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Summary of Resources and Land Use Issues Related to Riparian Areas in the Lake Manitoba Watershed Study Area

Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration
(AAFC-PFRA)
Winnipeg, MB

2005

Canada

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Manitoba Rural Adaptation Council Inc.
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Preface

This report is one of a series of watershed summary reports completed for the Agriculture Environmental Sustainable Initiative's Riparian Areas: Planning and Priority Setting project. Due to scale and data accuracy limitations, these reports do not replace the need for site-specific analysis; rather, they serve as a generalized guide for overall planning purposes on a watershed basis. These reports are available in .pdf format on the Manitoba Riparian Health Council's website (www.riparianhealth.ca), or can be obtained by contacting:

Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration
Prairies East Region,
200-303 Main Street
Winnipeg, Mb
R3C 3G7
Tel: (204)983-2243
Fax: (204)983-2178

Citation:
Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration, Prairies East Region. 2004. Summary of Resources and Land Use Issues Related to Riparian Areas in the Lake Manitoba Watershed Study Area. Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration, Winnipeg.

Acknowledgements:
Funding for this project was provided by the Manitoba Rural Adaptation Council. The following individuals from AAFC-PFRA contributed significantly to the compilation, interpretation and derivation of the information contained in this report.

Professional expertise was provided by:
P. Michiels, T. Horechko, J. Fitzmaurice, J. Powers, R. Lewis, T. Scott, N. Mischuk, J. Tokarchuk

Technical support was provided by:
C. Wyrzykowski, K. Gottfried, R. Aquino, S. Garrick, S. Solivar, J. Bergthorson, N. Diehl, R. Rosario

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Background

Riparian areas play an important role in surface water quality and their ability to carry out this function can be affected by anthropogenic activities on the landscape. Agriculture is only one component, with other human activities such as industry, recreation and residences contributing to degraded riparian areas. The intent of this report is to be a first step towards addressing the issue of riparian health, with respect to agriculture, in the Watershed Study Area. By providing information on the land resources and the agricultural activities in the study area, a better understanding of the issue can be obtained which will assist towards better planning and priority setting by local decision makers, land use planners and policy decision-makers. While this reports studies the agricultural aspect of the Watershed Study Area, in a true watershed study, all factors of activities of all sectors must be considered.

This project is a component of the Agriculture and Agri-Food Canada – Prairie Farm Rehabilitation Administration (AAFC-PFRA) Agricultural Riparian Areas: Planning and Performance Monitoring project. Funding was provided by the Manitoba Rural Adaptation Council (MRAC), through the Agricultural Environmental Stewardship Initiative (AESI). The purpose of this project is to provide a central source of riparian-related resource information in a format that is easily accessible to land use planners and policy decision-makers. The information provided can assist in strategic planning for riparian areas in Manitoba. Through the identification of potential problem areas, decision makers can make informed land use decisions that target priority areas.

As part of the Agricultural Riparian Areas: Planning and Performance Monitoring project, AAFC-PFRA has collected, analyzed, and displayed riparian-related data using an Internet Map Server (IMS). The IMS web server is designed to be a one-stop source of riparian-related data and information relevant for analysis, land-use planning, and program design. The IMS site is available under the tools menu on the Riparian Health Council website (*www.riparianhealth.ca*).

The Riparian Health Council (RHC) is comprised of government and non-government agencies with an interest in increasing producer involvement and improving the coordination of cooperative efforts among agencies that develop riparian projects with landowners throughout Manitoba. The Council has developed a vision for cooperative programming that enhances riparian areas and surface water quality across agro-Manitoba while also supporting landowner needs. This project will provide information which can assist the RHC in achieving its vision.

The boundaries used in this report are based on the watershed layer produced by a joint venture between Manitoba Conservation and AAFC-PFRA. For reporting purposes, water flow direction data was used to amalgamate individual sub-watershed units into larger sub-watershed and watershed groups (refer to Appendix D). Due to scale and data accuracy limitations, neither this report nor the information and data provided on the RHC website can replace the need for site-specific analysis. However, these information sources can serve as a guide for general watershed planning purposes.

Importance of Riparian Areas

Although riparian areas occupy only a small percentage of the area of a watershed, they represent an extremely important component of the overall landscape. They are the transitional areas between the aquatic and surrounding upland area. These “green zones” are one of the most ecologically diverse ecosystems. A healthy riparian area can perform a number of ecological functions, including trapping sediment, building and maintaining streambanks, storing floodwater and energy, recharging groundwater, filtering and buffering water, reducing and dissipating stream energy, maintaining biodiversity and creating primary productivity. These functions are essential for sustaining a majority of fish and wildlife species, maintaining functioning watersheds, providing good water quality, forage for livestock and supporting people on the landscape. Disturbance and alteration of a riparian area will impact its ability to carry out these ecological functions. Impacted riparian areas will have a reduced capacity to trap and store sediment and nutrients and stabilizing streambanks (important for surface water quality), provide fish and wildlife habitat, etc.

Recognizing that many sectors contribute to the alteration of riparian areas, including agriculture, recreation, urban and residential development, and forestry, this report will focus on the agricultural impacts to riparian areas in an attempt to provide information that can be used by the agricultural industry to begin to address the issue of riparian health.

Watershed Overview

The Lake Manitoba Watershed Study Area is approximately 725,851 ha in size and is comprised of twelve sub-watershed units (refer to Figure 1.0). The area is drained by numerous small streams, creeks and drains, including the Mud Lake and Hatchery Drains which are located east of Lake Manitoba. There are also many lakes present in this watershed area, including the Shoal Lakes, Dog Lake and Lonely Lake. Other contributors to Lake Manitoba include the Whitemud River Watershed, draining 741,396 ha of southern Manitoba, and the Portage Diversion, a structure used to divert water from the Assiniboine River to Lake Manitoba during periods of high water flow empties (located west of Delta Beach). Numerous wetlands and prairie potholes are also located within the watershed, including Delta Marsh, one of the largest lacustrine marshes in North America.

Minor changes in elevation occur throughout the watershed, with values ranging from 317 metres above sea level (masl) in the west, down to 238 masl in the Oak Point area (refer to Figure 2.0). An area of lower elevation is seen along the shores of Lake Manitoba.

At the time of this report, part of this watershed area is served by two Conservation Districts. The Alonsa Conservation District covers the western portion of the watershed, while the La Salle-Redboine Conservation District covers the south-eastern two sub-watersheds. The remaining area is outside the boundaries of an existing conservation district. There are thirteen Rural Municipalities (RMs) present within the watershed boundary and include Lakeview, Woodlands, Siglunes, Alonsa and Eriksdale (refer to Figure 3.0). The entire RM of Coldwell and St. Laurent are also present in this watershed area. Two First Nation Reserves are present in the Lake Manitoba Watershed Study Area: the Ebb and Flow and the Sandy Bay First Nation Reserves, which cover a total of 11,006 ha. St. Ambroise Provincial Park, located on the south east shore of Lake Manitoba, is popular for its bird-watching, beaches and camping. The Delta Marsh is located along the southern shore of Lake Manitoba, where the Delta Marsh Field Station, a 932 ha research and teaching facility of the University of Manitoba, is present. The population in the watershed is predominantly rural and/or farm-based. Larger towns and communities within the watershed include Lundar, St. Laurent, Alonsa and Amaranth, with a slightly greater population densities living on the Ebb and Flow and the Sandy Bay First Nation Reserves. The RM of St. Laurent sees a population increase in summer, with the influx of cottagers utilizing the water-based activities of Lake Manitoba. Agriculture comprises the basis for the local economy within the watershed, with an emphasis on cattle production and ranching in the RMs of Coldwell, Siglunes, Eriksdale and Alonsa. St. Ambroise Provincial Park and Delta Beach and Marsh also bring an important source of tourism revenue to the region.

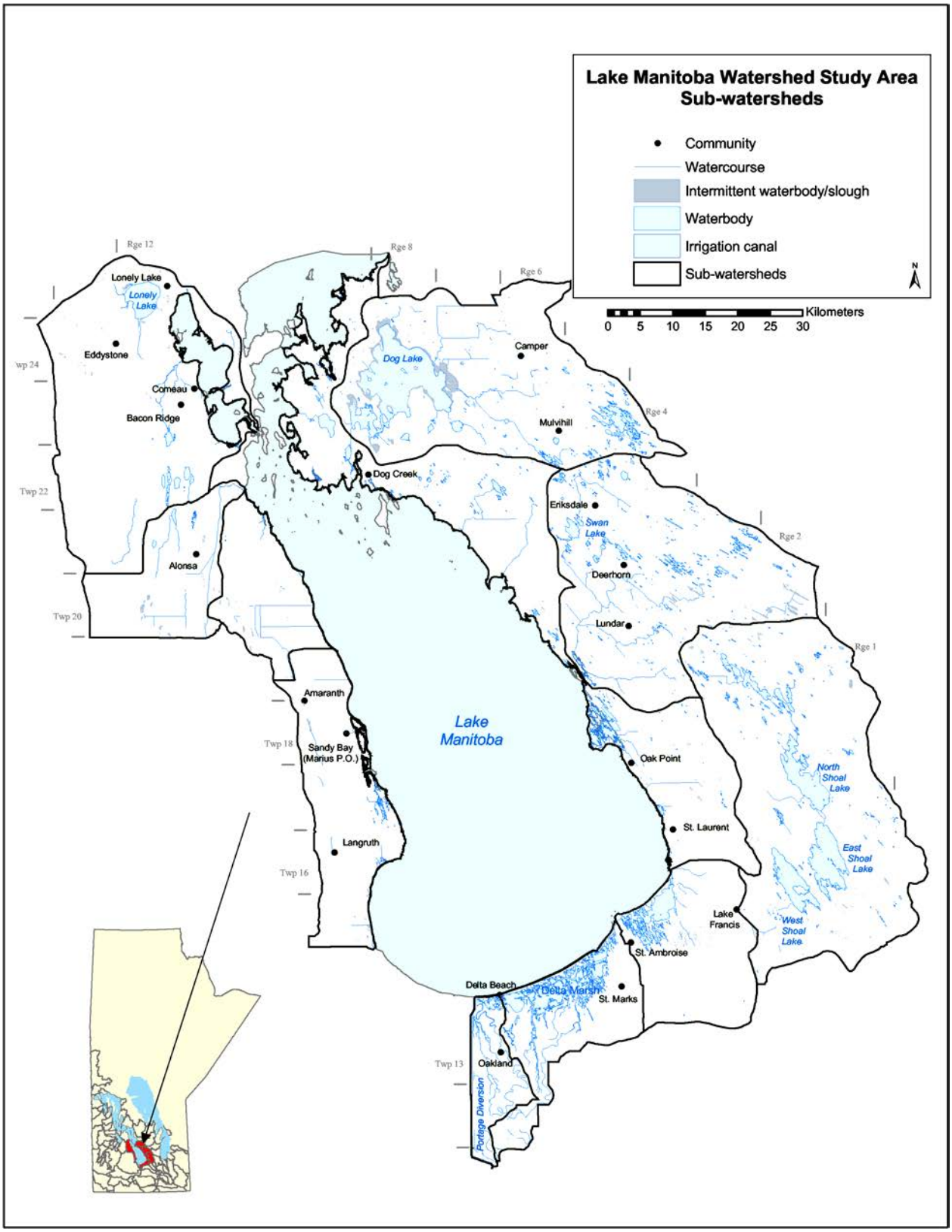

Figure 1.0 Sub-watersheds within the Lake Manitoba Watershed Study Area (water shown at 1:50,000 scale)

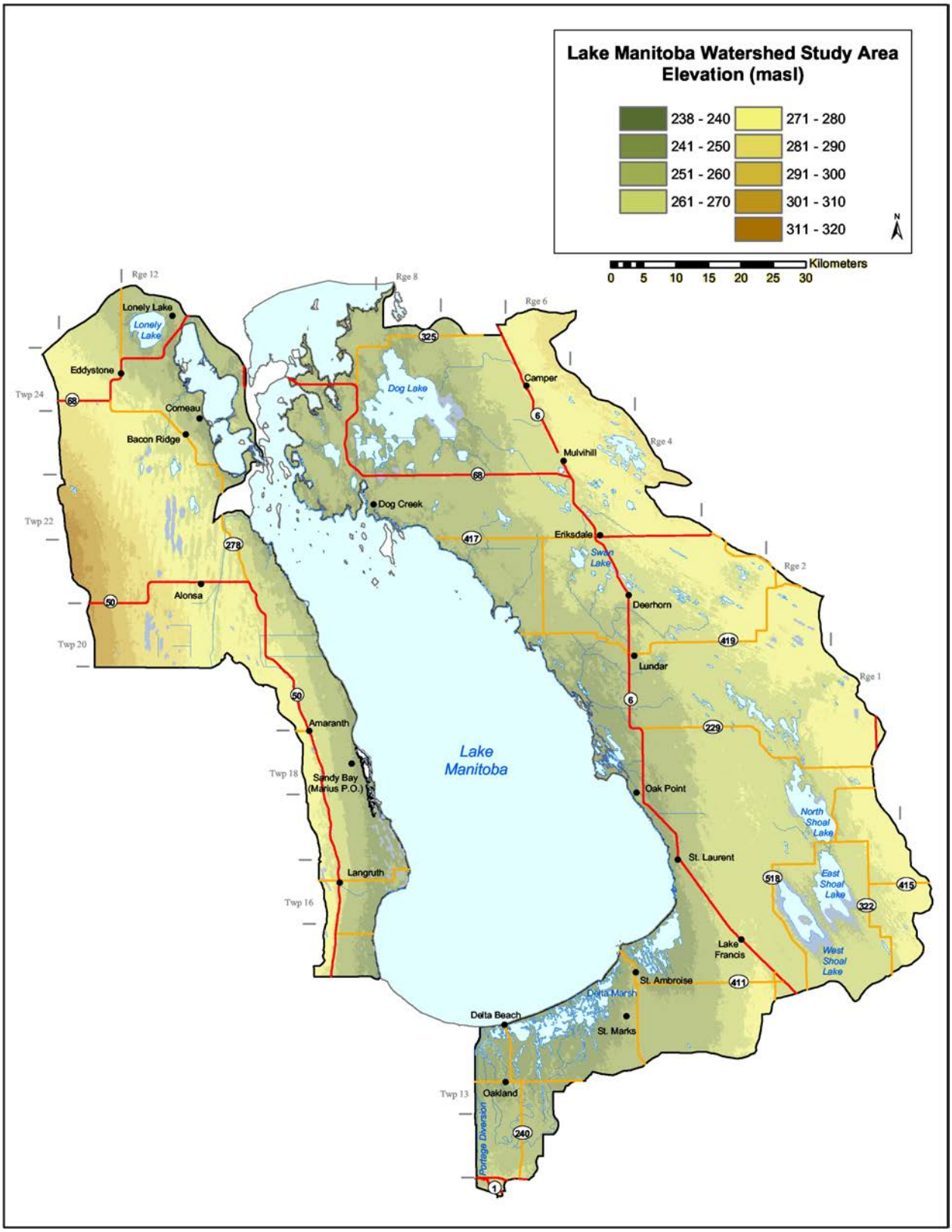

Figure 2.0 Digital elevation model of the Lake Manitoba Watershed Study Area (radar image was obtained by the Shuttle Radar Topography Mission, 2000)

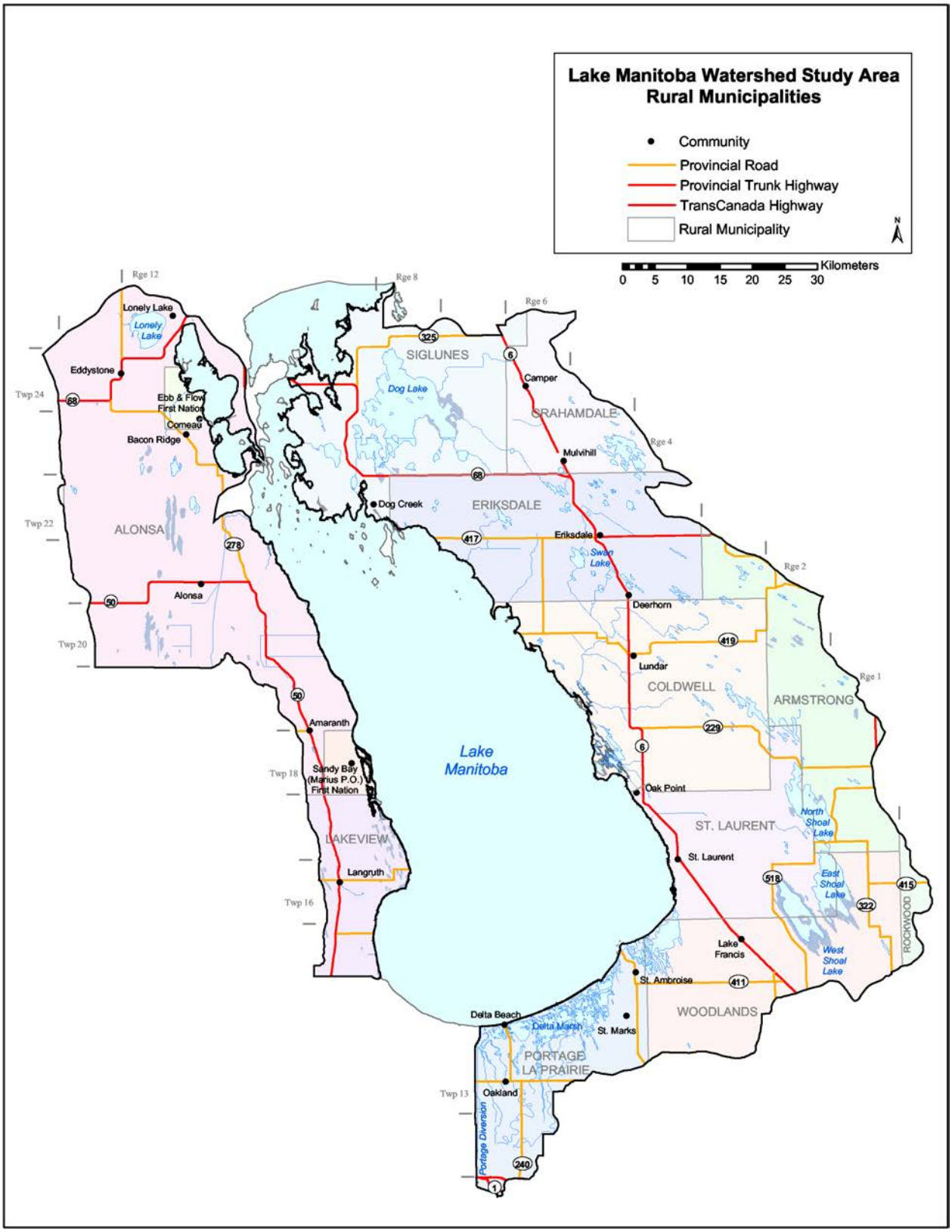

Figure 3.0 Rural municipalities in the Lake Manitoba Watershed Study Area

Climate & Ecology

The Canadian Ecological Land Classification System divides Canada's natural landscapes into terrestrial ecozones, which are further sub-divided into ecoregions and ecodistricts. The classification system was developed by integrating surface vegetation cover, underlying geology, physiography, soils, and climate data (Smith et al. 1998).

