Netley-Grassmere Study Area IWMP:

An Analysis of the Agricultural Change in the Netley-Grassmere Study Area Using Land Cover, Soils and Ag-Profiling

Submitted by

Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration

and

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Table of Contents

List of Figures:

List of Tables:

Executive Summary

Understanding changes in agricultural land use is essential for the development of the integrated watershed management plan. Changes over time help to develop an understanding of potential impacts on the basin's water quality, as well as help to identify opportunities for sustainable land use strategies and ultimately a more sustainable landscape.

Agriculture and Agri-Food Canada through the Prairie Farm Rehabilitation Administration (PFRA) has partnered with Manitoba Agriculture and Rural Initiatives (MAFRI) to examine the agricultural aspects of the Netley Creek and Grassmere Drain watersheds at the request by Manitoba Water Stewardship in support of developing an Integrated Watershed Plan. The study focuses on four key objectives: 1) to examine trends in the overall watershed and two smaller subwatersheds using available land cover data (from 1994, 2001-02, and 2005) and soils characteristics, and 2) to examine Census information collected by Statistics Canada Census between 2001 and 2006 in the two subwatersheds to help understand the agricultural "profile" of the area, and 3) to examine the adoption of beneficial management practices by producers in the overall watershed, as well as, the two subwatersheds. Recommendations have also been incorporated to assist the East Interlake Conservation District (EICD), who serves as the local Watershed Authority, and the Project Management Team (PMT) to consider for future land management policies within the watershed.

Based on 2005 land cover data, almost half (129,812 ha) of the land within this the watershed was classified as annual crop land. Water combined with wetlands cover approximately 10% of the watershed, signifying a fair amount of riparian or shoreline area. Urban and transportation land uses (i.e. infrastructure for urban, transport and recreation use) cover almost 5% of the land in this study area. Examining extent and change (in percentage) in land cover type between 1994 and 2005, an increase of 93% in forages was noted. This change was most likely influenced through government programs like the Permanent Cover Program that provided incentives for the conversion of marginal lands from annual cropping production to perennial cover following the demise of the Western Grain Transportation subsidy. The lower value of the Canadian dollar versus the United States dollar has also favoured alfalfa and timothy production in Canada for the United States market. A 23% increase in lands identified as urban/transportation is also of significance as this is attributed to increased pressure for urban development within the watershed, particularly near Stonewall and Selkirk where prime and viable lower classed agricultural land has been taken out of production.

A comparison of soils characteristics to annually cropped land (based on 2005 Land cover) led to a number of considerations for future land use. Approximately 10% of the annual cropland occurred on soils which may be more suitable for perennial forage production (Agricultural Capabilities of Class 4, 5, 6, 7 and Organic). Comparing soil texture to land cover revealed that approximately 6% of the annual cropland was located on soils with sand to coarse sand texture or organic soils, and 10% was in areas with coarse loamy textured soils. Although water erosion risk is generally low for the watershed (17%), approximately 22% of the annual cropland noted was located on soils with moderate risk to water erosion. Further analysis of 2002 and 1994 land cover data indicates that annual cropping practices on moderate soil erosion risk land have been declining since 1994. Seven percent of the Netley - Grassmere Study Area is considered to have severe or high wind erosion risk, which factored to 4% of annual cropland in the 2005 land cover. With respect to soil drainage, 73% of the total landbase can be considered imperfectly or poorly drained, most of which is determined to be annual cropland (88%) through 2005 Land Cover.

Assessing Ag-Profiles of the watershed provides a better understanding of the agricultural intensity and trends. Significant decreases were noted in summerfallow suggesting a reduced potential for soil erosion. This however, may be offset by the recent trends to produce lower residue pulse crops. Large decreases in areas where commercial fertilizers and pesticides are applied suggest a reduced potential

for nutrient and pesticide contamination. It is anticipated that this trend is due to an increase in crop inputs costs. It should also be noted that with the exception of beef cattle, it appears there are fewer but larger livestock and poultry operations in 2006 as compared to 2001.

In the Netley Creek Subwatershed, over 400 farm operations manage over 80% of the watershed. Half of the farmland is dedicated to annual crop production and another 40% to pasture, alfalfa, and hay and fodder crops. Of the annually cropped land, cereals make up almost 60% of the area, oilseeds another 30% and pulse crops cover 5%. Two-thirds of the cultivated land is managed using conventional tillage practices, over 30% using conservation tillage practices and less then 5% applying zero tillage practices. Livestock production is also of significance in this watershed, with the presence of poultry, hog and dairy operations. Analysis showed that in 2005, Netley Creek Subwatershed had 14% of annual cropland located on Class 4, 5, 6, 7,and organic soils. As well, 8% of the annual cropland on sand to coarse sand textured soils or organic soils, depicting an increasing trend. With respect to wind erosion, the Netley Creek Subwatershed had 8% of the annual cropland in 2005 located on soils with a high, to severe risk of erosion and another 8% on organic soils.

The Grassmere Drain Subwatershed is smaller with over 170 farms utilizing 85% of the watershed. This watershed shows farms having a higher capital investment (due in part to larger acreage of Class 2 and Class 3 soils where wetness is not a limiting factor) resulting in higher land values and additional crop input potential. Almost two thirds of the cultivated land is managed using conventional tillage practices, over 30% using conservation tillage practices and 5% using zero tillage practices. 21% of the annual cropland was located on soils with a moderate risk for erosion. Over 74% of the land base has been classed as imperfectly drained soils, 14% is on poor (improved) drained soils and 10% of the landbase is on well drained soils.

An increase in urban/transportation land use was also identified in the Netley–Grassmere Drain Study Area which can lead to multiple impacts on the watershed. This increase correlates to a loss of prime and viable lower classed agricultural land within the study area, especially in close proximity to the City of Winnipeg. The proximity to Winnipeg creates substantial development pressures in surrounding Rural Municipalities who are faced with the ongoing challenge of providing increased levels of services to commuters.

These services require a larger tax base to sustain them. Municipalities are trying to balance providing additional services without significantly increasing taxes to existing residents. Subdivisions being developed within the watershed also can lead to the fragmentation of agricultural land in the watershed, may limit opportunities for agricultural diversification, lead to potential land use conflicts between farming and non-farming residents, and lead to heavier stresses on lower class agricultural lands.

Producers in the watershed tend to be conscientious about the potential impacts that agriculture can have on the environment. Many have gained an improved understanding the potential environmental risks associated with agriculture and on their own farms through the Environmental Farm Planning (EFP) process that has been underway in Manitoba since 2005. The EFP process also allowed producers to develop an action plan that outlines how potential risks on their farms can be addressed through the adoption of beneficial management practices (BMPs). In the study area, 159 BMPs were adopted by producers using financial and technical support through the Canada-Manitoba Farm Stewardship Program, a program aimed at the acceleration of on-farm BMPs. Of these BMPs adopted, almost two-thirds were adopted in the Netley Creek watershed (the larger of the two subwatersheds). The top three BMPs adopted were Improved Cropping Systems, Product and Waste Management and Winter Site Management, which is consistent to adoption in other areas of Manitoba.

Acknowledgements:

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AAFC-PFRA: Holweger, U., Michiels, P., Powers, J., Vanrobaeys J., Bogdan, D., Kopytko, M. (Ag-Land and Agro-Forestry Unit, Ag Information Unit, Land Use Decision Support Unit, National Land & Water Information Service)

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Preface

In 2008, the East Interlake Conservation District (EICD) was designated as the Watershed Planning Authority to develop a comprehensive integrated watershed plan (IWMP) for the Netley - Grassmere Study Area. In support of developing the IWMP, a ten person Project Management Team (PMT) was formed to guide the watershed planning process. A formal request was made on behalf of the PMT and Manitoba Water Stewardship to Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration (PFRA) and Manitoba Agriculture Food and Rural Initiatives (MAFRI) to provide technical support as it relates to their respective mandates (See Appendix A) in support of developing the plan.

This report focuses on information related to agricultural activities and land resources in the watershed. It is important to note that in addition to agriculture, there are other industries, sectors, and users of the watershed's resources that also have an impact on the watershed. As there are scale and accuracy limitations associated with the data, it should be noted that the information contained within this report does not replace the need for site-specific analysis; rather, it serves as a guide for general planning purposes in the Netley - Grassmere Study Area.

Introduction

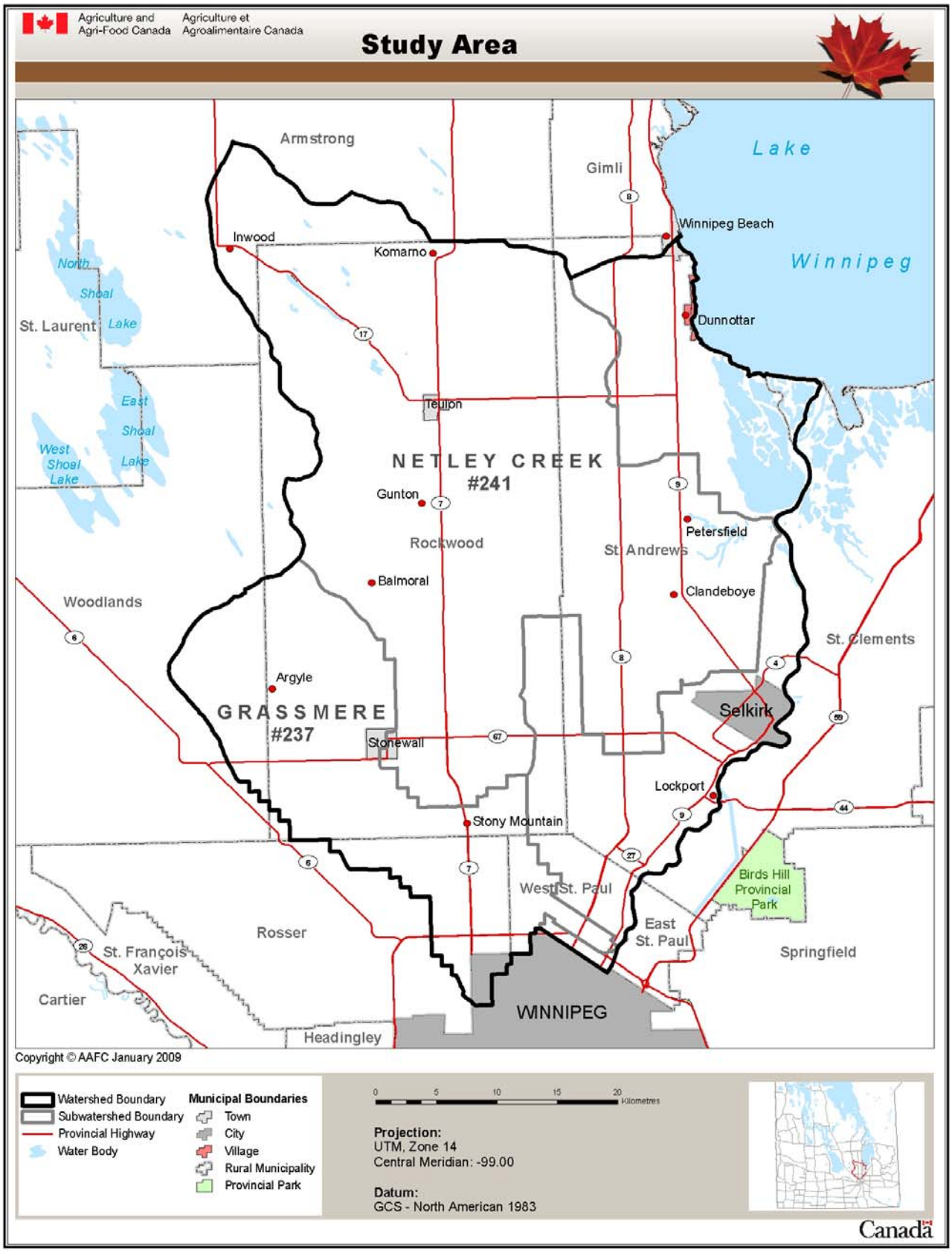
The Netley Grassmere Integrated Watershed Management Plan (IWMP) Area is defined as watershed "05OJ" by Manitoba Water Stewardship and is situated in the Interlake Region of Manitoba. Specifically the watershed is situated southeast of Lake Winnipeg and includes the communities of Inwood, Teulon and Stonewall (see ***Figure 1***).

The study area contains two smaller but important subwatersheds - the Netley Creek and Grassmere Drain watersheds (# 237 and 241) as defined by Manitoba Water Stewardship (see ***Figure 1***). The Netley Creek Subwatershed is the larger of the two watersheds, approximately 132,900 hectares in size. It encompasses a majority of the northwestern portion of the IWMP Study Area and extends almost to the eastern boundary of the IWMP Study Area. The Grassmere Drain Watershed is much smaller in size (approximately 47,140 hectares in size) and is the south and western portion of the Netley - Grassmere Study Area. Both watersheds drain to the southeast toward the Red River. The boundaries of these two watershed areas cover approximately 75% of the watershed and over 236,258 hectares in size.

Understanding trends in agricultural land use and practices is essential for the development of the integrated watershed management plan. Temporal changes in land cover and agricultural influences on the landscape can influence watershed processes and impact issues like water quality within the two studied subwatersheds. It can also help to identify opportunities to develop sustainable land use strategies for encouragement to healthier landscape. To understand these changes, PFRA and MAFRI partnered to examine the proposed watershed with respect to the following objectives:

i. To examine land cover maps derived from satellite imagery in 1994, 2001-02, and 2005 and examine trends within those periods and with respect to soils characteristics in the overall watershed and the two smaller subwatersheds.
ii. To examine Census of Agriculture data collected by Statistics Canada in 2001 and 2006 for the two smaller subwatersheds to help understand the agricultural "profile" of the area.
iii. To examine the adoption of beneficial management practices within the context of the overall watershed and its two subwatersheds.
iv. To provide recommendations for future land management policies for the EICD and PMT to consider.

Figure 1: Netley - Grassmere Study Area



Land Cover

Land cover maps used in this analysis were developed using raster-based data sets derived from 30 metre resolution LANDSAT Thematic Mapper satellite imagery. These data sets are point in time and allow users to see the spatial extent of general types of land cover within a given area over time. Comparisons between data sets (more than one year) can result in the emergence of general trends in land cover. These trends, along with other resource data such as soil information, can provide a general overview of land use practices within the watershed. Analysis of land cover changes over time can also be used to understand the impacts of other external factors such as government policies and regulations, infrastructure development, market impacts, etc. that influence land use. Further details on the information used for the land cover analysis and the constraints associated with this date are provided in ***Appendix B***.

Summary of the 2005 Land Cover in the Netley - Grassmere Study Area

Agriculture is the primary land use in the watershed. Based on 2005 land cover data, almost half (129,812 ha) of the land within this watershed area was classified as annual cropland, most of which is located in the southern and eastern portions of the study area (refer to ***Table 1.0, Figure 2***). Grasslands and trees also cover a large amount of study area and are mainly found in the north-western portion of the watershed and in small tracts scattered throughout the remainder of the study area. Large areas of grassland and wetlands are found around Oak Hammock Marsh in the centre of the study area and in the Netley Marsh area, adjacent to Lake Winnipeg. Ten percent of the watershed can be classified as water when combined with wetlands signifying that there is a fair amount of riparian or shoreline areas. Urban and transportation land uses (i.e. infrastructure for urban, transport and recreation) cover almost 5% of the study area, and are mostly found in the Winnipeg and Selkirk areas, as well as, in the corridor between these two urban centres along the Red River.

Table 1.0: Land Cover (2005) in the Netley - Grassmere Study Area

Class	Area[1] (ha)	Percent of Study Area
Annual Cropland	129,812	49%
Trees	26,883	12%
Water	8,532	3%
Grassland/Pasture	43,063	17%
Wetlands[2]	9,685	4%
Forages	8,227	7%
Urban/Transportation	10,053	5%

1. Area totals are approximate due to the nature of the image analysis procedure
2. Due to seasonal changes in wetland size, date of imagery will affect area

It should be noted, that significant increases in annual rainfall occurred in the years prior to the 2005 land cover mapping and classification. The cumulative impact of these rainfall events resulted in a significant amount of summerfallow, re-established as lowland vegetation or covered by standing water, particularly in the lower reaches of the Netley Creek Subwatershed (see ***Appendix K)***. Significant effort was used to bring many fields back into annual crop practice production which resulted in significant rutting and compaction in these areas.

Land Cover Type Changes 1994-2005

The table below summarizes the aerial extent and percentage change in land cover type during the period of 1994-2005.

