Prepared For:

Carrot-Saskatchewan River Watershed Integrated Watershed Management Plan

Water Quality Report

November 2013 (revised May 2014)

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 Carrot-Saskatchewan River watershed. There is one long term water quality monitoring station within the Carrot-Saskatchewan River watershed which is monitored monthly by Environment Canada. Other data contained within this report provide upstream and downstream comparisons of the watershed which may aid in watershed management. Upstream data include Environment Canada's Carrot River near Turnberry and downstream data include the Provincial Saskatchewan River at Grand Rapids, Saskatchewan River near the inlet of Cedar Lake, Cedar Lake (southeast) and Cedar Lake (west).

The Carrot-Saskatchewan River watershed area is characterized by agricultural production, forestry, mining, hunting, fishing, trapping, tourism, and urban and rural centres. 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. Forestry if not sustainably managed has potential to significantly increase erosion and sediment loading to adjacent waterways. 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.

Mining can present a number of water quality concerns depending on the type of mining. Mineral mining presents concerns in terms of metal loading to waterways, peat mining presents water quality in that the water contained in peat bogs tends to be acidic and during the de-watering phase of each quarry lease there is an impact to the receiving body of water by increasing levels of suspended sediments, increasing levels of nutrients (nitrogen and phosphorus), and lowering the pH; thus, potentially increasing levels of dissolved metals. The ability of wetlands to filter nutrients decreases as their ecological function is reduced. Furthermore, draining, ditching, de-watering, and harvesting peat lands increases nutrient loading to receiving waters; this is inconsistent with the Government of Manitoba's efforts for nutrient reduction.

Wetlands are an important aspect of the landscape in the Carrot-Saskatchewan River watershed and the Water Quality Management Section supports the retention of all wetlands including ephemeral or temporary wetlands. Wetlands serve as essential nutrient sinks, reducing the loading of nutrients to downstream waterways. Wetlands play a key role in retaining water and slowing down the rate of loss of drainage water, reducing the risk of downstream flooding and infrastructure damage. In addition, wetlands assist in drought management and groundwater recharge. Wetlands are vital for recharging groundwater aquifers and would also serve as surface water storage mechanisms in periods of drought.

The tributaries of most concern in the Carrot-Saskatchewan River watershed are the two major tributaries, the Saskatchewan and Carrot Rivers. As mentioned, currently there is one long term water quality monitoring station within the watershed which is maintained by Environment Canada, the Saskatchewan River above the Carrot River near The Pas. Environment Canada also maintains a long term water quality monitoring station upstream of the watershed on the Carrot River near Turnberry. These two Environment Canada monitoring stations are sampled on a monthly basis for general chemistry, nutrients, metals, bacteria, and pesticides. The Water Quality Management section maintains a long term water quality monitoring station downstream of the watershed on the Saskatchewan River at Grand Rapids. The monitoring station at Grand Rapids is sampled on a bi-weekly basis for general chemistry, nutrients and metals. Through Manitoba Hydro’s Coordinated Aquatic Monitoring Program (CAMP) there are three monitoring locations downstream of the watershed on the Saskatchewan River near the mouth of Cedar Lake, as well as two locations on Cedar Lake (southeast) and Cedar Lake (west). The three Manitoba Hydro CAMP monitoring stations are sampled for general chemistry, nutrients and metals and are sampled with the following frequency; Cedar Lake (southeast) on a quarterly basis, Cedar Lake (west) annually, and the Saskatchewan River near the mouth Cedar Lake on a two year rotational basis.

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). Environment Canada calculates the Water Quality Index using eleven variables (Table 1) and are compared with the Canadian water quality objectives and guidelines.

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

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

Variables	Units	Objective Value	Objective Use
pH	pH Units	6.5-9.0	Aquatic Life
Dissolved Oxygen	mg/L	6.5 (lower range)	Aquatic Life
Total or Extractable Copper*	mg/L	Calculation based on Hardness (7Q10)	Aquatic Life
Total Arsenic	mg/L	5.0	Aquatic Life
Total or Extractable Lead*	mg/L	Calculation based on Hardness (7Q10)	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 Ammonia as N	mg/L	Calculation based pH	Aquatic Life
Total Nitrogen	mg/L	1	Aquatic Life
Total Phosphorus	mg/L	0.05	Nuisance Plant Growth
Dissolved Chloride	mg/L	150	Aquatic Life

The Water Quality Index for the Saskatchewan River above the Carrot River was typically 'Good', occasionally 'Fair' and on one occasion 'Excellent' (Figure 1). This indicates water quality occasionally exceeded water quality guidelines for some variables. 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 Carrot-Saskatchewan River watershed.