Ecozones, the most generalized level in Environment Canada's ecological land classification system, are defined by Smith et al. (1998) as "areas of the earth's surface representative of very generalized ecological units that consist of a distinctive assemblage of physical and biological characteristics". Ecoregions are broad, integrated map units characterized by a unique combination of landscape physiography and ecoclimate. Ecodistricts are integrated map units characterized by relatively homogeneous physical landscape and climatic conditions and they contain Soil Landscapes of Canada polygons nested within them (Smith et al. 1998).

The vegetation of this watershed varies based on ecoregion characteristics. In some areas, much of the vegetation has been cleared or strongly influenced by agriculture, with some native vegetation remaining (Smith et al. 1998). The native vegetation of the Alonsa Ecodistrict consists of a mixture of trembling aspen groves and grassland. The wetter sites support balsam poplar, mixed with aspen and associated shrubs of beaked hazelnut, pincherry, saskatoon and red-osier dogwood. Herbs of the area include sweet scented bedstraw and sarsaparilla and grasses include big and little bluestem and wild rye. River flats are found to contain white elm, green ash, Manitoba maple, basswood and willow. The vegetation of the Ste. Rose Ecodistrict reflects the moist conditions of the area. Areas of improved drainage are composed of trembling aspen, with some balsam poplar, willows and grass species. Wetter areas contain much of the same, as well as sedges and reed and meadow grasses, which occur in the peat lands of the regions also. A large part of the Lundar Ecodistrict is made up of imperfectly drained land, mostly covered in sedge and willow, with some salt tolerant species in saline areas. Many of the original trembling aspen stands in the district have been impoverished by cattle grazing and shrub fires. The poorly-drained areas of the Lundar Ecodistrict host slough grass, reed and sedge vegetation. The Langruth and Portage Ecodistricts naturally consisted of meadow and tall grass communities, respectively, both containing small areas of trembling aspen and balsam poplar. The forested areas of the Portage Ecodistrict host species such as white elm, green ash, Manitoba maple and basswood. This area encloses Delta Marsh, which is close to its natural state, other than the alterations caused by the Lake Manitoba flood control structures, Vegetation includes reeds, willow, Manitoba maple, associated herbs, and poplar on beach ridges. The Ashern Ecodistrict contains much of the same vegetation as the rest of this watershed, in addition to some tamarack, swamp birch and mosses in its bog and peatland areas.

Despite weather similarities within the watershed, localized temperature and precipitation variations exist. Based on climate data for the ecoregions within the Lake Manitoba Watershed Study Area, mean annual precipitation ranges from 451 to 531 mm, while mean annual temperature ranges from 1.1 to 2.5 °C (refer to Table 1.0). The

average number of growing season days ranges from 175 to 183 and the average number of growing degree days ranges between 1600 and 1720. Mean annual moisture deficit ranges between 100 and 200 mm (Ecoregions Working Group 1989). These parameters provide an indication of moisture and heat energy available for crop and vegetation growth and generally are sufficient for good growth of a range of crops adapted to the prairies.

Table 1.0 Climate data for ecoregions within the Lake Manitoba Watershed Study Area

Ecozone	Ecoregion	Mean Annual Air Temp (°C)	Mean Growing Season (days)	Mean Growing Degree Days	Mean Annual Precipitation (mm)	Mean Annual Moisture Deficit (mm)
Boreal Plains	***Interlake Plain***	1.2	175	1500	510	100
Prairies	***Lake Manitoba Plain***	1.1-2.5	177-183	1600-1720	451-531	100-200

Note: Climate data is based on eco-climatic data (Ecoregions Working Group, 1989)

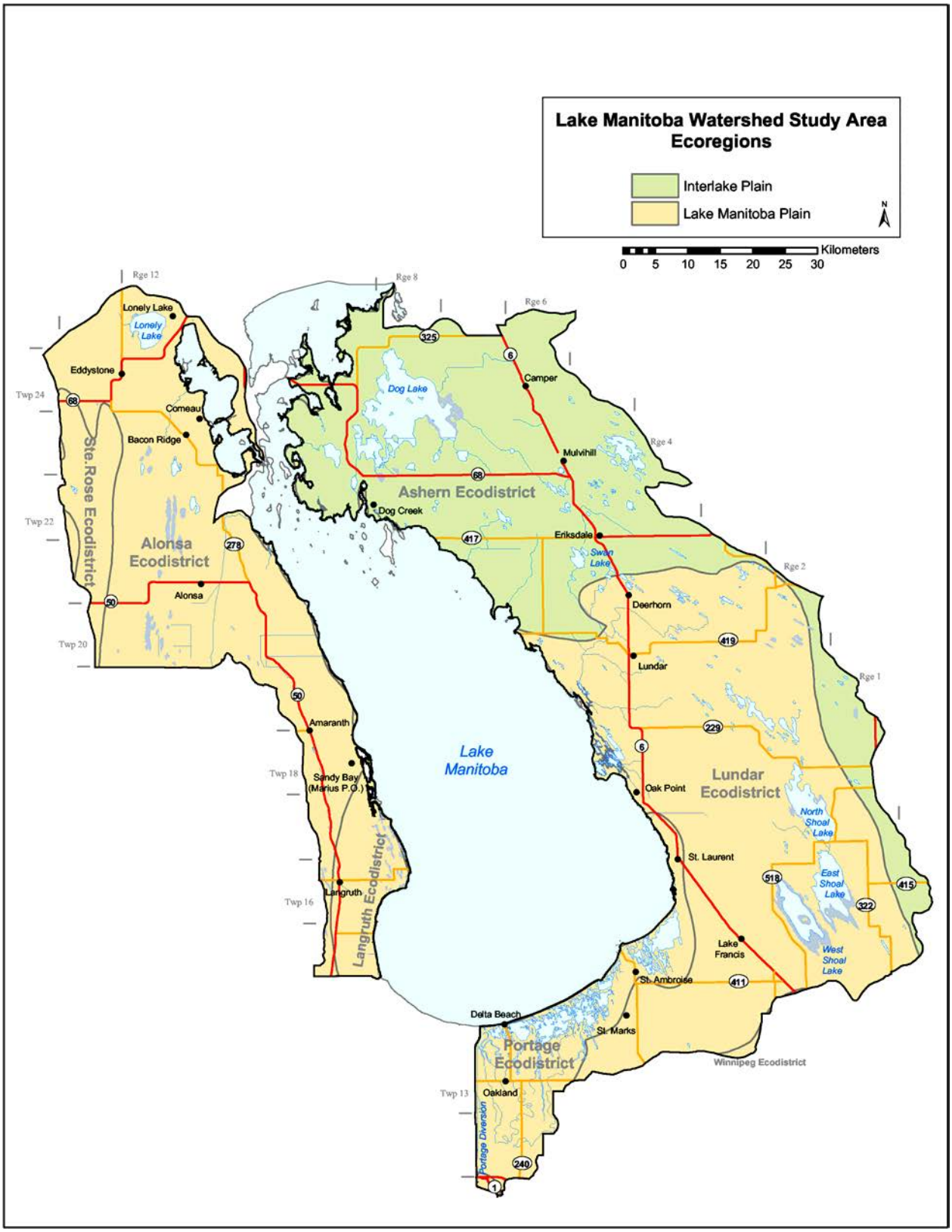

Figure 4.0 Ecoregions and ecodistricts in the Lake Manitoba Watershed Study Area

Water Resources

Hydrology

Water within the Lake Manitoba Watershed Study Area drains into Lake Manitoba (with the exception of the Shoal Lakes area), and is fed by various streams, creek and ditches of the surrounding area. There are also many lakes and marshes present, which drain local areas and eventually feed into Lake Manitoba. The Whitemud Watershed and Portage Diversion also drain into Lake Manitoba. Based on the 1:50,000 National Topographic Series (NTS) data sheets, the watershed contains approximately 1,771 km of river and stream shoreline (both sides of the waterways are included in the calculation), and 3,500 km of waterbody shoreline (both permanent and intermittent waterbodies included). The length of waterbody shoreline will be underestimated due to the fact that numerous small wetlands and potholes are not captured in the NTS data sheets. A more detailed survey was carried out by Ducks Unlimited Canada (DUC) in the mid 1980's using LANDSAT Imagery. According this habitat inventory, total area of wetlands in the study area was four times of that found in the NTS sheets. Therefore, in reality, total length of shoreline will be much higher.

Water Quality

Nutrient loading is an important concern with many large and small streams throughout Manitoba. As a result, Manitoba Conservation has developed a long-term nutrient management strategy for surface waters in Manitoba. A comprehensive trend analysis using existing water quality data has been done to detect temporal trends in nutrient concentrations in the streams and rivers in Manitoba (Jones and Armstrong 2001). Long term water quality data, however, is not available for any areas within this watershed. With the large number of lakes, rivers, streams and drains present in the watershed, as well as the contributions from the Whitemud Watershed and Portage Diversion, there is the potential for impacts on the water quality of the area, which would affect the drinking and surface water quality of many communities. Future monitoring should to be considered.

Wetlands and potholes are prevalent throughout the study area. Wetlands have an important function on the landscape. They are natural water filters; the soil and the plants in a wetland absorbs chemicals, nutrients, sediments and other impurities from the water as it passes through. In the Lake Manitoba Watershed Study Area, according to the DUC Habitat Inventory, there were over 63,000 wetlands in 1986 (of which 74% are under 1 ha in size). The trend, though, has been to drain wetlands for improved crop production. This loss of filtering capacity has consequences with respect to surface water quality in the lakes and rivers of Manitoba.

Land Cover

The land cover classification of the watershed has been interpreted from LANDSAT satellite imagery (which has a 30 metre resolution), using computerized classification techniques. Individual spectral signatures were classified and grouped into the seven land cover classes: annual crop land, forage, grassland, trees, wetlands, water, urban and transportation (refer to Appendix A for land cover class descriptions). Figure 5.0 provides a general representation of the 2000-2 land cover within the watershed (note that the northern part of the watershed was analyzed using imagery taken June 6, 2002, the eastern region with imagery taken August 2, 2001, the southern section with imagery taken September 3, 2001, and the western and Dog Creek areas with imagery taken May 18, 2000).

Land cover in the watershed is primarily trees and grassland. Based on 2000-2 land cover data, 30% (218,001 ha) of land within the watershed was classified as trees, while another 35% (255,688 ha) was identified as grassland (refer to Table 2.0, Figure 5.0). Wetlands also covered much of the watershed area, roughly 15% (111,229 ha), and were found throughout the watershed, with an increased presence around the Delta Marsh and north of Oak Point. Annual crop land covered about 8% of the study area.

Land cover information is also available from 1993-4 satellite imagery taken September 6, 1994 for the northern part of the watershed, October 26, 1994 for the eastern and southern regions, and May 5, 1993 for the western and Dog Creek areas (refer to Figure 6.0). Comparison between the two datasets can result in the emergence of general trends in land cover of the seven-year period, though this will be a rough estimate due to factors such as time/season of satellite image capture, climatic variability and classification requirements.

Comparison of this imagery with that taken in 2000-2 shows a substantial change in forage cover, with an 85% increase in land converted to forages (refer to Table 2.0). There was a small increase in annual crop land by approximately 3% during this time. Wetland and open water classifications showed a slight decrease in area though this may be over estimated due to:

- Precipitation amounts - Records from Environment Canada indicate that total precipitation at the weather station in Portage la Prairie were slightly lower in 2001, as compared to 1994. Conversely, the Alonsa station showed a mean increase of 164 mm in 1993 as compared to that from 2000.
- Classification effort -- The 1993-94 image classification concentrated specifically on annual cropland to aid in delivery of the Western Grains Transportation Payment Program. Greater attention was paid to all classification categories on the 2000-2 image classification.

Due to the small size, and tightly integrated nature of wetlands with other land cover categories such as grasslands and shrubs, they can be very difficult to quantify using course resolution imagery. A Prairie Habitat Joint Venture Habitat Monitoring Program coordinated by the Canadian Wildlife Service provides a detailed evaluation of wetland habitat trends in targeted areas of the prairies. Preliminary analysis indicated that in the

targeted areas in Manitoba, there has been a net change of -3.0% in wetland areas from 1985 to circa 2000.

Table 2.0 Land cover (2000-2) and general trend since 1993-4 in the Lake Manitoba Watershed Study Area

Class	Area[1] (ha)	Percent of Watershed	Change in Area (ha)	Percent Change Since 1993-4[2]
Annual Crop Land	57,204	7.9	1,765	3.2
Trees	218,001	30.0	14,558	7.2
Water	45,954	6.3	-3,140	-6.4
Grassland	255,688	35.2	-18,018	-6.6
Wetlands	111,229	15.3	-6,825[3]	-5.8[3]
Forages	25,568	3.5	11,762	85.2
Urban/Transportation	12,199	1.7	83.4	0.7
Total	725,842	100	--	--

1. Area totals are approximate due to the nature of the image analysis procedure
2. Negative changes indicate area has decreased since 1993-4, positive indicates an increase.
3. Due to seasonal changes in wetland size, date of imagery will affect change calculations.

