DRAFT

Agricultural Land Use and Management in the Whitemud River Watershed

Submitted by

Agriculture and Agri-Food Canada – Agri-Environment Services Branch (AESB)

and

Manitoba Agriculture Food and Rural Initiatives (MAFRI)

May 17th, 2011

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Manitoba

Table of Contents

List of Figures:

List of Tables

A. Executive Summary

The Whitemud River Watershed is approximately 731,800 hectares (ha) in size and is located in Manitoba's Parkland Region. An Integrated Watershed Management Plan (IWMP) is being developed for this watershed by the Whitemud Watershed Conservation District (WWCD) in collaboration with Manitoba Water Stewardship and numerous other stakeholders.

Understanding changes in agricultural land use is essential for the development of the Integrated Watershed Management Plan. The overall objective of this report is to examine risks to key watershed resources by analyzing the physical characteristics of the landscape with consideration of how specific agricultural activities may be influencing them. This analysis also assists in identifying where soil and water management efforts could be directed to help address priority issues or identified risks within the watershed.

An assessment at the watershed scale provides a snapshot in time of the various agricultural activities in the Whitemud River Watershed. Census of Agriculture data, temporal in nature, illustrates influences from external factors like weather, government programs and policies, market drivers, and technology to land use and land management decisions and the community response to those interactions. Consideration of such events, with an examination of a watershed's physical resource characteristics and risks, assists in developing an understanding of potential impacts on the basin's water, soil and wildlife resources and identify opportunities for future sustainable land use strategies. This information also assists in improving the understanding of the following three key issues that have been identified through public consultation for the Whitemud River IWMP: clearing of natural cover, large-scale irrigation, and surface water management (including drainage and retention).

Agricultural profiling examines variables from 2006 Census of Agriculture database depicted over four subwatershed regions, including farm area, type of farm, cropping practices, tillage practices, fertilizer and pesticide use, financial activity, and livestock numbers. The same variables from the 2006 Census of Agriculture data were used to examine 15-year changes in agricultural activities to the study area. Land cover data, derived from 1993, 1994, 2000, 2001, and 2006 satellite imagery, was analyzed to document temporal changes to land cover. Using soils data and modeling, environmental indicators were developed for agricultural capability, wind and water erosion risks, soil drainage, salinity, and surface texture characteristics. These were examined in combination with the annual cropland identified in the 2006 land cover. A review of recent federal and provincial policies and programs was conducted to assess their impact on agricultural land use and management.

The Whitemud River IWMP study area has a diverse agricultural landscape. Slight differences are evident from the western portion of the watershed compared to the eastern portion with respect to soil types, land use, cropping practices, crop types, livestock types, and sizes of livestock operations. From 1991 to 2006, there were fewer but larger farms located in the study area. Crop production is important throughout the entire watershed, and dominates the landscape near the eastern and western boundaries of the watershed, away from the escarpment. Livestock production is also important in the watershed, and is concentrated in the central and northern areas. During this fifteen year period, there has been an overall decrease in farmland and annual cropland (cereals in particular). The majority of farms have adopted conservation and zero tillage practices over the traditionally popular conventional methods. This change has become increasingly evident over the past 15 years.

Analysis of land cover change over a 14-year period was similar to Census data analyses, with minor discrepancies in change of annual cropland and grassland. Areas were identified and mapped within the watershed where the combination of annual cropping and landscape risk factors such as wind erosion, agricultural capability, drainage, and slope indicate special management of these lands may be warranted. An examination of land cover data was undertaken to identify changes in land cover with respect to grasslands, wetlands, and annual cropland, and how they relate to the issues of flooding and natural area conservation. Due to data limitations, all spatial analyses using land cover and soils data require further verification for accuracy assessment.

The interest and willingness of producers within the watershed to address environmental issues is demonstrated by their participation in environmental programs through the Agricultural Policy Framework (APF) and more recently under Growing Forward. Program participation in the Environmental Farm Plan (EFP) Program and the Canada-Manitoba Farm Stewardship Program (CMFSP) were analyzed in this report. Participation in both programs was strong; 693 beneficial management practice (BMP) projects were completed with financial and technical assistance through the CMFSP. Nearly 43% of these projects were non-point source crop related BMP projects and over 25% were non-point source livestock related BMPs.

The analyses focused on the IWMP study questions provided by the project management team relating to wildlife habitat, impacts surrounding irrigation development, and overland flooding on AESB Community Pasture. Each analysis provided similar results, and indicated that agricultural management in the watershed is moving in a positive direction. Analysis results also showed that the issues posed in the questions regarding agricultural land management were not evident in broad scale analysis of the watershed. There remains, however, a need to examine specific areas more closely through groundtruthing.

Key recommendations are provided as suggested strategies to the IWMP questions directed by the project management team. They include communication strategies to watershed stakeholders of the current and past plan activities, updates to any monitoring occurring as part of the IWMP plan, and a need for continued support to environmental farm planning. Strategies relating to aquifer health and security should include linkages to the Assiniboine Delta Aquifer Management Plan and communication strategies for the irrigation issues. While positive trends were noted with respect to the watershed's agricultural influence on aquifer health and wildlife habitat, there may still be a need to target specific BMPs at the site specific level to address local issues. These include groundwater protection BMPs, nutrient management planning, and incentives for irrigation management. There is also an opportunity to explore new BMP technologies to further address environmental risks identified in the watershed. Local leadership will be essential in developing partnerships between watershed stakeholders, coordinating multi-levels of government involvement, and to serve as a bridge between landscape needs and provincial/federal regulations.

B. Acknowledgements

The following individuals contributed to the compilation, interpretation, and derivation of information contained in this submission.

AAFC-AESB: Holweger, U., Michiels, P., Powers, J., Mischuk, N., Kopytko, M., Becker, J.

MAFRI: Mitchell, L.

C. Preface

In 2009, the Whitemud Watershed Conservation District (WWCD) was designated as the Watershed Planning Authority to develop a comprehensive Integrated Watershed Management Plan (IWMP) for the Whitemud River study area. A 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 - Agri Environment Services Branch (AESB) and Manitoba Agriculture Food and Rural Initiatives (MAFRI) to be involved in the IWMP process. Agriculture is a shared responsibility between the federal and provincial governments. As such, AESB and MAFRI are partnering to provide professional and technical guidance to the IWMP process on agricultural issues and agri–environmental priorities.

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 available 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 Whitemud River study area. More information on the data used in this document can be found within the Appendices section of the report.

D. Introduction

The Whitemud River IWMP study area is defined by Manitoba Water Stewardship as encompassing watershed “05LL”, situated along the Whitemud River southwest of Lake Manitoba (***Figure 1***). The Whitemud River IWMP study area is approximately 741,400 ha in size and consists of the area north of Spruce Woods Provincial Park, between Riding Mountain National Park and Lake Manitoba. Stony Creek and Boggy Creek, which flow down eastern lower slopes of Riding Mountain National Park, Whitemud River, Big Grass River, Pine Creek, Squirrel Creek, Rat Creek, Jackfish Lake and Big Grass Marsh are located and or flow through the study area. Some of the communities located within the study area include Neepawa, Gladstone, McGregor, Carberry, Austin, and Plumas. A small portion of Riding Mountain National Park (7,100 ha) is located in the northwest portion of the watershed.

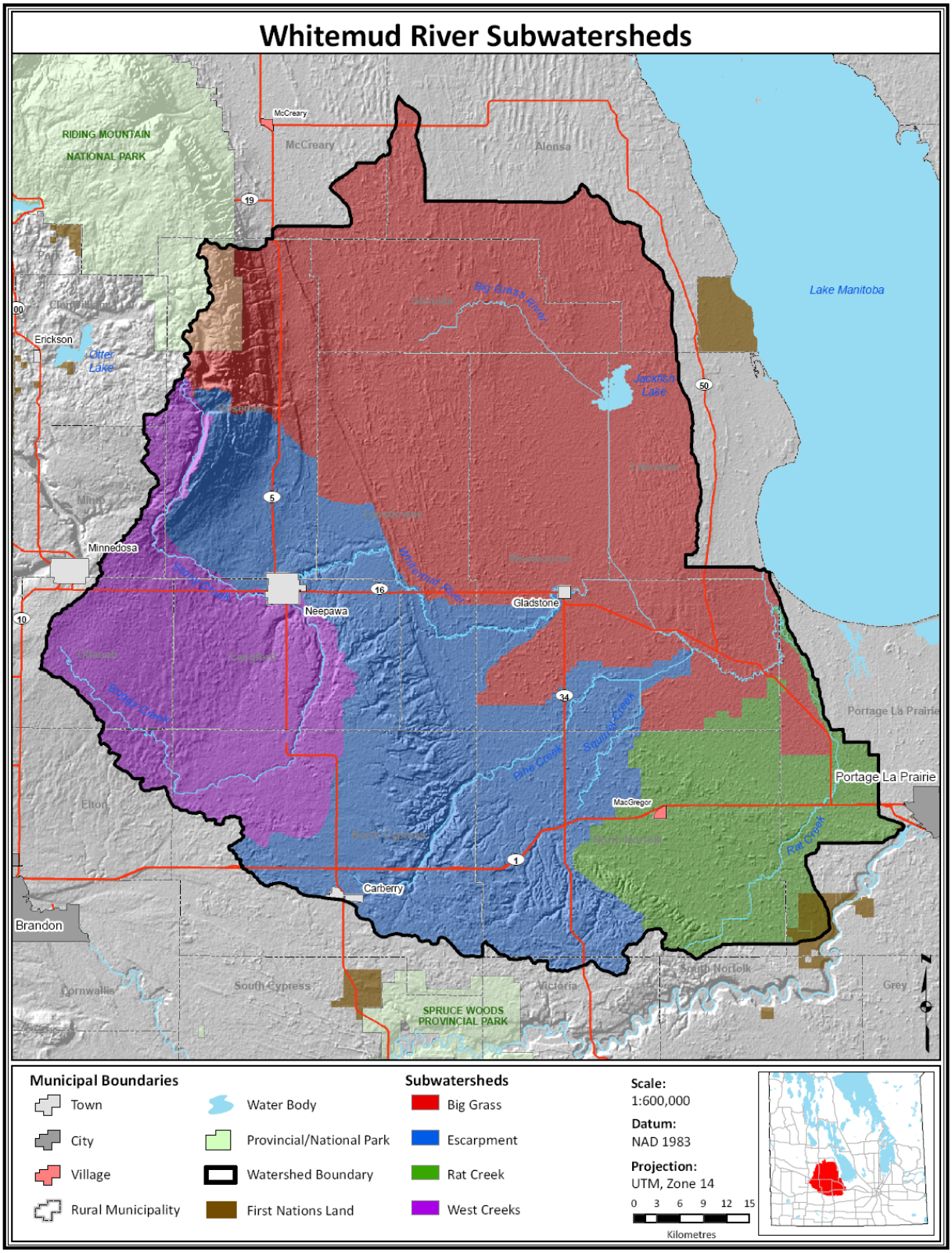
Significant changes in elevation occur throughout the watershed, with values ranging from 721 meters above sea level in Riding Mountain National Park, down to 345 meters above sea level in the eastern portion of the watershed at the Whitemud River delta at Lake Manitoba. There is a sharp change in elevation associated with the Manitoba Escarpment near Riding Mountain National Park, and then a gradual decrease in elevation heading east though the watershed. The Manitoba Escarpment runs south and slightly east through the middle of the watershed. The area west of the escarpment is dotted by numerous small lakes (potholes) and hills. East of the escarpment, the land slopes gently towards the western shore of Lake Manitoba.

Objective

Understanding the current state and trends in agricultural land use and management practices along with landscape characteristics, is essential for developing an IWMP. Agricultural land use and associated land cover can influence watershed processes and impact issues like water quality and hydrological flow within the watershed. Knowledge of these factors will support the development of sustainable land use strategies that will lead to a healthier and more ecologically functioning landscape. AESB and MAFRI have partnered to undertake an assessment of the changes to agricultural activities and their potential impacts within the watershed, focusing on the major issues identified in the 2009 public consultations in support of the IWMP. Specifically, the document will examine the following:

- **"Near-Current" Agricultural Land Use and Management using the latest available Census of Agriculture data and satellite imagery.**
- **Fifteen-year change in agricultural land use and management using 1991, 1996, 2001, and 2006 Census of Agriculture data and a time series of satellite imagery.**
- **Land cover data in combination with landscape risk factors pertaining to the soil and water resource.**
- **The impact of recent federal and provincial initiatives, policies and regulations impacting agricultural land management and land use planning activities in the watershed.**

Figure 1: Whitemud River IWMP study area and subwatershed groupings (2006 Census of Agriculture analysis)



E. Agricultural Land Use and Management

i. Current Agricultural Land Use of the Whitemud River IWMP study area

a) Agricultural Profile

Agricultural profiling refers to the characterization of agricultural production in a specified 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 A***. 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, financial data and for larger areas.

Agricultural activities were analyzed for the Big Grass, Escarpment, West Creeks, and Rat Creek subwatersheds (***Figure 1***). The Big Grass subwatershed comprises the northern portion of the study area including Big Grass River, Big Grass Marsh, and Jackfish Lake. This subwatershed includes the Lakeview, Westbourne, and a portion of the Alonsa and McCreary, AESB Community Pastures. The Escarpment subwatershed comprises the central portion of the watershed following the Manitoba Escarpment. It includes the western portions of the Whitemud River, Pine Creek, and Squirrel Creek, as well as a large portion of the Langford AESB Community Pasture. The West Creeks subwatershed comprises the southwest portion of the study area and includes Stony Creek and Boggy Creek, which flow into the Whitemud River near Neepawa. The West Creeks subwatershed covers the gently sloped plains west of the escarpment, is comprised of numerous potholes and a small portion of the Langford AESB Community Pasture. The Rat Creek subwatershed is located in the extreme southeast portion of the watershed and includes the Rat Creek and its tributaries. The subwatershed falls just east of the border of the Assiniboine Delta Aquifer at the base of the escarpment. ***Table 1*** lists these subwatersheds with their respective sizes and proportion of the IWMP study area.

Table 1: Subwatershed areas of the Whitemud River IWMP study area*

Subwatershed	Area (hectares)	Percent of IWMP study area
Big Grass	324,200	44%
Escarpment	209,400	29%
West Creeks	114,300	16%
Rat Creek	83,800	11%
IWMP Boundary	**731,800**	

* Subwatershed area totals are approximate due to the nature of the image analysis procedure and slight differences between census subwatershed boundaries and the IWMP boundary.

Land Use and Land Management

Big Grass Subwatershed:
According to 2006 Census of Agriculture data, nearly 45% of farmland in the Big Grass subwatershed was dedicated to annual crop production and almost 50% to pasture, alfalfa, hay, and fodder crops. Cereals made up over 45% of cultivated land while 25% was seeded to forages. Oilseeds, almost exclusively canola, made up over 20% of the cultivated land. Conservation tillage was practiced on over 40% of cultivated land, while conventional tillage was the most widely used tillage practice occurring on 50% of all cultivated land. Only 10% of cultivated land was managed using zero tillage practices. Beef production was common in the watershed, with over 250 farm operations managing nearly 28,100 beef cows, an average of 80 head per farm. Cattle and calves in the area was almost 63,520 animals. One hundred and fifteen farms reported a total of 1,350 horses and ponies. Thirty-five poultry farms reported over 157,000 birds. Thirty five farming operations reported 76,990 pigs, an average of 2,090 per farm.

Escarpment Subwatershed:
Fifty percent of the farmland in the subwatershed was dedicated to annual crop production, and nearly 45% to pasture, alfalfa, hay, and fodder crops. Cereals made up 50% of the cultivated area, oilseeds (mainly canola) over 20%, and forages just below 20%. In terms of land management practices, conventional and conservation tillage made up 45% and 40% of total cultivated land, respectfully. Management of cultivated land using zero-tillage practices was less common in the subwatershed and was practiced on less than 15% of the land. Beef was the main form of livestock production in the subwatershed, with 320 farm operations managing almost 52,850 beef cows, an average of almost 160 cows per farm. Total cattle and calves reported in the area added up to over 52,840 animals. One hundred and ten farms reported a total of 1,180 horses and ponies. Forty poultry farms reported a total of over 225,700 birds. A total of 43,850 pigs were reported from 20 farms; an average of 2,200 pigs per operation.

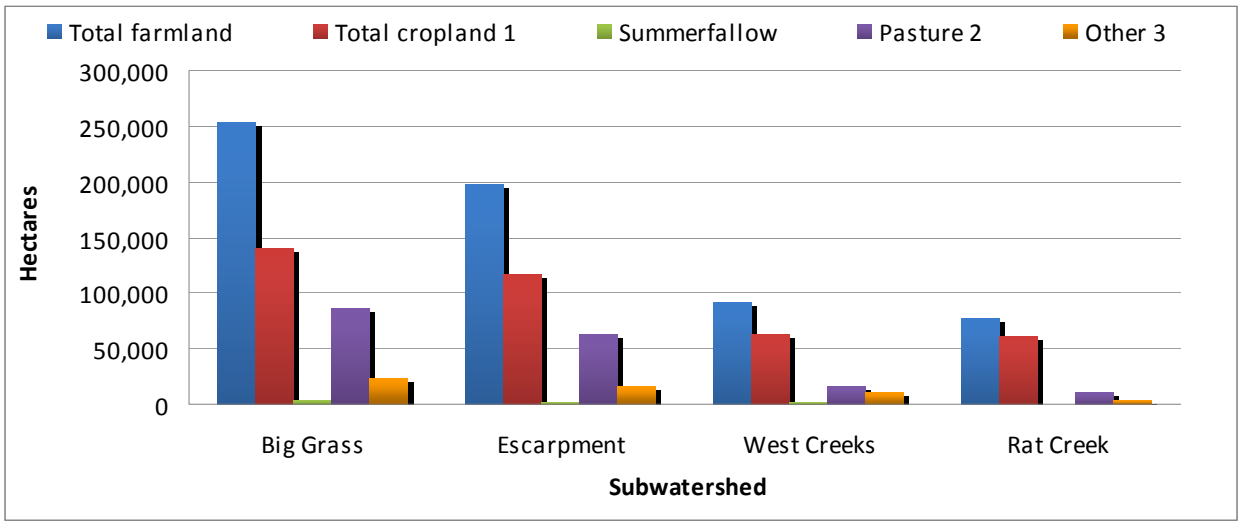
West Creeks Subwatershed:
In 2006, 60% of the farmland in the West Creeks subwatershed was dedicated to annual crop production, and almost 25% to pasture, alfalfa, hay, and fodder crops. Fifteen percent of the farmland within the watershed was classified as other land (including woodlands, wetlands, etc). Cereals made up slightly less than 50% of the cultivated area, oilseeds (mainly canola) almost 30%, and forages 15%. 30% of the cultivated land prepared with conventional tillage practices, and the remaining area was prepared using conservation tillage (50%) or zero tillage (20%). Cow/calf and beef operations were common in the subwatershed, with over 120 farms reported for each. Total cattle and calves reported in the subwatershed added up to almost 16,710 animals. Over 55 farms reported a total of 470 horses and ponies. Ten farms reported poultry, totalling nearly 87,900 birds. Ten farming operations reported pigs, an average of over 1,030 per operation.

Rat Creek Subwatershed:
In 2006, 70% of the farmland in the Rat Creek subwatershed was dedicated to annual crop production, and almost 25% to pasture, alfalfa, hay, and fodder crops. Cereals made up slightly more than 45% of the cultivated area, pulse crops (mainly dry white beans and soybeans) and oilseeds (mainly canola) each accounted for around 20%, and forages 10%. Fourty five % of the cultivated land was prepared with conventional tillage practices, 45% with conservational tillage and the remaining area with zero tillage. Cow/calf and beef production were the main forms livestock production in the subwatershed, with over 105 farms reported for each. Total cows and calves reported equalled nearly 15,970 animals. Thirty-five farms collectively reported a total of 180 horses and ponies. Fifteen poultry farms reported a total of nearly 76,800 birds.

Ten farms reported pigs in the watershed, totalling 19,700 animals, representing an average of 1,670 pigs per operation.

Cropland made up the majority of farmland in all four subwatersheds; however, the relative proportion of cropland in relation to other agriculture lands differed across subwatersheds. Both Big Grass and Escarpment subwatersheds had a higher proportion of land in pasture than did the other subwatersheds (34% and 32%, respectfully). In contrast, the smaller subwatersheds (West Creeks and Rat Creek) had a smaller percentage of pasture land . Seventy percent of farmland was cultivated to crops in the West Creeks subwatershed and 80% in the Rat Creek subwatershed. Other land made up between 5% and 15% of total farmland in each of the subwatersheds and the area of summerfallow was negligible in the each of the subwatersheds (***Figure 2***).

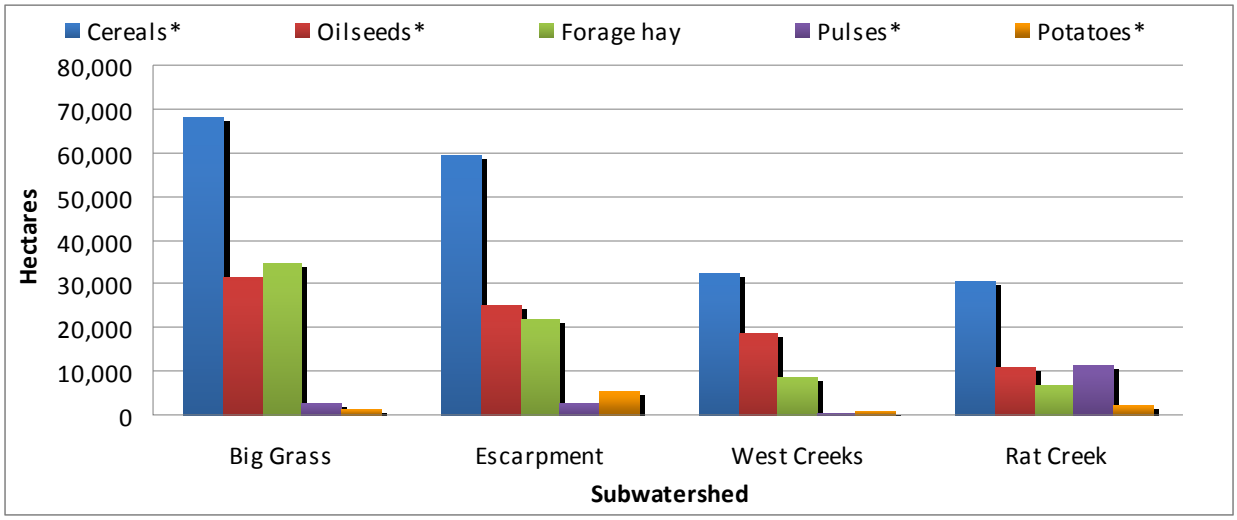
Figure 2: Distribution of agricultural land in the Whitemud River Watershed (2006 Census of Agriculture)



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

With respect to the distribution and types of crops grown in 2006, cereals (mainly wheat, but also some oats and barley) were the dominant crop in the watershed. Oilseeds (mainly canola) and forage hay (mainly alfalfa) each made up approximately 20% of crops in the Big Grass and Escarpment subwatersheds. Nearly 30% of the cropland in West Creeks was dedicated to oilseeds. A large portion of cropland in the Rat Creek subwatershed was also seeded to pulse crops (consisting mostly of dry white beans and soybeans) (***Figure 3***). Potatoes made up only a small portion of cropland in the subwatershed. The majority of potato crops in the watershed were located in the Escarpment subwatershed, over the Assiniboine Delta Aquifer.

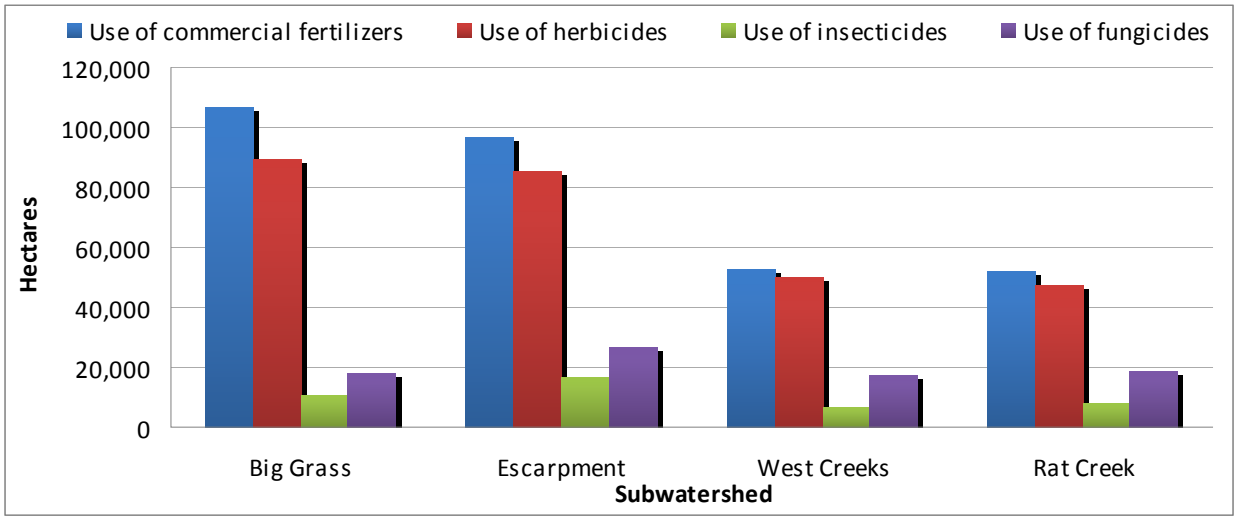
Figure 3: Distribution of the main crop types grown in the Whitemud River Watershed (2006 Census of Agriculture)



* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

Although the area of cropland which received crop inputs was higher in Big Grass and Escarpment, these subwatersheds are approximately twice the size of the other two subwatersheds. Therefore, the proportion of land receiving crop inputs is actually quite similar between all four subwatersheds (***Figure 4***). A much smaller proportion of cropland was treated with fungicides, and even less cropland was treated with insecticides in all subwatersheds.

Figure 4: Area treated to crop inputs in the 2005 crop year in the Whitemud River Watershed (2006 Census of Agriculture)



Erosion has been identified as an important issue in the Whitemud River Watershed, especially in the Escarpment subwatershed, due to the increased velocity of water flowing down the slopes of Riding Mountain National Park. With respect to seedbed preparation, including conservation tillage and zero tillage were common in the Whitemud River Watershed (***Figure 5***). Conventional tillage made up less than 50% of tillage practices in the Big Grass, Escarpment, and Rat Creek subwatersheds and less than 30% in the West Creeks subwatershed.

Figure 5: Tillage practices in the Whitemud River Watershed (2006 Census of Agriculture)

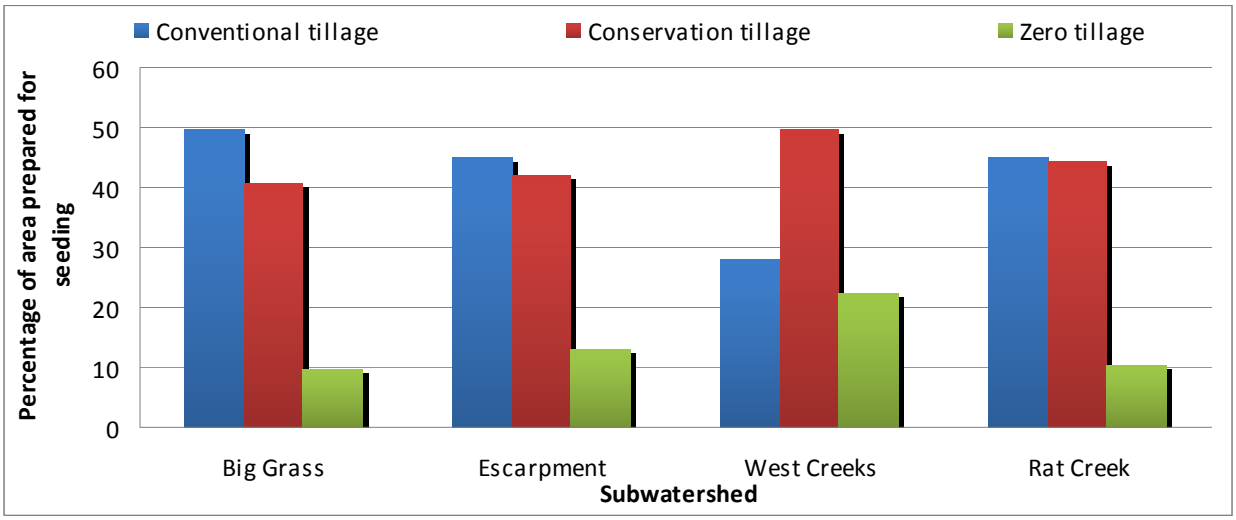
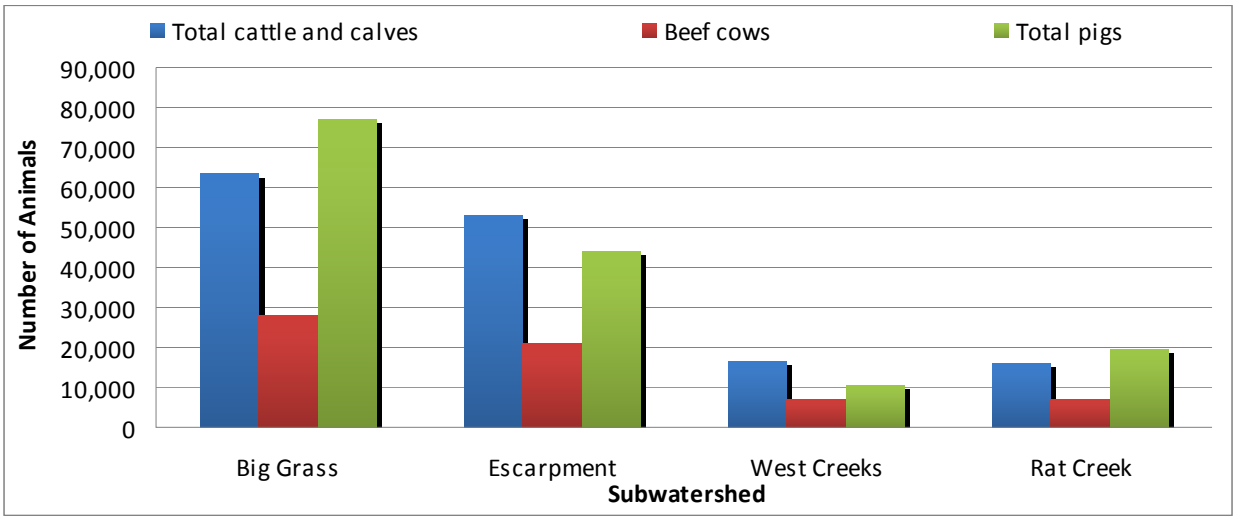


Figure 6 summarizes livestock numbers in the Whitemud River Watershed. A significant amount of livestock is raised in the watershed, especially in the Big Grass and Escarpment subwatersheds. In all four subwatersheds, beef production made up nearly half of the total cattle and calves number, an indication that cow/calf operations made up a large proportion of cattle farming in the watershed. Hog farms were also quite common within the watershed, and the total number of pigs surpassed the number of cattle in both the Big Grass and Rat Creek subwatersheds.

Figure 6: Total livestock numbers in the Whitemud River Watershed (2006 Census of Agriculture)



Total Animal Units (AU) produced in the watershed (based on annual nitrogen production) has been estimated using Manitoba's AU coefficients and by making several assumptions (refer to ***Appendix B***). As represented in ***Table 2***, cattle and calves had the highest contribution to animal units in the watershed, and accounted for over 75% of total AU in each subwatershed (81% overall in the entire watershed). Since beef production consists mainly of cow/calf

operations, manure nitrogen and phosphorous tend to be deposited directly onto pastureland by the animals during the grazing season. Depending on the winter management regime natural deposition of manure onto pastureland may continue over the winter season or may be accumulated on concentrated wintering sites. Hog operations contribute the majority of remaining animal units in the watershed, accounting for 13% of the total animal units to the watershed.

Table 2: Estimated annual animal units produced in the Whitemud River Watershed (according to the number of livestock reported on Census day, 2006)

Livestock Type	Animal Units (AU) by subwatershed				Total Animal Units (AU)	Percentage of Watershed's Total AU
	Big Grass	Escarpment	West Creeks	Rat Creek		
Total Cattle and Calves	40,888	31,408	10,487	9,672	92,456	81%
Total Pigs	8,637	3,981	942	1,473	15,032	13%
Total Poultry	682	1,203	381	428	2,695	2%
Total Horses and Ponies	1,361	1,178	470	178	3,187	3%
Other livestock - sheep, goats, bison, elk	265	257	478	160	1,160	1%
TOTAL AU*	51,833	38,028	12,758	11,912	114,530	

* Some livestock numbers have been suppressed by Statistics Canada to preserve landowner confidentiality and are not included in the calculations of total animal units

Figures 7 and ***8*** indicate the average size of livestock herds and bird flocks within the watershed. This number can be used to compare livestock production between subwatersheds and identify areas that may be at a higher risk of causing environmental damage associated with intensive livestock production. Additionally, highlighting these areas within the watershed helps with the targeting of livestock related beneficial management practices. The average herd size cattle/calves and beef cows is similar between the four subwatersheds. These values ranged from 130 to 170 pairs (cow/calf) and 60-80 head (beef cows) per farm (***Figure 7***). Pig herd size was also similar between subwatersheds, ranging from 1,000 – 2,200 per farm; although Big Grass and Escarpment had slightly larger herd sizes (***Figure 8***). Poultry flock size varied greatly between subwatersheds. West Creeks had an average flock size of nearly 9,300 birds while the sizes of flocks in the other subwatersheds were approximately half that size. These values must be observed with caution, however, because barns that were empty on census day would have had no inventory to report and may have lead to an under-reporting of livestock in the watershed.

Figure 7: Average number of cattle per farm in the Whitemud River Watershed (2006 Census of Agriculture)

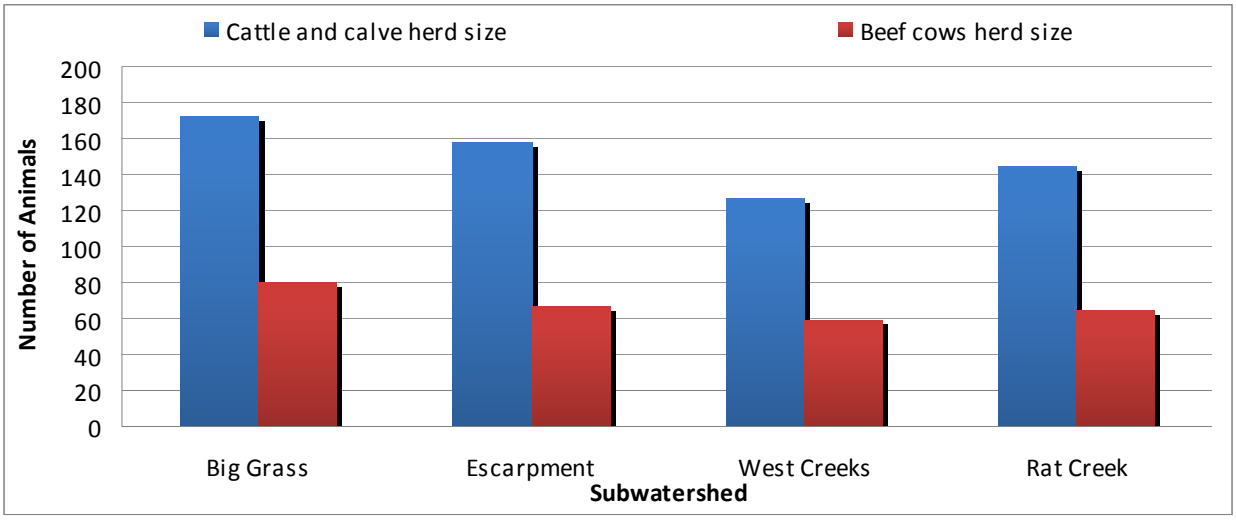
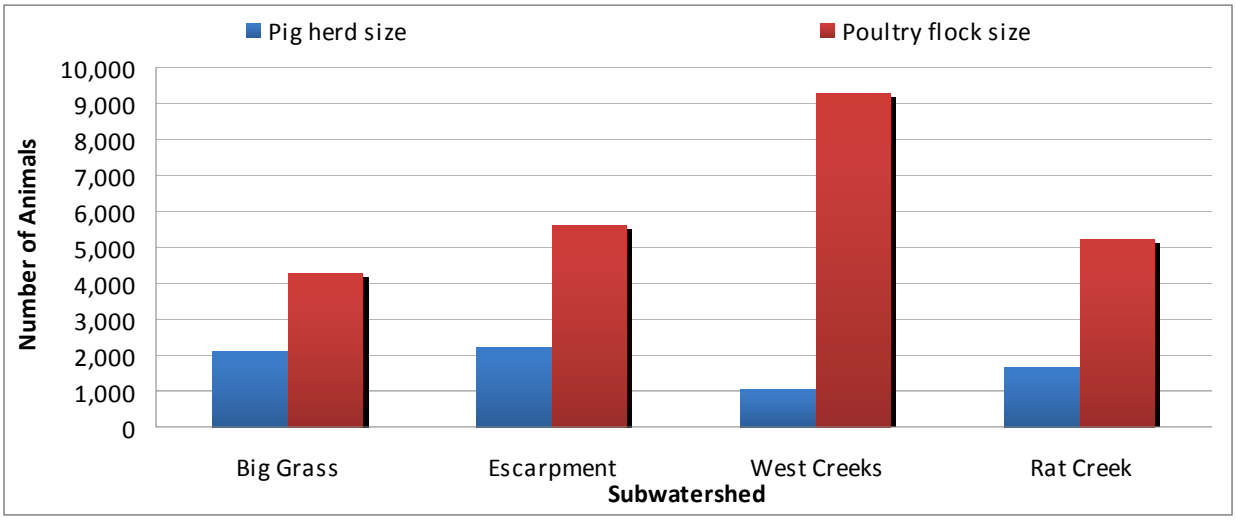


Figure 8: Average number of pigs and birds per farm in the Whitemud River Watershed (2006 Census of Agriculture)



Farm Financial Characteristics

Big Grass Subwatershed:
In 2006, 550 farms were reported within the Big Grass subwatershed, with 78% of the subwatershed area being used for farming. The average farm size was approximately 460 ha/farm (1,140 acres/farm) with an average capital investment of $1,900 per hectare of farmland (or almost $881,900/farm). Livestock-related expenses were over $70/ha of farmland and crop-related expenses were over $160/ha of cropland and summerfallow. Per farm, net cash income was estimated to be almost $28,600 and the sales to expense ratio was reported to be 1.18 (farm operations received $1.18 gross revenue for every $1 of agricultural expense).