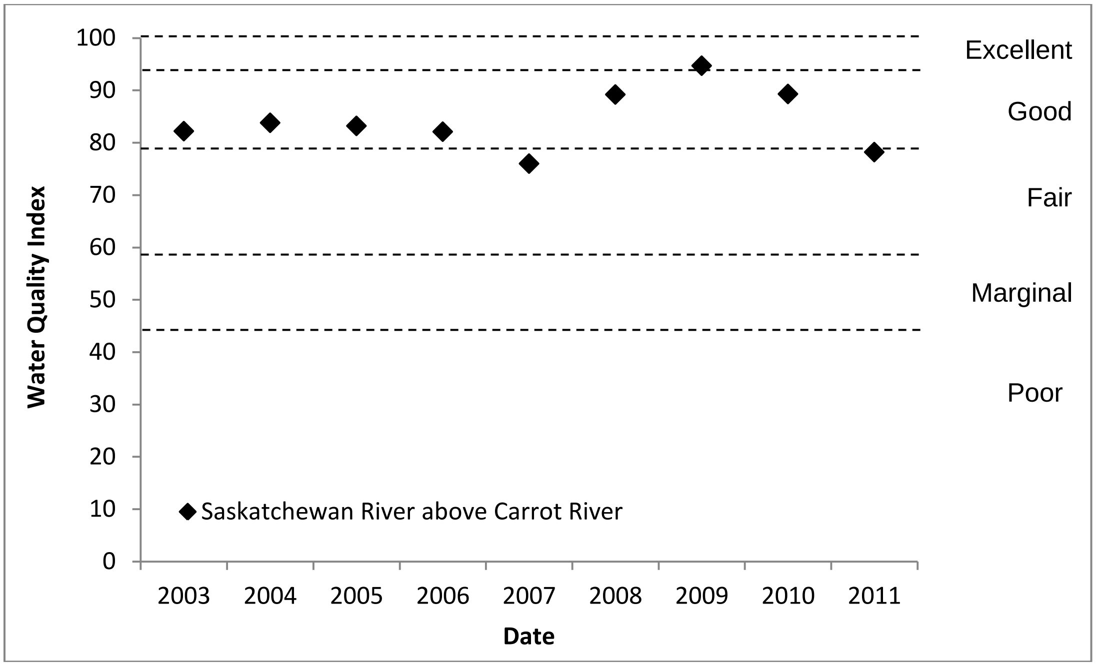

Figure 1: Water Quality Index calculated from 2003 to 2011 for the Saskatchewan River above Carrot River.

Figures 2 and 3 illustrate annual mean total phosphorus concentrations in the Carrot-Saskatchewan River watershed. Total phosphorus concentrations in the Carrot River near Turnberry were typically above the Manitoba Water Quality Guideline for both rivers 0.05 mg/L and lakes 0.025 mg/L (Williamson 2002). The Saskatchewan River above the Carrot River showed a high level of variability with total phosphorus concentrations both above and below the guideline for rivers. The Saskatchewan River at Grand Rapids and at the mouth of Cedar Lake were typically below the guideline for both rivers and lakes, this was with the exception of the Saskatchewan River near the mouth of Cedar Lake in August and September of 2010. Typically total phosphorus concentrations were below the guideline for lakes at Cedar Lake (southeast), however typically concentrations were above the guideline for lakes at Cedar Lake (west).

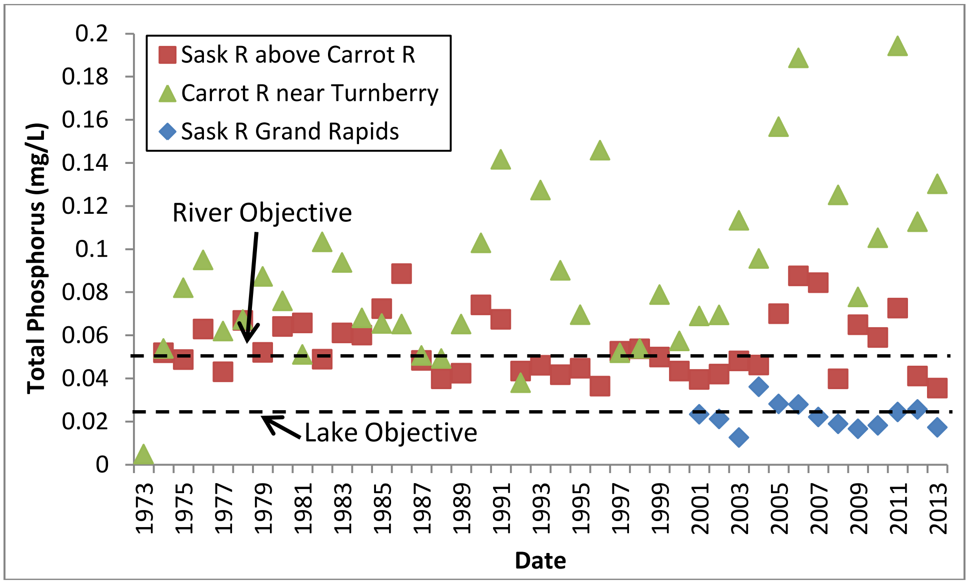

Figure 2: Annual mean total phosphorus (mg/L) concentrations for the two Environment Canada long term water quality monitoring stations; the Saskatchewan River above the Carrot River near The Pas (1973 to present), the Carrot River site upstream of the watershed (1973 to present), and the Water Quality long term monitoring station downstream of the watershed Saskatchewan River at Grand Rapids (2001 to present).