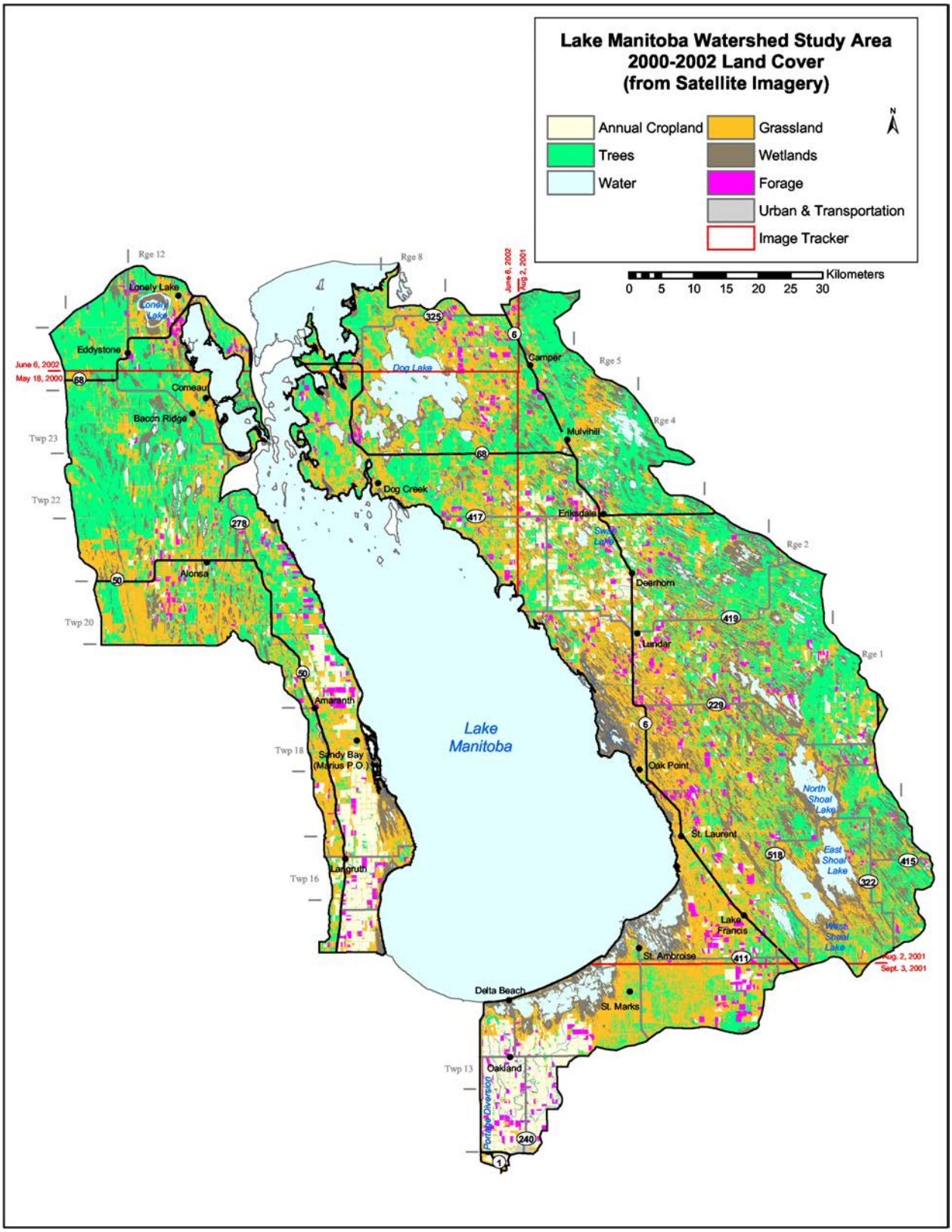

Figure 5.0 2000-2 Land cover in the Lake Manitoba Watershed Study Area

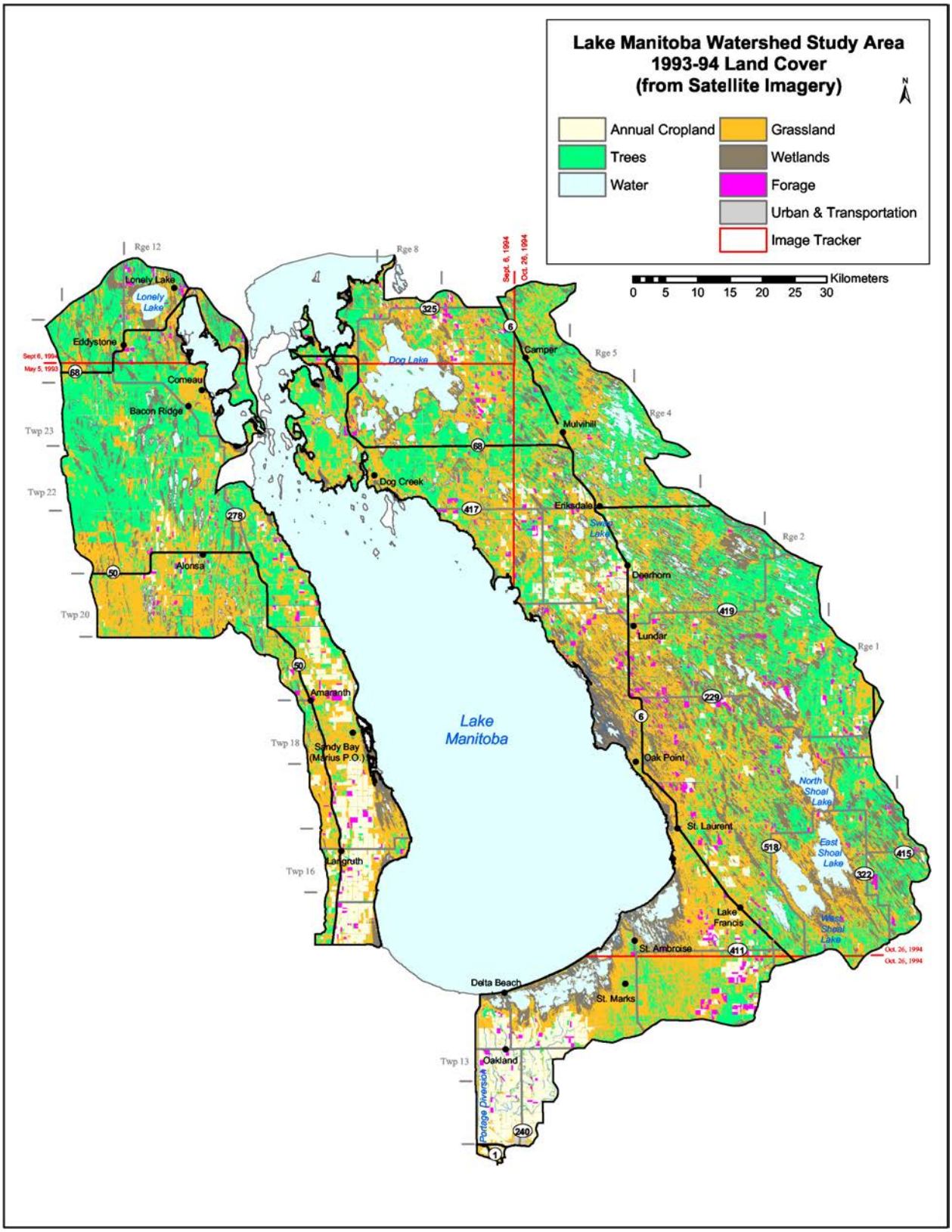

Figure 6.0 1993-4 Land cover in the Lake Manitoba Watershed Study Area

Soil Resources

Soils data is a critical component of land-use planning. Soil characteristics can be used to determine agricultural capability and to predict risks of erosion, leaching, and run-off. This type of information is important for determining suitable land uses, identifying sensitive areas, and targeting land-use improvement efforts. In terms of riparian health, analysis of soil characteristics can help to identify soils at high risk for erosion and run-off that could contribute to riparian degradation.

Soils data is available for all areas within the watershed. The soils data used in this report was mapped at a detailed scale of 1:20,000 for parts of the eastern shoreline of Lake Manitoba, the western Interlake. The remaining area was mapped at reconnaissance scales of 1:100,000 or 1:126,720. Soil information provided in this report is based on the characteristics of the dominant soil series within the soils polygon. A more detailed and complete description of the type, distribution and textural variability of soils in the watershed can be found in the published soil surveys for the area.

The majority of the soils in this watershed were deposited during the last glaciation at time of Glacial Lake Agassiz. Most of the soils were created on water-worked glacial till. The Alonsa and Portage areas, and the south-west shores of Lake Manitoba contain thin, sandy lacustrine materials underlain by glacial till. The eastern shoreline of Lake Manitoba is characterized by cobbly, bouldery beaches and poorly-drained, marshy areas; while the area south of the lake contains poorly-drained soils and consists of mostly marsh and open water. The Dog Lake area also contains marshy areas, as well as some saline mineral soils.

The soils within the watershed vary, depending on surface textures and moisture. Chernozems are the most prevalent order in this watershed, with Black Chernozems found throughout most areas. Humic Gleysols, some with peaty surface layers, are found amongst the Chernozems in poorly-drained sites and along the Lake Manitoba shoreline. Dark Grey Chernozems are more common in the north-east portions of the watershed and along the eastern edge. The RM of St. Laurent also contains some Dark Grey Chernozems, as well as Brunisols, on better drained ridges. Eutric Brunisols and thin Luvisols are found in the north-eastern regions in better drained areas, while some Organic soils are found in the wetter areas. Black Chernozems are a fertile soil, characteristic of tall grasslands, while Dark Grey Chernozems characterize a grassland/forest transition zone. Brunisols and Luvisols are typically forest soils found in a variety of climates.

Soil Surface Texture

Soil surface texture strongly influences the soil's ability to retain moisture, its general level of fertility, and the ease or difficulty of cultivation. For example, water moves easily through coarse-textured (sandy) soils, so little moisture is retained and these soils dry out more quickly than fine-textured (clayey) soils. Sandy soils are often characterized by a loose or single-grained structure which is very susceptible to wind erosion. On the other hand, clay soils have a high proportion of very small pore spaces which hold moisture tightly. Clay soils are usually fertile because they are able to retain plant nutrients better than sandy soils. However, they transmit water very slowly and are therefore susceptible to excess moisture conditions.

The predominant soil surface texture within the watershed is fine loamy (75%) (refer to Table 3.0, Figure 7.0). Organic soils cover 11% of the land in the watershed and are found in pockets in the north-east, west and along the eastern edge of the study area. Sands and coarse loams occur to a greater extent in the western portion of the watershed, while clay soils are more common around the community of Oakland.

Table 3.0 Soil surface texture in the Lake Manitoba Watershed Study Area[1]

Class	Area (ha)[1]	Percent of Watershed
Clayey	10,733	1.5
Fine Loamy	545,441	75.2
Coarse Loamy	16,805	2.3
Sand	21,837	3.0
Coarse Sand	2,022	0.3
Organic	81,442	11.2
Rock	614	0.1
Saline Flats	39	0.005
Water	41,774	5.8
Unclassified	4,447	0.6
Total	725,152	100

1. Soil surface texture is based on the dominant soils series for each soil polygon

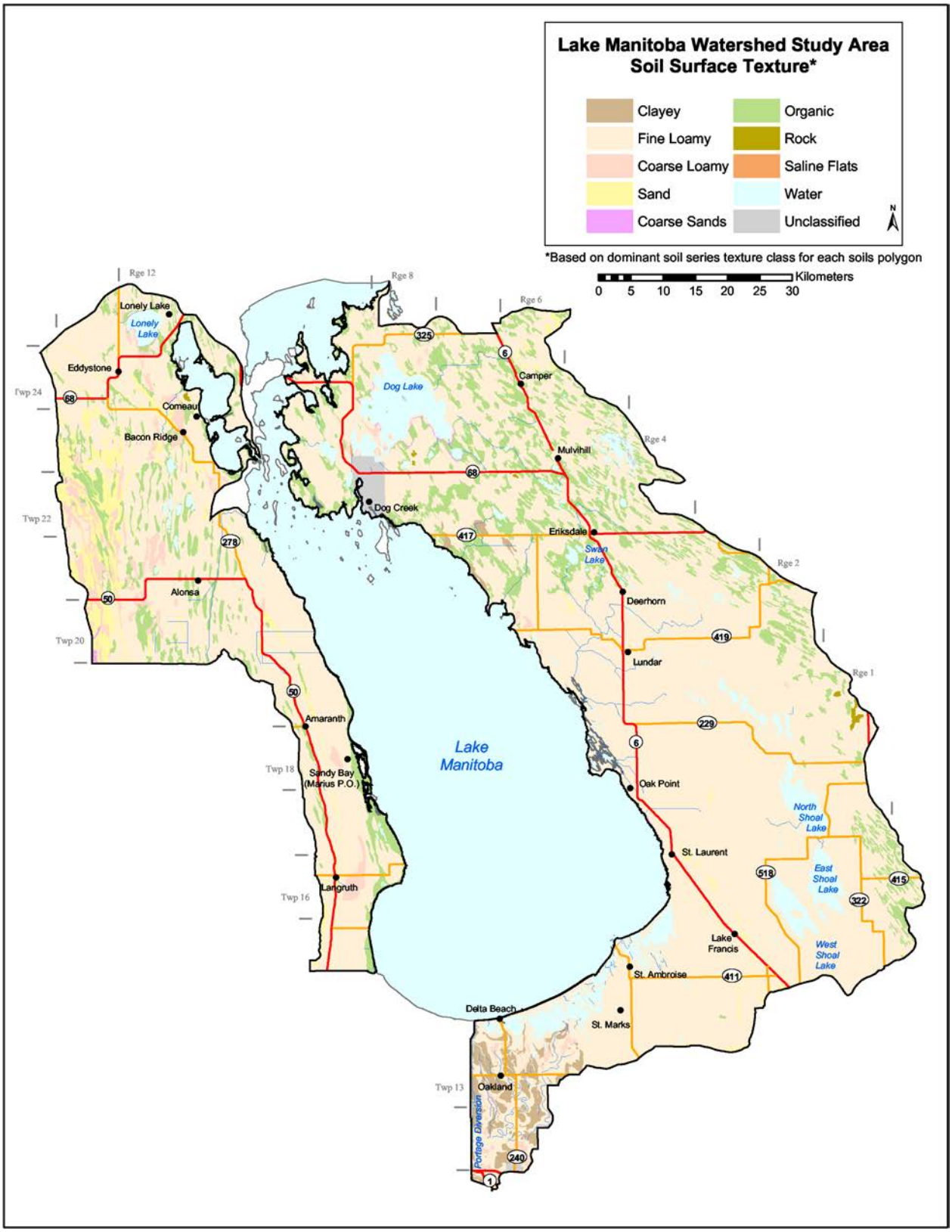

Figure 7.0 Soil surface texture in the Lake Manitoba Watershed Study Area

Soil Drainage

Soil drainage is described on the basis of actual moisture content in excess of field capacity and the length of the saturation period within the plant root zone. Excessive water content in the soil limits the free movement of oxygen and decreases the efficiency of nutrient uptake. Delays in spring tillage and planting are more frequent in depressional or imperfectly- to poorly-drained areas of a field. Surface drainage improvements and tile drainage are management practices that can be used to manage excess moisture conditions in soils. Agriculture and Agri-Food Canada's Land Resource Unit has divided soil drainage into five classes:

1) *Very Poor* - Water is removed from the soil so slowly that the water table remains at or on the soil surface for the greater part of the time the soil is not frozen. Excess water is present in the soil throughout most of the year.

2) *Poor* - Water is removed so slowly in relation to supply that the soil remains wet for a large part of the time the soil is not frozen. Excess water is available within the soil for a large part of the time.

3) *Imperfect* - Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly down the profile if precipitation is the major source.

4) *Well* - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying materials or laterally as subsurface flow.

5) *Rapid* - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep slopes during heavy rainfall.

Drainage classification is based on the dominant soil series within each individual soil polygon.

According to the drainage classes defined above, over 35% of the soils within the watershed are considered to be imperfectly-drained (refer to Table 4.0, Figure 8.0). Another 30% of the watershed is well-drained, mainly found west of Lake Manitoba and southeast of the town of St. Ambroise. Poor and very poorly-drained soils occur in almost 23% of the watershed, and are found spread throughout.

Table 4.0 Soil drainage classes for the Lake Manitoba Watershed Study Area[1]

Class	Area (ha)[1]	Percent of Watershed
Rapid	2,946	0.4
Well	212,606	29.3
Imperfect	255,943	35.3
Poor	80,276	11.1
Poor (Improved)	2,566	0.4
Very Poor	84,833	11.7
Water	41,774	5.8
Marsh	39,147	5.4
Rock	614	0.1
Unclassified	4,447	0.6
Total	725,152	100

1. Area has been assigned to the dominant drainage class for each soil polygon

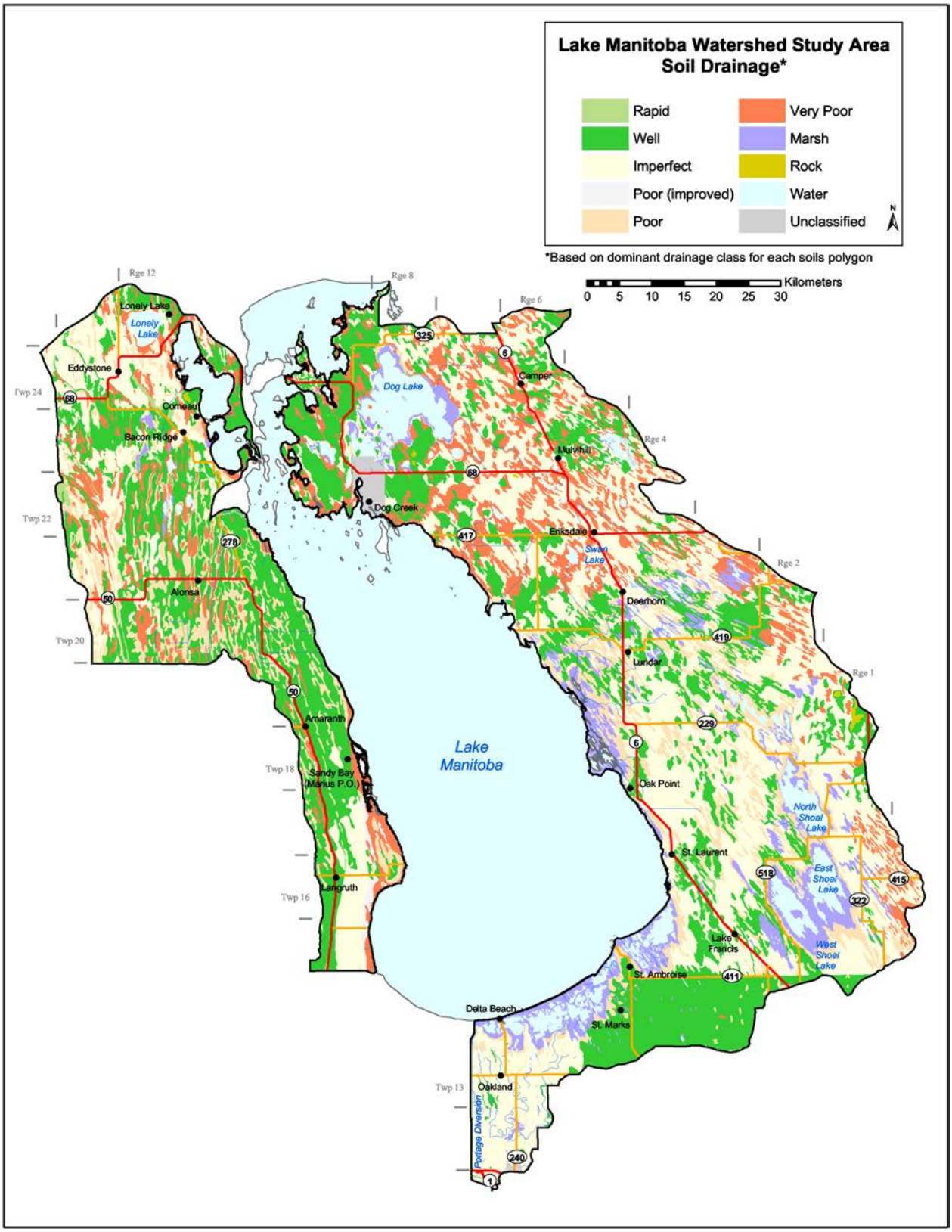

Figure 8.0 Soil drainage classes for the Lake Manitoba Watershed Study Area

Agricultural Capability

The Canada Land Inventory System (CLI) was used to classify land based on agricultural capability. The CLI is a comprehensive survey of land capability and use designed to provide a basis for making rational land-use planning decisions. Under the CLI, lands are classified according to physical capability for agricultural use. The system uses seven classes to rate agricultural capability, with Class 1 lands having the highest capability to support agriculture, and Class 7 the lowest. Table 6.0 provides a description of each class. Subclass descriptors are also used to identify specific limiting factors within each class (Table 7.0). The classes indicate the degree of limitation for mechanized agriculture imposed by the soil. The subclasses indicate the type of limitations that individually, or in combination with others, affect agricultural land use. The CLI classification assumes good land management and is independent of location, accessibility, ownership, distance from cities or roads, and the present use of the land (Natural Resources Canada 2000).