Escarpment Subwatershed:
In 2006, 495 farms were reported within the Escarpment subwatershed, with 94% of the subwatershed area being used for farming. The average farm size was approximately 400 ha/farm (980 acres/farm) with an average capital investment of $2,400 per hectare of farmland (or $967,500/farm). Livestock-related expenses were over $90/ha of farmland and crop-related expenses were $200/ha of cropland and summerfallow. Net cash income per farm was estimated to be almost $31,400 and the sales to expense ratio was reported to be 1.17 (farm operations received $1.17 gross revenue for every $1 of agricultural expense).

West Creeks Subwatershed:
In 2006, 260 farms were reported within the West Creeks subwatershed, with over 81% of the subwatershed area being use for farming. The average farm size was approximately 360 ha/farm (890 acres/farm) and farms had an average capital investment of $2,400 per hectare (or over $875,200 per farm). Average livestock-related were nearly $110/ ha of farmland, while crop-related expenses were over $170/ha of cropland and summerfallow. Net cash income per farm was estimated to be almost $19,400 and the sales to expense ratio was reported to be 1.12 (farm operations received $1.12 gross revenue for every $1 of agricultural expense).

Rat Creek Subwatershed:
In 2006, 220 farms were reported within the Rat Creek subwatershed, with over 93% of the subwatershed area being use for farming. The average farm size was approximately 350 ha/farm (870 acres/farm) and farms had an average capital investment of $2,300 per hectare (or over $963,900 per farm). Average livestock-related expenses were $70/ ha of farmland, while crop-related expenses were $230/ha of cropland and summerfallow. Net cash income per farm was estimated to be almost $26,300 and the sales to expense ratio was reported to be 1.15 (farm operations received $1.15 gross revenue for every $1 of agricultural expense).

The Big Grass and Escarpment subwatersheds are larger than the other subwatersheds in the area and have approximately twice the number of farms as the West Creeks or Rat Creek subwatersheds(***Figure 9***). Additionally, the larger subwatersheds had, on average, larger farms (approximately 400ha/farm) in comparison to the smaller subwatersheds (approximately 350ha/farm). Farm financial activity indicates that farms in the Rat Creek subwatershed tended to have higher sales and expenses, which may be cause by the high proportion of crop farmers in the area (***Figure 10***). Net cash income was highest in Escarpment subwatershed ($31,400/farm) and lowest in West Creeks subwatershed ($19,400/farm). The majority of financial activity in the watershed occurs in Big Grass and Escarpment, which is probably attributable to their large sizes (***Figure 11***).

Figure 9: Total number of farms and average farm size in the Whitemud River Watershed (2006 Census of Agriculture)

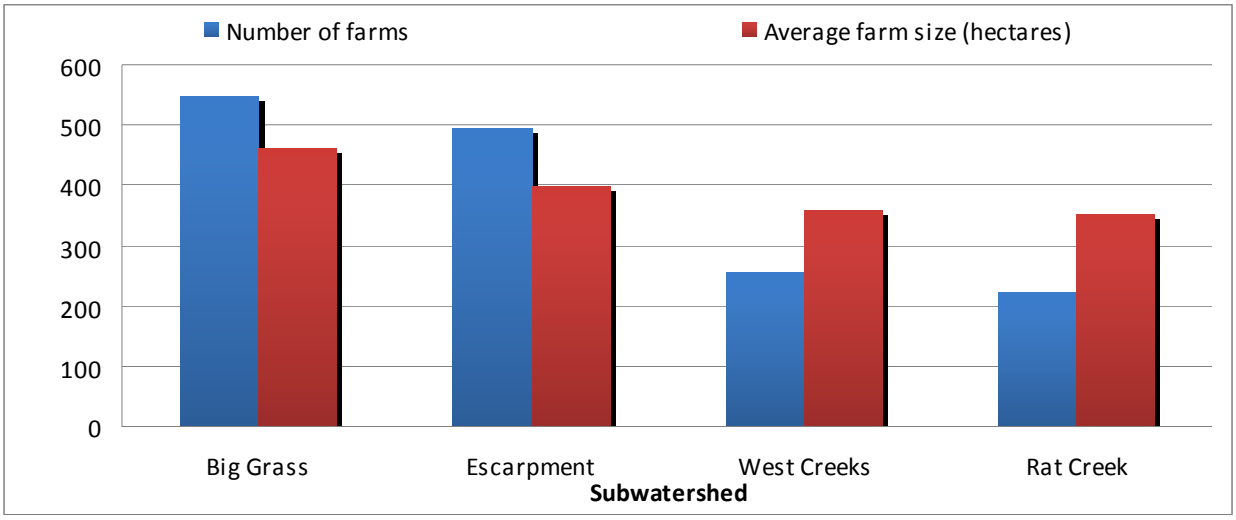


Figure 10: Summary of farm average financial activity for the 2005 calendar year in the Whitemud River Watershed (2006 Census of Agriculture)

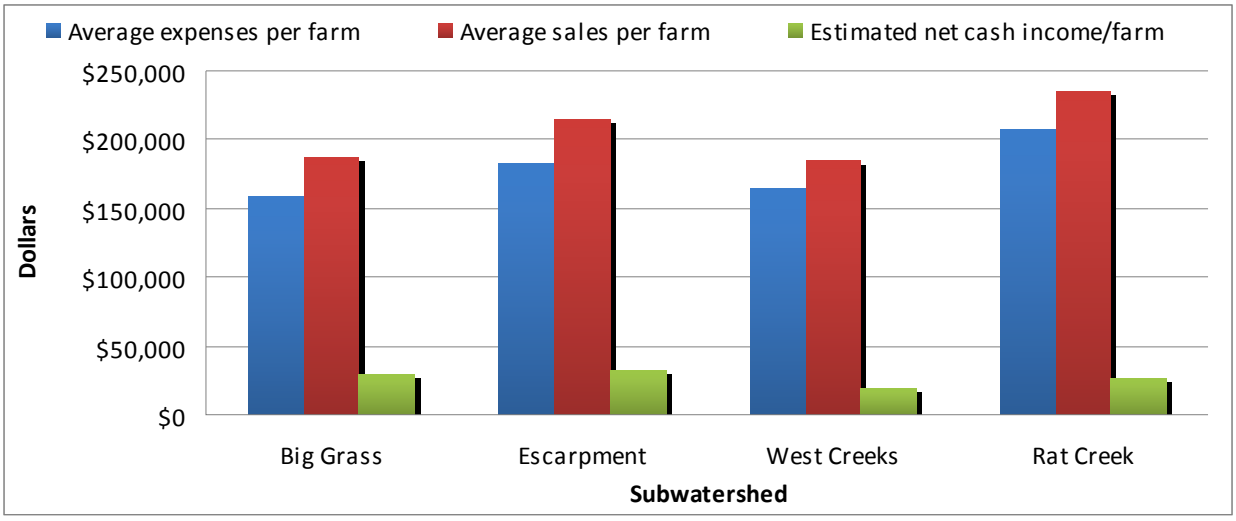
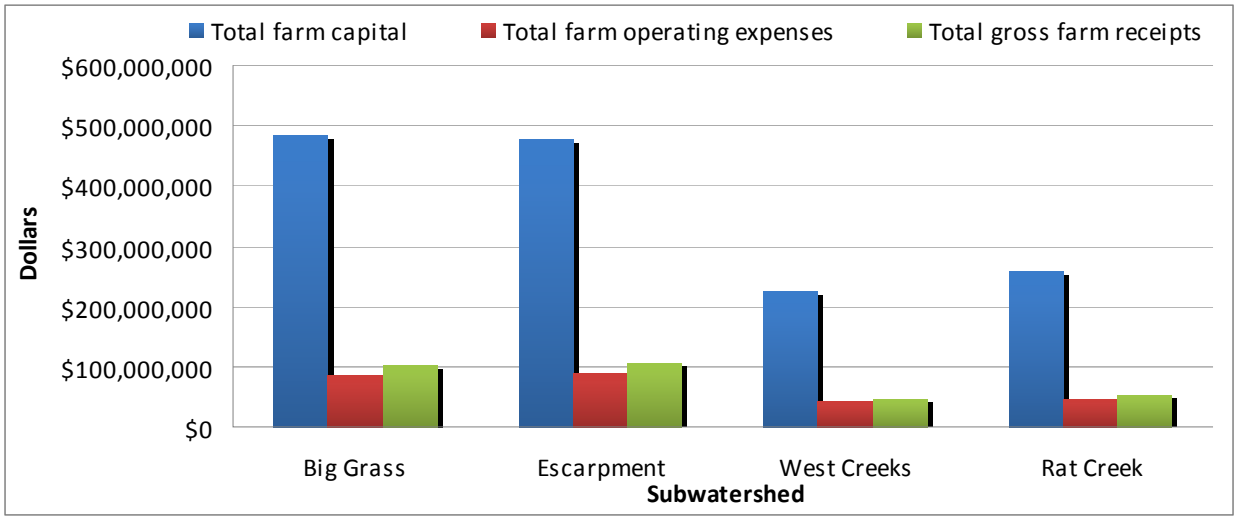
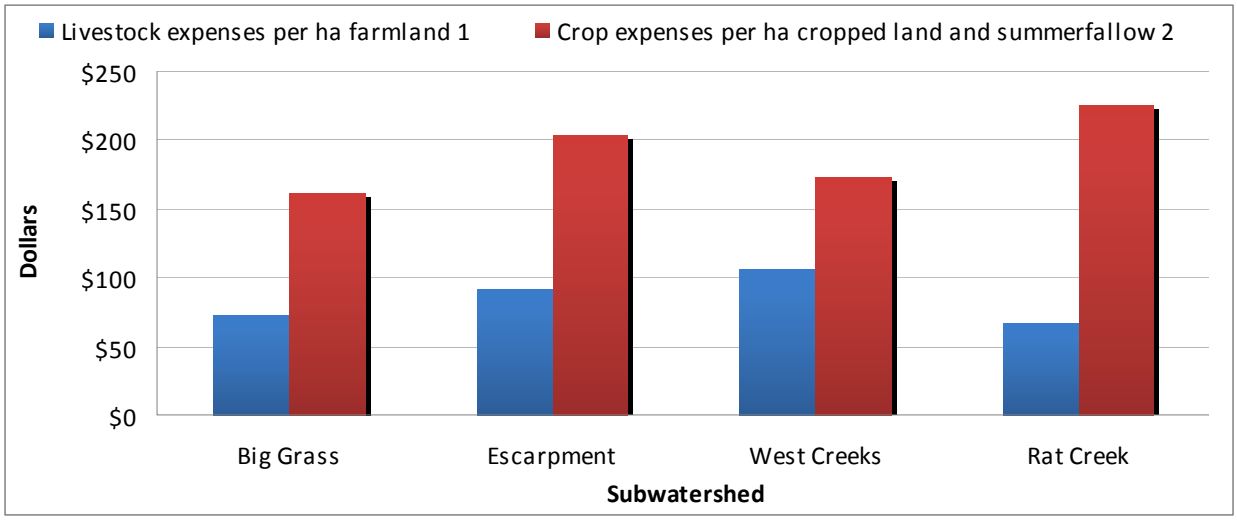


Figure 11: Summary of financial activity for the 2005 calendar year in the Whitemud River Watershed (2006 Census of Agriculture)



Livestock and crop-related expenses reported for the 2005 calendar year have been determined on a per hectare basis. ***Figure 12*** shows that the Rat Creek subwatershed had the lowest livestock expenses while West Creeks subwatershed had the highest; however values from all four subwatersheds were similar. With respect to fertilizer and herbicide related expenses, producers in the Rat Creek and Escarpment subwatersheds reported the highest expenses per hectare of cropped land and summerfallow (***Table 3***).

Figure 12: Average livestock and crop-related expenses per hectare for the 2005 calendar year in the Whitemud River Watershed (2006 Census of Agriculture)



[1] Livestock-related expenses include total feed, supplements, and hay purchases, livestock and poultry purchases, veterinary services, drugs, semen, breeding feeds, etc

[2] Crop-related expenses include purchases of fertilizer, lime, herbicides, insecticides, fungicides, and seed and plant (excluding materials purchased for resale)

Table 3: Average dollars per hectare spent on fertilizer and pesticides in the 2005 calendar year in the Whitemud River Watershed (2006 Census of Agriculture)

Subwatershed name	Dollars spent on fertilizer per hectare applied	Dollars spent on pesticides per hectare applied
Big Grass	$110	$60
Escarpment	$120	$60
West Creeks	$100	$50
Rat Creek	$120	$60

2006 Agriculture Profile Summary

- Approximately 70% of the land in the watershed was owned and managed by farm operations.
- Agriculture activity was similar throughout the watershed, howeverthe Big Grass and Escarpment subwatersheds had higher proportions of land dedicated to livestock production than did the West Creeks and Rat Creek subwatersheds, which had higher proportions of land seeded to crops.
- Crop production was the most important agricultural practice in the watershed. Approximately 65% of the farmland in the watershed was cultivated to crops. This percentage was slightly higher in West Creeks and Rat Creek, and slightly lower in Big Grass and Escarpment subwatershed. Fertilizers and herbicides were applied to 79% and 70% of cultivated fields in the watershed, respectfully. Average crop inputs were similar between for all subwatersheds.
- Alternative tillage was quite common in the watershed, practiced on over 50% of cultivated land. Conservation and zero tillage were most commonly practiced in the West Creeks subwatershed, while there was slightly less adoption of these methods in the other subwatersheds.
- Beef production is the main form of livestock production in the watershed. In the Big Grass and Escarpment subwatersheds, land used for beef production (pastures and seeded forage for hay) made up nearly 35% of the farmland, while in West Creeks and Rat Creek subwatersheds, it made up only 17% and 15%, respectfully. With respect to beef herds, farms in all four subwatersheds reported similar numbers of cattle and calves per farm numbers, on average.
- Despite their smaller average sizes, farms in the West Creeks and Rat Creek subwatersheds had relatively high levels of financial activity. All of the subwatersheds had similar average expenses per farm, although West Creeks subwatershed had a slightly lower average net profit than the other subwatersheds.

b) 2006 Land Cover Summary

Land cover data used in this analysis was derived from 30 metre resolution LANDSAT Thematic Mapper satellite imagery taken on August 15, 2006. The land cover data provides information on the spatial extent of general types of land cover within a given area at that point in time. Further details on the land cover data, and the constraints associated with this data, are provided in ***Appendix C***.

- Annual Cropland is the predominant land cover type in the watershed, accounting for nearly half of the total land cover (***Table 4***). The majority of the total annual cropland occurs within the Big Grass and Escarpment Subwatersheds (***Figure 14***). Although the area of cropland in West Creeks and Rat Creek subwatershed is less, it makes up a significant proportion of land cover in each subwatershed (84% and 74% of total area, respectfully).
- Grassland/pasture is the second most common land cover type and makes up 23% (or 167,384 ha) of the watershed. Within the watershed, grassland/pasture is restricted almost entirely to the Big Grass and Escarpment subwatersheds. Large patches of grassland are mixed throughout forested areas along the Manitoba Escarpment, where annual cropping is not feasible. Most of the grasslands within the Big Grass subwatershed occur in the Lakeview and Alonsa AESB community pastures, south of Big Grass Marsh, and throughout the central portion of the subwatershed, northeast of Neepawa.
- Trees are the third most predominant land cover type in the watershed comprising 16% (or 116,847 ha) of the total land cover. The vast majority of tree cover is located along the escarpment, as well as in and around Riding Mountain National Park.
- Forage land, usually indicative of alfalfa stands, makes up 4% of the watershed. Most of the forage is located in the lower areas below the Manitoba Escarpment and the center of the watershed on lighter soils.
- Wetlands occupy a small portion of the watershed (approximately 3%), and are located primarily within the Big Grass Marsh (around Jackfish Lake) and the Rural Municipalities of Alonsa and McCreary.
- Less than 1% of the watershed is classified as water, which is scattered throughout the pothole region west of Neepawa and in the vicinity of Jackfish Lake and Big Grass Marsh.

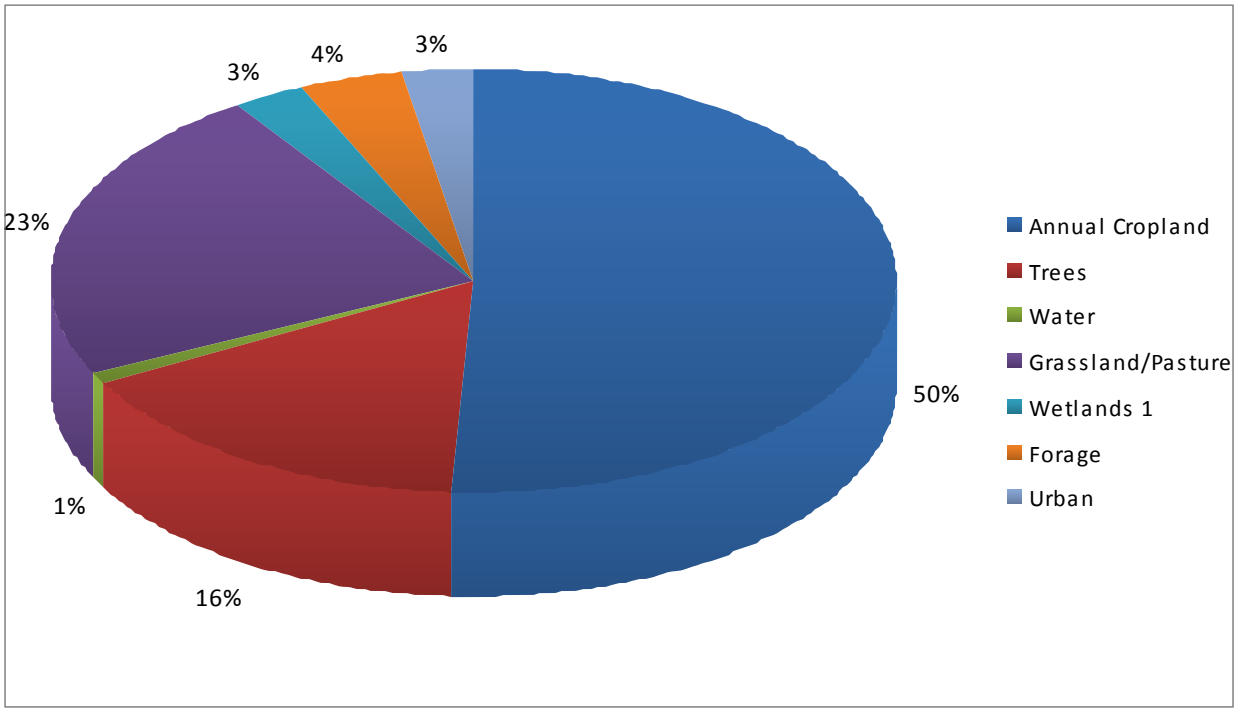
Table 4: 2006 Land Cover by Subwatershed (hectares)*

Subwatershed	Annual Cropland	Trees	Water	Grassland/ Pasture	Wetlands[1]	Forage	Urban	Total
Big Grass	138,432	51,510	3,449	92,842	14,441	15,742	7,722	324,138
Escarpment	102,203	47,601	983	42,987	1,494	7,787	6,383	209,437
West Creeks	70,579	10,168	1,324	20,685	3,261	4,816	3,510	114,344
Rat Creek	61,643	7,569	82	10,870	160	210	3,312	83,847
IWMP Boundary	**372,857**	**116,847**	**5,838**	**167,384**	**19,356**	**28,555**	**20,927**	**731,765**

* Subwatershed area totals are approximate due to the nature of the image analysis procedure and slight differences between census subwatershed boundaries and the IWMP boundary.

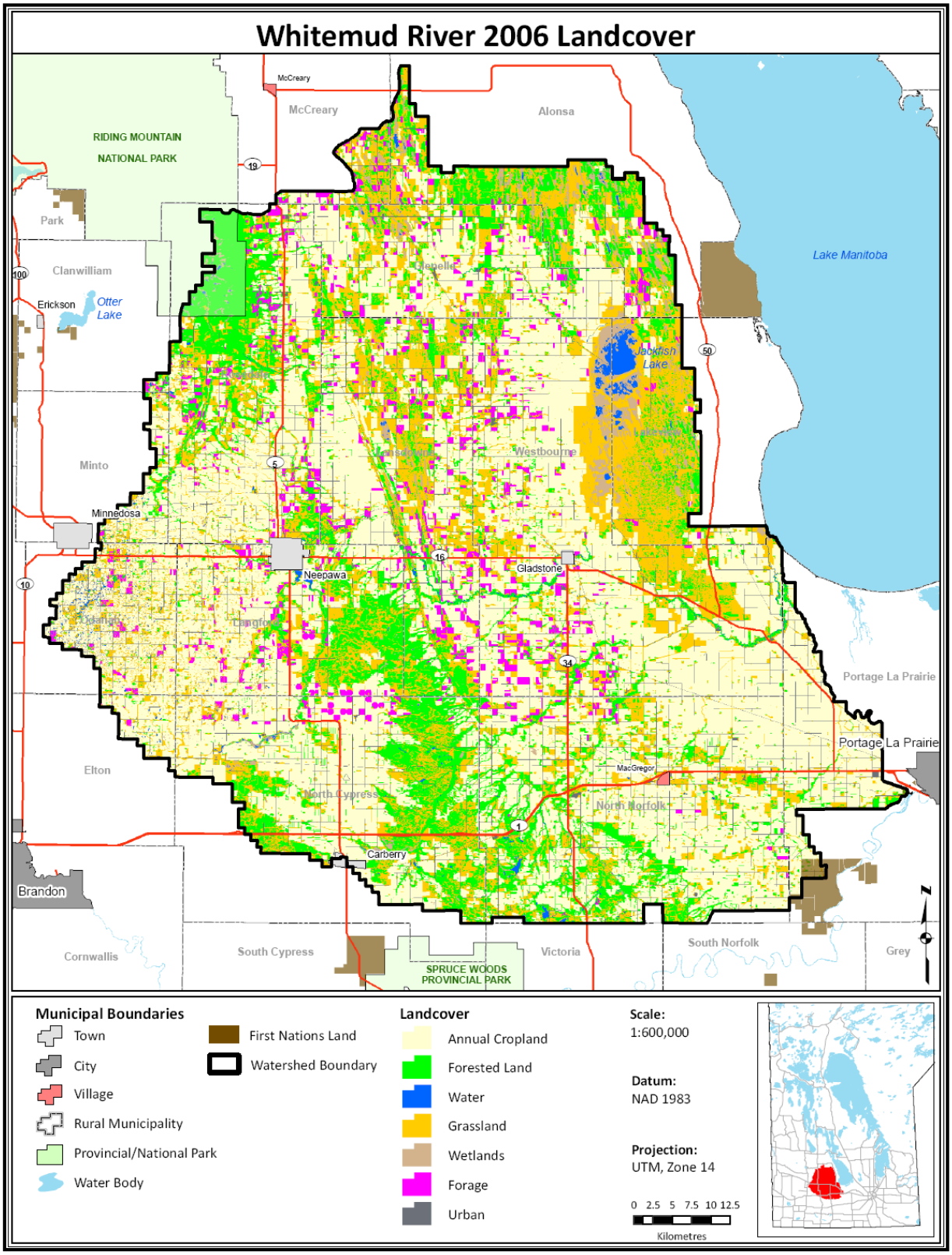
[1] Due to seasonal changes in wetland size, date of imagery will affect area.

Figure 13: Distribution of Land Cover within the Whitemud River Watershed in 2006



1 Due to seasonal changes in wetland size, date of imagery will affect area

Figure 14: 2006 Land Cover in the Whitemud River Watershed



*Land cover was derived from satellite imagery captured August 15, 2006.

ii. Agricultural Land Use Trends

Agricultural land use is diverse and there are many factors influencing changes over time. Influences include economic drivers like commodity prices, land values, input costs, and government programs, as well as social influences such as changing demographics and increasing environmental awareness. Understanding land use trends can guide the development of future programs and actions to encourage sustainable resource management in the watershed.

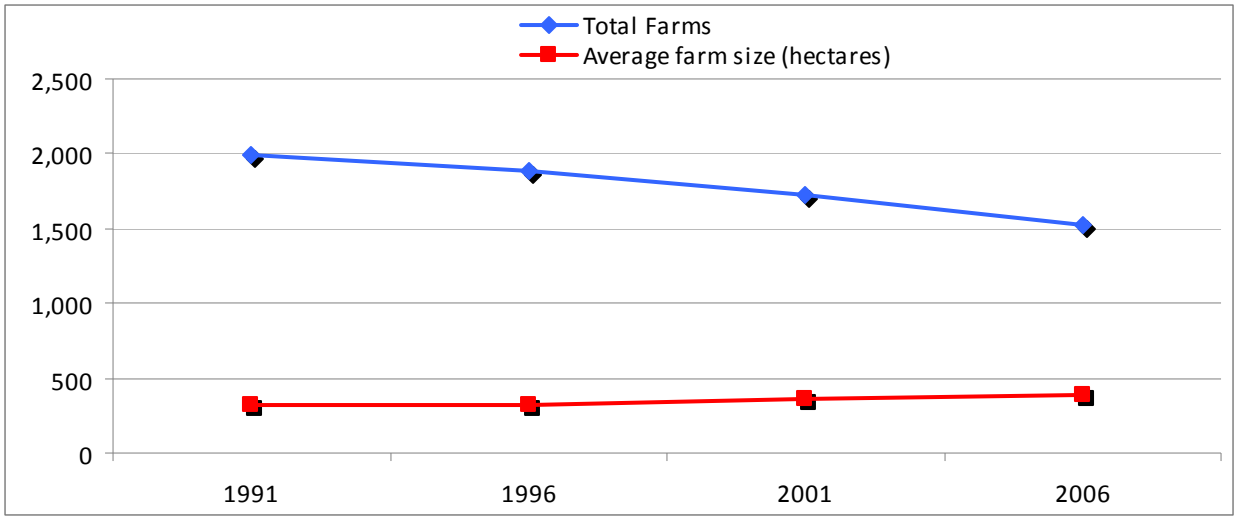
Additionally, there are many factors that influence decisions made on individual farms. In order to understand if changes are the result of adaptation in farming systems and/or practices, or are due to weather, market and other conditions, it is important to also be aware of events and conditions. As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

a) Changes in Agricultural Production (1991 to 2006 Census Data)

Census of Agriculture data from 1991, 1996, and 2001 has been acquired from Statistics Canada to the same subwatershed boundaries as the 2006 data. The use of multiple data sets can illustrate changes in agricultural production, practices, and financial characteristics. This can be analyzed to better understand the contributions of the agricultural industry's effects on landscape resources in the Whitemud River IWMP study area. For detailed information from the 1991, 1996, 2001 and 2006 Census of Agriculture refer to ***Appendix I, J, K,*** and ***L***.

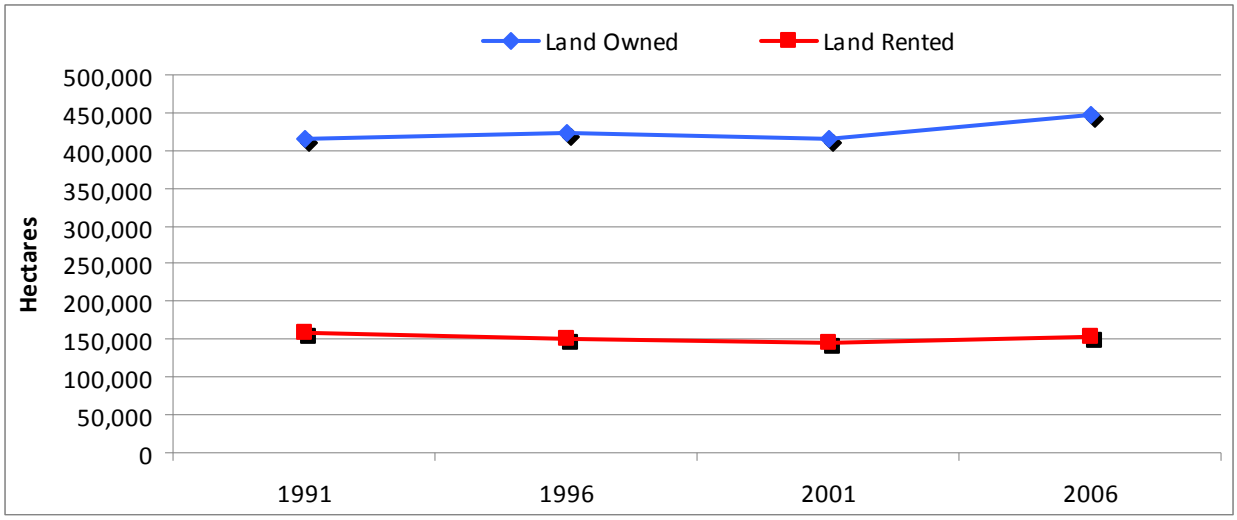
Number of Farms and Farmed Area
The number of farms in the Whitemud River Watershed declined from 1,990 in 1991 to around 1,520 farms in 2006, a decrease of 24% over the 15 year period (***Figure 15***). Even with a decrease in total farmland in the watershed over this time period (***Figure 17***), average farm size increased steadily from 320 ha in 1991 to 390 ha in 2006.

Figure 15: Total number of farms and average farm size in hectares in the Whitemud River Watershed from 1991 to 2006



Land Tenure
The area of rented land saw very little change from 1991 to 2006 (***Figure 16***). In 2001, a slight drop occurred; however this drop was followed by an increase to previous levels the following census year. The area of owned land remained relatively static from 1991 to 2001, but increased overall by approximately 30,300 ha between 1991 and 2006.

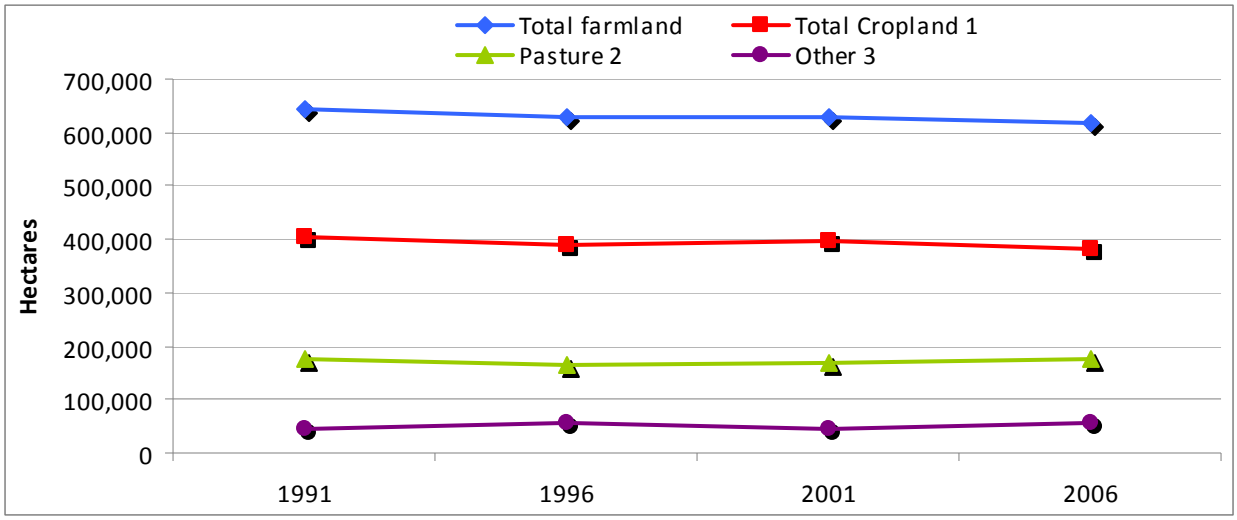
Figure 16: Owned and rented land in the Whitemud River Watershed from 1991 to 2006



Farmland Usage
A drop in total farmland area (25,600 ha) was observed during the period between 1991 and 2006 (***Figure 17***). While this loss is seemingly large, the Whitemud River Watershed is one of the largest watershed planning areas in Manitoba, and this drop represents only 3% of farmland within the watershed area. Concurrent with a decrease in total farmland, total cropland also declined steadily over the fifteen year period from 403,700 ha in 1991 to 380,000 ha in 2006, a decrease of 23,700 ha. During this fifteen year period, the most dramatic decrease in cropland occurred between 1991 and 1996 (approximately 15,200 ha).

Total area of pastureland (both natural and improved) decreased in area over this same time period, but only minimally (approximately 400 ha). More specifically, the area of natural pasture decreased by over 12,200 ha, and tame pasture increased in area by approximately 11,800 ha. The area of other land remained fairly static during the 15-year period, experiencing an overall increase of 9,500 ha (21%).

Figure 17: Farmland usage in the Whitemud River Watershed from 1991 to 2006

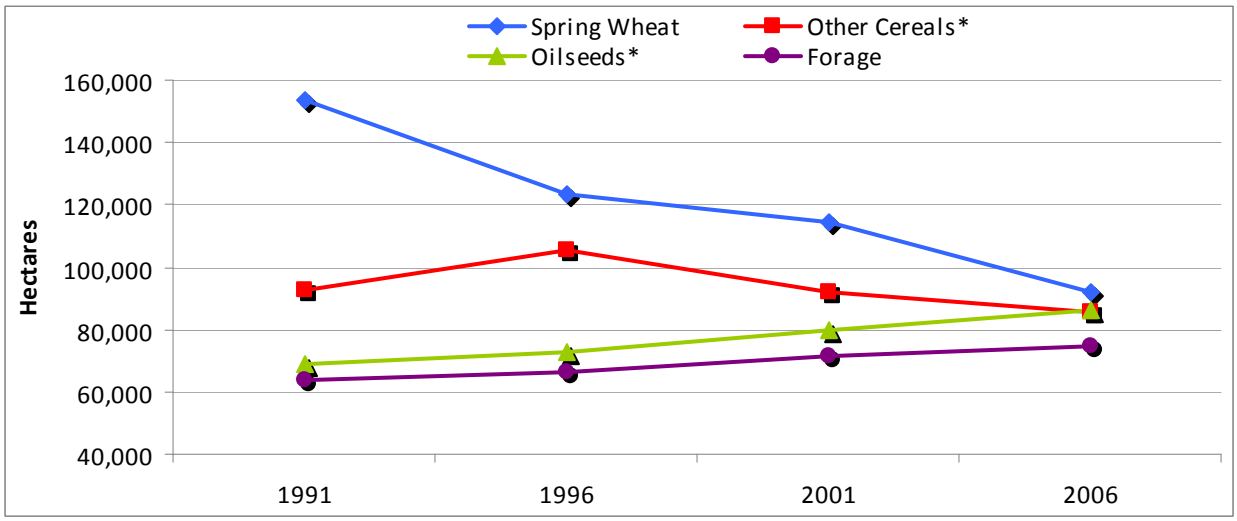


[1] Total cropland includes all field crops, vegetables, fruit and nuts, and sod
[2] Pasture includes tame pasture and natural areas used for pasture
[3] Other land refers to all other land uses including farmyard, woodlot, wetland, Christmas tree, etc.

