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Agricultural Land Use and Management in the Central Assiniboine and Lower Souris River Watershed

Submitted by

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and

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A. Executive Summary

The Central Assiniboine and Lower Souris River watershed is approximately 739,500 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 Assiniboine Hills Conservation District (AHCD) 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 for 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 a watershed scale provides a snapshot in time of the various agricultural activities in the Central Assiniboine and Lower Souris 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 five key issues that were identified through public consultation for the Central Assiniboine and Lower Souris River IWMP: excessive and unlicensed drainage, erosion, clearing of natural cover, large-scale irrigation, and water pollution (industrial, urban, and agricultural).

Ag-Profiling examines variables from 2006 Census of Agriculture database depicted over three 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 1994, 2000, 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 Central Assiniboine and Lower Souris 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, with a trend towards more modest, sustainable agriculture production. Crop production in the watershed has an increasing reliance on commercial fertilizers and pesticides, with a larger proportion of cropland being treated with crop inputs. In the same fifteen year period, there was an overall increase in grasslands, forages, and treed/forested areas (suggesting some encroachment) and large decreases in total farmland and in annual cropland (cereals in particular). The majority of farms have adopted alternative tillage practices (including conservation and zero-tillage) over traditionally popular conventional tillage. This change has become increasingly evident over the past 15 years.

Analysis of land cover over a 13-year period corresponds with the Census data analysis, particularly the conversion of annual cropland to grasslands and forage. 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 (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; 801 beneficial management practice (BMP) projects were completed with financial and technical assistance through the CMFSP. Over 45% of these projects were non-point source crop related BMP projects and 20% 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, salinity, and impacts surrounding irrigation development. Each analysis provided similar results, and indicated that the 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, salinity, and wildlife habitat, there may still be a need to target specific BMPs at the site level. 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.

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MAFRI: Gauer, E.

C. Preface

In 2009, the Assiniboine Hills Conservation District (AHCD) was designated as the Watershed Planning Authority to develop a comprehensive integrated watershed plan (IWMP) for the Central Assiniboine and Lower Souris 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 Central Assiniboine and Lower Souris River study area. More information on the data used in this document can be found within the Appendices section of the report.

D. Introduction

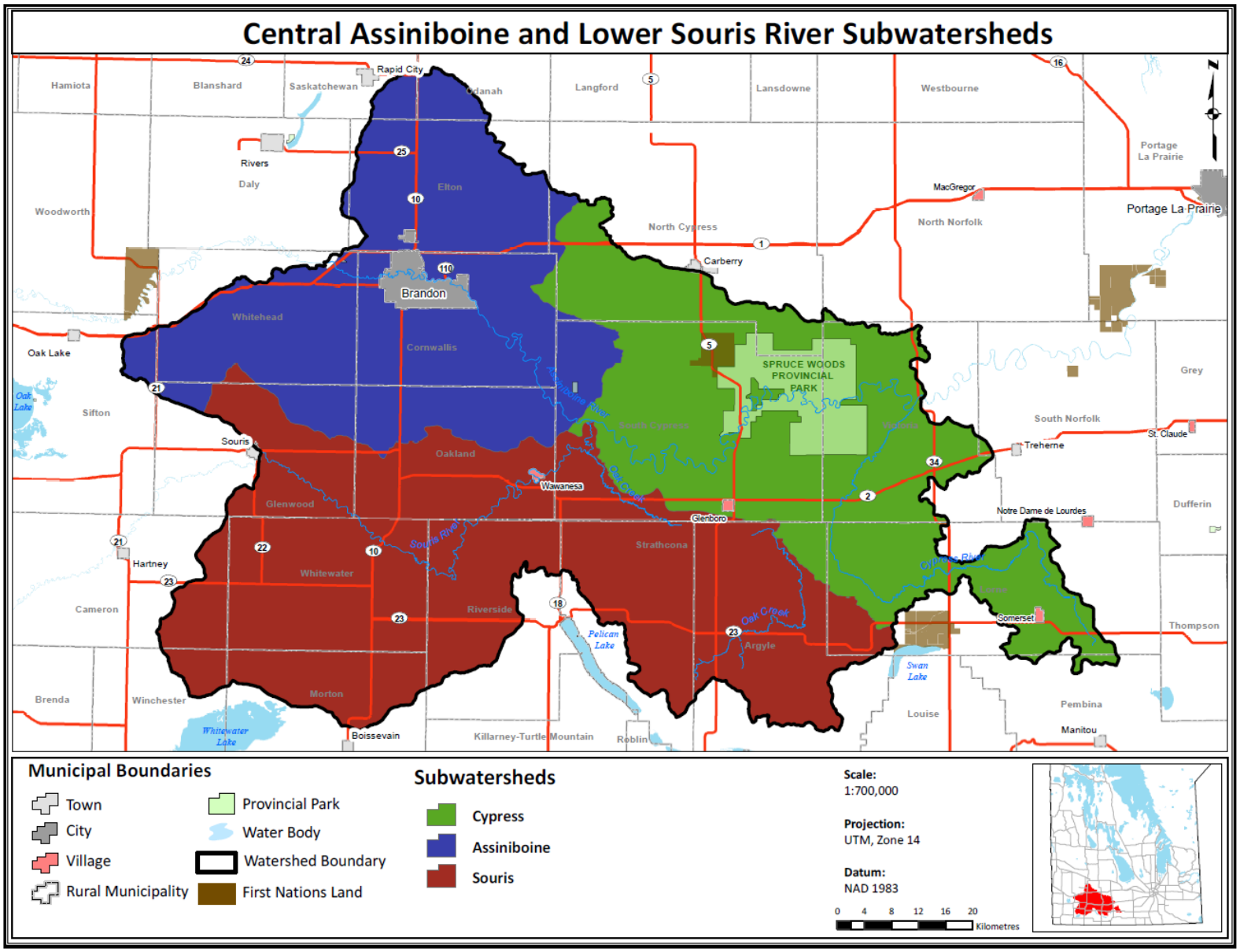
The Central Assiniboine and Lower Souris River Integrated Watershed Management Plan (IWMP) study area is defined by Manitoba Water Stewardship as encompassing watershed “05MH” and a portion of “05NG”, and is situated along the Assiniboine River southwest of Lake Manitoba. The Central Assiniboine and Lower Souris River IWMP study area is approximately 739,779 ha in size and consists of the area north of Turtle Mountain Provincial Park, east of Oak Lake, and south of Minnedosa/Neepawa (***Figure 1***). The study area contains the central portion of the Assiniboine River, as well as the lower end of the Souris River, the Cypress River, and Oak Creek. Portions of the Assiniboine Delta Aquifer lie beneath the northern portion of the study area. Some of the larger communities located within the area include Brandon, Wawanesa, Glenboro, and Minto. Additionally, Spruce Woods Provincial Park, Swan Lake First Nation, and Canadian Forces Base Shilo are located within the IWMP study area.

Objective

Understanding the current state and trends in agricultural land use and management practices along with landscape characteristics is essential for developing an integrated watershed management plan. 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 soil and water resources.**
- **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: Central Assiniboine and Lower Souris River Watershed Study Area and Subwatershed Groupings for the Agriculture Profile



E. Agricultural Land Use and Management

i. Current Agricultural Land Use of the Central Assiniboine and Lower Souris River IWMP Study Area

a) Agricultural Profile

Agricultural profiling refers to the characterization of agricultural production in a specified area or 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 geographic 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 1991, 1996, 2001, and 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, smaller financial data and smaller areas, and 100 for poultry, larger financial data and larger areas.

Agricultural activities were analyzed for the Assiniboine, Cypress, and Souris subwatersheds (***Figure 1***). The Assiniboine subwatershed comprises the northwest portion of the study area including the upper portion of the Assiniboine River and its tributaries, as well as the city of Brandon. The Cypress subwatershed comprises to the lower portion of the Assiniboine River within the study area as well as the Cypress River, which flows north into the Assiniboine River. The Souris subwatershed includes the southern portion of the study area and includes the Oak Creek and Souris River, which drain into the Assiniboine River (***Figure 1***). ***Table 1*** lists these subwatersheds with their respective sizes and proportion of the IWMP study area. Spruce Woods Provincial Park makes up a significant portion of the Cypress subwatershed that is not used for agriculture.

Table 1: Subwatersheds within the Central Assiniboine and Lower Souris River Watershed

Subwatershed	Area (hectares)	Percent of Central Assiniboine and Lower Souris River IWMP study area
Assiniboine	212,200	29%
Cypress	222,900	30%
Souris	304,500	41%
Central Assiniboine and Lower Souris River IWMP	739,500	

Land Use and Land Management

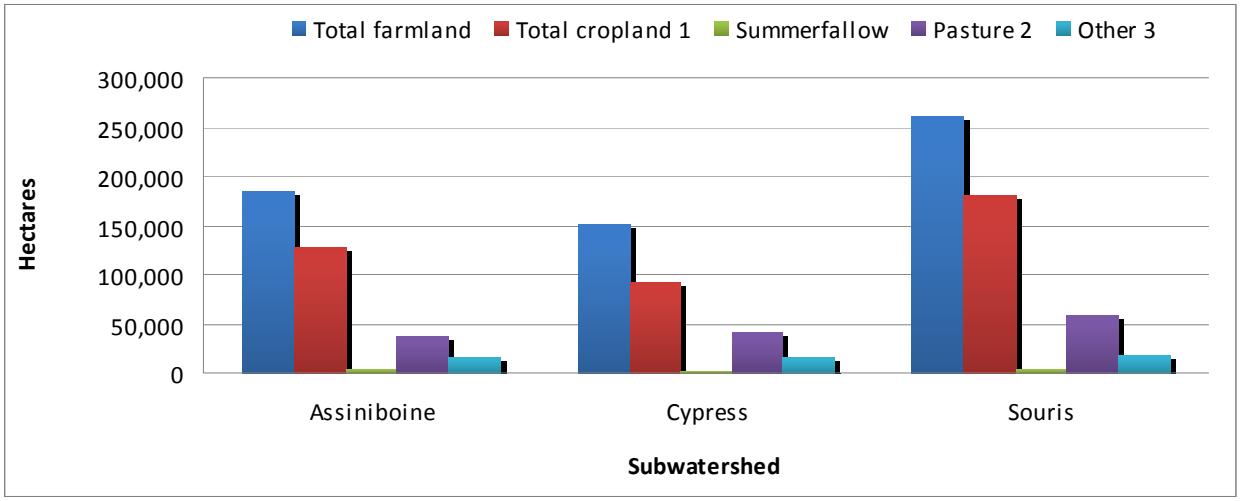
Assiniboine Subwatershed:
According to the 2006 Census of Agriculture, the Assiniboine subwatershed contains 515 farms with 87% of the land used for farming. Over 60% of the farmland was dedicated to annual crop production and approximately 30% to pasture, alfalfa, and hay and fodder crops. Cereals made up almost half of the cultivated land while just over 25% was seeded to oilseeds (mainly canola but also some flax). Only 15% of the cultivated land was in forages. Nearly 45% of cultivated land was managed using zero tillage. Conservation tillage practices were applied on over 30% of cultivated land while less than 25% of cultivated land was tilled conventionally. Beef production was the common in the watershed, with over 230 farm operations reporting nearly 14,200 animals; an average of over 60 head per farm. Total number of cattle and calves in the area totalled almost 34,000 animals. One hundred and fifteen farms reported an estimated 1,790 horses and ponies. Thirty farms reported poultry for a total of over 100,300 birds. Fifteen hog operations reported 27,290 animals; an average of 1,730 per operation.

Cypress Subwatershed:
A substantial portion of the Cypress subwatershed is occupied by Spruce Woods Provincial Park, which is comprised of mostly forested lands and grasslands. In 2006, the Cypress subwatershed reported approximately 395 farms with 68% of the total land base being used for farming. In 2006, 50% of the farmland in the subwatershed was dedicated to annual crop production, and nearly 40% to pasture, alfalfa, and hay and fodder crops. Cereals made up almost 40% of the cultivated area, oilseeds (mainly canola) over 25%, and forages approximately 15%. Almost 55% of the cultivated land was prepared with conservation or zero tillage practices, and the remaining area with conventional tillage practices. Beef production was the main livestock activity in the subwatershed, with 220 farm operations reporting almost 12,810 beef cows; an average of almost 60 head per farm. Total cattle and calves reported in the subwatershed totalled over 32,140 animals. Almost 75 farms reported 1,370 horses and ponies. Twenty farms reported poultry, totalling nearly 182,800 birds. A total of 40 hog operations reported an estimated 70,370 animals; an average of 1,810 per operation.

Souris Subwatershed:
The Souris subwatershed reported 630 farms with 86% of the total land dedicated to farming. In 2006, 60% of the farmland in the Souris subwatershed was in annual crop production, and almost 35% was pasture, alfalfa, and hay and fodder crops. Cereals made up slightly more than 50% of the cultivated area, oilseeds (mainly canola) almost 30%, and forages 15%. Only 25% of the total cultivated land was tilled conventionally. Alternative tillage practices (including conservation and zero till) were used on the remaining cultivated area. Beef production was the main livestock activity in the subwatershed, with over 350 farm operations reporting 24,070 beef cows; an average of 70 head per farm. Total cattle and calves reported in the area was almost 56,910 animals. Over 105 farms reported a total of 1,260 horses and ponies. Thirty-five farms reported poultry for a total of 18,600 birds. Thirty hog operations reported 67,090 pigs; an average of over 2,070 per operation.

When comparing the subwatersheds, all three had a similar proportion of total farmland in crops (63-71%). The proportion of farmland dedicated to pasture was also similar between the subwatersheds. It made up 27% of farmland in Cypress, 20% in Assiniboine and 23% in Souris. While summerfallow was present in all three subwatersheds, it comprised only a small area (less than 1%) of the watershed (***Figure 2***).

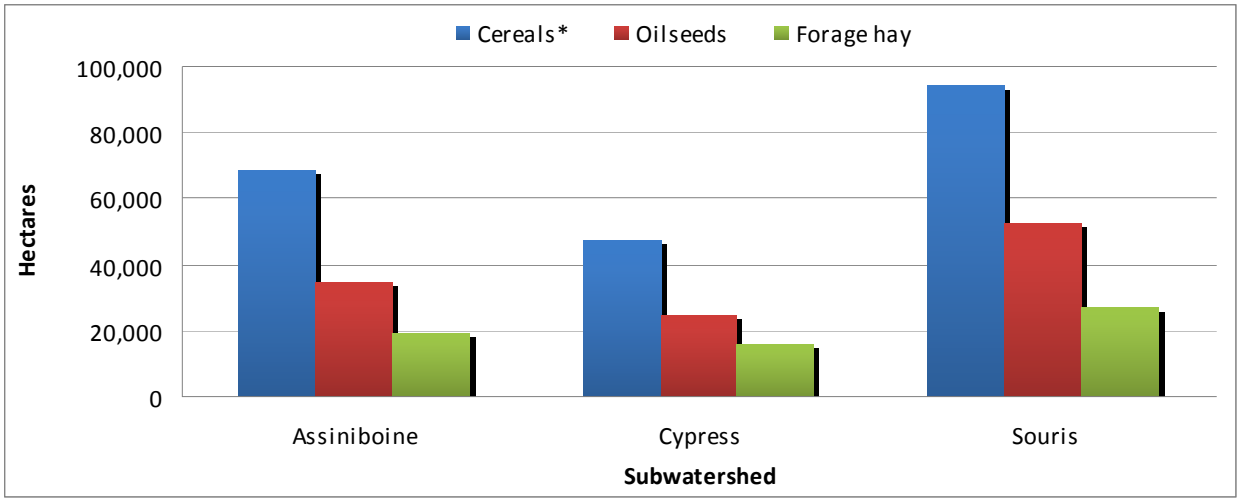
Figure 2: Distribution of agricultural land use in the Central Assiniboine and Lower Souris River watershed (2006 Census of Agriculture)



[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 land includes all other land uses including farmyard, woodlots, Christmas trees, wetlands, etc.

With respect to the distribution and types of crops grown in 2006, the three subwatersheds were quite similar. Less than 20% of the cropland was dedicated to forage for hay production in the Assiniboine, Cypress, and Souris subwatersheds. Oilseeds (mainly canola) were grown on approximately 25%-30% of available cropland, while cereals were the dominant crop (covering 50% of total cropland) in all three subwatersheds (***Figure 3***). All other crops made up no more than 5% of total cropland area in each of the three subwatersheds.