Table 5.0 Canada Land Inventory (CLI) class descriptions

Class #	Description
1	Soils in this class have no significant limitations in use for crops.
2	Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices.
3	Soils in this class have moderate limitations that restrict the range of crops or require special conservation practices.
4	Soils in this class have severe limitations that restrict the range of crops or require special conservation practices or both.
5	Soils in this class have very severe limitations that restrict their capability to produce perennial forage crops, and improvement practices are feasible.
6	Soils in this class are capable only of producing perennial forage crops, and improvement practices are not feasible.
7	Soils in this class have no capability for arable culture or permanent pasture
O	Organic soils

Source: Natural Resources Canada 2000.

Table 6.0 Canada Land Inventory (CLI) subclass descriptions

Subclass	Description
C	Adverse climate
D	Undesirable soil structure and/or low permeability
E	Erosion
F	Low fertility
I	Inundation by streams or lakes
M	Moisture limitations
N	Salinity
P	Stoniness
R	Consolidated bedrock
T	Topography
W	Excess water
X	This subclass is comprised of soils having a limitation resulting from the cumulative effect of two or more adverse characteristics

Source: Natural Resources Canada 2000

Figure 9.0 illustrates the classes of agricultural land found within the watershed. At this generalized map scale, subclass limitations could not be displayed. As Table 7.0 indicates, only 8% of the land within the watershed is productive agricultural land (Classes 1 to 3) and is mostly found south and southwest of Lake Manitoba (refer to Figure 9.0). More than half of the land is Class 4 land (54%), and is found throughout the watershed. Class 5 and 6 land (22% of the study area) is found in increased abundance on the west side of Lake Manitoba, while Class 7 land (6% of the study area) is found along the south shorelines of Lake Manitoba, the Shoal Lakes and Dog Lake. As indicated in Table 7.0, undesirable soil structure and stoniness are the main limitations in agricultural capability in the Class 4 land. Class 2, 5, 6 and 7 land is limited by excess water, while salinity can be a potential problem in Class 3 and 5.

Table 7.0 Agricultural capability in the Lake Manitoba Watershed Study Area [1] and the major type of limitations within each class.

Class	Subclass	Area (ha)	Percent of Watershed
Class 1		**6,995**	**1.0**
Class 2		**28,836**	**4.0**
	2M	*9,601*	*1.3*
	2W	*18,986*	*2.6*
Class 3		**19,754**	**2.7**
	3D	*3,231*	*0.4*
	3M	*7,197*	*1.0*
	3N	*4,876*	*0.7*
	3W	*2,721*	*0.4*
Class 4		**391,675**	**54.0**
	4DP	*389,223*	*53.7*
	4M	*2,005*	*0.3*
Class 5		**103,000**	**14.2**
	5M	*10,009*	*1.4*
	5P	*13,547*	*1.9*
	5W	*78,274*	*10.8*
Class 6		**56,740**	**7.8**
	6W	*54,481*	*7.5*
Class 7		**41,608**	**5.7**
	7W	*39,147*	*5.4*
Organic		**30,324**	**4.2**
Water		**41,774**	**5.8**
Unclassified		**4,447**	**0.6**
Total		**725,152**	**100**

1. Agricultural capability is based on the dominant soil series and slope gradient within each soil polygon

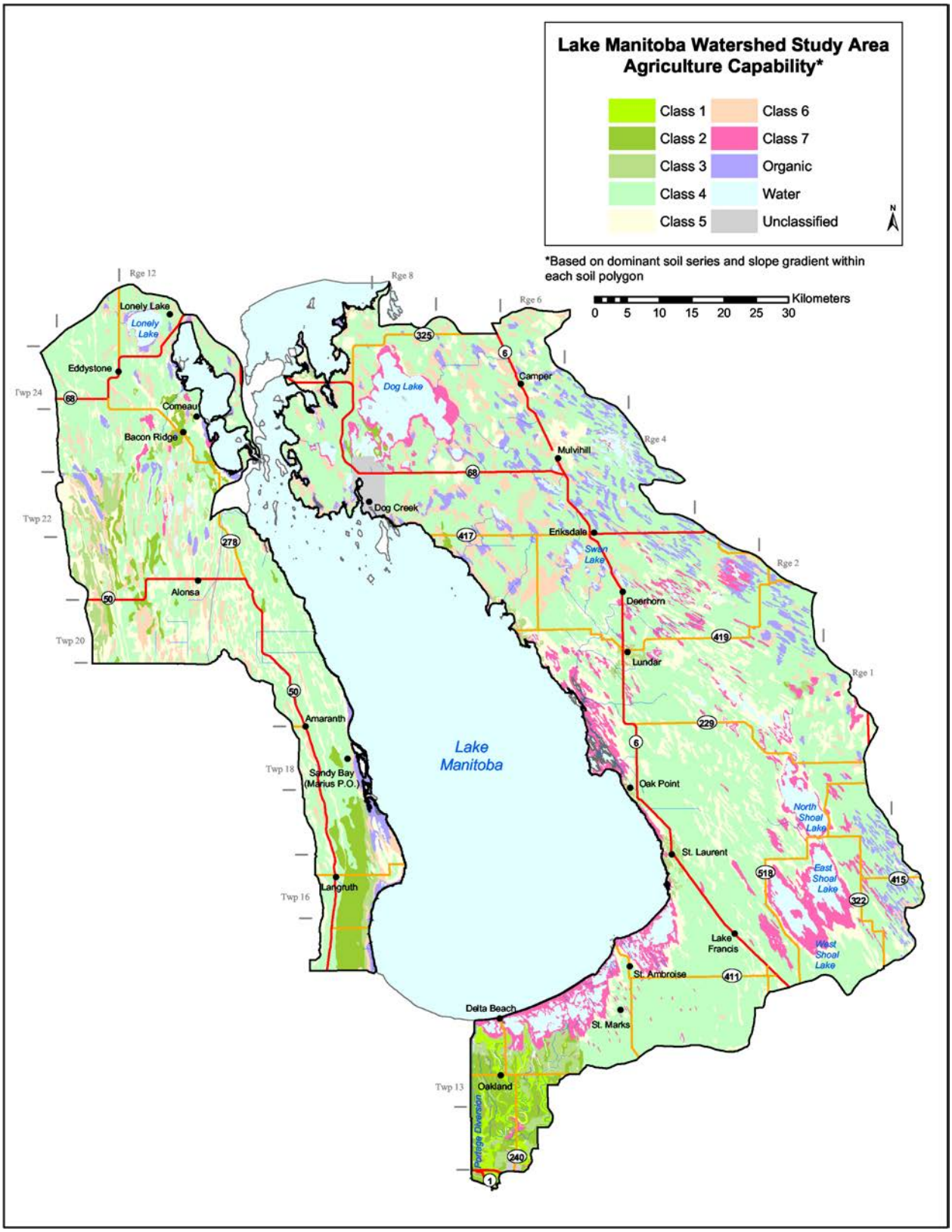

Figure 9.0 Agricultural capability class in the Lake Manitoba Watershed Study Area

Water Erosion Risk

The risk of water erosion was estimated using the Universal Soil Loss Equation (USLE) developed by Wischmeier and Smith (1965). The USLE predicted soil loss (tonnes/hectare/year) was calculated for each soil component in each soil map polygon. Water erosion risk factors used in the calculation include mean annual rainfall, slope length, slope gradient, vegetation cover, management practices, and soil erodibility (Eilers et al. 2002). Erosion risk classes were assigned based on the weighted average soil loss for each map polygon. The five classes of soil erosion risk (ranging from negligible to severe) are based on a bare, unprotected soil condition. However cropping and residue management practices can significantly reduce this risk depending on crop rotation, soil type, and landscape features. Basing the soil erosion risk on the bare soil case helps to identify areas dominated by sensitive, erosive soils which may otherwise be masked if a land use or surface vegetation cover factor was considered (Eilers et al. 2002).

According to the interpreted water erosion risk classification for soils, water erosion is not a concern within this watershed, with over 90% of the watershed rated with a low to negligible risk (refer to Table 8.0, Figure 10.0). Another 3% of the watershed is of moderate concern.

Table 8.0 Water erosion risk classes in the Pembina River Watershed Study Area [1]

Risk (tonnes/ha/yr)	Area (ha)	Percent of Watershed
Negligible (<6)	562,795	77.6
Low (6-11)	95,994	13.2
Moderate (11-22)	18,625	2.6
High (22-33)	1,517	0.2
Water	41,774	5.8
Unclassified	4,447	0.6
Total	725,152	100

1. Water erosion risk is based on the weighted average USLE predicted soil loss within each soil polygon, assuming a bare unprotected soil

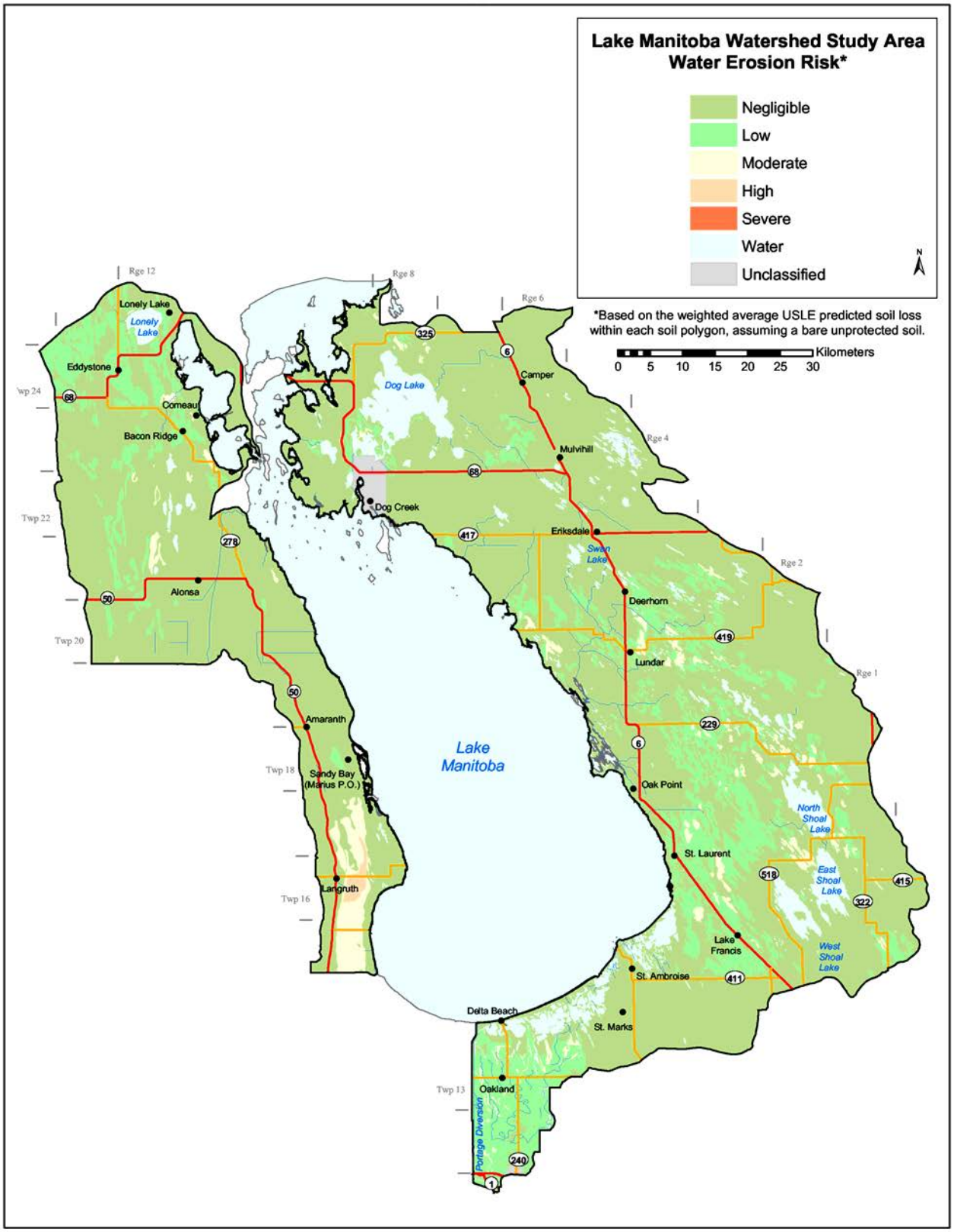

Figure 10.0 Water erosion risk in the Lake Manitoba Watershed Study Area

Agricultural Activities

Riparian areas can be impacted by anthropogenic activities occurring within a watershed. Land use and management practices within riparian zones and on upland areas affect the health of riparian areas. Although agriculture is only one component, with other human activities such as industry, recreation and residences contributing to degraded riparian areas, this report focuses on the impacts of agriculture. By knowing the extent and type of agricultural activities within the watershed, more effective decision-making and project planning can be put into place.

Agriculture data for the watershed was obtained from the 2001 Census of Agriculture using the farm headquarters reporting method, which links census data to the land location of the farm headquarters. In the 2001 Census, the farm headquarters was defined as "the operator's residence if he/she lives on land that is part of the agricultural operation; the location of the main building or main gate of the agricultural operation; or if many parcels of land without buildings are in separate locations, the parcel with the largest land area or share of gross agricultural receipts is considered the farm headquarters" (Statistics Canada 2002). It should be noted that in cases where the farm headquarters location is different from that of the actual farmed land or the location of livestock, inaccuracies in data will be introduced. For example, the reported farm headquarters could fall within one watershed, whereas a proportion of the land/livestock associated with that operation could fall within another. Despite the inaccuracies, the Census of Agriculture provides the most comprehensive source of available agricultural data (see Appendix B for more information and definitions).

The *Statistics Act* requires that all census information be kept confidential. As a result, any data that could disclose information concerning a particular agricultural operation or individual is suppressed in the data tables reported by Statistics Canada. For example, if there are only one or two dairy operations within a watershed, the number of farms reporting dairy will be given, however the total number of dairy cows reported within that watershed will be suppressed. In instances where a geographic area has very few agricultural operations, data are not released separately but are merged with data from one or more geographically adjacent areas (Statistics Canada 2002).

According to the 2001 Census, there were a total of 897 farms utilizing 68% (495,420 ha) of the land in the Lake Manitoba Watershed Study Area. For the purpose of this report, farmland includes all land that is owned, rented, leased (including government land) or crop-shared by agricultural operations. Of this land, 177,685 ha (36%) is leased government land. Of the farmland, 53,629 ha (7%) were prepared for seeding in the fall of 2000 or spring 2001. It should be noted that due to the smaller number of farms reporting on various activities, livestock and crops produced, there will be a higher incidence of data suppression.

Land use and management practices of upland areas are important considerations in watershed planning. Crop type (permanent vs. annual, high residue vs. low residue), tillage practices, nutrient management, and conservation practices on the upland landscape are all activities that can affect water quality within the watershed.

Table 9.0 summarizes the major crops grown in the watershed, including crops cut for hay, silage, green feed, etc. According to the 2001 Census data, forages were the most popular field crop, covering 18% of the farm land. This supports the fact that cattle production is important in many areas of this watershed. Approximately 27% of the farmland consisted of cultivated crops (including hay).

Table 9.0 Summary of cultivated crops (including crops cut for hay, silage, green feed, etc) grown in the Lake Manitoba Watershed Study Area (2001 Census)

Crop Type	Hectares[1]	Percent of Farm Land[1]	Percent of Watershed[1]
Cereals (wheat[4], barley, oats, mixed grain[6], buckwheat[4])	34,116	6.9	4.7
Forages (alfalfa, alfalfa mixtures, corn for silage[6], tame hay and other fodder crops, forage for seed[6])	89,340	18.0	12.3
Oilseeds (canola[5], flaxseed[6])	7,751	1.6	1.1
Potatoes[4]	296	0.06	0.04
Pulse Crops (dry field peas[3], dry beans[2])	3,985	0.8	0.5

1 - Numbers do not include suppressed data
2 - Data is suppressed for 1 farm reporting
3 – Data is suppressed for 2 farms reporting
4 - Data is suppressed for 3 farm reporting
5 – Data is suppressed for 4 farms reporting
6 - Data is suppressed for >5 farm reporting

Tillage practices on upland fields can affect the amount of erosion and runoff occurring. As the amount of tillage on a field increases, the chance of runoff (containing sediment and nutrients) entering waterways also increases. Table 10.0 provides a breakdown of tillage practices within the watershed. According to the 2001 Census of Agriculture, 81% of the land prepared for seeding in 2001 was tilled to incorporate most of the crop residue, whereas only 19% of the fields had little or no tillage for seedbed preparation, retaining most of the residue on the surface of the fields.

Table 10.0 Summary of tillage practices in the Lake Manitoba Watershed Study Area (2001 Census)

Tillage Practices	Hectares[1]	Percent of Seeded Area[1]	Percent of Watershed[1]
Tillage incorporating most crop residue[2]	43,257	80.7	6.0
Tillage retaining most crop residue on surface[2]	8,167	15.2	1.1
No till or zero till[2]	1,935	3.6	0.3
Total seeding area prepared	53,629	100	7.4

1 - Numbers do not include suppressed data
2 - Data suppressed for >5 farm reporting

In addition to minimum or no tillage, other conservation practices also reduce water erosion, thereby decreasing the amount of contaminated runoff entering waterways. Other conservation practices reported within the watershed included crop rotation (alternating low residue crops with high residue crops to maintain a good residue cover), permanent grass cover, winter cover crops, contour cultivation, strip cropping, grassed waterways and shelterbelts or windbreaks. Table 11.0 provides a breakdown of the percentage of farms using these conservation practices within the watershed.