Cropping Practices

The types of crops grown within the watershed fluctuated from 1991-2006, with some trends observed in the crop type (***Figure 18***). There was a steady decrease in of spring wheat production, with a total decrease of approximately 61,800 ha over the fifteen year period. Despite a slight increase between 1991and 1996, the overall area of other cereals production decreased from 92,500 ha in 1991 to 85,900 ha in 2006. These decreases were offset by increases in both oilseed and forage crops. Total oilseed area increased from approximately 68,800 ha in 1991 to 86,500 ha in 2006. Canola was the key oilseed crop that led to the increase. Area in forages increased by almost 20% over the fifteen years, with 74,400 ha of cropped land planted to forages in 2006.

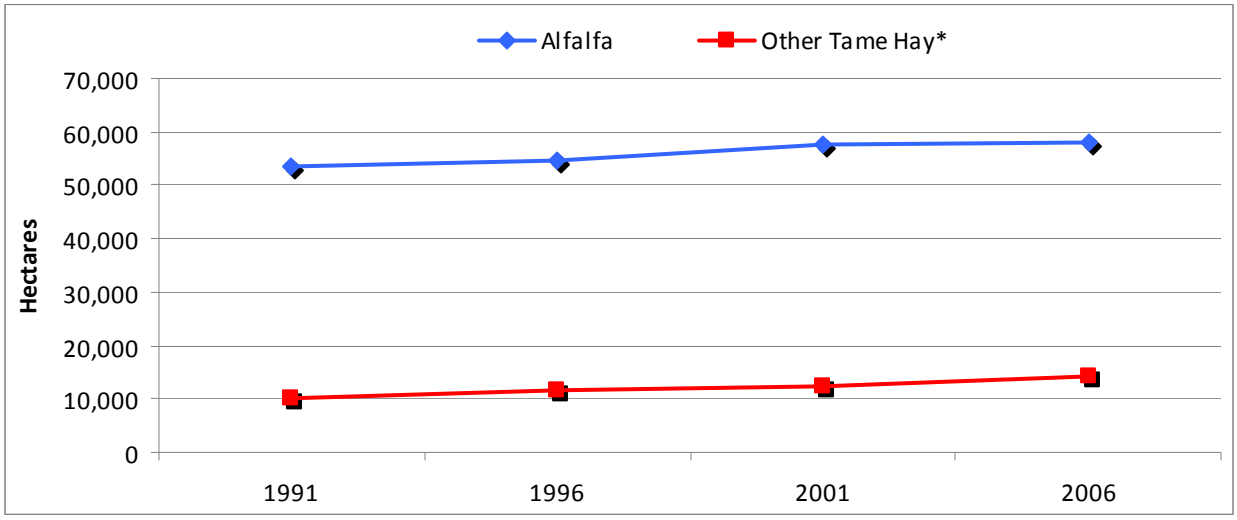
Figure 18: Major crop types in the Whitemud River Watershed from 1991 to 2006



* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

Alfalfa and Hay Production
Forage production, both alfalfa and other tame forages, increased over the fifteen years, and as of 2006 forage production made up almost 20% of the total cropland in the watershed in 2006 (***Figure 19***).

Figure 19: Alfalfa and tame hay area in the Whitemud River Watershed from 1991 to 2006

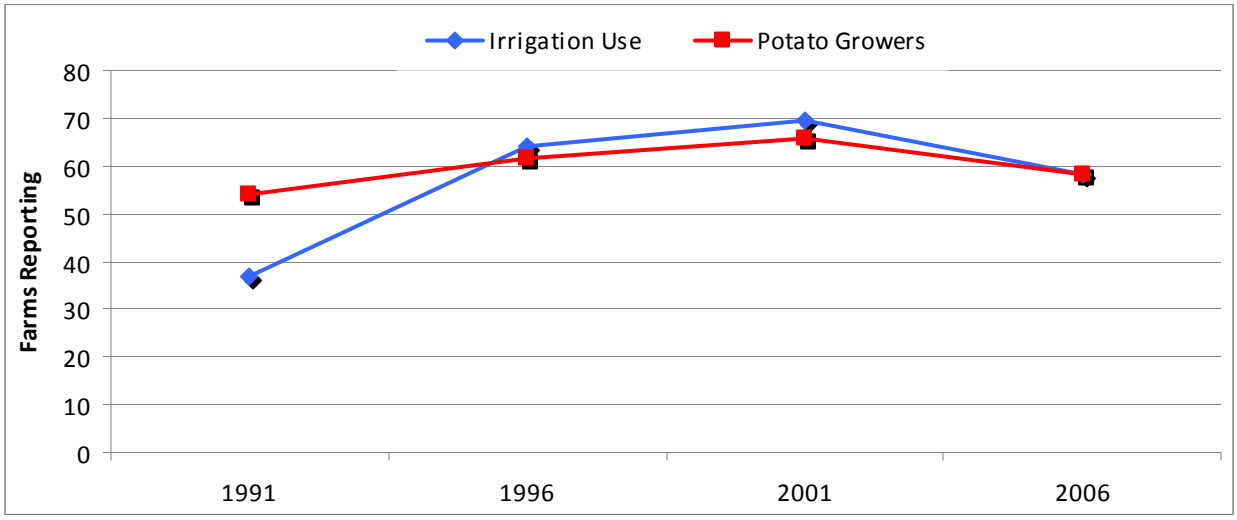


* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

Irrigation Practices
Irrigation practices and land clearing associated with potato production have been raised as in issue in the Whitemud River Watershed. Irrigation data collected in the Census of Agriculture includes farming operations that irrigate potatoes, cereals, other vegetables, fruit, and forage, among others. However, it does not contain specific information on potato irrigation. Alternatively, potato irrigation can be estimated by analyzing other data from the census, as well as other sources. In Manitoba, it is estimated that approximately 55% of irrigation operations and 75% of irrigated cropland is potatoes (Association of Irrigators in Manitoba 2007).

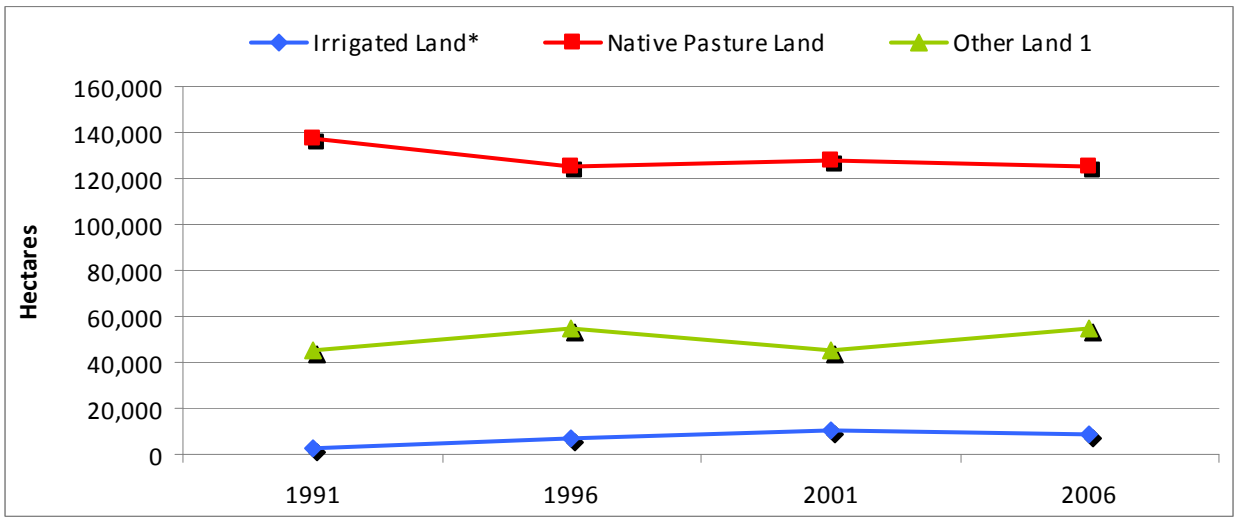
The number of farm operations in the watershed reporting irrigation use increased from 35 in 1991 to 60 in 2006 (***Figure 20***). This number peaked in 2001 at 70 farms. The number of potato farm operations was slightly less than the number of farms using irrigation (except in 1991, when it was higher); however, the two had very similar trends over the 15-year period. As such, it is likely that the increase in irrigators is correlated with the increase in irrigating potato producers operations.

Figure 20: Total number of farm operations using irrigation systems in the Whitemud River Watershed from 1991 to 2006



Irrigated land increased from 1991 to 2006 by 250% (***Figure 21)***, with a total increase of approximately 6,400 ha. Despite this increase, irrigated land makes up a very small portion of land in the watershed. When considered at the watershed scale, irrigated land made up approximately 1.4% of total farmland and potato production made up approximately 1.6% of the total farmland area. Comparably, during the same time period, while native pasture area decreased by 12,300 ha it remained a large portion of the total farmland area at approximately 125,000 ha. The area of other land (the vast majority of which is comprised by woodlands and wetlands) increased from 1991 to 2006 by 9,200 ha (21% of 1991 area).

Figure 21: Irrigated land, native pasture, and other land area in the Whitemud River Watershed from 1991 to 2006



[1] Other land refers to all other land uses including farmyard, woodlot, wetland, Christmas tree, etc.
* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

Livestock Production

The amount of livestock and poultry produced in the watershed varied between 1991 and 2006 (***Figure 22***). Both pig and cattle numbers saw modest increases each census year since 1991, with the exception of total pigs in 2006, which dropped slightly from the 2001 census year. In the fifteen years, the total number of pigs increased by more than 33,000 (118,100 in 1991 to 151,100 in 2006). Cattle numbers also saw a dramatic rise during this time, with an increase of over 40%. The number of poultry in the watershed also increased from 1991 to 2006. Numbers peaked in 2001 at almost 644,600 birds, and dropped by 97,200 over the next five years. The Escarpment subwatershed had the highest increase in poultry numbers, while Rat Creek poultry numbers increased only slightly from 1991 to 2006. It should be noted that census data regarding poultry must be interpreted with caution. Broiler and turkey inventories reflect the total number of birds on Census day. Depending on the operation, this number may be zero for farms that were empty on Census day and had no inventory to report, and underreporting may have occurred.

Cattle herd size and pig herd size increased steadily from 1991 to 2006 (***Figure 23***). The average cattle herd size increased by 70 head per farm during the 15-year period. Hog herd size saw the largest proportional increase of all livestock types, with an increase of over 325%. Poultry flock size increased dramatically from 1991 to 2001 and then decreased slightly in 2006 to 6,100 birds per farm. Increases in the size of flocks and herds are likely attributable to the decreasing number of farms (and increasing average farm size) within the watershed and the economic viability of these sectors between 1991 and 2006.

Figure 22: Major livestock production in the Whitemud River Watershed from 1991 to 2006

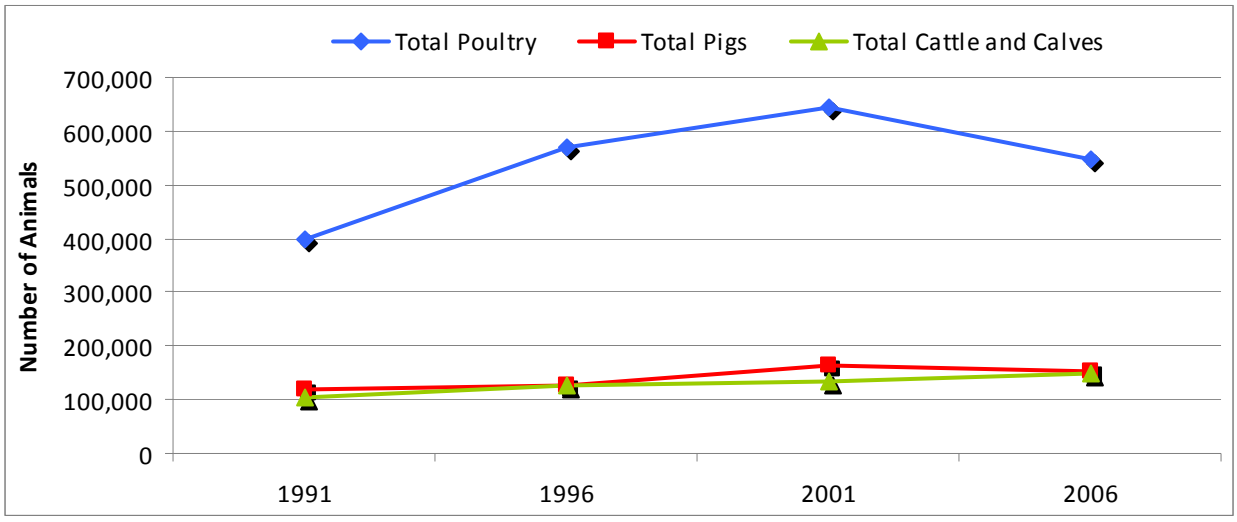
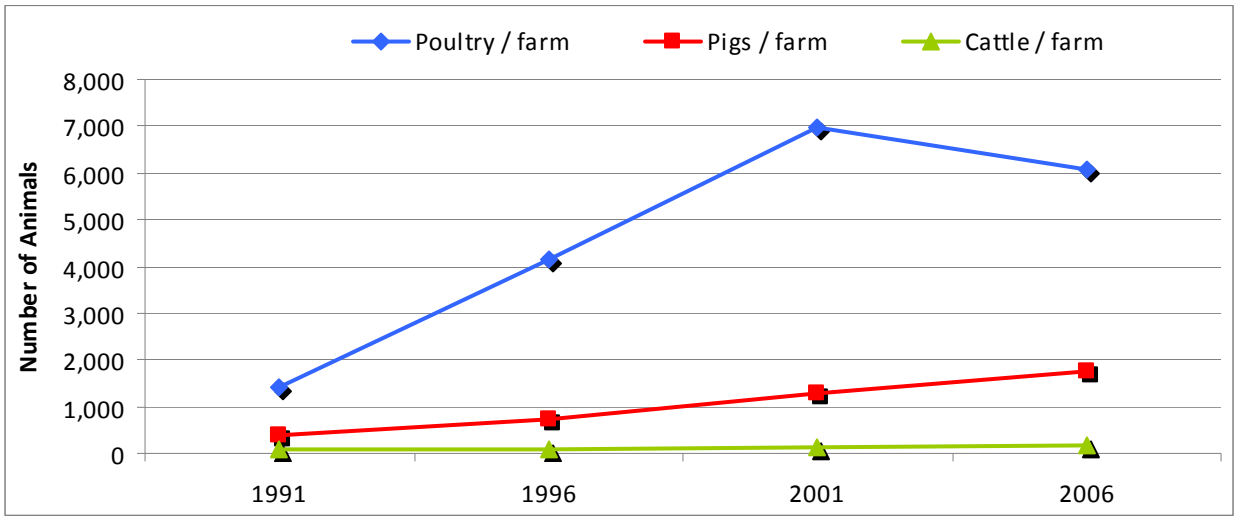


Figure 23: Average number of livestock per farm reporting in the Whitemud River Watershed from 1991 to 2006

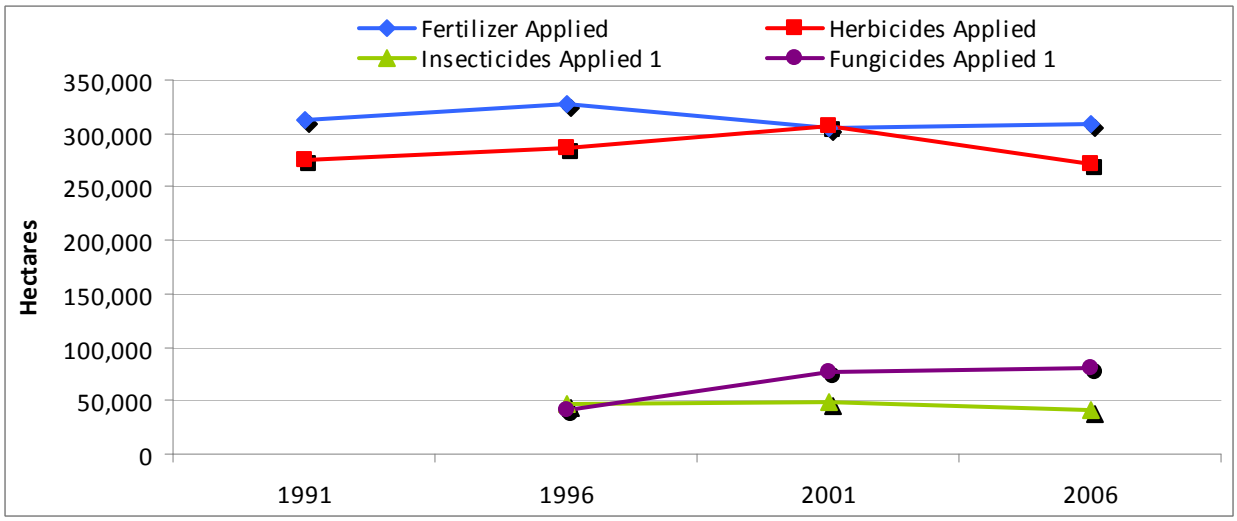


Land Management

Fertilizer and Pesticide Usage

The area of application of fertilizers and herbicides has remained relatively static since 1991 (***Figure 24***). In 2006, approximately 79% of cultivated land was treated with fertilizers and 70% of cultivated land was treated with herbicides. The use of fungicides within the watershed has increased from 1996, when data was first collected. In fact, over the ten year period, the area receiving fungicide application nearly doubled from 42,000 ha to 81,000 ha. The area of land in 2006 on which insecticide was applied dropped slightly from 1996.

Figure 24: Fertilizer, herbicide, insecticide, and fungicide use in the Whitemud River Watershed from 1991 to 2006

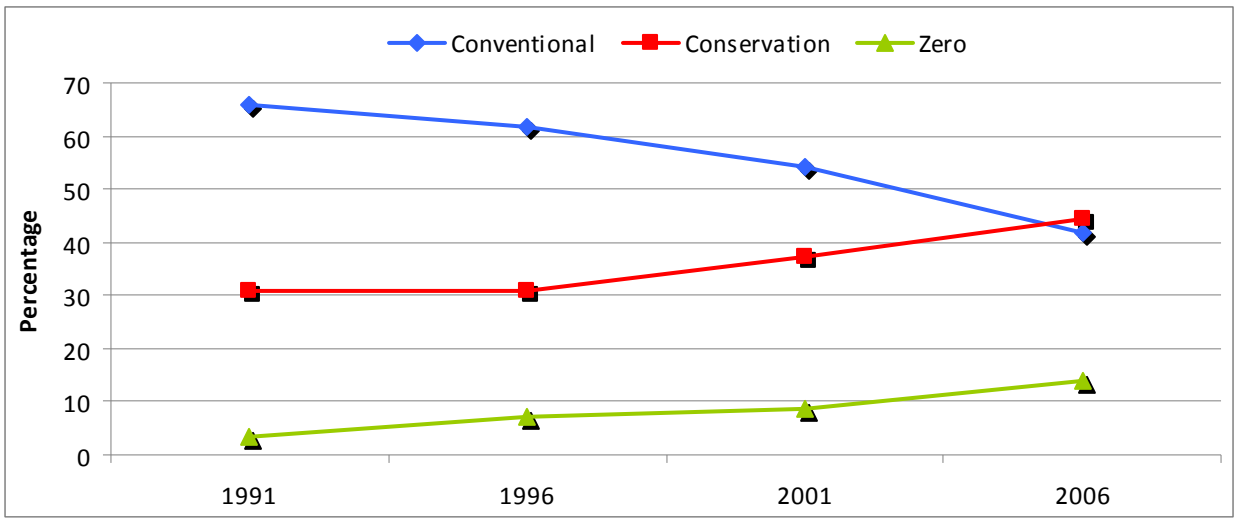


[1] Data for insecticides and fungicides was not available for the 1991 Census year

Tillage Practices

Land management of crop residue has undergone a dramatic shift in the watershed with the adoption of alternative (conservation and zero) tillage practices (***Figure 25***). The area of land managed with conservation tillage saw a steady increase over the fifteen year period, as did the area of land managed with zero tillage. In fact, zero tillage use increased nearly five fold from 3% to 14% of all cultivated land. These increases coincided with a decrease in the use of conventional tillage from 66% of cultivated land in 1991 to 42% in 2006. In the most recent census year, conservation tillage was the most widely adopted practise, followed closely by conventional tillage.

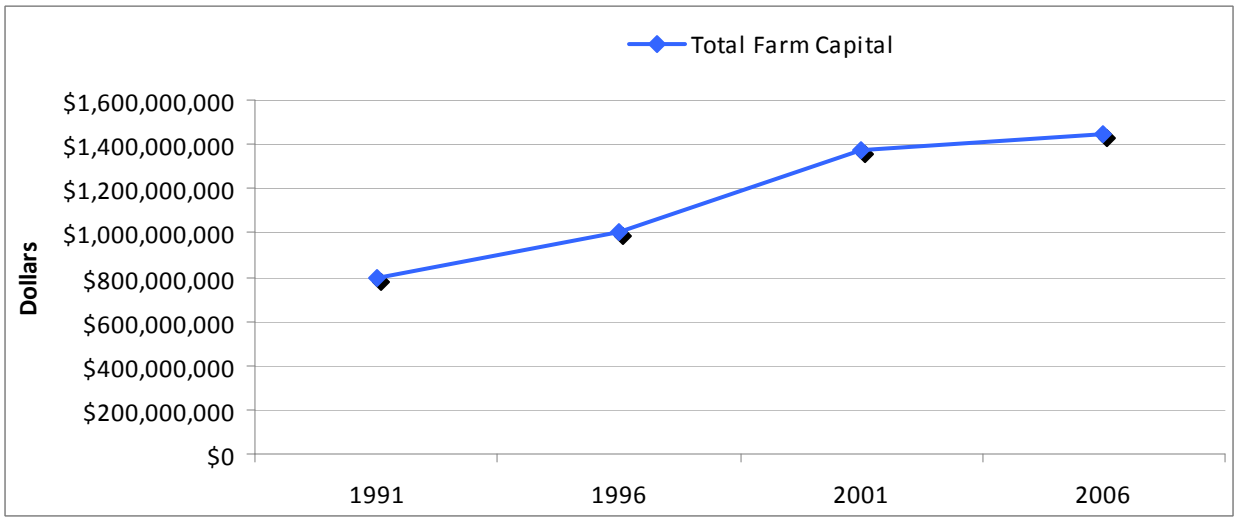
Figure 25: Tillage practices in the Whitemud River Watershed from 1991 to 2006



Financial Characteristics

A steady increase of total farm capital occurred in the watershed over the fifteen year period. Farm capital nearly doubled from $795 million in 1991 to over $1.444 billion in 2006 (***Figure 26***).

Figure 26: Total farm capital in the Whitemud River watershed from 1991 to 2006*



*Inflation has not been accounted for in total farm capital

b) Changes in Land Cover – 1993/94, 2000/2001, 2006

Land cover maps used in this analysis were developed 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. Land cover within the Whitemud Watershed from the early 1990's and early 2000's was captured over two-year periods (1993/94 and 2000/2001, respectfully) and was captured in one year in 2006. Further details on the information used for the land cover analysis and the constraints associated with this data are provided in ***Appendix C***.

Summary of Land Cover Change

Although there are some inherent limitations in analyzing land cover data from 1993/94, 2000/2001 and 2006 to determine changes in land use, some general changes can be noted including (***Table 5***, ***Figure 27***):

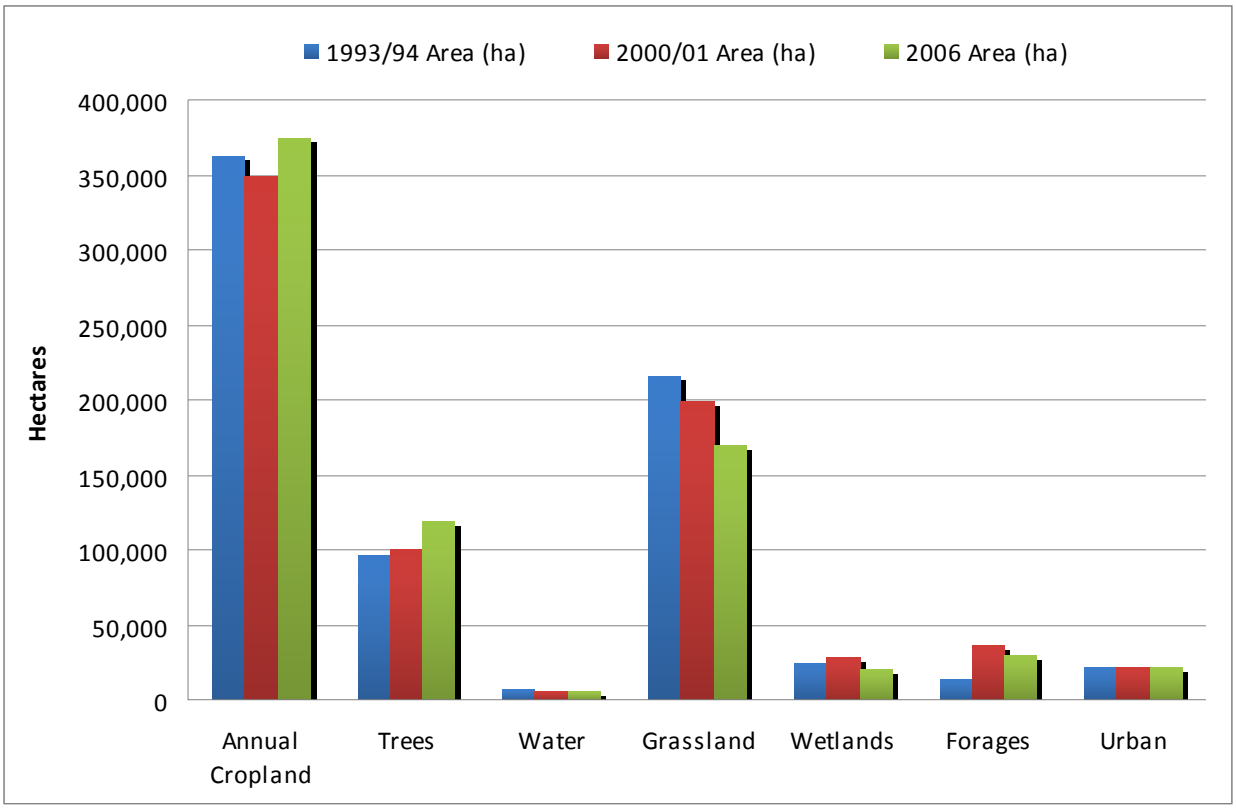
- The largest change in land cover was observed in grassland area, where there was a decrease of approximately 46,700 ha (from 216,200 ha to 169,600 ha). These changes have been linked to increases in forested areas, annual cropland, and forage.
- The area of annual cropland dropped slightly between 1993/94 and 2000/2001, but increased to higher than previous levels (1993/94) by 2006.
- Treed areas increased slightly between 1993/94 and 2000/2001, followed by a dramatic increase by 2006 (for a total increase of 23,400 ha).
- Wetland areas experienced a large decrease in area of over 4,000 ha (18%).
- Wetland and open water classifications may not be accurately estimated due to fluctuations in precipitation amounts and classification effort differences between years. Total precipitation levels and total rainfall levels recorded for the watershed tended to be higher than the 30 year average in 1999-2001 and low in 2006 (see ***Appendix P)***. Some wetlands may also be difficult to quantify due to their small size in conjunction with the relatively coarse resolution of LANDSAT data.
- Satellite imagery shows slight differences from results obtained using Census of Agriculture data

Table 5: Change in land cover from 1993/94, 2000/2001 and 2006*

Land Cover	1993/94 Area (ha)	2000/01 Area (ha)	2006 Area (ha)	Change from 1993/1994 to 2000 (ha)	Change from 2000 to 2006 (ha)	Overall Change from 1993/1994 to 2006 (ha)
Annual Cropland	362,861	349,774	375,252	-13,087	25,479	12,391
Trees	96,013	99,829	119,120	3,816	19,291	23,108
Water	6,384	5,966	5,915	-419	-51	-469
Grassland	216,213	198,915	169,551	-17,298	-29,364	-46,662
Wetlands	24,037	28,089	19,773	4,052	-8,316	-4,264
Forages	13,371	36,125	28,692	22,755	-7,433	15,321
Urban	20,772	20,966	21,197	195	231	425
Totals	**739,650**	**739,664**	**739,501**			

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

Figure 27: Comparison of change in land cover from 1993/94, 2000/2001 and 2006*



* Area totals are approximate due to the nature of the image analysis procedure

iii. Other Agricultural Land Use Trends/Impacts

Agricultural land use is constantly changing due to factors such as climate, markets, crop rotation or changes in agricultural production systems (livestock versus crop production). The previous section summarized the overall change in land cover from 1993/94 to 2006. A more detailed examination of the land cover classes from 1993/94 and correlating them to data collected from the 2006 imagery can not only tell us how much one classification has changed over a time period, it can also identify where changes in land use are occurring, thereby giving some indication of influences of land management or land use change. It should be noted that data classification limitations and the acquisition dates of the satellite images can introduce discrepancies into these values. As noted in the earlier section, precipitation levels noted for the land cover dates may also influence land cover classifications. Further field investigations would be required to verify these findings.

Changes in Annual Cropland Area

Changes in land use can reflect changes in land management practices and the environmental risks that may be associated to those lands. Annual cropland changes can be attributed to a number of factors including crop rotations, market and economic drivers, and environmental factors. ***Figure 29*** identifies parcels of land which experienced changes to and from annual cropland from 1993/94 to 2006.

In the Whitemud River IWMP:

- Changes to annual cropland cover occurred throughout the entire watershed (***Figure 29***), and were not localized to any specific location. That being said, there was generally more cropland loss in the southern portion of the watershed and more areas being converted to cropland in the northern portion.
- A concentrated patch of irrigated cropland in 1993/94 (located between Neepawa and Carberry) was classified as forage in 2006.
- The area of annual cropland increased over 12,400 ha (3%) in the watershed between 1993/94 and 2006 (***Table 5***).
- Analysis indicates that most of the new annual cropland appearing by 2006 had been previously classified as grasslands (37,200 ha). Around 20,700 ha of land experienced the reciprocal conversion from annual cropland to grassland by 2006, resulting in a net increase in the total area annual cropland (***Figure 28***).
- Nearly 14,000 ha of cropland was converted to forages during the 14-year period. Approximately 65% of that amount (8,900 ha) experienced the reciprocal conversion from forage to cropland during that time.
- Other changes to and from annual cropland were associated with treed and urban areas, however the amounts were negligible in comparison to the size of the watershed.
- A number of communities witnessed annual rainfall amounts in 1992 and 2006 that were well below the 30 year average, possibly influencing the area of annual cropland in 2006 (See ***Appendix P***).

Figure 28: Total change in area of annual cropland, in relation to other land cover types, in the Whitemud River IWMP study area (from 1993/94 to 2006)

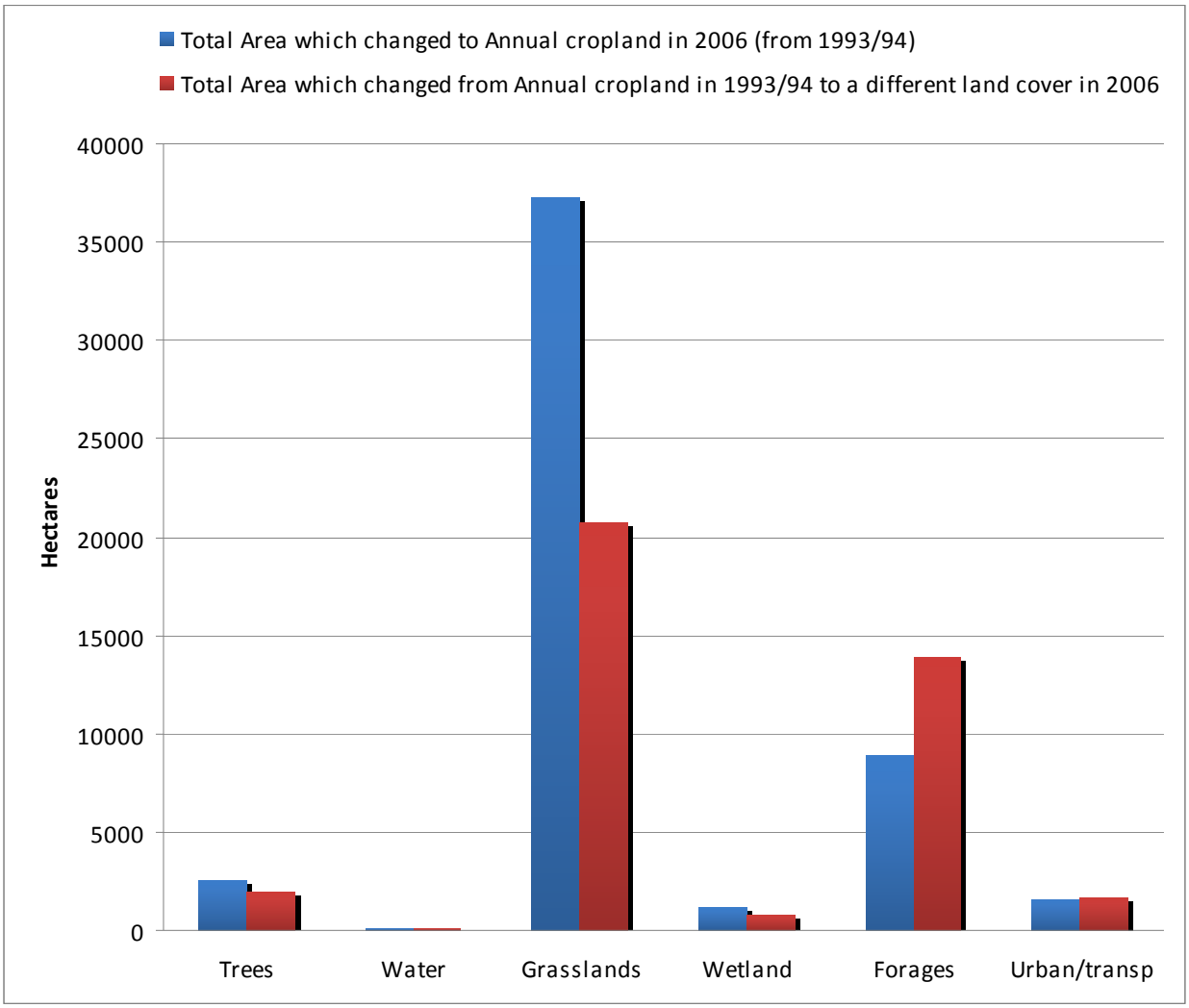
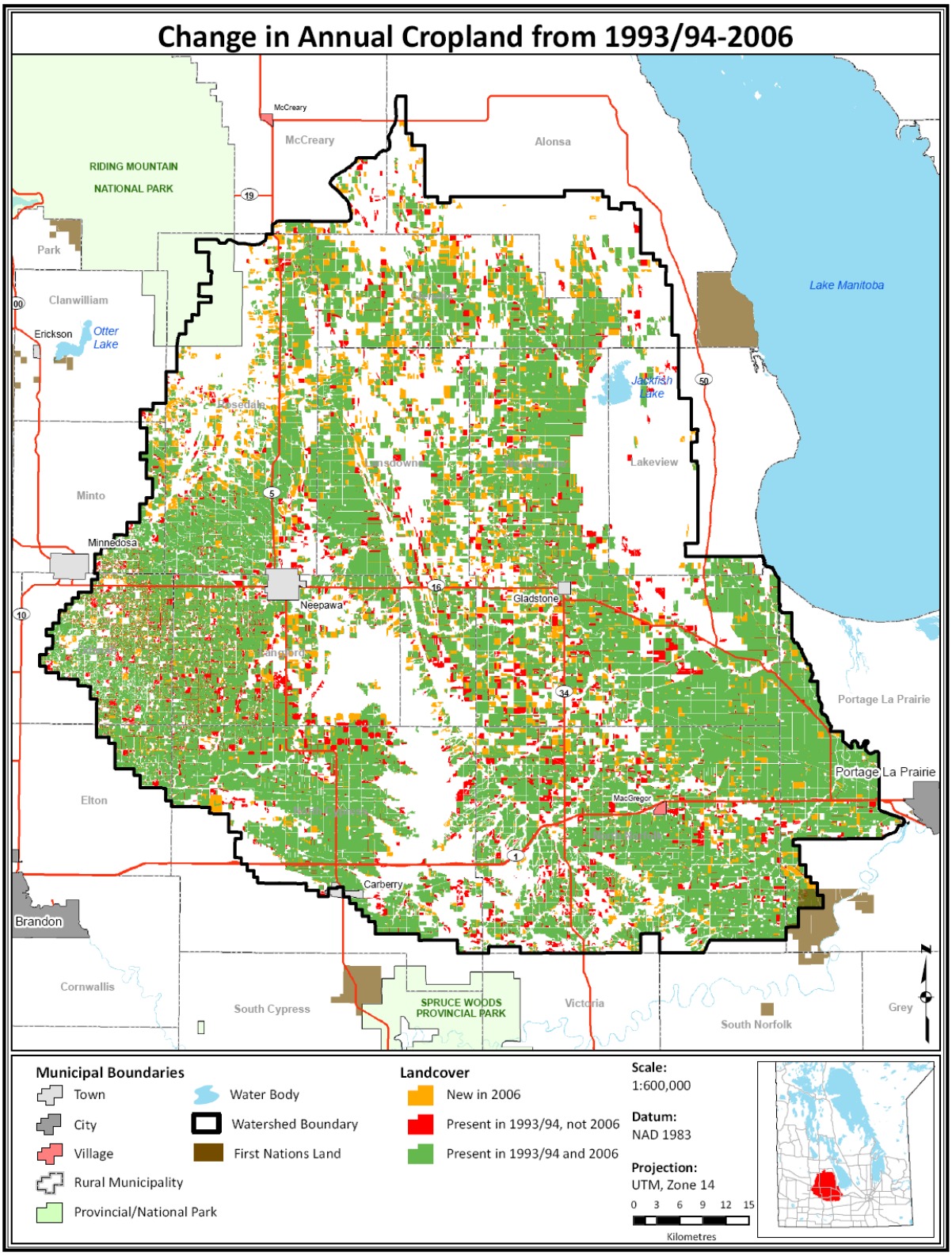


Figure 29: Analysis of Annual Cropland changes between the 1993/94 and 2006 Land Cover data*



* Land cover is derived from satellite imagery that was captured on May 5, 1993, May 26, 1993, October 26, 1994, and August 15, 2006.