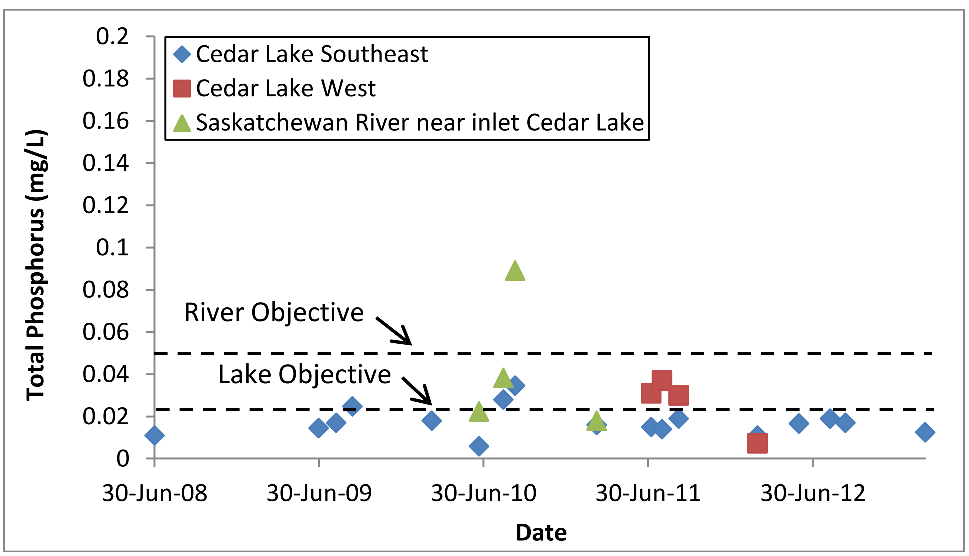

Figure 3: Annual mean total phosphorus (mg/L) concentrations for three Manitoba Hydro CAMP long term water quality monitoring stations downstream of the Carrot-Saskatchewan River watershed (2008 to present).

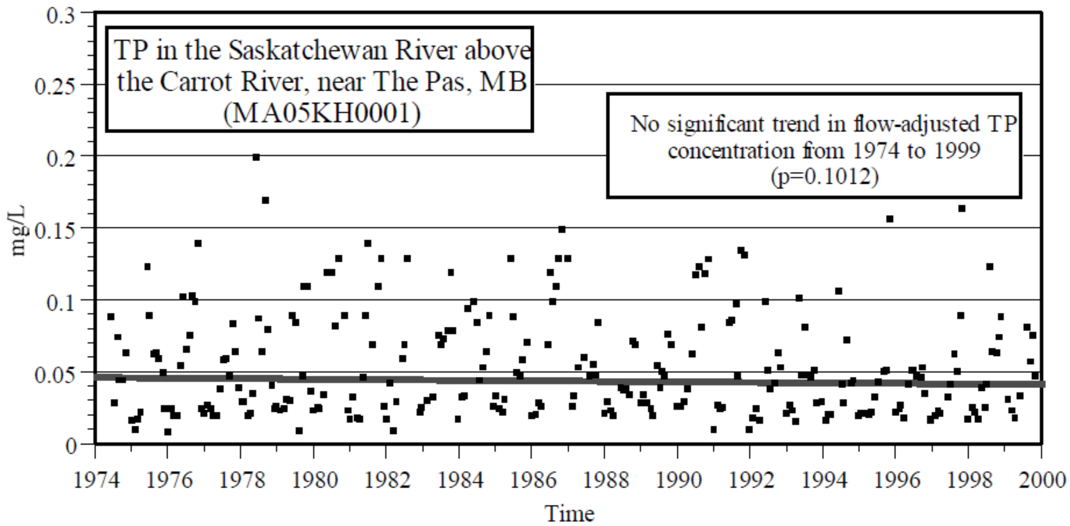

Figure 4: Trend in total phosphorus (TP) concentration in the Saskatchewan River above the Carrot River near The Pas, 1974 to 1999 (inclusive). Dots represent measured concentrations, while the solid line represents the trend in flow-adjusted concentrations.

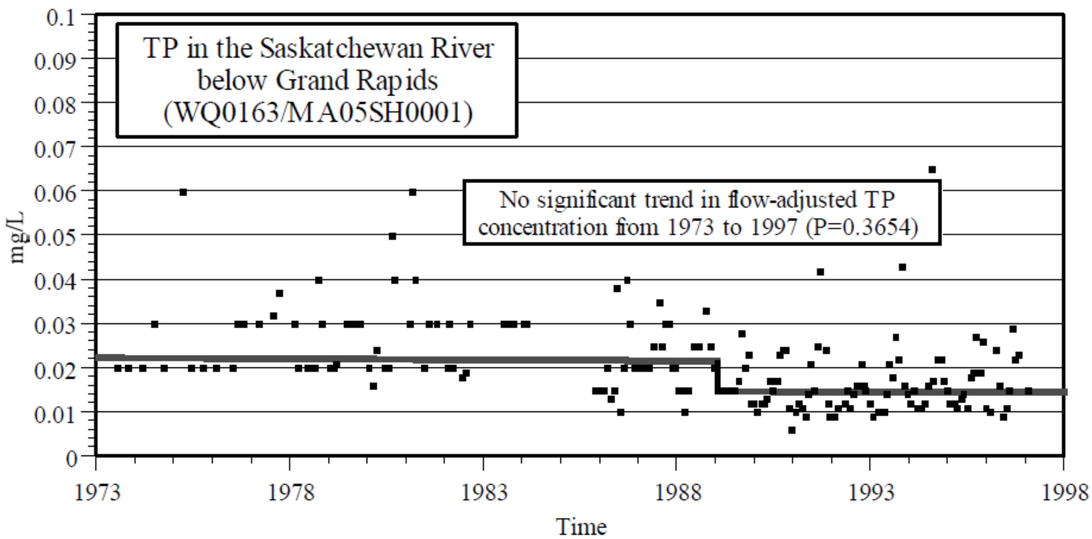

Figure 5: Trend in total phosphorus (TP) concentration in the Saskatchewan River below Grand Rapids, 1973 to 1997 (inclusive). Dots represent measured concentrations, while the solid line represents the trend in flow-adjusted concentrations.