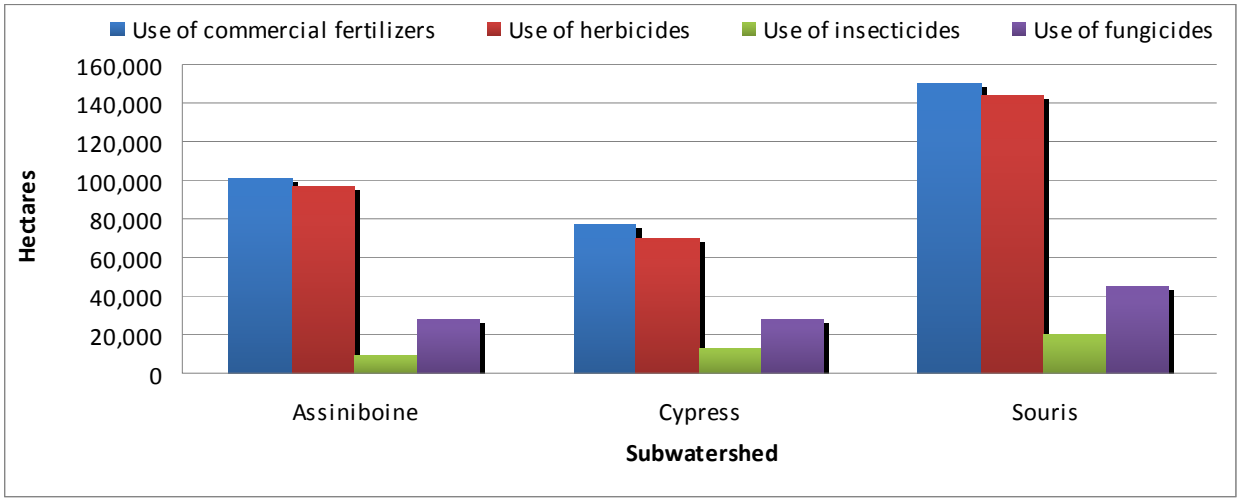
Figure 3: Distribution of the main crop types grown in the Central Assiniboine and Lower Souris River watershed (2006 Census of Agriculture)



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

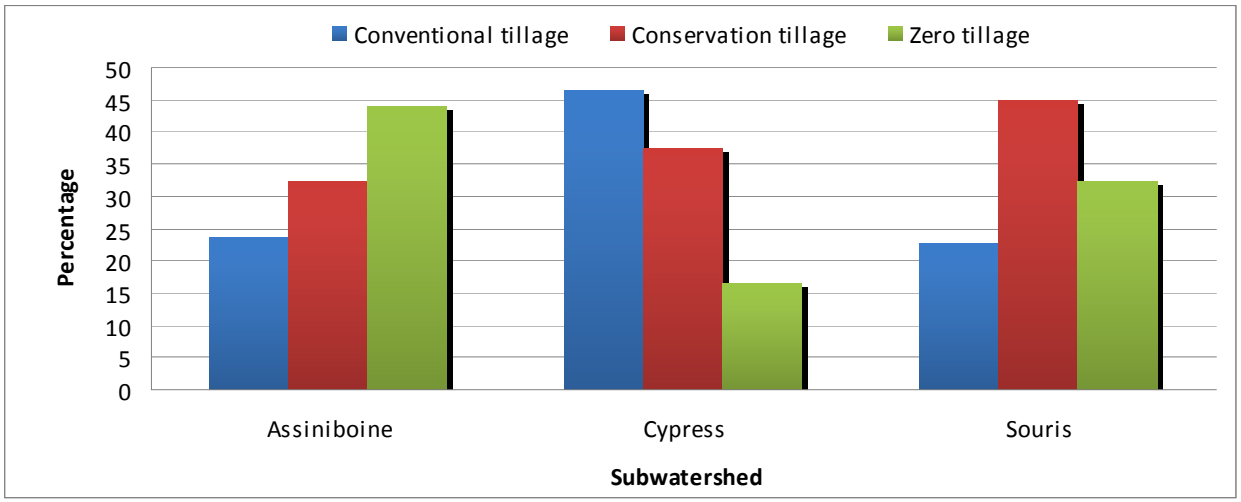
In terms of crop inputs, the Souris subwatershed contained the largest area of cropland which received crop inputs (***Figure 4***). In terms of fertilizer and pesticide use relative to cropland area, the proportion of crops receiving inputs was similar between subwatersheds and only a small proportion were treated with insecticides and fungicides.

Figure 4: Area of land treated to crop inputs in the 2005 crop year in the Central Assiniboine and Lower Souris River watershed (2006 Census of Agriculture)



With respect to seedbed preparation, conservation or zero tillage practices were widely adopted in the Central Assiniboine and Lower Souris River watershed. Together, conservation and zero-tillage made up more than 75% of land management in the Assiniboine and Souris subwatersheds. While conventional tillage was the most widely adopted tillage practice in the Cypress subwatershed, conservation and zero-tillage practices (collectively) were utilized for more than 50% of the total area prepared for seeding (***Figure 5***).

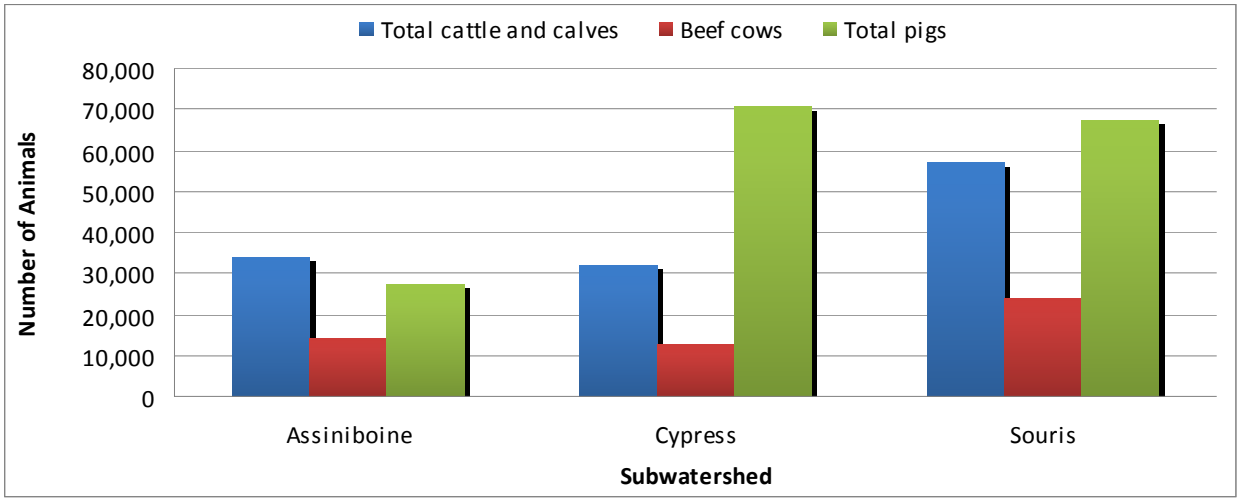
Figure 5: Tillage practices in the Central Assiniboine and Lower Souris River watershed (2006 Census of Agriculture)



Livestock production is important in the watershed, and livestock numbers are summarized in ***Figure 6***. In all three subwatersheds, beef cows made up nearly half of the total number of cattle

and calves, indicating that cow/calf operations dominated. The Souris subwatershed reported the highest number of cattle and calves (56,910 animals). Hog farms were common within the watershed, with most of the operations occurring within Cypress and Souris. While they were present in the Assiniboine subwatershed, the number of hog farms was lower than in the other subwatersheds.

Figure 6: Total livestock numbers in the Central Assiniboine and Lower Souris 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, consisting primarily of beef cattle, contributed the majority of animal units produced in each of the subwatersheds and accounted for approximately 76% of the AU in the watershed. Since beef production consists mainly of cow/calf operations, manure nitrogen (and phosphorous) will be deposited on pastureland naturally by the animals during the grazing season. Depending on the type of winter management used (with the application of extensive over-wintering) natural deposition of manure onto pastureland may continue over the winter season. Pig farms contributed most of the remaining total animal units to the watershed, especially in the Cypress and Souris subwatersheds. These operations contributed 17% of the total animal units to the watershed.

Table 2: Estimated annual animal units produced in the subwatersheds of the Central Assiniboine and Lower Souris River watershed (according to the number of livestock reported on Census day, 2006)

Livestock Type	Animal Units (AU)			Total Animal Units	Percentage of Total AU
	Assiniboine	Cypress	Souris		
Total Cattle and Calves	22,115	21,484	37,060	80,658	76%
Total Pigs	3,600	7,396	7,581	18,577	17%
Total Poultry *	740	1,075	108	1,922	2%
Total Horses and Ponies	1,785	1,368	1,262	4,415	4%
Other livestock - sheep, goats, bison, elk *	554	110	510	1,174	1%
TOTAL AU	28,793	31,432	46,521	106,747	

* 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 targeting of livestock related beneficial management practices. In all subwatersheds, the average number of total cattle and calves as well as beef cows per farm is similar. The average total cattle and calves per farm ranged from 130 to 150 with an average of 60 beef cows per farm (***Figure 7***). Hog herd size was also very similar between subwatersheds, averaging 1,890 animals per farm (***Figure 8***). Poultry flock size varied greatly between subwatersheds. Souris had an average flock size of less than 600 while Cypress had an average flock size of over 8,200 birds. These values must be observed with caution however, because barns that were empty on census day had no inventory to report.

Figure 7: Average number of cattle per farm in the Central Assiniboine and Lower Souris watershed (2006 Census of Agriculture)

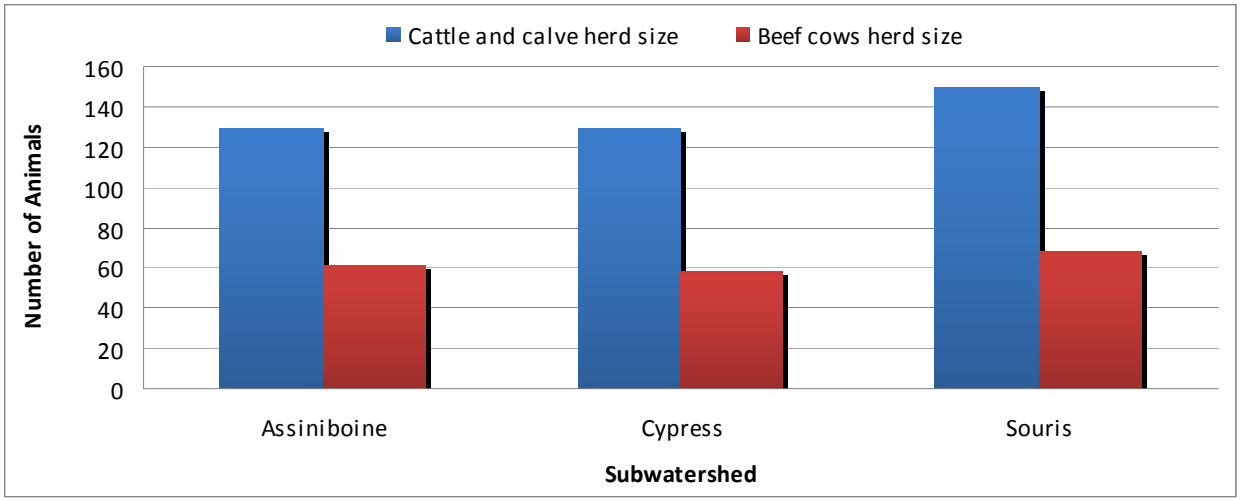
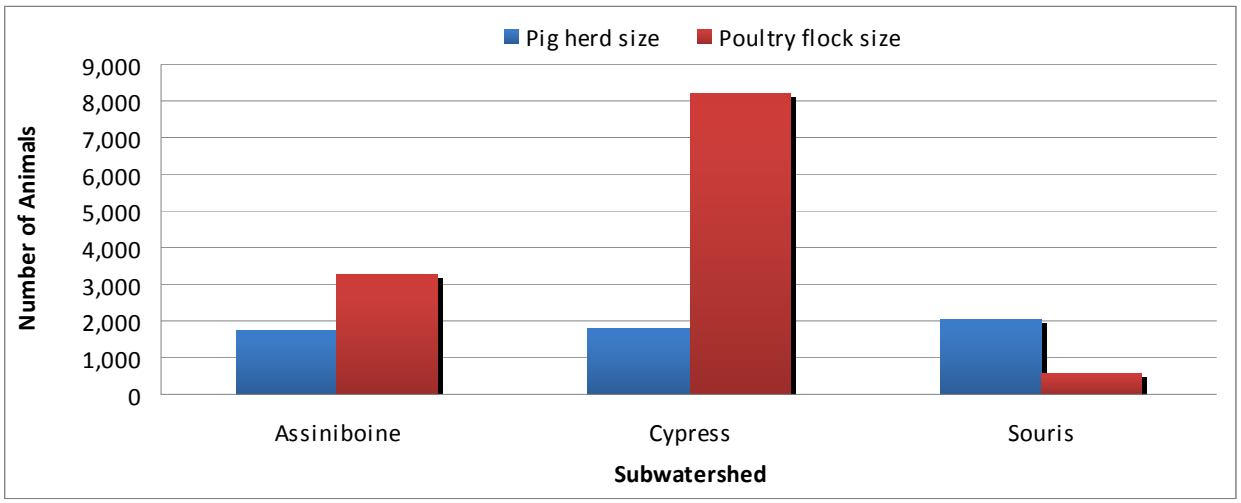


Figure 8: Average number of pigs and poultry per farm in the Central Assiniboine and Lower Souris watershed (2006 Census of Agriculture)



Farm Financial Characteristics

Assiniboine Subwatershed:
In 2006, the Assiniboine subwatershed reported approximately 515 farms with 87% of the subwatershed area being used for farming. The average farm size was approximately 360 ha/farm (880 acres/farm) with an average capital investment of $2,600 per hectare of farmland (or almost $911,000/farm). Livestock-related expenses were nearly $100/ha of farmland and crop-related expenses were over $170/ha of cropped land and summerfallow. Per farm, net cash income was estimated to be almost $18,900 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).

Cypress Subwatershed:
In 2006, the Cypress subwatershed reported approximately 395 farms with 68% of the subwatershed area being used for farming. The average farm size was approximately 380 ha/farm (940 acres/farm) with an average capital investment of $2,900 per hectare of farmland (or almost $1,099,100/farm). Livestock-related expenses were over $100/ha of farmland and crop-related expenses were over $210/ha of cropped land and summerfallow. Per farm, net cash income was estimated to be over $43,900 and the sales to expense ratio was reported to be 1.23 (farm operations received $1.23 gross revenue for every $1 of agricultural expense).

Souris Subwatershed:
In 2006, the Souris subwatershed reported almost 630 farms with over 86% of the subwatershed being used for farming. The average farm size was around 420 ha/farm (1,030 acres/farm) and farms had an average capital investment of almost $2,300 per hectare (or over $963,900 per farm). Average livestock-related expenses were nearly $90/ ha of farmland, while crop-related expenses were nearly $160/ha of cropped land summerfallow. Net cash income was estimated to be almost $25,800 per farm 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).

Farms in the three subwatersheds were similar in size, although they tended to be slightly larger in the Souris subwatershed, which also had the highest number of farms (***Figure 9***). Farm financial activity shows that farms in Cypress had, on average, higher sales and higher expenses than the other subwatersheds. Additionally, farms in the Cypress subwatershed had a higher average estimated net cash income (***Figure 10***). In terms of financial activity, the Souris subwatershed had the highest total farm capital, total farm expenses, and total farm receipts (***Figure 11***), which is likely attributable to the higher number of farms in the area.