Table 2.0: Percent Change in Land Cover over a 12-year span in the Netley - Grassmere Study Area (1994, 2001, and 2005)

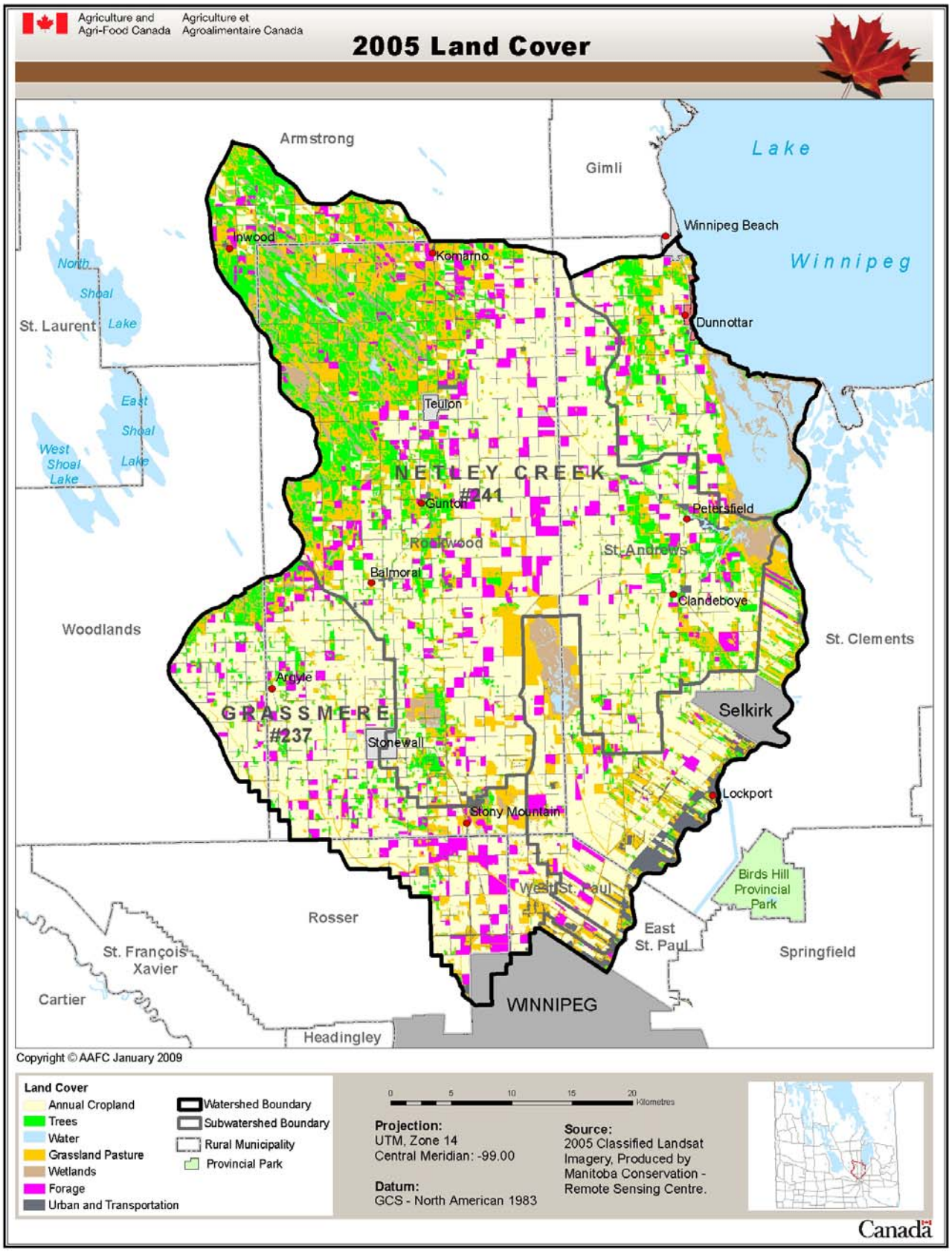
Land Cover	1994 Area[1] (ha)	2001 Area[1] (ha)	2005 Area[1] (ha)	% Change[1] from 1994 to 2001 (7-year span)	% Change[2] from 2001 to 2005 (5-year span)
Annual Cropland	129,812.31	120,970.62	118,008.27	-7%	-2%
Trees	26,883.00	27,566.64	29,235.33	3%	6%
Water	8,532.45	8,389.71	8,135.37	-2%	-3%
Grassland/Pasture	43,063.02	45,795.33	41,311.26	6%	-10%
Wetlands	9,685.71	8,917.20	9,553.05	-8%	7%
Forage	8,227.80	13,133.70	17,455.95	60%	33%
Urban/Transportation	10,053.81	11,484.90	12,558.87	14%	9%

1. % Change is calculated as Year 2001-Year 1994/Year 1994 x 100
2. % Change is calculated as Year 2005-Year 2001/Year 2001 x 100

Although there are some inherent limitations in utilizing land cover analysis methods to determine changes in land use, some important trends can be identified:

- Annual cropland remains the predominant land cover type in the watershed with a 9% reduction in area between 1994 and 2005.
- There is an increase in forages by 93%. This can most likely be attributed to the Permanent Cover Program (PCP) introduced in the early 1990s to encourage the conversion of marginal lands from annual cropping production to perennial cover. The repeal of the Western Grain Transportation Act (WGTA) also influenced the conversion of annual cropland to forage production on marginal lands. Impacts of the PCP and the removal of the WGTA coupled with favourable exchange rates (higher Canadian dollar versus United States dollar) led to accelerated land conversion of both viable lower class and prime agricultural land to forages. In addition to using these forages to feed local livestock, they are also used for forage seed production (predominantly perennial rye and alfalfa) and high quality alfalfa and timothy production for the United States market.
- Further localized droughts in Manitoba (specifically in the North Interlake and Westlake area) and in Alberta led to higher demand for beef quality hay and higher prices in 2001-2002.
- Also of significance is the 23% increase in lands identified as urban/transportation. The increased pressure for urban development within the watershed, particularly near Stonewall and Selkirk has taken prime and viable lower classed agricultural land out of production.

Figure 2: 2005 Land Cover for the Netley - Grassmere Study Area



Soils

The soils data used in this report included detailed soil survey at a scale of 1:20,000 for the Rural Municipality of Rockwood, and in the Winnipeg Region Study Area. Soil information for the remainder of the watershed is at a scale of 1:100,000 scale for the Fisher - Teulon region and at a reconnaissance scale of 1:126,720 for the area covered by the Winnipeg - Morris Map Sheet Area. Soil information provided in this report is based on the characteristics of the dominant soil series within the various soils polygons (See ***Appendix C***).

Soils within the watershed have been analyzed to determine agriculture capability, surface texture, water erosion and wind erosion. These datasets were used in conjunction with the land cover changes for the period 1994-2006 to conduct additional analysis of the two subwatersheds of Netley Creek and Grassmere Drain.

As a majority of the soil survey information within the Netley Creek Grassmere Drain IWMP has been collected at a reconnaissance scale, it is suitable for broader landscape based analysis and regional planning purposes. This information is not suitable for site specific planning purposes as more detailed soils information is required for assessments and management considerations at a more detailed scale.

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 land use aimed at providing a basis for making land-use planning decisions. Under the CLI, lands are classified according to physical capability for agricultural use (PFRA, 2005).

Agriculture capability can best be described as the ability of the land to support the appropriate type of crops and agriculture management techniques. Not all land can be managed in the same manner with soil types, topography, stoniness, soil moisture deficiency and low fertility and other potential limitations influencing land use and practices. Classes ranging from 1 to 7 have been established with 1 being the highest rated land class and 7 being the lowest rated land for agriculture. Further information about CLI and specific characteristics and limitations associated with individual land classes is provided in ***Appendix D***.

Within the Netley - Grassmere Study Area, the majority of the land is classified as Classes 1, 2, and 3, covering approximately 69% of the study area (see ***Figure 3*** and ***Table 3***). Class 2 and 3 soils can be found in both the Red River Valley (lacustrine clays) and the Interlake Till Plain (lacustrine clay over tills) and are widely distributed across the watershed. Another 24% of the soils are considered Class 4, 5, 6 and 7 while another 2% as organic soils. In general terms, Class 4,5 and 6 soils are found within the Manitoba Till Plain is located in the northwestern portion of the IWMP study area. Organic soils are generally found adjacent to the Oak Hammock and Netley Marshes. In the 2005 growing season, about 10% of the annual crop production occurred on soils which may be more suitable for perennial forage production (Class 4, 5, 6, and Organic).

Table 3.0 : Agricultural Capability in the Netley - Grassmere Study Area [1]

Class	Area (ha)	Percent of Study Area	Distribution of Annual Cropland [2]
Class 1	1,131	0%	0%
Class 2	82,245	35%	47%
Class 3	80,771	34%	43%
Class 4	38,517	16%	6%
Class 5	9,160	4%	2%
Class 6	10,578	4%	2%
Class 7	1,980	1%	0%
Organic	4,742	2%	0%
Unclassified	160	0%	0%
Water	6,946	3%	0%
TOTAL	**236,232**	**100%**	**100%**

1. Agricultural Capability is based on the CLI Rating of the dominant soil series for each soil polygon
2. Annual Cropland taken from the 2005 Land Cover (from Landsat Imagery)

In the Netley Creek Subwatershed:

- Approximately 63% (83,240 ha.) of the landbase is prime agricultural land (Class 1, 2, and 3)
- In 2005, approximately 14% of the annual cropland (8,094 ha) was found on Class 4, 5, 6 and 7 and organic soils (see ***Figure 4***).

In the Grassmere Drain Subwatershed:

- Approximately 90% (42,794 ha.) of the landbase is prime agricultural land
- In 2005, approximately 3% of the annual cropland (887 ha) was located on Class 4, 5, 6 and 7 and organic soils (see ***Figure 4***).

Figure 3: Agricultural Capabilities Map for the Netley - Grassmere Study Area

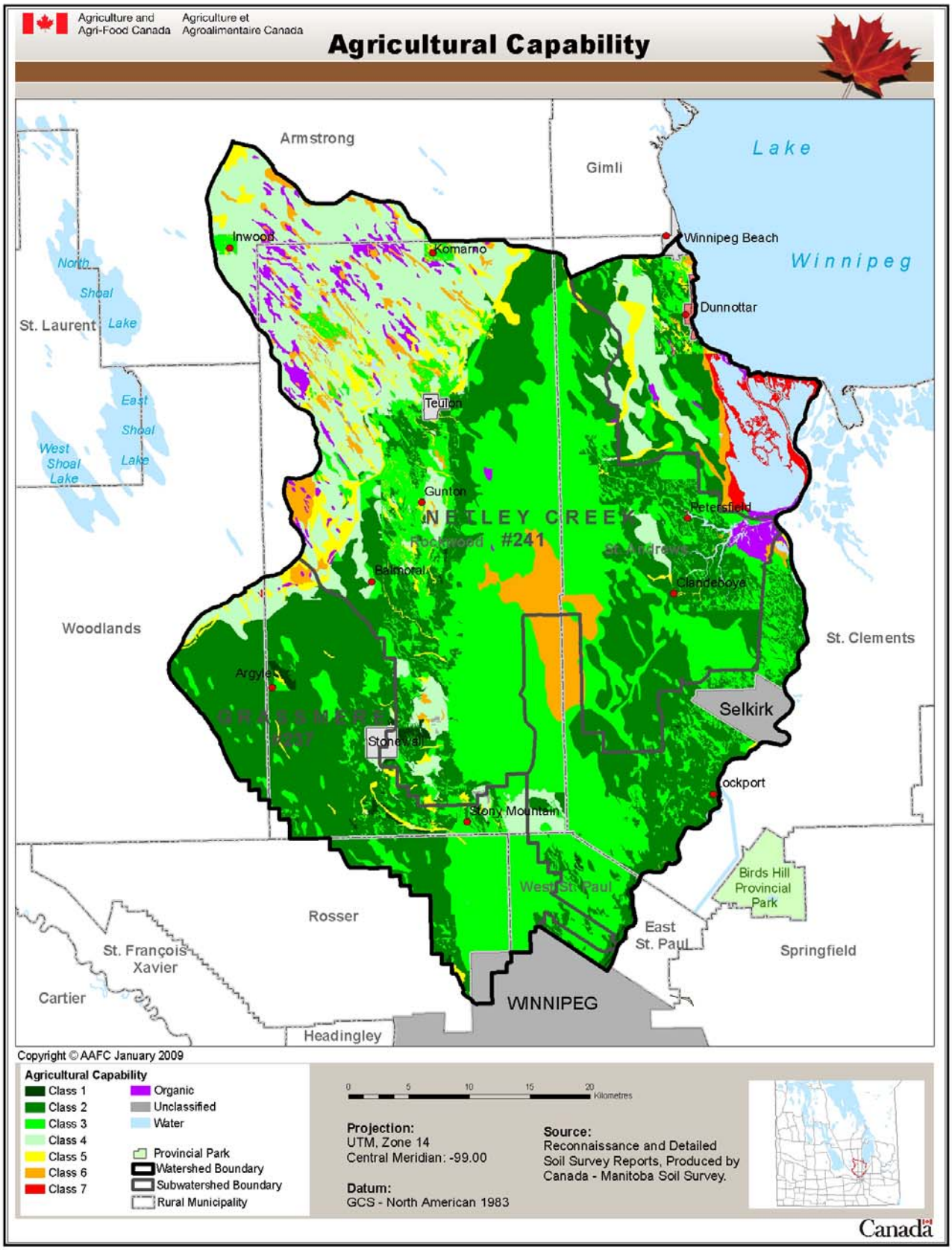
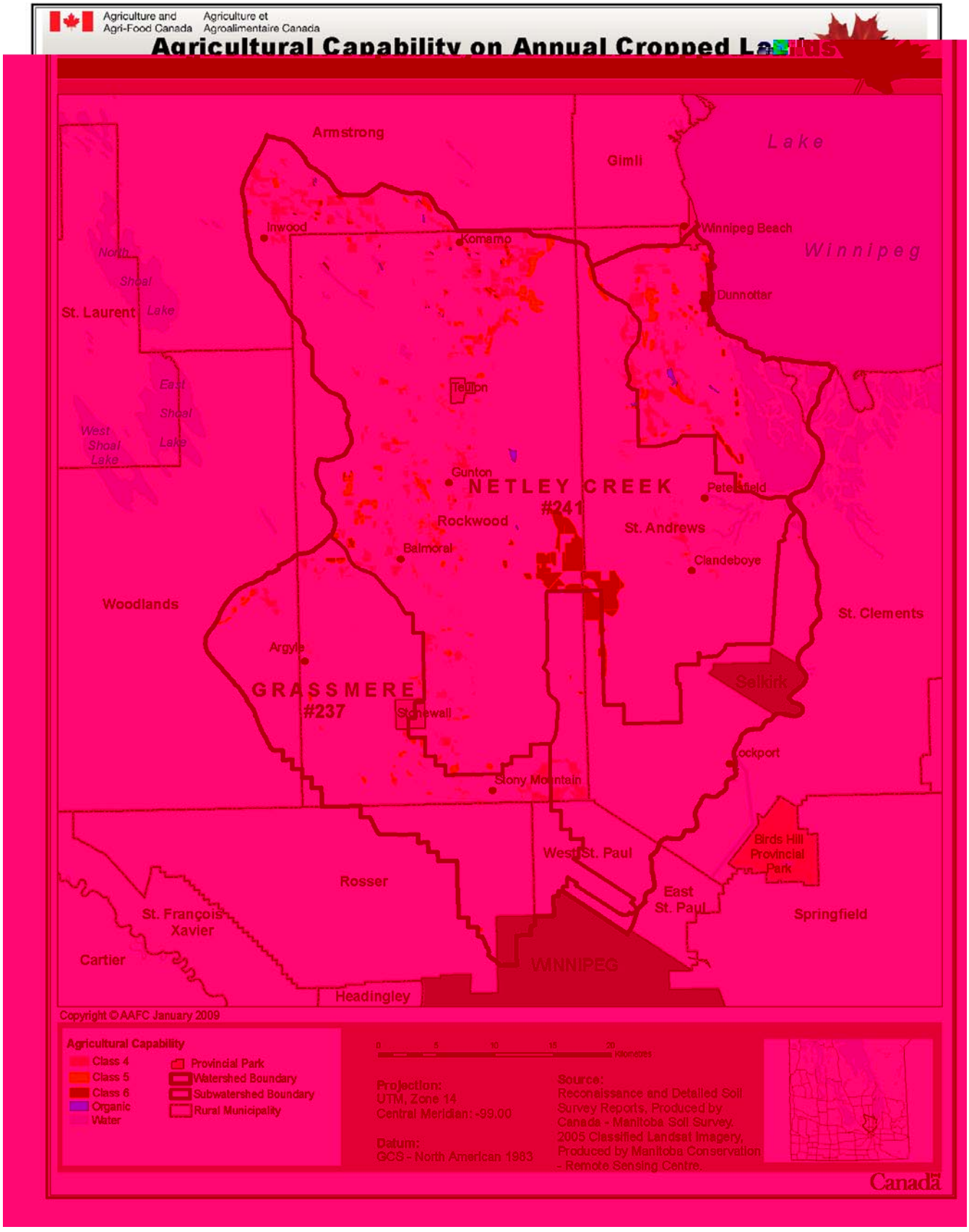


Figure 4: Agricultural Capabilities Map with Respect to 2005 Annual Cropping in the Netley - Grassmere Study Area



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, with little moisture being retained resulting in these soils drying out more quickly than fine-textured (clayey) soils. Sandy soils are often characterized as having a loose or single-grained structure which is very susceptible to wind erosion whereas clay soils have a high proportion of very small pore spaces that are capable of retaining moisture. Clay soils are usually fertile because they have a greater capacity to retain nutrients than sandy soils. However, they transmit water very slowly and are therefore susceptible to excess moisture conditions (PFRA, 2005)

Approximately 41% of the watershed is comprised of fine loamy soils which are generally located within the western portion of the watershed (refer to ***Figure 5*** and ***Table 4***). Another 38% of the soils are classified as clayey type soils and are generally located within the eastern portion of the watershed. About 7% of the soils in the watershed are considered organic from a textural perspective, and are located in and around Oak Hammock and Netley - Libau Marshes, as well as in disbursed pockets in the very northwestern portion of the study area. Another 7% of the total land base has coarse loamy textured soils. These soils are found primarily in the area extending between the communities of Stonewall and Balmoral and a small portion located northeast of the community of Teulon. These soils generally correspond to the significant terminal moraine that marks the boundary between the Interlake Till Plain and the Red River Valley. This terminal moraine and its characteristic texture and topography are of significance when evaluating the potential water erosion within the watershed. Sandy textured soils, associated with moraine deposition, account for approximately 3% of the watershed area.