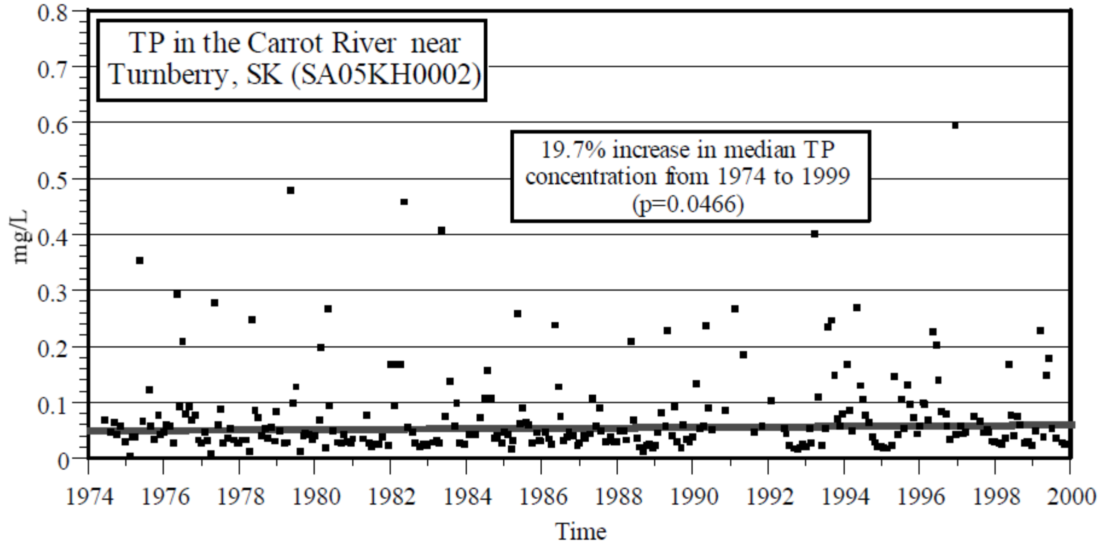

Figure 6: Trend in total phosphorus (TP) concentration in the Carrot River near Turnberry, SK, 1974 to 1999 (inclusive). Dots represent measured concentrations, while the solid line represents the trend in flow adjusted concentrations. The percent change in median concentration refers to the median concentration of the flow-adjusted trend line.

Figures 4, 5 and 6 illustrate a flow adjusted trend in total phosphorus concentrations. Analysis of data from the Saskatchewan River above the Carrot River (MA05KH0001) did not detect a significant trend (p=0.1012) in flow-adjusted total phosphorus concentrations for the period of record (Figure 4). Analysis of the data from the Saskatchewan River at Grand Rapids also did not detect a significant trend (p=0.3654) in flow-adjusted total phosphorus concentrations for the period of record (Figure 5). Thus, according to the trend analysis results, artificial loading of total phosphorus from point sources and non-point sources within the watershed has not resulted in increased concentrations of total phosphorus upstream and downstream of the Carrot-Saskatchewan River watershed over the period of record. However, results for the Carrot River near Turnberry indicate a significant trend of increasing flow-adjusted total phosphorus concentration from 1974 through 1999 (Figure 6). This trend of increase may have been due in part to agricultural development and increased erosion associated with land clearing and improved drainage within the watershed (Johnson 1977). However, because of the variability in the flow and concentration data, the level of significance for the trend line was not very high (p=0.0466) and thus the relationship between time and flow-adjusted concentration was relatively weak. Spatially, concentrations tended to decrease in the Saskatchewan River moving from upstream of the watershed to downstream of the watershed to Cedar Lake.

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

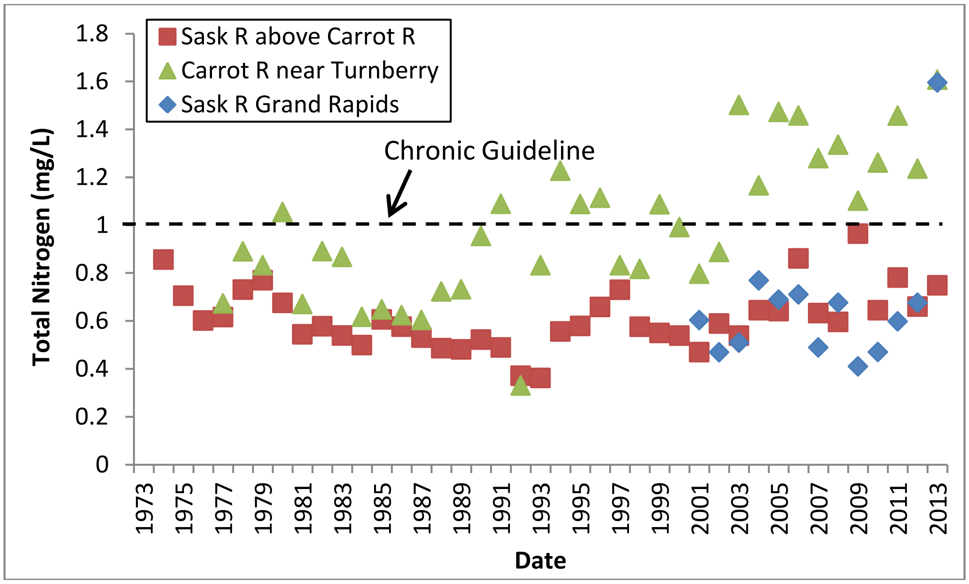

Figure 7: Annual mean total nitrogen (mg/L) concentrations for the two Environment Canada long term water quality monitoring stations; the Saskatchewan River above the Carrot River near The Pas (1973 to present), the Carrot River site upstream of the watershed (1973 to present), and the Water Quality long term monitoring station downstream of the watershed Saskatchewan River at Grand Rapids (2001 to present).

