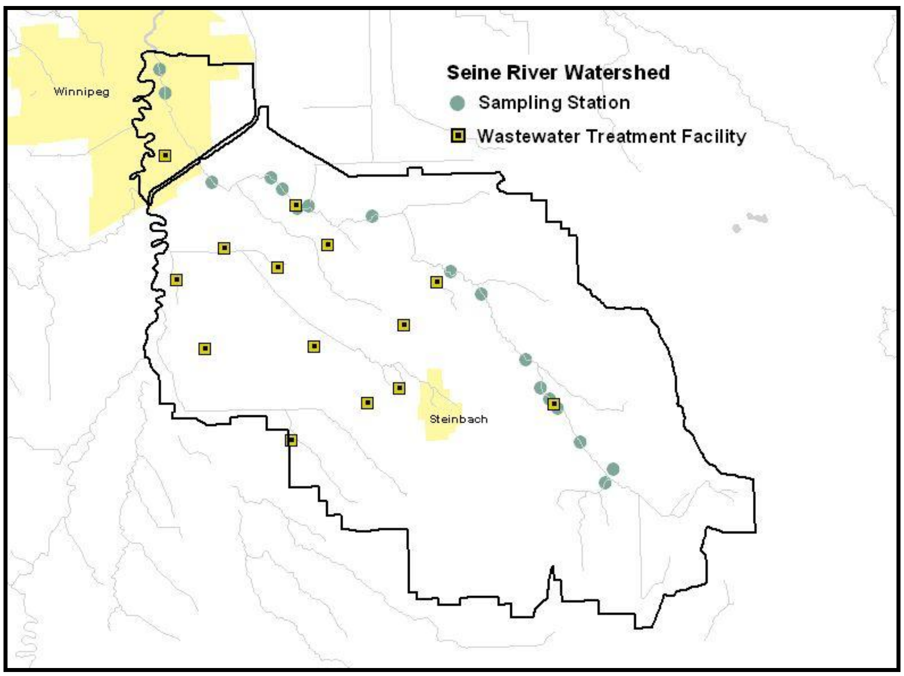
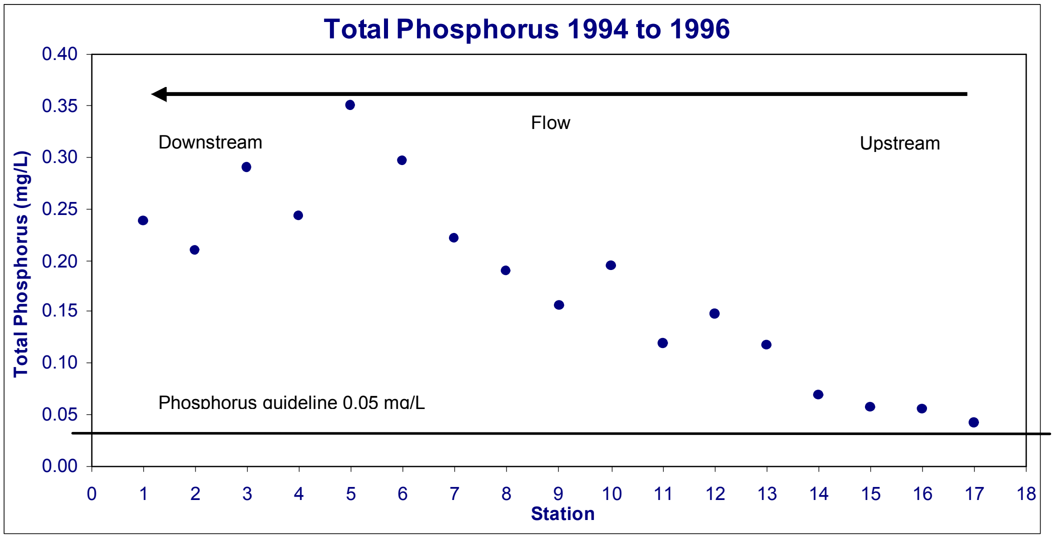
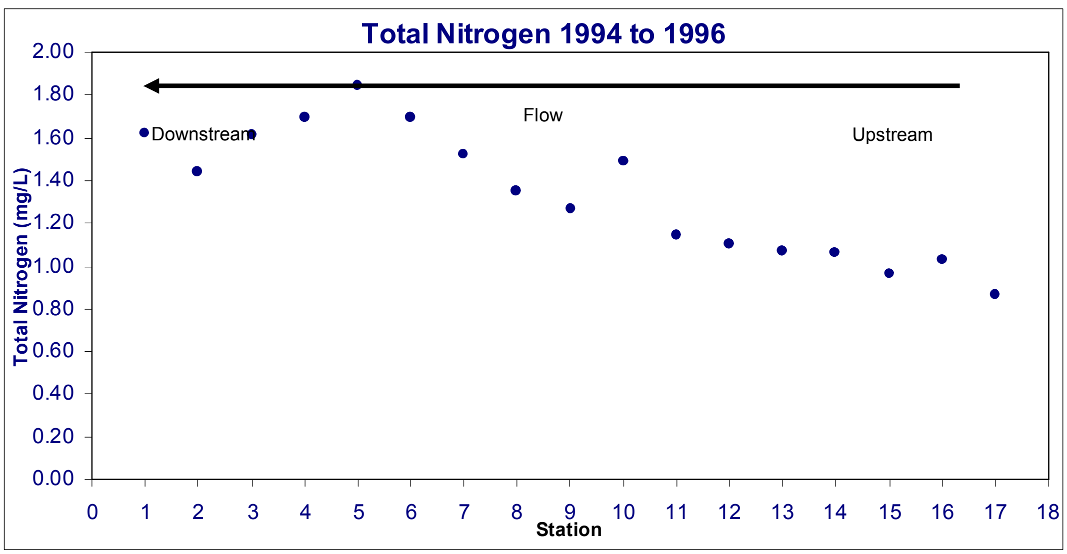
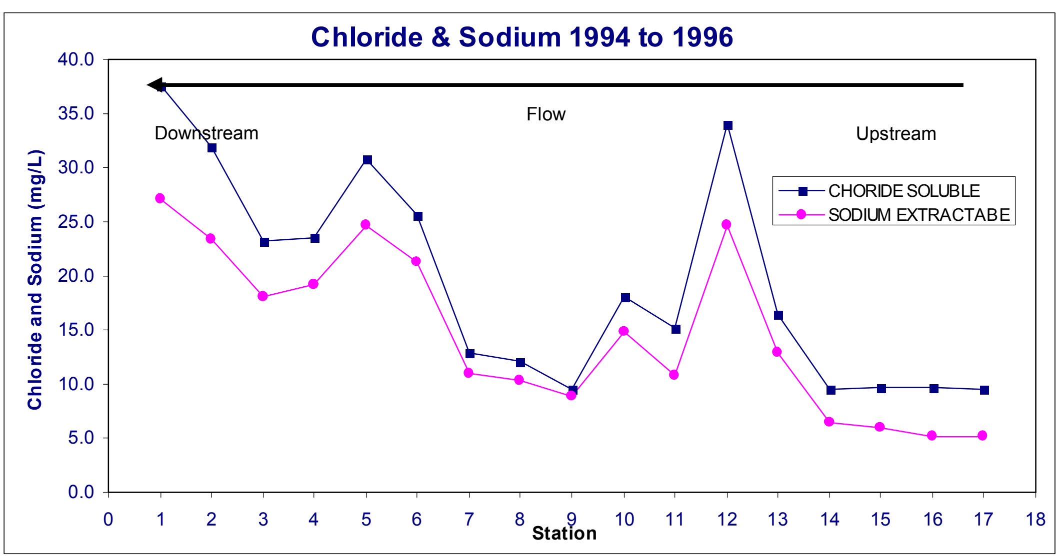