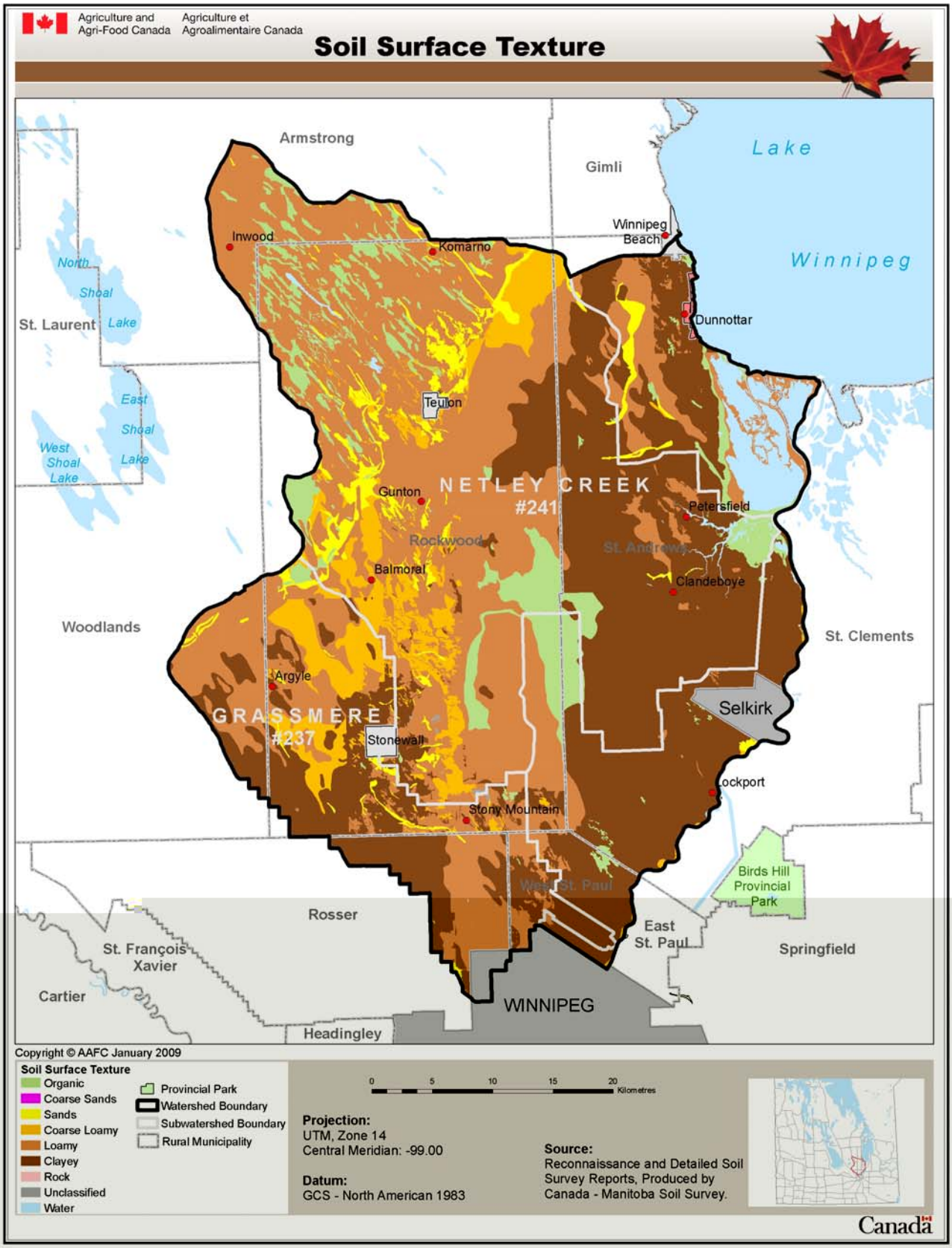
In the 2005 cropping season, approximately 6% of the annual cropland was located on soils with sand to coarse sand texture or organic soils. Another 10% of the annual crop production occurred in areas with coarse loamy textured soils.

Table 4.0: Soil Texture Classes in the Netley - Grassmere Study Area [1]

Class	Area (ha)	Percent of Study Area	Distribution of Annual Cropland[2]
Organic	17,047	7%	4%
Coarse Sands	64	0%	0%
Sands	7,620	3%	2%
Coarse Loamy	17,095	7%	10%
Loamy	97,578	41%	35%
Clayey	89,718	38%	49%
Rock	3	0%	0%
Unclassified	160	0%	0%
Water	6,946	3%	0%
TOTAL	**236,232**	**100%**	**100%**

1. Soils Surface Texture is based on the textural rating of the dominant soil series for each soil polygon
2. Annual Cropland taken from the 2005 Land Cover (from Landsat Imagery)

Figure 5: Soil Surface Texture for the Netley - Grassmere Study Area



In the Netley Creek Subwatershed:

- Approximately13% of the landbase has sand to coarse sand textured soils or organic soils while 8% has coarse loamy soils.
- In 2005, approximately 8% of the annual cropland (1,665 ha) was located on sand to coarse sand textured soils, 5% on organic soils, and another 12% (7,329 ha) on coarse loamy textured soils.
- Further analysis using 2002 and 1994 land cover data, indicate that annual cropping on sand to coarse sand textured soils, or organic soils and have increased.

In the Grassmere Drain Subwatershed:

- Approximately 3% of the landbase has sand to coarse sand textured soils or organic soils while 12% has coarse loamy soils.
- In 2005, approximately 1% of the annual cropland (306 ha) was located on sand to coarse sand textured soils, less than 1% on organic soils, and another 16% (4,598 ha) on coarse loamy textured soils.
- Further analysis using 2002 and 1994 land cover data indicates that annual cropland on sand to coarse sand textured soils, or organic soils has decreased.

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 bare and unprotected soil conditions. 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 a bare soil scenario 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).

Approximately 17% of the Netley Creek - Grassmere Drain IWMP Study Area is considered to have a moderate water erosion risk (refer to ***Figure 6*** and ***Table 5***). This risk is mainly situated in an area delineated in a north-south pattern between the communities of Teulon, Stonewall, and Stony Mountain. Approximately 80% of the study area is considered to have a low or negligible risk for water erosion. There may be some small, localized areas with a high to severe risk of erosion in the study area but they could not be identified using the scale of data used for this analysis.

In the 2005 cropping season, approximately 22% of the annual cropland was located on soils with moderate risk to water erosion. Further analysis of 2002 and 1994 land cover data indicates that annual cropping practices on moderate soil erosion risk have declined since 1994.

Table 5.0: Water Erosion Risk in the Netley - Grassmere Study Area [1]

Class	Area (ha)	Percent of Study Area	Distribution of Annual Cropland[2]
Negligible	114,863	49%	40%
Low	73,560	31%	38%
Moderate	40,605	17%	22%
High	73	0%	0%
Severe	24	0%	0%
Unclassified	160	0%	0%
Water	6,946	3%	0%
TOTAL	**236,232**	**100%**	**100%**

1. Water Erosion Risk is based on the dominant soil series for each soil polygon and assumes bare soil
2. Annual Cropland taken from the 2005 Land Cover (from Landsat Imagery)

In the Netley Creek Subwatershed:

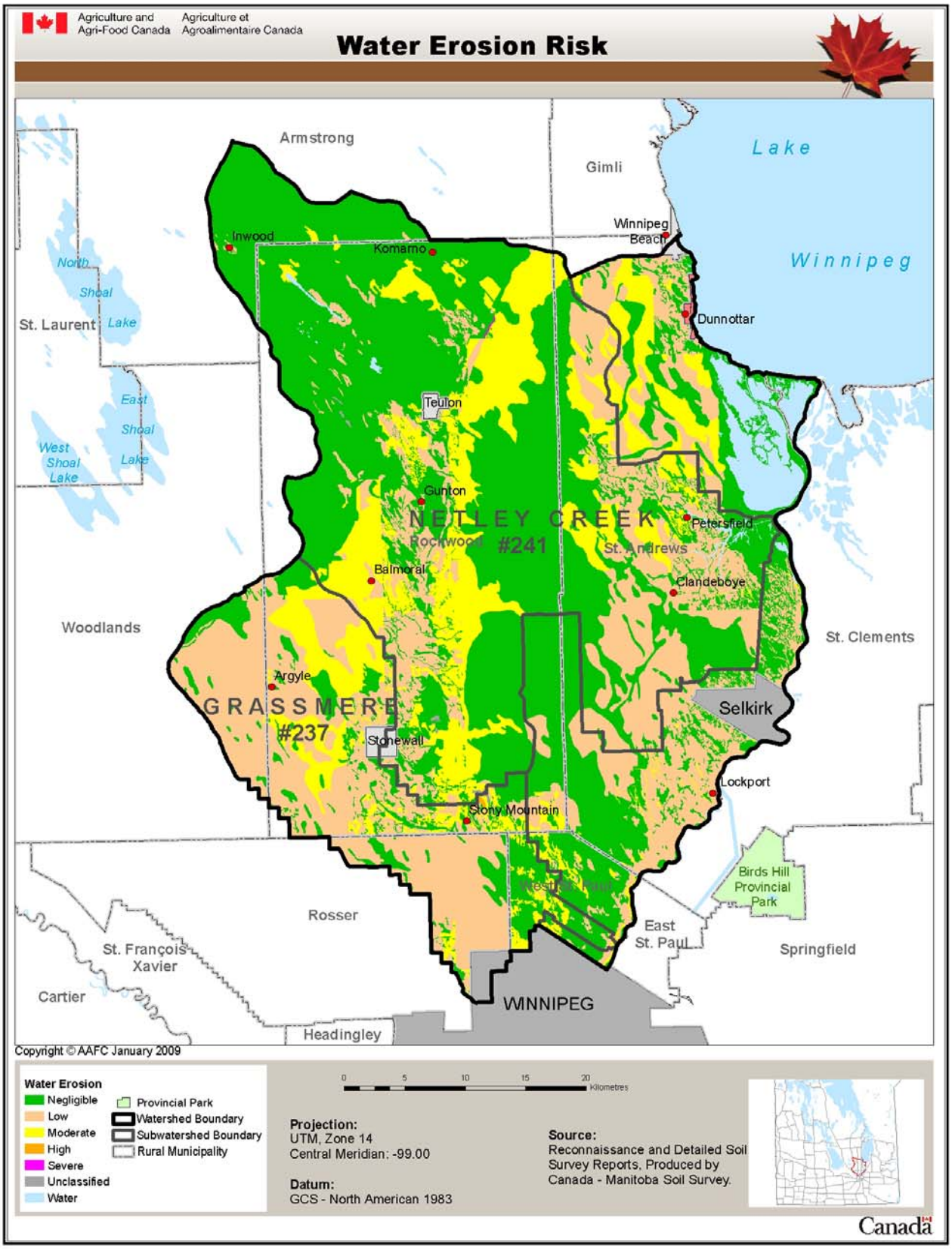
- Approximately 19% of the landbase is at a moderate risk for water erosion.
- In 2005, approximately 26% of the annual cropland (16,626 ha) was located on soils with a moderate risk for water erosion.

In the Grassmere Drain Subwatershed:

- Approximately 18% of the landbase is at a moderate risk for water erosion.
- In 2005, approximately 21% of the annual cropland (6,107 ha) was located on soils with a moderate risk for water erosion.

Conservation tillage practices, crop selection and residue management are extremely important in mitigating water erosion risk within the watershed and reducing particulate phosphorus transport into the local drainage system.

Figure 6: Water Erosion Risk for the Netley - Grassmere Study Area[1]



1. Water Erosion Risk is based on bare soil and does not take into account vegetative cover on management practices

Wind Erosion Risk

Wind erosion risk information in Manitoba has been developed from the provincial soil survey data and the Soil Landscapes of Canada (SLC Ver 1.0 - See ***Appendix E***). The Wind Erosion Risk model used for the Agriculture Canada Wind Erosion Risk Maps (1989) incorporates soil moisture, surface roughness and aggregate size, and drag velocity by wind. 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 and do not consider land use and crop management factors. 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 a bare soil scenario 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. 1989).

Approximately 6% of the Netley - Grassmere Study Area is considered to have a high or severe wind erosion risk (***Figure 7*** and ***Table 6***), primarily in the north-western portion of the watershed. Affected areas generally correspond to the Red River Valley portion of the study area where fine textured clay over till soils are found (***Figure 7***). Approximately 38% of the watershed is considered low or negligible for soil erosion risk and is generally associated with land under perennial cover, often correlating with Class 4, 5, and 6 soils.

Based on 2005 land cover approximately 4% of the annual cropland is located on soils with a high to severe risk for wind erosion (see ***Figure 8***). Organic soils, when dry and exposed, are also at risk to wind erosion. In 2005, about 3% of the annual cropland was located on organic soils.

Table 6.0: Wind Erosion Risk in the Netley - Grassmere Study Area [1]

Class	Area (ha)	Percent of Study Area	Distribution of Annual Cropland[2]
Negligible	4,563	2%	1%
Low	84,727	36%	31%
Moderate	110,071	47%	61%
High	8,559	4%	3%
Severe	4,216	2%	1%
Organic Soil	14,900	6%	3%
Water	7,074	3%	0%
Bare Rock	3	0%	0%
Unclassified	2,147	1%	0%
TOTAL	**236,260**	**100%**	**100%**

1. Wind Erosion Risk is based on the weighted wind erosion rating for each soil polygon and assumes bare soil.
2. Annual Cropland taken from the 2005 Land Cover (from Landsat Imagery)

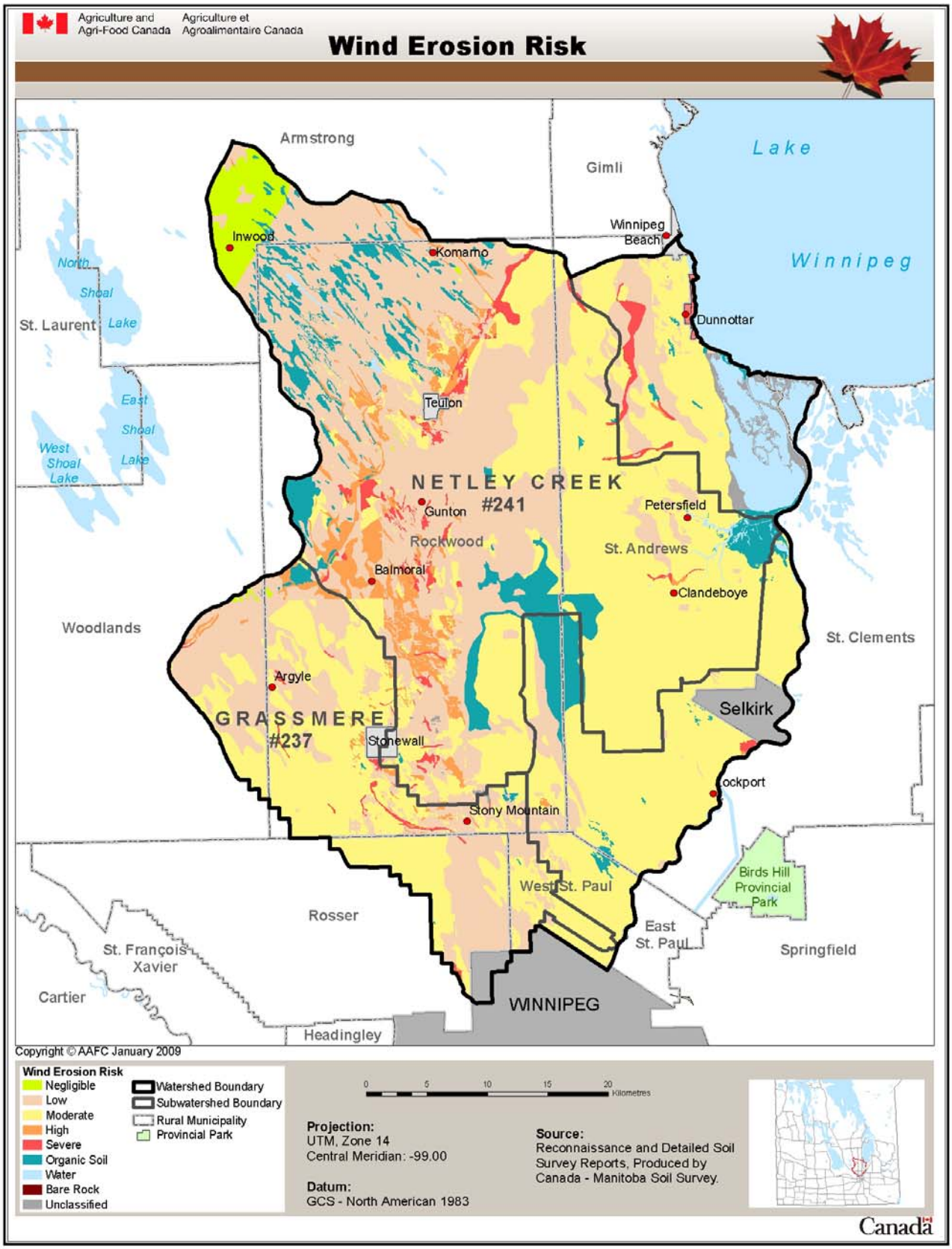
In the Netley Creek Subwatershed:

- Approximately 8% of the landbase has a high to severe risk for wind erosion. Another 8% has organic soils which could possibly at risk depending on management practices.
- In 2005, approximately 7% of the annual cropland (4,754 ha) was located on soils with a high to severe risk for erosion. Another 4% (2,509 ha) was located on organic soils (see ***Figure 7***), and have risk depending on what type of cropping practice.
- Further analysis using 2002 and 1994 land cover data indicates that the number of hectares identified for annual cropland on high to severe wind erosion risk appears to be declining slightly.

