LONG-TERM TRENDS IN TOTAL NITROGEN AND TOTAL PHOSPHORUS CONCENTRATIONS IN MANITOBA STREAMS

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EXECUTIVE SUMMARY

Eutrophication is the nutrient enrichment of a surface waterbody (lake, stream, reservoir) from natural and human sources. The major nutrients contributing to eutrophication are nitrogen and phosphorus. Nutrient enrichment can result in excessive growth of algae and macrophytes in surface waters leading to oxygen depletion and fish kills, decreased biodiversity, taste and odour problems, increased water treatment costs, and blue-green algae toxin production (if blue-green algae are present). Nuisance blooms of algae periodically occur in many waterbodies in Manitoba. Combined with relatively high concentrations of nitrogen and phosphorus this is one of the most important water quality issues requiring assessment at the present time.

Manitoba Conservation recently drafted a Nutrient Management Strategy that outlines steps for establishing a long-term strategy to manage nutrients in Manitoba surface waters. The document identified a number of key items and issues that require consideration during the strategy development process. One of the items called for was a comprehensive analysis of existing water quality data to detect temporal trends in nutrient concentrations in provincial waterways. Results from this analysis will help to describe the present nutrient status of streams within the province and will aid in prioritizing waterways and regions that require more immediate attention in terms of future nutrient management.

Although algae and other aquatic plants generally utilize nutrients such as phosphorus and nitrogen in their dissolved inorganic forms (*e.g.*, phosphates for phosphorus, nitrate and ammonia for nitrogen), this report was restricted to identifying trends in total nitrogen (TN) and total phosphorus (TP) concentrations. Data sets for TN and TP were more extensive in terms of sample size and time frame, and had fewer censured values (*i.e.*, values less than detection) than data sets for ammonia, nitrate, dissolved phosphorus, and ortho-phosphorus. Furthermore, derivation of water

quality objectives and criteria for nitrogen and phosphorus in other jurisdictions has focussed primarily on total values rather than inorganic or dissolved fractions.

Trend analysis was conducted on data from 46 long-term water quality monitoring stations representing 33 different waterways in Manitoba. Stations were selected on the basis of sample size, period of reporting, and availability of flow data. Thirty-three of the stations are maintained by Manitoba Conservation, while the remainder are operated by Environment Canada. Trend analyses were performed with two separate statistical methods depending on the extent of the data set involved. *QWTrend*, a computer program developed by the United States Geological Survey to analyze trends in water quality data, was used on data sets with over 60 data points and more than 15 years of data. The program uses relatively complex statistical methods to identify trends in concentration data after accounting for variation due to flow (or discharge). Trends in TN and TP data at water quality stations with fewer than 60 samples or less than 15 years of data were identified with a series of simple linear regressions on log-transformed data.

Analysis indicated great variability in long-term trends in TN and TP concentrations between streams and within streams in Manitoba. Nineteen water quality stations from 13 different streams had trends of increasing TN concentrations, while TP concentrations exhibited positive trends at 18 stations from 15 streams. Eleven monitoring sites, representing 9 different streams, had trends of increasing concentrations for both TN and TP. Most of these streams were in the southern portion of the province in the Assiniboine and Red River watersheds. The majority of streams in these watersheds are susceptible to anthropogenic nutrient loading because human population densities are high and agricultural land-use is intensive.

Four monitoring stations from four separate streams were found to have trends of decreasing TN concentration, while trends of decreasing TP were found in data from seven monitoring stations representing seven streams. Streams with trends of decrease were found in the northern and west-central regions of the province. Only two monitoring stations, one on the Swan River and the other on the Burntwood River, had decreasing trends for both TN and TP.

Ten monitoring stations from 10 streams and 20 stations from 15 streams showed no detectable trends in TN or TP, respectively. Seven monitoring stations, each from a different stream, showed no detectable trend in both TN and TP concentrations. Streams with stations that showed no trend

in either TN or TP or both variables, although found in all areas of the province, tended to be located in the western portion of the Province north of the Assiniboine River and Boggy Creek-Whitemud River watersheds. Watersheds in this region of the province are generally less dominated by agricultural land-use (on a proportional land basis) than watersheds in the south. Several of these monitoring sites had relatively small data sets. Small sample size and a short period of record, coupled with high variability in the data may have made detection of statistically significant trends difficult. Trend detection may increase as more data is collected at these sites.