Figure 9: Total number of farms and average farm size in the Central Assiniboine and Lower Souris River watershed (2006 Census of Agriculture)

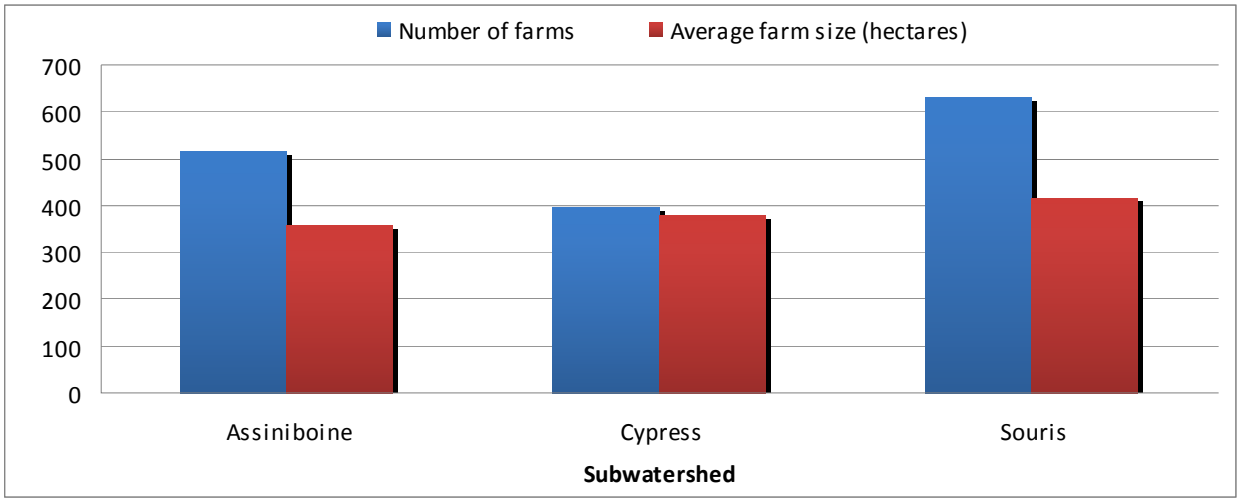


Figure 10: Summary of farm average financial activity for the 2005 calendar year in the Central Assiniboine and Lower Souris River watershed (2006 Census of Agriculture)

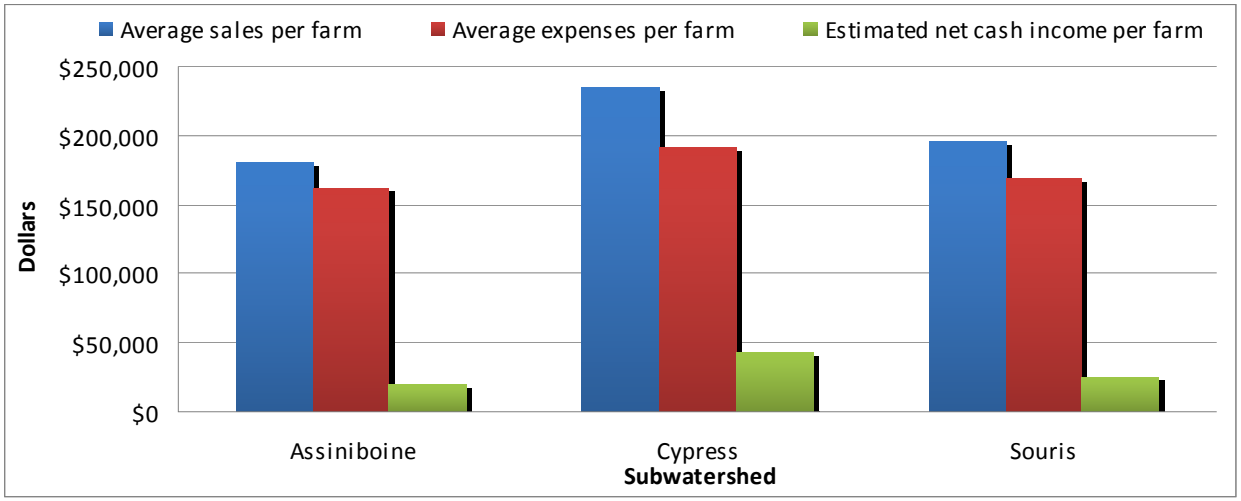
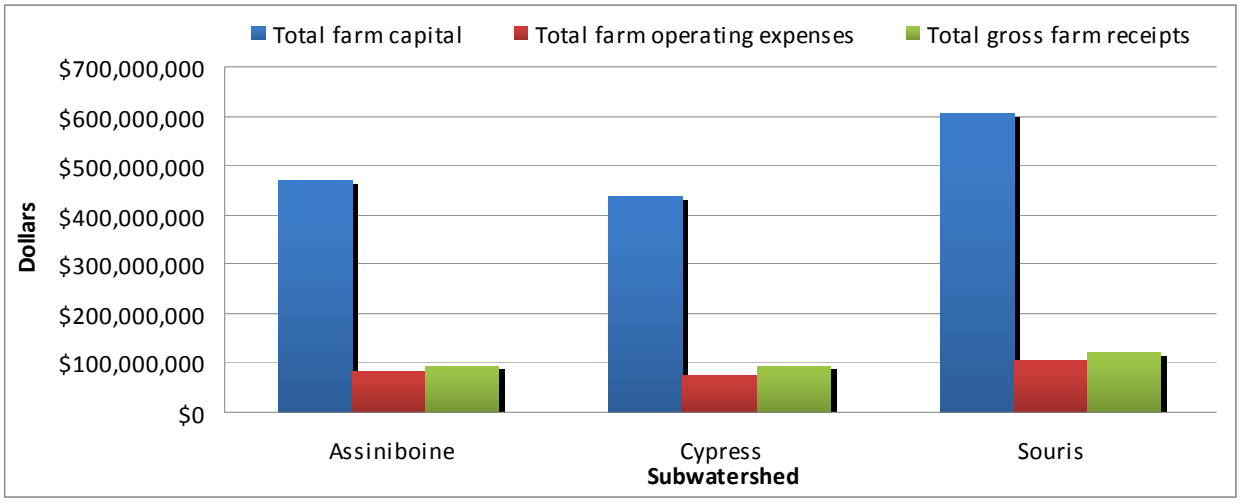
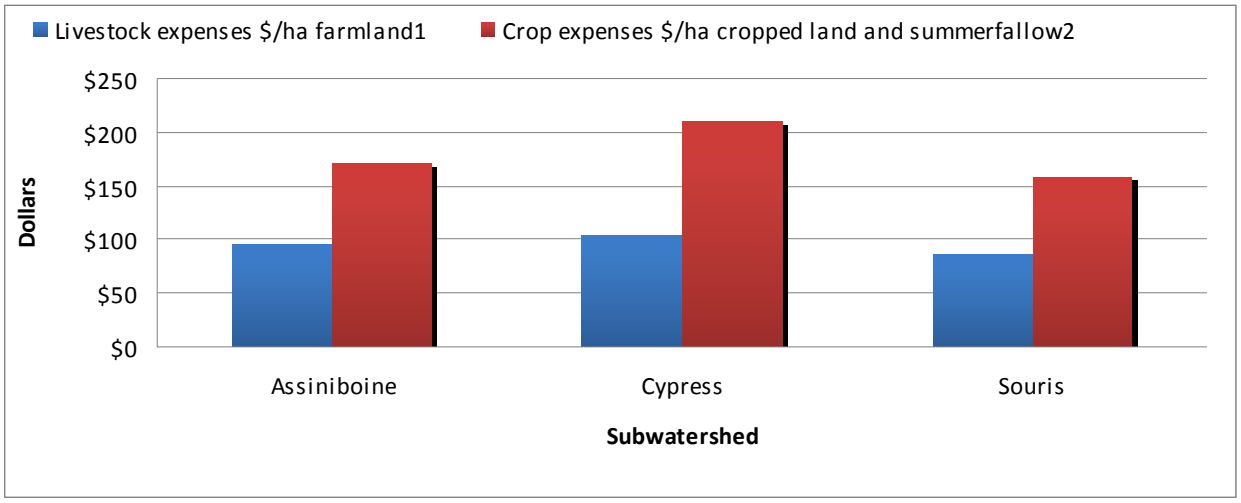


Figure 11: Summary of subwatershed financial activity for the 2005 calendar year in the Central Assiniboine and Lower Souris River watershed (2006 Census of Agriculture)



Livestock and crop-related expenses reported for the 2005 crop year have been determined on a per hectare basis. ***Figure 12*** shows that, on average, farm operations in Assiniboine, Cypress, and Souris had similar livestock-related expenses per hectare of farmland. With respect to crop-related expenses, producers in Cypress reported the highest expenses per hectare of cropped land and summerfallow. A closer look at the crop input costs indicates that farms in Cypress, on average, spent more per hectare on fertilizer and pesticides than farms in Assiniboine or Souris (***Table 3***).

Figure 12: Average livestock and crop-related expenses per hectare for the 2005 calendar year in the Central Assiniboine and Lower Souris 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 Central Assiniboine and Lower Souris River watershed (2006 Census of Agriculture)

Subwatershed name	Dollars spent on fertilizer per hectare applied	Dollars spent on pesticides per hectare applied
Assiniboine	$100	$60
Cypress	$120	$60
Souris	$90	$50

2006 Agriculture Profile Summary

- Approximately three quarters of the land in the watershed is owned and managed by farm operations.
- Agricultural activities are similar throughout the watershed, with some differences in agricultural practices and management between the subwatersheds. Due to the higher amount of forested and wetland areas in Cypress, it had less agricultural activity than the other two subwatersheds. Additionally, it had a higher proportion of farmland dedicated to pasture, with less cropland present.
- Crop production is the most important agricultural practice in the watershed. Approximately 70% of the farmland in the watershed is seeded to crops. The Cypress subwatershed was slightly lower than this average, but also contained less farmland. Fertilizers and herbicides were applied to 80% and 76% of cultivated fields in the watershed, respectfully. Crop input averages for each subwatershed were similar to the average of the entire watershed.
- Alternative tillage methods are quite common in the watershed, used on over 70% of all cultivated land. Conservation and zero tillage were the most common practice in the Assiniboine and Souris subwatersheds, while conventional tillage remained the most common in Cypress.
- Beef production is the main livestock industry in the watershed. In the Cypress subwatershed, land use for beef production (pastures and seeded forage for hay) made up nearly 40% of the farmland, while in Assiniboine and Souris, it made up 30% and 35%, respectfully. With respect to beef herds, farms in all three subwatersheds reported very similar number of cattle and calves per farm, with farms in Souris having a slightly larger average herd size.
- While it is the smallest of the three subwatersheds, farms in Cypress had, on average, the most financial activity (including highest total income, expenses, and net cash income). Total income and expenses in Assiniboine and Souris were slightly lower than in Cypress; however net cash income was substantially lower in these two 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***.

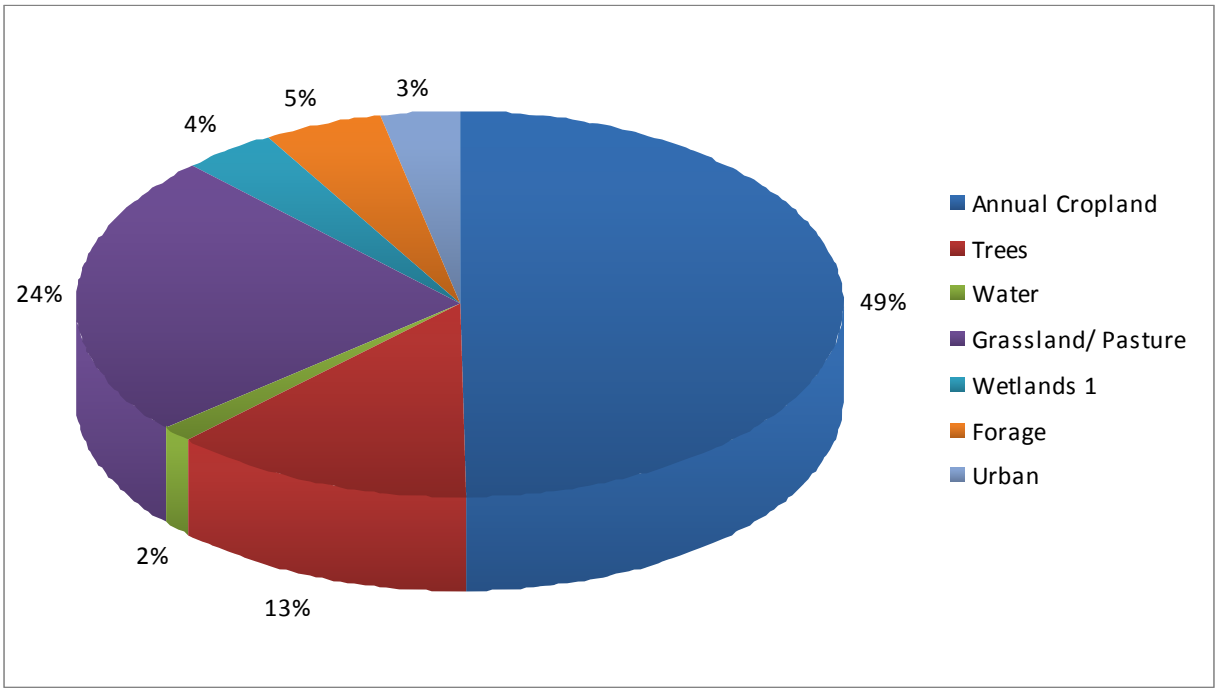
- Annual Cropland is the predominant land cover type in the watershed and accounts for almost half of the total land cover, the majority of which is located within the Assiniboine and Souris subwatersheds.
- Grassland/pasture is the second most common land cover type and makes up 24% (175,490 ha) of the watershed. Despite its small size, the Cypress subwatershed has the largest area of grassland/pasture of any of the subwatersheds, due to a large area of pasture south of the wetlands surrounding the Assiniboine River.
- Trees are the third most predominant land cover type in the watershed with 13% (93,123 ha) of the total land cover. The vast majority of tree cover is in the Cypress subwatershed, in and around Spruce Woods Provincial Park.
- In 2006, approximately 19% of the land cover (132,258 ha) was classified as trees, water, or wetlands (***Table 4, Figures 13 and 14***). A large portion of the total forested cover occurs within the Cypress subwatershed.
- Forage land, usually indicative of alfalfa stands, makes up 5% of the watershed.
- Wetlands occupy a small portion of the watershed (approximately 4%) and relatively equal areas of wetland cover are present in the three subwatersheds. There is a large, concentrated portion of wetland in the Spruce Woods Provincial Forest in the Cypress subwatershed.
- Approximately 2% of the watershed is classified as water.

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

Subwatershed	Annual Cropland	Trees	Water	Grassland/ Pasture	Wetlands [1]	Forage	Urban	Total [2]
Assiniboine	114,167	14,772	1,979	52,329	7,470	11,440	10,038	212,195
Cypress	68,484	58,208	3,394	66,929	8,376	11,959	5,520	222,872
Souris	182,472	20,104	5,863	56,232	12,090	14,037	8,477	299,275
IWMP Boundary	**365,123**	**93,085**	**11,237**	**175,490**	**27,936**	**37,436**	**24,035**	**734,342**

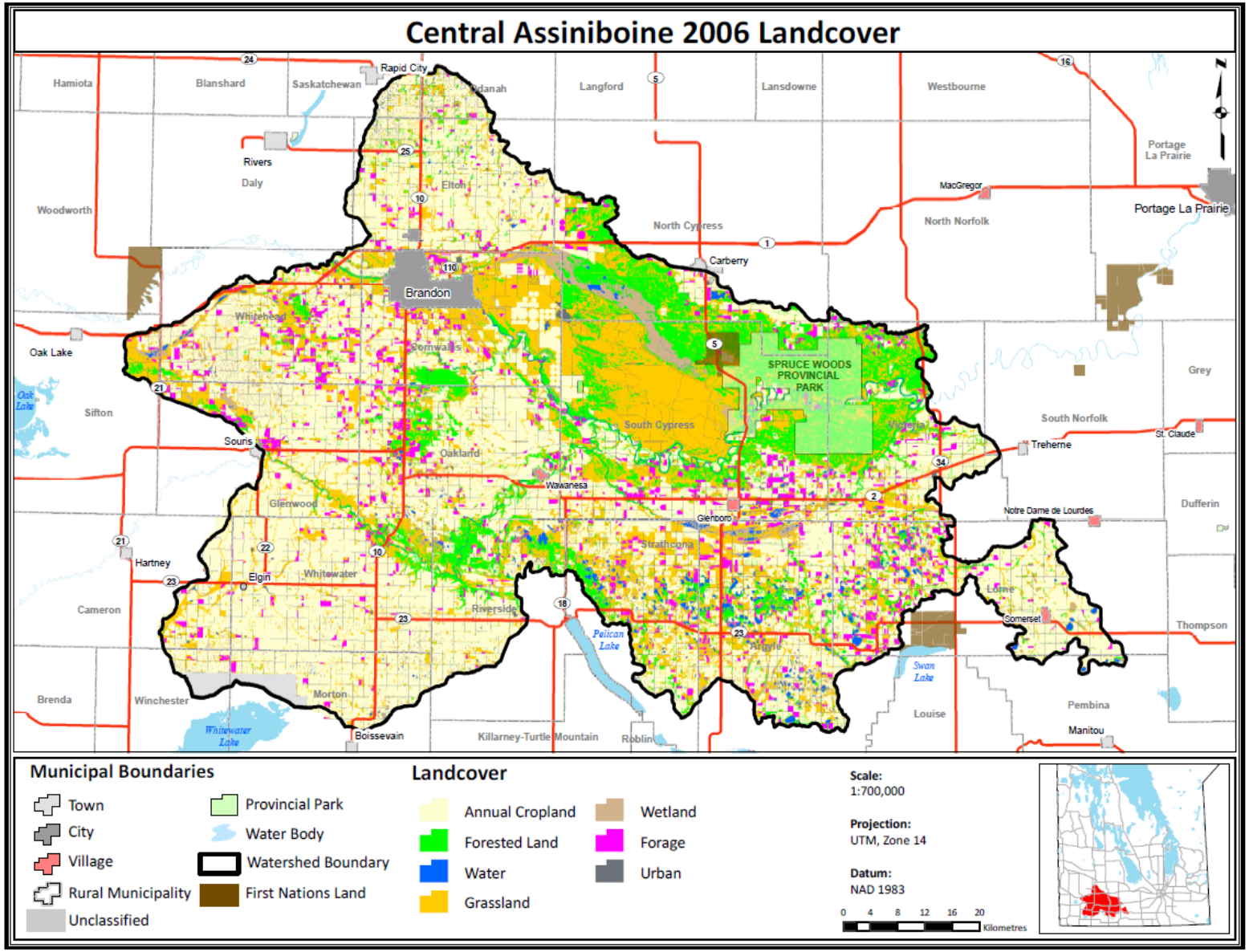
* Area totals are approximate due to the nature of the image analysis procedure
[1] Due to seasonal changes in wetland size, date of imagery will affect area.
[2] Extent of Land Cover image does not encompass entire IWMP study area.