In the Grassmere Drain Subwatershed:

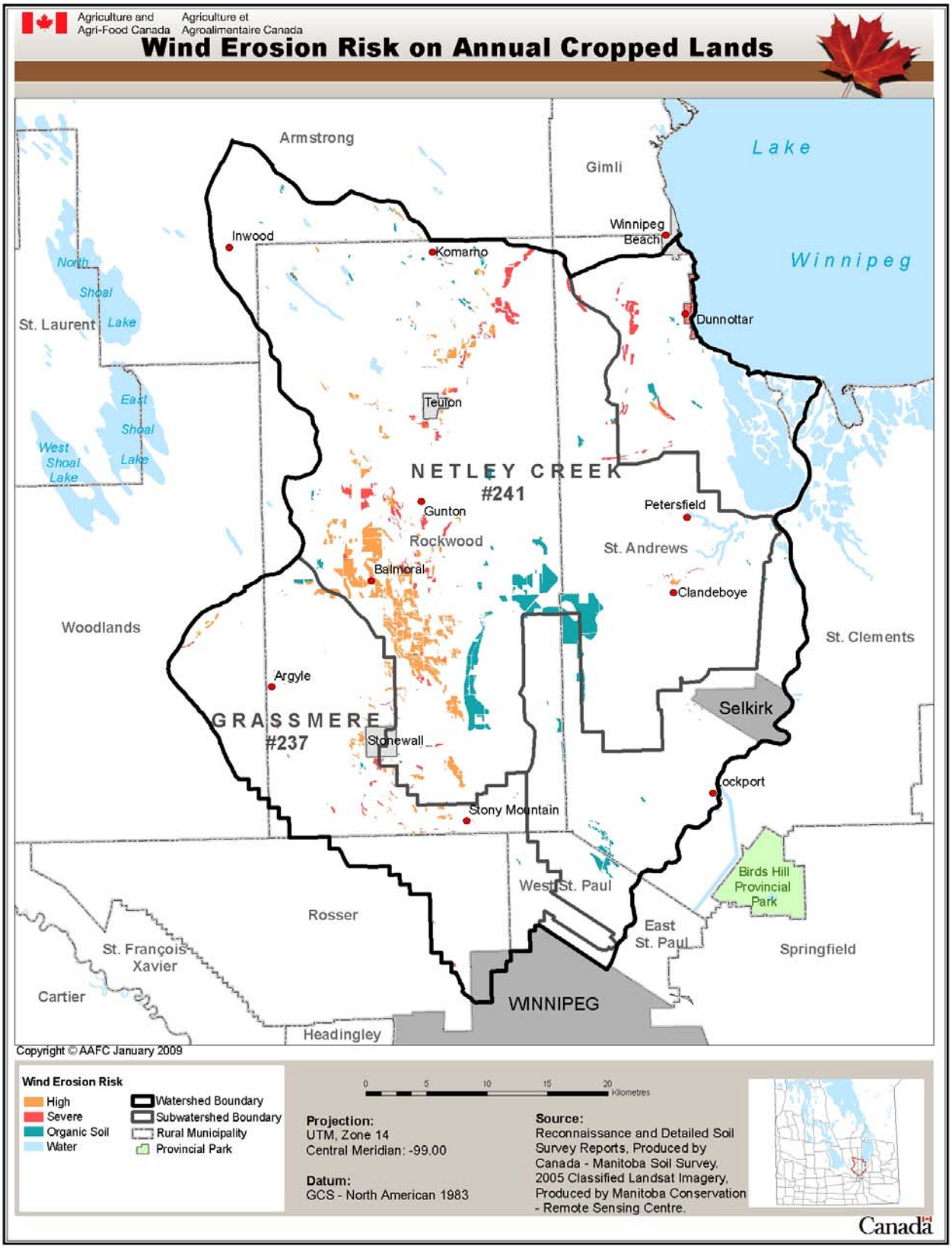
- Approximately 3% of the landbase has a high to severe risk for water erosion. There is an insignificant amount of organic soils in the watershed.
- In 2005, approximately 2% of the annual cropland (591 ha) was located on soils with a high to severe risk for erosion (see ***Figure 8***).
- Further analysis using 2001 and 1994 land cover data, indicates that the number of hectares identified as annual cropland on high to severe wind erosion risk appears to be unchanged.

Figure 7: Wind Erosion Risk for the Netley - Grassmere Study Area[1]



1. Wind Erosion Risk is based on bare soil and does not take into account vegetative cover on management practices

Figure 8: Wind Erosion Risk with Respect to 2005 Annual Cropping in the Netley - Grassmere Study Area[1]



1. Wind Erosion Risk is based on bare soil and does not take into account vegetative cover on management practices

Soil Drainage

Soil drainage reflects the actual moisture content in excess of field capacity and the length of the saturation period within the plant root zone. Excess water content in the soil limits the free movement of oxygen and decreases the efficacy of nutrient uptake. Delays in spring tillage and planting are more likely to occur in depressional or imperfectly to poorly drained areas of individual fields. Surface drainage improvements and tile drainage are management practices that can potentially be used to manage excess moisture conditions in soils but should only be used if deemed appropriate for the location and site specific situation and endorsed by the regulations in the Province of Manitoba. Agriculture and Agri-Food Canada (AAFC) has classified soils for their drainage capacity using a five class system (see ***Appendix F***).

Approximately 73% of the landbase within the study area can be considered imperfectly or poorly drained (***Figure 9***). A significant amount of this land is under annual crop production based on 2005 land cover data (see ***Figure 10*** and ***Table 7***). Improved drainage indicates areas where networks of surface drains accelerate surface runoff and reduce the duration of surface ponding. While these drains effectively move water off fields and decrease the amount of standing water in agricultural fields, other adverse effects need to be considered.

The drains facilitate water moving off fields more quickly than under natural run off conditions resulting in river channels being filled to high water levels during heavy precipitation events. High water levels could lead to a flood or near-flood stage, thereby increasing the risk for water erosion. Man-made drainage systems tend to also not have riparian buffers associated with them unlike natural and undisturbed watercourses. With decreased or non-existing riparian buffers, there is an increased risk of nutrient and sediment loading into watercourses, a critical water quality issue associated with Lake Winnipeg. Riparian areas and perennial vegetation on adjacent lands are able to trap and store sediment and nutrients from field runoff during the growing season, reducing the risk of contaminating surface water.

Table 7.0: Soil Drainage Classes in the Netley - Grassmere Study Area [1]

Drainage Class	Area (ha)	Percent of Study Area	Distribution of Annual Cropland[2]
Rapid	1571	1%	0%
Well	34836	15%	12%
Imperfect	116977	50%	53%
Poor (Improved)[3]	54893	23%	31%
Poor	3777	2%	1%
Very Poor	15155	6%	3%
Unclassified	160	0%	0%
Marsh	1913	1%	0%
Water	6946	3%	0%
TOTAL	**236,229**	**100%**	**100%**

1. Soil Drainage is based on the dominant soil series for each soil polygon
2. Annual Cropland taken from the 2005 Land Cover (from Landsat Imagery)
3. Poor (Improved) represents soils that were considered poorly drained soils that have been improved with drainage.

In the Netley Creek Subwatershed:

- 48.6% of the land is classed as imperfectly drained soils
- Approximately 23% (31,820 ha.) of the land is classed as poor (improved) drained soils and 15% (20,639 ha.) is considered well drained soils
- Annual cropland on imperfectly drained soils has declined since 1994 (see ***Figure 9***).
- Annually cropped land on rapidly drained soils has increased since 1994.
- Forage acres have increased on imperfectly and poor drained soils.

In the Grassmere Drain Subwatershed:

- Over 74% of the land base has been classed as imperfectly drained soils
- Approximately 14% (6,798 ha.) of the land is considered to be poor (improved) drained soils and 10% (4,725 ha.) is considered well drained soils (see ***Figure 9***).
- Annual cropland on poorly drained, Imperfectly Drained and Well Drained soils has declined since 1994.

Figure 9: Soil Drainage for the Netley - Grassmere Study Area

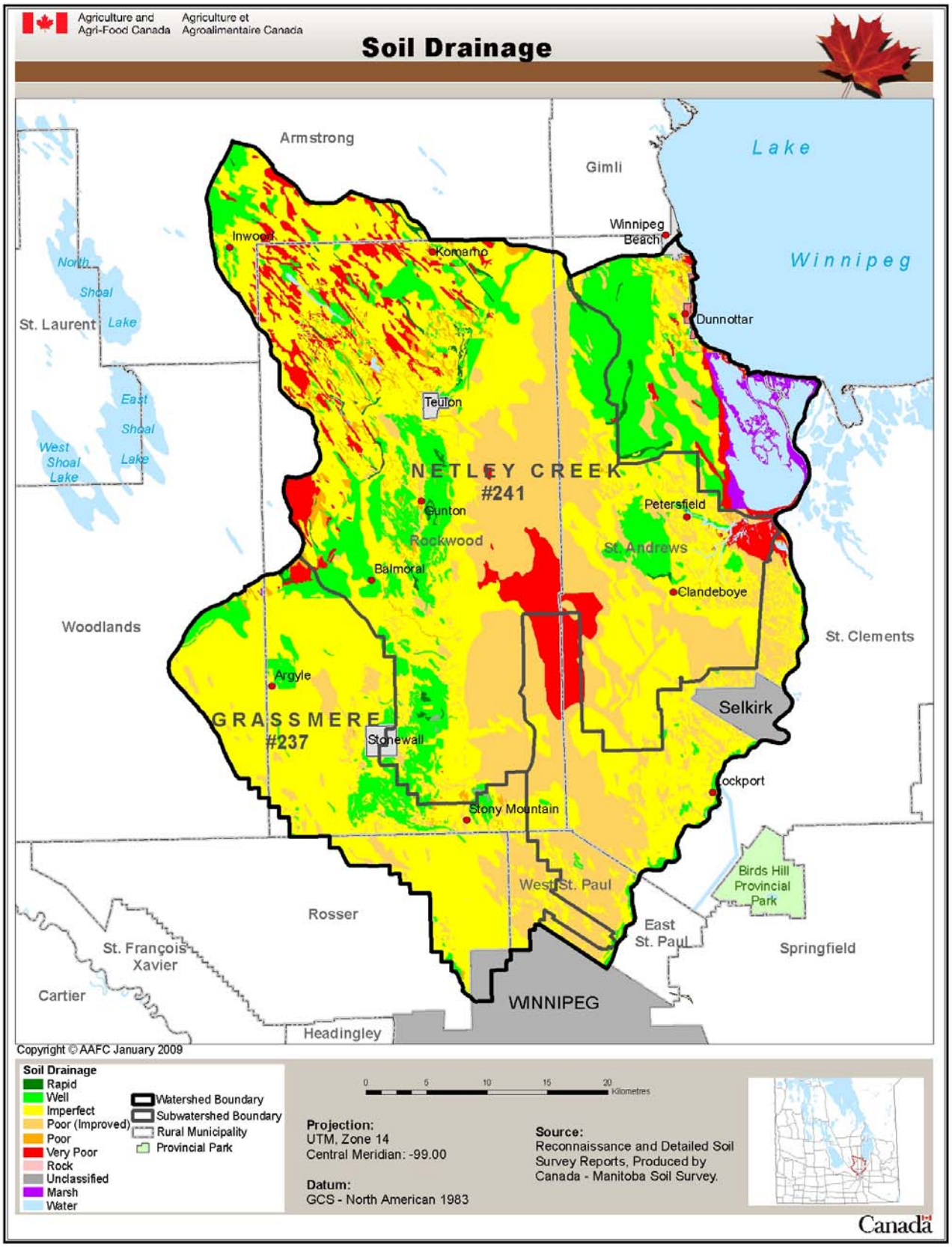
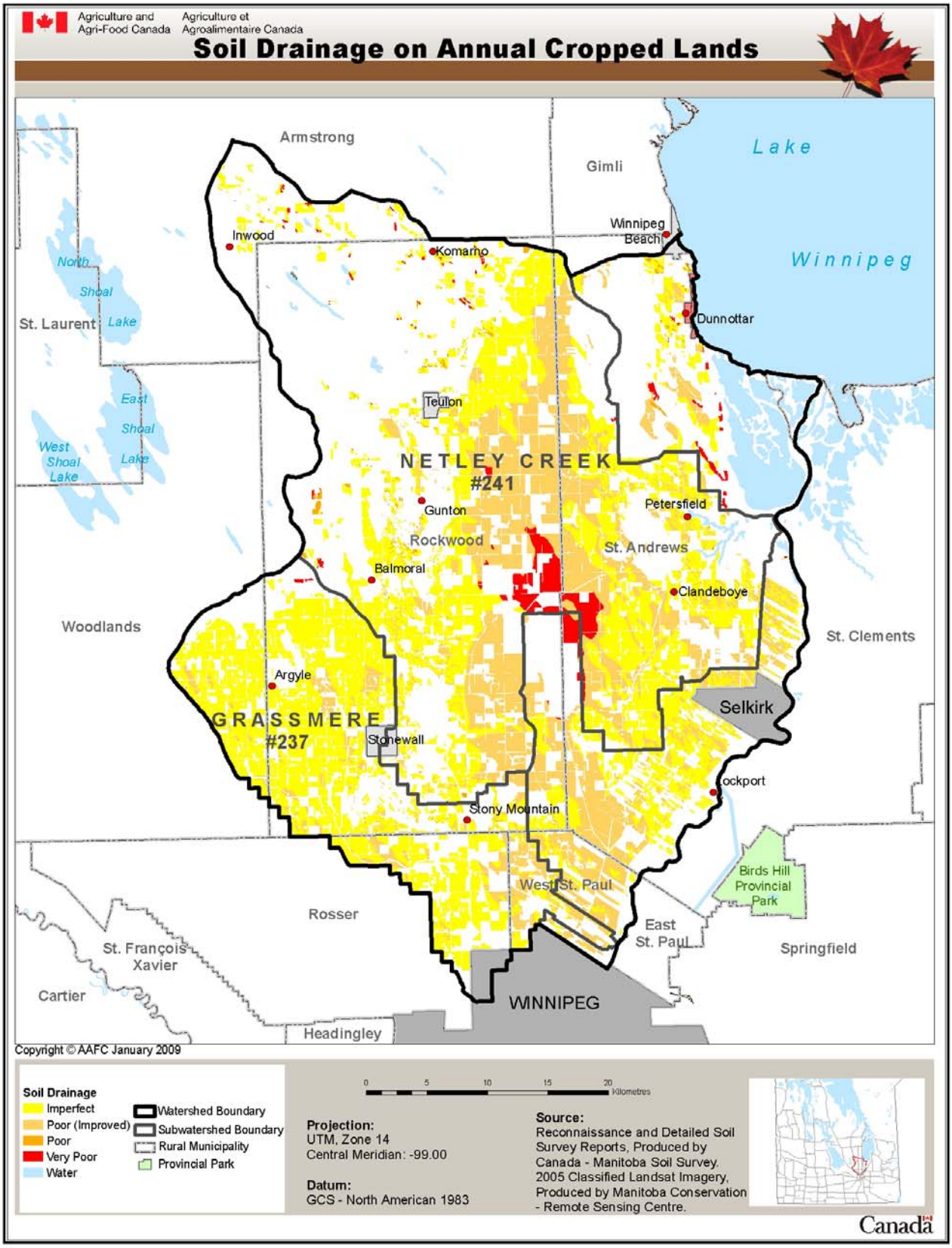


Figure 10: Soil Drainage with Respect to 2005 Annual Cropping in the Netley - Grassmere Study Area



Salinity

Saline soils are those that contain enough soluble salts in the root zone to adversely affect the growth of most crop plants. Saline soils are caused by a combination of geological, climatic and cultural conditions. The salt content of a soil can be estimated by measuring electrical conductivity (EC), which is usually expressed in deciSiemens per metre (dS/m). Salinity within the Netley - Grassmere Study Area is variable on an annual basis and correlates to moisture deficit, hydrologic conditions and depth to salinity during the growing season. As a result, soils defined as weakly saline may exhibit moderately or strongly saline conditions dependent upon the factors identified above. It should be noted that weakly saline soils can support a wide range of crop choices (including soybeans) under average normal moisture regimes (see ***Appendix G***). Risks associated with fine textured weakly saline soils (which may influence crop yield) along with disease potential should be taken into consideration when making cropping decisions. Similarly, fine textured soils classified as moderately and strongly saline will demonstrate higher levels of salinity under moisture deficit conditions. It should also be noted that moderately saline areas with localized areas of strongly saline soils have been identified adjacent to the terminal moraine that runs from the Stoney Mountain area north to Balmoral and Teulon.

Salinity maps based on soil reconnaissance show that the majority of the watershed (almost 83% or 195,716 ha.) is considered to be non-saline in nature (see ***Figure 11*** and ***Table 8***). Approximately 14% (32,157 ha.) are considered weakly saline (< 4 dS/m.). Although these soils would be prone to salinity development under the right environmental conditions and land management practices, there are minor limitations for crop selection and yield impacts.