Results of the analysis of long-term trends in TN and TP in Manitoba waterways were interpreted in terms of there having been an increase, a decrease, or no detectable change in concentration over the period of record. A positive trend at a monitoring station could be attributed to an increase in nutrient additions to the waterway. However, further study, as identified in the Nutrient Management Strategy, is required to determine the potential source of nutrient addition (*i.e.* point or non-point source, anthropogenic or natural). Also trend results did not indicate whether such an increase was ecologically significant. 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. For example, TP concentrations at site WQ0201 on Boggy Creek fluctuated between 0.05 and 0.15 mg/L suggesting significant variation in nutrient loading over the period of record. Further study is required to determine what magnitude of fluctuation in TP or TN concentration will trigger the negative impacts associated with nutrient enrichment.

Copies of the full report can be obtained by contacting one of the following:

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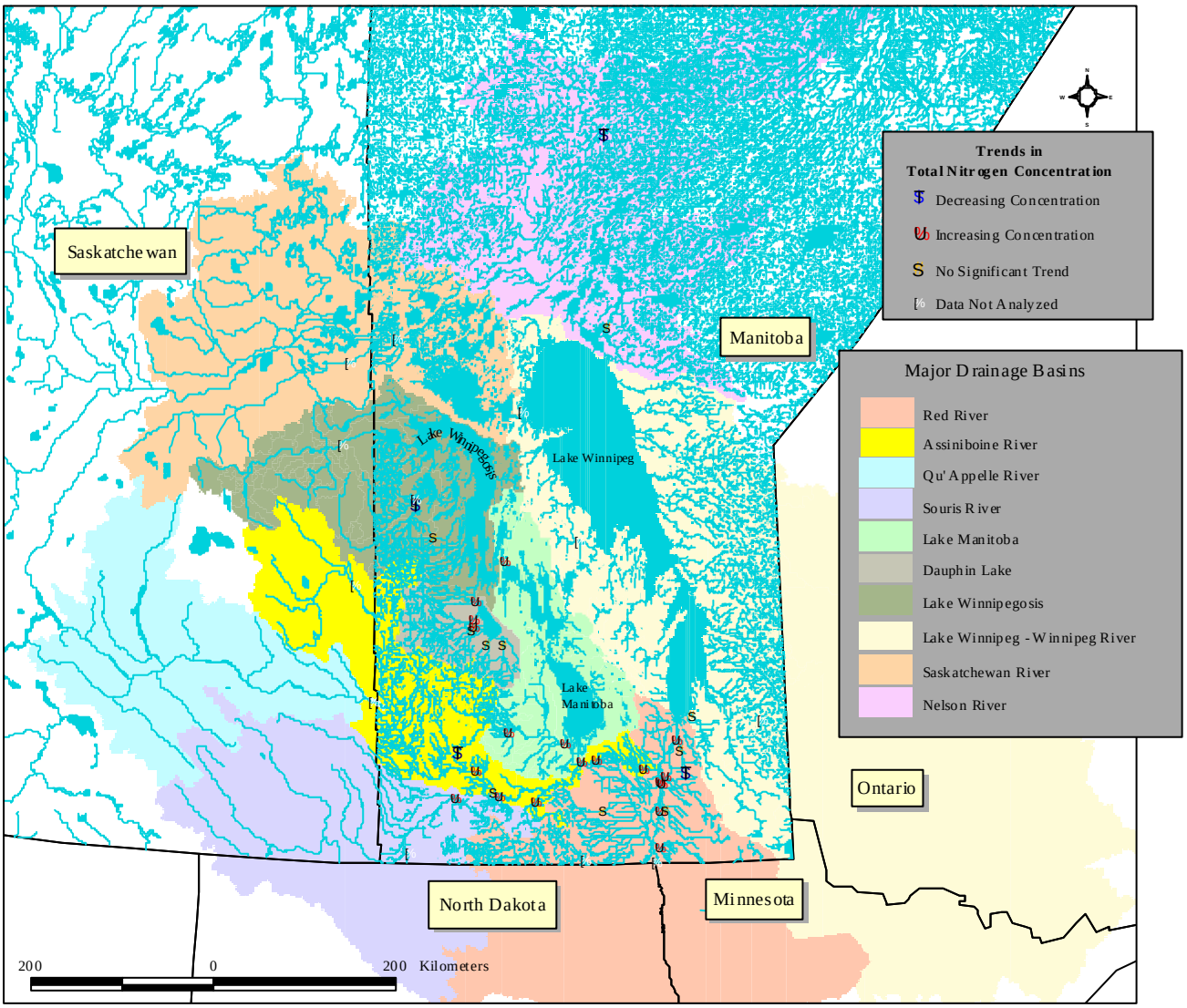
Summary results of trend analysis performed on TN and TP data from long-term monitoring sites in Manitoba streams.