Figure 13: Distribution of Land Cover within the Central Assiniboine and Lower Souris 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 Central Assiniboine and Lower Souris 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 to social influences like changing demographics and increasing environmental awareness. Changes in land use can have an environmental and economic impact on the health of a watershed. 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 due to weather, market or other conditions, it is important to also be aware of events and conditions. As a result, many of the noted land use changes will need to be further examined by land use and industry specialists and individuals with significant local watershed knowledge.

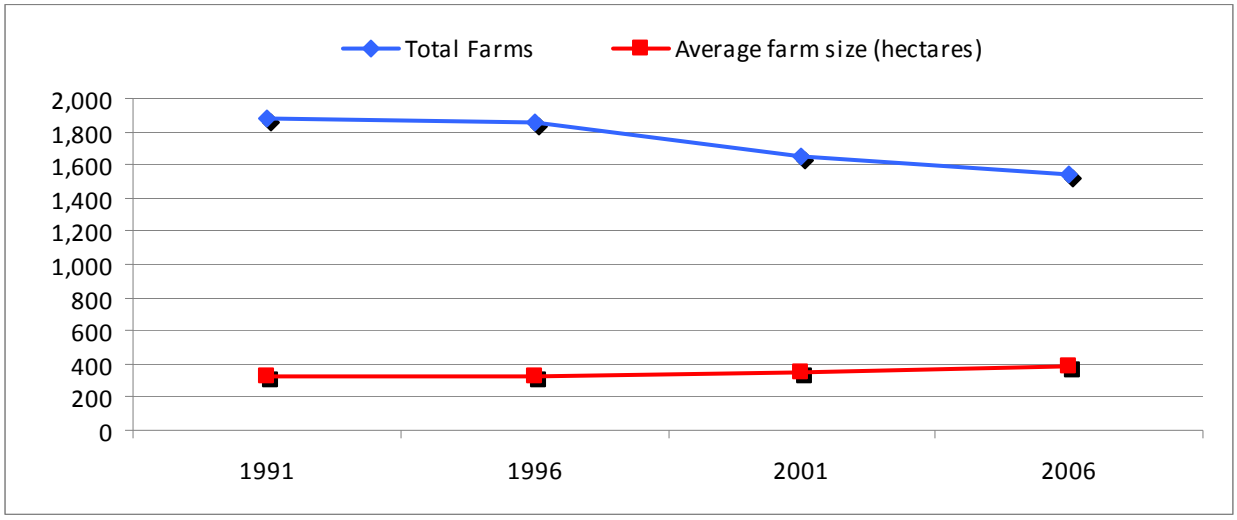
a) Changes in Agricultural Production (1991 to 2006 Census Data)

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 agricultural industry's effects on landscape resources in the Central Assiniboine and Lower Souris River watershed. For more detailed data 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 Central Assiniboine and Lower Souris River watershed has declined from 1,885 in 1991 to around 1,540 farms in 2006, a decrease of approximately 18% over the 15 year period (***Figure 15***). Although a noticeable decrease in total farmland occurred in the watershed over this time period (***Figure 17***), average farm size has increased steadily from 330 ha in 1991 to 380 ha in 2006.

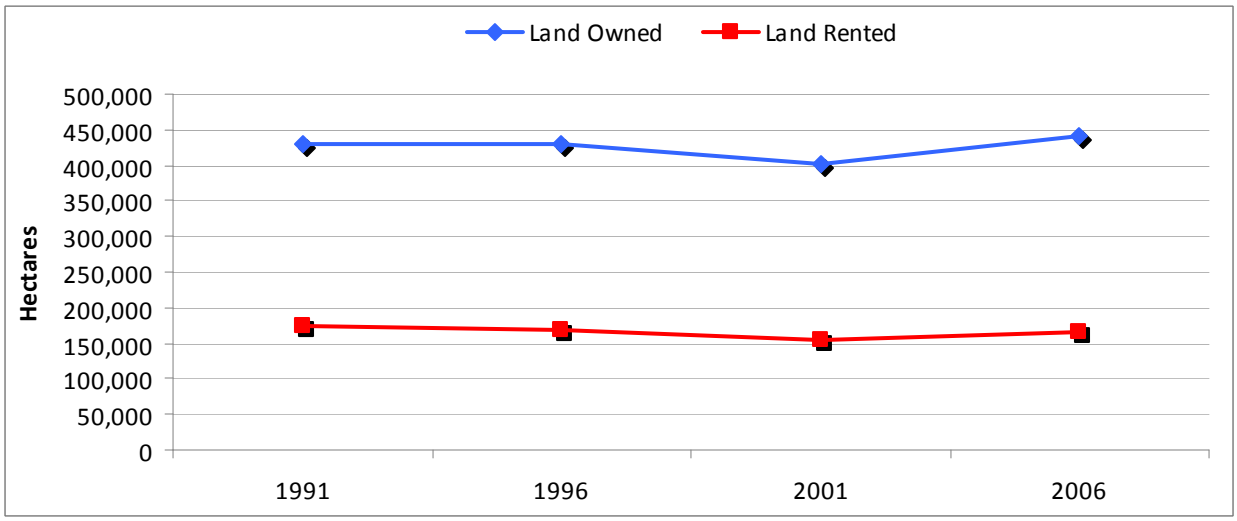
Figure 15: Total number of farms and average farm size in hectares in the Central Assiniboine and Lower Souris River watershed from 1991 to 2006



Land Tenure

Owned and rented land area saw very little change from 1991 to 2006 (***Figure 16***). In 2001, a slight drop occurred in the area of both owned and rented land, but local knowledge of farming practices would be required to confirm the cause. The drop was followed by an increase to previous levels the following census year.

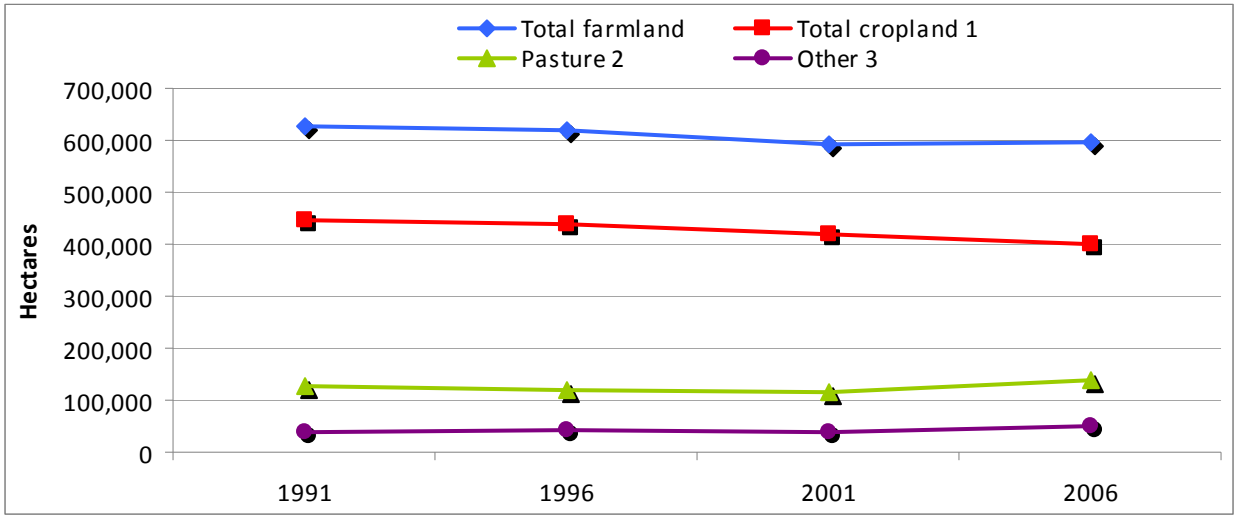
Figure 16: Owned versus rented lands in the Central Assiniboine and Lower Souris watershed from 1991 to 2006



Farmland Usage

A substantial drop in total farmland area (over 29,800 ha) occurred during the period between 1991 and 2006 (***Figure 17***). While this loss is seemingly large, the Central Assiniboine and Lower Souris River watershed is one of the larger watersheds in Manitoba, and this decrease represents a loss of less than 5% of total farmland area. Concurrent with a decrease in total farmland, total cropland also declined steadily over the fifteen year period from 444,700 ha in 1991 to 400,700 ha in 2006, a decrease of 44,000ha. Pasture (both natural and improved) and other land saw little change from 1991 to 2001, but increased from 2001 to 2006 by 21,200ha (18%) and 8,800ha (22%), respectfully. Collectively, natural areas (pasture and other areas) have increased within the watershed over the fifteen year period.

Figure 17: Farmland usage in the Central Assiniboine and Lower Souris River watershed from 1991 to 2006

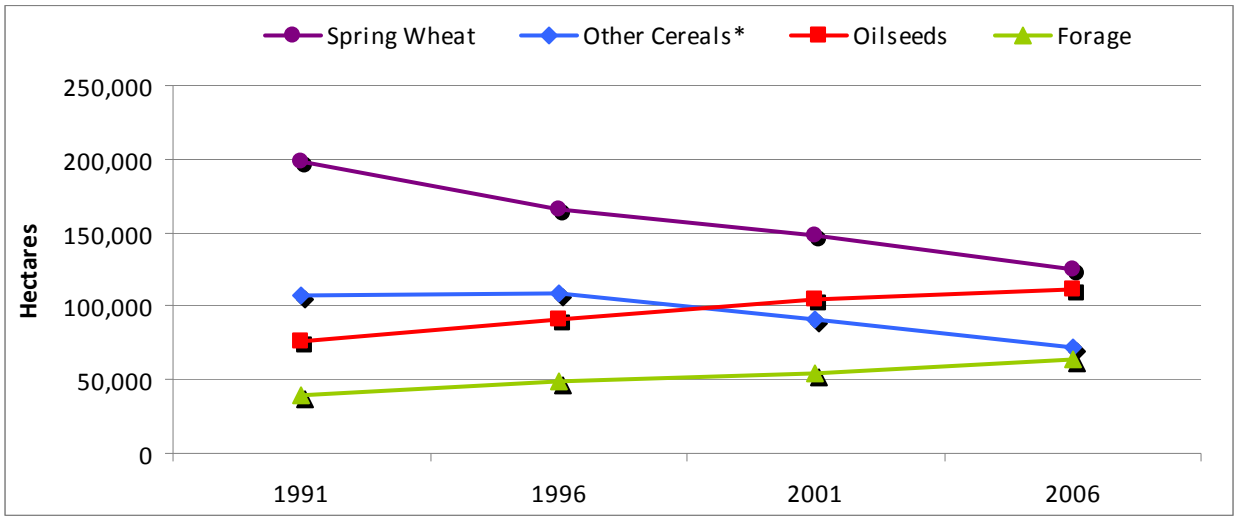


[1] Total cropland includes all field crops, vegetables, fruit and nuts, and sod
[2] Pasture includes tame pasture and natural areas used for pasture
[3] Other land refers to all other land uses including farmyard, woodlot, wetland, Christmas tree, etc.

Cropping Practices

The area of land seeded to different types of crops showed very consistent changes year to year from 1991 to 2006 (***Figure 18***). There was a steady decrease in the area of spring wheat, with a total decrease of over 73,700 ha over the fifteen year period. The area of other cereals also decreased from 107,800 ha in 1991 to 71,900 ha in 2006. These decreases are partially offset by increases in oilseed and forage crops. Oilseed area increased from approximately 75,400 ha in 1991 to 111,600 ha in 2006. Area in forages increased by 60% over the fifteen year period, with 63,500 ha of cropped land planted to forages in 2006. Increases in canola production led to the sharp increase in oilseeds over 15 years, with a reported production increase of over 100% since 1991. The remaining decrease of area cropped to cereals is likely due to the reduction of total farmland and cropland from 1991 to 2006 (***Figure 17***).

Figure 18: Major crop types in the Central Assiniboine and Lower Souris River watershed from 1991 to 2006

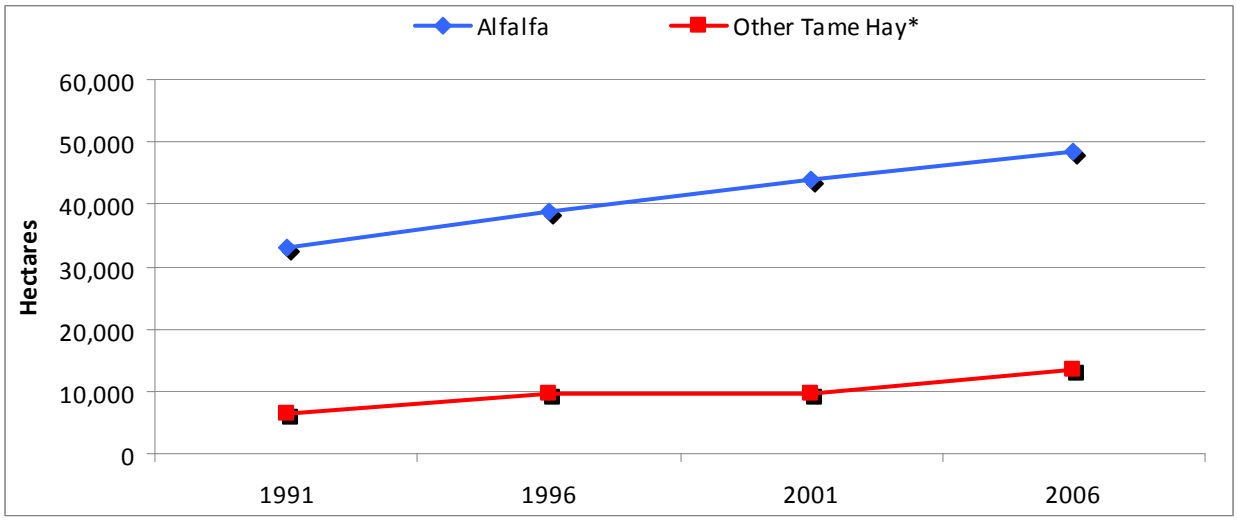


* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

Alfalfa and Hay Production

Forage production made up just over 15% 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***).

Figure 19: Alfalfa and tame hay trends in the Central Assiniboine and Lower Souris River watershed from 1991 to 2006



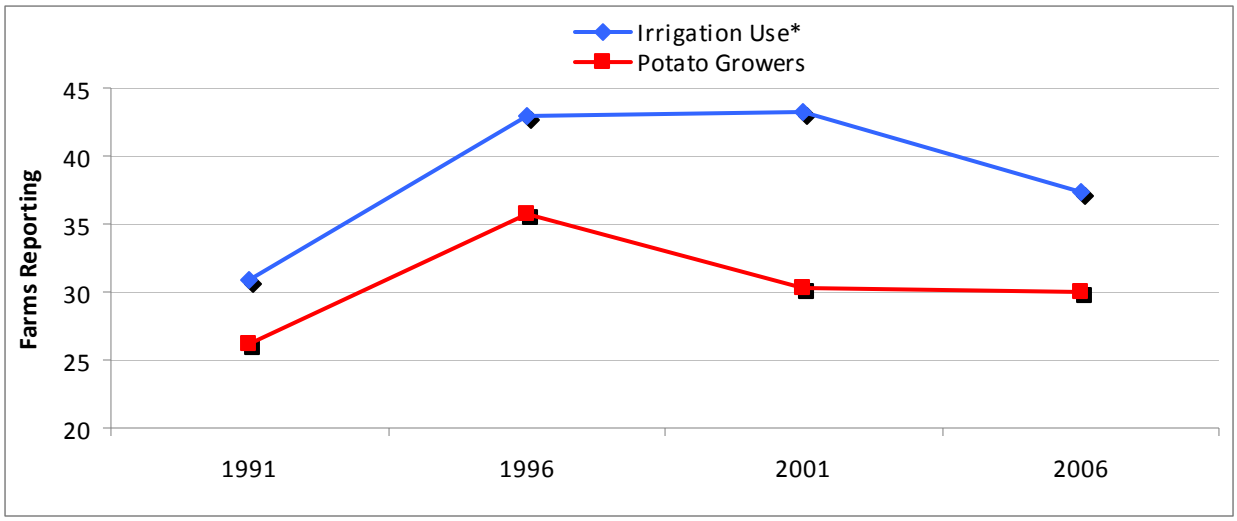
* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

Irrigation Practices

Irrigation data collected in the Census of Agriculture includes farming operations that irrigate potatoes, cereals, other vegetables, fruit, and forage, among others. Potato farming and associated irrigation practices have been raised as in issue in the Central Assiniboine and Lower Souris River watershed. Census of Agriculture data is not collected specifically on potato irrigation. However, 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 irrigating operations and nearly 75% of the irrigated area is potatoes (Association of Irrigators in Manitoba 2007).