Table 11.0 Summary of the conservation practices carried out in the Lake Manitoba Watershed Study Area (2001 Census)

Conservation Practices	Percentage of Farms Using Conservation Practice
Crop rotation	30.1
Permanent grass cover	53.0
Winter cover crops	1.1
Contour cultivation	1.9
Strip cropping	1.7
Grassed waterways	7.8
Windbreaks or shelterbelts	15.7

A number of farms within the watershed reported having livestock. As a result, manure production and the utilization of riparian areas by grazing animals are two areas where appropriate management practices should be implemented to reduce nutrient loading into rivers and streams and maintain healthy riparian areas. Table 12.0 provides a breakdown of the livestock distribution within the watershed. Over 75% of the farms within the watershed had cattle, the majority of which were beef cows. There were also 50 farms with hens and chickens and 20 farms reported having pigs.

Total Animal Units (AU) produced in the watershed (based on annual nitrogen production) has been calculated using Manitoba's Animal Unit coefficients and by making several assumptions (refer to Appendix C). As represented in Figure 12.0, beef cattle made the largest contribution to the total AU produced in the study area (87%). Horses contributed 6% to the total AU while dairy contributed to only 4%. Because of the level of suppressed data in the some livestock categories, AU calculations will be underestimated.

Table 12.0 Livestock distribution in the Lake Manitoba Watershed Study Area (2001 Census)

Livestock	Total Number of Farm[1]	Number of Animals[2]	AU Coefficient[3]	Total AU[2]
Total cattle and calves	679	116,874	--	
Total dairy cows	28(5)	1,519	2	3,038
Total beef cows	632	50,626	1.25	63,283
Total heifers & steers for slaughter and feeding (1 yr and older)	--	7,646	0.631	4,825
Total pigs	20(11)	1,601	--	
Total sows	14(6)	372	0.313	116
Total nursing and weaner pigs	10(7)	59	--	
Total grower and finisher pigs	14(11)	50	0.143	7
Boars	12(6)	26	0.2	5
Total hens and chickens	50(4)	5,710	--	
Broilers and Roasters	17(9)	1,635	0.005	8
Layers (19 weeks and older)	40(24)	523	0.0083	4
Pullets (under 19 weeks)	7(4)	61	0.0033	0
Turkeys	9(6)	47	0.014	1
Total sheep and lambs	29(8)	1,455	--	
Ewes	26(10)	717	0.2	143
Lambs	22(11)	550	--	
Total horses and ponies	203	4,876	1	4,876
Bison	6(2)	1,898	0.8875	1,684
Elk	1(1)	0	0.52	0
Goats	25(6)	405	0.143	58
				78,049

1 - Numbers in parentheses indicate the number of farms for which data is suppressed for that livestock category
2 - Numbers do not include suppressed data
3 - Refer to Appendix C for the definition of Animal Unit and assumptions used to derive Animal Unit coefficients

Manure is a valuable source of nutrients for crop production. With the prevalence of livestock production in the study area, manure management becomes important. Table 14.0 provides a summary of the method of manure application on the land in the watershed. Solid manure was the most common manure type applied to the land and was broadcasted on 7,774 ha in 2000. Liquid manure was applied using broadcast methods on 10 farms; only one farm injected it. In order to achieve efficient use of the nutrients while ensuring no adverse effects to riparian health and water quality, management practices should include incorporation of manure as soon as possible after field application, determination of application rates based on crop nutrient requirements, and timing of field applications to nutrient utilization by crops.

Table 13.0 Summary of manure application in the Lake Manitoba Watershed Study Area in 2000 (from 2001 Census of Agriculture)

Method of Manure Application	Number of Farms Reporting[1]	Area (ha) [2]
Solid Spreader	299	7,774
Liquid Spreader (on surface)	10 (4)	188
Liquid Spreader (injected)	1 (1)	--

1. Numbers in parentheses indicate the number of farms for which data is suppressed in that category
2. Numbers do not include suppressed data

Watershed Considerations

The Lake Manitoba Watershed Study Area is made up of numerous streams, creeks, shallow lakes and sloughs which drain into Lake Manitoba. This large amount of riparian area must be properly managed to protect surface water quality within the watershed and that of Lake Manitoba. Land Management decisions in upland areas will also influence riparian health.

Soils and Land Cover

The characteristics of the soil and landscape affect the land use. The majority of the soils within the watershed are rated as Class 4 or 5 (68% of the watershed) and only a small portion is productive agricultural lands. The main limiting factors to production range from excess water in the Class 2, 5 and 6 land to lack of moisture in Class 2 and 3 land. The Class 4 soils in the study area generally have undesirable soil structure and are stony. Water erosion is generally not a concern, though a small area east of Langruth has a high risk of water erosion.

Land cover provides a glimpse into agricultural practices in the watershed. In 2000-2 the dominant land cover was trees and grassland, making up 65% of the watershed. Annual crop land covered only a small portion. The most notable change in land cover since 1993-4 is the increase in forage cover. Although forages made up a small part of the watershed (4%) in 2000-2, the area had almost doubled since 1993-4. The increase in forages reflects the expansion of the livestock industry in Manitoba over the last several years.

Riparian Areas

In order to provide an indication of the amount of riparian areas present in the study area, a shoreline density was calculated using the length of shoreline around watercourses and waterbodies. This shoreline density can provide a glimpse into how much upland is in contact with surface waterbodies and watercourses (riparian areas). A higher shoreline density could mean there is a greater potential for interaction between upland activities and surface water. For this analysis, length of shoreline of both permanent and intermittent waterbodies and watercourses was determined from the 1:50,000 NTS datasheets (note that densities will be underestimated since numerous small wetlands and potholes as well as some small constructed water

courses (first, second and third order drains) are not captured by the NTS sheets). Table 14.0 provides a summary of the length and density of shoreline in the study area. In the Lake Manitoba Watershed Study Area, Sub-watersheds #167 and 168 have the highest concentration of riparian areas with approximately 22.4 and 24.6 m of shoreline/ha. Riparian pasture management will be very important in this area since beef is the most important livestock in the area. Waterbodies (including intermittent waterbodies) make up the majority of shoreline in the sub-watersheds, with the exception of Sub-watersheds #152, 165 and 167, where over 64% of the shoreline comes from watercourses (refer to Figure 11.0). A higher shoreline density will indicate a greater concentration of riparian areas. Since riparian areas provide a buffer between upland areas and surface water, management practices (including riparian pasture management, buffer strips, and grassed waterways) become important to maintain this vegetated buffer area surrounding waterbodies and watercourses.

Table 14.0 Summary of shoreline density in the Lake Manitoba Watershed Study Area (includes permanent and intermittent streams and waterbodies).

Sub-watershed ID	Length of Shoreline[1] (m)	Percent Watercourse Shoreline	Percent Waterbody Shoreline	Shoreline Density[2] (m/ha)
151	380,291	36.4	63.6	4.0
152	185,549	70.7	29.3	5.6
165	145,294	62.3	37.7	5.3
166	298,229	29.0	71.0	6.5
167	313,990	75.3	24.7	22.4
168	714,130	25.1	74.9	24.6
170	245,317	42.8	57.2	6.4
171	558,827	22.1	77.9	8.6
174	591,968	14.9	85.1	5.1
175	276,348	28.9	71.1	7.1
176	745,652	39.6	60.4	7.8
177	814,894	26.6	73.4	9.9

1. 1. Length of shoreline is determined from the 1:50,000 NTS data sheets and will be underestimated due the fact that many small wetlands and potholes as well as some small constructed water courses (first, second and third order drains) are not captured in the data sheets
2. Area is calculated as the entire area of the sub-watershed (minus area of waterbodies from the 1:50,000 NTS data sheets)

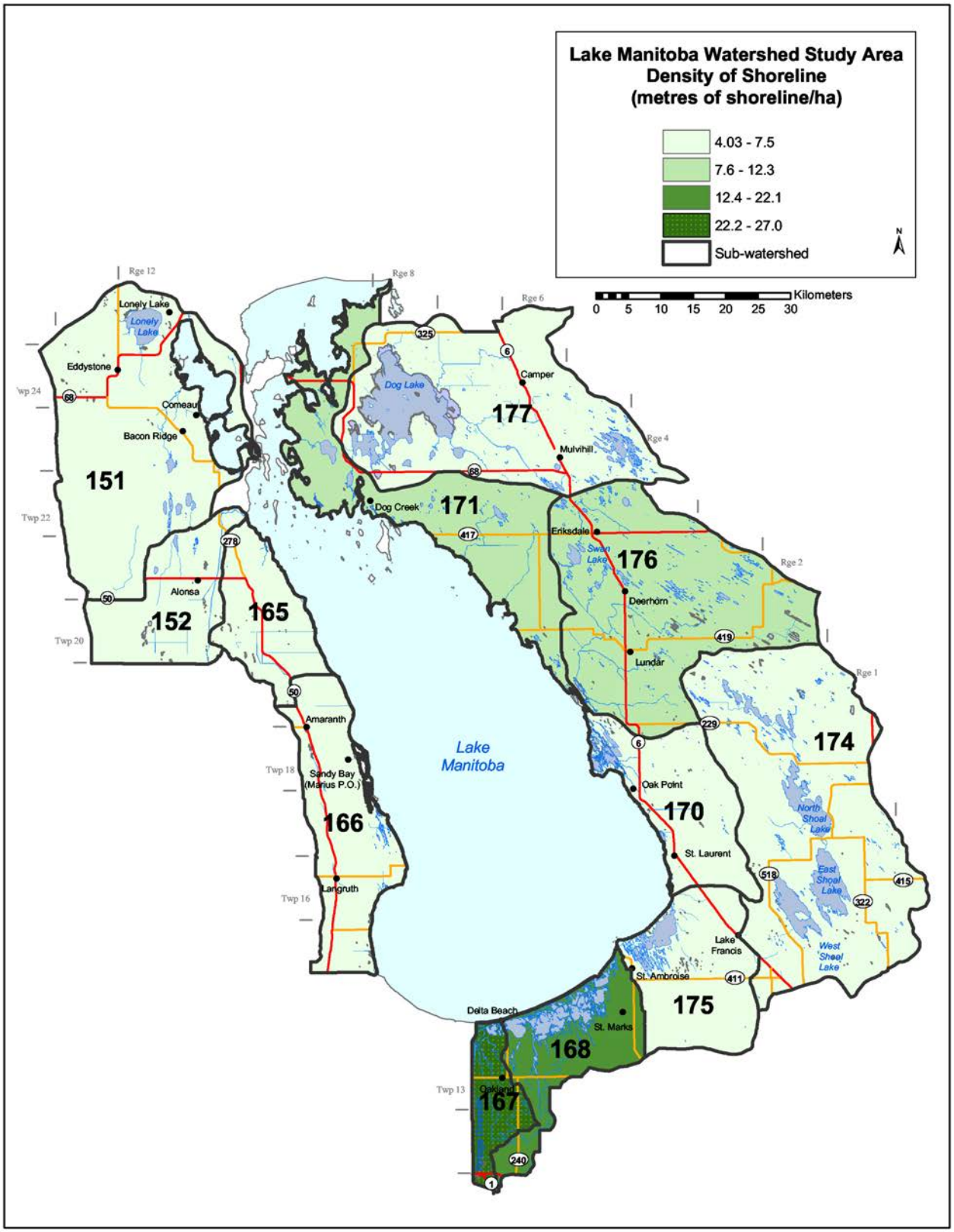

Figure 11.0 Density of shoreline in the Lake Manitoba Watershed Study Area, as determined by the 1:50,000 NTS data sheets

Riparian areas play a very important role in reducing the impact of agriculture on surface water quality. Riparian areas reduce the amount of contaminants, nutrients, and pathogens reaching surface waters by trapping and filtering sediments and by absorbing excess nutrients. The health of a riparian area determines the extent to which the riparian area can perform its functions. Riparian health is generally determined by on-site assessment and evaluation; however this was not feasible for this project. Instead, land cover in a 50 m buffer around waterbodies and water courses (both permanent and intermittent) within the watershed was analyzed, since these areas will have a greater likelihood of influencing water quality. Although this method cannot determine management practices occurring in the riparian areas (ie. livestock use of riparian areas, nutrient and pesticide management practices, etc), percentage of trees and annual crops within the buffered area could give an indication of possible health of riparian areas as well as potential agricultural impacts to water quality. Trees are an important part of the riparian area. Tree roots help to stabilize banks and hold the soil in place while canopy cover provides protection from rain drops. Their sparse presence could be an indication of declining riparian health. Another indicator of potential decline in riparian health is the presence of annual crop land in the buffer area. Annual crop land can potentially impact water quality by allowing contaminated runoff to enter surface water.

Table 15.0 provides a summary of the 2000-2 land cover in a 50 m buffer area all around water courses and waterbodies in the Lake Manitoba Watershed Study Area (from the 1:50,000 NTS data sheets). Approximately 3% of the study area is located within 50 m of a watercourse or waterbody (including intermittent streams and wetlands). In these buffered areas, only a small portion was treed or in annual crops. The main landcover was grassland or wetland (72%).

Potential impacts of crop production to riparian areas may be greater in areas where annual crop land is predominant within a 50 m area from a watercourse or waterbody. In the Lake Manitoba Watershed Study Area, annual crop is not a major land cover in the 50 m buffer, but does occur to a larger extent in Sub-watersheds #167 and 168. In areas where annual crop land does occur, potential impacts to water quality will be reduced slightly due to the fact that 19% of the crop land was prepared using minimum or zero tillage.

The presence of trees within the 50 m buffer around watercourses and waterbodies may give an indication of the potential for a riparian area to be healthy. In the Lake Manitoba Watershed Study Area, trees are not very common in the 50 m buffer with the highest occurrence found in the northwest part of the watershed (refer to Table 15.0). Absence of trees can be a result of several factors; trees have been removed due to overgrazing, cultivation, straightening of creeks, or hydrological conditions have changed. In this watershed, grasslands and wetlands are the dominant cover in the riparian area. Riparian areas and lands adjacent that have permanent vegetation will trap and store sediment and nutrients found in field runoff, reducing the risk of contamination of surface water.

Table 15.0 Summary of land cover in a 50 m buffer around all waterbodies and on either side of watercourses in the Lake Manitoba Watershed Study Area (using 2000-2 satellite imagery and 1:50,000 NTS water layers)[1].

Sub-watershed ID	Buffered area (percent of sub-watershed)	Percent of Buffered Area						
		annual crop land	trees	water	grassland	wetland	forages	roads, urban
151	2.0	0.2	17.8	9.6	23.0	48.1	0.6	0.7
152	2.8	1.0	10.2	6.5	45.8	30.3	1.9	4.3
165	2.6	2.0	19.2	3.2	45.0	21.0	1.1	8.5
166	2.6	3.2	1.7	12.7	25.5	54.8	0.0	2.0
167	10.5	32.0	3.2	4.7	38.9	10.9	3.4	6.9
168	8.1	16.8	2.7	8.1	18.6	49.9	2.0	1.9
170	3.0	1.3	0.8	2.8	24.4	65.3	2.0	3.4
171	4.3	1.1	6.0	11.3	35.8	44.8	0.2	0.9
174	2.3	0.1	4.6	29.4	10.6	54.6	0.3	0.3
175	2.9	1.5	2.2	16.6	17.7	59.2	2.2	0.5
176	4.0	4.0	8.0	18.1	27.4	40.0	1.5	1.0
177	3.1	1.2	13.6	9.3	31.1	39.4	2.5	3.0
Total	3.4	5.3	7.4	12.9	26.7	44.1	1.4	2.1

1. Due to the nature of clipping raster data (land cover layer) with vector data (1:50,000 NTS water layer) and the various scales of the data, areas are estimate.

Farm Management Practices

The 2001 Census of Agriculture had 897 farm headquarters reporting within the study area (note that census data is attached to farm headquarter and reports on activities on farmland associated with that farm headquarter, therefore whether or not the farmland is located within the watershed cannot be differentiated). In 2001, agriculture in the watershed consisted mainly of livestock and grain production with about 68% of the land utilized by farmers. This includes land that is owned, rented, leased (including government land) or crop-shared. Land management practices will have an effect on the health of the riparian areas. Upland management practices such as crop selection and rotation, tillage practices, nutrient management and grassed waterways can have impacts on riparian areas. According to the census data, 7% of the farmland was prepared for the 2001 growing season, of which 29% was prepared using minimum or zero tillage, resulting in a reduction of the risk of soil erosion. Crop rotation along with minimum and zero will assist in providing extra soil protection by carrying residues over from one year to the next. Grassed waterways are another effective practice and, when located along natural drainage paths in fields, can help to reduce water erosion and filter out sediments from runoff before it enters the watercourse or waterbody. In the Lake Manitoba Watershed Study Area, 8% of the farms reported using grassed waterways. Efforts should continue to promote reduced tillage, crop rotation, grassed waterways and other practices which will help reduce soil erosion.

Livestock grazing management is important to the health of riparian areas. Although grazing livestock in the watershed include cattle, sheep and horses, beef production is predominant with approximately 70% of the farms having cow/calf operations. Pastures and forages are necessary for summer grazing and winter feed, and land cover trends show an increase in area dedicated to forages to meet the demand for feed. In order to maximize forage productivity and promote healthy riparian vegetation, ranchers must ensure that they avoid grazing riparian areas during vulnerable times, such as when streambanks and shorelines are saturated and are more vulnerable to trampling. Ranchers should also ensure that they allow the vegetation a proper rest period after grazing during the growing season. Vegetation requires adequate rest in order to rebuild roots (energy supply), and restore vigour. During grazing periods, ranchers should utilize management tools to distribute livestock evenly over the grazing area. This not only reduces streambank damage due to trampling and overuse, but it also helps to distribute manure evenly across the grazing area. Manure is a valuable source of nutrients for plants, and when evenly distributed can be fully utilized with minimal risk of contamination to nearby waterbodies.