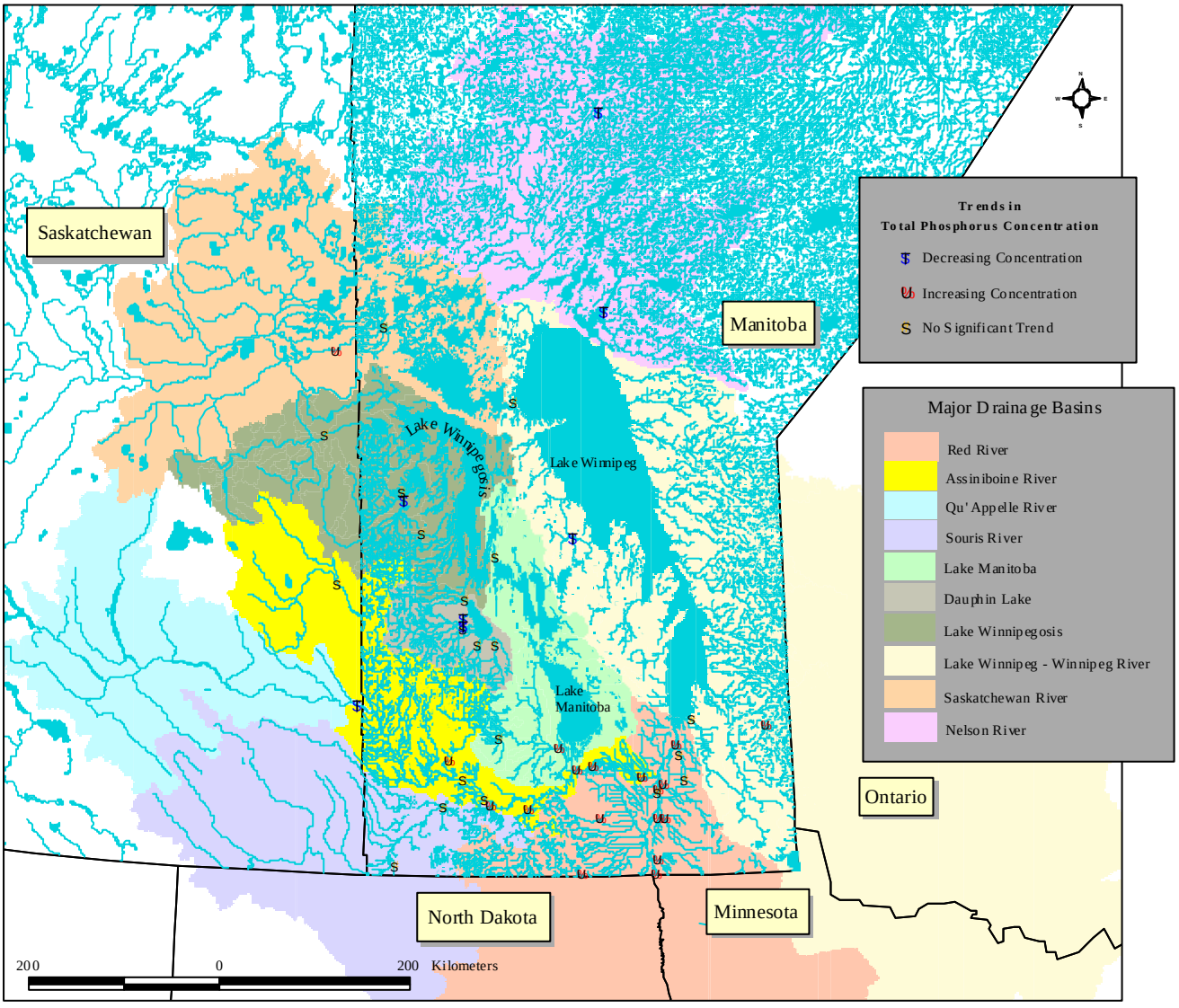
Stream	Sample Station	Station Location	Total Nitrogen		Total Phosphorus	
			Trend	% Change in Median	Trend	% Change in Median
Red River	MA05OC0001	At Emerson, MB	Not available		Increase (p=0.0108)	22.5
	WQ0367	At south gate of Winnipeg floodway, east of PTH #75	Increase (p<0.0001)	28.8	None (p=0.1487)	-
	WQ0142	At Selkirk Bridge, Selkirk, MB	Increase (p<0.0001)	57.8	Increase (p=0.0003)	28.8
La Salle River	WQ0068	Near bridge upstram of PTH #75 in St. Norbert, Winnipeg, MB	Increase (p<0.0001)	145.5	Increase (p=0.0043)	193.8
Boyne River	WQ0029	At bridge, one block west of PTH #13, Carman, MB	None (p=0.0940)	-	Increase (p=0.0016)	Not known
Pembina River	MA05OB0001	At Windygates, MB	Not available		Increase (p<0.0001)	52.1
Roseau River	WQ0153	At PR #200, Dominion City, MB	Increase (p<0.0001)	45.2	Increase (p<0.0001)	45.2
Rat River	WQ0131	At PR #303 at Otterburne, MB	None (p=0.0785)	-	Increase (p=0.0026)	Not known
Marsh River	WQ0365	At PR #303 , west of Otterburne, MB	Increase (p<0.0001)	113.8	Increase (p=0.0100)	65.9
Seine River	WQ0166	At south perimeter Hwy, Winnipeg, MB	Increase (p<0.0001)	74.9	Increase (p<0.0001)	187.7
Cooks Creek	WQ0644	At municipal road 1 km south of Millbrook, MB	Decrease (p=0.0219)	Not known	None (p=0.0929)	-
	WQ0643	At boundary of St. Clements and Springfield	None (p=0.3659)	-	None (p=0.2858)	-