The number of farm operations reporting irrigation use increased from 30 in 1991 to 35 in 2006 (***Figure 20***). Farms using irrigation peaked between 1996 and 2001 with 45 farms reporting both years. While the actual number of potato farms was less than the number of farms using irrigation; the two had very similar trends over the 15 year period. It is likely that the reduction in potato farmers is correlated with the reduction in irrigating operations.

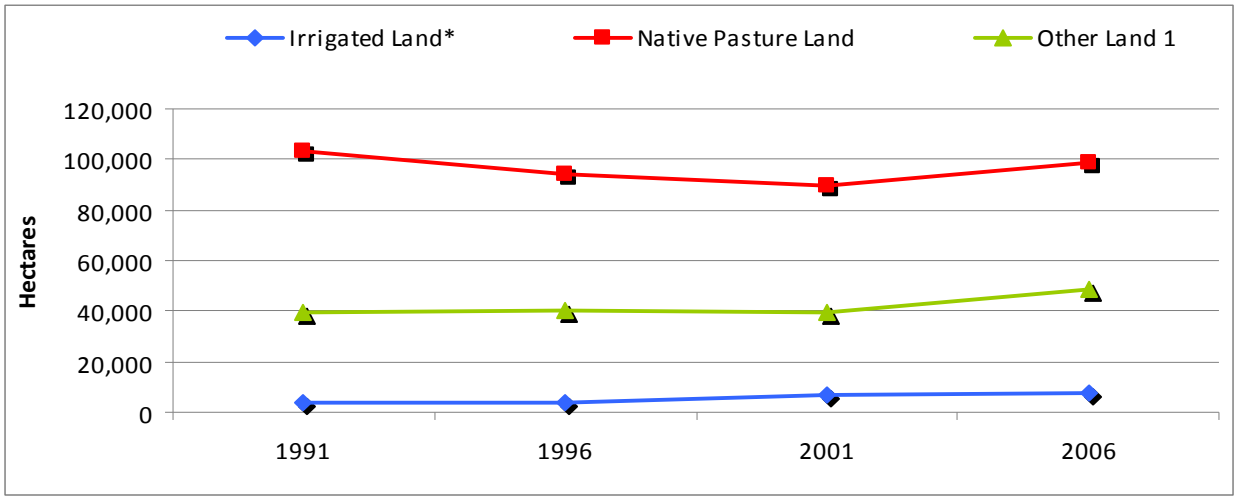
Figure 20: Total number of farm operations using irrigation in the Central Assiniboine and Lower Souris River watershed from 1991 to 2006



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

Irrigated land increased from 1991 to 2006 by 90% (***Figure 21)***, an increase of approximately 3,500 ha. However, irrigated land continues to make up a very small portion of total crops in the watershed. When considered at the watershed scale, irrigated land makes up around 1.2% of total farmland and potato production makes up approximately 0.8% of the total farmland area. Comparably, during the same time period, native pasture area decreased by 5,200 ha, but remained a large portion of the total farmland area at approximately 17% (98,400 ha). The area of other land (the vast majority of which is comprised by woodlands and wetlands) remained relatively unchanged from 1991 to 2001, but saw a large increase from 2001 to 2006 (an overall increase of 9,200 ha) and made up 8% of total farmland area in 2006.

Figure 21: Irrigated land, native pasture, and other land area trends in the Central Assiniboine and Lower Souris River watershed from 1991 to 2006

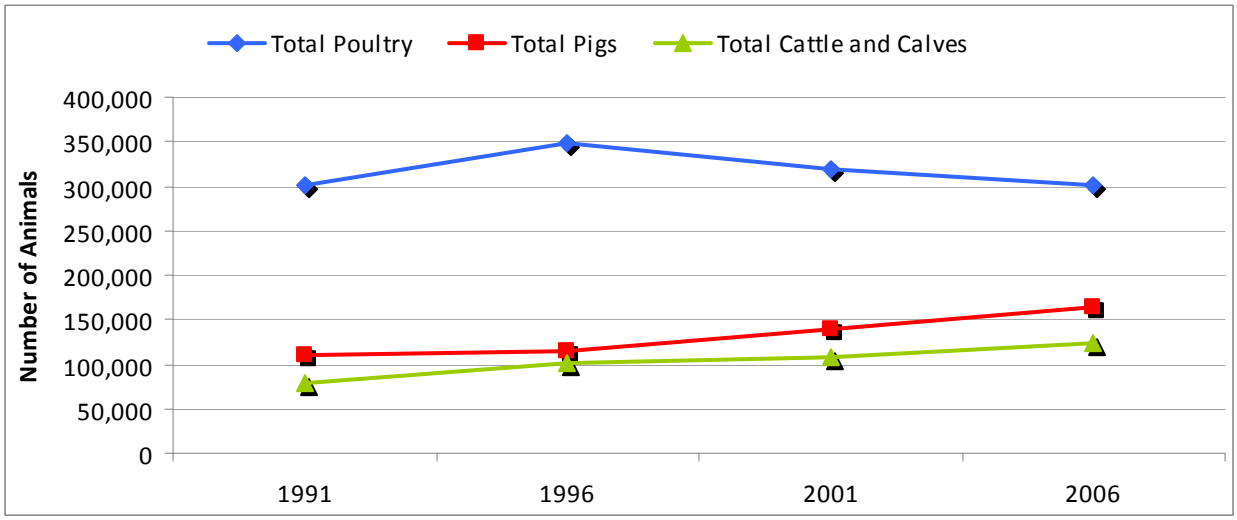


[1] Other land refers to all other land uses including farmyard, woodlot, wetland, Christmas tree, etc.
* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

Livestock Production

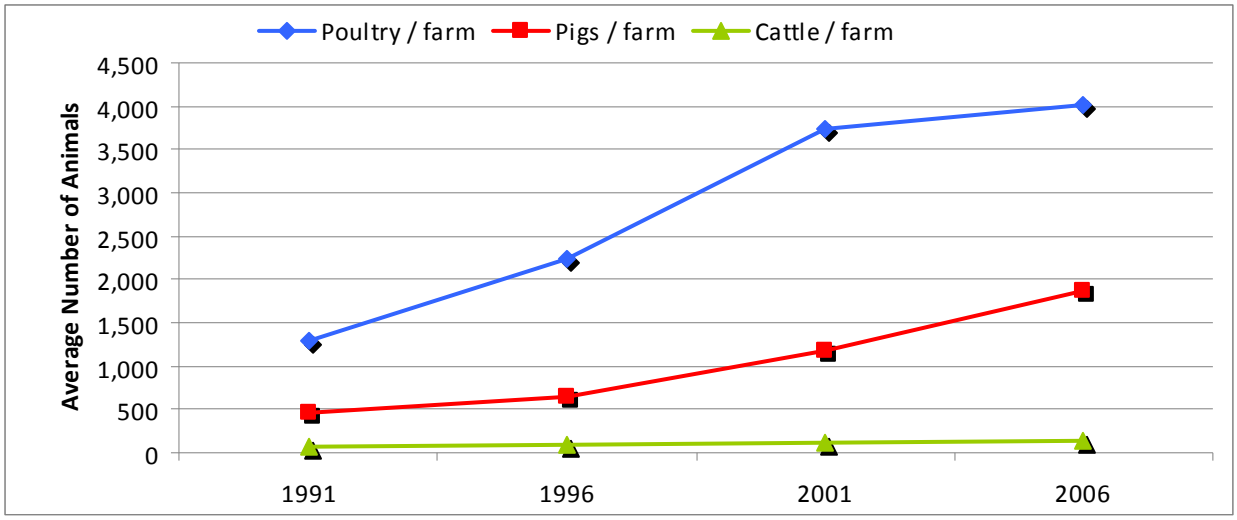
The amount of livestock and poultry produced in the watershed varied during the 1991 to 2006 period (***Figure 22***). Both pig and cattle numbers increased every year since 1991. The number of pigs reported by hog operations increased by 54,200 animals during the time period from 110,500 to 164,700 animals. Cattle numbers also saw a dramatic rise from 1991, with an increase of over 55% over fifteen years. Poultry production in the watershed remained relatively static from 1991 to 2006. The number of birds peaked in 1996 with almost 348,600 birds. However, there was a large change in number of birds at the subwatershed level. Assiniboine saw a decrease of over 109,000 birds over the fifteen year period, while the number of birds reported from the Cypress subwatershed increased by over 125,000. Census data regarding poultry numbers 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.

Figure 22: Major livestock productions trends in the Central Assiniboine and Lower Souris river watershed from 1991 to 2006



Poultry flock size, cattle herd size, and pig herd size increased steadily between 1991 and 2006 (***Figure 23***). This increase may be attributable to the decreasing number of farms (and increasing average farm size) within the watershed and the viability of these sectors between 1996 and 2006. Hog herd size saw the largest relative increase of all livestock types, with an increase of over 300%.

Figure 23: Average number of livestock per farm reporting in the Central Assiniboine and Lower Souris River watershed from 1991 to 2006

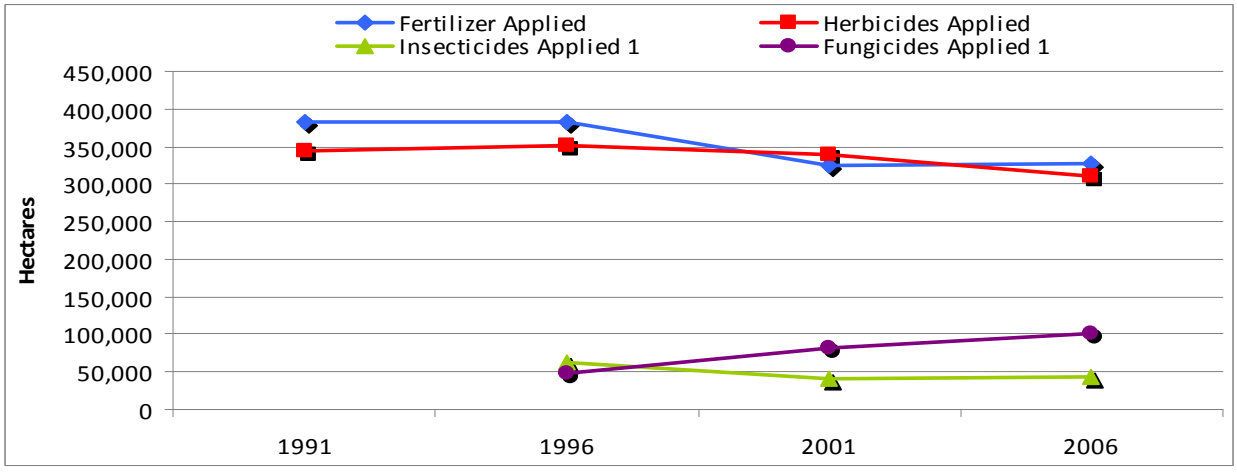


Land Management

Fertilizer and Pesticide Usage

The area of crops with fertilizer and herbicide inputs has decreased in application since 1991 (***Figure 24***). In 2006, approximately 80% of cultivated land was treated with fertilizer and 76% of cultivated land was treated with herbicides. The use of fungicides within the watershed increased steadily since 1996, when data was first collected. Over the ten year period, fungicide application doubled from 47,300 ha to 101,400 ha. Insecticide use remained fairly consistent from 1996, with a slight overall decrease in area applied.

Figure 24: Fertilizer, herbicide, insecticide, and fungicide use in the Central Assiniboine and Lower Souris watershed from 1991 to 2006

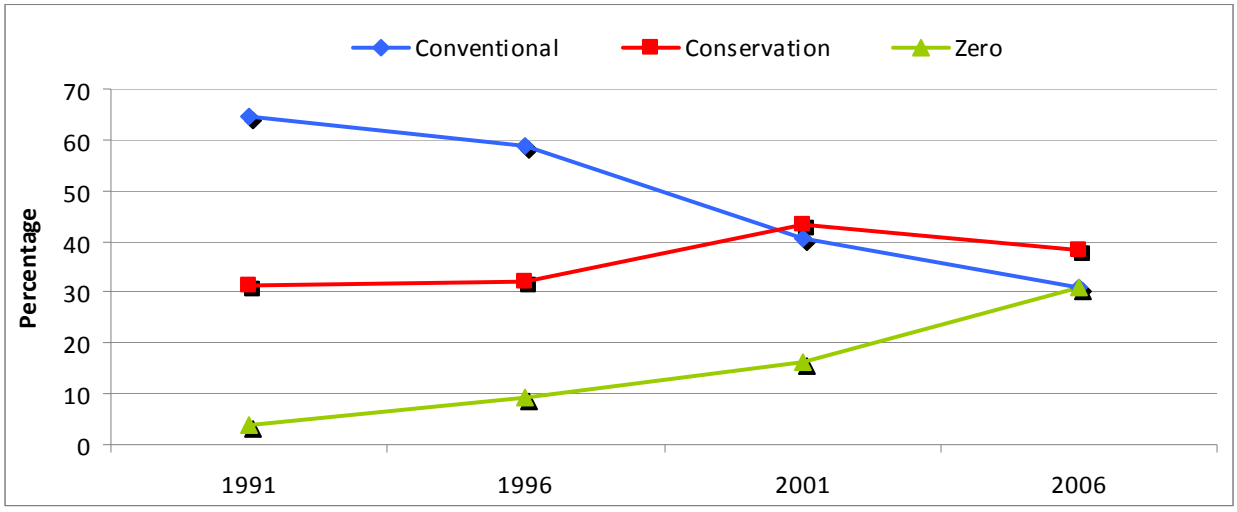


[1] Data for insecticides and fungicides was not available for the 1991 Census year

Tillage Practices

Land management of crop residue underwent a dramatic shift in the watershed with the adoption of conservation and zero tillage practices (***Figure 25***). The area of land managed with conservation tillage saw a modest increase over the fifteen year period. The area of land managed with zero tillage increased steadily over the fifteen year period. In fact, zero tilled land area increased nearly eight fold from 4% to 31% of all cultivated land. This increase coincided with a dramatic decrease in the usage of conventional tillage on 65% of cultivated land to 31%. In the most recent census year, conservation tillage was the most widely adopted practice while conventional and zero tillage management were each used on 31% of land.

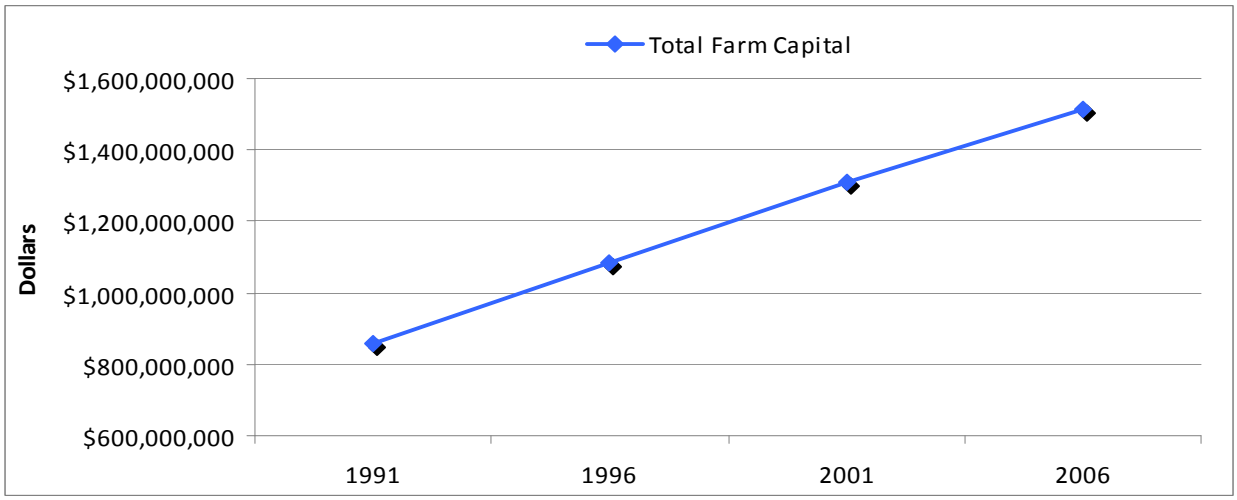
Figure 25: Tillage practices in the Central Assiniboine and Lower Souris River watershed from 1991 to 2006



Financial Characteristics

A near linear increase of total farm capital occurred in the watershed over the fifteen year period. Farm capital nearly doubled from $857 million in 1991 to over $1.512 billion in 2006 (***Figure 26***).