In contrast to grazing systems, confined livestock operations often result in an accumulation of manure that will require mechanical removal and subsequent land application. In the Lake Manitoba Watershed Study Area, there were 28 dairy operations, 20 hog operations and 50 poultry operations in 2001. The majority of these will have confined livestock facilities with associated manure storage facilities. Accumulated manure is a valuable source of plant nutrients and organic matter, which can be used to improve soil quality and crop production. Although riparian areas can trap nutrients found in runoff from fields and reduce the risk of contamination of water sources, manure management practices should include incorporation as soon as possible after application to the field and maintenance of buffer zones around riparian areas to minimize the risk of contaminated runoff entering water sources. Other manure management practices include soil and manure testing to assist in applying nutrients to crop requirements.

Agriculture Production Intensity

Riparian areas can be affected by all aspects of activities within a watershed, including agriculture, urban areas, recreation activities, etc. For this report, an attempt was made to determine the level of agriculture production intensity within each sub-watershed to determine which areas of the watershed may have a greater potential to impact riparian health. The level of livestock and crop production was determined on a per hectare basis. Because information is not available to indicate at what point the livestock density or crop production intensity becomes critical with respect to potential impacts on riparian health, the values calculated were compared to the highest value calculated in a sub-watershed in all of Manitoba.

Livestock density was calculated for each sub-watershed. Densities of different types of livestock were standardized by calculating Animal Units per hectare (AU/ha). In Manitoba, an Animal Unit (AU) is defined as the number of livestock required to excrete 73 kg (160 lbs) of nitrogen in a 12-month period. Refer to Appendix C for assumptions used to derive AU coefficients. Suppression of livestock numbers in the census data will

affect total AU to varying degrees, depending on the amount of suppression (refer to Table 12.0). Area used in the calculation consisted of hay and crop land, summerfallow, tame pasture and native land used for pasture (as reported in the 2001 Census of Agriculture). In Manitoba, the sub-watershed in which the City of Steinbach is located (in the Seine River Watershed Study Area, refer to Appendix D), had the highest livestock density (0.98 AU/ha). All other livestock densities were compared to this one.

Table 16.0 and Figure 12.0 illustrate the different livestock densities within the sub-watersheds of the Lake Manitoba Watershed Study Area. Beef cattle produced the majority of Animal Units in all sub-watersheds. Although Sub-watershed #174 produced the most AU in the study area, Sub-watershed #175 had the greatest livestock density of 0.42 AU/ha. This is still only 43% of the province's highest value. This area also has a high shoreline density (refer to Table 14.0), therefore riparian pastures are likely common and riparian pasture management may be important to maintain or improve riparian health. Livestock production at any density requires attention to manure management, nutrient management and riparian pasture management.

Table 16.0 Comparison of livestock density in the Lake Manitoba Watershed Study Area using 2001 Census livestock numbers converted to Animal Units[1]

Sub-watershed ID	Area[2] (ha)	Livestock Density	
		AU/ha[1]	As a percentage of 0.981 AU/ha[3]
151	77,247	0.13	13.5
152	32,872	0.11	11.2
165	18,600	0.14	14.2
166	30,162	0.17	17.3
167	14,401	0.08	7.7
168	15,399	0.09	9.0
170	22,253	0.18	18.6
171	41,836	0.24	24.6
174	57,514	0.23	23.1
175	21,402	0.42	43.2
176	52,814	0.19	19.2
177	51,175	0.15	15.7

1. Refer to Appendix C for assumptions used in calculating Animal Units. Some suppression of data occurs (see Table 13.0)
2. Area is calculated as the amount of land planted to annual and hay crops, summerfallow, tame pasture and native land used for pasture, as reported in the 2001 Census of Agriculture
3. Value is calculated as a percentage of the highest AU/ha value determined in Manitoba (using 2001 Census of Agriculture data)

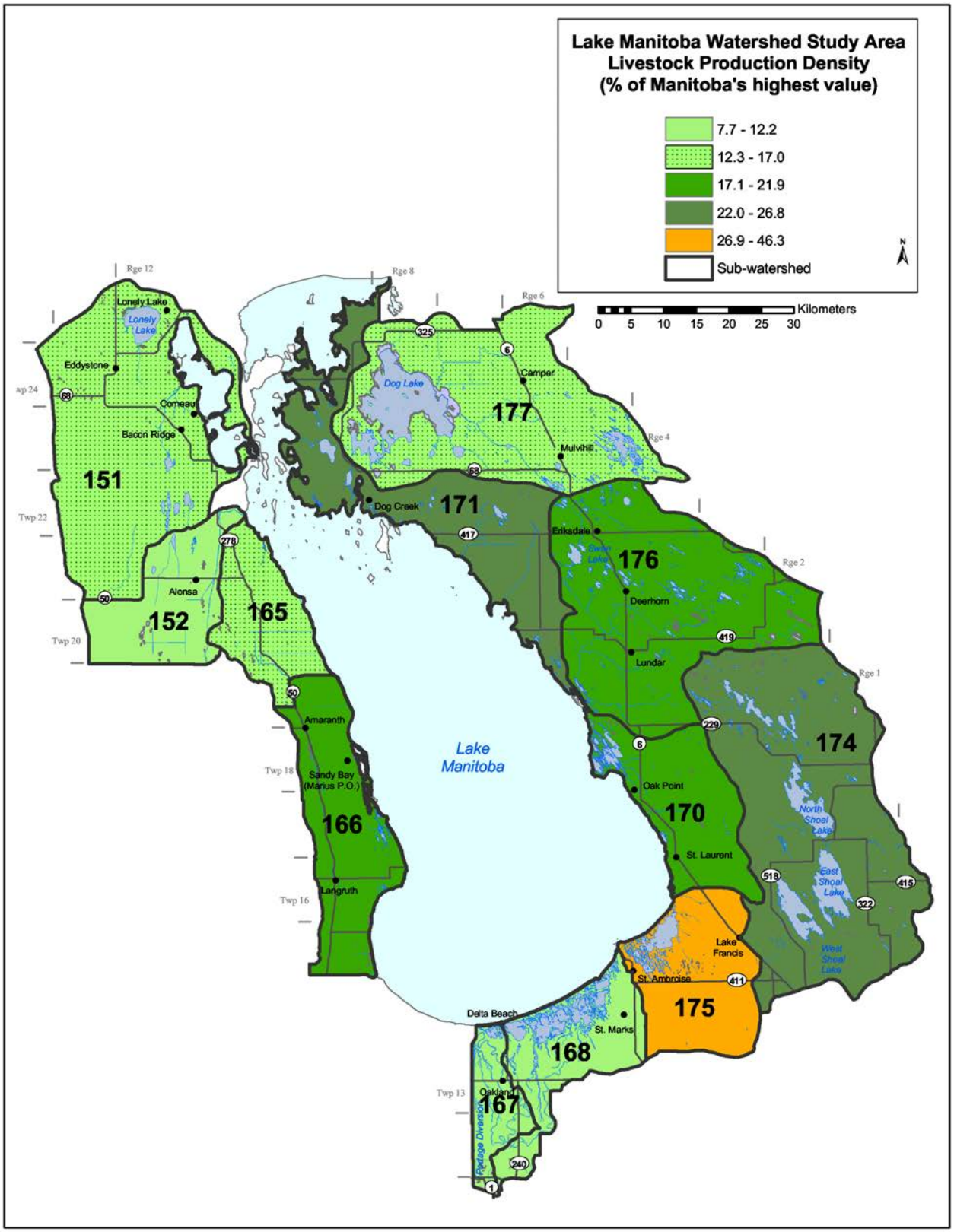

Figure 12.0 Livestock density in the Lake Manitoba Watershed Study Area, as a percentage of the highest value in Manitoba of 0.98 AU/ha (as reported in the 2001 Census of Agriculture)

The potential for crop production to impact riparian health is present in all the sub-watersheds but may be greater in those with higher fertilizer and pesticide crop inputs. Run-off containing nutrients from manure and commercial fertilizers, pesticides, and pathogens can affect riparian vegetation and biodiversity. The value of commercial crop inputs can be used as an indication of crop production intensity. Crop production intensity within a watershed was determined as dollars spent on fertilizers and pesticides (herbicides, insecticides and fungicides) per hectare in the year 2000, as reported by farms in the 2001 Census. Land area was calculated as the number of hectares used for crop and hay production and summerfallow (as reported by farms within the study area). These numbers ($ fertilizer/ha, $ pesticides/ha) were then compared to the highest respective value calculated in all the sub-watersheds with census data in Manitoba. Fertilizer dollars spent per hectare were compared with the highest value of $101.23ha, found in the sub-watershed containing the community of Bagot (in the Whitemud River Watershed Study Area). Pesticide dollars were compared with the highest value of $81.65/ha, found in the sub-watershed containing the communities of Poplar Point and High Bluff, north of the Assiniboine River (in the Lower Assiniboine River Watershed Area, refer to Appendix D).

Table 17.0 and Figures 13.0 and 14.0 illustrate the different levels of fertilizer and pesticide use in 2000 within the sub-watersheds of the Lake Manitoba Watershed Study Area. Fertilizer and pesticide inputs were highest in Sub-watershed #167. This area, along with the adjacent sub-watershed have the highest shoreline density in the study area (refer to Table 15.0), therefore these crop inputs may have a greater potential to affect water quality. The top three areas for both fertilizer and pesticide inputs were Sub-watersheds #166, #167 and #168. These areas reported the majority of pulse crops, oilseeds and potatoes grown. Though areas with higher crop production intensities may have a greater potential to impact riparian areas, best management practices with regards to pesticide and fertilizer use are important in all areas.

Table 17.0 – Comparison of crop production intensity the Lake Manitoba Watershed Study Area (using dollars spent on pesticides and fertilizers in 2000, as reported in the 2001 Census of Agriculture)

Sub-watershed ID	Area[1] (ha)	Fertilizer[2] (as a percentage of $101.23/ha)	Pesticides[2] (as a percentage of $81.65/ha)
151	12,849	15.2	5.3
152	6,292	22.5	9.7
165	7,823	18.3	18.8
166	17,342	60.0	50.3
167	13,026	67.1	82.8
168	6,779	57.9	65.0
170	8,443	8.4	2.4
171	18,075	22.4	11.2
174	14,589	24.1	19.1
175	10,342	49.5	29.8
176	17,257	14.5	5.4
177	15,161	14.3	3.2

1. Area is calculated as the land planted to annual and hay crops, and summerfallow, as reported in the 2001 Census of Agriculture
2. Value is calculated as a percentage of the highest fertilizer (or pesticide) dollars/ha value determined in Manitoba (using 2001 Census of Agriculture data)

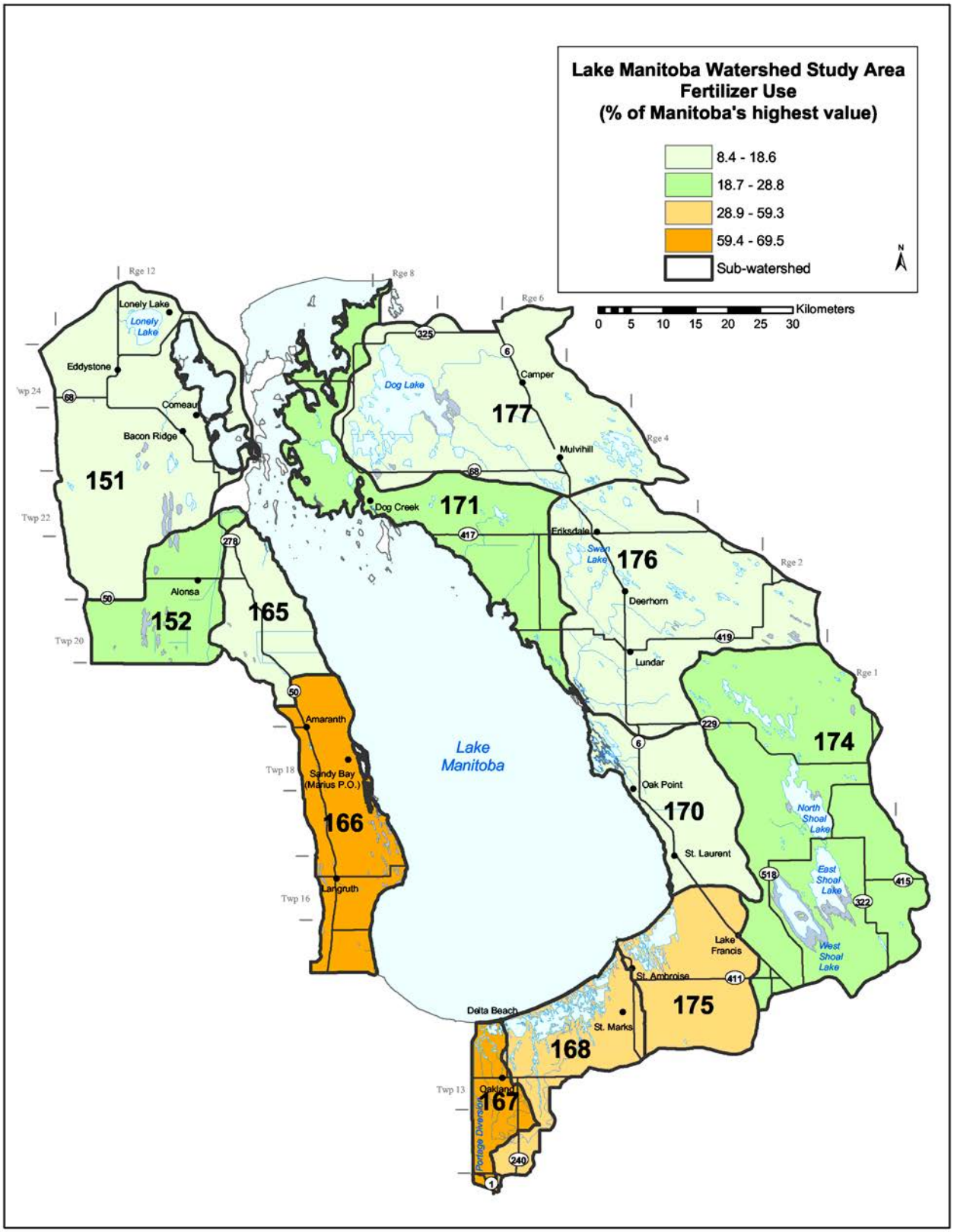

Figure 13.0 Level of fertilizer use in the Lake Manitoba Watershed Study Area in 2000, as a percentage of the highest value in Manitoba of $101.23/ha (as reported in the 2001 Census of Agriculture)

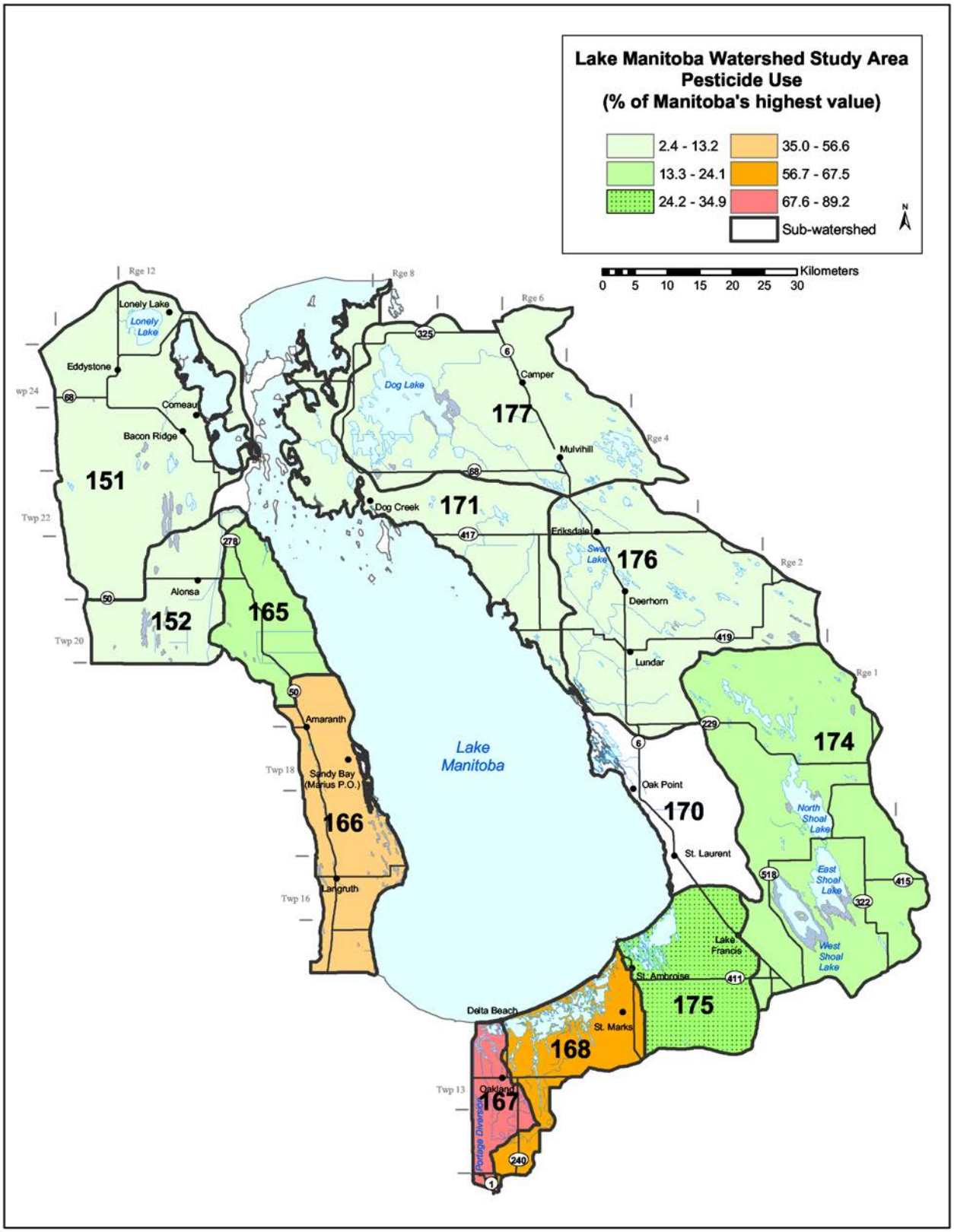

Figure 14.0 Level of pesticide in use the Lake Manitoba Watershed Study Area in 2000, as a percentage of the highest value in Manitoba of $81.65/ha (as reported in the 2001 Census of Agriculture)

Summary

Although riparian areas are affected by all activities in a watershed, this report concentrates on the potential impacts from agricultural activities. The Lake Manitoba Watershed Study Area contains a variety of soils and landscapes and, as a result, supports a diverse agricultural landscape. Appropriate management of agricultural activities is very important to protect riparian areas in the watershed.