Assiniboine River	SA05MD0001	At Kamsack, SK	Not available		None (p=0.0777)	-
	WQ0009	At 18th Str. Bridge, Brandon, MB	Increase (p=0.0147)	12.7	None (p=0.2290)	-
	WQ0012/WQ0636	At PR #340 at Treesbank Ferry/At PR #340upstream of Treesbank, MB	None (p=0.0720)	-	None (p=0.0654)	-
	WQ0014	Downstream of WTP reservoir at Spillway Park, Portage la Prairie, MB	Increase (p=0.003)	20.5	Increase (p<0.0001)	39.6
	WQ0015	At Trans-Canada Hwy bridge east of Portage la Prairie, MB	Increase (p=0.0165)	36.5	Increase (p<0.0001)	39.6
	WQ0018	At PR #334, south of Headingley, MB	Increase (p<0.0001)	54.5	Increase (p<0.0001)	62.2
Little Saskatchewan River	WQ105	At PTH #25 bridge, near Rivers, MB	Decrease (p<0.0001)	-28.2	Increase (p=0.0018)	39.3
Cypress River	WQ398	On municipal road east of Cypress River, MB	Increase (p<0.0001)	66	Increase (p<0.0001)	189.7
Souris River	MA05NF0001/US05NFH 0001	At Coulter, MB/at Westhope, ND	Not available		None (p=0.3351)	-
	WQ0371	At PTH #22 bridge in town of Souris, MB	Increase (p<0.0024)	25.9	None (p=0.1147)	-
	WQ0350	At PR #530 near Treesbank, MB	Increase (p<0.0001)	45.2	Increase (p<0.0001)	51.4
Qu' Appelle River	SA05JM0014	Near Welby, SK	Not available		Decrease (p<0.0001)	-40.4
Brokenhead River	WQ0038	At PTH #59 bridge, southeast of Scanterbury, MB	None (p=0.2915)	-	None (p=0.0999)	-
Winnipeg River	MA05PF0022	At Pointe Du Bois, MB	Not available		Increase (p<0.0001)	29.4