Changes in Grassland Area

Analyzing changes in grassland cover can be useful to understand potential risks associated with the loss of natural cover in the watershed. Grasslands can also be beneficial for reducing runoff and enhancing flood mitigation. ***Figure 31*** summarizes the parcels of land that experienced changes to and from grassland from 1993/94 to 2006.

While conversion to grasslands may sometimes be the result of market trends and present economic opportunities and benefits, there may be a risk to the environment associated with the land change. For example, the increased conversion of grasslands to annual cropland on soils prone to erosion could impact water quality, as well as increase flooding downstream due to the potential of increased runoff levels. In turn, it could also lead to increased concentrations of contaminants in runoff if appropriate management practices are not utilized.

In the Whitemud River IWMP:

- There was an overall decrease of almost 47,000 ha of grassland by 2006 (***Table 5***), a decrease of nearly 22% from 1993/94 cover. Most of these losses were attributable to increases in annual cropland, forested areas, and forages (***Figure 30***).
- New grassland areas were distributed equally throughout the watershed. Grassland losses were concentrated in the northern and central portions of the watershed, and were practically absent in the southern portion of the watershed (***Figure 31***). Tree encroachment was responsible for most of these losses near the northern border of the watershed, while conversion to cropland and forages was most common in the central portions.
- Tree encroachment was the primary factor responsible for the overall decrease in grassland cover (***Figure 30***) across the watershed. Over 28,000 ha of grassland were encroached upon over the 14-year period. 6,700 ha of land experienced the reciprocal conversion of forested area to grassland, resulting in a net decrease of grassland of nearly 22,000 ha.
- Conversion of grassland to annual cropland also had an impact on the total area of grasslands in the watershed. A large area of grassland (37,222 ha) was converted to cropland, but was partially offset by conversion of annual cropland to grassland (20,687 ha).
- A relatively large area of grassland was converted to forages over the 14-year period (10,000 ha). These changes occurred primarily in the center of the watershed, in the areas surrounding Neepawa and Gladstone.
- All other land cover categories (water, wetland, and urban) experienced small changes to and from grasslands. Wetlands were the only land cover type to show a net change to grasslands in the watershed, although the change was small (2,300 ha).
- A number of communities witnessed Total Annual Rainfall amounts in 1992 and 2006 that were well below the 30 year average, possibly influencing the amount of Grassland Hectares in 2006 (See ***Appendix P***).

Figure 30: Total change in area of grassland, in relation to other land cover types, in the Whitemud River IWMP study area (from 1993/94 to 2006)

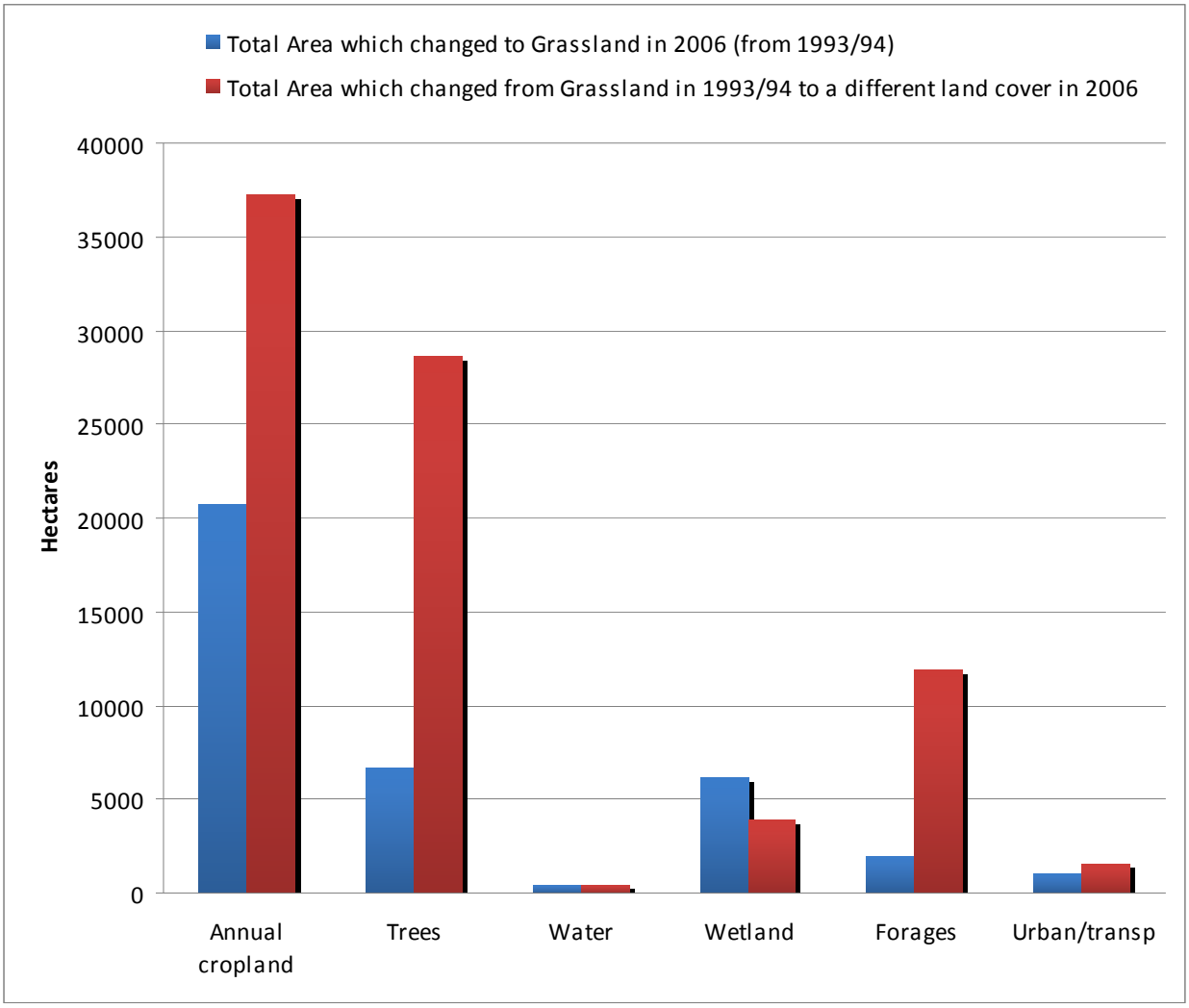
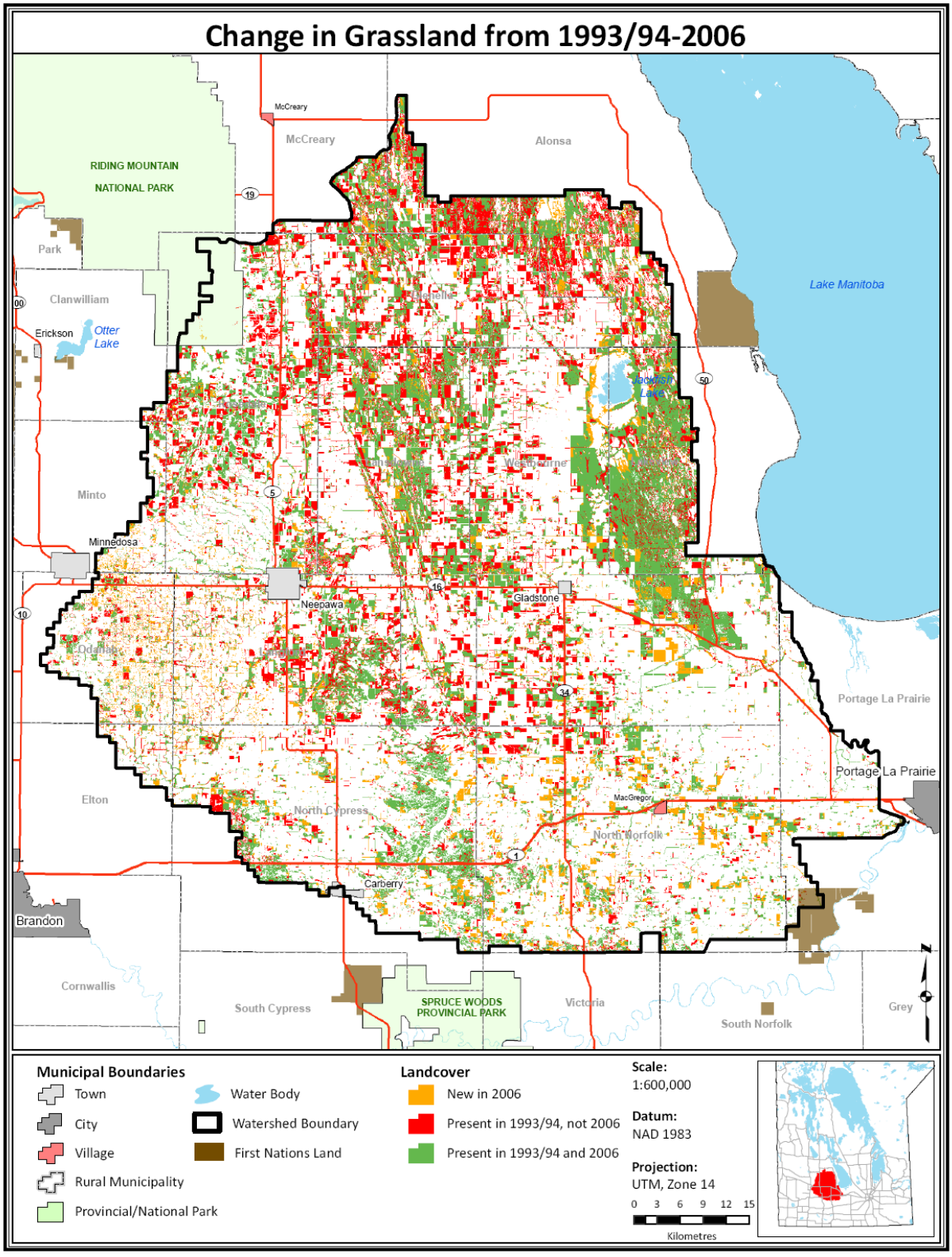


Figure 31: Analysis of Grassland changes between the 1993/94 and 2006 Land Cover data*



* Land cover is derived from satellite imagery that was captured on May 5, 1993, May 26, 1993, October 26, 1994, and August 15, 2006.

Changes in Forested Areas

Changes in forested areas can provide some information about potential impacts on flooding, on water supply and quality, as well as the state of natural cover within the watershed. ***Figure 33*** summarizes the parcels of land which experienced changes to and from forested areas from 1993/94 to 2006.

In the Whitemud River IWMP:

- Forested area experienced the second largest overall change in cover (an increase of 24%) of all land cover types over the 14-year period (***Table 5***).
- There was an overall increase of approximately 23,135 ha of forested areas between 1993/94 and 2006 (***Table 5***). Changes to forested areas were almost entirely associated with conversion from grasslands (***Figure 31***). A total of 28,600 ha of grassland in 1993/94 were classified as forested area in 2006. 6,700 ha of land experienced the reciprocal conversion of forested area to grassland, resulting in a net increase of forested area of nearly 22,000 ha.
- Areas of forested cover that had disappeared by 2006 were scattered throughout the watershed; however a significant portion of this area was located within, and in the vicinity of, the Alonsa AESB Community Pasture in the northeast corner of the watershed (***Figure 33***).
- Most of the new forested areas noted in 2006 were the result of previously forested areas encroaching into adjacent grasslands. This was increasingly evident in the northern portion of the watershed in the RMs of Alonsa and Glenella. Additionally, large areas of newly forested cover were located along the escarpment southeast of Neepawa.

Figure 32: Total change in Forested Areas, in relation to other land cover types, in the Whitemud River IWMP study area (from 1993/94 to 2006)

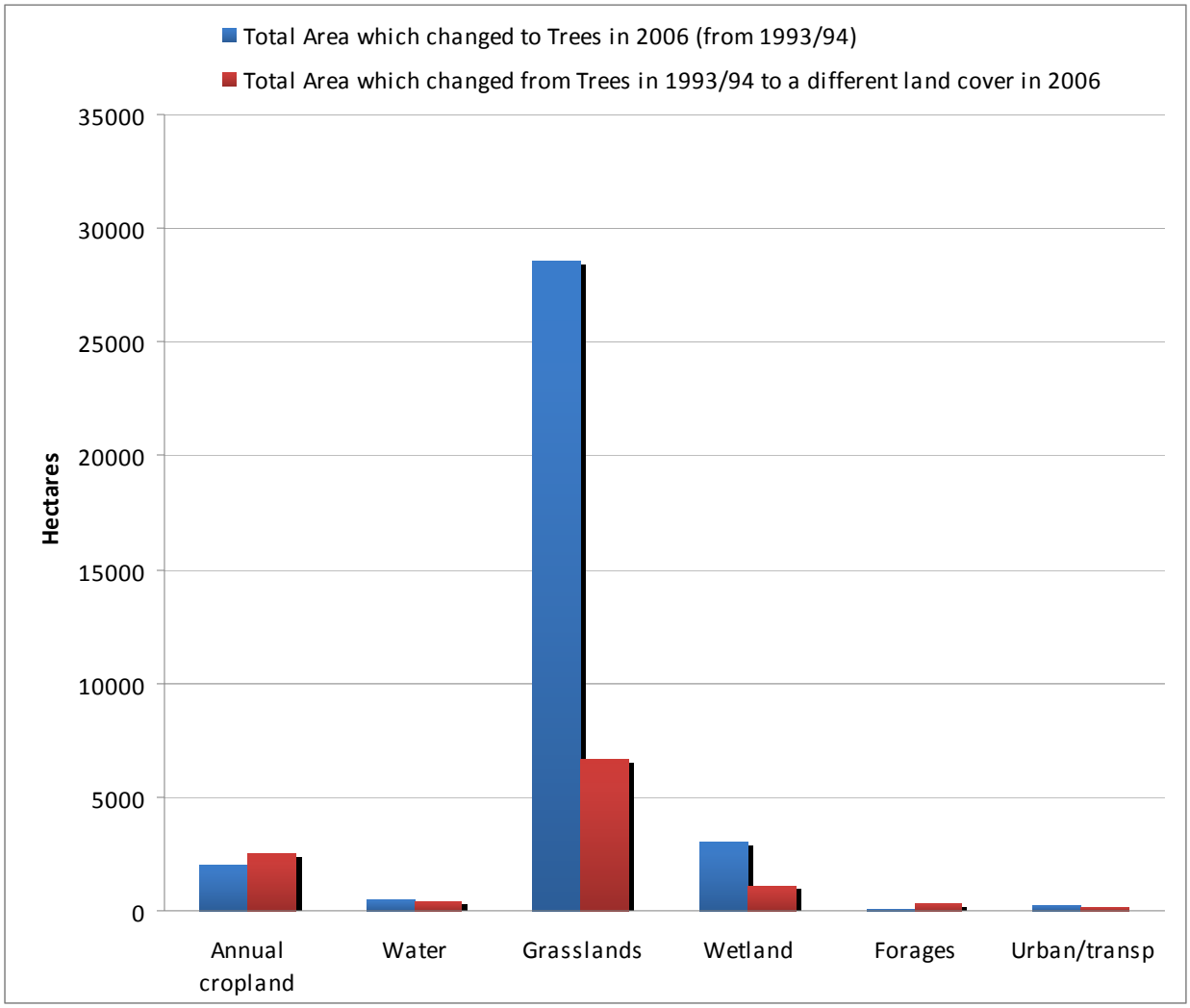
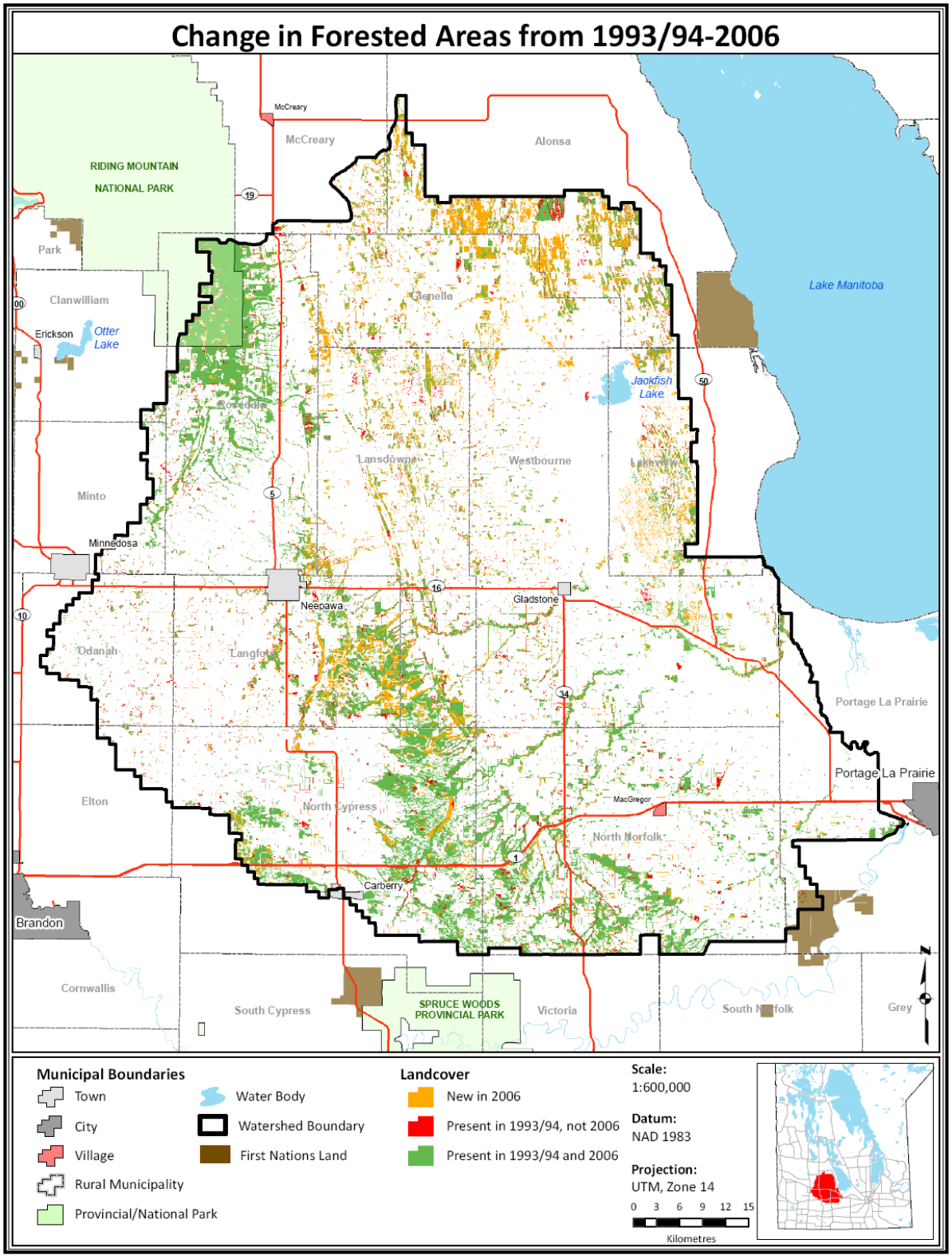


Figure 33: Analysis of Forested Area change between the 1993/94 and 2006 Land Cover data*



** Land cover is derived from satellite imagery that was captured on May 5, 1993, May 26, 1993, October 26, 1994, and August 15, 2006.

Changes in Forage Area

Changes in forage area can provide information regarding the conservation of natural habitat and the adoption of erosion control beneficial management practices. The conversion of natural areas to forage have less potential impact to the environment than conversion to annual cropland because they act as a form of perennial cover, protecting soil and water quality, and provide a form of habitat to wild animals. ***Figure 35*** summarizes parcels of land which experienced changes to and from forages from 1993/94 to 2006.

In the Whitemud River IWMP:

- Forage cover increased substantially in the watershed between 1993/94 and 2006, by nearly 115% (an increase of 15,300 ha) (***Table 5***).
- Analysis indicates that changes in forage area in the watershed resulted primarily from changes to/from grassland and annual cropland.
- The majority of forage losses occurred in the southeast, most of which was converted to annual cropland (***Figure 35***).
- New forage cover in 2006 was evenly located throughout the central and northern portions of the watershed, but was largely absent in the RMs of North Cypress and North Norfolk.
- A large area of grasslands in 1993/94 changed to forage cover by 2006 (11,900 ha). Only about 15% of this amount changed from forage to grasslands during the same time period (1,900 ha).
- 13,900 ha of cropland were converted to forage during the 14-year period. 8,900 ha of forage experienced the reciprocal conversion to cropland during that time.
- The increase in forages from 1993/94 to 2006 is likely attributed, in part, to the Permanent Cover Program (PCP) introduced in the early 1990s to encourage the conversion of marginal lands for agriculture from annual crop production to perennial cover. Federal and Provincial assistance programs like Farming for Tomorrow and Green Plan provided further support in the way of soil conservation groups and seed drill rentals. 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.
- Increases in forage production may also reflect a higher demand for forage crops due to the expansion of the livestock industry in the watershed over past several years. This assumption correlates with the increasing number of livestock reported in the watershed through the Census of Agriculture during this time period.

Figure 34: Total change in area of forages, in relation to other land cover types, in the Whitemud River IWMP study area (from 1993/94 to 2006)

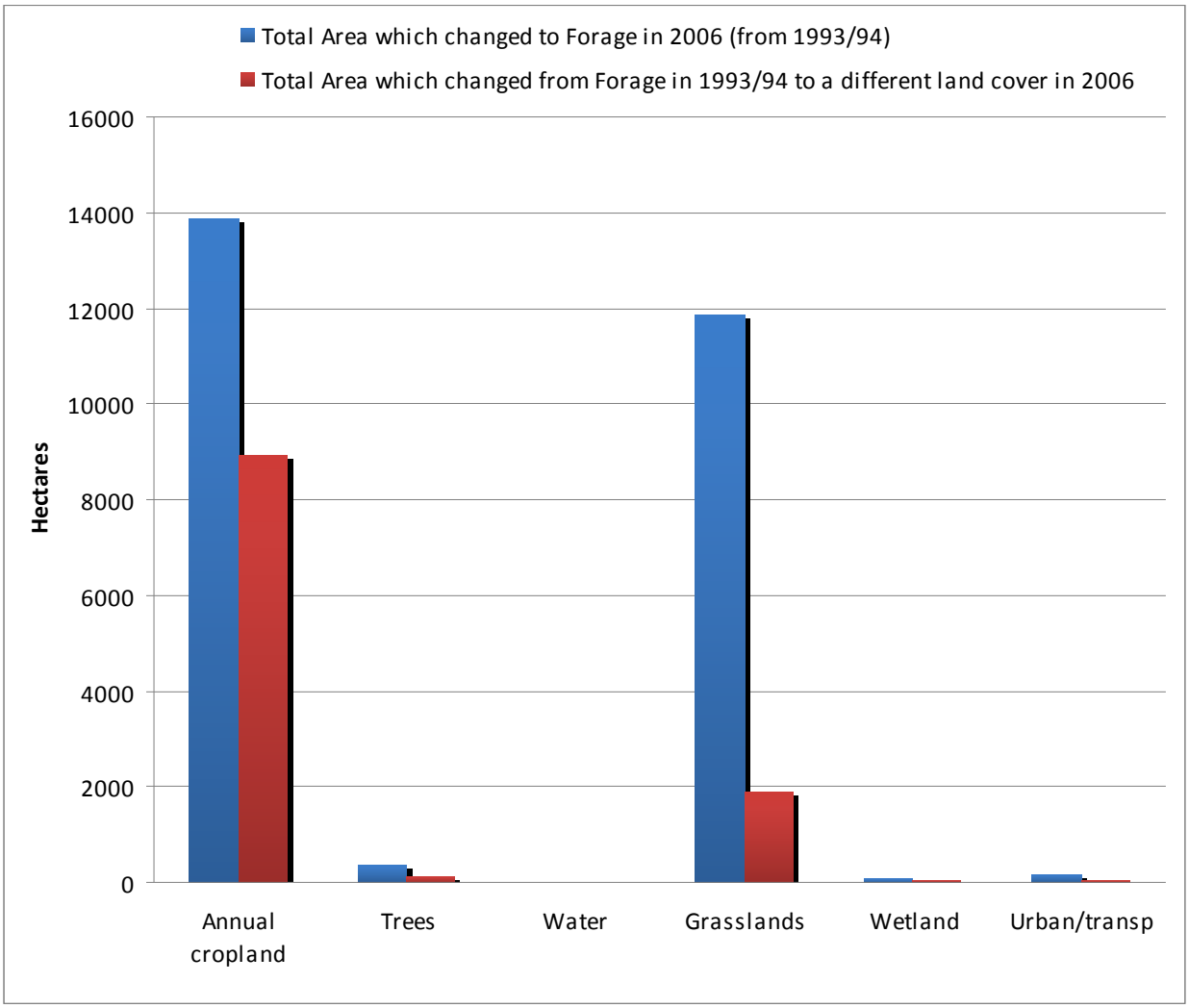
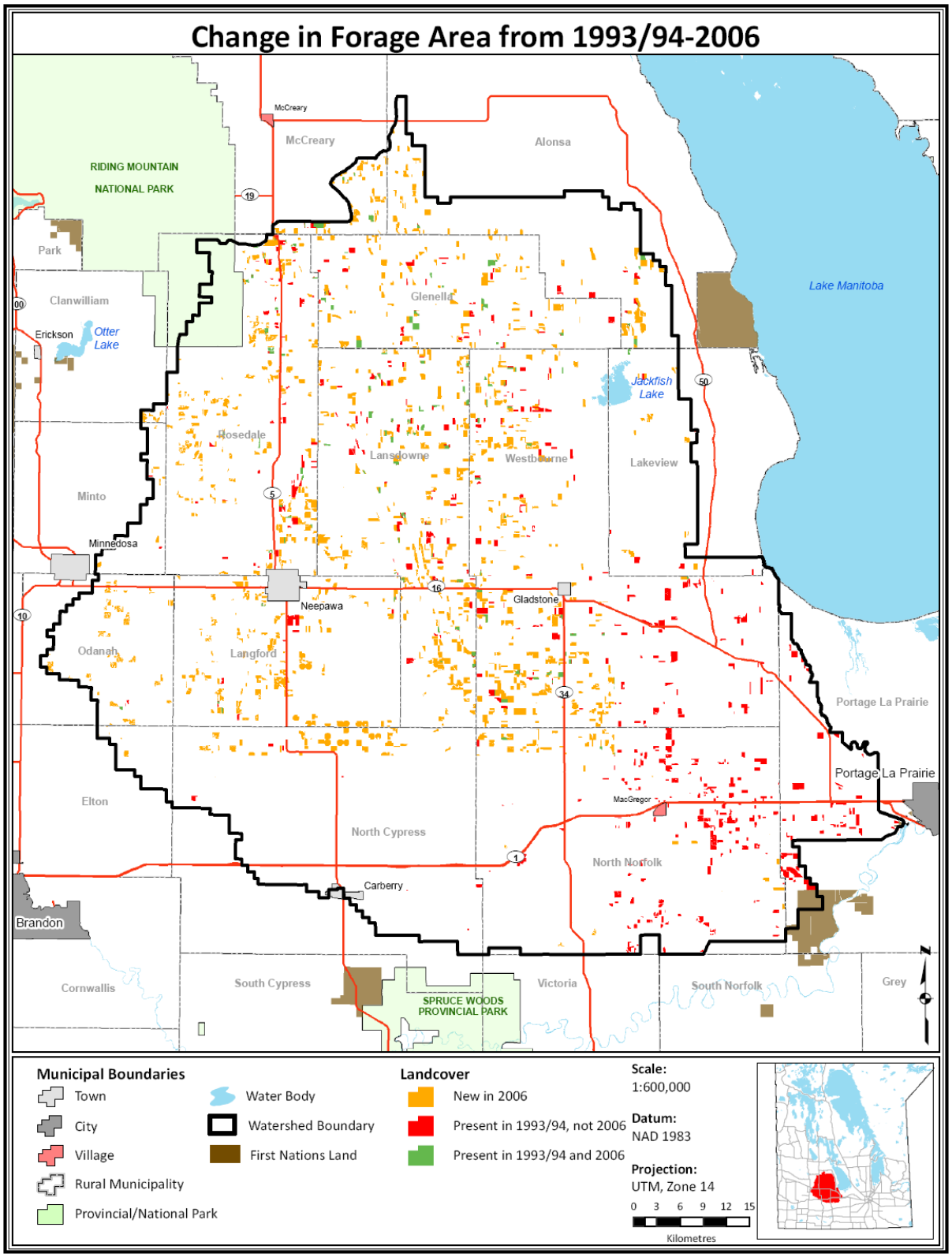


Figure 35: Analysis of Forage changes between the 1993/94 and 2006 Land Cover data*



** Land cover is derived from satellite imagery that was captured on May 5, 1993, May 26, 1993, October 26, 1994, and August 15, 2006.

Advanced Wide Field Sensor Land Cover Analysis on Cropping Practices

Advanced Wide Field Sensor (AWiFS) is a newer satellite sensor with slightly coarser resolution (56 meters) than LANDSAT. 2009 AWiFS imagery has been acquired and processed across the entire agricultural extent of Manitoba. This imagery has been classified into 18 land cover classes, 12 that can specifically relate to annual cropland management.

AWiFS allows further examination of areas previously identified as one class that exhibited change from 1994 to various types of annual cropland practices in 2009. Specifically, this analysis will examine those lands previously identified as grasslands and forest in 1994 and examine what annual cropland practice may be occurring there now. This may provide a better understanding of the land use in the area, as well as, the influence agriculture has on these lands.

Examination of AWiFS land cover with respect to grassland changes

- In ***Figure 36***, the number of annual cropland classes has been reduced to four for display purposes.
- The majority of lands that had changed from grasslands to a different land cover class were identified as cereals in 2009 (11,200 ha).
- The area of land that changed from grassland to trees was similar to what changed to cereals (9,073 ha).
- Most of the identified converted area was dispersed throughout the watershed as small fragments.
- Only 245 ha of land identified as grasslands in 1993/94 were identified as potatoes in 2009. This area is isolated in a region to the northwest of Carberry. Potato production, in this area, has been identified and confirmed in this region through local knowledge.

Examination of AWiFS land cover with respect to forestry changes

- Lands previously identified as forested lands in 1993/94 were further identified using AWIFS land cover.
- Much of the converted forest area identified was dispersed throughout the watershed as small fragments. Due to the highly fragmented nature of the land cover, results are displayed in table format (***Table 6***).
- Only a small area of land (5,808 ha) changed from forested lands to other land cover types. Of this, most of the forested land reverted back to grassland (3,300 ha).
- Approximately 1,200 ha of converted land were identified as either cereals (approximately 800 ha) or canola/rapeseed (approximately 400 ha) in 2009.
- The amount of land identified as potatoes in 2009 was insignificant (58 ha).