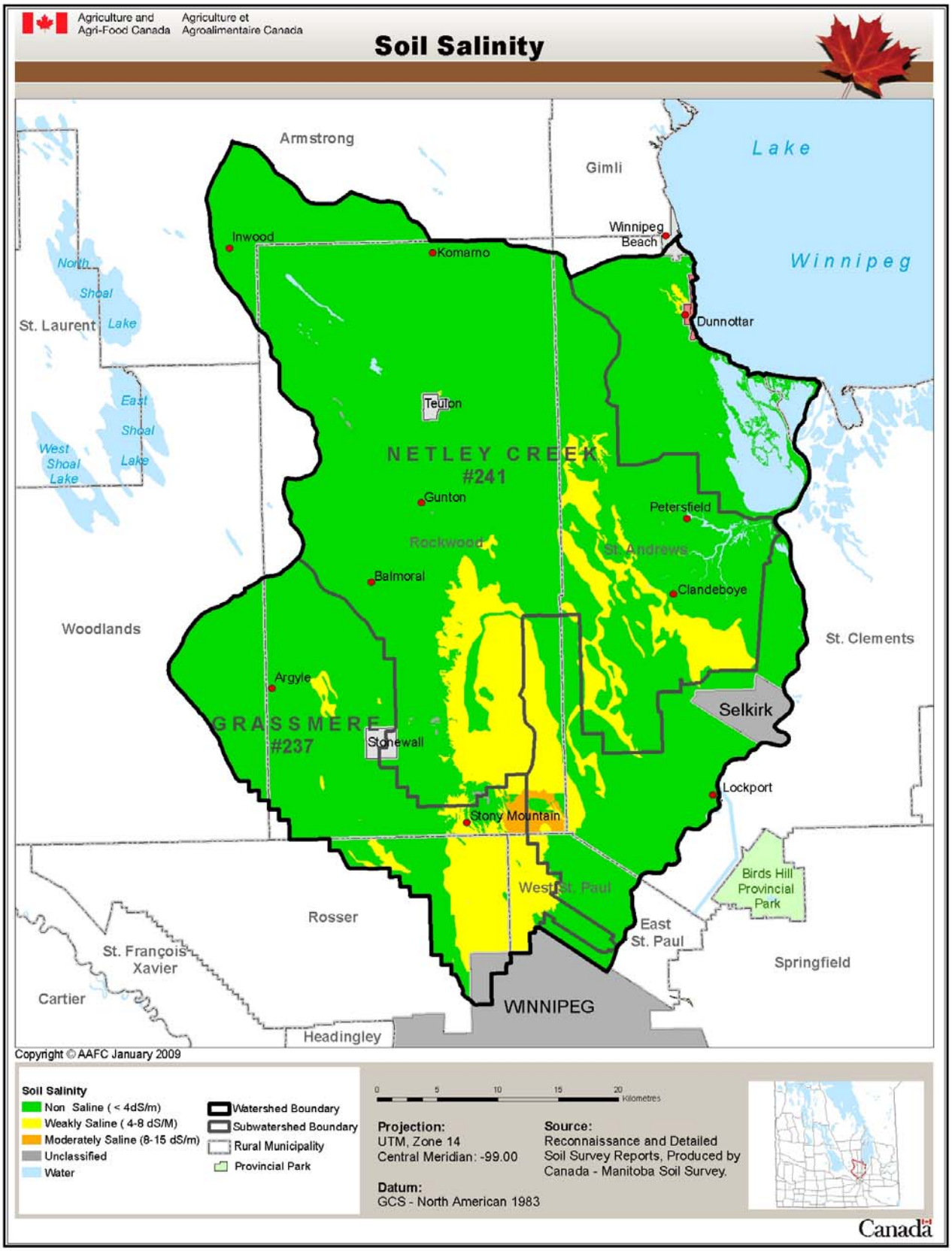
A small area (1,251 ha.) east of Stony Mountain and within the Grassmere Drain subwatershed has been identified as being moderately saline. When comparing soil salinity with land cover data, 55% (693.45 ha.) of what has been classified as moderately saline soils is under annual crop production based on 2005 data. It has also been noted that this number has steadily decreased from what was identified in the 2002 and 1994 Land cover data. This could be attributed to 2005 being a wet year, and/or that greater attention is given to more suitable land management and conservation practices.

Table 8.0: Salinity Classes in the Netley - Grassmere Study Area[1]

Salinity Class	Area (ha)	Percent of Study Area	Distribution of Annual Cropland[2]
Non Saline (< 4dS/m)	195,716	83%	82%
Weakly Saline (4-8 dS/M)	32,157	14%	17%
Moderately Saline (8-15 dS/m)	1,252	1%	1%
Unclassified	160	0%	0%
Water	6,946	3%	0%
TOTAL	**236,232**	**100%**	**100%**

1. Salinity is based on the dominant soil series for each soil polygon
2. Annual Cropland taken from the 2005 Land Cover (from Landsat Imagery)

Figure 11: Soil Salinity for the Netley Creek - Grassmere Drain Study Area



Agricultural Profile of the Netley - Grassmere Study Area

Agricultural profiling refers to the characterization of agricultural production in an area or a region. The ability to use Census of Agriculture information collected from producers can provide a snapshot in time of the agricultural footprint on the landscape. The information can be portrayed either on a municipal or geographical boundary (like a watershed) and can provide value to understanding the role and trends of the industry to the area.

Census of Agriculture data at a subwatershed scale has been obtained from Statistics Canada for the 2006 Census year. Further details on the method used to interpolate Statistics Canada's Census of Agriculture from a geographic boundary to a subwatershed boundary are provided in ***Appendix H***. For reporting purposes, numbers have been rounded to the nearest 5 for farm numbers, 10 for livestock and smaller area data, and 100 for poultry and for larger area and financial data.

It has been noted that the boundaries used by Statistics Canada does not completely align for analysis with the boundary of the Netley - Grassmere Study Area. But do when examining the two subwatersheds of the Netley - Grassmere Study Area; the Grassmere Drain Subwatershed and Netley Creek Subwatershed. These two subwatersheds represent approximately 75% of the Netley - Grassmere Study Area (See ***Figure 12***). While this agricultural profile will be for a smaller area than the IWMP Study Area, it will capture a majority of the agriculture industry in the IWMP Study Area and will be a fairly accurate representation to agricultural trends and activities.

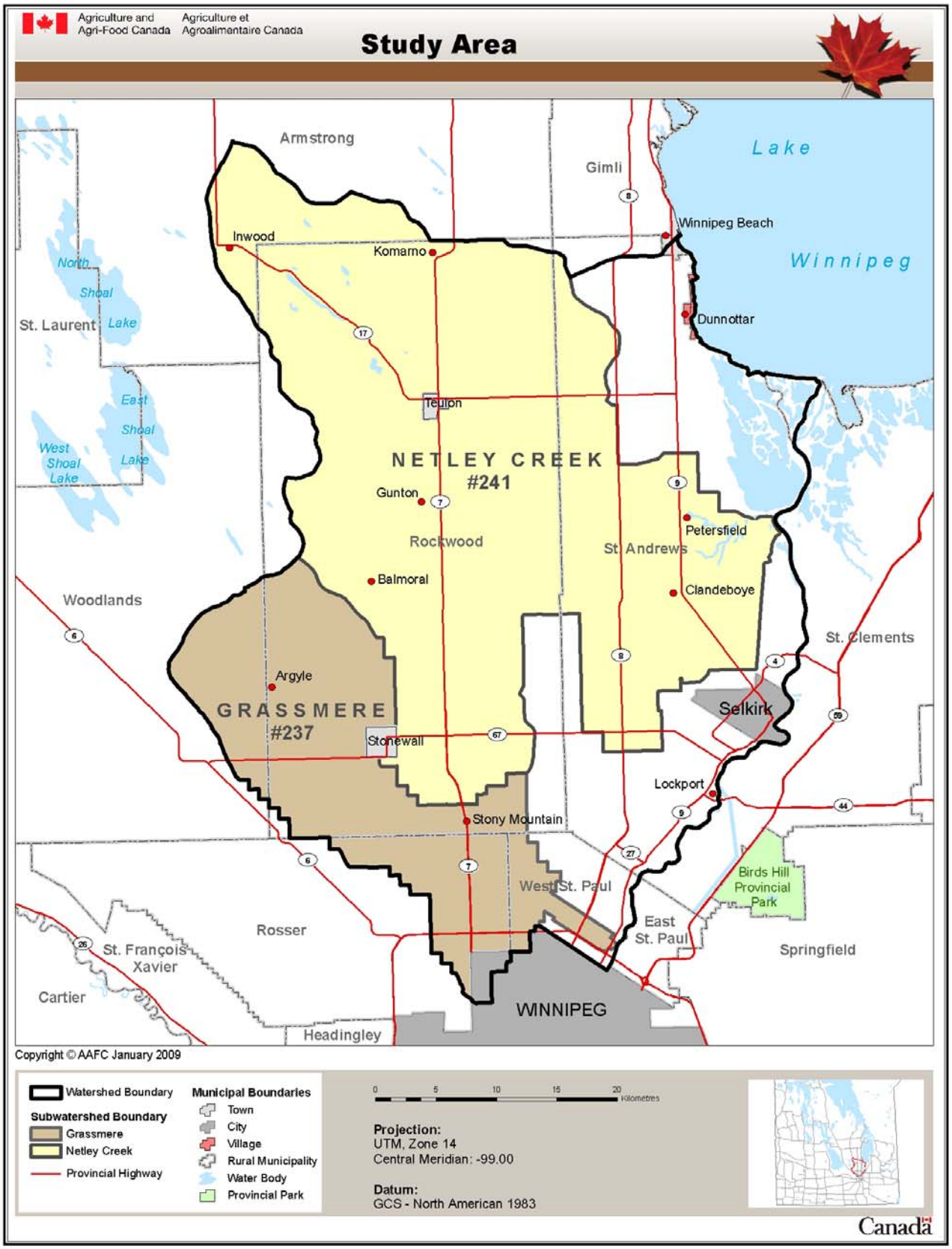
Summary of Farm Financial Characteristics

The Grassmere Drain Subwatershed is the smaller of the two watersheds with over 170 farms reporting an area of total farmland equivalent to over 85% of the Subwatershed. Generally, the average farm size is almost 240 ha/farm (580 acres) with an average capital investment of almost $4,000 per hectare of farmland (or $926,600 per farm). Livestock-related expenses per hectare of farmland are under $150/ ha of farmland, reflecting the overall smaller emphasis on livestock and poultry in the Subwatershed. Crop-related expenses are almost $180/ha which is higher than in the Netley Creek Subwatershed, as are the areas treated to pesticide and commercial fertilizer applications, due to the greater importance of crop production in this area.

In the Netley Creek Subwatershed, over 400 farm operations manage an area of farmland equivalent to over 80% of the subwatershed. Generally, the average farm size is almost 240 ha/farm (580 acres) and farms have a lower average capital investment at $3,500 per hectare or $907,000 per farm. Average livestock-related expenses per hectare of farmland are higher than that of Grassmere Drain at $240/ ha farmland, reflecting the importance of intensive livestock operations in the area.

In comparing the two sub-watersheds, the Grassmere Drain portion shows a higher capital investment (due in part to larger acreage of Class 2 and Class 3 soils where wetness is not a limiting factor) resulting in higher land values and additional crop input potential.

Figure 12: Agricultural Profile Coverage of Grassmere Drain and Netley Creek Subwatersheds



Summary of Land Use and Land Management

In the Grassmere Drain Subwatershed, over 60% of the farmland is dedicated to annual crop production and another 30% to pasture, alfalfa, and hay and fodder crops. Cereals make up about 60% of the annual crops while almost 30% is seeded to oilseeds. Land management practices include almost two thirds of the cultivated land prepared using conventional tillage practices, over 30% using conservation tillage practices and 5% prepared with zero tillage. As well, livestock production is also important in this subwatershed, with the presence of several intensive poultry, hog and dairy operations. Over 10 farms report poultry with an average flock size of almost 5,400 birds per farm. Over 5 operations reported pigs with an average of almost 3,200 animals/farm; most of these farms reported sows with an average of fewer than 600 sows per farm. As for dairy, fewer than 10 operations report an average of 60 dairy cows per farm. Only a third of the farm operations report beef cows, with an average of almost 50 cows per farm.

In the Netley Creek Subwatershed, half of the farmland is dedicated to annual crop production and another 40% to pasture, alfalfa, and hay and fodder crops. Cereals make up almost 60% of the area dedicated to annual crops, oilseeds another 30% and pulse crops cover 5%. Land management practices include almost two thirds of the cultivated land prepared using conventional tillage practices, over 30% using conservation tillage practices and less then 5% prepared with zero tillage. Crop-related expenses are lower than that of the Grassmere Drain Subwatershed, (at almost $130/ha cropland) as is the percentage of cropland treated to pesticide and commercial fertilizer applications. As well, livestock production is important in this subwatershed, with the presence of poultry, hog and dairy operations. Over 30 farms report poultry with an average flock size of under 2,800 birds. Almost 20 operations reported pigs with an average of almost 3,570 animals/farm; half of these farms reported sows with an average of over 730 sows per farm. As for dairy, over 10 operations report an average of almost 70 dairy cows per farm. In addition, almost half of the farm operations in the Subwatershed report beef cows with fewer than 50 cows per farm.

Relative Changes in Agricultural Production (2001 to 2006 Census Data)

Since 2001 Census of Agriculture data has also been acquired to the same subwatershed boundaries as the 2006 data, “relative changes” in production can be analyzed and can contribute to an understanding of the agricultural industry in the Netley - Grassmere Study Area and its two subwatersheds. Relative change is presented on a percentage basis.

The relative changes are categorized as:

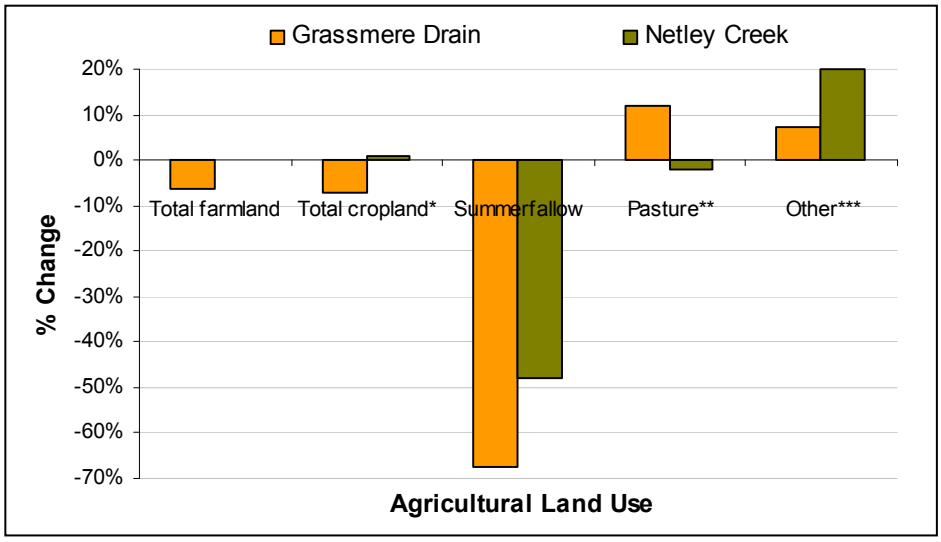
- Incomplete data – due to data suppression
- Large decrease – less than or equal to -30%
- Moderate decrease – -16% to -29%
- Little change – +/- 15%
- Moderate increase – 16% to 29%
- Large increase – 30% or more

It should be noted that there are many factors that influence decisions made on individual farms. In order to understand if changes are due to adaptation in farming systems and/or practices or due to weather, market and other conditions, it is important to also be aware of events and conditions. As a result, many of the noted changes will need to be further examined by land use and industry specialists and individuals with local watershed knowledge.

Relative Change in Land Use

According to the analysis of the Census of Agriculture, there is little overall change in total farmland area (see ***Figure 13***) over the 5 year period, though land use within the farmland shows some change. In both the Grassmere and Netley subwatersheds there is little change the Cropland and Pasture categories, while Summerfallow show a large decrease in area (for absolute numbers, please refer to ***Appendix I, Table 1***).

Figure 13: Percent change in agricultural land use types from 2001 to 2006 according to Census of Agriculture data.



* Total cropland includes all field crops, vegetables, fruit and nuts and sod
** Pasture includes tame pasture and natural areas used for pasture
*** Other category includes all other land uses including farmyard, woodlots, Christmas trees, wetlands, etc.

Relative Changes to Annual Cropping Practices

Analysis of 2001-2006 Ag. Census data (see ***Figure 14***) shows a decrease in cereal production with an increase in acreage of oilseeds, pulses and forages. (for absolute numbers see ***Appendix I, Table 2***).

Within the Grassmere Drain Subwatershed, from 2001 to 2006:

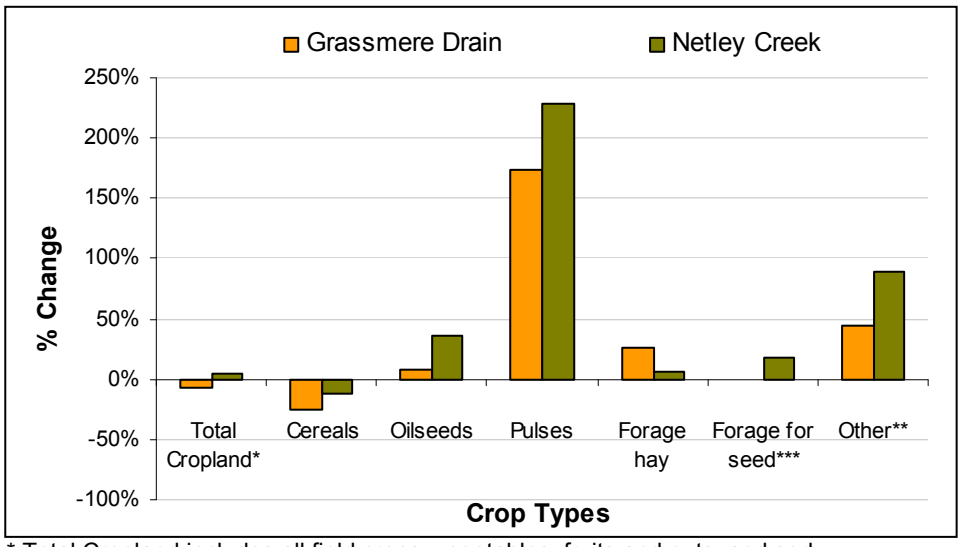
- Cereals experienced a moderate decrease in area
- Oilseeds showed little change in area
- Pulses and Forages for Hay had a large increase in area

Within the Netley Creek Subwatershed, from 2001 to 2006:

- Cereals and Forage for Hay had little change in area
- Oilseeds and Pulses had large increases
- Forage for Seed had a moderate increase

Conversion of Class 4 and 5 soils to forage production has mitigated risk for annual crop production on these soils. Higher input costs, lower grain prices, disease pressures, increased transportation costs coupled with a higher potential return and on-farm diversification has accelerated this trend from 1996 to present day. Producers continue to seek diversified income opportunities resulting in significant increase in acres of special crops (for example, increases in soybean production during the last Agricultural Census period).