The majority of the area in Lake Manitoba Watershed Study Area is Class 4 and 5 land. The dominant land cover was grassland or wetland in 2000-2. Forage hectares had almost doubled since 1993-4, reflecting the expansion of the livestock industry. Beef cattle made up the majority of the livestock, representing almost 87% of the Animal Units produced in the study area. Efforts should continue on education and awareness of the importance of nutrient management, manure management, residue management and crop rotation.

By looking at land cover in an area within a 50 metre distance from all waterbodies and watercourses, an attempt was made to determine areas which might have the potential for healthier riparian areas and areas which may be impacted by agricultural activities. In the Lake Manitoba Watershed Study Area, grassland and wetlands made up the majority of the land cover in this buffer area, and trees and annual crop land were much less common. Annual crop land occurred in higher amounts south of the Lake. In this area, there may be greater opportunity for contaminated runoff or chemical drift to affect riparian areas and water quality. Trees occurred in higher proportions in the northwest but still only occupied less than 20% of the buffered area. Trees are an important part of the riparian area and their presence can indicate a certain level of riparian health. More detailed on-site analysis will be required to determine actual riparian health.

Calculation of shoreline densities provides information on areas where riparian areas are more concentrated. In the Lake Manitoba Watershed Study Area, waterbodies (including intermittent waterbodies) make up the majority of shoreline. The sub-watersheds containing the Portage Diversion and Delta Marsh have the highest shoreline densities. A higher shoreline density will indicate a greater concentration of riparian areas. Since riparian areas provide a buffer between upland areas and surface water, efforts should continue to promote management practices which maintain or improve riparian health.

An attempt was made to determine an overall level of agricultural intensity with respect to livestock production and crop production. Because thresholds are not known, determinations of high, medium and low were not made. Instead, values were compared to the highest value calculated in Manitoba. In the Lake Manitoba Watershed Study Area, livestock densities tend to be higher in the central portions of the study area, with the highest value found in the ‘St. Ambrose’ sub-watershed. This is still only 43% of the highest livestock density in Manitoba. Crop production intensity was found to be highest in the southern part of the watershed. Areas with higher levels of livestock density or crop production intensity, or both, should be targeted for programs which

promote the use of management practices that improve riparian health and reduce impacts to water quality.

This report has been presented to provide a central source of riparian-related information to assist in strategic planning for riparian areas in Manitoba. Riparian areas play an important role in surface water quality and their ability to carry out this function can be affected by anthropogenic activities on the landscape. Agriculture is only one component, with other human activities such as industry, recreation and residences contributing to degraded riparian areas. The intent of this report is to be a first step towards addressing the issue of riparian health, with respect to agriculture, in the watershed study area. By providing information on the land resources and the agricultural activities in the study area, a better understanding of the issue can be obtained which will assist towards better planning and priority setting by local decision makers, land use planners and policy decision-makers. While this reports studies the agricultural aspect of the watershed study area, in a true watershed study, all factors of activities of all sectors must be considered. Due to scale and accuracy limitations, this report does not replace the need for site-specific analysis; rather, it serves as a guide for general planning purposes in the Lake Manitoba Watershed Study Area.

Future Steps

Agriculture is a significant land use found within many watersheds across the southern portions of Manitoba. The way in which individual producers manage their land can have positive and negative impacts on the environment. The understanding of the relationship between management choices available to agricultural producers in Manitoba and the type and extent of their impact on riparian and water quality issues is not well understood. It is crucial that a better understanding of these relationships be developed. This, in combination with more information about the agricultural activities within a watershed, will provide a solid foundation of science and information upon which programs, policies and beneficial management practices can be developed and evaluated.

However, agriculture is only one component of the anthropogenic activities that occur within any given watershed. Other human activities, such as industry, residences and recreation can also significantly contribute to degraded riparian areas and reduced water quality within a watershed. As with agriculture, the relationship between these activities and the type and extent of their impact is typically not well known. If issues related to riparian areas and water quality within watersheds are to be understood there needs to be significant work done to collect information on these other activities and relate them to watershed issues. This will require all sectors, public and private, to jointly focus on these issues and work together to reaching their resolution.

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Glossary

Animal Unit - the number of livestock required to excrete 73 kg (160 lbs) of nitrogen in a 12-month period in Manitoba

Erosion – The wearing away of the land surface by detachment and transportation of soil and rock material through the action of moving water, wind or other geological processes.

Field Capacity – The amount of water remaining in a soil after free water has been allowed to drain away after the root zone had been previously saturated

Glacial till – Unstratified glacial deposits consisting of clay, sand, gravel and boulders intermingled in any proportion.

Lacustrine – Mineral deposits that either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action. The sediments generally consist of either stratified are varved (layered annual deposits) fine sand, silt and clay deposited on the lake bed; or moderately well sorted and stratified sand and coarser materials that are beach and other near-shore sediments transported and deposited by wave action.

Mean Annual Growing Degree Days - accumulation of days that the daily average temperature [average of maximum and minimum temperature] is greater than 5 C multiplied by the number of 5 C the daily average exceeds 5 C for each day).

Moisture Deficit – Precipitation [P] – Potential Evapotranspiration [PE] = Moisture Deficit accumulated over the growing season by August 13 or September 30.

Permeability – The ease with which water and air pass through the soil to all parts of the profile.

Appendix A

Classification Scheme: Land Cover Mapping of Manitoba	
1. Annual crop land:	Land that is normally cultivated on an annual basis.
2. Forage:	Perennial forages, generally alfalfa or clover with blends of tame grasses.
3. Grassland:	Areas of native or tame grasses, may contain scattered stands of trees
4. Trees:	Lands that are primarily in tree cover
5. Wetlands:	Areas that are wet, often with sedges, cattails, and rushes
6. Water	Open water – lakes, rivers, streams, ponds, and lagoons
7. Urban and Transportation:	Towns, roads, railways, quarries

Appendix B

The Census of Agriculture is conducted concurrently with the Census of Population by Statistics Canada, every five years. The 2001 Census of Agriculture is the most recent Census to date. The Census of Agriculture collects information from operations that meet the definition of a census farm.

In 1996 and 2001, a census farm was defined as "an agricultural operation that produces at least one of the following products intended for sale: crops (hay, field crops, tree fruits or nuts, berries or grapes, vegetables, seed); livestock (cattle, pigs, sheep, horses, game animals, other livestock); poultry (hens, chickens, turkeys, chicks, game birds, other poultry); animal products (milk or cream, eggs, wool, furs, meat); or other agricultural products (Christmas trees, greenhouse or nursery products, mushrooms, sod, honey, maple syrup products)" (Statistics Canada 2002).

The *Statistics Act* requires that all census information be kept confidential. As a result, any data that could disclose information concerning a particular agricultural operation or individual is suppressed in the data tables reported by Statistics Canada. Suppressed data are, however, included in the aggregate subtotals and totals within each data table. In instances where a geographic area has very few agricultural operations, data are not released separately, but are merged with data from one or more geographically adjacent areas (Statistics Canada 2002).

2001 Census of Agriculture Terms and Definitions (*Source: Statistics Canada 2002)*

Agricultural operation: a farm, ranch or other agricultural operation producing agricultural products for sale. Other agricultural operations include, for example: feedlots, greenhouses, mushroom houses, nurseries, Christmas tree farms, fur farms, hobby farms, game farms, beekeeping, sod, fruit and berry, maple syrup and poultry hatchery operations. Sales in the past 12 months are not necessary but there **must** be the intent of sales.

Summerfallow land: a term used to describe land on which no crop will be grown in order to conserve moisture but which will be sprayed or cultivated for weed control.

Tame or seeded pasture: grazeable land that has been improved from its natural state by seeding, draining, irrigating, fertilizing or weed control.

Natural land for pasture: grazeable land that has not been recently improved.

Tillage: the practice of working the soil for the purpose of bringing about the more favourable conditions for plant growth. Clean-till (conventional tillage) incorporates most of the crop residue into the soil, while minimum-till (conservation tillage) retains most of the crop residue on the surface. No-till includes direct seeding into stubble or sod.

Crop rotation: a practice where crops are alternated each year, or in a multi-year cycle, for soil conservation or disease control purposes.

Permanent grass cover: a practice where a field or land is kept in grass cover indefinitely to keep the soil from being eroded away.

Winter cover crops: crops such as oats or fall rye seeded in the fall to protect the soil from water and wind erosion during the winter and from heavy rains and runoff in the spring.

Green manure crops for plough down: the practice of incorporating young green plants into the soil for fertility purposes. These plants are usually grown with the single purpose of being used as a soil improver. Common examples are buckwheat and red clover.

Contour cultivation: the practice of cultivating the field across the slope to reduce soil erosion from rapid water runoff.

Grassed waterways: either natural or constructed, to control soil erosion. The waterway is permanently grassed and consists of a shallow channel, which is designed to slow down runoff water. The grass stabilizes the soil and prevents it from being washed away. They are usually shaped to allow easy crossings by farm machinery.

Strip-cropping: (or strip farming, field strip-cropping or wind strip-cropping) a method of controlling soil erosion by dividing the farm into narrow fields having different crops, with or without fallow. For example, the narrow fields may be alternately cropped–uncropped (e.g., wheat–fallow–wheat–fallow) or they may be strips of different crops (cereals, corn, soybeans). The widths of the cropped strips are usually multiples of a tillage implement or spray boom, etc.

Windbreaks or shelterbelts: trees, either planted or naturally present. This practice is used more predominantly in western Canada where farmland is more susceptible to wind action and where trapping snow for moisture is important.

Appendix C

Summary of Animal Unit coefficients used in Manitoba as compared to those used for calculations in this report[1]. Assumptions are given in the following Table.

Livestock	Animal Units produced by one animal (MAFRI)	Animal Unit coefficient used in report
Dairy		
Milking Cows (including associated livestock)	2.000	2.000
Beef		
Beef Cows, incl. associated livestock	1.250	1.250
Backgrounder	0.500	\
Summer pasture	0.625	} 0.631
Feedlot	0.769	/
Hogs		
Sows, farrow-to-finish	1.250	--
Sows, farrow-to-weanling	0.313	0.313
Sows, farrow-to-nursery	0.250	--
Weanlings	0.033	--
Grower/finishers	0.143	0.143
Boars (artificial insemination operations)	0.200	0.200
Chickens		
Broilers	0.0050	0.0050
Roasters	0.0100	--
Layers	0.0083	0.0083
Pullets	0.0033	0.0033
Turkeys		
Broilers	0.010	\
Heavy Toms	0.020	} 0.014
Heavy Hens	0.010	/
Horses (PMU)		
Mares, including associated livestock	1.333	1.00
Sheep		
Ewes, including associated livestock	0.200	0.200
Feeder Lambs	0.063	--
Goats	0.143	0.143
Bison		
Cow	1.00	\
Bull	1.00	} 0.8875
Calf	0.25	/
Elk		
Cow	0.53	\
Bull	0.77	} 0.520
Calf	0.05	/

1. An Animal Unit is defined as the number of livestock required to excrete 73 kg (160 lbs) of nitrogen in a 12-month period (as defined in the Farm Practices Guidelines for Poultry Producers in Manitoba)

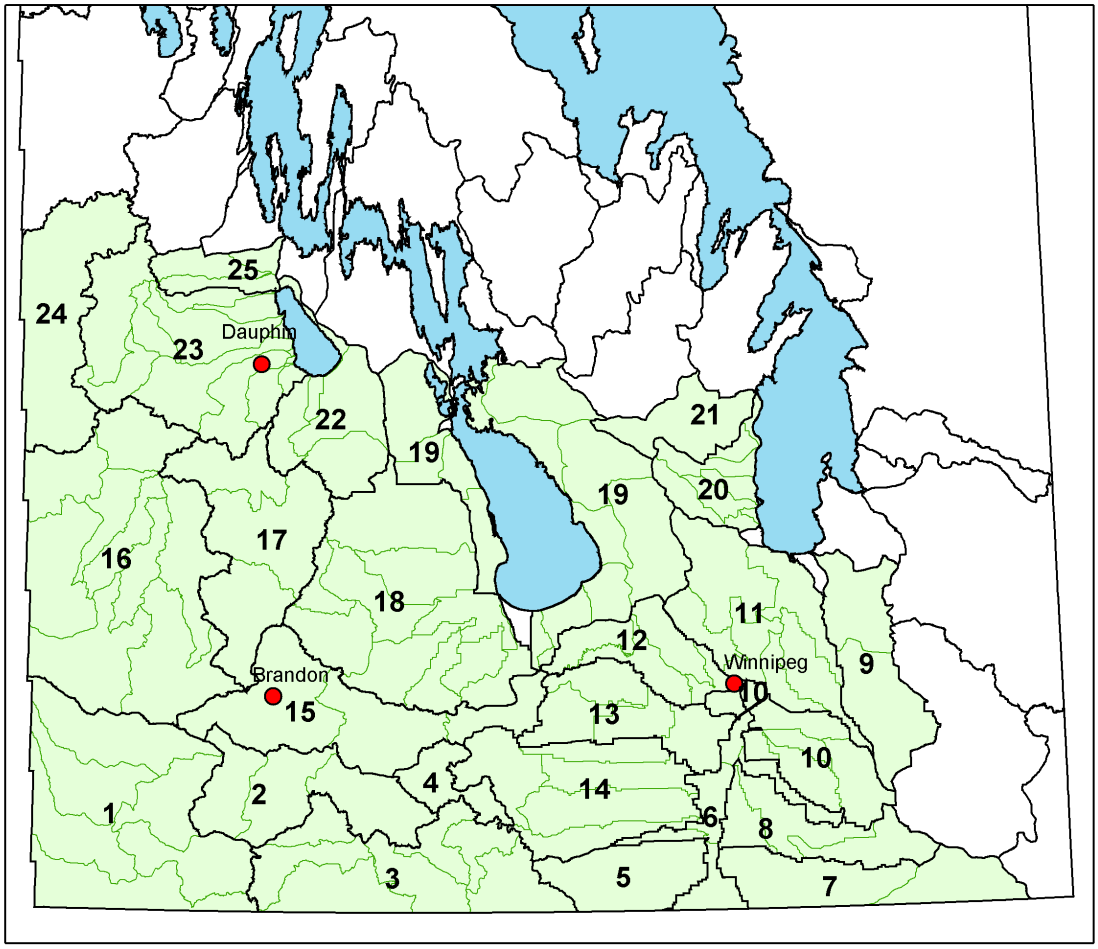
Summary of assumptions made in calculating Animal Units[1] from 2001 Agricultural Census Data.

Livestock	Manitoba Animal Unit Category	Census Category	Assumptions Used for Animal Unit Calculations with Census Data
Dairy	Milking cows (including associated livestock)	Dairy cows	Assumed categories are equal.
Beef	Beef cows	Beef cows	Assumed number of beef cows reported in Census equal cow/calf pairs
	Backgrounder Summer pasture Feedlot cattle	Heifers and steers for slaughter or feeding 1 yr and older (combined categories)	Assumed steers and heifers reported in these Census categories are split into the three categories (communication with MAFRI). Animal unit coefficient determined using this ratio.
Pigs	Sows, farrow–to-weanling	Sows	Assumed there are no farrow-to-finish operations and no weanling operations in Manitoba – only farrow-to-weanling and grower/finisher operations.
	Grower/finishers	Grower and finisher pigs	
	Boars (artificial insemination operations)	Boars	Assumed all boars reported in the Census are from artificial inseminations.
Chickens	Broilers	Broilers and roasters	Assumed all birds reported in the Census category are broilers (communication with MAFRI).
	Layers	Laying hens (19 weeks and older)	Assumed categories are equal.
	Pullets	Pullets (under 19 weeks)	Assumed categories are equal.
	Broiler breeding hens	Laying hens in hatcheries	Assumed all laying hens in hatchery supply flocks reported in Manitoba are broiler breeder hens.
Turkeys	Broiler, Heavy Toms, Heavy Hens	Turkeys	Assumed “turkeys” represents 20% boilers, 40% heavy toms, 40% heavy hens (communication with MAFRI). Animal unit coefficient is determined using this ratio.
Sheep	Ewes, including associated livestock	Ewes	Assumed ewe/lamb pairs (communication with MAFRI).
	Feeder lambs	Lambs	Assumed no feeder lambs in province since numbers are very small and cannot be determined from census data (communication with MAFRI).
Horses	Horses	Total horses and ponies	Assumed each animal produces 1 Animal Unit – PMU farms not identified in Census (communication with MAFRI).

Livestock	Manitoba Animal Unit Category	Census Category	Assumptions Used for Animal Unit Calculations with Census Data
Bison	Bison	Bison	Assumed adults represent 85% and calves represent 15% of bison population in Manitoba (communication with MAFRI). Animal unit coefficient is determined using this ratio.
Elk	Elk	Elk	Number of calves and sex of animals not identified in Census – assumed 45% cows, 35% bulls and 20% calves (communication with MAFRI). Animal unit coefficient is determined using this ratio.
Goats	Goats	Goats	Number of kids and sex of animals not identified in Census – assumed 7 goats make up one Animal Unit, irregardless of age and sex.