Figure 36: Land cover changes from 1993/94 Grassland to other land cover types in 2009, as identified by AWiFS

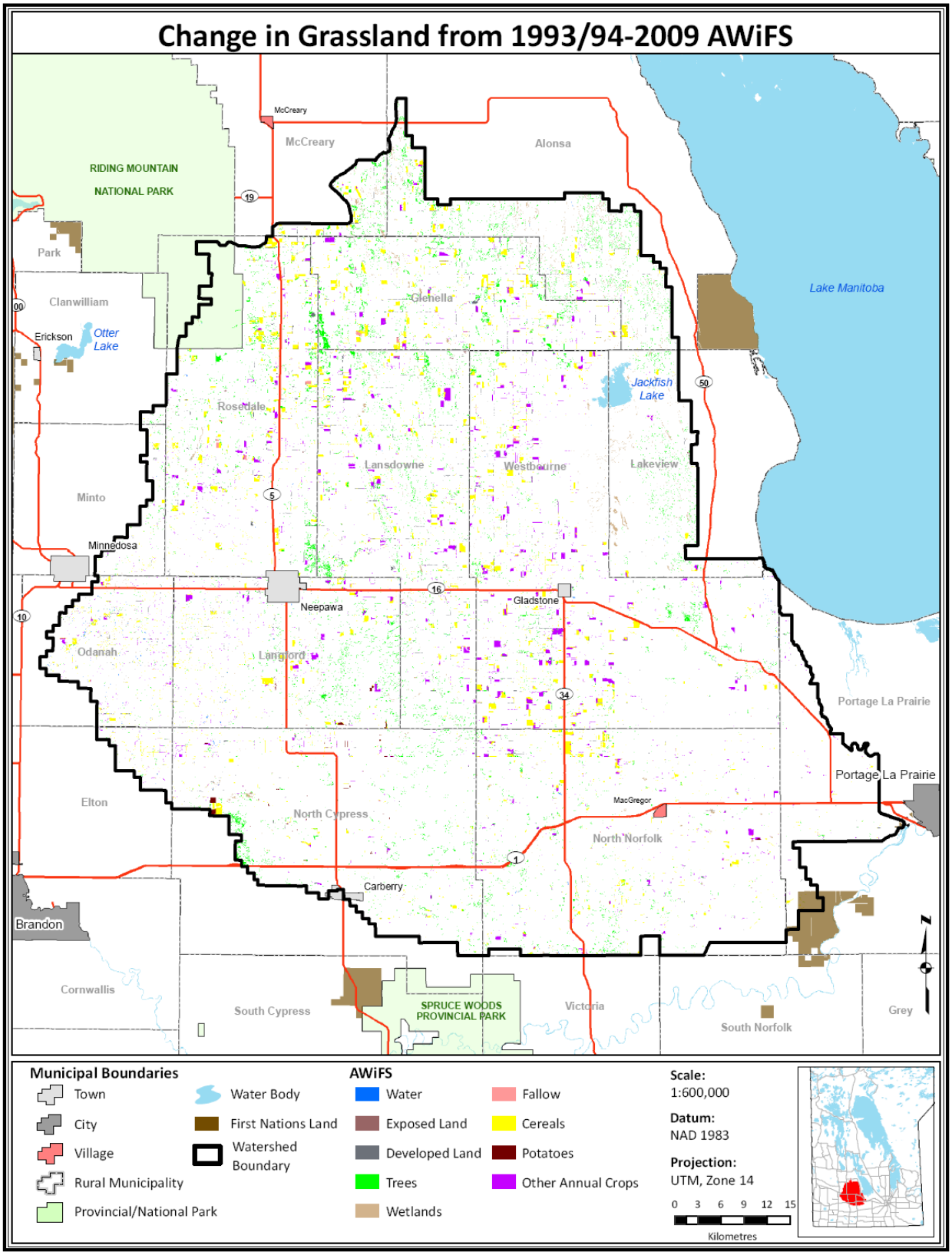


Table 6: Land cover changes from 1993/94 Forested land to other land cover types in 2009, as identified by AWiFS

2009 Land Cover Type	Area of land classified (ha)	Percentage of land classified (ha)
Water	181	3%
Exposed Land	5	0%
Developed Land	234	4%
Wetlands	690	12%
Grassland/Pasture	3,281	56%
Fallow	4	0%
Cereals	815	14%
Corn	28	0%
Canola and Rapeseed	409	7%
Flax	12	0%
Sunflowers	43	1%
Soybeans	14	0%
Pulse Crops	30	1%
Lentils	0	0%
Potatoes	53	1%
Canary Seed	0	0%
Other Crops	8	0%
TOTAL	**5,808**	

F. Agricultural Land Use and Management Considerations

This section presents the analysis of a combination of factors, including land use and the characteristics of the local landscape, in order to determine where consideration should be given as to how the land is used or managed, including the potential for adoption of Beneficial Management Practices (BMPs). Land cover data indicates how the land is being used, while relevant landscape characteristics and risk factors are contained within the soils dataset. Further information regarding land cover data can be found in ***Appendix C***, while more information regarding the soils data can be found in ***Appendix D***.

i. Agricultural Capability Analysis

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 their physical capability for agricultural use (PFRA 2005).

Agricultural capability can best be described as the ability of the land to support the appropriate type of crops and agriculture management techniques. Soil properties and landscape conditions such as topography, stoniness, and other potential limitations all influence how the land is being used and what agricultural management practices should be in place to reduce environmental risks. Classes ranging from 1 to 7 have been established, with 1 being the highest rated land class with no limitations to annual crop production and 7 being the lowest rated land (not suitable for agriculture). Further information about CLI and specific characteristics and limitations associated with individual land classes is provided in ***Appendix E***.

Analytical Methods
With respect to land cover, analysis of the land classes helps to understand the extent of agricultural activity on marginal lands. Such an analysis can also provide an indication of where producers are undertaking good land management practices by utilizing these marginal lands for purposes other than annual crop production.

In the Whitemud River IWMP:

- Approximately half of the land in the watershed is considered highly productive Class 1, 2 and 3 lands (59% or approximately 435,700 ha).
- 41% (304,000 ha) of the soils in the watershed are Class 4 and lower (or organic).
- Roughly 2% of the watershed (16,400 ha) is considered as organic soil.

On annual cropland with respect to agricultural capability:

- Within the Whitemud River Watershed study area, the majority of the annual cropland is located on productive agricultural land, classified as Class 3 or higher (81%, 304,400 ha).
- The majority of the annual cropland on Class 4 and lower soils is located along the escarpment and through the center of the watershed (***Figure 37***). The fertile plains southwest of Neepawa, as well as the cropland northeast of MacGregor, are practically void of marginal lands.
- A small amount annual cropland on Class 6 and 7 lands is present in the watershed and is mainly located along the escarpment.
- In 2006, there was a small area of land with organic soils used as annual cropland (***Table 7***).

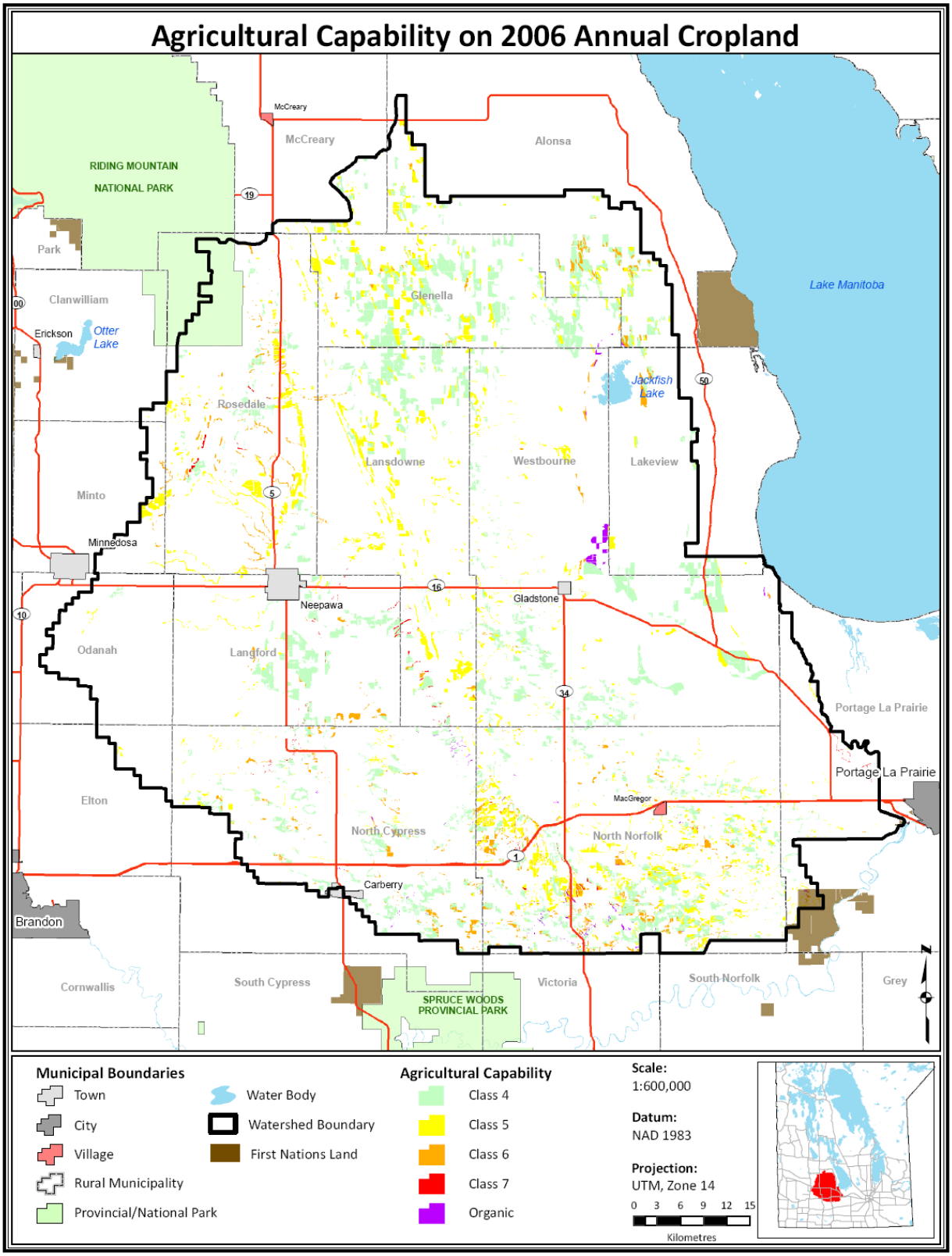
- The amount of land being used for annual cropland has increased slightly since 1993/94. This is reflected in all classes, with the majority of the increases noted on Class 2, 3 and 4 soils.

Table 7: Agricultural Capability in the Whitemud River Watershed study area

Class[1]	Total Area in IWMP (ha)	1993/94 Annual Cropland (ha)	2006 Annual Cropland (ha)	Distribution of 2006 Annual Cropland (%)	1993/94 to 2006 Change in Annual Cropland Area (ha)
Class 1	58,093	47,701	47,531	13%	-170
Class 2	191,955	138,735	142,836	38%	4,101
Class 3	185,626	109,965	114,019	30%	4,054
Class 4	134,415	39,207	41,801	11%	2,593
Class 5	77,609	19,669	21,451	6%	1,781
Class 6	59,208	6,240	6,400	2%	160
Class 7	5,422	346	413	0%	67
Organic	16,463	932	749	0%	-183
Unclassified	8,266	24	10	0%	-13
TOTAL	**739,664**	**362,861**	**375,252**	**100%**	**12,391**

[1] Agricultural Capability is based on the CLI Rating of the dominant soil series for each soil polygon

Figure 37: Agricultural Capability (CLI 4 and lower and Organic) of 2006 Annual Cropland in the Whitemud River Watershed IWMP study area[1]



[1] Agricultural capability is based on the CLI Rating of the dominant soil series for each soil polygon

ii. Wind Erosion Risk Analysis

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 G***). 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 erosion risk depending on crop rotation, soil type, and landscape features. Basing 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).

In the Whitemud River IWMP:

- A large portion of the watershed (362,000 ha or 49%) is considered to have a negligible to low risk of wind erosion.
- While 65,400 ha of the watershed have a severe risk of wind erosion, only 16,300 ha (25%) of this area contains annual cropland.

On annual cropland with respect to wind erosion risk:

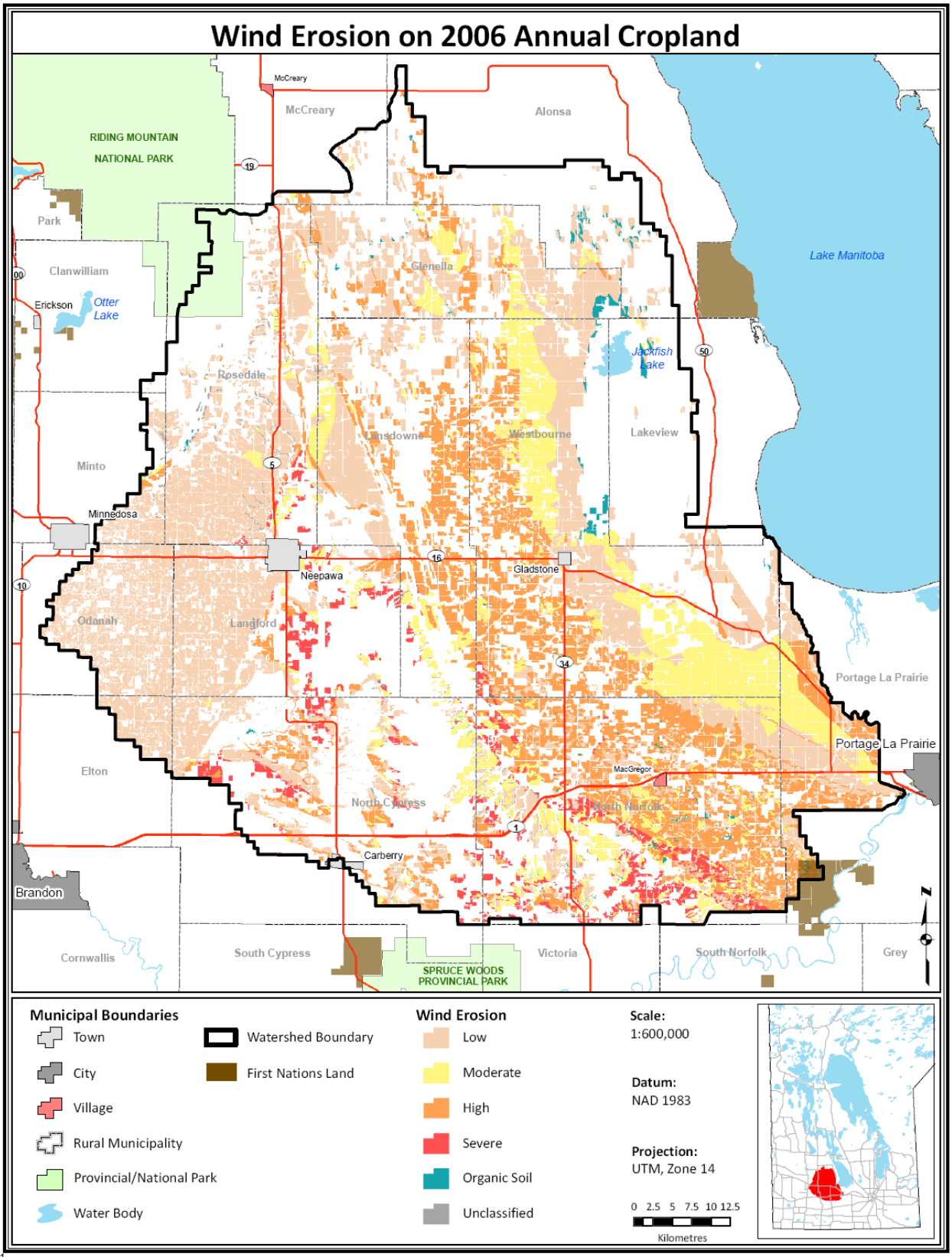
- Based on the 2006 land cover data, approximately 45% (170,500 ha) of the annual cropland was located on soils with moderate, high, or severe risk for wind erosion (***Table 8***).
- Most of the annual cropland located on soils with a severe wind erosion risk is located along the escarpment. A strip of annual cropland with high wind erosion risk is located at the base of the escarpment, from the north-central portion of the watershed down to the southeast corner (***Figure 38***).
- Annual cropland to the west of Neepawa generally has a low or negligible risk of wind erosion.

Table 8: Wind Erosion Risk in the Whitemud River Watershed study area based on 2006 Land Cover [1]

Wind Erosion[1]	Total Area in IWMP (ha)	1993/94 Annual Cropland (ha)	2006 Annual Cropland (ha)	Distribution of 2006 Annual Cropland (%)	1993/94 to 2006 Change in Annual Cropland Area (ha)
Negligible	43,799	30,424	31,524	8%	1,100
Low	318,151	162,447	168,231	45%	5,784
Moderate	95,211	61,759	62,496	17%	736
High	160,467	86,867	91,639	24%	4,772
Severe	65,419	16,502	16,337	4%	-165
Organic Soil	32,140	3,241	3,048	1%	-193
Water	2,645	52	51	0%	0
Unclassified	21,832	1,568	1,926	1%	357
TOTAL	**739,664**	**362,861**	**375,252**	**100%**	**12,391**

[1] Wind Erosion Risk is based on the weighted wind erosion rating for each soil polygon and assumes bare soil.

Figure 38: Wind Erosion Risk on 2006 Annual Cropland in the Whitemud Watershed[1]



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

iii. Water Erosion Risk Analysis

The overland flow of water can, under certain circumstances, carry particles of soil with it. Rain splash erosion, sheet erosion, rill erosion and gully erosion are all caused by water. Where this occurs, there is the potential to carry large quantities of sediment and contaminants to nearby waterways and waterbodies throughout the watershed. This section examines where in the watershed that there may be a greater potential for this to happen. The analysis focuses on annual cropland from land cover data (see ***Appendix C***) in conjunction with water erosion risk (see ***Appendix F***) and the proximity of these areas to water courses.

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 the 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 erodability (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).

In the Whitemud River IWMP:

- Parts of the Whitemud River Watershed, the Manitoba Escarpment in particular, are prone to water erosion. Following heavy precipitation events and spring melt, water runs east from Riding Mountain at accelerated rates and the erosion potential is greater than most other areas in agricultural Manitoba.
- An examination of the watershed shows that approximately 33% of the study area (243,000 ha) has a moderate to severe risk of water erosion. 7% of the watershed has been identified as having a severe water erosion risk (***Table 9***).

On annual cropland with respect to water erosion risk:

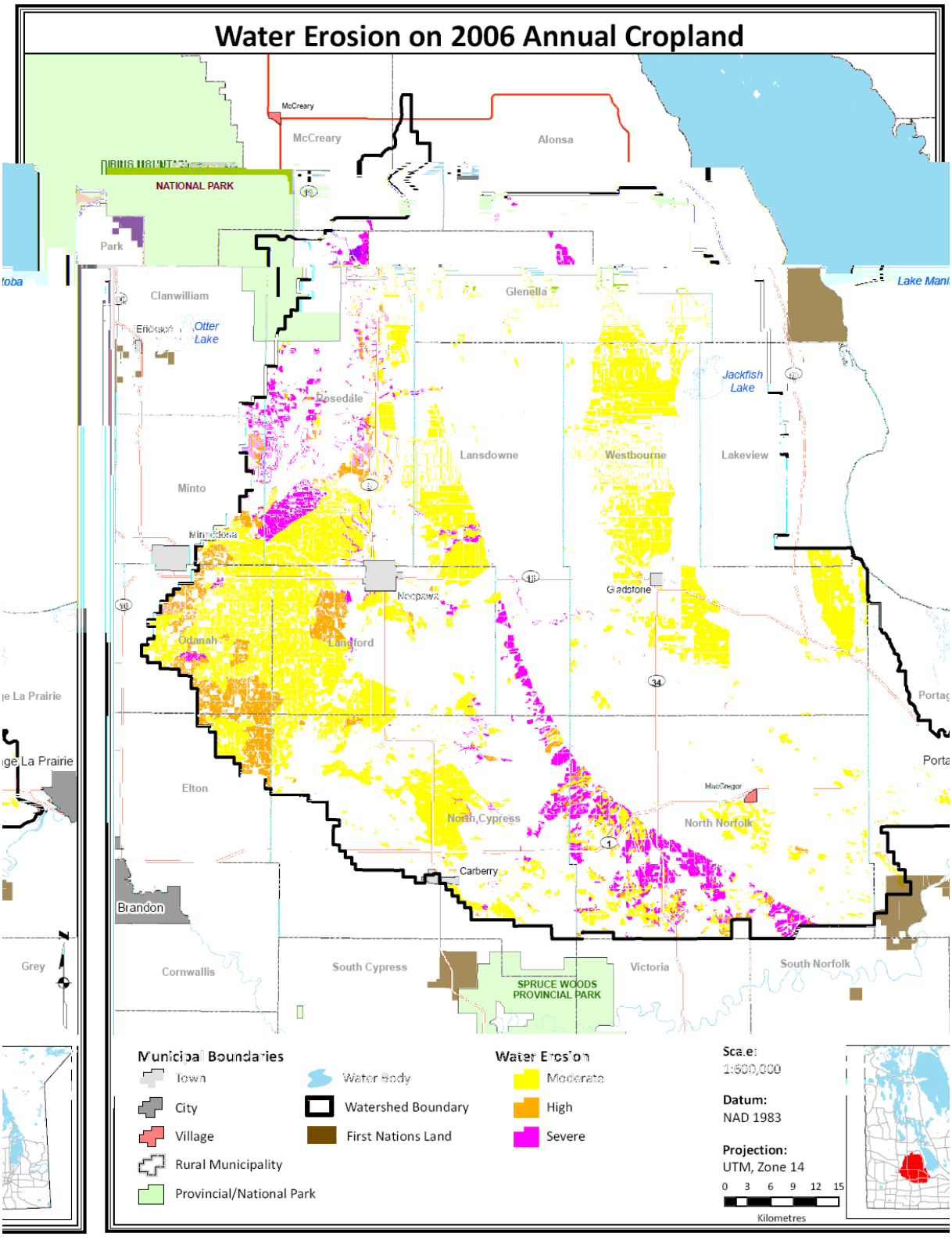
- Analysis of 2006 land cover shows that approximately 42% (158,100 ha) of annual cropland was located on soils with a moderate, high, or severe water erosion risk.
- In contrast to the low risk of wind erosion, the area west of Neepawa has a greater risk to water erosion (moderate to severe) due to its position on the sloped plain that runs southeast of Riding Mountain (***Figure 39***).
- As expected, there is a long strip of annual cropland on soils with a severe risk of water erosion along the escarpment from Neepawa to the southeast corner of the watershed.

Table 9: Water Erosion Risk in the Whitemud River Watershed study area from 2006 Land Cover

Water Erosion[1]	Total Area in IWMP (ha)	1993/94 Annual Cropland (ha)	2006 Annual Cropland (ha)	Distribution of 2006 Annual Cropland (%)	1993/94 to 2006 Change in Annual Cropland Area (ha)
Negligible	344,960	114,269	121,210	32%	6,941
Low	140,810	93,079	95,925	26%	2,846
Moderate	167,492	120,679	122,708	33%	2,029
High	24,920	15,635	15,614	4%	-20
Severe	50,608	19,135	19,743	5%	608
Water	2,608	42	42	0%	1
Unclassified	8,266	24	10	0%	-13
TOTAL	**739,664**	**362,861**	**375,252**	**100%**	**12,391**

[1] Water Erosion Risk is based on the weighted average USLE predicted soil loss within each soil polygon, assuming bare unprotected soil.

Figure 39: Water Erosion Risk (Moderate to Severe) on 2006 Annual Cropland in the Whitemud River Watershed[1]



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

iv. Soil Drainage Analysis

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 efficiency 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 a site specific situation and only where regulations requirements can be met. Agriculture and Agri-Food Canada (AAFC) has classified soils for their drainage capacity using a five class system (see ***Appendix H***).

Improved drainage indicates areas where networks of surface drains can accelerate surface runoff to reduce the duration of surface ponding and provide greater flexibility to crop management. 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 levels during heavy precipitation events. High water levels could lead to a flood or near-flood stage, thereby increasing the risk for water erosion or property damage. Unlike natural and undisturbed watercourses, man-made drainage systems tend not to have healthy riparian buffers associated with them. Insufficiently sized (or a complete absence of) riparian buffers may result in an increased risk of nutrient and sediment loading into watercourses. 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.

In the Whitemud River IWMP:

- Analysis of the soil drainage shows that the vast majority (79% or 582,600 ha) of the study area is well to imperfectly drained (***Table 10***).
- Smaller total areas of land in the watershed are rapidly (6% or 47,300 ha) or imperfect to very poorly drained (13% or 94,400 ha).
- Less than 1% (4,500 ha) of the watershed is considered marsh.

On annual cropland with respect to soil drainage:

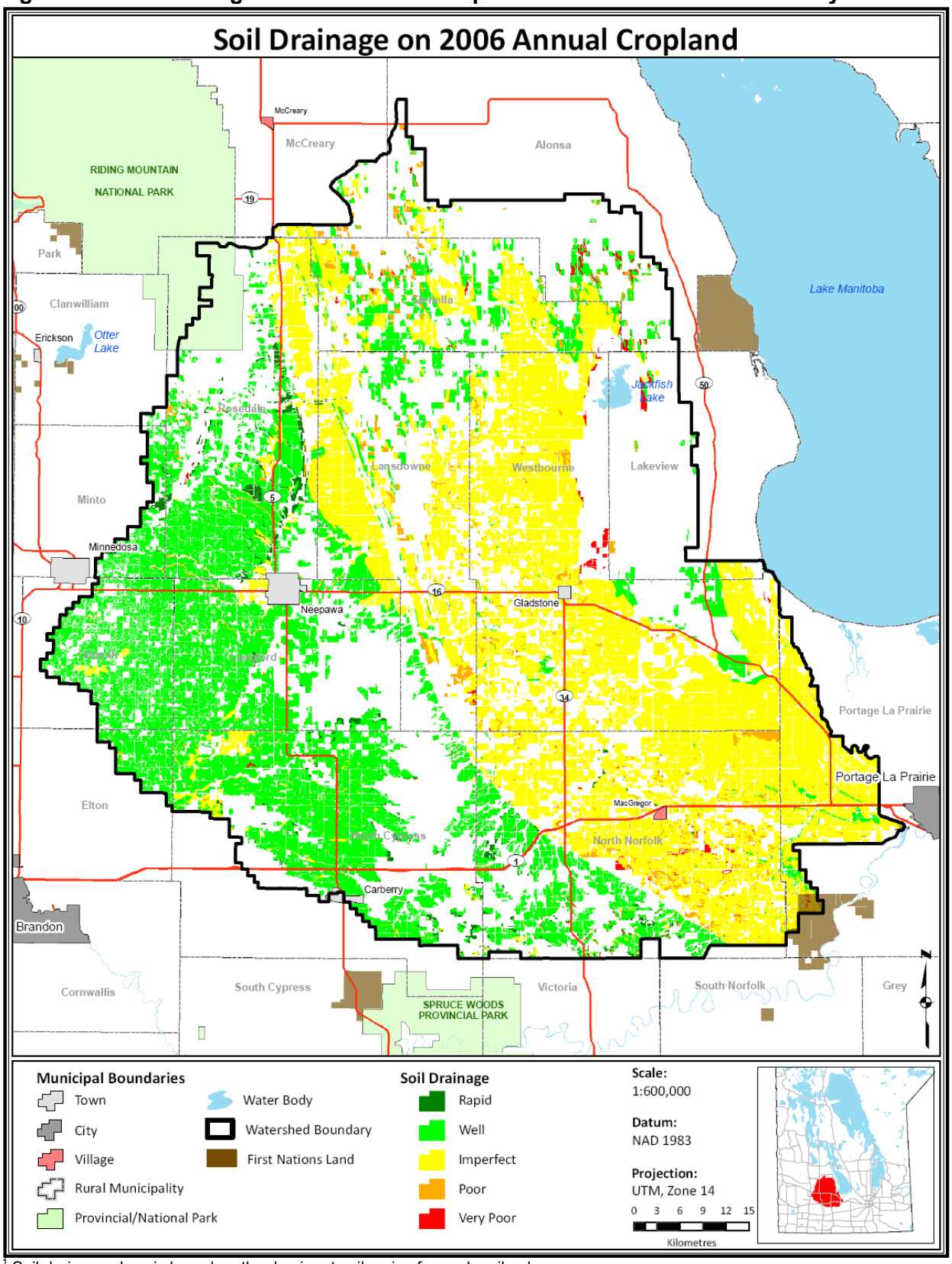
- Most of the annual cropland in 2006 was located on well (41%) or imperfectly (51%) drained soils.
- The escarpment acts as a dividing line between well and imperfectly drained annual cropland. The majority of land to the west of the escarpment is well drained, while that to the east is (with the exception of the northern portion of the watershed) is imperfectly drained (***Figure 40***).
- Poorly and very poorly drained soils make up only 6% of annual cropland within the watershed. These patches are located throughout the eastern half of the watershed, along the base of the escarpment, around the grasslands of Jackfish Lake, and in the RMs of Glenella and North Norfolk.
- There is a an area west of Big Grass Marsh (Jackfish Lake) in the RM of Glenella with well-drained soils, due to the establishment of a network of municipal drainage ditches.

Table 10: Soil Drainage Classes in the Whitemud River Watershed

Drainage Class[1]	Total Area in IWMP (ha)	1993/94 Annual Cropland (ha)	2006 Annual Cropland (ha)	Distribution of 2006 Annual Cropland (%)	1993/94 to 2006 Change in Annual Cropland Area (ha)
Rapid	47,261	5,332	5,946	2%	614
Well	298,579	151,614	154,600	41%	2,986
Imperfect	284,065	184,401	192,415	51%	8,014
Poor (Improved)	10,325	6,583	6,932	2%	349
Poor	51,792	11,601	12,186	3%	585
Very Poor	32,307	2,977	2,800	1%	-177
Unclassified	8,266	24	10	0%	-13
Marsh	4,461	289	320	0%	32
Water	2,608	42	42	0%	1
TOTAL	**739,664**	**362,861**	**375,252**	**100%**	**12,391**

[1] Drainage Class is based on the CLI Rating of the dominant soil series for each soil polygon

Figure 40: Soil Drainage on 2006 Annual Cropland in the Whitemud River study area[1]



[1] Soil drainage class is based on the dominant soil series for each soil polygon

v. Soil Texture Analysis

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 and more resistant to wind erosion. Clay soils are usually more fertile because they have a greater capacity to retain nutrients than sandy soils. However, they transmit water very slowly and are therefore susceptible to saturation from excess moisture conditions (PFRA, 2005).

Soil texture in the Whitemud River Watershed can have a bearing on groundwater management and contamination risk. Proper land management is important as soil textures can contribute to greater subsurface movement to the groundwater source, particularly where there is thin soil overburden to the aquifer. Furthermore, surface water movement into the bedrock material can increase contamination risks due to the chemical makeup of the surface water and by the physical properties of freezing and thawing.

In the Whitemud River IWMP:

- Loamy textured soil makes up the largest portion of the watershed at 47% or 350,000 ha (***Table 11)***.
- The majority of the remaining land in the watershed is either sandy or coarse loamy soil (188,600 ha and 106,900 ha, respectfully).
- A relatively small portion of soil in the watershed is considered clayey (40,300 ha). These clayey soils are concentrated in an area between Gladstone and Portage le Prairie along Highway 16.
- Very little soil in the watershed is considered organic (4% or 33,300 ha), located mainly in the vicinity of the Jackfish Lake.
- Only a small portion of the watershed is considered eroded slopes, with these areas occurring along tributary creeks on the escarpment as well as near Riding Mountain National Park in the northwest part of the watershed.

On annual cropland with respect to soil texture:

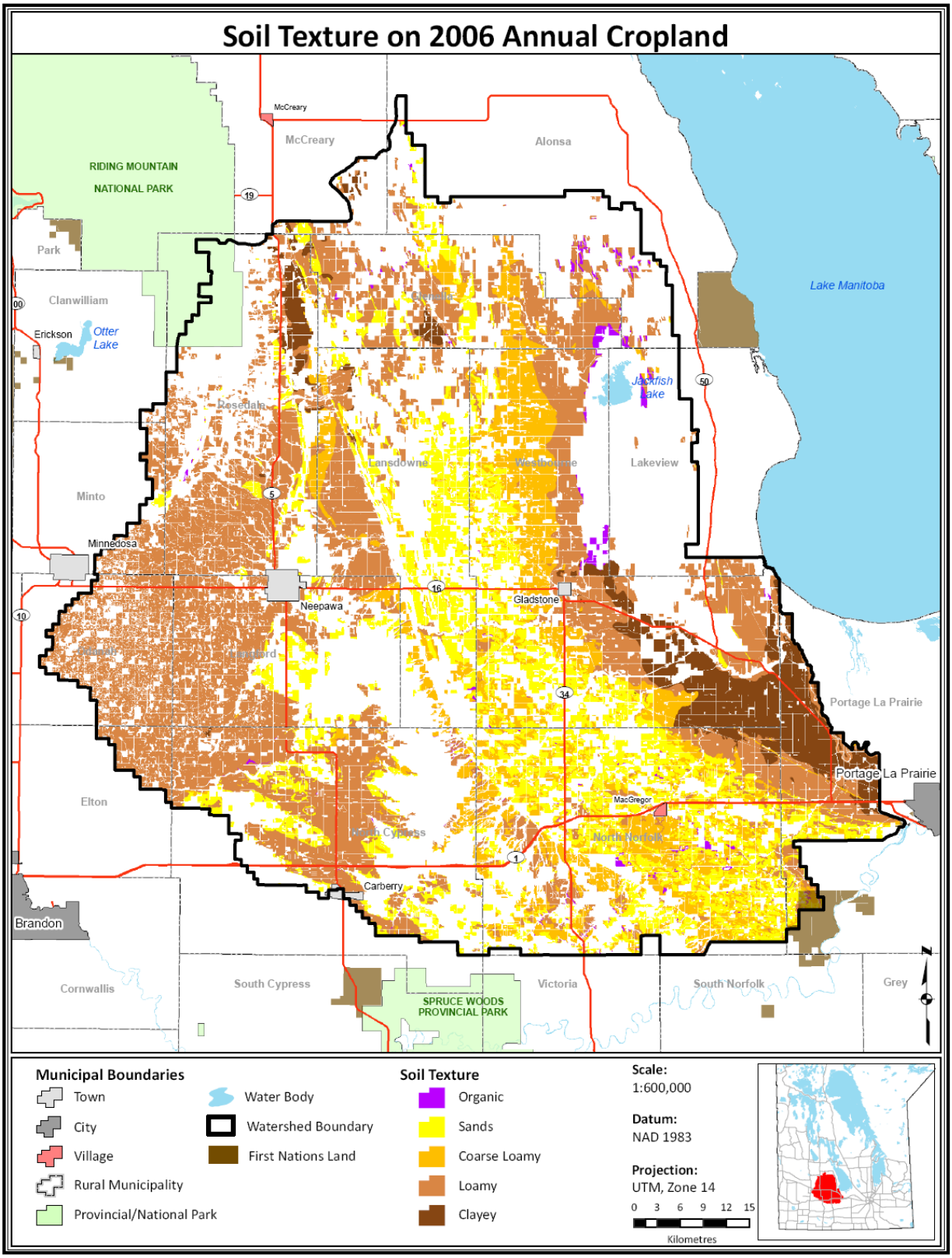
- Approximately 50% (189,300 ha) of the 2006 annual cropland was located on loamy textured soils. These soils are located west of the escarpment and scattered throughout the far eastern portion of the watershed (***Figure 41***).
- A long strip of sandy soils is located along the Manitoba escarpment from the north to southeast corner of the watershed. These sandy soils are particularly susceptible to wind erosion.

Table 11: Soil Texture in the Whitemud River Watershed study area

Surface Texture[1]	Total Area in IWMP (ha)	1993/94 Annual Cropland (ha)	2006 Annual Cropland (ha)	Distribution of 2006 Annual Cropland (%)	1993/94 to 2006 Change in Annual Cropland Area (ha)
Organic	33,250	3,562	3,303	1%	-259
Coarse Sands	640	210	333	0%	123
Sands	188,593	81,142	84,779	23%	3,637
Coarse Loamy	106,876	63,659	65,221	17%	1,562
Loamy	350,044	182,963	189,325	50%	6,362
Clayey	40,266	30,004	30,643	8%	639
Unclassified	8,266	24	10	0%	-13
Eroded Slopes	9,120	1,256	1,595	0%	339
Water	2,608	42	42	0%	1
TOTAL	**739,664**	**362,861**	**375,252**	**100%**	**12,391**

[1] Soils Surface Texture is based on the textural rating of the dominant soil series for each soil polygon

Figure 41: Surface Texture on 2006 Annual Cropland in the Whitemud River Watershed IWMP study area[1]



[1] Soils Surface Texture is based on the textural rating of the dominant soil series for each soil polygon

vi. Salinity

Saline soils are those that contain enough soluble salts in the root zone to adversely affect the growth of most annual crops. 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 Whitemud River 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 normal moisture regimes. 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. Fine textured soils classified as moderately and strongly saline will demonstrate higher levels of salinity under moisture deficit conditions.

In the Whitemud River IWMP:

- Salinity maps based on soil reconnaissance show that the majority of the watershed (almost 88% or 650,400 ha) is considered to be non-saline in nature (***Table 12***).
- Approximately 11% (77,900 ha) of the watershed is considered weakly saline (< 4 dS/m). As 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 three could be yield impacts.
- A minimal amount of soil is considered either moderately or strongly saline (480 ha).