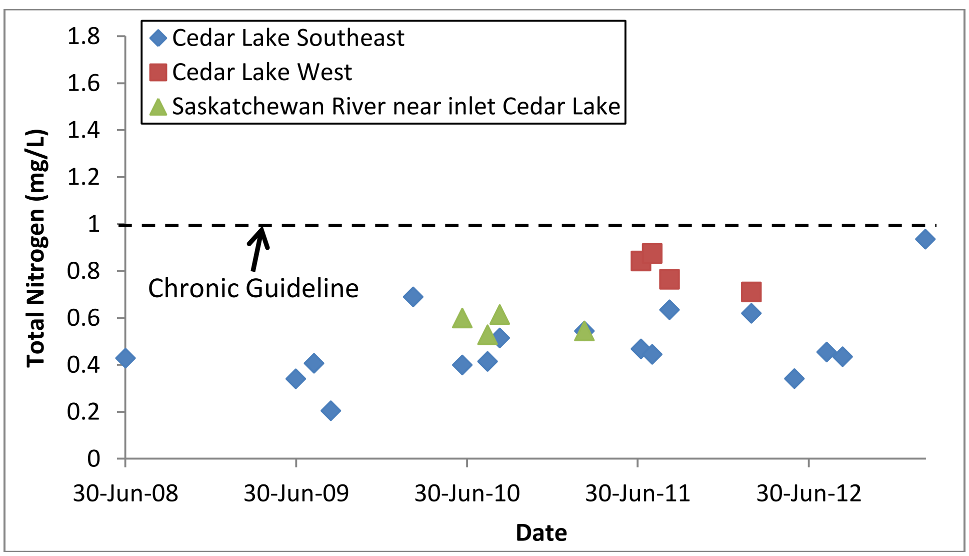

Figure 8: Annual mean total nitrogen (mg/L) concentrations for three Manitoba Hydro CAMP long term water quality monitoring stations downstream of the Carrot-Saskatchewan River watershed (2008 to present).

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.

Currently there is no guideline for total nitrogen for the protection of aquatic life in Manitoba. However, other jurisdictions have adopted a chronic total nitrogen guideline of 1.0 mg/L (Alberta Environment 1999). 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 Winnipeg and its watershed. Figures 7 and 8 illustrate annual mean total nitrogen concentrations in the Carrot-Saskatchewan River watershed. Typically, total nitrogen concentrations for the Saskatchewan River, Carrot River and Cedar Lake were below the chronic guideline. This is with the exception of the Carrot River near Turnberry in which total nitrogen concentrations have shown a significant increasing trend and concentrations well above the chronic guideline from 1990 to present. Although total nitrogen concentrations in Cedar Lake (southeast) are well below the guideline, the data suggest an increasing trend with 2013 data marginally below the guideline of 1.0 mg/L. Overall spatially concentrations tended to decrease in the Saskatchewan River moving from upstream of the watershed to downstream of the watershed to Cedar Lake.

Maintenance of adequate dissolved oxygen levels is essential to the health of aquatic life inhabiting rivers and streams. Dissolved oxygen data were only collected on the two Environment Canada long term monitoring stations; Saskatchewan River above the Carrot River near The Pas, and the Carrot River near Turnberry (Figure 9). Typically dissolved oxygen levels were above the 5.0 mg/ L Manitoba objective indicating adequate oxygen available for healthy aquatic life (Williamson 2002). This is with the exception of one sample each in 1996 and 2006 which were below the objective. Overall, the data suggest both long term stations have adequate dissolved oxygen available for healthy aquatic life. 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.

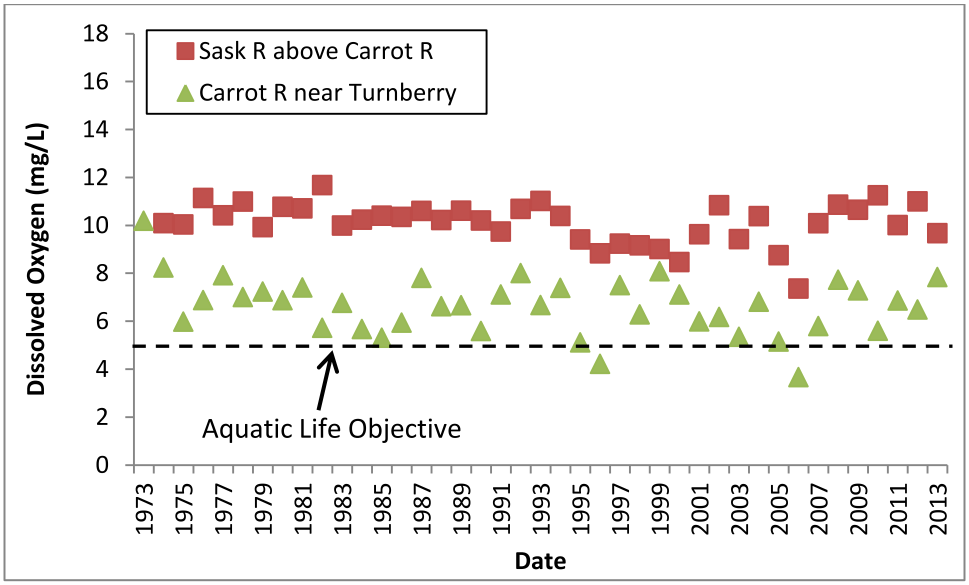

Figure 9: Annual mean dissolved oxygen (mg/L) concentrations for the two Environment Canada long term water quality monitoring stations; the Saskatchewan River above the Carrot River near The Pas (1973 to present), and the Carrot River site upstream of the watershed (1973 to present).