Summary results of trend analysis performed on TN and TP data from long-term monitoring sites in Manitoba streams (cont.)

tream	Sample Station	Station Location	Total Nitrogen		Total Phosphorus	
			Trend	% Change in Median	Trend	% Change in Median
Boggy Creek - Whitemud	WQ0201	At PTH #16 at Neepawa, MB	Increase (p<0.0001)	35.8	None (p=0.2549)	-
	WQ0197	At PTH #16 at Westbourne, MB	Increase (p<0.0001)	36.5	Increase (p<0.0001)	64.4
Turtle River	WQ0245	At PTH #5 at Ste. Rose Du Lac, MB	None (p=0.8014)	-	None (p=0.3436)	-
Ochre River	WQ0227	At PTH #5 near town of Ochre River, MB	None (p=0.6226)	-	None (p=0.4483)	-
Vermillion River	WQ0252	At PTH #20 north of Dauphin, MB	None (p=0.1952)	-	None (p=0.0518)	-
Wilson River	WQ0255	At PTH #20 north of Dauphin, MB	Increase (p=0.0345)	21.3	Decrease (p=0.0321)	-13.5
Valley River	WQ0250	At PTH #20 north of Dauphin, MB	Increase (p=0.0027)	16.4	Decrease (p=0.0350)	-9.6
Mossy River	WQ0390	At continuation of PR # 273, approximately 3.2 km east of PTH #20	Increase (p<0.0001)	37.4	None (p=0.1423)	-
North Duck River	WQ0217	At PTH #10 near Cowan, MB	None (p=0.2045)	-	None (p=0.4660)	-
Swan River	WQ0244	At PR #268 near Lenswood, MB	Decrease (p=0.0322)	Not known	Decrease (p=0.0148)	Not known
Woody River	WQ0259	At PR #268	Not available		None (p=0.3065)	-
Red Deer River	SA05LC0001	Near Erwood, SK	Not available		None (p=0.1443)	-
Waterhen River	WQ0561	At PR #328 near Waterhen, MB	Increase (p=0.0279)	19.1	None (p=0.0540)	-
Dauphin River	WQ0404/MA05LM0005	Upstream of Anama Bay, MB	Not available		Decrease (p<0.0001)	-45.8
Saskatchewan River	MA05KH0001	Above the Carrot River in Manitoba	Not available		None (p=0.1012)	-
	WQ0163/MA05SH0001	Below Grand Rapids, MB	Not available		None (p=0.3654)	-
Carrot River	SA05KH0002	Near Turnberry, SK	Not available		Increase (p=0.0466)	19.7
Nelson River (east	WQ0049	At Norway House, MB	None (p=0.1935)	-	Decrease (p=0.0013)	-20.6
Burntwood River	WQ0093	At bridge on PTH #6, Thompson, MB	Decrease (p<0.0001)	-24.1	Decrease (p<0.0001)	-43.8



Map showing long-term trends in TN concentration at stream water quality monitoring stations in Manitoba. (Note the period of record often varied between sites. Refer to text for details.)



Map showing long-term trends in TP concentration at stream water quality monitoring stations in Manitoba. (Note the period of record often varied between sites. Refer to text for details.).