On Annual Cropland with respect to soil salinity:

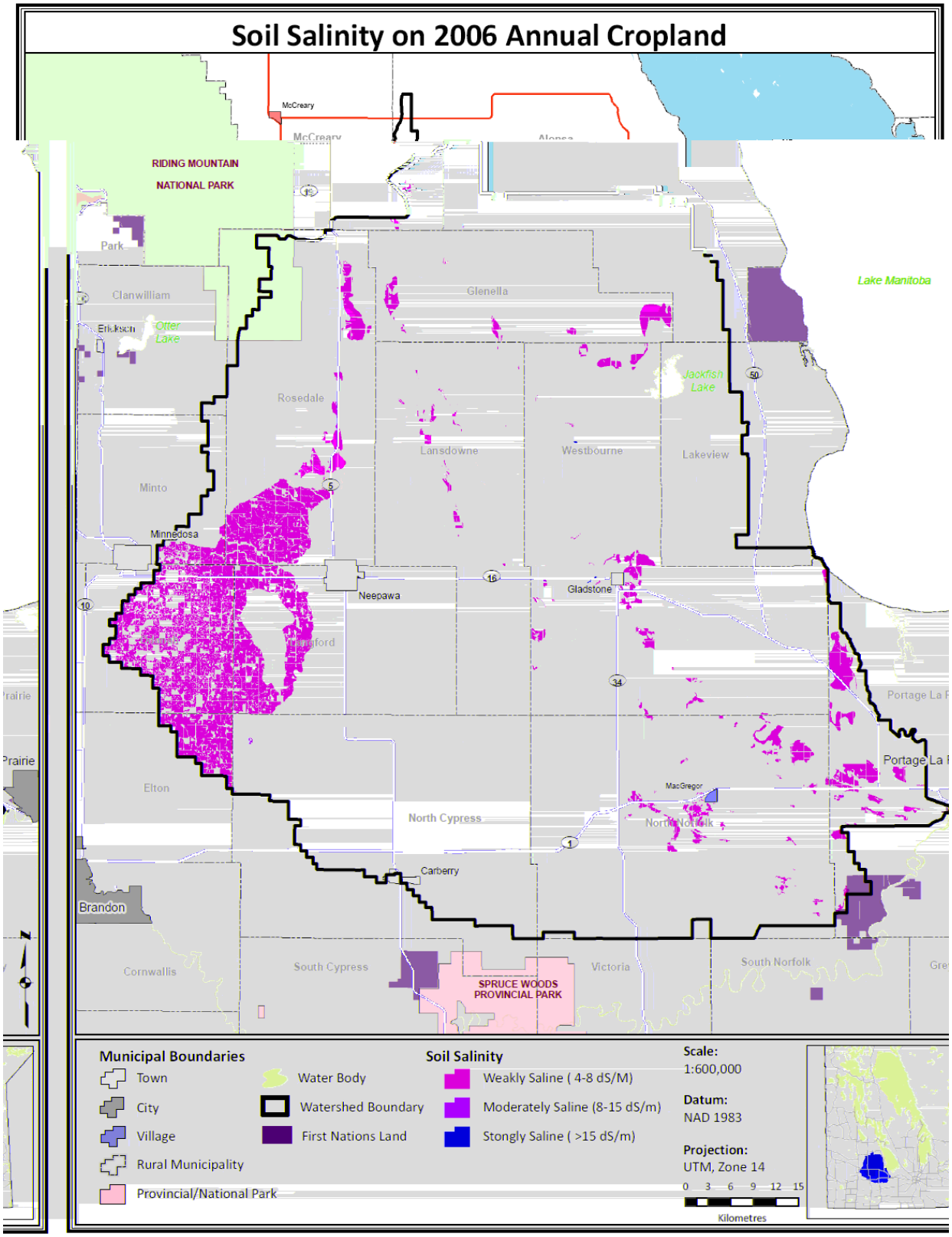
- When comparing soil salinity with annual cropland classified using land cover data, 85% (320,300 ha) of soils under annual cropland were identified as non-saline. A small amount of annual cropland was present on weakly to strongly saline soil. However, the area of cropland on saline soils has decreased since 1993/94 levels, despite an overall increase in annual cropland in the watershed. This decrease may be partially attributable to the adoption of beneficial management practices offered under the Canada Manitoba Farm Stewardship Program that were available to producers during this time, including financial support for perennial cover and management plans soils at risk (including saline soils).
- The majority of weakly saline soils were found west of Neepawa; while other patches of saline soil were present throughout the watershed **(***Figure 42***)**.

Table 12: Salinity in the Whitemud River Watershed study area

Salinity[1]	Total Area in IWMP (ha)	1993/94 Annual Cropland (ha)	2006 Annual Cropland (ha)	Distribution of 2006 Annual Cropland (%)	1993/94 to 2006 Change in Annual Cropland Area (ha)
Non Saline (< 4dS/m)	650,454	307,459	320,325	85%	12,866
Weakly Saline (4-8 dS/m)	77,858	55,231	54,801	15%	-430
Moderately Saline (8-15 dS/m)	446	87	49	0%	-39
Strongly Saline (> 15 dS/m)	32	18	25	0%	7
Unclassified	8,266	24	10	0%	-13
Water	2,608	42	42	0%	1
TOTAL	**739,664**	**362,861**	**375,252**	**100%**	**12,391**

[1] Salinity is based on the dominant soil series for each soil polygon

Figure 42: Salinity on 2006 Annual Cropland in the Whitemud River Watershed study area



G. Recent Federal and Provincial Policies and Programs Affecting Agricultural Land Use and Management

i. Crown Land Management in the Whitemud River Watershed Area

Crown Land in the Whitemud River study area make up a small portion of the watershed, approximately 8% (59,384 ha). Half of this land is located in the Alonsa, Langford, Lakeview, McCreary, and Westbourne AESB Community Pastures (***Table 13*** and ***Figure 43***).

In the Whitemud River IWMP:

- There are approximately 59,384 ha of Crown Land in the watershed.
- 8,000 ha of the Crown Land have no agricultural use. These lands consist mostly of wildlife management/protected areas, utility sites, and erosion prone/fragile lands.
- The vast majority (51,070 ha) of Crown Land in the watershed is classified as having some sort of agricultural use (lease, yearly permits, or Community Pasture). Land available for agricultural use through the Agricultural Crown Land Leasing and Permitting Program (See *Appendix M*) makes up 36% this area.
- Approximately 25% of Crown Land within the watershed can be found in the Rural Municipality of Lakeview. Most of this land occurs within the Lakeview AESB Community Pasture. Other Rural Municipalities with large amounts of crown land are Alonsa, Langford, and Rosedale (***Table 14***).

Crown Land is subject to specific land use and management based on government acts, regulations and policies. MAFRI is involved in the planning and regulatory management to approximately 648,500 Crown Land leased hectares in Manitoba. More information regarding Crown Land Policy, Management, and regulation can be found in ***Appendix M***. This provincially owned land base, which is primarily utilized for forage production and rangeland, provides the annual feed requirements for approximately 10 % of the provincial beef herd according to local authorities.

Table 13: Crown Lands based on MAFRI Crown Land Use Coding

Generalized Operation Land Use Code	Total Area (ha)	Percentage
Agricultural Use (Lease)	19,395	33%
Agricultural Use (Yearly Permits)	1,912	3%
Community Pastures (Managed by AESB)	29,954	50%
No Agriculture Use (Wildlife, Recreational)	8,006	13%
Uncoded (No Agricultural Use)	118	0%
TOTAL	**59,384**	100%

Table 14: Area of Crown Lands by Rural Municipality in the Whitemud River Watershed study area

Rural Municipality	Total Area (ha)	Percentage
Alonsa	10,610	18%
Clanwilliam	0	0%
Elton	0	0%
Glenella	2,346	4%
Lakeview	14,782	25%
Langford	8,277	14%
Lansdowne	2,965	5%
McCreary	716	1%
Minto	0	0%
North Cypress	4,408	7%
North Norfolk	1,956	3%
Odanah	0	0%
Portage La Prairie	322	1%
Rosedale	6,850	12%
South Norfolk	0	0%
Victoria	0	0%
Westbourne	6,152	10%
TOTAL	**59,384**	100%

ii. Management Considerations on Crown Lands

a) Land Capability Classification

The agricultural land use capability of Crown Land in the Whitemud River Watershed is illustrated in ***Table* 15**. The majority (89%) of Crown Lands within the watershed have marginal to poor agricultural capabilities at Class 4 or higher (***Table 15*)**. The majority of class 6 and 7 soils are located along the Escarpment (including the Langford AESB Community Pasture) and the majority of organic soils are located near Jackfish Lake in the Westbourne AESB Community Pasture (***Figure 44***).

Table 15: Agricultural Capability of Crown Lands in the Whitemud River Watershed study area

Agricultural Capability	Total Area (ha)	Percentage
Class 1-3	6,664	11%
Class 4-5	29,869	50%
Class 6-7	17,362	29%
Organic	5,281	9%
Water	183	0%
Unclassified	25	0%
TOTAL	**59,383**	**100%**

Figure 43: Crown Land Characterization Coding in the Whitemud River Watershed Area

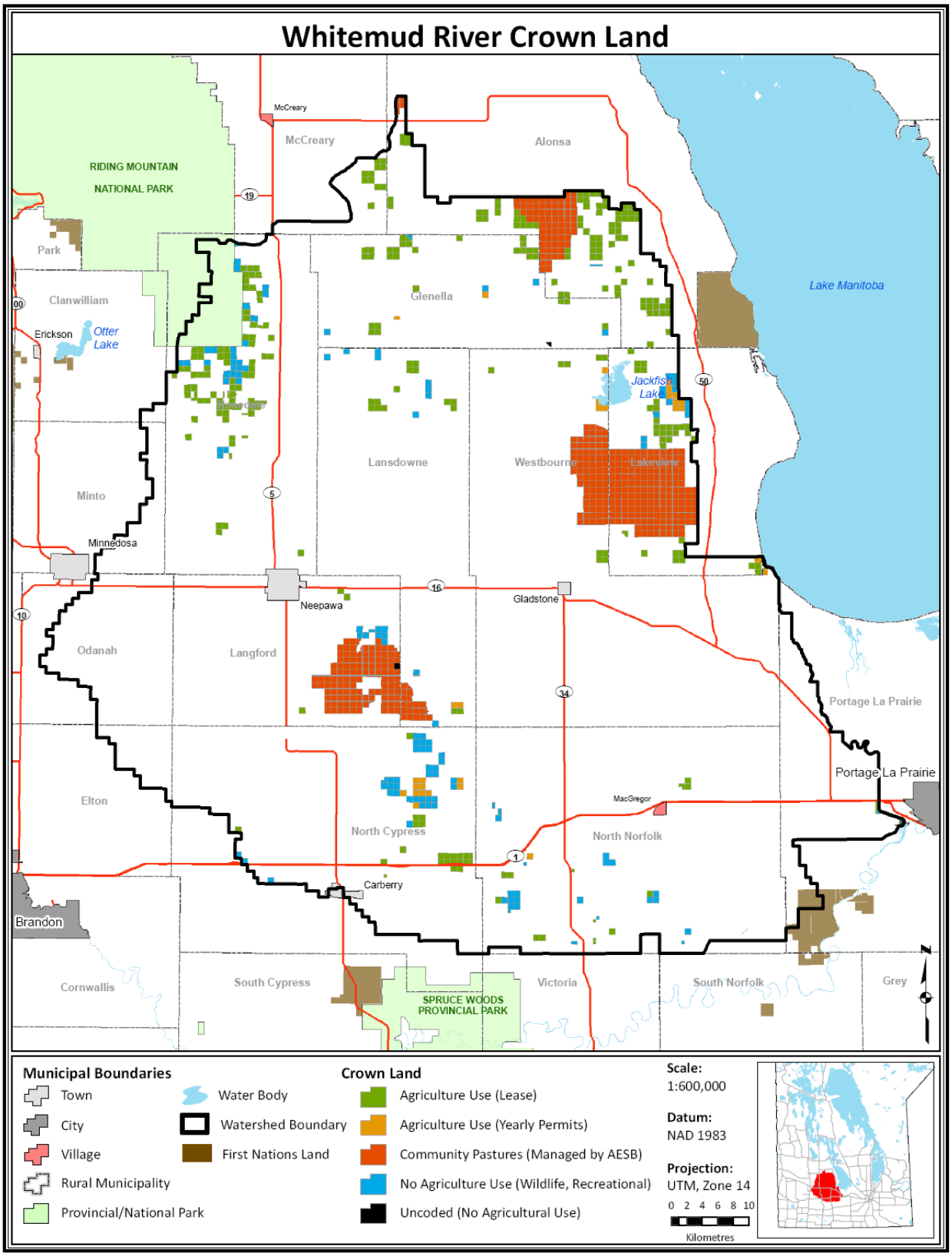
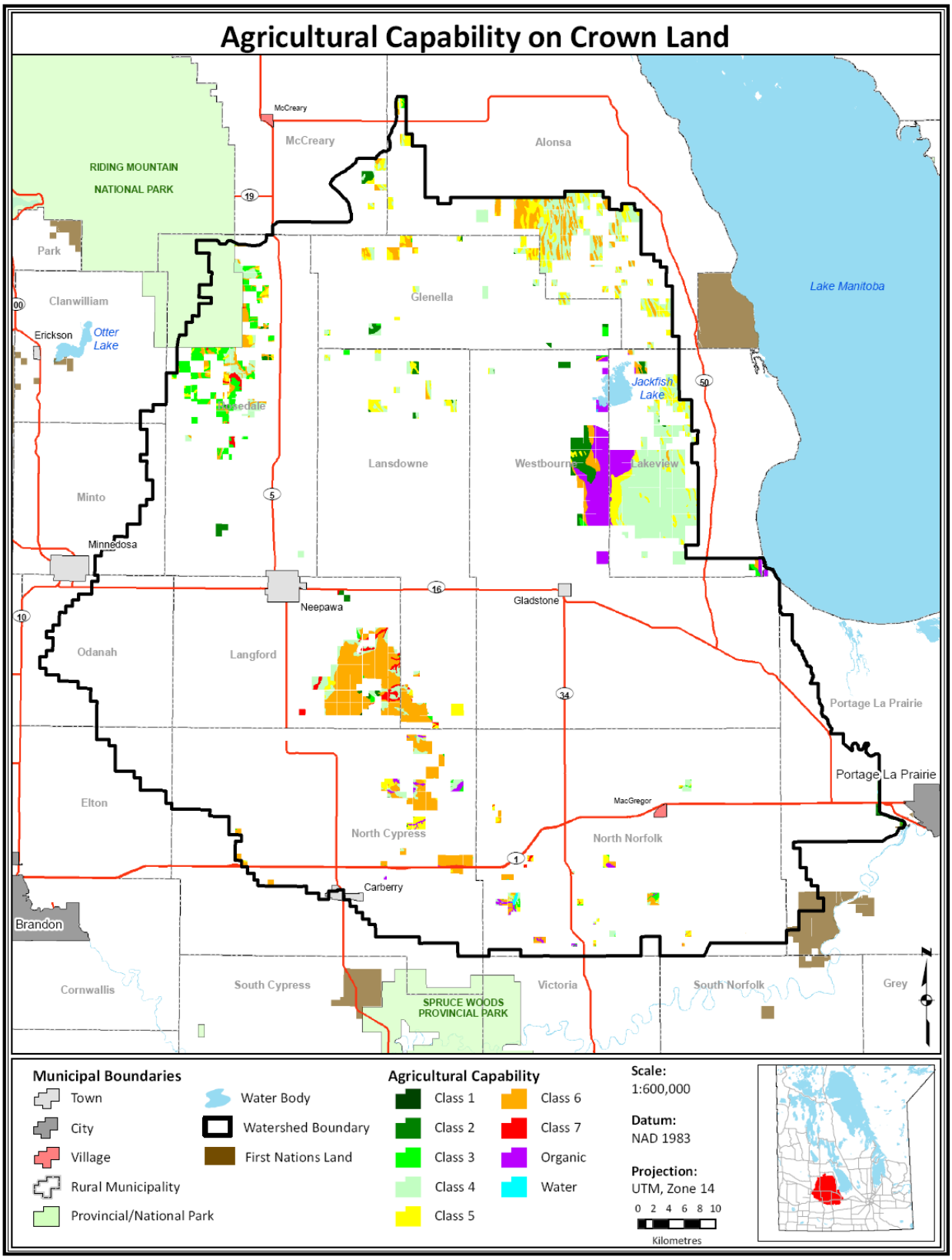


Figure 44: Agricultural Capability of Crown Lands in the Whitemud River Watershed



b) Woody Species Encroachment on Crown Lands

As noted in Section E iii, there was an overall decrease of almost 47,000 ha of grassland between 1993/94 and 2006 in the watershed. On Crown Land within the watershed, 7,862 ha of grassland were lost to tree encroachment (***Table 16***). Encroachment occurred across the various types of Crown Land, but was concentrated in the Langford, Lakeview, and Alonsa AESB Community Pastures, as well as leased land parcels in the northeast corner of the watershed (***Figure 33***).

Woody species encroachment is a function of management (e.g. grazing), weather (rainfall), drainage, and financial pressures in the industry. Generally, the primary woody species encroaching on grassland tend to be poplar and willow.

Table 16: Change in Grassland to Trees on Crown Lands (1993/94-2006)

Generalized Operation Land Use Code	Total Area (ha)	Area that changed from grassland in 1993/94 to trees in 2006 (ha)	% Change
Agricultural Use (Lease)	19,395	2,704	14%
Agricultural Use (Yearly Permits)	1,912	113	6%
Community Pastures (Managed by AESB)	29,954	4,367	15%
No Agriculture Use (Wildlife, Recreational)	8,006	654	8%
Uncoded (No Agricultural Use)	118	24	20%
Total	**59,384**	**7,862**	**13%**

c) AESB Community Pasture Management in the Watershed

There are six Community Pastures within the Whitemud Watershed with a total area of approximately 30,000 ha. AESB operates five Community Pastures in the watershed, while a sixth pasture called the Big Grass Community Pasture is operated by a local co-op grazing board (see ***Figure 43***). The AESB Community Pasture Program has two objectives:

(a) Manage a productive bio-diverse rangeland and promote environmentally responsible land use practices,
(b) Utilize the resource to complement livestock production.

The Lakeview and Westbourne pastures are located next to Big Grass Marsh. The Lakeview Community Pasture is located on the east side of the Big Grass River, a Whitemud Watershed Conservation District drain. The Westbourne Community Pasture is on the west side of the drain and is prone to overland flooding. In the last six years, this Community Pasture has experienced heavy flooding and a significant portion of the north end remaining permanently under water since flooding began. Large spring rain and runoff events have covered more than half of the remaining portion of the Westbourne Community Pasture with standing water for extended periods during the spring.

AESB have been able to mitigate for potential agricultural impacts to surface water quality through various means. Stocking rate adjustments, based on pasture carrying capacity, have been applied to Westbourne Community Pasture in response to the flooded lands (from 1200 head of cow/calf pairs to 800). Livestock were also delayed entry in Westbourne Community

Pasture until late June in 2009 and 2010 (much later than the normal dates of the fourth week of May for other pastures) to allow spring runoff events to dissipate.

The AESB community pastures are responsive and adaptive to sudden changes in pasture conditions. In 2005, significant flooding occurred within the Westbourne Community Pasture. Pasture management was able to move livestock to neighbouring Community Pastures. Cross fencing, implemented in Westbourne to provide more sustainable pasture management, also provided exclusion of livestock from the flooded areas.

The Grazing Management scheme have maintained the natural conditions of these areas, protecting and enhancing biodiversity, protecting f numerous species at risk on these pastures. A biodiversity inventory completed in 2000 for the Lakeview and Westbourne Pastures found 250 plant and 81 bird species observed during the study period in both pastures. Furthermore, ten vascular plant and eight bird species that are designated as rare to uncommon for the province were found (Jones *et al.* 2000).

The RM's of Langford and Landsdowne recently protected their respective land within the Langford Community Pasture through a Conservation Agreement with the Manitoba Habitat Heritage Corporation, as they recognize the value of sustainable management and the perpetual protection of this land.

The grazing opportunities provided by the Westbourne Community Pasture and others serve as an important resource to the area and Manitoba cattle producers at large. AESB's ability to keep the land in permanent cover reduces erosion risk and reduces nutrient loading into the Whitemud watershed and Lake Manitoba.

ii. Recent Federal-Provincial Programs

Environmental Farm Planning and Canada-Manitoba Farm Stewardship Program - On-Farm Beneficial Management Practices Adoption

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 this watershed, have participated in the EFP process gaining an improved understanding of the potential environmental risks associated with agriculture, as well as, those on their own farms. Potato growers within the watershed contracted for processing must complete an environmental farm plan as part of the processing industry's requirements. The EFP process helped 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 available 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 N***).

Participation in the Environmental Farm Plan Program is aggregated by municipalities in the study area in ***Appendix O***. The information portrays the number of participants in the Environmental Farm Planning process based on where EFP workshops were held. It should be noted that participants may reside in the surrounding area and not necessarily in location of the workshop. Environmental Farm Planning Workshops were well attended, with a high degree of producers completing the process to receive a Statement of Completion for eligibility to BMP funding through the CMFSP. Participation numbers within the study area were at the Manitoba average, indicating that producers in the Whitemud River watershed are proactive and that addressing environmental issues are high on their priorities.

In the Whitemud River Watershed study area, a total of 693 BMP projects were completed by producers (***Table 17***). Of the 693 completed, 297 of the projects were categorized as Non Point Source – Crop Related BMPs.

The top three BMP categories adopted by producers in the study area were Improved Cropping Systems, Wintering Site Management, and Product and Waste Management. Specifically, the top three BMPs adopted were precision farming applications, portable shelters and windbreaks, and equipment modification on pre-seeding/seeding/post-seeding implements. Irrigation has been highlighted as an important issue in the study area by some producers. Seventeen irrigation-related projects were adopted within the study area.

The adoption of BMPs by producers is not limited to those funded through the CMFSP. Other agencies like Conservation Districts, Ducks Unlimited Canada, and Manitoba Habitat Heritage Corporation also support the adoption of 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, so it is difficult to determine precise adoption levels. However, considering the number of farms in the watershed, the CMFSP program data does suggest that producers in the watershed are progressive in terms of BMP adoption and that future conservation programs that may stem from IWMP implementation are likely to have considerable levels of participation in this region.

Table 17: BMP Adoption through the Canada-Manitoba Farm Stewardship Program 2003-2008 [9]

BMP Categories	Whitemud IWMP
Point Source - Livestock Manure Related [1]	13
Point Source - Other (Petroleum, Nutrients from Feed, Pesticides, etc.) [2]	53
Non Point Source - Livestock Related [3]	181
Non Point Source - Crop Related [4]	297
Non Point Source - Crop Related (Irrigation) [5]	17
Non- Point Source - Crop Related (Pesticides) [6]	49
Soil Erosion - Soils at Risk [7]	43
Biodiversity [8]	40
Total	693

1. These include BMPs 1, 2, 4, 5, 6
2. These include BMPs 8, 9, 17
3. These include BMPs 3, 7, 10, 26, 30
4. These include BMPs 14, 24
5. These include BMPs 18, 29
6. These include BMPs 16, 20, 25
7. These include BMPs 11, 12, 13, 15, 19, 27
8. These include BMPs 21, 22, 23, 28
9. Refer to Appendix N for BMP description

Growing Forward: Environmental Farm Action and Manitoba Sustainable Agriculture Practices Programs

As noted above, the adoption of BMPs by producers is not limited to those funded through the CMFSP. Other agencies like Conservation Districts, Ducks Unlimited Canada, and Manitoba Habitat Heritage Corporation also support the adoption of various BMPs. In 2009, Manitoba Food and Rural Initiatives (MAFRI) began offering programs under the Growing Forward Agriculture Policy Framework, a provincial and federal commitment over five years (2008 – 2013), such as continued environmental farm planning and BMP support (see ***Appendix P***).

Table 18: BMPs available through the Environmental Farm Action Program (EFAP) and/or Manitoba Sustainable Agriculture Practices Program (MSAPP)

BMP Categories	BMP Suite
Increased Manure Storage Capacity	EFAP
Improved Manure Storage and Handling	EFAP
Solid-Liquid Separation of Manure	EFAP
Composting of Manure	EFAP
Farmyard Runoff Control	EFAP
Relocation of Livestock Confinement Facilities	EFAP
Wintering Site Management	EFAP
Riparian Area Management	EFAP
Improved Crop Residue Management	EFAP
Precision Agriculture Applications	EFAP
Nutrient Management Planning	EFAP
Reduced Greenhouse Gas (GHG) Emissions from Manure Storage	MSAPP
Manure Land Application	MSAPP
Reduced Tillage	MSAPP
Spring Fertilizer Application	MSAPP
Perennial Cover for Sensitive Land	MSAPP
Cover Crops	MSAPP
Improved Pasture and Forage Quality	MSAPP
Increased Perennial Legumes in Annual Crop Rotation	MSAPP
Grazing and Pasture Management Planning	MSAPP

Financial and technical support is available through Growing Forward's suite called Environmental Action, directed to improve the environmental performance and sustainability of agricultural operations. Funding for eligible BMPs focuses on agriculture's capacity to reduce risk to water and air quality, improve soil productivity and enhance wildlife habitat. BMP support is available to producers upon completion of an environmental farm plan.

Once producers complete the EFP program, they receive a Statement of Completion which enables them to apply for financial assistance for specific beneficial management practices through the Environmental Farm Action Program (EFAP). In addition, the Manitoba Sustainable Agriculture Practices Program (MSAPP) is a provincial climate change program and has an objective to assist in implementing practices that reduce greenhouse gas emissions from agriculture. ***Table 18*** outlines the BMPs available through each respective program.

Further information about the current Growing Forward Program in support of Environmental Farm Planning and BMPs can be found on the MAFRI website at:
http://www.gov.mb.ca/agriculture//soilwater/farmplan/index.html

H. Agricultural Land Use and Management Recommendations*

Watershed Issue	Analysis	Recommended Actions*	Target Areas*	Potential Indicators*
How has the extent of natural cover changed in this watershed over 30 years?	**Influences on Natural Habitat Change** –The following trends have been noted in the watershed: • **2006 Land Cover -** In 2006, approximately 19% of the land (142,000 ha) in the watershed was classified as trees, water, or wetlands. Trees are the third most predominant land cover class in the watershed with 16% (or 117,000 ha) of total watershed area. Grassland/pasture is the second most common land cover type and makes up 23% (or 167,400 ha) of the watershed (**Table 4, Figures 13 and 14, Pages 24-26**). • **Farmland Usage-Census Trends (1991-2006)** - A drop in total farmland area (nearly 25,600 ha) was observed between 1991 and 2006. Pasture (both natural and improved) decreased in area over the time period, but only by 400 ha. Natural Pasture decreased by over 12,200 ha, but tame pasture increased in area by approximately 11,800 ha (**Figure 17, Page 29).** • **Number of Farms with Irrigation -Census Trends (1991-2006) -** The number of farm operations reporting irrigation use increased from 35 in 1991 to 60 in 2006. Farms using irrigation peaked in 2001, with 70 farms reporting. The number of potato farm operations was slightly less than the number of farms using irrigation. Both had similar trends over the 15 year period (**Figure 20, Page 31**). • **Forages-Census Trends (1991-2006)** - Area in forages increased by almost 20% over fifteen years, with 74,400 ha of cropped land planted to forages in 2006 **(Figure 18, Page 29).** • **Annual Cropland- Census Trends (1991-2006) -** Forage production made up almost 20% of the total cropland in the watershed in 2006. This proportion has increased over 15 years, as both alfalfa and other tame forages rose during this time (**Figure 19, Page 30).** • **Native Pasture and Other Land Trends - Census Trends (1991-2006)** -Native pasture area decreased by 12,300 ha, but remained a large portion of the total farmland area at approximately 125,000 ha. The area of other land (the vast majority of which is comprised by woodlands and wetlands) increased by 9,600 ha from 1991 to 2006 **(Figure 21, Page 31).** • **Land Cover – 1994, 2000, and 2006** - **(Table 5, Page 36)** (a) **Annual Cropland –**The area of annual cropland dropped slightly between 1993/94 and 2000/2001, but increased in 2006 to higher than previous levels. (b) **Grasslands**- The largest change in land cover was observed in grassland area, where there was a decrease of approximately 46,700 ha (from 216,200 ha to 169,600 ha). (c) **Natural Areas-** Forested area experienced the second largest overall change in cover (an increase of 24%, approximately 23,135 ha) while wetlands decreased by approximately 4,300 ha between 1994 and 2006. (d) **Forage-** Forage cover increased substantially in the watershed between 1993/94 and 2006, by nearly 115% (15,300 ha). The increase was associated with decreases in annual cropland over the 13-year period. (e) **Other Classes-** The area of water decreased slightly; however, the amounts were negligible in comparison to the size of the watershed. • **Changes to Annual Cropland** - There was an increase of approximately 12,400 ha (from 363,000 to 375,000 ha). Annual cropland loss was noted in the southern portion of the watershed. Areas being converted to cropland were identified in the northern portion. Analysis indicates that most of the new annual cropland appearing by 2006 had been previously classified as grasslands (37,200 ha). Around 20,700 ha of land experienced the reciprocal conversion from annual cropland to grassland by 2006, resulting in a net increase in the total area annual cropland **(Figure 29, Page 39).** • **Changes to Grassland Area -** Tree encroachment was the primary factor responsible for the overall decrease in grassland cover across the watershed (over 28,000 ha). Only 6,700 ha of land experienced the reciprocal conversion of forested area to grassland, resulting in a net decrease of grassland to nearly 22,000 ha. A large area of grassland (37,222 ha) was converted to cropland, but was partially offset by conversion of annual cropland to grassland (20,687 ha). A relatively large area of grassland was converted to forages over the 14-year period (10,000 ha). These changes occurred primarily in the center of the watershed, in the areas around Neepawa and Gladstone. (**Table 5**, **Figure 30, Pages 40-42**). • **Change in Forested Area –** There was an overall increase of approximately 23,100 ha of forested areas between 1993/94 and 2006 These areas were scattered throughout the watershed; however a significant portion of this area was located within, and in the vicinity of, the Alonsa AESB Community Pasture in the northeast corner of the watershed (**Figure 33**). Most of the newly forested areas noted in 2006 were the result of previously forested areas encroaching into adjacent grasslands. This was increasingly evident in the northern portion of the watershed. (**Table 5, Figure 33, Page 43-45).** • **Change in Forage Area-**. Analysis indicates that changes in forage area in the watershed resulted primarily from changes to/from grassland and annual cropland. The majority of forage losses occurred in the southeast, most of which was converted to annual cropland. New forage cover in 2006 was evenly located throughout the central and northern portions of the watershed, but was largely absent from the RMs of North Cypress and North Norfolk. Approximately 13,900 ha of cropland were converted to forage during the 14-year period. (**Table 5, Figure 35, Page 46-48).** **AWiFs change (Figure 36, Table 6, Page 50-51)** **Grassland land cover change from 1994** (a) The majority of lands that had changed from grasslands to a different land cover class were identified as cereals in 2009 (11,200 ha). Many of the hectares identified were dispersed throughout the watershed as small fragments. (b) 245 ha of land identified as grasslands in 1993/94 were identified as potatoes in 2009. These changes were isolated in a region northwest of Carberry. Potato production has been identified and confirmed in this region through local knowledge. **Forested Areas land cover change from 1994** (a) Approximately 1,200 ha were identified as either cereals (approximately 800 ha) or canola/rapeseed (approximately 400 ha) in 2009. Much of the converted forest area identified was dispersed throughout the watershed as small fragments. (b) Total area of land identified as being in potato production in 2009 was less than 60 ha. **Agricultural Capability –**41% (304,000 ha) of the soils in the watershed are Class 4 and lower (or organic). Approximately 2% of the watershed (16,400 ha) is considered organic soil. The majority of annual cropland on Class 4 and lower soils are located along the escarpment and through the center of the watershed. The amount of land being used for annual cropland has increased slightly since 1993/94. This is reflected in all classes, with the majority of the increases noted on Class 2, 3 and 4 soils (**Table 7, Figure 37**, **Page 53-54**). • **Crown Lands** - There are approximately 59,384 ha of Crown Land in the watershed. The vast majority (51,070 ha, 86%) of Crown Land in the watershed is classified as having some sort of agricultural use (lease, yearly permits, or Community Pasture). On Crown Land, there was an overall loss of 7,862 ha of grassland to tree encroachment, which was concentrated in the Langford, Lakeview, and Alonsa AESB Community Pastures, as well as leased land in the northeast corner of the watershed (**Table 13-16, Figure 44, Page 69-73**). • **BMP Adoption -** Of the 693 completed under the program, 40 of the projects were categorized as Biodiversity BMPs **(Table 17, Page 75).** • **Timing of Land cover Imagery** -Timing of Imagery and classification definitions may affect the number (i.e. a decrease or increase) of wetlands identified and should be verified with site specific analysis (ground truthing) • **Precipitation Levels –** Precipitation levels recorded throughout the watershed can influence land cover analysis. Total Annual Rainfall amounts exceeded the 30 year average in 1993, 1999, and 2000. Conversely, 1992 and 2006 had a number of communities who witnessed Total Rainfall levels well below the 30 year average (see ***Appendix P, Page 115)*.**	**Site Specific BMP Implementation for Wildlife Habitat** - Promote BMPs and provide technical assistance that encourage natural habitat (e.g. riparian buffers, wetland restoration, headwater storage options, and wildlife habitat) in key priority areas of the watershed. **Education -** Encourage environmental educational initiatives that demonstrate BMPS which maintain and enhance natural cover. (e.g EFPs) Encourage sustainable land management practices on soils with lower agricultural capability that maintain /support wildlife habitat	Areas in the watershed that are: • class 4 or lower and are adjacent to Spruce Woods Provincial Park, Assiniboine River or Souris River Valley, • class 4 or lower and suitable wetland habitat Entire Study Area	Proportion of watershed: • with annual cropland on Class 4 and lower lands, • that is wetland or treed, • that is grassland/pasture or forage Number of BMPs implemented that have a wildlife benefit. Change in number of restored wetlands. Number of educational initiatives presented.
	Data Gaps Identified: • *Most of the lands identified as annual cropland with high or severe wind erosion risk are located in areas with reconnaissance soil data.* • *Census data is collected on a volunteer basis.* • *Land cover Analysis is developed using a 30 meter pixel. Native Grasslands are not distinguished from tame grass under the Grassland category.*			

* Specific approaches and opportunities related to recommended actions, including potential target areas and indicators; need to be explored further by the Project Management Team. Potential collaboration with partners and stakeholders should be considered Specific recommendations from the IWMP process must be forwarded to local councils for consideration within the Development Plan. These recommendations should take agricultural land management into consideration, for preservation of existing farm land and operations.