Figure 8. Water quality means for concentrations of total phosphorus, total nitrogen, and salts calculated for the 16 sites monitored on the Seine River from 1994 to 1996 (n value ranged from 67 to 10). The direction of flow is from the most upstream site (Site 17 near Marchand Manitoba) to the most downstream site (Site 1 near the confluence with the Red River).







Additionally, accumulative impacts appear to occur for a number of water quality variables (including: nutrients, dissolved salts and minerals, suspended sediments, and turbidity) as the river flows downstream towards the City of Winnipeg (Figure 8). Spikes in the mean concentrations of total nitrogen, total phosphorus, and some salts (chloride and sodium) could be related to discharges from municipal wastewater treatment facilities (WWTF) since increases in mean concentrations occurred at Seine River sites just downstream of discharges. Wastewater treatment facilities are licensed under *The Environment Act* to release effluent during certain yearly time-frames and samples for this study were collected during these releases.

Nutrients

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 fishers' 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 per cent to Lake Winnipeg and nitrogen loading has increased by about 13 per cent. A similar phenomenon has also occurred in many other Manitoba streams, rivers, and lakes.

Manitobans, including those in the Seine River 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 the Lake Winnipeg Action Plan, the provincial government 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 Seine River.

Nutrient reduction targets under the Lake Winnipeg Action Plan are interim targets that reflect the need to take immediate action to reduce nutrient loads to Lake Winnipeg. Manitoba Water Stewardship is working to develop long-term, ecologically-relevant objectives for nutrients in Lake Winnipeg and its contributing drainage areas including the Seine River Watershed. Long-term, ecologically-relevant objectives will also replace narrative guidelines that are currently applied across Manitoba.

However, reducing nutrients across Manitoba, the Seine River watershed, and the Lake Winnipeg watershed is a challenge that will require the participation and co-operation of all Manitobans and will involve:

- Implementing expensive controls on nutrients in municipal and industrial wastewater treatment facilities.
- Developing scientifically-based measures to control the application of inorganic fertilizers, animal manure, and municipal sludge to agricultural lands.
- Reducing nutrient contributions from individual cottagers and homeowners.
- Working with our upstream neighbours.

Individual Manitobans can help by taking the following steps:

- <u>Maintain a natural, riparian buffer along waterways</u>. Natural vegetation slows erosion and helps reduce the amount of nitrogen and phosphorus entering lakes, rivers and streams.