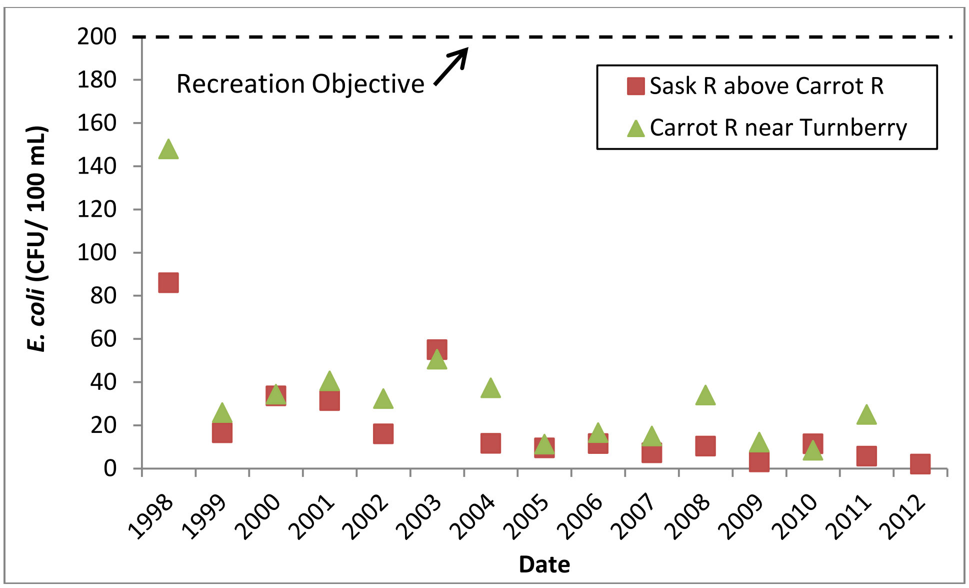

Figure 10: Annual mean *E. coli* densities (CFU/100 mL) for the two Environment Canada long term water quality monitoring stations; the Saskatchewan River above the Carrot River near The Pas (1973 to present), and the Carrot River site upstream of the watershed (1973 to present).

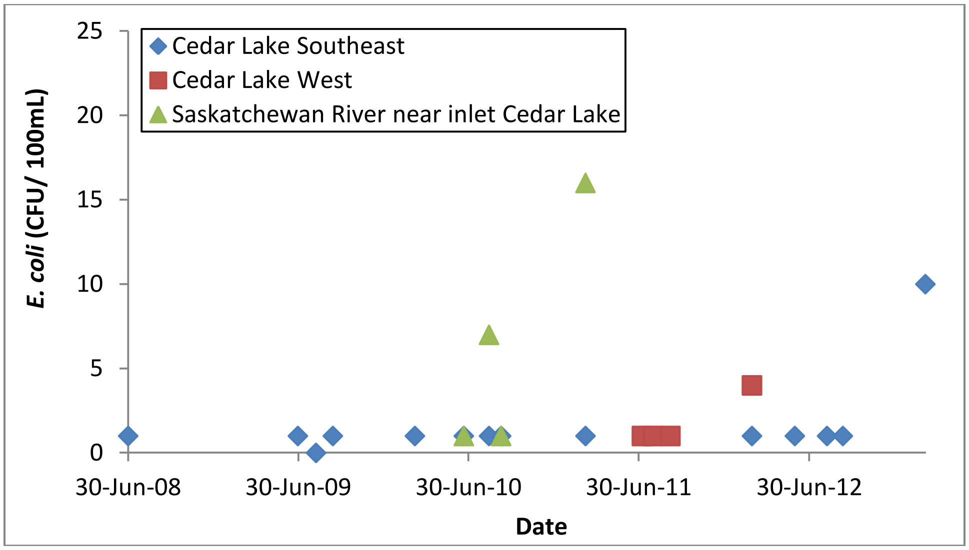

Figure 11: Annual mean *E. coli* densities (CFU/ 100 mL) for three Manitoba Hydro CAMP long term water quality monitoring stations downstream of the Carrot-Saskatchewan River watershed (2008 to present).

Escherichia coli (E. coli) is one type of fecal coliform, which is a bacteria commonly found in 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. Figures 10 and 11 illustrate annual mean *E. coli* densities from two upstream Environment Canada long term water quality monitoring stations and three Manitoba Hydro CAMP downstream stations surrounding the Carrot-Saskatchewan River watershed. Both the Manitoba Hydro CAMP and Environment Canada long term water quality monitoring stations had *E. coli* densities well below both the irrigation objective of 1000 CFU/ 100 mL, and the recreation objective of 200 CFU/ 100 mL (Williamson 2002) (Figure 11).

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. Data for the drinking water variables listed above were only available for July 2013 at the two Water Quality long term stations, with the exception of nitrate in which there was data available for 2011 to present. Drinking water variables were almost always at the detection limit and therefore well below the objectives. Drinking water variables for both the Manitoba Hydro CAMP monitoring stations as well as the two Environment Canada long term monitoring stations were also almost always at the detection limit and therefore well below the objectives. This is with the exception of total dissolved solids in the Carrot River near Turnberry which is discussed in more detail below.