Watershed Issue	Analysis	Recommended Actions*	Target Areas*	Potential Indicators*
How has the rate of irrigation changed in this watershed over 30 years?	**Changes reflecting irrigation impact on the landscape:** • **Farmland Usage-Census Trends (1991-2006)** - A drop in total farmland area (nearly 25,600 ha) was observed between 1991 and 2006. Pasture (both natural and improved) decreased in area, but only by approximately 400 ha. Natural Pasture decreased by over 12,200 ha, but tame pasture increased in area by approximately 11,800 ha (**Figure 17, Page 29).** • **Number of Farms reporting Irrigation -Census Trends (1991-2006) -** The number of farm operations reporting irrigation use increased from 35 in 1991 to 60 in 2006. Farms using irrigation peaked in 2001 with 70 farms reporting. The number of potato farm operations was slightly less than the number of farms using irrigation. Both had similar trends over the 15 year period (**Figure 20, Page 31**). • **Land trends (Census trends 1991-2006) -** Irrigated land increased from 1991 to 2006 by 250%, an increase of approximately 6,400 ha. However, irrigated land make s up a very small portion of total crops in the watershed (**Figure 21, Page 31**). • **Changes to Annual Cropland** - There was an increase of approximately 12,400 ha (from 363,000 to 375,000 ha). Annual cropland loss was noted in the southern portion of the watershed. Areas being converted to cropland were identified in the northern portion. Analysis indicates that most of the new annual cropland appearing by 2006 had been previously classified as grasslands (37,200 ha). Around 20,700 ha of land experienced the reciprocal conversion from annual cropland to grassland by 2006, resulting in a net increase in the total area of annual cropland **(Figure 29, Page 39).** **AWiFs change (Figure 36, Table 6, Page 50-51)** **Grassland land cover change from 1994** (a) The majority of lands that had changed from grasslands to a different land cover class were identified as cereals in 2009 (11,200 ha). The area of land that changed from grassland to trees was similar to what changed to cereals (9,073 ha). (b) 245 ha of land identified as grasslands in 1993/94 were identified as potatoes in 2009. This area is isolated in a region to the northwest of Carberry. Potato production has been identified and confirmed in this region through local knowledge. **Forested Areas land cover change from 1994** (a) Approximately 1,200 ha were identified as either cereals (approximately 800 ha) or canola/rapeseed (approximately 400 ha) in 2009. Much of the converted forest area was dispersed throughout the watershed as small fragments. (b) Total area of land identified as being in potato production in 2009 was less than 60 ha. **ADA/Equivalent Agri- Environmental Farm Plan – Report listed** (Any updates should be consulted with the Department of Water Stewardship.) (a) Water License Allocations- As of May 1st, 2005, allocations for the Whitemud Subbasin of the Assiniboine Delta Aquifer were at 6,667 acre-feet/year. The Upper Whitemud West, East, and Pine Creek North are fully or nearly fully allocated. (b) Water Quality- 80% of the wells monitored over the Assiniboine Delta Aquifer had nitrate concentration below the Canadian Drinking Water Quality Guidelines (of 2000) (c) Projected Water Demands- projected Domestic/Municipal water demands over the aquifer will increase to 3,500 acre-feet/year, based on a population increase to its communities of 15 % growth. **BMP Adoption -** Of the 693 completed under the Program, 183 of the projects were categorized as Point Source type BMPs. There were also 17 projects that were completed as Non-Point Source -Crop Related (Irrigation) **(Table 17, Page 75).** ***Data Gaps Identified:*** *(a) Most of the lands identified as annual cropland on high or severe wind erosion risk are located in areas with reconnaissance soil data (scale of 1:126,720).* *(b) Census data is collected on a volunteer basis.* *(c) Land cover Analysis is developed using a 30 meter pixel. Native Grasslands are not distinguished from tame grass under the Grassland category.*	**Analysis of existing information revealed that, on the broad scale, there has not been a dramatic change in irrigation in the watershed over the last 15 years. As with any land use activities, more localized changes have resulted. As such, all recommendations should be considered at a site specific level.** Coordinate with ADA Plan on an assessment of outstanding vulnerabilities and location with respect to groundwater (i.e. groundwater risks such as contamination sources in or near wellheads) **Communication/Education Strategies –** (a) Presentation technical findings from previous plans to stakeholders regarding irrigation change (ADA Plan, Assiniboine Delta EAEP, etc.) (b) Continual education and communication of findings from monitoring programs to stakeholders, (c) Continue to encourage producers to develop or update environmental farm plans, (d) Provide information for sustainable land management practices for annually cropped areas on lands with a lower agricultural capability. **BMP Adoption** that encourage recharge and protect water quality. These include: (a) **Wellhead Protection** – Promote the adoption of BMPs which upgrade old wells, as well as the installation of new wells, and prevent the contamination of groundwater, (b) **Nutrient Management** -Promote the adoption of BMPs that assist in the reduction of nutrients entering water courses and waterbodies. These include the adoption of riparian buffers, a management regime for healthy buffers, increase the size of buffers near specific streams, and nutrient management planning, soil testing, and manure testing, feedlot relocation, winter site management, and farmyard runoff control) **Irrigation Suitability –** Encourage irrigation development within areas that have higher irrigation suitability (as identified in ADA Plan). Ensure that appropriate management practices are utilized in areas where irrigation development may be less suitable.	Groundwater risk areas, specifically those that are contamination sources in or near wellheads). Entire Study Area Areas near source water or waterways and are: • Groundwater risk areas, (see above), • In annual crop production and receive nutrient (fertilizer or manure) application Areas within and immediately surrounding the ADA	Proportion of recharge area under perennial cover Number of educational initiatives presented by stakeholders and the presence of attendees Change in watershed where: • # of farmers implementing BMPs toward aquifer protection (e.g. nutrient management plans, buffer strips, soil and manure testing) and # of BMPs adopted by each farmer • An increase are forested or wetland areas, • grazing BMPs are implemented for the riparian areas, • There is a percent change of land cover to Perennial cover. Changes that reflect positive source water quality testing results.

* Specific approaches and opportunities related to recommended actions, including potential target areas and indicators; need to be explored further by the Project Management Team. Potential collaboration with partners and stakeholders should be considered Specific recommendations from the IWMP process must be forwarded to local councils for consideration within the Development Plan. These recommendations should take agricultural land management into consideration, for preservation of existing farm land and operations.

Watershed Issue	Analysis	Recommended Actions*	Target Areas*	Potential Indicators*
Clearing of land for irrigation has been considered one of the greatest threats to watershed health (wind erosion, wildlife habitat, aquifer security) in this region. What strategies are proposed to encourage a cooperative effort between levels of government ?	**Wind Erosion Risk** • Approximately 45% (170,500 ha) of annual cropland is considered to have soils with a moderate, high, or severe wind erosion risk. A strip of annual cropland with high wind erosion risk is located at the base of the escarpment, from the north-central portion of the watershed down to the southeast corner **(Table 8, Figure 38, Page 55-56).** • **Forage Production -Census Trends (1991-2006) -** Area in forages increased by almost 20% over fifteen years, with 74,400 ha of cropped land planted to forages in 2006 **(Figure 19, Page 30)**. • **Zero Tillage -Census Trends (1991-2006)** -The area of land managed with conservation tillage and zero tillage increased steadily over the fifteen year period. This increase was met conversely with a dramatic decrease in the usage of conventional tillage from 66% of cultivated land to 42% **(Figure 25, Page 34)**. • **BMP Adoption -** Of the 693 completed under the program, 43 of the projects were categorized as Soil Erosion BMPs. **(Table 17, Page 75).** **Wildlife Habitat** • **Land Cover – 1994, 2000, and 2006** - **(Table 5, Page 36)** • **Annual Cropland –**The area of annual cropland dropped slightly between 1993/94 and 2000/2001, but increased in 2006 to higher than previous levels. Annual cropland loss was noted in the southern portion of the watershed. Areas being converted to cropland were identified in the northern portion. Analysis indicates that most of the new annual cropland present appearing by 2006 had been previously classified as grasslands (37,200 ha). Around 20,700 ha of land experienced the reciprocal conversion from annual cropland to grassland by 2006, resulting in a net increase in the total area annual cropland **(Figure 29, Page 39)** • **Grasslands**- The largest change in land cover was observed in grassland area, where there was a decrease of approximately 46,700 ha (from 216,200 ha to 169,600 ha). • **Natural Areas-** Forested area experienced the second largest overall change in cover (an increase of 24%, approximately 23,135 ha) while wetlands have decreased by approximately 4,300 hectares from 1994 to 2006. • **Forage-** Forage cover increased substantially in the watershed between 1993/94 and 2006, by nearly 115% (15,300 ha). The increase was associated with changes noted in annual cropland over the 13-year period. Analysis indicates that changes to forage area in the watershed resulted primarily from changes to/from grassland and annual cropland (**Table 5 – Page 36, Figure 35 - Page 47).** • **Other Classes-** Water land cover had shown a small decrease, however, the amounts were negligible in comparison to the size of the watershed. • **Crown Lands** - There are approximately 59,384 ha of Crown Land in the watershed. The vast majority (51,070 ha, 86%) of Crown Land is classified as having some sort of agricultural use (lease, yearly permits, or Community Pasture). On Crown Land, there was an overall loss of 7,862 ha of grassland to tree encroachment, which was concentrated in the Langford, Lakeview, and Alonsa AESB Community Pastures, as well as leased land in the northeast corner of the watershed (**Table 13-16, Figure 44, Page 69-73**). • **BMP Adoption -** Of the 693 completed through the program, 40 of the projects were categorized as Biodiversity BMPs. **(Table 17, Page 75).** • **Timing of Land cover Imagery** -Timing of Imagery and classification definitions may affect the number (i.e. a decrease or increase) of wetlands identified and should be verified with site specific analysis (ground truthing) • **Agricultural Capability –** 41% (304,000 ha) of the soils in the watershed are Class 4 and lower (or organic). Approximately 2% of the watershed (16,400 ha) is considered organic soil. The majority of the annual cropland on Class 4 and lower soils are located along the escarpment and through the center of the watershed. The amount of land being used for annual cropland has increased slightly since 1993/94. This is reflected in all classes, with the majority of the increases noted on Class 2, 3 and 4 soils (**Table 7, Figure 37**, **Page 53-54**). **Irrigation Trends** • **Farmland Usage-Census Trends (1991-2006)** - A drop in total farmland area (nearly 25,600 ha) was observed between 1991 and 2006. Pasture (both natural and improved) decreased in area over the time period, but only by 400 ha. Natural Pasture decreased by over 12,200 ha, but tame pasture increased in area by approximately 11,800 ha (**Figure 17, Page 29).** • **Number of Farms Using Irrigation -Census Trends (1991-2006) -** The number of farm operations reporting irrigation use increased from 35 in 1991 to 60 in 2006. Farms using irrigation peaked in 2001 with 70 farms reporting. The number of potato farm operations was slightly less than the number of farms using irrigation. Both had similar trends over the 15 year period (**Figure 20, Page 31**). • **Annual Cropland- Census Trends (1991-2006)** Forage production made up almost 20% of the total cropland in the watershed in 2006. This proportion increased over 15 years, as both alfalfa and other tame forages rose during this time (**Figure 19, Page 30).** • **BMP Adoption -** Of the 693 completed under the program, 86 of the projects were categorized as Point Source type BMPs. There were also 17 projects that were completed as Non-Point Source-Crop Related (Irrigation). **(Table 17, Page 75).** **AWiFs change (Figure 36, Table 6, Page 50-51)** **Grassland land cover change from 1994** (a) The majority of lands that had changed from grasslands to a different land cover class were identified as cereals in 2009 (11,200 ha). The area of land that changed from grassland to trees was similar to what changed to cereals (9,073 ha). (b) 245 ha of land identified as grasslands in 1993/94 were identified as potatoes in 2009. This area is isolated in a region to the northwest of Carberry. Potato production has been identified and confirmed in this region through local knowledge. **Forested Areas land cover change from 1994** (a) Approximately 1,200 ha previously identified as forested were identified as either cereals (approximately 800 ha) or canola/rapeseed (approximately 400 ha) in 2009. Much of the converted forest area identified was dispersed throughout the watershed as small fragments. (b) Total area of land identified as being in potato production in 2009 was less than 60 ha. **Assiniboine Delta Aquifer (ADA) Security** **ADA/Equivalent Agri- Environmental Farm Plan – Report listed** (Any updates should be consulted with the Department of Water Stewardship.) (a) Water License Allocations- As of May 1st, 2005, allocations for the Whitemud Subbasin of the Assiniboine Delta Aquifer were at 6,667 acre-feet/year. The Upper Whitemud West, East, and Pine Creek North are fully or nearly fully allocated. (b) Water Quality- 80% of the wells monitored over the Assiniboine Delta Aquifer had nitrate concentration below the Canadian Drinking Water Quality Guidelines (of 2000) (c) Projected Water Demands- projected Domestic/Municipal water demands over the aquifer will increase to 3,500 acre-feet/year, based on a population increase to its communities of 15 % growth.	**Analysis is limited in providing any assessment of the threat on watershed health (wind erosion, wildlife habitat or aquifer security) from land clearing to support irrigation. This analysis was completed on a broad watershed perspective, and recommendations should be further examined at a site specific level.** **Communication/Education Strategies –** (a) Present technical findings from previous plans to stakeholders that examine the issues surrounding watershed health (ADA Plan, Assiniboine Delta EAEP, etc.). (b) Continual education of annual findings from monitoring programs to watershed stakeholders. (c) Continue to encourage producers to develop or update environmental farm plans. **ADA Strategies-** (a) Link IWMP issues identified for irrigation to the ADA Goals and Activities. (b) Initiate the review of the ADA report card to be completed every 5 years (c) Use the ADA committee meetings as the strategic communication link for watershed irrigation issues. (d) Ensure ADA membership includes representation from various levels of government. **CD Leadership Strategies -** (a) Serve as liaison to landscape needs and provincial/federal regulations. (b) Examine opportunities for partnerships with various government and non government agencies. (c) Target BMPs for the IWMP directives on a landscape approach. (d) Investigate collaboration opportunities between government and NGOs for new BMP technology.	Areas in the watershed that are: • in close proximity to ADA and Spruce Woods Provincial Park • Annually-cropped lands of class 4 and lower Areas within and immediately surrounding the ADA Areas throughout the IWMP study Area	Number of educational initiatives presented Number of Environmental Farm Plans Updated An IWMP implementation strategy for the IWMP that is synchronized to the directives found in the ADA Plan Strong Attendance to ADA meetings by all groups Number of Partnerships that support the IWMP plan and assist with deliverables Number of action items identified in the IWMP plan that have been completed through targeting of BMPs

* Specific approaches and opportunities related to recommended actions, including potential target areas and indicators; need to be explored further by the Project Management Team. Potential collaboration with partners and stakeholders should be considered Specific recommendations from the IWMP process must be forwarded to local councils for consideration within the Development Plan. These recommendations should take agricultural land management into consideration, for preservation of existing farm land and operations.

Watershed Issue	Analysis	Recommended Actions*	Target Areas*	Potential Indicators*
The Big Grass Marsh Community Pasture floods following heavy rain events, resulting in cattle in the water. Are there any alternative plans for this community pasture?	**Crown Lands and AESB Community Pasture Program – (Section G, Pages 69- 77)** 1. The vast majority (51,070 ha) of crown land in the watershed is classified as having some sort of agricultural use (lease, yearly permits, or Community Pasture). Land available for agricultural use through the Agricultural Crown Land leasing and permitting program makes up about 36% this area (**Table 13, Figure 43**). 2. Approximately 25% of crown land within the watershed can be found in the Rural Municipality of Lakeview. Most of this land occurs within the Lakeview AESB Community Pasture. 3. The majority (89%) of crown lands within the watershed have marginal to poor agricultural capabilities at Class 4 or lower. The majority of organic soils are located near Jackfish Lake in the Westbourne AESB Community Pasture (**Table 15**, **Figure 44)**. 4. There was an overall loss of 7,862 ha of grassland to tree encroachment on crown lands. Encroachment occurred on most types of Crown Land, but was concentrated in the AESB Community Pastures (including Big Grass Marsh), as well as leased land in the northeast corner of the watershed **(Table 16, Figure 33**). **AESB Community Pasture Management Strategy for flooding** • The Westbourne Community Pasture has experienced heavy flooding and a significant portion of the north end has been permanently under water for the last six years. • Stocking rate adjustments have been made based on pasture carrying capacity, and have been applied in the Westbourne Community Pasture in response to the flooded lands (from 1,200 head of cow/calf pairs to 800). • Livestock were also delayed entry in Westbourne Community Pasture until late June in 2009 and 2010 (later than the normal dates of the fourth week of May for other pastures) to allow spring runoff events to dissipate. • In 2005, significant flooding occurred to the Westbourne Community Pasture. Pasture management were able to move livestock to neighbouring Community Pastures. • Cross Fencing was also implemented in Westbourne to provide more sustainable pasture management control of the livestock from the flooded areas. • The RM's of Langford and Landsdowne recently had their respective lands within the Langford Community Pasture protected through a Conservation Agreement with MHHC. **Bioinventory/Utilization/Rangeland Assessments** • In 2000, a Biodiversity Inventory was completed for the Lakeview and Westbourne Community Pastures. Overall, 250 plant species and 81bird species were documented during the study period in both pastures. Of these, ten vascular plant species and eight bird species that are rare to uncommon for the province were recorded. • The Westbourne Community Pasture has had Rangeland Condition Assessments completed in 1997, 2000, and 2001 (unpublished). Reports indicate that the overall condition of the pasture was good. • Utilization Strategies were completed in 2001 for the Westbourne Community Pasture (unpublished) and are reviewed on an annual basis.	**Maintaining and improvement of Crown Lands -** Through mechanical or chemical control of woody species to stabilize and enhance local forage production for cow/calf producers in Whitemud watershed. **Management of Environmentally Sensitive Lands -** Explore options to utilize Big Grass Marsh Community Pasture for demonstration projects or extension activities for BMPS related to priority IWMP issues (surface water management, water quality, and/or wildlife habitat). These options would further the goals of the IWMP while at the same time supporting the mandate of the Community Pasture Program. **Pasture Condition Assessments – Utilization Strategies-** Assessment that includes stocking rates, Cattle Distribution, Control Grazing, and Entry/removal timelines. **Rangeland Assessment** – Examination of the flora found on the pasture, as well as its condition, under grazing conditions **Biodiversity Assessment**- Examination of the flora, fauna, and species at risk found in the pasture under grazing conditions **Pasture Management Flooding Strategies**- Stocking Rate Adjustments, delayed entry to allow flood water to dissipate, and adaptive grazing strategies in conjunction with other AESB pasture management Strategies	Crown Lands under lease in watershed Big Grass Marsh Community Pasture and other wetlands or perennial cover (forest, grassland or pasture) near class 4 or lower land Big Grass Marsh Community Pasture	Healthier ecosystems within the Crown Lands measured through land assessments Successful two way extension activities between the watershed stakeholders and Community Pasture Increased Species composition (Flora and Fauna) Surface Water Quality Results Downstream on the Big Grass Marsh Drain

* Specific approaches and opportunities related to recommended actions, including potential target areas and indicators; need to be explored further by the Project Management Team. Potential collaboration with partners and stakeholders should be considered Specific recommendations from the IWMP process must be forwarded to local councils for consideration within the Development Plan. These recommendations should take agricultural land management into consideration, for preservation of existing farm land and operations.

I. References

Agriculture and Agri-Food Canada. 2003-2008. *BMP Fact Sheets*, Canada-Manitoba Farm Stewardship Program

Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration, *Historical Perspective of Precipitation on the Prairies*. Agriculture and Agri-Food Canada – Prairie Farm Rehabilitation Administration, Regina, Saskatchewan. www.agr.gc.ca/pfra/drought/drhistprecip_e.htm

Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration, Prairies East Region. 2005. *Summary of Resources and Land Use Issues Related to Riparian Areas in the Whitemud River*. Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration, Winnipeg.

Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration, Prairies East Region. 2006. Assiniboine Delta Aquifer: Equivalent Agri-Environmental Plan (EAEP) Issue Scan. Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration & Manitoba Agriculture Food and Rural Initiatives.

Assiniboine Delta Aquifer Committee, 2005. *Assiniboine Delta Aquifer Management Plan: planning for the Future of the Assiniboine Delta Aquifer.* Department of, Water Stewardship, Winnipeg Manitoba.

Association of Irrigators in Manitoba. 2007. *2006 Manitoba Irrigation Survey*.

Coote, Eilers & Langman. 1989. *Agriculture Canada Wind Erosion Risk Maps*

Eilers, R.G., G.W. Lelyk, P. Cyer, and W.R. Fraser. *Status of Agricultural Soil Resources of Manitoba; Summary of Applications and Interpretations of RMSID, (Rural Municipality Soil Information Data Base).*

Environment Canada, *Canadian Climate Normals or Averages 1971-2000*, http://www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html

Jones, R. E., Mansell, T.L., Newman, K. E. 2000. *Biodiversity Inventory of the Lakeview and Westbourne Community Pastures*. Manitoba Conservation, Winnipeg.

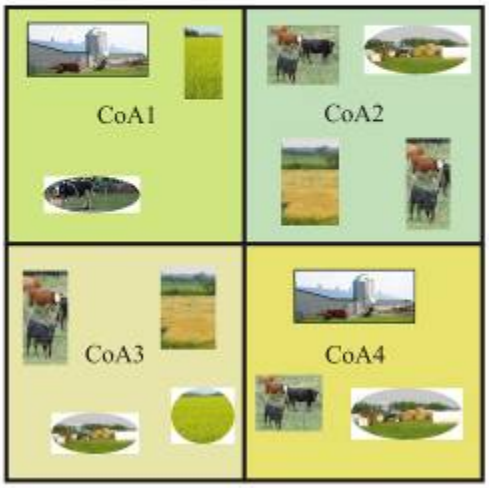
Manitoba Conservation. 2001, 2006. *Land Use/Land Cover Descriptions*. Geomatics and Remote Sensing Branch

J. Appendices

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

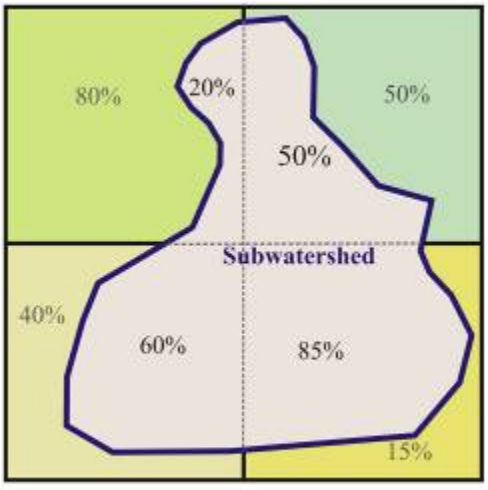
Basic concept of interpolating Census of Agriculture (CoA) using the area weighting method*

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 B: Animal Unit Calculations

Summary of Animal Unit coefficients used in Manitoba as compared to those used for calculations in this report[1]

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

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

Summary of assumptions made in calculating Animal Units1 from 2006 Agricultural Census Data

Livestock	Manitoba Animal Unit Category	Census Category	Assumptions Used for Animal Unit Calculations with census data
Dairy	Milking cows (including associated livestock)	Dairy cows	Assumed categories are equal.
Beef	Beef cows	Beef cows	Assumed number of beef cows reported in 2006 Census equal cow/calf pairs
	Backgrounder Summer pasture Feedlot cattle	Heifers and steers for slaughter or feeding 1 yr and older (combined categories)	Assumed steers and heifers reported in these census categories are split into the three categories (communication with MAFRI). Animal unit coefficient determined using this ratio.
Pigs	Sows, farrow–to-weanling	Sows	Assumed there are no farrow-to-finish operations and no weanling operations in Manitoba – only farrow-to-weanling and grower/finisher operations.
	Grower/finishers	Grower and finisher pigs	
	Boars (artificial insemination operations)	Boars	Assumed all boars reported in the 2006 Census are from artificial inseminations.
Chickens	Broilers	Broilers and roasters	Assumed all birds reported in the census category are broilers (communication with MAFRI).
	Layers	Laying hens (19 weeks and older)	Assumed categories are equal.
	Pullets	Pullets (under 19 weeks)	Assumed categories are equal.
	Broiler breeding hens	Laying hens in hatcheries	Assumed all laying hens in hatchery supply flocks reported in Manitoba are broiler breeder hens.
Turkeys	Broiler, Heavy Toms, Heavy Hens	Turkeys	Assumed "turkeys" represents 20% boilers, 40% heavy toms, 40% heavy hens (communication with MAFRI). Animal unit coefficient is determined using this ratio.
Sheep	Ewes, including associated livestock	Ewes	Assumed ewe/lamb pairs (communication with MAFRI).
	Feeder lambs	Lambs	Assumed categories are equal.
Horses	Horses	Total horses and ponies	Assumed each animal produces 1 Animal Unit – PMU farms not identified in Census (communication with MAFRI).
Bison	Bison	Bison	Assumed adults represent 85% and calves represent 15% of bison population in Manitoba (communication with MAFRI). Animal unit coefficient is determined using this ratio.
Elk	Elk	Elk	Number of calves and sex of animals not identified in Census – assumed 45% cows, 35% bulls and 20% calves (communication with MAFRI). Animal unit coefficient is determined using this ratio.
Goats	Goats	Goats	Number of kids and sex of animals not identified in Census – assumed 7 goats make up one Animal Unit, irregardless of age and sex.

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

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

For the IWMP study area, imagery was available for the years of 1993/94, 2000/2001, and most recently, 2006. 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 1993/94 land cover used satellite imagery that was captured on May 5, 1993, May 26, 1993, and October 26, 1994. Imagery for the 2000/2001 land cover data was taken May 18, 2000 and September 3, 2001. The 2006 land cover data utilized satellite imagery that was captured on August 15, 2006.

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:

- Classification effort - the 1994 image classification concentrated specifically on annual cropland to aid in delivery of the Western Grains Transportation Payment Program. Greater attention was paid to all classification categories on the 2000 image classification.

The classification of forages and 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.

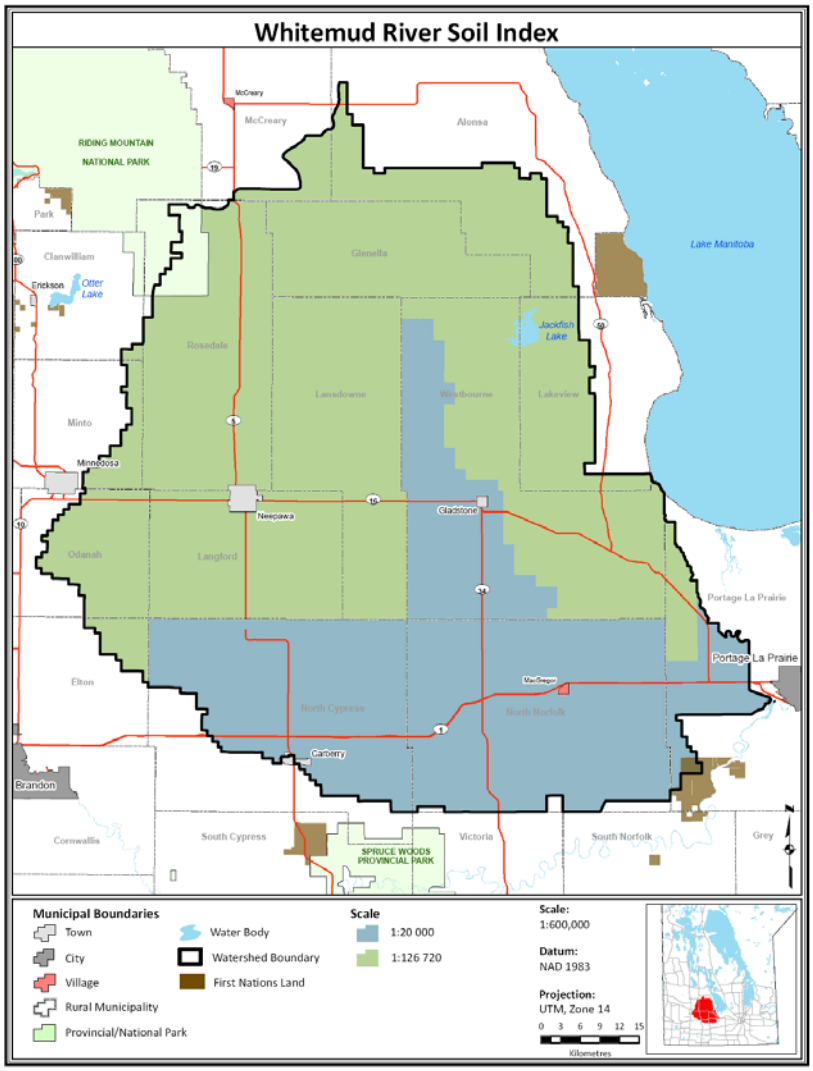
Classification Scheme: Land Cover Mapping of Manitoba	
1. Annual crop land:	Land that is normally cultivated on an annual basis.
2. Forage:	Perennial forages, generally alfalfa or clover with blends of tame grasses.
3. Grassland:	Areas of native or tame grasses, may contain scattered stands of trees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

Appendix D: Soil Information and Background

Soils data within the watershed can be used to provide information on various soil characteristics as well as interpretative ratings such as agriculture capability, water and wind erosion risk. Used in conjunction with the land cover data from 1993/94-2006, observations about temporal land use trends can be made and used to explain any changes in land management practices.

Soils data within Manitoba have been mapped at different scales of accuracy. In the Whitemud River study area, soils were surveyed at a reconnaissance scale of 1:20,000 and 1:126,720 (see figure on following page).

Reconnaissance soils data is more suitable for broader landscape based analysis and regional planning purposes. This information is not suitable for the development of municipal development plans/zoning by-laws, agronomic assessment for irrigation and other site specific land use activities. Analysis of this nature requires more detailed soils information for assessments and management considerations. Soil information provided in this report is based on the characteristics of the dominant soil series within the various soils polygons.



Appendix E: Canada Land Inventory System Land Classes

Agricultural Capability for Manitoba

Agriculture capability is a 7 class rating of mineral soils based on the severity of limitations for dryland farming. This system does not rate the productivity of the soil, but rather its capability to sustain agricultural crops based on limitations due to soil properties and landscape features and climate. This system is usually applied on a soil polygon basis and the individual soil series are assessed and maps portray the condition represented by the dominant soil in the polygon. Class 1 soils have no limitations, whereas Class 7 soils have such severe limitations that they are not suitable for agricultural purposes. In general, it takes about 2 acres (0.8 hectares) of Class 4 land to equal production from 1 acre (0.4 hectares) of prime (Class 1) land. (From *Land: The Threatened Resource*).

Class 1: Soils in this class have no important limitations for crop use. The soils have level to nearly level topography; they are deep, well to imperfectly drained and have moderate water holding capacity. The soils are naturally well supplied with plant nutrients, easily maintained in good tilth and fertility; soils are moderately high to high in productivity for a wide range of cereal and special crops (field crops).

Class 2: Soils in this class have moderate limitations that reduce the choice of crops or require moderate conservation practices. The soils have good water holding capacity and are either naturally well supplied with plant nutrients or are highly responsive to inputs of fertilizer. They are moderate to high in productivity for a fairly wide range of field crops. The limitations are not severe and good soil management and cropping practices can be applied without serious difficulty.

Class 3: Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The limitations in Class 3 are more severe than those in Class 2 and conservation practices are more difficult to apply and maintain. The limitations affect the timing and ease of tillage, planting and harvesting, the choice of crops and maintenance of conservation practices. Under good management, these soils are fair to moderate in productivity for a fairly wide range of field crops.

Class 4: Soils in this class have significant limitations that restrict the choice of crops or require special conservation practices or both. These soils have such limitations that they are only suited for a few field crops, the yield for a range of crops may be low or the risk of crop failure is high. These soils are low to moderate in productivity for a narrow range of field crops but may have higher productivity for a specially adapted crop or perennial forage.

Class 5: Soils in this class have severe limitations that restrict their capability to producing perennial forage crops and improvement practices are feasible. These soils have such serious

soil, climatic or other limitations that they are not capable of use for sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame species of perennial forage plants.

Class 6: Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible. Class 6 soils have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic or other limitations as to make impractical the application of improvement practices that can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents the use of farm machinery or because the soils are not responsive to improvement practices.

Class 7: Soils in this class have no capability for arable culture or permanent pasture because of extremely severe limitations. Bodies of water too small to delineate on the map are included in this class. These soils may or may not have a high capability for forestry, wildlife and recreation.

Agriculture capability subclasses identify the soil properties or landscape conditions that may limit use. A capital letter immediately following the class number identifies the limitation (eg. 2W, 3N, etc.).

Subclasses:
C - adverse climate (outside the boundaries of agro-Manitoba)
D - undesirable soil structure and/or low permeability
E - erosion damage
I - inundation (flooding) by streams and lakes
M - moisture (droughtiness) or low water holding capacity
N - salinity
P - stoniness
R - consolidated bedrock
T - topography (slopes)
W - excess water other than flooding (inadequate soil drainage or high water table)
X - two or more minor limitations

Appendix F: Water Erosion Risk

Water erosion information is available as part of the provincial soil survey data that has been compiled from reconnaissance (1:126,720 scale) and detailed (1:40,000 & 1:20,000 scale) soil survey reports. The Universal Soil Loss Equation (USLE) that was developed by Wischmeier and Smith (1965) was used to provide information on water erosion as part of the provincial soils data. The USLE provides a quantitative estimate on the amount of soil that is displaced due to water erosion (either tonne/ha or ton/ac) on an annual basis due to soil, climatic, landscape and management factors that influence the rate of erosion. The USLE can be written as:

A = RKLSCP

Where:

A = Predicted water erosion rate
R = Erosivity of rainfall and snowmelt factor
K = Soil erodibility factor
L = Slope length factor
S = Slope steepness factor
C = Crop cover and management factor (set at 1.0 - assuming bare, unprotected soil)
P = Conservation practice factor (set at 1.0 - assuming no conservation practices)

Due to limitations that are inherent in the model, the lack of the inclusion of conservation management practices and crop cover factors, the numbers that are generated from the USLE should not be used as a value for actual soil loss due to water erosion. However, the USLE is useful in comparing water erosion risk between soils based on their soil/landscape properties and climatic conditions. To accomplish this, the computed USLE values have been compiled into the following 5 group risk classes:

N = Negligible	< 2.7 ton/ac/yr (< 6 tonne/ha)
L = Low	2.7 – 4.9 ton/ac/yr (6 – 11 tonne/ha)
M = Moderate	4.9 – 9.8 ton/ac/yr (11 – 22 tonne/ha)
H = High	9.8 – 14.7 ton/ac/yr (22 – 33 tonne/ha)
S = Severe	> 14.7 ton/ac/yr (> 33 tonne/ha)

By using the risk class groupings, soils can be compared on the basis of their soil physical properties, landscape and climate for resource analysis and targeting of soil conservation programming.

Appendix G: 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 H: Soil Drainage Classes*

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 I: 2006 Census of Agriculture data

Table 1: Agricultural Land Use area (hectares) reported in the 2006 Census of Agriculture

Subwatershed	Total Farmland	Total Cropland*	Summerfallow	Pasture**	Other***
Big Grass	252,461	140,262	3,868	85,337	22,994
Escarpment	196,779	116,183	1,426	62,986	16,185
West Creeks	92,071	62,234	2,410	15,917	11,510
Rat Creek	77,753	61,380	462	11,620	4,290

* Total cropland includes all field crops, forages, 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.

Table 2: Distribution of crop types (area in hectares) as reported in the 2006 Census of Agriculture*

Subwatershed	Cereals	Oilseeds	Pulses	Potatoes	Forage for hay	Forage for seed	Other**
Big Grass	68,248	31,737	2,758	1,235	34,692	917	301
Escarpment	59,233	25,269	2,555	5,586	22,102	617	0
West Creeks	32,516	18,615	370	863	8,722	299	92
Rat Creek	30,807	10,875	11,480	2,388	6,796	294	385

* Some data has been suppressed by Statistics Canada to preserve confidentiality of the data
** Other category includes other special field crops, fruits and nuts, sod, vegetables, and all suppressed hectares in the listed categories

Table 3: Total area (hectares) treated with crop inputs for the 2005 cropping year, as reported in the 2006 Census of Agriculture

Subwatershed	Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides	Use of Fungicides
Big Grass	106,912	89,050	10,366	18,045
Escarpment	96,867	85,148	16,391	26,916
West Creeks	52,749	50,099	6,917	17,402
Rat Creek	52,097	47,033	8,068	18,597

Table 4: Total dollars spent on crop inputs for the 2005 cropping year, as reported in the 2006 Census of Agriculture

Subwatershed	Total crop expenses	Total fertilizer and lime	Total herbicides, insecticides, & fungicides	Total seed
Big Grass	$23,311,118	$11,820,665	$6,812,246	$4,678,207
Escarpment	$23,928,278	$11,605,177	$7,628,274	$4,694,827
West Creeks	$11,225,405	$5,458,388	$3,837,458	$1,929,558
Rat Creek	$13,968,275	$6,000,735	$4,428,288	$3,539,252

Table 5: Tillage practices on areas prepared for seeding as reporting as a percentage of total cultivated land, as reported in the 2006 Census of Agriculture

Subwatershed	Tillage incorporating most crop residue into the soil	Tillage retaining most crop residue on the surface	No-till or zero-till seeding
Big Grass	50%	41%	10%
Escarpment	45%	42%	13%
West Creeks	28%	50%	22%
Rat Creek	45%	44%	10%

Table 6: Total number of livestock and poultry on Census Day in 2006, as reported in the 2006 Census of Agriculture*

Subwatershed	Total cattle	Beef cows	Dairy cows	Total pigs	Sows	Total poultry
Big Grass	63,520	28,098	373	76,991	6,964	156,991
Escarpment	52,843	21,095	415	43,850	3,537	225,740
West Creeks	16,710	7,247	0	10,550	1,903	87,905
Rat Creek	15,963	6,762	111	19,697	0	76,784

* Some data has been suppressed by Statistics Canada to preserve confidentiality

Table 7: Total number farms reporting livestock and poultry on Census Day in 2006, as reported in the 2006 Census of Agriculture

Subwatershed	Total cattle	Beef Cows	Dairy cows	Total pigs	Sows	Total poultry
Big Grass	370	351	15	37	19	37
Escarpment	335	318	14	20	9	40
West Creeks	132	122	4	10	6	9
Rat Creek	111	106	6	12	3	15

Table 8: Average number of livestock animals or poultry birds per farm on Census Day in 2006, as reported in the 2006 Census of Agriculture*

Subwatershed	Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Big Grass	172	80	24	2,094	369	4,272
Escarpment	158	66	30	2,197	397	5,610
West Creeks	127	59	0	1,030	310	9,263
Rat Creek	144	64	20	1,674	0	5,234

* Some data has been suppressed by Statistics Canada to preserve confidentiality

Table 9: Summary of farm financial characteristics in 2005, as reported in the 2006 Census of Agriculture

Subwatershed	Number of farms	Average farm size (ha)	Average capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)	Average crop-related expenses ($/ha cropland and summerfallow)	Estimated profit ($/farm)
Big Grass	548	461	$881,684	$73	$162	$28,398
Escarpment	494	398	$968,387	$91	$203	$31,408
West Creeks	257	359	$875,192	$106	$174	$19,366
Rat Creek	221	351	$1,169,379	$67	$226	$26,263

Appendix J: 2001 Census of Agriculture data

Table 1: Agricultural Land Use area (hectares) reported in the 2001 Census of Agriculture

Subwatershed	Total Farmland	Total Cropland*	Summerfallow	Pasture**	Other***
Big Grass	253,716	147,055	11,133	78,488	17,041
Escarpment	189,220	114,499	4,349	55,727	14,645
West Creeks	105,973	70,295	3,089	22,876	9,713
Rat Creek	81,190	64,968	1,992	10,510	3,720

* Total cropland includes all field crops, forages, 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.