Figure 26: Total farm capital trends in the Central Assiniboine and Lower Souris River watershed from 1991 to 2006*



*Inflation has not been accounted for in total farm capital

b) Changes in Land Cover – 1994, 2000, 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. Further details on the information used for the land cover analysis and the constraints associated with this data are provided in ***Appendix C***. The 1994 land cover was derived from satellite imagery captured on May 26, 1994, and the 2000 land cover is from imagery taken on May 18, 2000, while the 2006 land cover was captured on August 15, 2006.

Summary of Land Cover Change
An analysis of land cover data from 1994, 2000 and 2006 satellite imagery supports the trends observed in the census data, with a large decline in annual cropland and increases in forages and grassland since the 1990s (***Table 5***, ***Figure 27***).

Although there are some inherent limitations in analyzing land cover data to determine changes in land use, some general changes can be noted:

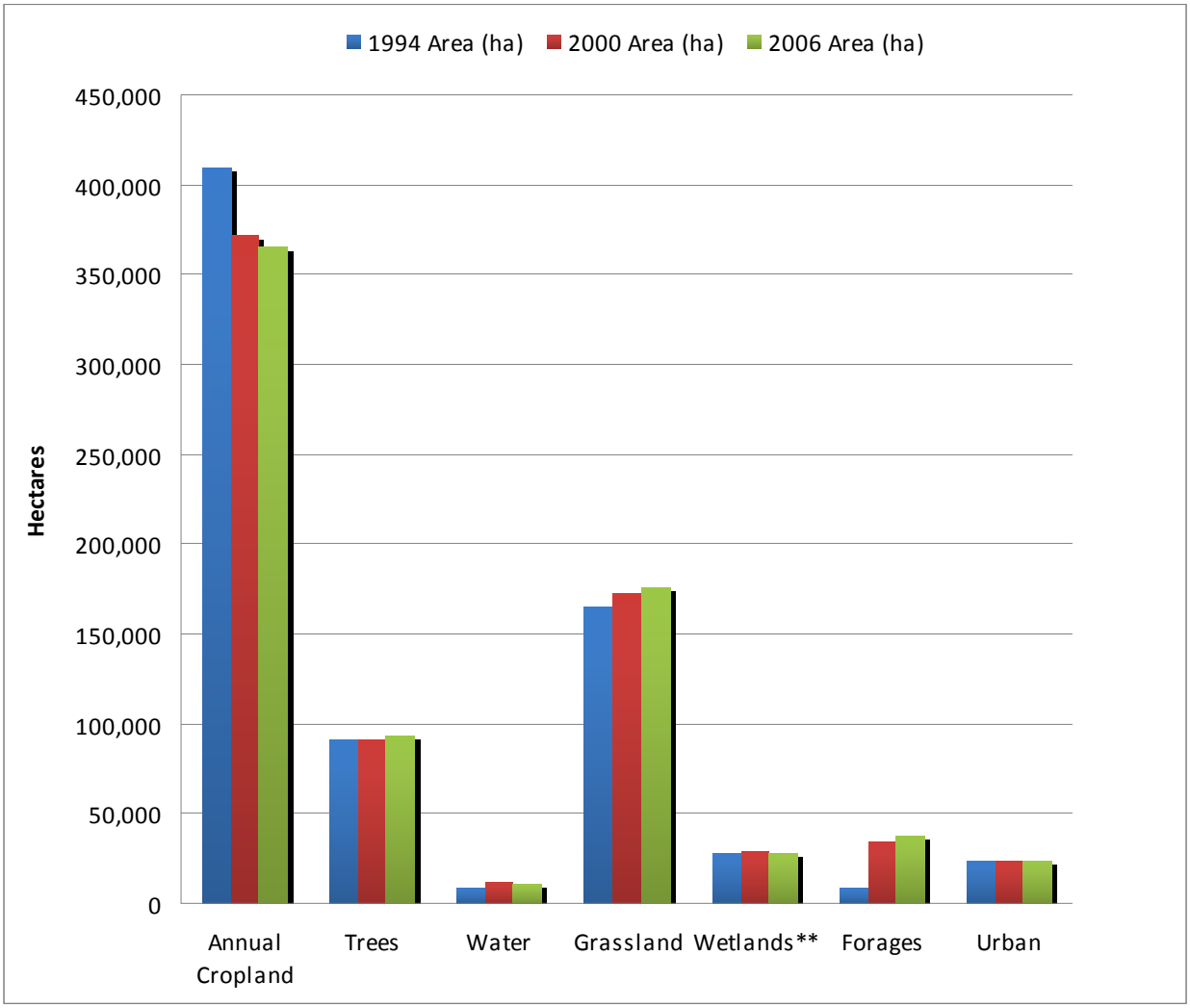
- The largest change in land cover was observed in annual cropland, where there was a decrease of approximately 44,000 ha (from 410,000 to 365,000 ha). These changes have been linked mainly to increases in grasslands and forage.
- All other land cover classifications increased in area from 1994 to 2006 (except wetlands, which had a very small decrease of 121 ha). The land cover classification with the largest increase in area was forages, which increased 28,600 ha over the 13-year period. Some of the forage increases may be attributed to the Assiniboine Hills Conservation District's forage seed assistance program.
- The area of natural areas, including grassland/pasture and forested land, increased between 1994 and 2006.
- Total precipitation levels and total rainfall levels recorded for the watershed were lower than the 30 year average in 2006 and higher in 2000. Weather stations in the northwest portion of the watershed recorded levels in 1994 that were lower the 30-year average, but were higher in the southeast portion. This information is particularly important when considering the extent of wetland areas, which may be overly or under represented during years when recorded rainfall deviates from the average (see ***Appendix Q***).

Table 5: Change in land cover from 1994 to 2006*

Land Cover	1994 Area (ha)	2000 Area (ha)	2006 Area (ha)	Change from 1993 to 2000 (ha)	Change from 2000 to 2006 (ha)	Total Change from 1994 to 2006 (ha)
Annual Cropland	409,722	371,381	365,234	-38,341	-6,147	-44,488
Trees	90,956	91,463	93,140	507	1,677	2,184
Water	8,702	12,246	11,248	3,544	-998	2,546
Grassland	164,712	172,671	175,538	7,959	2,867	10,825
Wetlands**	28,056	28,620	27,936	564	-685	-121
Forages	8,826	34,541	37,444	25,715	2,903	28,618
Urban	23,606	23,659	24,041	53	382	435
TOTAL	**734,581**	**734,581**	**734,581**			

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

Figure 27: Comparison of change in land cover from 1994 to 2006*



* 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

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 1994 to 2006. A more detailed examination of the land cover classes from 1994 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 possible impacts felt in environmentally sensitive areas. 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 1994 to 2006.

In the Central Assiniboine and Lower Souris River IWMP:

- Most of the changes to annual cropland cover occurred within the southern and western portions of the watershed (***Figure 29***). Although change in annual cropland cover did occur in the western portion of the watershed, it was localized near the Cypress River, southeast of Spruce Woods Provincial Park.
- Annual cropland was most often converted to grassland and forages, which is consistent with trends observed using Census of Agriculture data (***Figure 28***). Conversion from cropland to other land cover was distributed equally across the entire watershed, while conversion to cropland appeared to be concentrated in the northern portion of the watershed around Brandon.
- A decrease of almost 44,500 ha (11%) of annual cropland was observed in the watershed from 1994 to 2006 (***Table 5***).
- 31,000 ha of cropland were converted to forages during the 13-year period. Less than 15% of that (4,200 ha) experienced the reciprocal conversion to cropland during that time.
- Approximately 29,000 ha of annual cropland was converted to grasslands in 2006. Around 13,000 ha experienced the reciprocal conversion from cropland to grassland by 2006, resulting in a net decrease of annual cropland (16,500 ha).
- Other changes to and from annual cropland cover were associated with wetlands and treed areas; however the amounts were negligible in comparison to the size of the watershed.

Figure 28: Total change in area of annual cropland, in relation to other land cover types, in the Central Assiniboine and Lower Souris River IWMP study area (from 1994 to 2006)

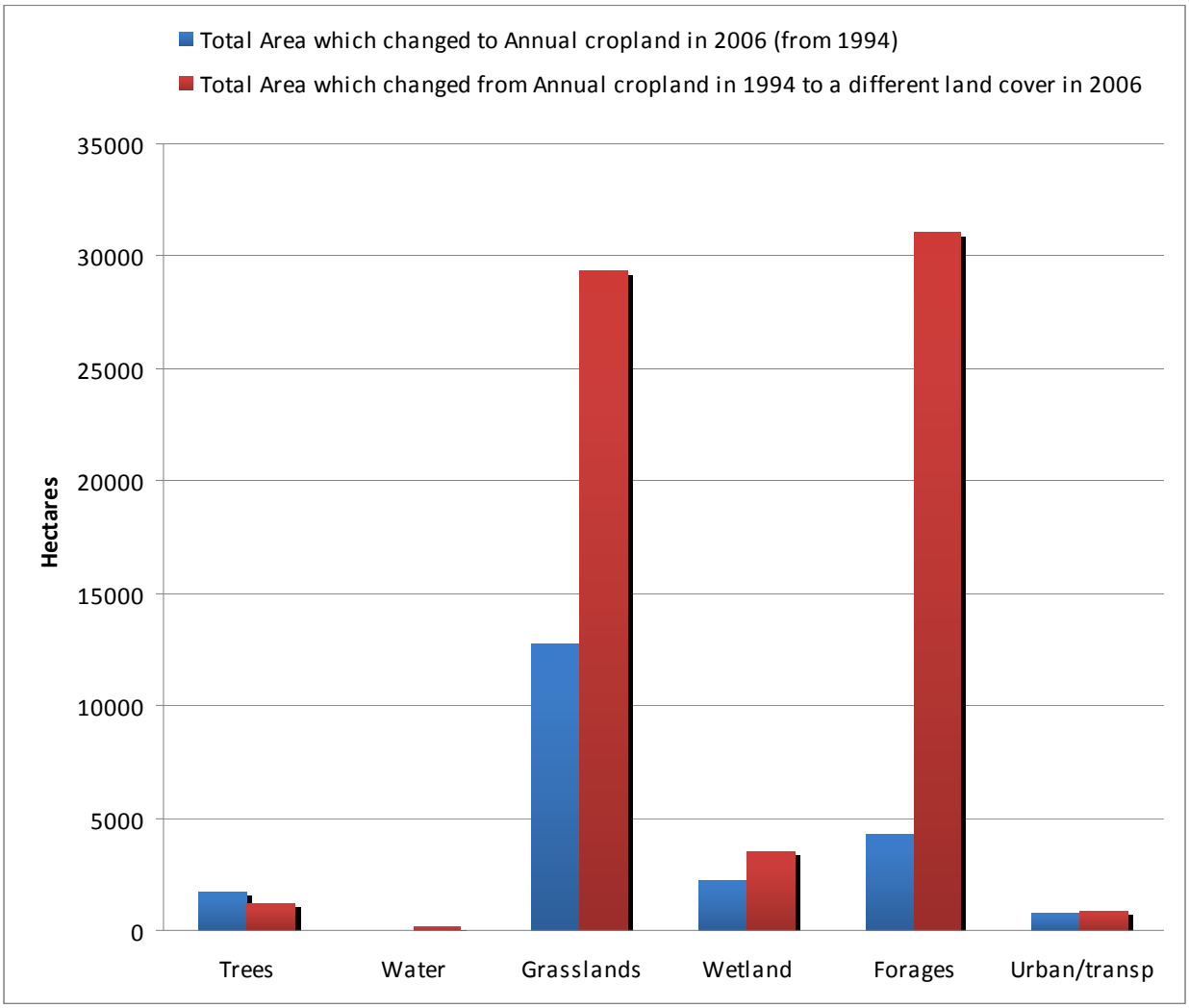
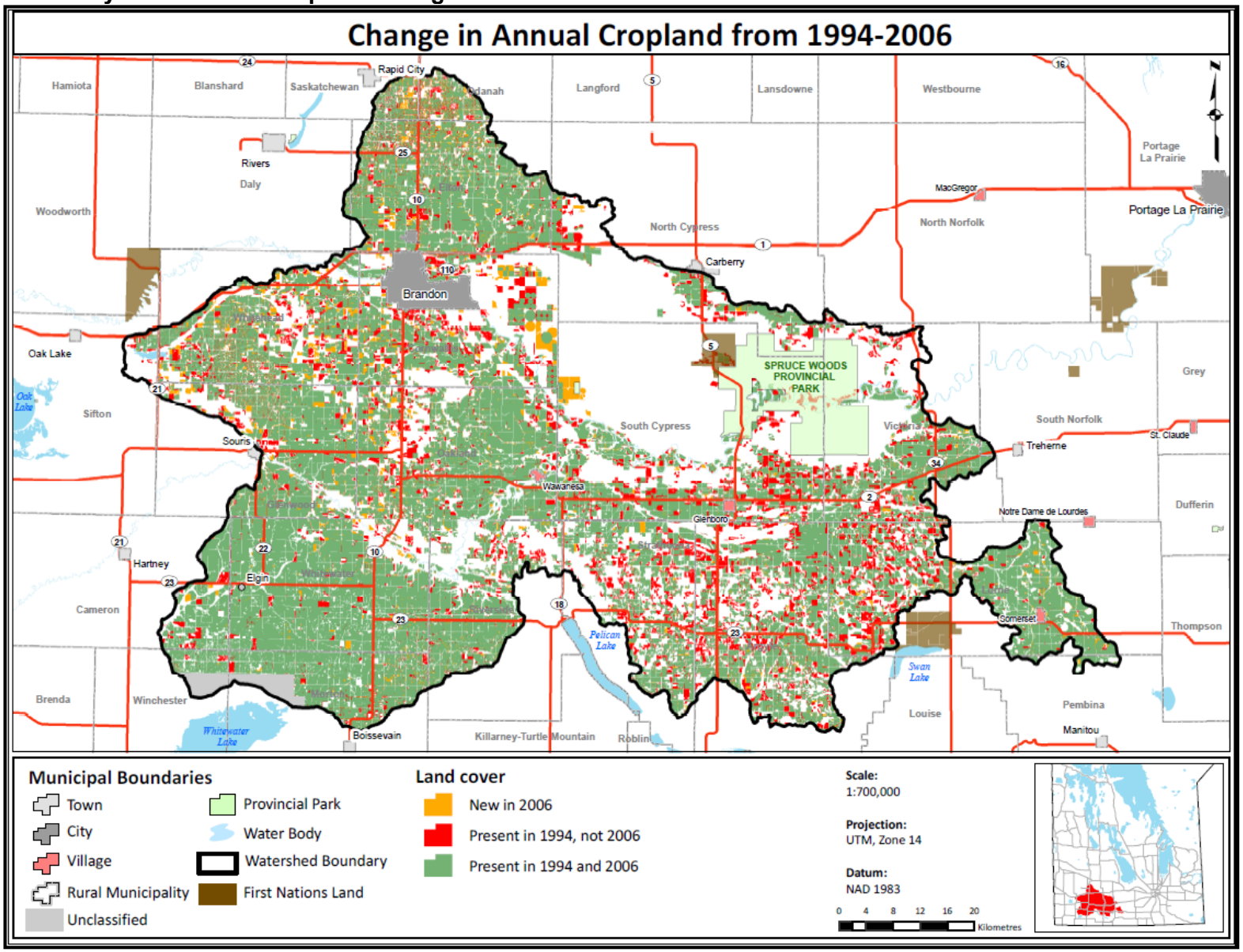


Figure 29: Analysis of Annual Cropland changes between the 1994 and 2006 Land Cover data*



* Land cover is derived from satellite imagery taken May 26, 1994 and August 15, 2006

Changes in Grassland Area

Grasslands can be beneficial for reducing runoff, enhancing flood mitigation and providing natural cover for wildlife. Analyzing changes in grassland cover can provide some insight into potential risks associated with water quality. ***Figure 31*** summarizes parcels which experienced changes to and from grassland from 1994 to 2006.

While conversion to and from grasslands may sometimes be the result of market trends and present economic opportunities and benefits, there may be an associated risk to the environment. 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, increased runoff levels would increase the concentrations of contaminants in water if appropriate management practices are not utilized.