Figure 14: Percent change in crop types from 2001 to 2006 according to Census of Agriculture data.



* Total Cropland includes all field crops, vegetables, fruits and nuts, and sod

** Other category includes other special field crops, fruits and nuts, sod, vegetables, and all suppressed hectares in the listed categories (which make up over 95% of the values)

*** Values have been suppressed to protect confidentiality in Netley Creek.

Relative Change in Annual Cropping Inputs

According to the two Census databases, areas with applications of commercial fertilizers, herbicides, insecticides or fungicides decreased (see ***Figure 15)*** (for absolute numbers see ***Appendix I, Tables 3*** and ***4***).

Within the Grassmere Drain Subwatershed, from 2001 to 2006, there was:

- A moderate decrease in areas treated to commercial fertilizers and herbicides
- A large decrease in areas treated to insecticides and fungicides

Within the Netley Creek Subwatershed, from 2001 to 2006, there was:

- A moderate decrease in areas treated to commercial fertilizer and herbicides
- A large decrease in areas treated to insecticide
- Little change in areas treated to fungicides

There may be several reasons for the decrease in copping inputs but the most likely reason is due to the increase in costs of these inputs. For example, while there is little change in dollars spent on commercial fertilizer and lime (see ***Figure 16***), there is a moderate decrease in application area. Further analysis indicates that although the area with fertilizer applications decreased, farmers spent an average of $50 more per hectare. Therefore, the decrease in fertilizer and pesticide use can be attributed to the increased costs. As well, reduction in crop inputs can be attributed to abnormally high rainfall from the fall of 2004 through 2005, which also impacted crop inputs in these years.

Figure 15: Percent change in areas treated to crop inputs from 2000 to 2005 according to Census of Agriculture data.

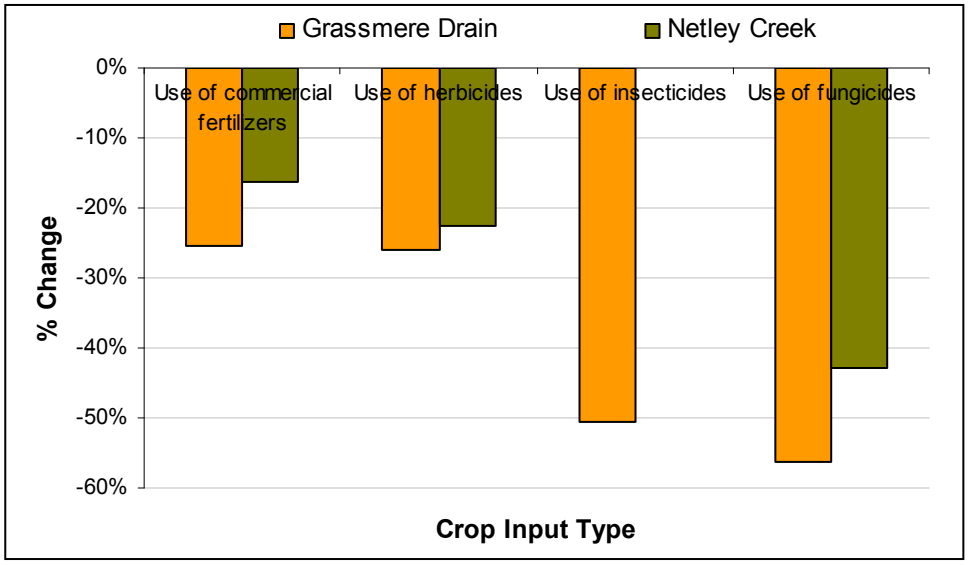
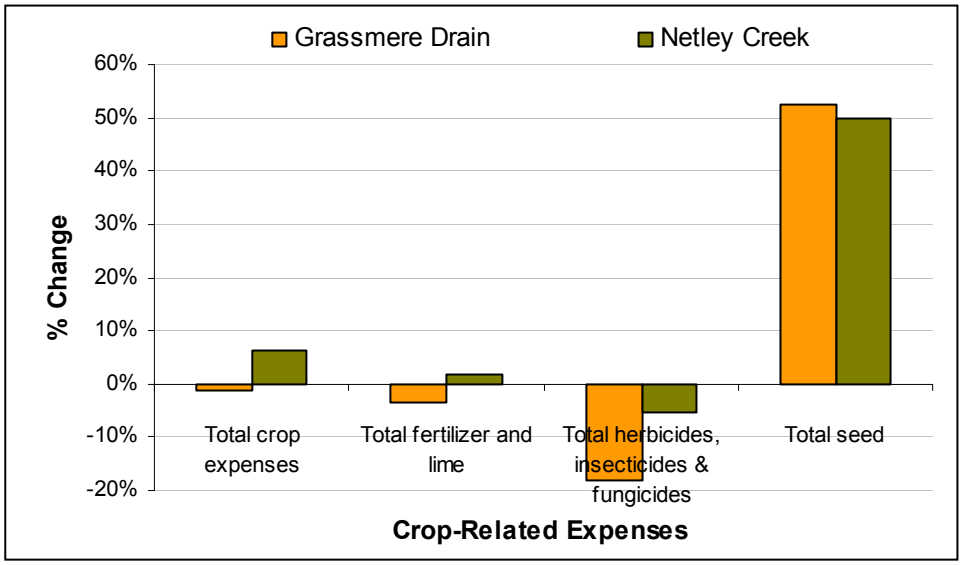


Figure 16: Percent change in crop-related expenses from 2000 to 2005 according to Census of Agriculture data.



Relative Change in the Livestock and Poultry Sector

With respect to livestock, from 2001 to 2006, there was an overall slight decrease in total cattle reported, as well as the number of farms reporting cattle (see ***Figures 17*** and ***18).*** For absolute numbers see ***Appendix I, Table 5*** and ***6***.

Cattle Industry

From 2001 to 2006 in the Grassmere Drain Subwatershed, there was:

- Little change in number of Beef Cows reported as well as number of farms reported
- Little change in number of Dairy Cows with a moderate decrease in number of farms reporting, resulting in fewer but slightly larger dairy herds in 2006

From 2001 to 2006 in the Netley Creek Subwatershed, there was:

- Little change in number of Beef Cows reported as well as number of farms reported
- Little change in number of Dairy Cows but a large decrease in number of farms reporting, resulting in fewer but larger dairy herds in 2006

Reductions in herd size and number of farms reporting beef cattle can be attributed to Bovine Spongiform Encephalopathy (BSE), low commodity prices and retiring farmers. Intensification within the dairy sector (fewer farmers and quota consolidation) demonstrates the relative change in the dairy sector not only in this watershed but also consistent with provincial trends.

Hog Industry

With respect to the hog production, there appears to be an overall intensification of the industry.

From 2001 to 2006 in the Grassmere Drain Subwatershed, there was:

- Little change in number of Total Pigs reported with a large increase in number of Sows reported, indicating a shift towards nursery production
- A moderate decrease in the number of farms reporting total pigs
- A large decrease in total farms reporting Sows

From 2001 to 2006 in the Netley Creek Subwatershed, there was:

- A moderate increase in numbers of both Total Pigs and Sows categories, while there was a large decrease in number of farms reporting, indicating fewer but larger hog operations

Intensification and increase in the size of hog operations has dominated the sector since 1996. Larger specialized hog operations were developed in response to opportunities of scale in the sector. At the same time, older smaller facilities reached their life expectancy along with an increase in numbers of retiring producers which contributes to the continuing the trend within the agricultural industry to larger more specialized operations.

Poultry Industry

Within the Grassmere Drain Subwatershed, from 2001 to 2006, there was:

- A moderate decrease in number of farms reporting, there was a very large increase in number of birds.

Within the Netley Creek Subwatershed, from 2001 to 2006, there was:

- Little change in the number of birds reported, with is a moderate decrease in number of farms reporting, resulting in fewer but larger poultry operations

Such statistics are consistent with the opportunities of scale, farmer retirements and quota consolidation, particularly in the Grassmere Drain Subwatershed.

Figure 17: Percent change in number of livestock and poultry from 2000 to 2005, according to Census of Agriculture data.

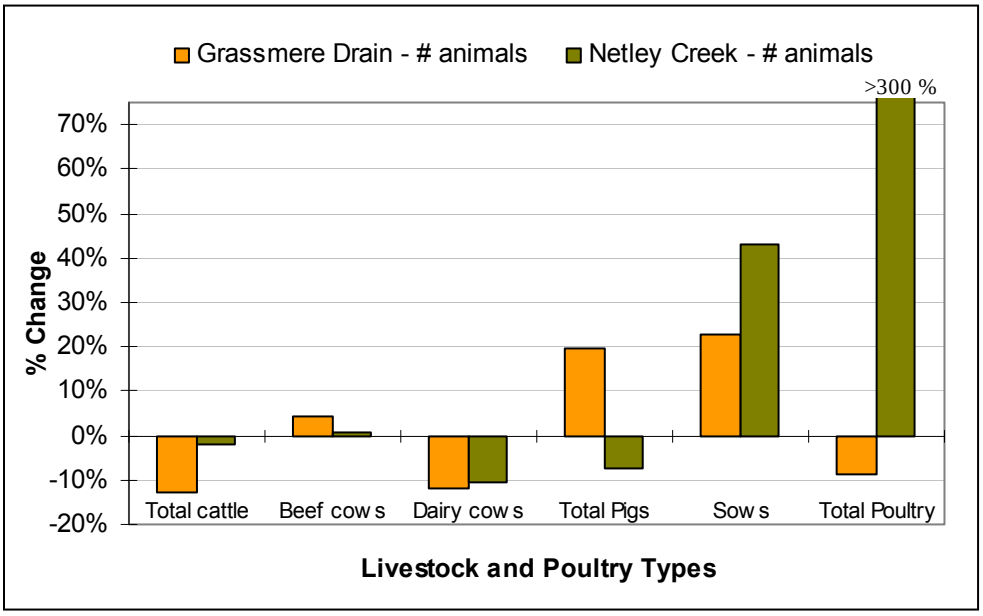
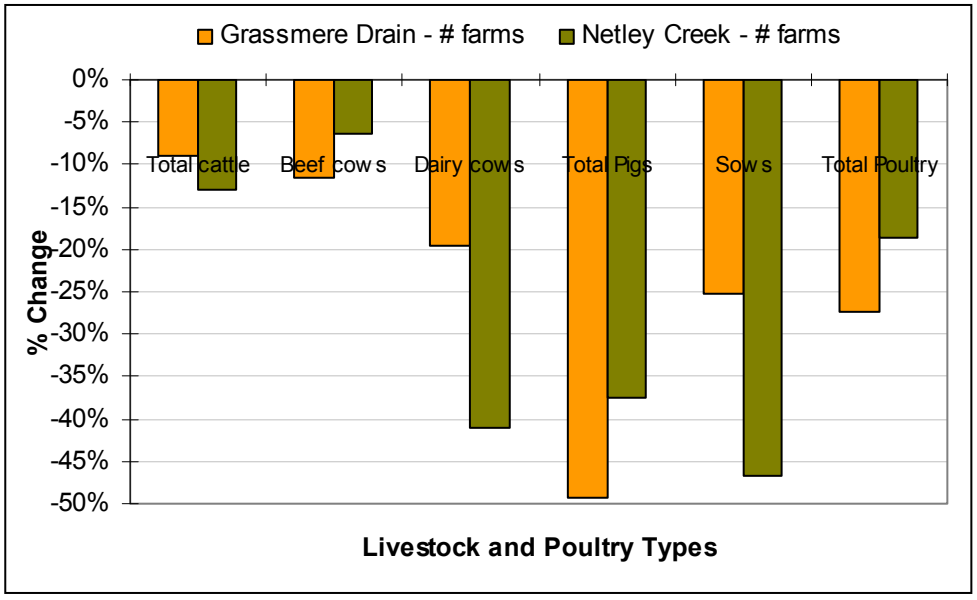


Figure 18: Percent change in number farms reporting livestock and poultry from 2000 to 2005, according to Census of Agriculture data.



Agricultural Land Use Planning in the Netley – Grassmere Study Area

As indicated earlier in this report, there has been a 23% increase in lands identified as urban/transportation through land cover analysis. The increased pressure for urban development within the watershed, particularly near Stonewall and Selkirk has taken prime and viable lower class land out of production agriculture. Much of this increase in urban and rural residential growth can be correlated to a

loss of prime and viable lower class agricultural land within the Netley Creek/Grassmere Drain subwatersheds. This watershed also has a number of navigable waterways which connect to the Red River and Lake Winnipeg. As a result, increased pressure for seasonal recreational land development and the conversion of seasonal recreational developments to high density rural residential areas has increased significantly over the past 10 years.

The conversion of land to urban/recreational/transportation use is directly related to the proximity to the City of Winnipeg. The commuter distance allows residents to easily travel to Winnipeg or other major centres for work on a daily basis. The influence of major metropolitan area of Winnipeg on population trends and development pressures must be taken into consideration as influencing the landscape and use in and around other urban areas within the watershed including the City of Selkirk, Teulon, Stonewall as well as the Winnipeg - Selkirk Corridor.

These increased development pressures act to inflate land values creating opportunities for existing land owners (many of which are agricultural producers) to create income generating opportunities far beyond what is possible through agricultural production.

Rural Municipalities within the watershed are trying to balance the ongoing challenge of providing increased levels of services (infrastructure maintenance and upgrades, recreational and cultural opportunities) without the increasing taxes to existing residents.

There are a number of issues associated with the conversion of prime and viable lower class land from agricultural to rural/seasonal recreational within the Netley Creek and Grassmere Drain Subsatersheds as outlined below.

Issues in Land Use Planning with the Netley - Grassmere Study Area

Land Fragmentation of Land

The fragmentation of farmland poses a potential concern for agriculture. Fragmentation of agricultural lands to create parcels for residential use is usually of carried out randomly and with little planning which results in parcels of various acreages and/or shapes. This leads to the direct transfer of actual or potential agricultural lands to residential use. The fragmentation of land that is required for more intensive, larger farm operations makes the operation of farm machinery and equipment difficult and reduces the efficiency of farm operations.

This rural non-farm development raises the probability of conflicts with agriculture, changes the farm/non-farm composition of rural communities and due to a higher population density contributes to the potential for nuisance complaints and restrictive policies and potential regulations curtailing farming practices.

Agricultural Land Values and Taxation Levels

The conversion of agricultural land to residential/seasonal recreational use within the subwatersheds, inflate surrounding land values and have an indirect effect on the viability of surrounding agricultural lands. Farmers have to compete in land market influenced by speculators, investors, developers, commuters and hobby farmers, most of whom have greater financial resources to draw on than do farmers. Non-agricultural uses may also create undue expenses for road, drainage or other infrastructure services that are not generally related to local agricultural needs.

Soils within the watershed are predominantly lacustrine clays. Such soils have very low permeability and high surface runoff potential. Environmental risks such as failing septic fields can cause wastewater to pond and runoff. This may lead to serious odour, groundwater contamination, pollution and drainage problems that will need to be addressed.

Diversification Opportunities for Crop and Livestock Production
Agriculture has and will continue to experience considerable rationalization and diversification particularly in the livestock sector to ensure economic viability of agricultural producers and operations. Agricultural producers within the subwatersheds are constantly seeking opportunities to remain into the future. This requires available resources including a land base capable of supporting both crop and livestock production.

Agricultural producers must be environmentally responsible to ensure the sustainability of their operation. It is important for the agricultural industry to maintain a balance between environmental responsibilities and economic opportunities.

Some of the priority issues within Manitoba include livestock industry expansion, irrigated crop production, economic survival and effective management of the resource base in a way that facilitates sustainable agricultural production.

Protection of Lower Class Agricultural Land
In addition to prime agricultural land, there are areas of lower class agricultural land can be used for annual cropland under careful and appropriate management practices. Lower class agricultural lands are suitable for other agricultural diversification opportunities such as forage production, use as pasture land for cattle operations, for the location of livestock production operations and other diversification opportunities such as agro-forestry.

There is significant provincial Crown Land within the Netley Creek - Grassmere Drain IWMP Area much of which is Class 4-7. Although much of the Class 6 and 7 land is designated for non-consumptive uses such as wildlife management, Class 4-5 lands may be used for agricultural purposes under long term leases or short term permits within a multiple use concept.

Statistics supplied by the Land Use Planning Knowledge Centre of MAFRI, show that the Rural Municipalities of Rockwood, Rosser and St. Andrews have 141 parcels totaling 15,505 acres available for agriculture use on a long term or annual basis.

A portion of the Rural Municipality of Armstrong is also located within this IWMP area. There are significant Crown Lands under lease within this municipality with 785 parcels totaling 115,172 acres available for agriculture use on a short or long term basis.

These Crown Lands and other lower class lands located within the IWMP study area provide land use and grazing opportunities for the existing and potential cow/calf production.

Land Use Conflicts between Farm and Non-Farm Residents
Land use changes that introduce non-agricultural activities into an agricultural area frequently have restrictive effects on agricultural production in an area. Some non-farm uses may be incompatible with a full range of farming activities as some legitimate farm practices such as manure application, ground and aerial crop spraying, etc. may be incompatible with adjacent uses.

Standard farming practices that may create noise, dust, odours, etc. are incompatible with some land uses (i.e. rural residential). Restrictions on agricultural activities are often imposed as a consequence of conflicts resulting from incompatible land uses. The situation can cause pressure for the potential curtailment of farming operations and can potential impact the economic viability of agriculture in an area. Many conflicts are due to the disbursement of a non-farming population throughout primarily farmed regions within rural areas.