1. One Animal Unit is defined as the number of livestock required to excrete 73 kg (160 lbs) of nitrogen in a 12-month period (as defined in the Farm Practices Guidelines for Poultry Producers in Manitoba)

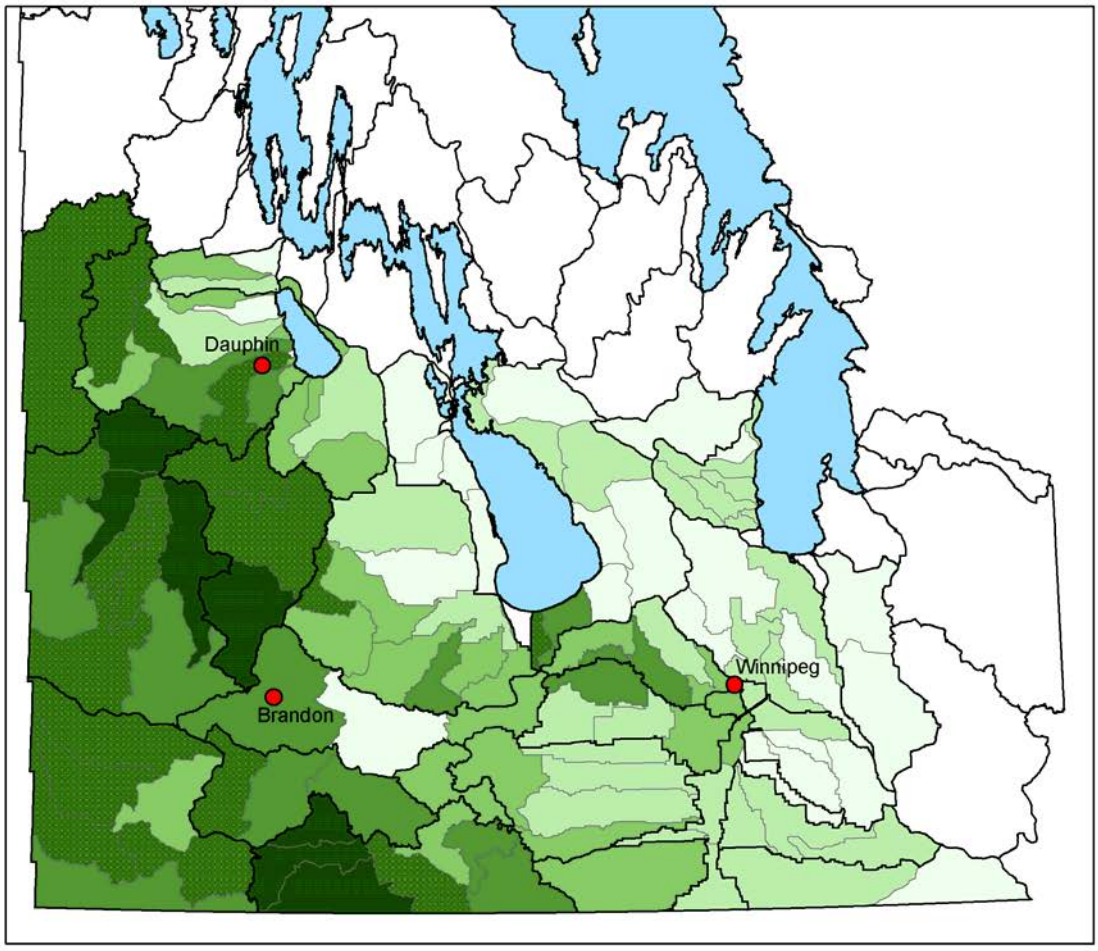
Appendix D



Watershed Study Area Summary Reports in Manitoba (black outline) and the sub-watershed areas (green outlines) used for the custom tabulation of the 2001 Census data.

Watershed Study Areas Sub-watershed areas

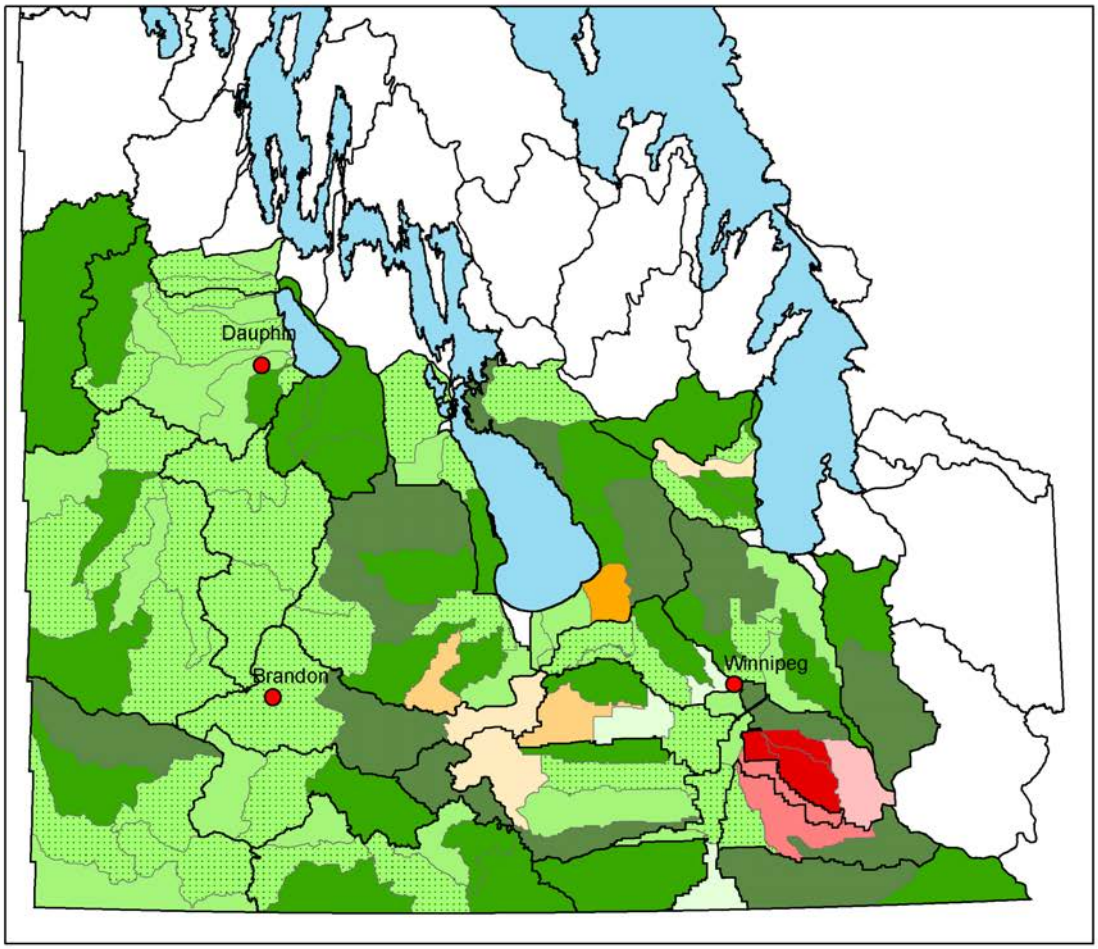
ID	Report	ID	Report
1	Upper Souris River Watershed Study Area	14	Boyne-Morris River Watershed Study Area
2	Lower Souris River Watershed Study Area	15	Middle Assiniboine River Watershed Study Area
3	Pembina River Watershed Study Area	16	Upper Assiniboine River Watershed Study Area
4	Cypress River Watershed Study Area	17	Little Saskatchewan River Watershed Study Area
5	Plum River Watershed Study Area	18	Whitemud River Watershed Study Area
6	Upper Red River Watershed Study Area	19	Lake Mantitoba Watershed Study Area
7	Roseau River Watershed Study Area	20	Lower West Lake Winnipeg Watershed Study Area
8	Rat-Marsh River Watershed Study Area	21	Icelandic River Watershed Study Area
9	Brokenhead River Watershed Study Area	22	South Dauphin Lake Watershed Study Area
10	Seine River Watershed Study Area	23	West Dauphin Lake Watershed Study Area
11	Lower Red River Watershed Study Area	24	Shell River Watershed Study Area
12	Lower Assiniboine River Watershed Study Area	25	Mossy River Watershed Study Area
13	La Salle River Watershed Study Area		



Comparison of Shoreline Densities in Manitoba calculated as metres of shoreline/ha in each sub-watershed*

2.6 - 7.5	17.3 - 22.1
7.6 - 12.3	22.2 - 27.0
12.4 - 17.2	27.1 - 31.8

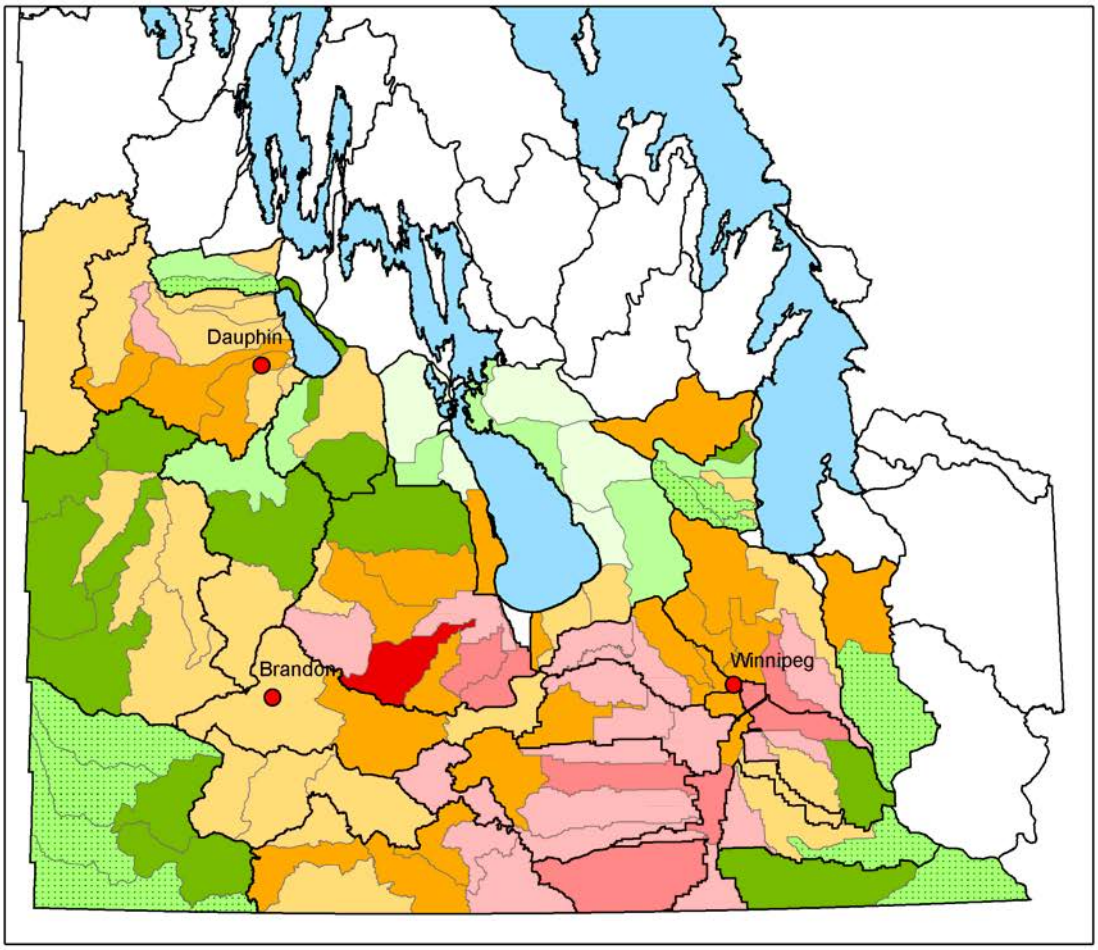
* Length of shoreline of both permanent and intermittent waterbodies and watercourses was determined from the 1:50,000 NTS datasheets (note that densities will be slightly underestimated since numerous small wetlands and potholes as well as some small constructed water courses (first, second and third order drains) are not captured by the NTS sheets).



Comparison of livestock production densities in Manitoba as a percentage of the highest value calculated in a sub-watershed using 2001 Census livestock numbers converted to Animal Units*

2.4% - 7.3%	17.1% - 21.9%	31.8% - 36.6%	75.7% - 80.5%
7.4% - 12.2%	22.0% - 26.8%	41.4% - 46.3%	95.1% - 100%
12.3% - 17.0%	26.9% - 31.7%	70.7% - 75.6%	

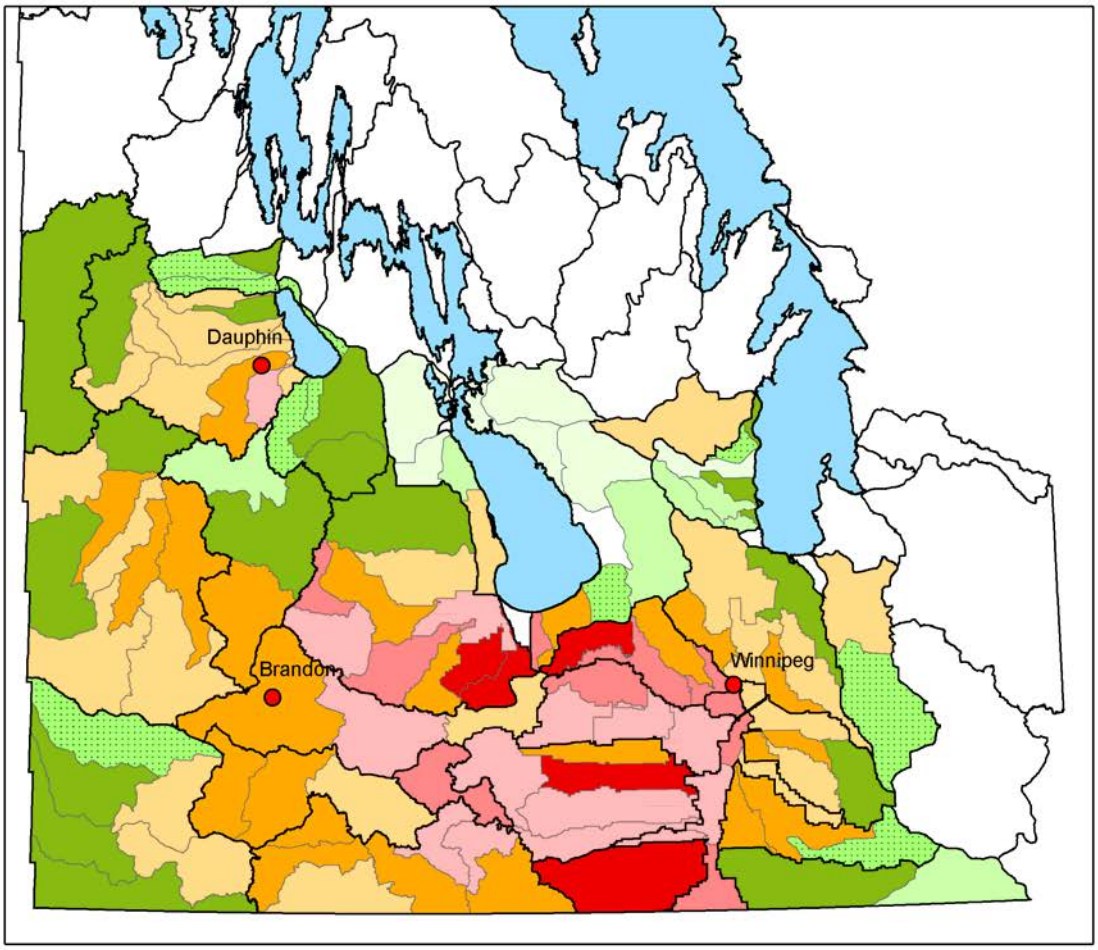
* Densities of different types of livestock were standardized by calculating Animal Units per hectare (AU/ha). In Manitoba, an Animal Unit is defined as the number of livestock required to excrete 73 kg (160 lbs) of nitrogen in a 12-month period (refer to Appendix C for assumptions used to derive AU coeffiecients). Suppression of livestock numbers in the census data will affect total AU to varying degrees, depending on the amount of suppression. Area used in calculation consisted of hay and crop land, summerfallow, tame pasture and native land used for pasture (as reported in the 2001 Census of Agriculture).



Comparison of commercial fertilizer use in sub-watersheds in Manitoba, calculated as a percentage of the highest value in a sub-watershed (as reported in the 2001 Census of Agriculture).*

8.4% - 18.6%	39.0% - 49.1%	69.6% - 79.6%
18.7% - 28.8%	49.2% - 59.3%	79.7% - 89.8%
28.9% - 38.9%	59.4% - 69.5%	89.9% - 100%

* Level of fertilizer use is calculated as dollars spent on fertilizers per hectare in the year 2000, as reported by farms in the 2001 Census of Agriculture. Land area was calculated as the number of hectares used for crop and hay production and summerfallow (as reported by farms for the 2001 Census).



Comparison of pesticide use in sub-watersheds in Manitoba, calculated as a percentage of the highest value in a sub-watershed (as reported in the 2001 Census of Agriculture).*

2.4% - 13.2%	35.0% - 45.8%	67.6% - 78.3%
13.3% - 24.1%	45.9% - 56.6%	78.4% - 89.2%
24.2% - 34.9%	56.7% - 67.5%	89.3% - 100%

* Level of pesticide use (herbicides, insecticides and fungicides) is calculated as dollars spent on fertilizers per hectare in the year 2000, as reported by farms in the 2001 Census of Agriculture. Land area was calculated as the number of hectares used for crop and hay production and summerfallow (as reported by farms for the 2001 Census).