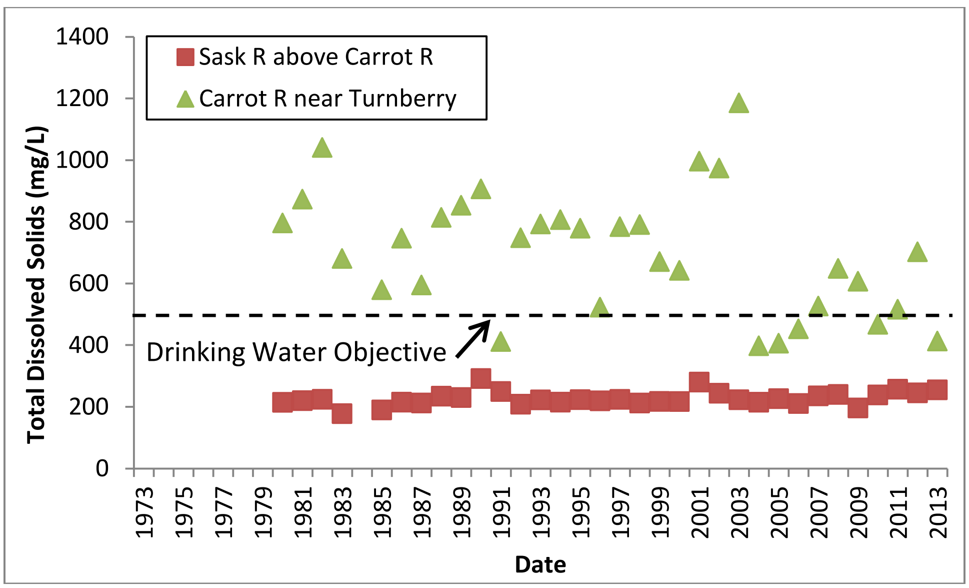

Figure 12: Annual mean total dissolved solids (mg/L) concentrations for the two Environment Canada long term water quality monitoring stations; the Saskatchewan River above the Carrot River near The Pas (1973 to present), and the Carrot River site upstream of the watershed (1973 to present).

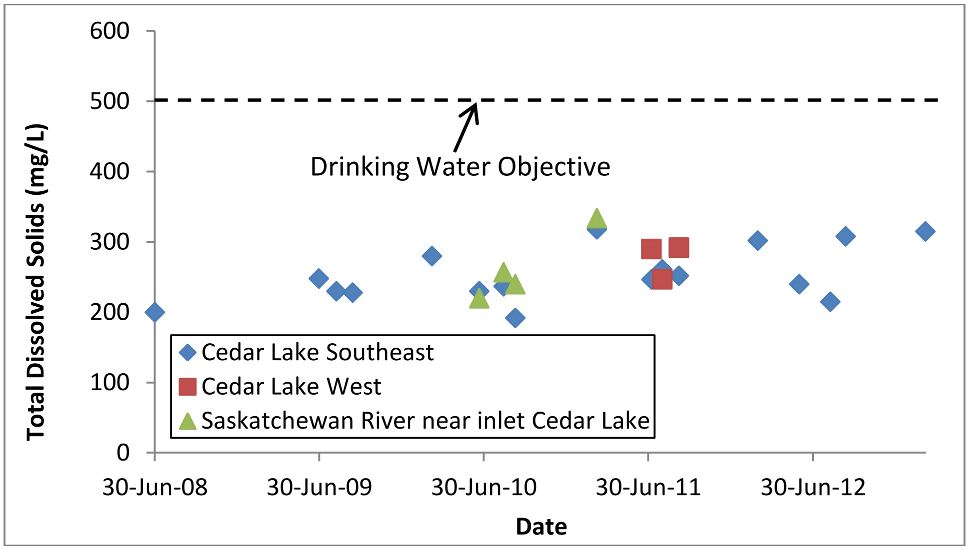

Figure 13: Annual mean total dissolved solids (mg/L) concentrations for three Manitoba Hydro CAMP long term water quality monitoring stations downstream of the Carrot-Saskatchewan River watershed (2008 to present).

Total dissolved solids were all well below the drinking water objective of 500 mg/L for the Carrot-Saskatchewan River watershed, with the exception of the Carrot River near Turnberry in which most samples were well above the guideline (Figure 12 and 13). However, data indicate a decreasing trend in total dissolved solids in the Carrot River near Turnberry with a few samples in recent years below the guideline. 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.

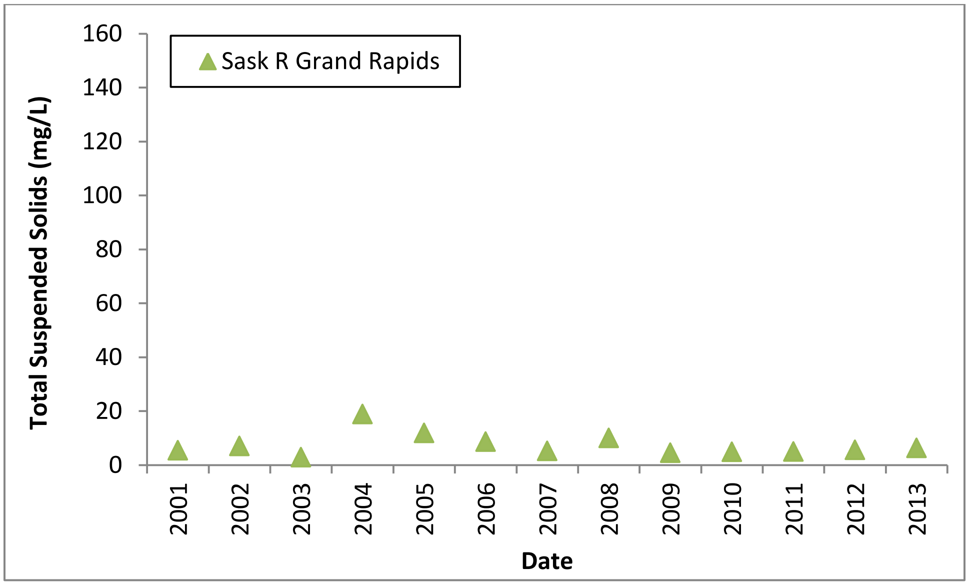

Figure 14: Annual mean total suspended solids (mg/L) concentrations for Water Quality's long term water quality monitoring station Saskatchewan River at Grand Rapids between 2001 and 2013.