In the Central Assiniboine and Lower Souris River IWMP:

- There was an overall increase of almost 11,000 ha of grassland in 2006 (***Table 5***), an increase of almost 7% from1994 cover.
- Conversion of cropland to grassland was the primary factor responsible for the increase in grassland cover (***Figure 30***). Over 29,000 ha of cropland was converted to grassland over the 13-year period. Around 13,000 ha of land experienced the reciprocal conversion of grassland to annual cropland, resulting in a net increase of 16,500 ha of grassland.
- All other land cover categories (trees, water, wetland, forages, and urban) experienced a net increase in their respective areas as a result of changes to and from grasslands. Of these, treed areas had the largest area converted from grasslands.
- New grassland areas were distributed equally throughout the watershed. Loss of grassland (primarily to annual cropland) was concentrated in the northwest (***Figure 31***), some of which was converted to irrigated land (***Figure 21***).

Figure 30: Total change in area of grassland, in relation to other land cover types, in the entire Central Assiniboine and Lower Souris river IWMP study area (from 1994 to 2006)

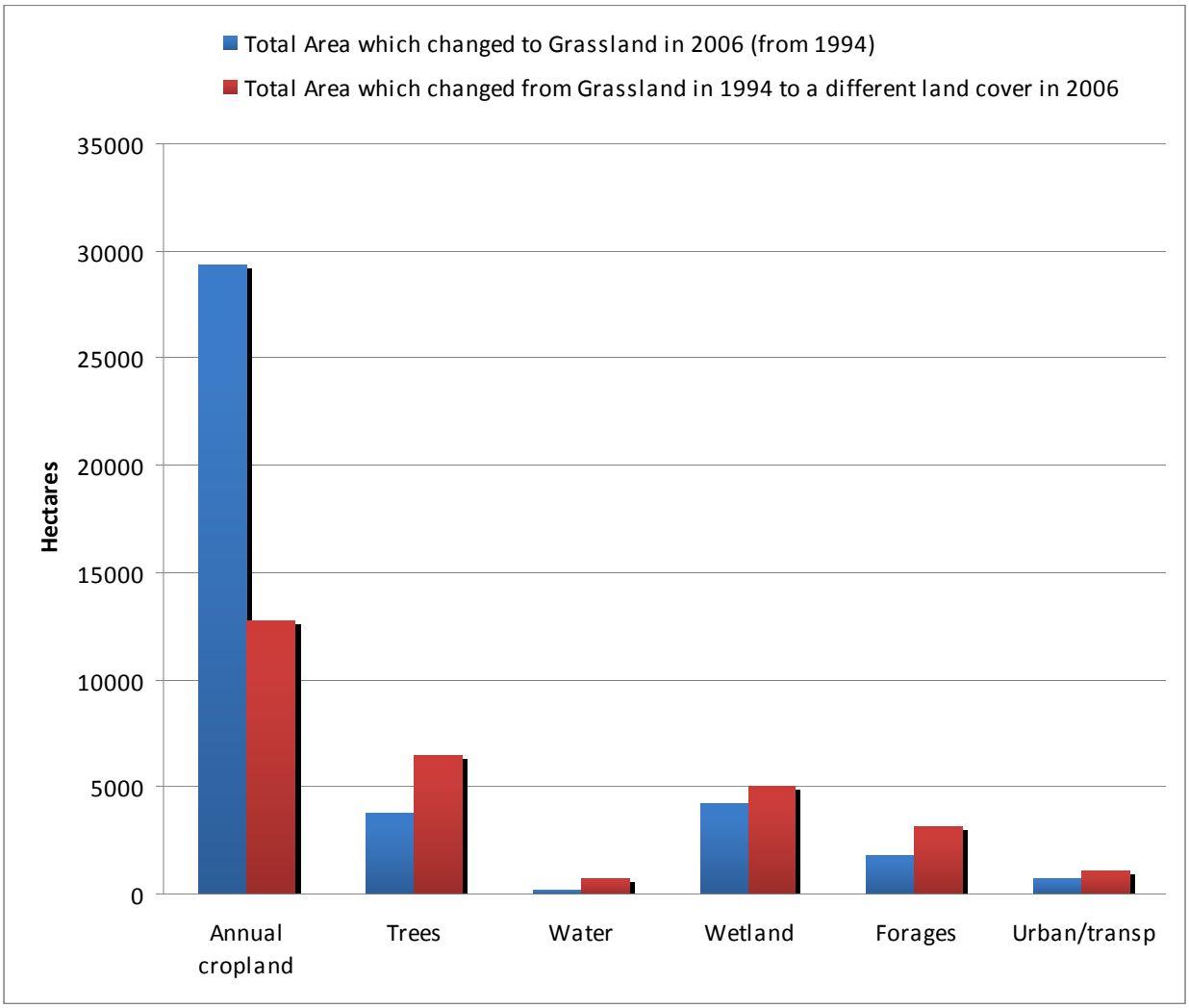
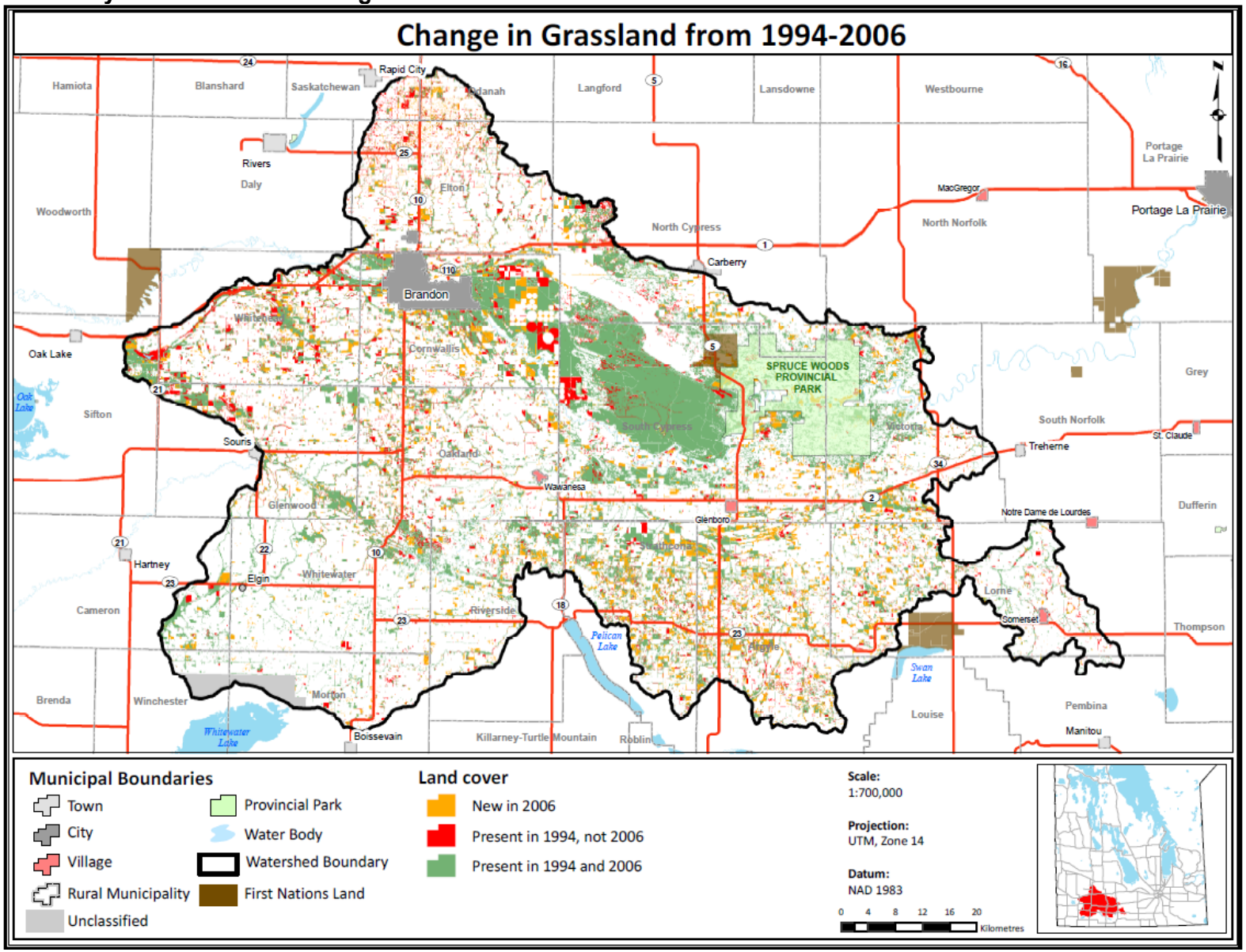


Figure 31: Analysis of Grassland changes between the 1994 and 2006 Land Cover data*



* Land cover is derived from satellite imagery taken May 26, 1994 and August 15, 2006

Changes in Forested Areas

Assessing the Forested Areas classification change can provide some information about impacts of flooding, water supply and quality, as well as natural areas. ***Figure 33*** summarizes parcels which experienced changes to and from forested areas from 1994 to 2006.

In the Central Assiniboine and Lower Souris River IWMP:

- Forested areas covered a large portion of the watershed (13%). The area of forest in the watershed remained fairly consistent over the 13-year period, increasing 2,200 ha in overall cover (2% increase compared to 1994 cover) (***Table 5***).
- There was an overall increase of approximately 2,100 ha of forested areas in 2006 when compared to 1994 (***Table 5***).
- The largest change to forested cover was in respect to grassland cover. Forest encroachment resulted in conversion of 6,500 ha of grassland. The reciprocal conversion of forested area to grassland was 3,700 ha (***Figure 32***).
- Other large changes occurred with the annual cropland and wetland land cover categories; however, reciprocal changes to and from forested areas were near equal resulting in little contribution to the overall change.
- Most of the new forested areas noted for 2006 resulted from encroachment of previously forested areas into adjacent grasslands near Spruce Woods Provincial Park. Much of the forested land lost to other cover types was located in the extreme northern portion of the watershed, as well as a large area of land west of Spruce Woods Provincial Park that changed to wetland.

Figure 32: Total change in Forested Areas, in relation to other land cover types, in the Central Assiniboine and Lower Souris River IWMP study area (from 1994 to 2006)

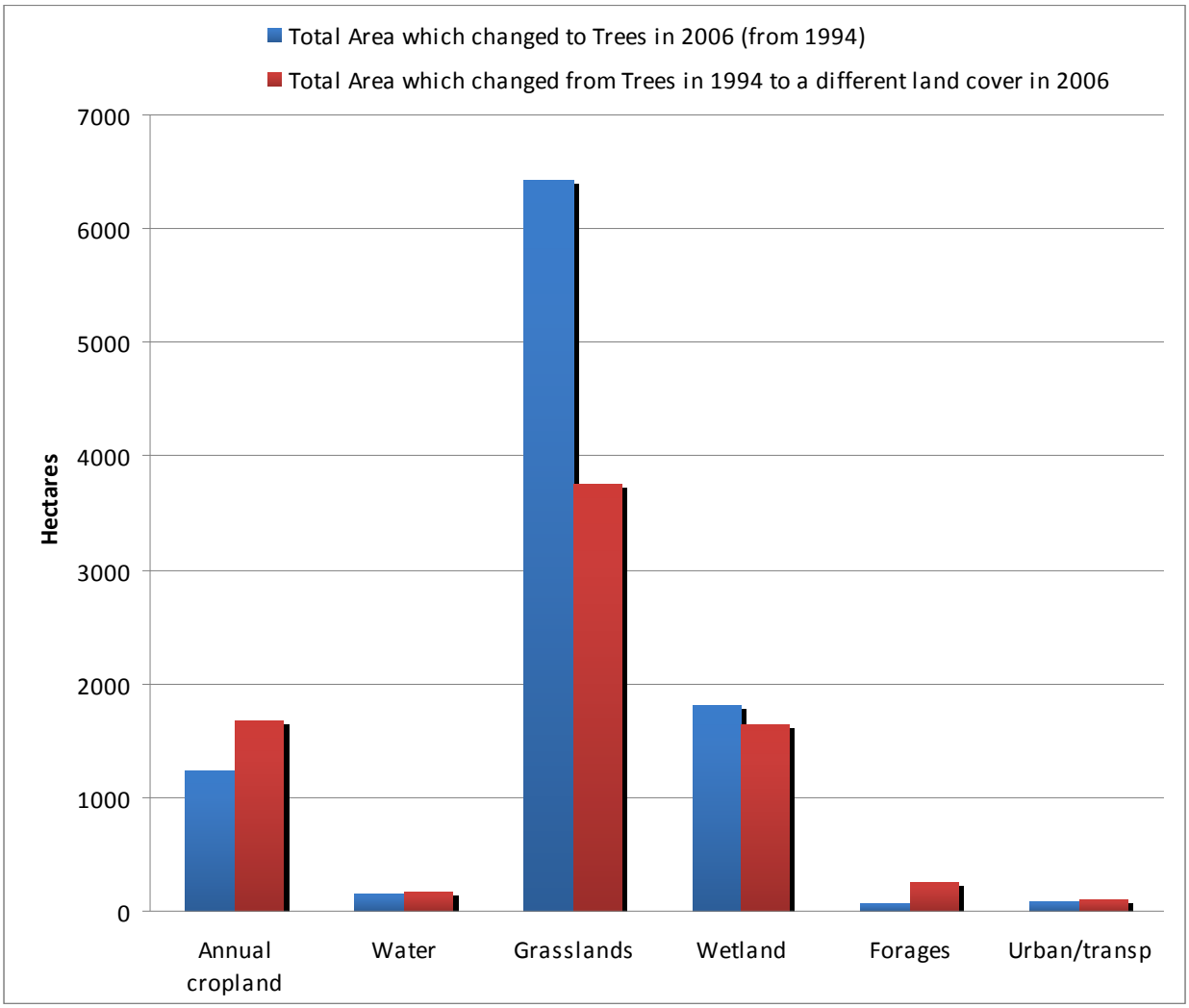
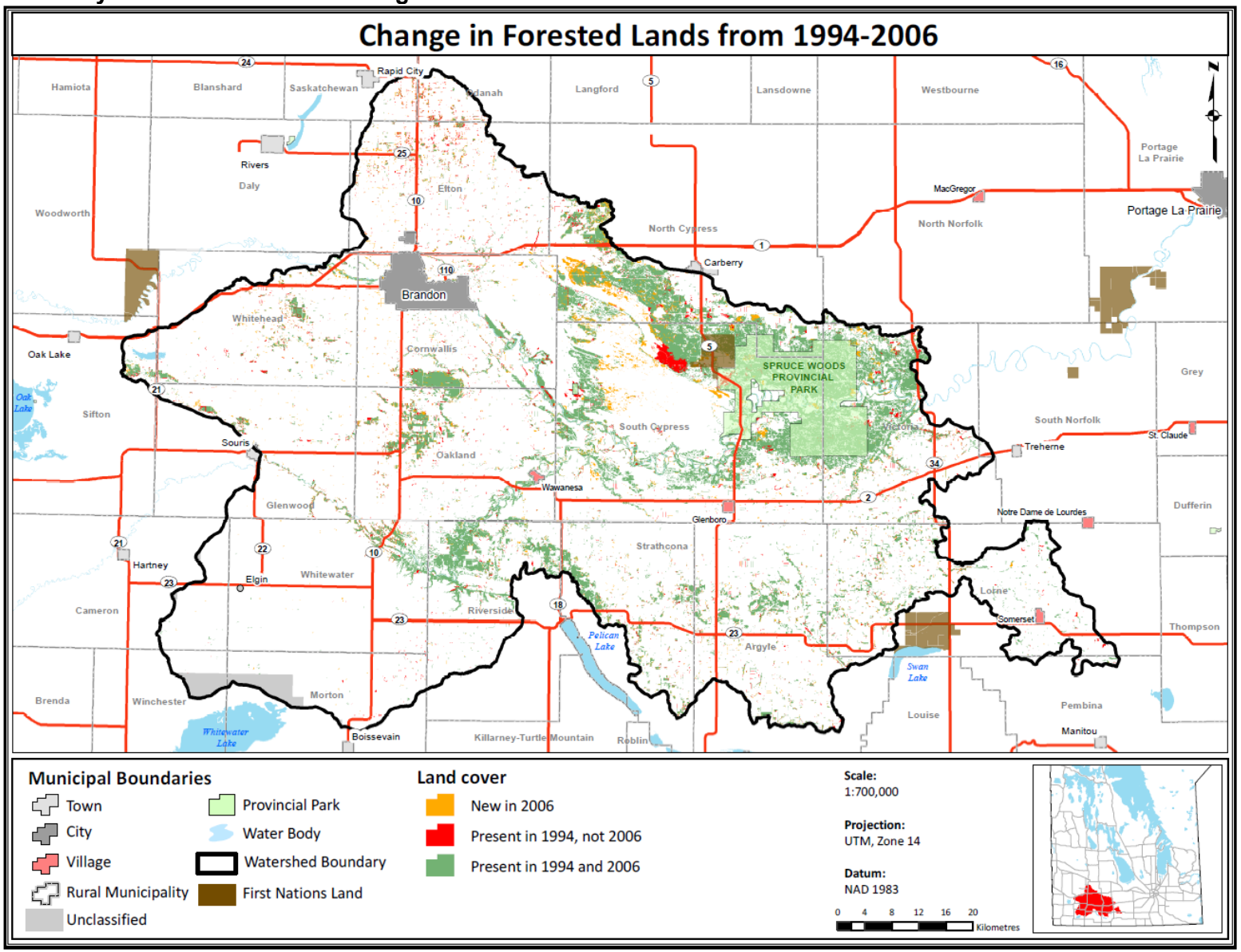


Figure 33: Analysis of Forested Area change between the 1994 and 2006 Land Cover data*



* Land cover is derived from satellite imagery taken May 26, 1994 and August 15, 2006

Changes in Forage Area

Assessing Forage Area classification changes can provide information regarding the conservation of natural habitat and the adoption of erosion control beneficial management practices. ***Figure 35*** summarizes parcels which experienced changes to and from forages from 1994 to 2006.