Settlement Centres versus Rural Residential Development

Residential development in the Capital Region has occurred at the periphery of urban areas. Many residents have migrated from older residential neighbourhoods in Winnipeg to the suburban areas or to locations beyond the urban boundaries.

There has been a concentration of new infrastructure investment in suburbs areas and neighbouring municipalities.

Some of the rationales of individuals and families moving to neighbouring municipalities include: a desire to return to rural ethnic roots, desiring a more relaxed or semi-rural lifestyle on larger lots, and taking advantage of near-urban standards of service at lower property tax rates.

Canada Manitoba Farm Stewardship Program - Adoption of On-Farm Beneficial Management Practices

In 2003, the Agricultural Policy Framework (APF) was launched as a new national approach to support agricultural activities associated with Business Risk Management, food safety and quality, science and innovation, environment, and skill development. In support of priorities related to soil, air, water and biodiversity, various environmental initiatives were introduced across Canada including Environmental Farm Planning and the National Farm Stewardship Program. Environmental Farm Planning (EFP) is awareness and planning tool used to enhance producers' understanding of potential on-farm environmental risks and to develop action plans for how these risks can be addressed. Many producers in Manitoba, including those in the watershed, have participated in the EFP process to gain an improved understanding of the potential environmental risks associated with agriculture, as well as, those on their own farms. The EFP process also allowed producers to develop an action plan that outlines how potential risks on their farms can be addressed through the adoption of beneficial management practices (BMPs). Financial and technical support has been offered to producers wishing to adopt BMPs through the Canada Manitoba Farm Stewardship Program (CMFSP) between 2003 and 2009. This program offered 30 different BMPs to producers that had completed an EFP. (For a list and description of the BMPs, see ***Appendix J***). A summary of BMP uptake by producers in the study area is displayed in ***Table 9***.

Within the Netley - Grassmere Study Area, there were 159 BMP projects that were adopted by producers. All of these BMPs contribute to reducing risks to water quality. Of the 159 adopted, 72 of the BMPs were livestock related BMPs, 180 were cropping based BMPs, and 66 were BMPs specific to point source protection that could apply to either a cropping or livestock operation.

Table 9.0: BMP Adoption through the Canada-Manitoba Farm Stewardship Program 2003-2008(4)

BMP Categories	Netley Subwatershed	Grassmere Subwatershed	Remaining Study Area	Netley - Grassmere Study Area
Livestock-related BMPs (1)	20	9	7	36
Cropping-related BMPs (2)	48	31	11	90
Point Source Protection-related BMPs (3)	19	7	7	33
Total	**87**	**47**	**25**	**159**

(1) These include BMPs 1,4, 5,6,7,10, and 21
(2) These include BMPs 14,15,16,24, 25
(3) These include BMPs 8,9
(4) Refer to Appendix J for BMP category and names

Of the 159 BMPs adopted in the IWMP study area, almost 2/3 were adopted in the Netley Creek watershed, which is the bigger watershed. There is also a fairly consistent percentage for the adoption of all BMPs within the Grassmere Drain watershed. It should also be noted that 25 BMPs were adopted outside of the Netley Creek - Grassmere Drain subwatersheds but within the IWMP study area. The top three BMPs adopted by producers in the study area are Improved Cropping Systems, Product and Waste Management, and Winter Site Management which is consisted with trends throughout Manitoba.

The adoption BMPs by producers is not limited to the CMFSP. Other agencies like the East Lake Conservation District, Ducks Unlimited Canada, and Manitoba Habitat Heritage Corporation also promote various BMPS. In addition, as indicated in the public consultation process for the IWMP, there have been many producers who have adopted BMPS on their own initiative, and as such, it is unknown what types and how many have been adopted. The number of BMPs adopted under the Farm Stewardship Program and the uniformity across the study area reaffirms that producers in this watershed are interested and willing to adopt various BMPs that may be offered through various opportunities including the potential future IWMP implementation.

Summary

Examination of the watershed through ag-profiling, land cover analysis, and physical characteristics like soil, collectively provide insight into agricultural land use and practices within the Netley - Grassmere Study Area and its subwatersheds. It can also tell us about the characteristics of the agriculture base in the watershed and their relationship with the resources of the watershed (what role resource management plays to sustain an important agricultural economy). The following table summarizes the findings with recommendations to support the issues identified in the IWMP process to date:

Suggested Recommendations with Respect to Water Quality

Watershed Issues	Analysis	Recommendations
Land Use	– Majority the area is prime agricultural land (Class 1, 2, and 3), covering approximately 69% of the study area – Another 24% of the soils are considered Class 4, 5, 6 and 7 – 2% of watershed has been identified as organic soils – According to 2005 Satellite Imagery, annual cropland remains the predominant land cover type in the watershed, although it experienced a 9% reduction in area between 1994 and 2005. – In the 2005 growing season, about 10% of the annual cropland occurred on soils which may be more suitable for perennial forage production (Class 4, 5, 6, or Organic soils). Depending on limitation and cropping practices, these soils may susceptible to erosion. – From 1994, to 2005, there was an increase of area in forages by 93%, resulting in more permanent vegetative cover. – A 23% increase in lands identified as urban/transportation. The increased pressure for urban development within the watershed, particularly near Stonewall and Selkirk has taken prime and viable lower class land out of production agriculture – According to the 2006 Census of Agriculture survey, around 60% of the farmland is dedicated to annual crop production and another 30% to pasture, alfalfa, and hay and fodder crops. – In the Netley Creek Watershed in the 2005 growing season, approximately 8000 ha of annual cropland was located on Class 4,5, 6 or organic soils. In Grassmere Drain Watershed, the area was almost 1000 hectares.	➢ Promote special management considerations and support the adoption of sustainable beneficial management practices where annual cropland is located on soils with agricultural capabilities of Class 4 and, poorer, as well as organic soils
Water Erosion* *Erosion risks are for bare soil (assumes no vegetative cover)	– In the 2005 cropping season, approximately 22% of the annual cropland was located on soils with moderate risk to water erosion. Risk will be mitigated by cropping practices – Census survey indicates about 35% of the annual cropland was prepared for seeding using conservation or zero tillage practices. – Further analysis with respect to 2002 and 1994 land cover indicates that annual cropping practices on moderate soil erosion risk appears to be declining since 1994	➢ Encourage educational opportunities promote sustainable land management practices that protect soil from erosion ➢ Encourage the adoption of beneficial management practices that maintain adequate vegetative cover and streambank protection in riparian areas ➢ Promote alternative renovation strategies of forage stands to limit risk of nutrient migration into waterways

Watershed Issues	Analysis	Recommendations
Wind Erosion * *Erosion risks are for bare soil (assumes no vegetative cover)	IWMP Study Area: – Approximately 4% of annual cropland was located on soils with a high to severe risk for wind erosion – Two percent of the watershed has been identified as organic soils, which are susceptible to wind erosion when dried out and exposed – In 2005, about 3% of annual cropland was located on organic soils. – Acording to the 2006 Census of Ag survey, almost two thirds of the cultivated land was prepared using conventional tillage practices, over 30% using conservation tillage practices and 5% prepared with zero tillage. Therefore, it can be assumed that the risk for erosion was reduced on at least a third of these sensitive areas. – Large decrease in summerfallowed fields result in reduced potential for soil erosion – According to the 2006 Census data, there was a large increase in pulse crops, due to increase in soybeans which are low residue crops. This can result in increased risk for soil erosion	➢ Encourage or support the adoption of soil based beneficial management practices (perennial cover, shelterbelts, etc.) that promote sustainable land protection in areas that are prone to moderate risk of wind erosion ➢ Explore opportunities to develop and pursue programs that support beneficial management practices that are compatible with pulse and low residue crops on susceptible soils ➢ Seek opportunities to encourage minimum or no tillage BMPs
Surface Drainage	– Aapproximately 73% of the soils in the study area can be considered imperfectly or poorly drained, on which the majority of 2005 annual cropland occurred – Significant portion of watershed susceptible to flooding – In the 2005 growing season, in the Netley Creek Subwatershed approximately 23,000 ha of annual cropland occurred on soils with improved drainage, or areas with a network of surface drains to enhance runoff and reduce duration of surface ponding. In the Grassmere Drain Subwatershed, this area was 4,000 hectares. – Pesticide use on annual crops can be potential risk to water quality. Ag census shows that in 2005, over half of cropped land in the Netley Creek Subwatershed, and almost 70% of Grassmere Drain Subwatershed received applications of herbicide, though this is moderately less than that applied in 2000 – Manure storage and application also provides a risk to contaminating surface runoff. Ag Census shows that in 2006, about 70% of the farms in Netley Creek Subwatershed and almost half of the Grassmere Drain Subwatershed farms have	➢ Encourage sustainable land management practices which reduce the potential for contaminants to enter surface runoff ➢ Promote the use of grassed waterways and buffer strips near? riparian areas ➢ Encourage manure and soil testing to calculate application rates that will meet the crop's nutrient needs

Watershed Issues	Analysis	Recommendations
	beef cattle. Potential risks with beef production include riparian grazing and winter manure packs – Compared to 1991, pig and poultry operations tend to be fewer in number but larger in herd/bird size. This intensification of the pig and poultry operations can result in more manure produced per farm and challenges in field applications	
Nutrient Management	– A decrease in cereal production with an increase in acreage of oilseeds, pulses and forages – Areas with applications of commercial fertilizers, herbicides, insecticides or fungicides decreased – An overall slight decrease in total cattle reported, as well as number of farms reporting cattle – With respect to the hog industry, there appears to be an overall intensification of the industry – Large decreases in area treated to commercial fertilizers and pesticides – reduced potential for nutrient and pesticide contamination – In general, with the exception of beef, it appears there are fewer but larger livestock and poultry operations in 2006 as compared to 2001	➢ Encourage and support landscape based soil testing ➢ Support education opportunities that demonstrate the benefits of key or specific? beneficial management practices such as Nutrient Management Planning
Salinity	– 55% (693 ha) of what has been classified as moderately saline soils were under annual cropland practices – number has steadily decreasing from what was identified in the 2002 and 1994	➢ Encourage conversion of slightly and moderately saline soils to forage production ➢ Create awareness and understanding of impact and limitations of land conversion to special crops particularly on fine textured Class 2 and 3 slightly to moderately saline soils
Land Use Planning	– Fragmentation of Land – Agricultural Land Values and Taxation Levels – Diversification Opportunities for Crop and Livestock Production – Protection of Lower Class Agricultural Land – Land Use Conflicts Between Farm and Non-Farm Residents – Settlement Centres Versus Rural Residential Development	➢ Adopt more rigorous and thorough planning efforts that ensure future development occurs in suitable locations and where possible, seek opportunities for higher density residential development in or near existing urban centres. ➢ Ensure planning efforts allow for greater protection of prime and viable lower class agricultural land for agricultural uses and minimize fragmentation of agricultural land by other uses in sustaining the agricultural way of life within the IWMP study area.

Watershed Issues	Analysis	Recommendations
		➢ Ensure planning efforts allow for greater protection of prime and viable lower class agricultural land and associated operations from encroachment and fragmentation by non-farm residences and other non-compatible uses facilitating viability of the agricultural way of life within the IWMP study area.

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Appendices

Appendix A: Mandates of Federal and Provincial Agriculture Departments

i) **Agriculture and Agri-Food Canada – Prairie Farm Rehabilitation Administration (PFRA)**
PFRA's mission is to provide expertise and services to producers and stakeholders for the sustainable use of agricultural land and water resources. PFRA's focus is agricultural land, agricultural water, and resource analysis and interpretation.

ii) **Manitoba Agriculture, Food and Rural Initiatives (MAFRI)**
MAFRI's mission is to assist with the compilation of a technical resource package and deliver expertise with the technical information to aid in issue identification, and to assist the proponent in completing the final Integrated Watershed Management Plan.

Appendix B: Land Cover Time Frame, Classifications, and Constraints

For the IWMP study area, imagery was available for the years of 1994, 2001-02, and most recently, 2005. Imagery was classified by the Manitoba Conservation - Manitoba Remote Sensing Centre into 16 unique land cover classes. To simplify the analysis, the 16 classes were aggregated into 7 basic land cover classes: annual cropland, forages, grasslands/pasture, trees, wetlands, water, and urban/transportation.

The 1994 land cover used satellite imagery that was captured on October 26 for the northern and the southwestern part of the IWMP Study Area and on September 17 for the southeastern portion. For the 2001-02 land cover data, the northern portion of the watershed was analyzed using imagery taken August 2, 2002, the southwestern portion with imagery taken September 3, 2001 and the southeastern portion with imagery from September 28, 2001. The 2005 land cover data utilized satellite imagery that was captured on July 13 for the northern and southwestern portion and August 5 for the southeastern portion

Data Constraints

It should be noted that the use of land cover data has limitations from a couple of perspectives. Weather patterns in years leading up to the imagery will impact the cover analysis and may be short term as opposed to a long term trend. Further, past image classifications were undertaken for specific purposes with standardization occurring between 2000-2001 and 2005-2006 as detailed below:

- Precipitation Amounts – Records from Environment Canada indicate that total precipitation at stations near Stony Mountain were higher in 1993-1994 and 2000-2001 as compared to 2005-2006. 2006 had particularly lower precipitation than most.
- Classification effort - the 1993 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 1999-2000 image classification.
- The classification of forages and forages/grasslands - As the land cover classifications could be difficult to interpret given the age of the forage stand and the reflectance of the satellite imagery for classification.
- With respect to the increased level of forages, some of the forage conversion trends may be explained through the adoption of Permanent Cover Program offered by Agriculture Canada in the early 1990s. A program summary for the Netley – Grassmere Study area could provide more insight toward understanding the forage trends and if they were indeed related to the Permanent Cover Program, however, the data could not be made available in time for this report. There is some indication from local contacts that the program uptake by producers was low for this watershed, however, without an actual program summary, it cannot be quantified. This information will be available for future reports or for this watershed at a later date.
- It should be noted, however that significant increases in annual rainfall occurred in the years prior to the 2005 land cover mapping and classification. The cumulative impact of these rainfall events resulted in significant acres unseeded, re-establishment of lowland vegetation and areas of standing water common, particularly in the lower reaches of the Netley Creek Watershed. Significant work was required to bring many fields back into production with significant rutting and compaction occurring.

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

Source: *Manitoba Conservation, 2001*

Appendix C: Soil Information and Background

The Detailed Soils Report for the Rural Municipality of Rockwood (D-27), which in general describes the physiographic characteristics of the study, states the Rockwood municipality study areas are located in Manitoba Plain division of the Interior Plains of Canada. The portion of the Manitoba Plain covered by this survey has been subdivided into two sections, the Red River Plain and Interlake Plain, and two subsections, the Red River Valley and Woodlands Plain. The Red River Valley subsection is a level to depressional basin with deep loamy to clayey deposits, much being poorly drained. The Woodlands Plain subsection is a lake terrace of the Red River Plain, with land lying on average between the 275 meter (900 feet) and the 244 meter (800 feet) A.S .L. contour levels. This lower terrace is a transition between the lacustrine plain to the south and the lake scoured terrain of the Interlake Plain. It consists of a thin mantle of lacustrine sediments overlying calcareous till, except where low ridges of eroded till occur at the surface at irregular intervals. Limestone bedrock is at or near the surface in several locations.

The southern portion of the study area is primarily dedicated for cereal production. These areas consist of good agricultural soils having been cleared of trees and where stones do not offer any problem to production. The soils for the most part have been developed on smooth stone free lacustrine sediments. The northern art of the study area is utilized for forage and livestock production with a minor amount of cereal production. For the most part these areas are treed and have a severe stone problem.

The soils in these areas have been developed on hi~h lime stony till deposits. Land in this area is slowly being cleared of stones and trees, for forage and improved pasture. The Interlake Plain Section is characterized by a gently undulating plain traversed by intermittent low ridges of till with a thin covering of coarse textured reworked sediments, and is situated above the 259 meter (850 ft.) contour . The land between the ridges consists of imperfectly and drained swales. The terrain has been modified by wave action and the surface deposits are stony and extremely calcareous.

These regions tend to have distinct soils characteristics and land covers. The majority of soils in this watershed were deposited during the time of glacial Lake Agassiz, and is derived from lacustrine deposits and lacustrine deposits underlain by loamy glacial till.

Glacial till deposition is also present in the northwest corner of the watershed, with some fluvio-lacustrine areas scattered in amongst it (PFRA 2005).

Appendix D: Canada Land Inventory System Land Classes

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 are capable only of producing perennial forage crops, and improvement practices are not feasible
O	Organic Soils
Source: *Agriculture and Agri-Food Canada*	

Appendix E: Wind Erosion Risk

Wind erosion information in Manitoba has been developed from the provincial soil survey data and the Soil Landscapes of Canada (SLC Ver 1.0). A geographic information system (GIS) was used to combine both spatial datasets, creating a derived product upon which wind erosion was calculated.

The wind erosion model that is used for the Agriculture Canada Wind Erosion Risk Maps (1989) was applied to the derived dataset. The model was developed from the works of Chepil (1945, 1956) and Chepil and Woodruff (1963) and derives an index value *E* for wind erosion risk (Coote, Eilers & Langman, 1989). The model is stated as:

$$E = kC(V_*^2 - \gamma W^2)^{1.5}$$

Where:

E = maximum instantaneous soil movement by wind (dimensionless)
k = surface roughness and aggregation factor (dimensionless)
C = factor representing soil; resistance to movement by wind (dimensionless)
V_* = drag velocity of wind at soil surface ($cm \cdot s^{-1}$)
γ = soil moisture shear resistance (dimensionless), a value of 5000 was used
W = available moisture of the surface soil ($m^3 water \cdot m^{-3} soil$)

For the analysis, the V_* and *W* values were used from the Soil Landscapes of Canada series. These values are listed for each polygon in the Wind Erosion Risk publication. A listing of *k* and *C* values are also listed in the report and are based on soil surface texture. The values were entered into the database based on soil surface texture types taken from the provincial soil survey data.