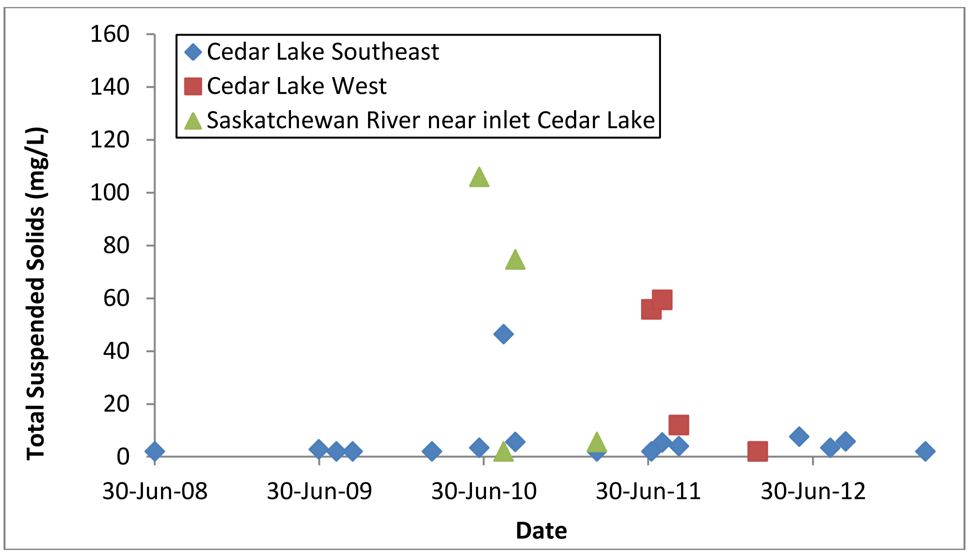

Figure 15: Annual mean total suspended solids (mg/L) concentrations for three Manitoba Hydro CAMP long term water quality monitoring stations downstream of the Carrot-Saskatchewan River watershed (2008 to present).

Currently there is no guideline for total suspended solids for the protection of aquatic life in Manitoba. Total suspended solids include organic and inorganic materials suspended in the water column, including soil, plankton (algae) and wastes. Total suspended solids can result from erosion, including soil, stream bank, urban, agricultural and industrial, as well as bottom feeders such as carp and algal growth. High concentrations of total suspended solids absorb light thereby increasing water temperatures which reduces the ability of water to hold oxygen necessary for aquatic life. Therefore, high concentrations of total suspended solids are in indication of deteriorated water quality. The Saskatchewan River at Grand Rapids (Figure 14) and Cedar Lake (southeast) both show little temporal variation in total suspended solid concentrations from 2001 and 2008, respectively, to the present (Figure 15). Cedar Lake (west) and the Saskatchewan River near the mouth of Cedar Lake both have highly variable total suspended solid concentrations, with the greatest concentrations observed during mid-summer, and June and September, respectively (Figure 15).

Pesticide data was only available for the downstream Saskatchewan River at Grand Rapids long term water quality monitoring station. All pesticides examined were below the level of detection, and therefore did not exceed water quality objectives.

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 Carrot-Saskatchewan 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 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 Carrot-Saskatchewan River 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 Carrot-Saskatchewan River 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 Carrot-Saskatchewan River 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) —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.

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_2O_5, 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 A1 in Appendix 1).

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.

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. Total phosphorus and nitrogen data in the Carrot-Saskatchewan River watershed indicate an overall decreasing trend in concentrations from upstream to downstream locations in the watershed. The six sites monitored were below water quality objectives for both total phosphorus and nitrogen, with the exception of the Carrot River near Turnberry, which indicated a significant increasing trend in total phosphorus concentrations. Therefore, management decisions should focus on nutrient reductions to the Carrot River, and also to the whole Carrot-Saskatchewan River watershed to ensure the reduction of phosphorus and nitrogen loading.

2. Although *E. coli* densities were below the irrigation and recreation objectives, management decisions should continue to ensure livestock are excluded direct access to water bodies. This will continue to minimize not only bacterial contamination but also nutrient loading to surface waters in the Carrot-Saskatchewan River watershed.

3. Total dissolved solids were typically below the drinking water objective, with the exception of the Carrot River near Turnberry in which the majority of samples were well above the guideline. Therefore, future programming should target best management practices aimed at reducing soil erosion, stream bank erosion, and reducing spring runoff via retention ponds and incorporation of wetlands on the landscape on the Carrot River and also the whole Carrot-Saskatchewan River watershed.

4. Overall, strategies need to be implemented to protect and enhance the water quality and habitat in the Carrot-Saskatchewan River watershed. Best Management Practices should be adopted to reduce nutrient loading to the watershed. Consistent with the interim water quality targets set out in the Lake Winnipeg Action Plan, the Carrot-Saskatchewan River watershed could consider setting a nutrient reduction goal of 10%.

5. Many steps can be taken to protect the Carrot-Saskatchewan River 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.
- 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 Carrot-Saskatchewan River watershed.

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Appendix 1:

Table A1. The Nutrient Buffer Zone widths as outlined in the Nutrient Management Regulation (MR 62/2008) under *The Water Protection Act*.

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

(1) 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.