Table 2: Distribution of crop types (area in hectares) as reported in the 2001 Census of Agriculture*

Subwatershed	Cereals	Oilseeds	Pulses	Potatoes	Forage for hay	Forage for seed	Other**
Big Grass	76,693	28,794	3,298	509	34,655	260	0
Escarpment	64,139	21,339	1,606	5,417	20,689	407	222
West Creeks	39,216	19,125	829	1,858	8,170	84	255
Rat Creek	35,612	10,503	8,317	3,391	6,454	415	287

* Some data has been suppressed by Statistics Canada to preserve confidentiality of the data
**Other category includes other special field crops, fruits and nuts, sod, vegetables, and all suppressed hectares in the listed categories

Table 3: Total area (hectares) treated with crop inputs for the 2000 cropping year, as reported in the 2001 Census of Agriculture

Subwatershed	Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides	Use of Fungicides
Big Grass	108,882	104,826	12,834	20,509
Escarpment	81,760	86,991	15,761	20,842
West Creeks	58,887	60,003	8,890	17,974
Rat Creek	55,865	55,991	11,881	18,278

Table 4: Total dollars spent on crop inputs for the 2000 cropping year, as reported in the 2001 Census of Agriculture

Subwatershed	Total crop expenses	Total fertilizer and lime	Total herbicides, insecticides, & fungicides	Total seed
Big Grass	$19,558,405	$9,679,628	$6,589,371	$3,289,407
Escarpment	$20,152,808	$9,153,893	$7,032,654	$3,966,261
West Creeks	$11,305,976	$5,079,561	$4,345,854	$1,880,561
Rat Creek	$14,365,057	$5,648,094	$5,186,429	$3,530,534

Table 5: Tillage practices on areas prepared for seeding as reporting as a percentage of total cultivated land, as reported in the 2001 Census of Agriculture

Subwatershed	Tillage incorporating most crop residue into the soil	Tillage retaining most crop residue on the surface	No-till or zero-till seeding
Big Grass	59%	35%	6%
Escarpment	57%	38%	5%
West Creeks	34%	51%	15%
Rat Creek	68%	25%	7%

Table 6: Total number of livestock and poultry on Census Day in 2001, as reported in the 2001 Census of Agriculture*

Subwatershed	Total cattle	Beef cows	Dairy cows	Total pigs	Sows	Total poultry
Big Grass	58,427	24,577	431	67,895	7,604	125,643
Escarpment	47,838	17,660	383	53,998	5,574	224,446
West Creeks	16,584	7,385	43	15,916	875	219,892
Rat Creek	12,490	4,817	130	27,650	1,569	74,668

* Some data has been suppressed by Statistics Canada to preserve confidentiality

Table 7: Total number farms reporting livestock and poultry on Census Day in 2001, as reported in the 2001 Census of Agriculture

Subwatershed	Total cattle	Beef Cows	Dairy cows	Total pigs	Sows	Total poultry
Big Grass	435	406	18	66	40	38
Escarpment	391	355	15	43	25	61
West Creeks	150	136	4	20	9	14
Rat Creek	121	107	8	14	5	16

Table 8: Average number of livestock animals or poultry birds per farm on Census Day in 2001, as reported in the 2001 Census of Agriculture*

Subwatershed	Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Big Grass	134	61	24	1,027	189	3,342
Escarpment	123	50	26	1,259	224	3,661
West Creeks	110	54	11	812	97	16,288
Rat Creek	104	45	16	1,961	320	4,609

* Some data has been suppressed by Statistics Canada to preserve confidentiality

Table 9: Summary of farm financial characteristics in 2000, as reported in the 2001 Census of Agriculture

Subwatershed	Number of farms	Average farm size (ha)	Average capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)	Average crop-related expenses ($/ha cropland and summerfallow)	Estimated profit ($/farm)
Big Grass	628	404	$746,795	$95	$124	$23,426
Escarpment	570	332	$824,927	$124	$170	$22,991
West Creeks	278	381	$790,157	$76	$154	$14,875
Rat Creek	252	323	$869,026	$82	$215	$29,679

Appendix K: 1996 Census of Agriculture data

Table 1: Agricultural Land Use area (hectares) reported in the 1996 Census of Agriculture (hectares)

Subwatershed	Total Farmland	Total Cropland*	Summerfallow	Pasture**	Other***
Big Grass	257,533	147,786	10,742	77,980	21,024
Escarpment	183,155	109,088	4,495	53,489	16,083
West Creeks	106,841	68,850	4,356	21,543	12,093
Rat Creek	81,963	62,772	3,153	10,748	5,290

* Total cropland includes all field crops, forages, 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.

Table 2: Distribution of crop types (area in hectares) as reported in the 1996 Census of Agriculture*

Subwatershed	Cereals	Oilseeds	Pulses	Potatoes	Forage for hay	Forage for seed	Other**
Big Grass	85,605	25,047	938	451	31,067	0	0
Escarpment	61,821	17,929	639	4,661	21,144	35	0
West Creeks	41,107	16,676	481	1,481	7,843	0	0
Rat Creek	39,206	12,872	1,315	2,985	6,133	0	0

* Some data has been suppressed by Statistics Canada to preserve confidentiality of the data
** Other category includes other special field crops, fruits and nuts, sod, vegetables, and all suppressed hectares in the listed categories

Table 3: Total area (hectares) treated with crop inputs for the 1995 cropping year, as reported in the 1996 Census of Agriculture

Subwatershed	Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides	Use of Fungicides
Big Grass	121,261	103,741	15,636	14,023
Escarpment	86,652	73,509	11,634	9,949
West Creeks	61,300	57,558	8,223	8,607
Rat Creek	58,026	51,544	12,151	9,439

Table 4: Total dollars spent on crop inputs for the 1995 cropping year, as reported in the 1996 Census of Agriculture

Subwatershed	Total crop expenses	Total fertilizer and lime	Total herbicides, insecticides, & fungicides	Total seed
Big Grass	$17,493,677	$9,441,085	$5,489,640	$2,562,953
Escarpment	$14,630,744	$7,711,840	$4,539,360	$2,379,544
West Creeks	$9,698,596	$5,143,381	$3,258,813	$1,296,402
Rat Creek	$11,760,717	$5,644,297	$4,041,614	$2,074,807

Table 5: Tillage practices on areas prepared for seeding as reporting as a percentage of total cultivated land, as reported in the 1996 Census of Agriculture

Subwatershed	Tillage incorporating most crop residue into the soil	Tillage retaining most crop residue on the surface	No-till or zero-till seeding
Big Grass	69%	28%	3%
Escarpment	64%	30%	6%
West Creeks	50%	39%	12%
Rat Creek	64%	27%	8%

Table 6: Total number of livestock and poultry on Census Day in 1996, as reported in the 1996 Census of Agriculture

Subwatershed	Total cattle	Beef cows	Dairy cows	Total pigs	Sows	Total poultry
Big Grass	56,388	22,389	1,393	54,556	5,300	93,217
Escarpment	42,937	14,819	1,044	46,378	4,068	331,251
West Creeks	15,799	6,308	451	13,824	1,162	73,798
Rat Creek	12,290	4,360	569	13,546	1,552	71,543

Table 7: Total number farms reporting livestock and poultry on Census Day in 1996, as reported in the 1996 Census of Agriculture

Subwatershed	Total cattle	Beef Cows	Dairy cows	Total pigs	Sows	Total poultry
Big Grass	466	415	49	69	38	52
Escarpment	400	352	42	54	24	53
West Creeks	184	160	10	24	13	17
Rat Creek	146	123	21	19	10	17

Table 8: Average number of livestock animals or poultry birds per farm on Census Day in 1996, as reported in the 1996 Census of Agriculture

Subwatershed	Total cattle	Beef cows	Dairy cows	Total Pigs	Sows	Total Poultry
Big Grass	121	54	28	792	140	1,798
Escarpment	107	42	25	866	172	6,258
West Creeks	86	40	44	574	91	4,222
Rat Creek	84	35	27	729	158	4,281

Table 9: Summary of farm financial characteristics in 1995, as reported in the 1996 Census of Agriculture

Subwatershed	Number of farms	Average farm size (ha)	Average capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)*	Average crop-related expenses ($/ha cropland and summerfallow)*	Estimated profit ($/farm)
Big Grass	669	385	$511,652	$87	$110	$25,347
Escarpment	607	302	$526,128	$108	$129	$28,551
West Creeks	329	325	$497,239	$67	$132	$24,698
Rat Creek	277	296	$628,937	$58	$178	$35,508

Appendix L: 1991 Census of Agriculture data

Table 1: Agricultural Land Use area (hectares) reported in the 1991 Census of Agriculture

Subwatershed	Total Farmland	Total Cropland*	Summerfallow	Pasture	Other***
Big Grass	274,461	158,048	9,132	92,051	15,230
Escarpment	185,589	114,420	4,093	53,388	13,689
West Creeks	104,762	70,214	4,775	20,394	9,379
Rat Creek	79,858	61,038	1,289	10,442	7,088

* Total cropland includes all field crops, forages, 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.

Table 2: Distribution of crop types (area in hectares) as reported in the 1991 Census of Agriculture*

Subwatershed	Cereals	Oilseeds	Pulses	Potatoes	Forage for hay	Forage for seed	Other**
Big Grass	90,790	24,331	616	323	32,129	105	0
Escarpment	65,639	19,080	584	2,891	19,673	38	0
West Creeks	46,190	13,682	286	824	7,025	0	0
Rat Creek	39,101	11,671	1,334	1,898	4,795	0	0

* Some data has been suppressed by Statistics Canada to preserve confidentiality of the data
** Other category includes other special field crops, fruits and nuts, sod, vegetables, and all suppressed hectares in the listed categories

Table 3: Total area (hectares) treated with crop inputs for the 1990 cropping year, as reported in the 1991 Census of Agriculture

Subwatershed	Use of commercial Fertilizers	Use of Herbicides
Big Grass	114,617	96,329
Escarpment	86,555	77,305
West Creeks	60,086	56,163
Rat Creek	50,572	45,396

Table 4: Total dollars spent on crop inputs for the 1990 cropping year, as reported in the 1991 Census of Agriculture

Subwatershed	Total crop expenses	Total fertilizer and lime	Total herbicides, insecticides, & fungicides	Total seed
Big Grass	$10,237,950	$5,311,546	$3,034,403	$1,892,001
Escarpment	$9,003,504	$4,736,612	$2,585,669	$1,681,223
West Creeks	$5,481,111	$2,902,197	$1,826,989	$751,925
Rat Creek	$6,596,754	$3,206,989	$1,959,033	$1,430,731

Table 5: Tillage practices on areas prepared for seeding as reporting as a percentage of total cultivated land, as reported in the 1991 Census of Agriculture

Subwatershed	Tillage incorporating most crop residue into the soil	Tillage retaining most crop residue on the surface	No-till or zero-till seeding
Big Grass	67%	30%	3%
Escarpment	67%	30%	3%
West Creeks	60%	36%	4%
Rat Creek	69%	28%	3%

Table 6: Total number of livestock and poultry on Census Day in 1991, as reported in the 1991 Census of Agriculture

Subwatershed	Total cattle	Beef cows	Dairy cows	Total pigs	Sows	Total poultry
Big Grass	49,175	18,632	1,294	53,653	4,706	114,922
Escarpment	33,113	11,768	1,058	43,904	4,518	163,281
West Creeks	12,482	4,636	367	7,188	598	49,922
Rat Creek	9,556	3,382	590	13,323	1,426	69,224

Table 7: Total number farms reporting livestock and poultry on Census Day in 1991, as reported in the 1991 Census of Agriculture

Subwatershed	Total cattle	Beef Cows	Dairy cows	Total pigs	Sows	Total poultry
Big Grass	481	424	74	106	60	108
Escarpment	416	357	65	91	48	102
West Creeks	172	150	21	40	16	39
Rat Creek	143	111	30	32	22	41

Table 8: Average number of livestock animals or poultry birds per farm on Census Day in 1991, as reported in the 1991 Census of Agriculture

Subwatershed	Total cattle	Beef Cows	Dairy cows	Total Pigs	Sows	Total Poultry
Big Grass	102	44	18	509	78	1,065
Escarpment	80	33	16	485	93	1,604
West Creeks	73	31	18	179	37	1,281
Rat Creek	67	30	19	421	64	1,695

Table 9: Summary of farm financial characteristics for the 1990, as reported in the 1991 Census of Agriculture

Subwatershed	Number of farms	Average farm size (ha)	Average capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)	Average crop-related expenses ($/ha cropland and summerfallow)	Estimated profit ($/farm)
Big Grass	739	371	$398,839	$53	$61	$13,402
Escarpment	636	292	$385,310	$60	$76	$14,703
West Creeks	330	318	$381,473	$79	$73	$16,290
Rat Creek	285	280	$452,933	$49	$106	$22,770

Appendix M: Private and Crown Land Planning in the Whitemud River Watershed

Overview
The Provincial Land Use Policies (PLUPs) outline Agriculture's interests of both private and crown land that is used for agriculture by maintaining this land as viable agricultural land, minimizing subdivision, and protecting farms from encroachment or other uses which may be incompatible with normal farming operations.

Policy #1 of the Provincial Land Use Policies Regulation deals with General Development while Policy #2 deals with Agriculture. The objectives of policy #2 are to maintain a viable base of agricultural lands for present and future food production and agricultural diversification, and to protect economically viable agricultural operations.

Provincial Land Use Policies
These policies guide local and provincial authorities in preparing Development Plans and in making land use decisions. The PLUPS cover nine broad policy areas, of which Agriculture is one component. The other areas, besides agriculture, are General Development, Renewable Resources, Water and Shoreline, Recreational Resources, Natural Features and Heritage Resources, Flooding and Erosion, Provincial Highways, and Mineral Resources. The various government departments "own" their policies and are involved in establishing them.

Development Plans
The Development Plan is the agreement between the local and provincial governments on matters concerning land use. Once in place, all proposed development and land use changes must be evaluated under the policies of the development plan. This is where the policies governing the protection of prime agricultural land and agricultural operations are set out.
The Provincial Land Use Policies are applied at the local level through the Development Plans, initiated by a municipality or planning district (group of municipalities). The purpose is to set out land use objectives and patterns or characteristics of development for an area. Through the Development Plan, lands are designated for certain uses such as agriculture, agriculture restricted, residential, industrial or commercial.

Zoning By-Laws
Regulating the Use of the Land: Following the approval of a development plan, a municipality must enact a zoning by-law that is consistent with their development plan. A municipal zoning by-law contains the rules and regulations that control development as it occurs. A zoning by-law further divides a municipality into various zones such as rural residential, highway-commercial and general agricultural. For example, an area that is designated as Agricultural in a development plan may be further zoned as Agricultural General and Agricultural Restricted, with both zones having separate criteria for agricultural development. The zoning by-law sets out requirements and criteria under which development may occur, including property site size, dimensions, separation distances and other siting criteria. It also specifies permitted and conditional uses within each zone.

Planning - General
Integrated watershed planning is a community based focused planning process around issues which effective water management. This planning needs to support the existing community framework for economic development and land use planning. In most cases, this means, integration of the IWMP into the existing Development Plan. The Development Plan is the local legal framework under the Provincial Land Use Policies.

All of the municipalities (with exception of Alonsa) included in the Whitemud IWMP area have Development Plans which govern land use decisions including the protection and use of agricultural lands. The Rural Municipality of Alonsa is developing their first ever development plan.

Development of rural lands for non-agricultural use can impact watershed health, and may result in enhanced drainage above agricultural requirements. Because of this, the ability of the landscape to provide ecological goods and services such as the retention and filtering of water is impacted with development. Within a Development Plan, protecting agricultural land from non agricultural use may also mean protecting wetlands and tree cover, especially if the farmland is maintained for grazing purposes. For these reasons, having agricultural lands protected in a Development Plan will have benefits for the five issues (surface water quality, ground water quality, source water protection, soils and land use and habitat & wildlife) identified in the public consultations.

There are 9 planning districts within the Whitemud IWMP area (with associated municipalities):

- Agassiz Planning District (McCreary),
- Big Grass Planning District (Glenella, Lakeview, Westbourne)
- Brandon & Area Planning District (Elton)
- Cypress Planning District (North Cypress)
- Neepawa & Area Planning District (Langford, Lansdowne, Rosedale)
- Nor-Mac Planning District (Portage la Prairie)
- South Riding Mountain Planning District (Clanwilliam)
- Tanner's Crossing Planning District (Minto, Odanah)

The following sections describe the framework for land use planning from a legal perspective, set out by the Provincial Government.

Crown Land Management and Planning in the Whitemud River Watershed.

Overview

In ***1930***, responsibility for ***Crown Lands*** was transferred to the provincial government of ***Manitoba.*** Virtually all of Northern ***Manitoba***, beyond the Department of Aboriginal and Northern Affairs boundary, is what they called "unorganized territory" and is also ***Crown land***. Today, Manitoba's Crown Lands are used for varying purposes, including agriculture, mining, and cottages. Other areas are set aside for research, environmental protection, public recreation, and resource management. Approximately 95% of the province's forests sit within provincial Crown land.

Operations

The planning and classification of Crown land in agro-Manitoba is the ultimate responsibility of the Crown Lands Assistant Deputy Minister's Committee (CLADMC), previously known as the Crown Land Classification Committee (CLCC). The CLCC was created in 1975 by the Premier of Manitoba for the specific purpose of Crown land use planning and resolution of land and resource use conflicts between departments of government. It is an interdepartmental committee with representation from Manitoba Agriculture, Food and Rural Initiatives (MAFRI), Conservation, Water Stewardship, Aboriginal and Northern Affairs, Science Technology Energy & Mines (STEM) and Intergovernmental Affairs (IAF). The committee reports to cabinet.

The CLCC determined that to achieve its objectives, there was a need for on-the-ground planning and resource management expertise. This was obtained by creating local Block Planning Committees (BPC's), comprised of regional specialists from those departments on CLADMC. Eight BPCs were created in 1976. The BPC's meet every two months or as needed to discuss issues related to crown lands in their respective regions. Minutes are then forwarded to CLADMC for final approval.

Multi-Use Concept

The Provincial Crown Land Planning Process is strongly guided by the concept of multiple resource use whereby Crown Lands may be used by both competing and complementary users. Complementary use of Crown land requires special consideration be given to management in order to ensure that one resource use does not compromise the other. One such example is timber harvesting/livestock grazing, where a project initiated by MAFRI (Garland Project) is showing that proper management (of livestock grazing and forestry practices) can result in long term benefits to both resource users. The science and research from this project will be very beneficial in resolving a longstanding land use issue, and ultimately make more land available for complementary use. The information from this project will also assist private landowners in terms of managing their resources (e.g.; in instances where the land management objective is to enhance both forestry potential and livestock grazing).

Management and Administration

Management and administration of Crown land is shared by Manitoba Conservation, Manitoba Agriculture, Food and Rural Initiatives (MAFRI), Aboriginal and Northern Affairs and Manitoba Infrastructure and Transportation (MIT). The Crown Lands and Property Agency of MIT is responsible for the administration of Crown land, issues leases and permits upon the direction of MAFRI with regard to Crown lands classified for agricultural uses and issues leases and permits for all other Crown lands as directed by Manitoba Conservation. Manitoba Aboriginal and Northern Affairs maintain authority equivalent to that of local government for Crown land dispositions in the Northern Affairs area.

Manitoba Agricultural Crown Lands

Agricultural Crown Lands in Manitoba are managed and regulated by the Agriculture Crown Lands section of the Land Use Branch of Manitoba Agriculture, Food and Rural Initiatives. MAFRI issues agricultural leases and permits on those lands which are designated as primarily agricultural as well as multi-use lands which may be used for agricultural purposes on a secondary or interim use-basis, subject to specific conditions and covenants required by other resource users. The section also advertises available agricultural Crown lands for lease and ensures equitable allocation.

MAFRI is also responsible for compiling the land for AESB Community Pastures. These pastures are a combination of provincial, federal, municipal and even private lands, and are brought together under AESB management through contracts negotiated by MAFRI. This also enables the coordination of federal-provincial issues on these lands, such as the Protected Areas Initiative.

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

NFSP System Development
BMP Category Code/Practice Code Assignment

NOTE 1: The units of measurement are: distance = kilometers (km), area = acres, volume = cubic meters (m3)

NOTE 2: Funding is expressed as thousands of $ = K (eg. $4K = $4,000)

BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
01	Improved Manure Storage and Handling	0101	increased storage to meet winter spreading restrictions (including satellite storage)	volume (m^3)	30%	$30K
		0102	improved features to prevent risks of water contamination (leaks, spills)	N/A		
		0103	slurry storage covers to reduce odours and GHG emissions	N/A		
		0104	containment systems for solid manure (includes covers)	N/A		
		0105	assessment and monitoring of existing manure storage infrastructure	N/A		
		0106	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)	N/A		
02	Manure Treatment	0201	dewatering systems, nutrient recovery systems	N/A	30%	$30K
		0202	composting of manure			
		0203	anaerobic biodigestors			
		0204	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
03	Manure Land Application	0301	specialized/modification to equipment for improved manure application	N/A	30%	$10K
04	In Barn Improvements	0401	more efficient livestock watering devices and cleanout systems to reduce water use and decrease manure volumes	N/A	30%	$20K
		0402	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			

BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
05	Farmyard Runoff Control	0501	upstream diversion around farmyards ;downstream protection (eg. catch basins, retention ponds, constructed wetlands)	N/A	50%	$20K
		0502	construction of impermeable base and roof for minimizing runoff from livestock pen areas and confinement areas (feed bunks, water infrastructure, walls and electrical costs are not eligible)			
		0503	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
06	Relocation of Livestock Confinement and Horticultural Facilities	0601	relocation of livestock facilities such as corrals, paddocks and wintering sites away from riparian areas	N/A	50%	$30K
		0602	relocation of horticultural facilities such as greenhouses and container nurseries from riparian areas			
		0603	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
07	Wintering Site Management	0701	shelterbelt establishment	# kms	50%	$15K
		0702	portable shelters and windbreaks	# kms		
		0703	alternative watering systems (ie: solar, wind or grid power)	N/A		
		0704	field access improvements: alleyway/access lane upgrades	# kms		
		0705	fence modifications	# kms		
08	Product and Waste Management	0801	improved on-farm storage and handling of agricultural products (eg. fertilizer, silage, petroleum products, and pesticides)	N/A	30%	$15K
		0802	improved on-farm storage, handling, and disposal of agricultural waste (eg. livestock mortalities, fruit and vegetable cull piles, wood waste)			
		0803	composting of agricultural waste (eg. Livestock mortalities fruit, vegetable, wood, straw residue)			
		0804	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
		0901	sealing & capping old water wells	N/A	50%	$6K

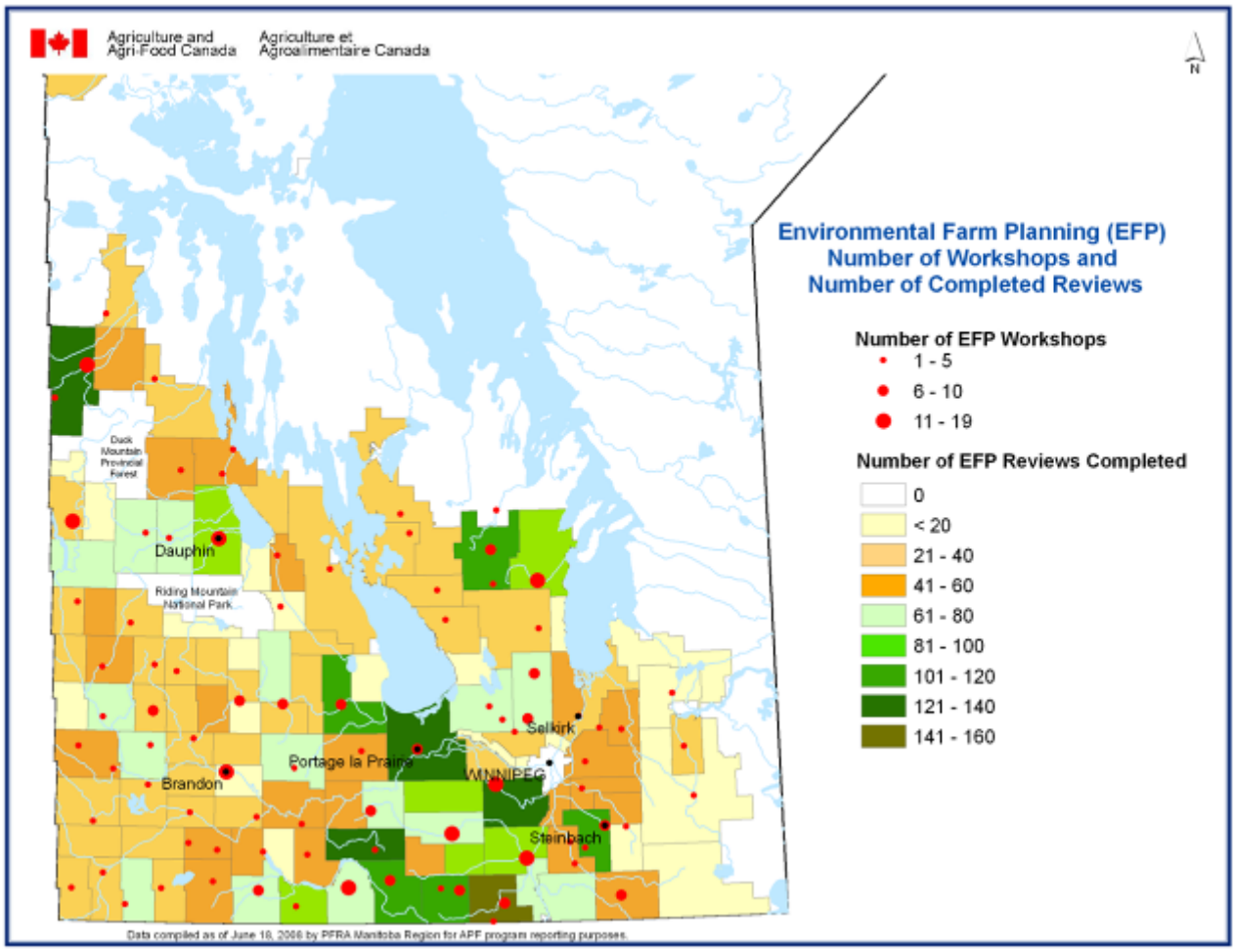
BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
09	Water Well Management					
		0902	protecting existing water wells from surface contamination			
10 10	Riparian Area Management (GREENCOVER) Riparian Area Management (GREENCOVER)	1001	alternative watering systems (ie: solar, wind or grid power)to manage livestock:	N/A	50%	$20K
		1002	buffer establishment and planting of forages (planting and establishment costs for trees and shrubs for the year of planting and one year after the planting year, or the termination of the NFSP funding, whichever comes first)	# acres		
		1003	fencing to manage grazing and improve riparian condition/function	# kms		
		1004	native rangeland restoration or establishment: native species of forages, shrubs, and trees	# acres		
		1005	grazing management in surrounding uplands: alternative watering systems (ie: solar, wind or grid power) and cross fencing	# kms offence		
		1006	improved stream crossings	N/A		
11	Erosion Control Structures(Riparian) (GREENCOVER)	1101	constructed works in riparian areas: contour terraces, gully stabilization, bank stabilization, erosion control matting, silt fencing, drop inlet and enhanced infiltration systems, in-channel control, retention ponds and erosion control dams	N/A	50%	$20K
		1102	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
12	Erosion Control Structures(Non Riparian)	1201	constructed works in non riparian areas: contour terraces, gully stabilization, bank stabilization, erosion control matting, silt fencing, drop inlet systems and enhanced infiltration systems, in-channel control, retention ponds and erosion control dams, mechanical wind screens	N/A	50%	$20K
		1202	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
13	Land Management for Soils at Risk	1301	forage or annual barrier establishment for soils at risk (eg. stripcropping, grassed waterways, perennial forages on severely erodible or saline soils)	# acres	50%	$5K
		1302	straw mulching	# acres		

BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
		1303	grazing management in critical erosion areas not associated with riparian zones: alternative watering systems (ie: solar, wind or grid power), crossfencing	# kms offence		
14	Improved Cropping Systems	1401	equipment modification on pre-seeding implements for restricted zone tillage for row crops, seeding and post seeding implements for low disturbance placement of seed and fertilizer	N/A	30%	$15K
		1402	chaff collectors and chaff spreaders installed on combines			
		1403	precision farming applications: GPS information collection, GPS guidance (ie: autosteer, lightbars, software) , manual and variable rate controllers for variable fertilizer application			
15	Cover Crops	1501	establishment of non-economic cover crop	# acres	30%	$5K
		1502	equipment modification for inter row seeding of cover crops (eg. relay crops)	N/A		
16	Improved Pest Management	1601	equipment modification for improved application	N/A	30%	$5K
		1602	information collection and monitoring			
		1603	biological control agents			
		1604	cultural control practices			
		1605	mobile water tanks			
17	Nutrient Recovery from Waste Water	1701	recycling of waste water streams from milkhouses, fruit and vegetable washing facilities, and greenhouses in order to recover nutrients	N/A	30%	$20K
		1702	engineering design work (this practice code will stand alone if project does not proceed for economic, technical or environmental reasons (CEAA)			
18	Irrigation Management	1801	irrigation equipment modification/improvement to increase water or nutrient use efficiency	N/A	30%	$10K
		1802	equipment to prevent backflow of altered irrigation water into water sources			
		1803	improved infiltration galleries and irrigation intake systems			

BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
19	Shelterbelt Establishment (GREENCOVER)	1901	establishment of shelterbelts for farmyard, live stock facilities, dugout snowtrap, wildlife habitat enhancement, field (planting and establishment costs for trees and shrubs for the year of planting and one year after the planting year, or the termination of the NFSP funding, whichever comes first)	# kms	50%	$10K
		1902	tree materials required for shelterbelt establishment	N/A		
20	Invasive Alien Plant Species Control	2001	integrated approaches (cultural, mechanical, and biological) for control of invasive plant species (eg. leafy spurge, purple loosestrife, scentless chamomile)	N/A	50%	$5K
21	Enhancing Wildlife Habitat and Biodiversity	2101	buffer strips: native vegetation	# acres	50%	$10K
		2102	alternative watering systems (ie: solar, wind or grid power)	N/A		
		2103	improved grazing systems: crossfencing	# kms		
		2104	wildlife shelterbelt establishment	# kms		
21	Enhancing Wildlife Habitat and Biodiversity	2105	improved stream crossings	N/A		
		2106	hayland management to enhance wildlife survival	N/A		
		2107	wetland restoration	acres		
22	Species at Risk	2201	alternative watering systems (ie: solar, wind or grid power)	N/A	50%	$10K
		2202	improved grazing systems: crossfencing	# kms		
		2203	plant species establishment	# acres		
		2204	infrastructure development and relocation	N/A		
23	Preventing Wildlife Damage	2301	forage buffer strips	# acres	30%	$10K
		2302	fencing or netting to protect stored feed, concentrated livestock, high value crops, drip irrigation systems, and other ag. activities	# km offence		
		2303	scaring and repellent systems and devices	N/A		

BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
24	Nutrient Management Planning	2401	consultative services to develop nutrient management plans, planning and decision support tools	# acres	50%	$4K
25	Integrated Pest Management Planning	2501	consultative services to develop integrated pest management plans, planning and decision support tools	# acres	50%	$2K
26	Grazing Management Planning (GREENCOVER)	2601	consultative services to develop range and grazing management plans, planning and decision support tools	# acres	50%	$2K
27	Soil Erosion and Salinity Control Planning	2701	consultative services to develop soil erosion and salinity control plans, planning and decision support tools	# acres	50%	$2K
28	Biodiversity Enhancement Planning	2801	consultative services to plan habitat enhancement, wetland restoration, stewardship for species at risk and/or wildlife damage prevention within agricultural land base; planning and decision support tools	# acres	50%	$2K
29	Irrigation Management Planning	2901	consultative services for planning improved water use efficiency and reduced environmental risk of existing irrigation systems, planning and decision support tools	# acres	50%	$2K
30	Riparian Health Assessment (GREENCOVER)	3001	consultative services for assessing riparian health, planning and decision support tools	# acres	50%	$2K

Appendix O: Environmental Farm Plan Workshops and EFP Statement of Completions in Manitoba



Appendix P: Annual Precipitation for weather stations located in the Whitemud River IWMP for selected years.*

Degree of Moisture Surplus

Light Blue indicates yearly amount exceeded the 30 year average by 50 millimeters
Dark Blue indicates yearly amount exceeded the 30 year average by 100 millimeters

Degree of Moisture Deficit

Yellow indicates yearly amount was lower than the 30 year average by 50 millimeters
Orange indicates yearly amount was lower than the 30 year average by 100 millimeters

	Total Annual Rainfall (mm)								
Weather Station	**1992**	**1993**	**1994**	**1999**	**2000**	**2001**	**2005**	**2006**	**30-year average (1971 - 2000)**
Alonsa[1]	369.8	415.5	400.2E	563.0	477.6	395.4	408.0	434.1	424.9
Beaver	344.7	498.4	438.4	429.0	545.6	447.4	349.8	357.2	407.9
Delta Marsh CS[1]	345.6	492.6	395.9	416.7	522.5	460.9	436.1	259.5	401.9
Gladstone South	336.4	412.7	433.0	M	M	M	M	M	387.7
Langruth[1]	342.3	424.6	389.4	467.8	542.1	M	M	M	411.0
MacDonald	366.2	526.6	403.4	452.6	549.1	434.6	437.4	288.4	397.9
McCreary[1]	369.3	482.4	487.3	551.6	485.5	374.4	365.4	359.4	425.8
Neepawa Water	318.8	M	477.7	514.2	592.4	352.4	397.8	286.4	405.7
Portage la Prairie CDA[1]	334.6E	476.2E	456.9E	M	689.4	391.8	566.6	286.1	416.0

	Total Annual Precipitation (mm)								
Weather Station	**1992**	**1993**	**1994**	**1999**	**2000**	**2001**	**2005**	**2006**	**30-year average (1971 - 2000)**
Alonsa[1]	528.4	489.0i	536.6E	640.6	652.7	543.0	606.6	616.1	566.5
Beaver	514.4	538.4	491.9i	534.0	698.6	569.4	501.8	516.2	542.7
Delta Marsh CS[1]	443.0	539.3	453.6	535.6	677.0	572.1	619.0i	424.4	524.6
Gladstone South	449.6	441.3	508.2	M	M	M	M	M	476.3
Langruth[1]	455.6	462.5	465.2	563.4	700.6	M	M	M	546.2
MacDonald	471.2	553.0	450.8	532.8	670.5	534.2	553.4	414.6	504.6
McCreary[1]	501.7	549.2	574.7	644.8	638.4	482.7	588.2	640.2	554.4
Neepawa Water	451.6	M	574.6	605.8	733.1	459.7	567.3	462.1	516.3
Portage la Prairie CDA[1]	465.4E	530.3E	521.8i	M	825.5	480.0	723.4E	421.4	535.3

*Annual precipitation and rainfall data was obtained from the Environment Canada website at:
http://www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html
[1] Data was gathered from a community located outside the IWMP study area.
M refers to missing data.
E refers to estimated data.
i refers to values based on incomplete data.