Following entering of values for *K*, *C*, *W* and calculating values for V_*, the dimensionless wind erosion index values (*E)* were calculated for each polygon. These values were rated as per the rating system in the Wind Erosion Risk publication.

Class	E Value
Negligible	< 100
Low	101 - 250
Moderate	251 - 400
High	401 - 700
Severe	> 700

The ratings are for bare soil and do not consider land use and crop management factors. *E* values were calculated only for those soils within the seamless soil layer that had a mineral soil surface texture rating. Polygons that were rated as being organic soils, bare rock and water in either the seamless soil data or the SLC data did not have *E* values calculated.

For those polygons that have secondary and/or tertiary soils listed within the map unit, a weighted calculation was done based on the percent of occurrence. If organic soils existed in any combination (primary, secondary, tertiary) with mineral soils, weightings were based on mineral soils only.

Appendix F: Soil Drainage Class

Soil Drainage Class	Description
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
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.
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
Well	Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying materials or laterally as subsurface flow
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.
Source: *System of Soil Classification of Canada – Canada-Manitoba Soil Survey Reports*	

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

Appendix G: Crop Tolerance on Saline Soil Conditions

The tables below summarize the relative salt tolerance of Manitoba Crops

Table 2: Relative Salt Tolerance of Manitoba Crops (adapted from McKenzie, 1988)

EC Tolerance* (dS/m)	Field Crops	Forages	Vegetables	Trees/shrubs
High (16)		Tall wheatgrass Russian wildrye Slender wheatgrass		Sea buckthorn Silver buffaloberry
Moderate (8)	6-row barley 2-row barley Fall rye Winter wheat Spring wheat Oats Flax Canola	Birdsfoot trefoil Sweetclover Alfalfa Bromegrass Crested wheatgrass Intermediate wheatgrass Meadow fescue Reed canarygrass	Garden beets Asparagus Spinach Tomatoes Broccoli Cabbage	Russian olive Poplar Apple
Low (4)	Sunflowers Soybeans Corn Peas Field beans	Timothy White Dutch clover Alsike clover Red clover	Potatoes Carrots Onions Strawberries Raspberries	Common lilac Manitoba maple Colorado blue spruce Cottonwood Birch

*Crop should yield at least 50% of normal yield at the indicated salinity levels.

Table 3: Salt Tolerance at Two Stages of Growth (Soils '84)

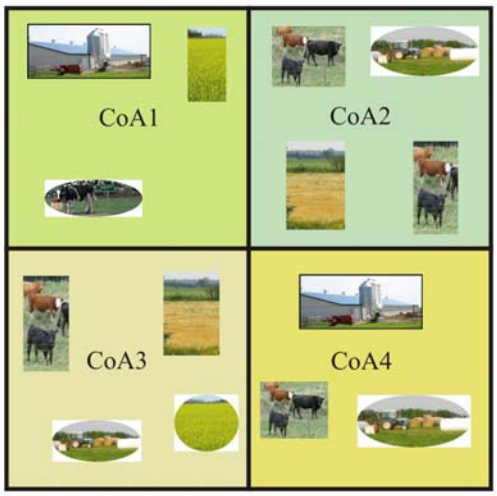
Crop	Growth Stage	
	Germination	Established
Barley	High	High
Fall rye	High	Moderate
Wheat	Moderate	Moderate
Alfalfa	Low	Moderate
Corn	Moderate	Low
Field beans	Very low	Very low

Source: *Soil Management Guide, Manitoba Agriculture Food and Rural Initiatives*

Appendix H: Diagram for Interpolating Census of Agriculture Data (Area Weighting Method)

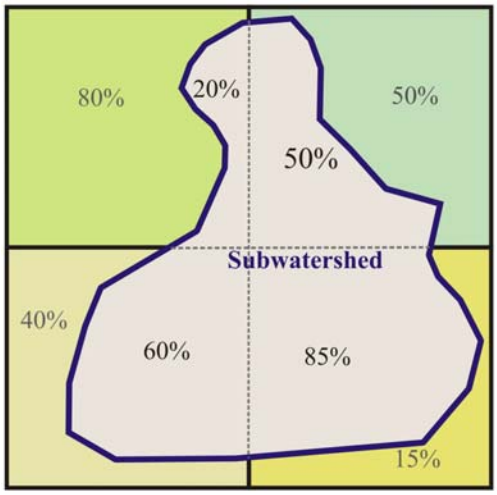
Basic concept of interpolating Census of Agriculture (CoA) using the area weighting method*

Census of Agriculture (CoA) from Statistics Canada's geographic boundaries



CoA from Statistics Canada's geographic boundary

CoA interpolated to subwatershed boundary



CoA is the sum of all survey forms of farms with farm headquarters located in the specific boundary

For Example - Total cattle and calves

CoA1 = 540 total cattle
CoA2 = 300 total cattle
CoA3 = 125 total cattle
CoA4 = 1200 total cattle

Interpolated CoA for Subwatershed =
(CoA1: 540 cattle x 20%) +
(CoA2: 300 cattle x 50%) +
(CoA3: 125 cattle x 60%) +
(CoA4: 1200 cattle x 85%) = 1353.6 total cattle and calves**

** due to the methodology of interpolating data, final census numbers are estimates.

*This is a simplified explanation of the methodology used to interpolated Census of Agricultural data from Statistic Canada's geographic boundaries into other specified boundaries such as watersheds. There are other factors not explained here that are taken into account during the process.

Appendix I – Percent Changes in 2006 from 2001 using Census of Agriculture data (percent change is calculated as: 2006-2001/2001*100)

Table 1: Percent change in land use from 2001 to 2006 (according to 2001 and 2006 Census of Agriculture)

Subwatershed		Total Farmland	Total Cropland**	Summerfallow	Pasture***	Other*
Grassmere Drain						
2001	ha	43,077	32,831	1,757	6,549	1,941
2006	ha	40,420	30,447	569	7,325	2,079
difference		-2,658	-2,383	-1,189	776	139
%change		**-6%**	**-7%**	**-68%**	**12%**	**7%**
Netley Creek						
2001	ha	101,860	65,721	2,456	26,232	7,452
2006	ha	104,699	69,057	1,621	24,835	9,186
difference		2,839	3,335	-835	-1,396	1,734
%change		**3%**	**5%**	**-34%**	**-5%**	**23%**

*Other category includes all other land uses including farmyard, woodlots, Christmas trees, wetlands, etc.
** Total cropland includes all field crops, vegetables, fruit and nuts and sod
*** Pasture includes tame pasture and natural areas used for pasture.

Table 2: Percent change in field crops from 2001 to 2006 (according to 2001 and 2006 Census of Agriculture)

Subwatershed		Total Cropland*	Cereals	Oilseeds	Pulse	Forage for hay	Forage for seed	Other**
Grassmere Drain								
2001	ha	32,831	20,875	6,609	683	4,270	88	306
2006	ha	30,447	15,649	7,127	1,873	5,355	X***	443
difference		-2,383	-5,225	518	1,191	1,084	--	137
%change		**-7%**	**-25%**	**8%**	**174%**	**25%**	**--**	**45%**
Netley Creek								
2001	ha	65,721	35,069	11,838	817	16,144	1,246	606
2006	ha	69,057	30,544	16,093	2,680	17,122	1,469	1,148
difference		3,335	-4,525	4,255	1,863	978	223	542
%change		**5%**	**-13%**	**36%**	**228%**	**6%**	**18%**	**89%**

* Total Cropland includes all field crops, vegetables, fruits and nuts, and sod
** Other category includes other special field crops, fruits and nuts, sod, vegetables, and all suppressed hectares in the listed categories
***"x" indicates that values have been suppressed to protect confidentiality in Grassmere Drain.

Table 3: Percent change in area treated to crop inputs according to the 2001 and 2006 Census of Agriculture (for the 2000 and 2005 cropping years)

Subwatershed		Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides	Use of Fungicides
Grassmere Drain					
2001	ha	28,946	28,224	1,535	5,727
2006	ha	21,554	20,858	758	2,507
difference		-7,393	-7,365	-777	-3,220
%change		**-26%**	**-26%**	**-51%**	**-56%**
Netley Creek					
2001	ha	48,431	47,923	4,817	9,485
2006	ha	40,477	37,142	4,821	5,408
difference		-7,954	-10,782	4	-4,077
%change		**-16%**	**-22%**	**0%**	**-43%**

Table 4: Percent change in crop-related expenses according to the 2001 and 2006 Census of Agriculture (for the 2000 and 2005 cropping years)

Subwatershed		Total crop expenses	Total fertilizer and lime	Total herbicides, insecticides & fungicides	Total seed
Grassmere Drain					
2001	dollars	$4,848,842	$2,330,991	$1,830,824	$687,027
2006	dollars	$4,793,695	$2,246,608	$1,499,422	$1,047,665
difference		-$55,147	-$84,383	-$331,402	$360,638
%change		**-1%**	**-4%**	**-18%**	**52%**
Netley Creek					
2001	dollars	$8,445,638	$4,456,377	$2,785,713	$1,203,548
2006	dollars	$8,978,342	$4,540,217	$2,634,919	$1,803,205
difference		$532,704	$83,840	-$150,794	$599,657
%change		**6%**	**2%**	**-5%**	**50%**

Table 5: Percent change in livestock and poultry numbers reported according to the 2001 and 2006 Census of Agriculture

Subwatershed		Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Grassmere Drain							
2001	# animals	7,214	2,644	529	19,710	2,049	15,249
2006	# animals	7,061	2,659	474	18,243	2,935	65,953
difference		-152	15	-55	-1,467	886	50,704
%change		**-2%**	**1%**	**-10%**	**-7%**	**43%**	**332%**
Netley Creek							
2001	# animals	21,211	7,750	957	55,991	5,579	96,514
2006	# animals	18,502	8,084	842	67,100	6,860	88,148
difference		-2,710	334	-115	11,109	1,282	-8,365
%change		**-13%**	**4%**	**-12%**	**20%**	**23%**	**-9%**

Table 6: Percent change in number of farms reporting livestock and poultry according to the 2001 and 2006 Census of Agriculture

Subwatershed		Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Grassmere Drain							
2001	# farms	76	64	10	11	7	17
2006	# farms	69	57	8	6	5	12
difference		-7	-7	-2	-6	-2	-5
%change		**-9%**	**-12%**	**-20%**	**-49%**	**-25%**	**-27%**
Netley Creek							
2001	# farms	227	185	21	30	18	39
2006	# farms	197	173	12	19	9	32
difference		-30	-12	-9	-11	-8	-7
%change		**-13%**	**-6%**	**-41%**	**-38%**	**-47%**	**-19%**

Appendix J: Beneficial Management Practices offered under the Canada Manitoba Farm Stewardship Program 2003-2008

BMP Category	Type of Practice
1. Improved Manure Storage and Handling	Increased storage to meet winter spreading restrictions (including satellite storage)
	Improved features to prevent risks of water contamination (leaks, spills)
	Slurry storage covers to reduce odours and GHG emissions
	Containment systems for solid manure (includes covers)
	Assessment and monitoring of existing manure storage infrastructure
2. Manure Treatment	Dewatering systems, nutrient recovery systems
	Composting of manure and dead livestock
3. Manure Land Application	Specialized/modification to equipment for improved manure application
4. In Barn Improvements	More efficient livestock watering devices and cleanout systems to reduce water use and decrease manure volumes
5. Farmyard Runoff Control	Upstream diversion around farmyards
	Downstream protection (e.g. catch basins, retention ponds, constructed wetlands)
6. Relocation of Livestock Confinement and Horticultural Facilities	Relocation of livestock facilities such as corrals, paddocks and wintering sites away from riparian areas
	Relocation of horticultural facilities such as greenhouses and container nurseries away from riparian areas
7. Wintering Site Management	Shelterbelt establishment
	Portable shelters and windbreaks
	Mobile water systems: summer/winter water systems (solar, wind, pipeline, other)
	Field access improvements: alleyway/access lane upgrades
	Fence modifications
8. Product and Waste Management	Improved on-farm storage and handling of agricultural products (e.g. fertilizer, petroleum products, and pesticides)
	Improved on-farm storage, handling and disposal of agricultural waste (e.g. livestock mortalities, fruit and vegetable cull piles, wood waste)
	Composting of agricultural waste (e.g. fruit, vegetable, wood, straw residue)
9. Water Well Management	Sealing & capping old water wells
	Protecting existing water wells from surface contamination
10. Riparian Area Management	Remote watering systems to manage livestock: gravity fed, pump and pipeline systems
	Buffer establishment: forages, shrubs, trees - planting, weed control
	Fencing to manage grazing and improve riparian condition/function
	Native rangeland restoration or establishment: native species of forages, shrubs and trees
	Grazing management in surrounding uplands: watering systems and cross fencing
	Improved stream crossings
11. Erosion Control Structures (Riparian)	Constructed works in riparian areas: contour terraces, gully stabilization, bank stabilization, drop inlet and enhanced infiltration systems, in-channel control, retention ponds and erosion control dams

BMP Category	Type of Practice
12. Erosion Control Structures (Non Riparian)	Constructed works in non riparian areas: contour terraces, gully stabilization, bank stabilization, drop inlet systems and enhanced infiltration systems, in-channel control, retention ponds and erosion control dams, mechanical wind screens
13. Land Management for Soils at Risk	Forage or annual barrier establishment for soils at risk (e.g. stripcropping, grassed waterways, perennial forages on severely erodible or saline soils)
	Straw mulching
	Grazing management in critical erosion areas not associated with riparian zones: watering systems, crossfencing
14. Improved Cropping Systems	Equipment modification on seeding and post seeding implements for low disturbance placement of seed and fertilizer
	Chaff collectors and chaff spreaders installed onto existing combines
	Precision farming applications: GPS information collection, GPS guidance, manual controllers for variable rate fertilizer application
15. Cover Crops	Establishment of non-economic cover crop
	Equipment modification for inter row seeding of crops (e.g. relay crops)
16. Improved Pest Management	Equipment modification for improved application
	Information collection and monitoring
	Biological control agents
	Cultural control practices
	Mobile water tanks
17. Nutrient Recovery from Waste Water	Recycling of waste water streams from milkhouses, fruit and vegetable washing facilities, and greenhouses in order to recover nutrients
18. Irrigation Management	Irrigation equipment modification/improvement to increase water or nutrient use efficiency
	Equipment to prevent backflow of altered irrigation water into water sources
	Improved infiltration galleries and irrigation intake systems
19. Shelterbelt Establishment	Establishment of shelterbelts for farmyard, livestock facilities, dugout snowtrap, wildlife habitat enhancement, field
	Tree materials required for shelterbelt establishment
20. Invasive Alien Plant Species Control	Integrated approaches (cultural, mechanical and biological) for control of invasive plant species (e.g. leafy spurge, purple loosestrife, scentless chamomile)
21. Enhancing Wildlife Habitat and Biodiversity	Buffer strips: native vegetation
	Off site watering systems
	Improved grazing systems: crossfencing
	Wildlife shelterbelt establishment
	Improved stream crossings
	Hayland management to enhance wildlife survival
22. Species at Risk	Off site watering systems
	Improved grazing systems: crossfencing
	Plant species establishment
	Infrastructure development and relocation
23. Preventing Wildlife Damage	Forage buffer strips
	Fencing to protect stored feed, concentrated livestock, high value crops, drip irrigation systems and other ag. activities
	Scaring and repellant systems and devices
24. Nutrient Management Planning	Consultative services to develop nutrient management plans, planning and decision support tools
25. Integrated Pest Management Planning	Consultative services to develop integrated pest management plans, planning and decision support tools
26. Grazing Management Planning	Consultative services to develop range and grazing management plans, planning and decision support tools
27. Soil Erosion and Salinity Control Planning	Consultative services to develop soil erosion and salinity control plans, planning and decision support tools
28. Biodiversity Enhancement Planning	Consultative services to plan habitat enhancement, stewardship for species at risk and/or wildlife damage prevention within agricultural land base; planning and decision support tools
29. Irrigation Management Planning	Consultative services for planning improved water use efficiency and reduced environmental risk of existing irrigation systems, planning and decision support tools
30. Riparian Health Assessment	Consultative services for assessing riparian health, planning and decision support tools

Source: *Canada-Manitoba Farm Stewardship Program, 2003-2009*

Appendix K: Seeded Acres Report for Watershed Region

thousand acres	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	97-06 Ave.
Agricultural Region 11											
Spring Wheat	145	110	140	180	175	120	120	125	77	126	165
Durum Wheat	0	0	0	0	1	0	0	0	X	0	-
Winter Wheat	0	2	4	2	6	5	13	8	X	29	-
ALL WHEAT	**146**	**112**	**144**	**182**	**182**	**125**	**133**	**133**	**78**	**155**	**198**
Oats	51	60	55	55	85	75	75	70	38	75	196
Barley	75	70	55	75	70	60	60	60	38	59	158
Rye	0	1	0	1	1	0	0	0	0	2	-
Flax	25	28	26	15	17	15	13	10	9	13	147
Canola	100	110	130	105	75	100	110	150	75	101	134
TOTAL MAJOR CROPS	**397**	**380**	**409**	**433**	**430**	**375**	**392**	**423**	**239**	**405**	**170**
Tame Hay	120	130	110	115	125	105	100	140	135	116	86
Summerfallow	30	25	18	14	31	15	5	25	179	19	11
Pasture	22	22	22	22	39	39	39	39	39	39	100
TOTAL ABOVE.....	**569**	**557**	**559**	**584**	**625**	**534**	**536**	**627**	**907**	**579**	**64**

The IWMP area roughly corresponds to Agricultural Region 11 above. Note summerfallow acres for 2005 totals 179 k acres while average (96-06) is 11 k.

Source: *2006 Manitoba Agriculture Yearbook*