- 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.
- Don't use fertilizer close to waterways. Heavy rains or over-watering your lawn can wash nutrients off the land and into the water.
- Use phosphate-free soaps and detergents. Phosphates have been prohibited from laundry detergents but many common household cleaners including dishwasher detergent, soaps, and other cleaning supplies still contain large amounts of phosphorus. Look for phosphate-free products when you are shopping.
- Ensure that your septic system is operating properly and is serviced on a regular basis. It's important that your septic system is pumped out regularly and that your disposal field is checked on a regular basis to ensure that it is not leaking or showing signs of saturation.

Macroinvertebrates

Another indicator of water quality is the density, abundance, and diversity of macroinvertebrates (organisms without backbones, such as insects and snails, representing a variety of taxa). A number of measurements are used to assess the quality of an aquatic site as being 'non-impaired', 'slightly impaired', 'moderately impaired' or 'severely impaired'. These designations, or biological conditions, depend upon characteristics of the dominant species that are present at the site. Some organisms are intolerant of poor water quality and thus would not be present in severely impacted water while others can tolerate poor water quality.

Macroinvertebrates were collected from the Seine River yearly between 1995 and 2005 at the same location as the long-term water quality station (South Perimeter Highway). Macroinvertebrates were collected with kick nets to collect five 1 m^2 hauls at the Seine River site once per year between mid-August and the end of September. Snails were generally the predominant species at the Seine River site. However, during some years, mayflies and side swimmers were predominantly found. Biological conditions indicated no impairment in 1995, moderate impairment from 1996 through to 1998, and from 2002 to 2003. Biological condition from 1999 to 2001, and 2004 to 2005 was slight impairment (Hughes 2007, in preparation).

Figure 9. Overall biological condition of the Seine River in reference to biotic stream assessments from 1995 to 2005 (Hughes 2007, in prep.).

Year	Biological Condition Category
1995	No impairment
1996	Moderate Impairment
1997	Moderate Impairment
1998	Moderate Impairment
1999	Slight Impairment
2000	Slight Impairment
2001	Slight Impairment
2002	Moderate Impairment
2003	Moderate Impairment
2004	Slight Impairment
2005	Slight Impairment

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 re-construction 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.

- Surface drainage should be constructed as shallow depressions and minimal removal of vegetation and soil should be observed during their construction.
- Based on Canada Land Inventory Soil Capability Classification for Agriculture (1965) Class 6 and 7 soils should not be drained.
- When sloughs or potholes are drained, an additional holding pond or wetland should be constructed as a collection point for the water prior to entering the municipal drain, creek or river. This will help filter nutrients from runoff from the land as well as compensate for the loss of wetlands that support wildlife.
- Erosion control methodologies according to the guidelines outlined in *Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat* should be used where the surface drain intersects another water body.
- A strip of vegetation of at least 1 metre should be maintained along the surface drainage channel as a buffer. This will reduce erosion of the channel and reduce nutrient loading.
- When necessary, the proponent must revegetate exposed areas along the bank of the surface drainage channel.
- Discharge from tile drainage should enter a holding pond or wetland prior to discharging into a drain, creek or river.
- Nutrient application rates need to be established to complement the most efficient uptake by the crop and application should occur just prior to seeding. Fall application of manure or fertilizer should not be permitted on drained land.

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.

Other Measurements of Interest:

Number of Wastewater Treatment Facilities in the Watershed	14
Number of Intensive Livestock Operations (>300 AU) in the Watershed	53
Number of Waste Disposal Grounds in the Watershed (Class I to III and Transfer Stations)	5
Number of Storm water sewer outfalls in the City of Winnipeg that drain to the Seine River	44
Number of emergency sanitary sewer outfalls in the City of Winnipeg draining to the Seine R.	13
Number of Combined Sewer Overflows draining to the Seine River within the C of W	1

Summary

- Long-term trend data indicate that total nitrogen and total phosphorus in the Seine River have significantly increased from 1973 to 2001.

- The Water Quality Index, which uses numerous variables in the calculations and provides an overall indication of water quality, ranged between ‘Fair’ and ‘Good’ in the Seine River from 1990 to 2005.

- There may be incidents when aquatic life and wildlife may be impacted due to low dissolved oxygen levels.

- There is strong evidence to suggest that nutrients, dissolved salts and minerals, suspended sediments, and turbidity increase significantly as water flows from the most upstream sites to the most downstream sites. These accumulative impacts are likely a result of land-use practices, municipal discharges, decreases in vegetated buffer strips along the Seine River, and contributions from major drains.

References:

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Hughes, C.E. 2007. In Preparation. Biological condition and water quality of 29 major streams in south and central Manitoba, Canada, 1995 through 2005. Water Quality Management Section, Water Science and Management Branch, Manitoba Water Stewardship, Winnipeg, MB. Manitoba Water Stewardship Report No. 2007-01.

Williamson, D.A. 2002. Final Draft. Manitoba water quality standards, objectives, and guidelines. Manitoba Conservation Report 2002-11. Winnipeg, Manitoba.