In the Central Assiniboine and Lower Souris River IWMP:

- Forage cover increased dramatically in the watershed by nearly 325% from 1994 to 2006 (an increase of over 28,500 ha) (***Table 5***).
- Analysis indicates that conversion from annual cropland was primarily responsible for the increased forage cover in the watershed, which is consistent with trends observed using Census of Agriculture data.
- 31,000 ha of cropland were converted to forages during the 13-year period. Less than 15% of that (4,200 ha) experienced the reciprocal conversion to cropland during that time.
- In correlation with the decrease in annual cropland, there was an increase in forages and grassland from 1994 to 2006. This can be 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.
- A small amount of grasslands was converted to forages between 1994 and 2006 (3,173 ha).

Figure 34: Total change in area of forages, in relation to other land cover types, in the Central Assiniboine and Lower Souris River IWMP study area (from 1994 to 2006)

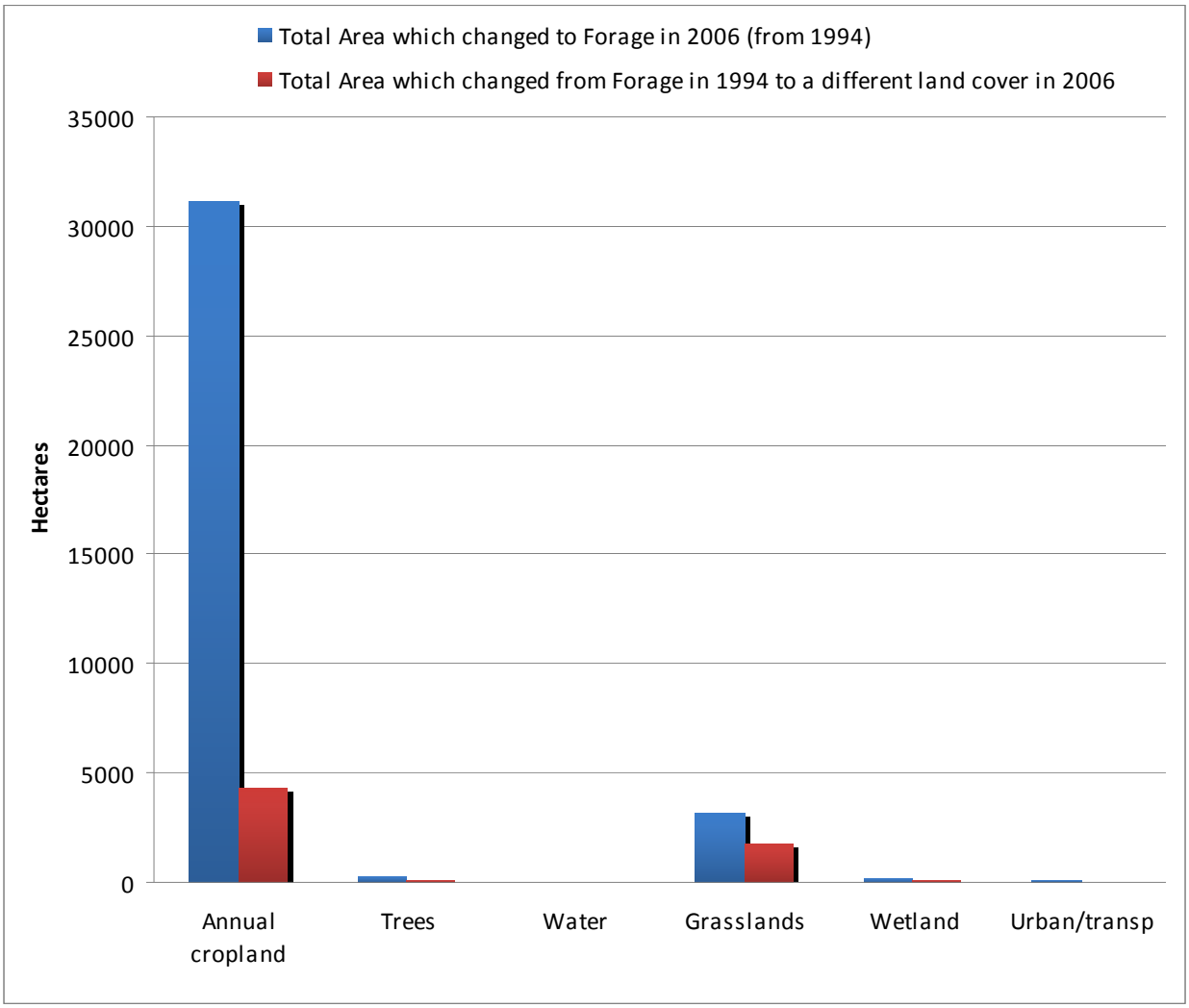
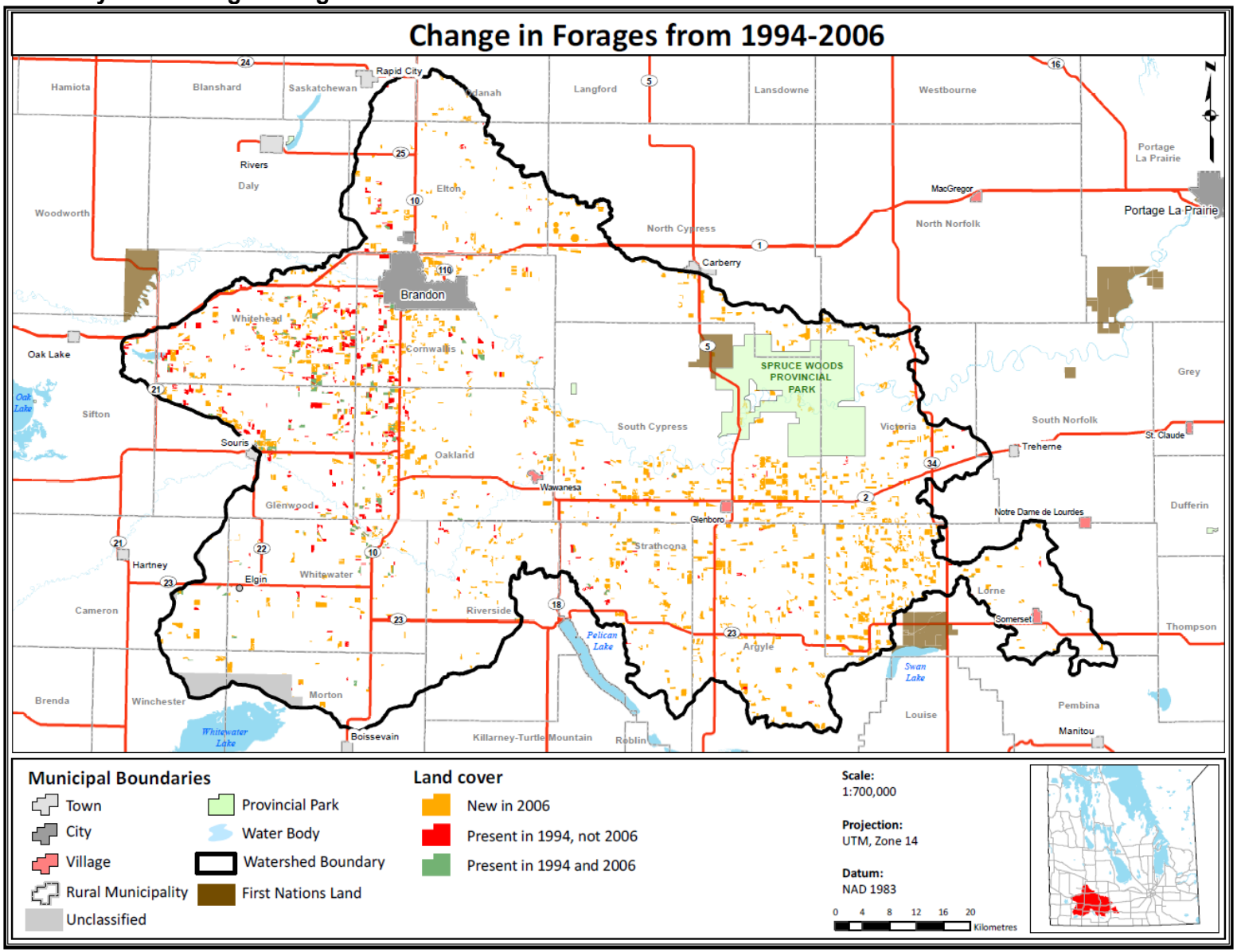


Figure 35: Analysis of Forage changes between the 1994 and 2006 Land Cover data*



* Land cover is derived from satellite imagery taken May 26, 1994 and August 15, 2006

Advanced Wide Field Sensor Land Cover Analysis on Cropping Practices

Advanced Wide Field Sensor (AWiFS) is a more recent 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 in 1994 to annual cropland in 2009 were identified as cereals (28,248 ha)
- Most of the converted area identified was dispersed throughout the watershed as small fragments.
- Some concentrated areas of change were located in the northcentral and northwest portions of the watershed (***Figure 36***)
- Only 800 ha that were identified as grasslands in 1994 were identified as potatoes in 2009. This area is isolated in a region to the southwest of Brandon.
- Potato production has been identified and confirmed through local knowledge southwest of Brandon.

Examination of AWiFS land cover with respect to forest changes

- Lands previously identified as forested lands in 1994 that became annual cropland were further analyzed using AWiFS land cover.
- Much of the area identified was dispersed throughout the watershed as small fragments and along the Assiniboine and Souris Rivers. Due to the highly fragmented nature of the land cover, results are displayed in table format (***Table 6***)
- Approximately 4,217 ha of converted land were identified as either cereal (approximately 3,200 ha.) or canola/rapeseed (approximately 1,000 ha.) in 2009.
- The amount of previously forested land identified as potatoes in 2009 was less than 100 ha. This was consistent with other row and pulse crops.
- The results noted here are consistent with other land cover analyses and information obtained from the agricultural profile using Census of Agriculture data.

Figure 36: Land cover changes from 1994 Grasslands to other land cover types in 2009, as identified by AWiFS

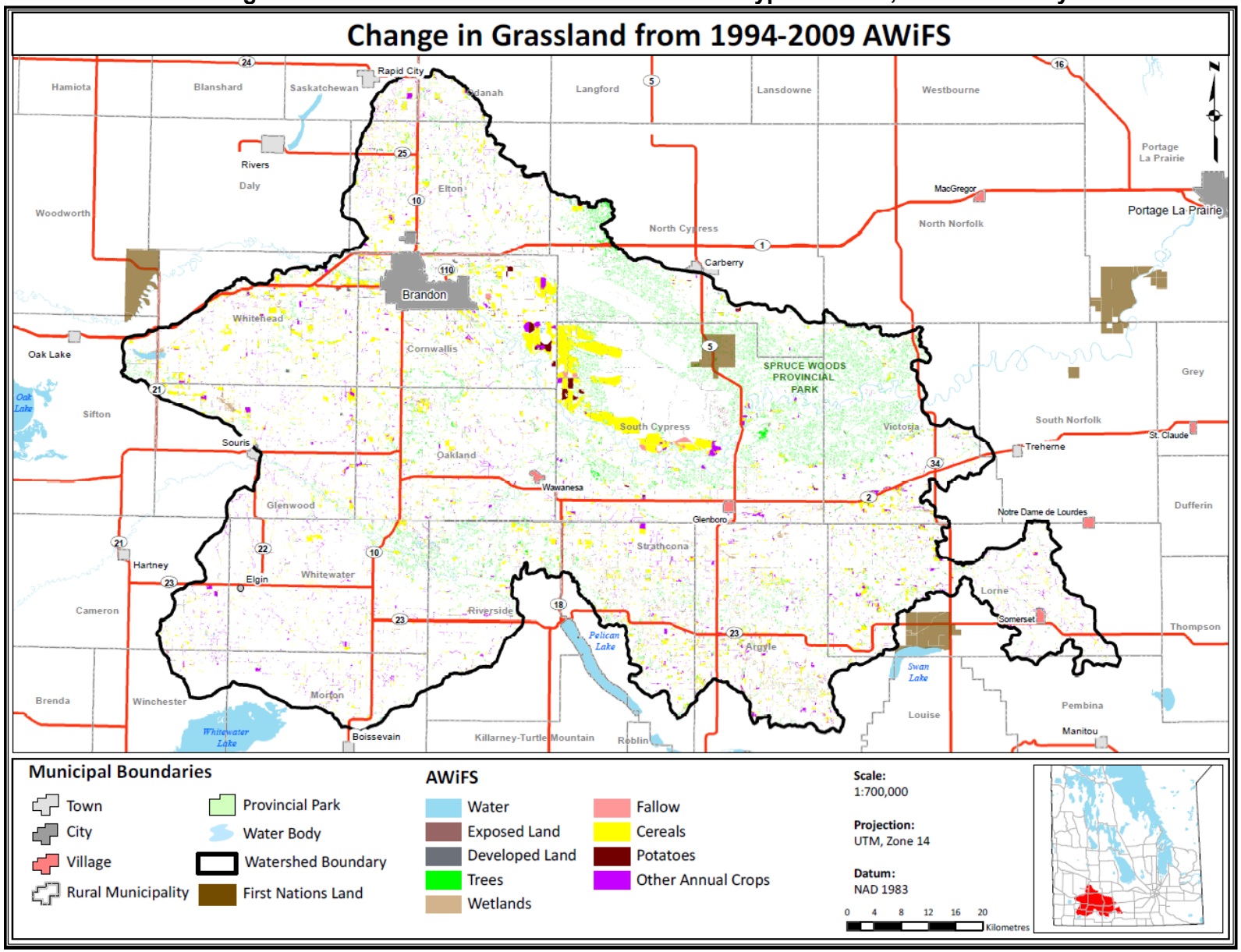


Table 6: Land cover changes from 1994 Forest land to other land cover types in 2009, as identified by AWiFS

2009 Land Cover Type	Area of land classified (ha)	Percentage of land classified (ha)
Water	1,018	5%
Exposed Land	28	0%
Developed Land	726	4%
Wetlands	1,482	8%
Grassland/Pasture	11,868	60%
Fallow	7	0%
Cereals	3,172	16%
Corn	61	0%
Canola and Rapeseed	1,045	5%
Flax	111	1%
Sunflowers	68	0%
Soybeans	8	0%
Pulse Crops	13	0%
Lentils	0	0%
Potatoes	93	0%
Canary Seed	2	0%
Other Crops	2	0%
TOTAL	**19,706**	

F. Agricultural Land Use and Management Considerations

This section presents analysis of a combination of factors, including land cover 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 demonstrating good land management practices by utilizing these marginal lands for purposes other than annual crop production.

In the Central Assiniboine and Lower Souris River IWMP:

- A large proportion of cropland in the watershed is considered highly productive Class 1, 2 and 3 lands (60% or approximately 442,300 ha).
- 40% (297,000 ha) of the soils in the watershed are Class 4 and lower.
- Less than 2% of the watershed (13,000 ha.) has organic soils.

On Annual Cropland with respect to agricultural capability:

- Within the Central Assiniboine and Lower Souris River Watershed study area, the majority of the annual cropland is located on productive agricultural land, classified as Class 3 and higher (82%, 301,100 ha).
- The majority of the annual cropland on Class 4 and lower soils are located in the central portion of the watershed, in the areas surrounding Brandon, adjacent to the Assiniboine River, and along the tributaries of Oak Creek (see ***Figure 37***). A small area of cropland on Class 7 soils are present in the watershed and are located near the town of Wawanesa and the Souris River.
- In 2006, there was a small area of land used as annual cropland on organic soils (***Table 7***).

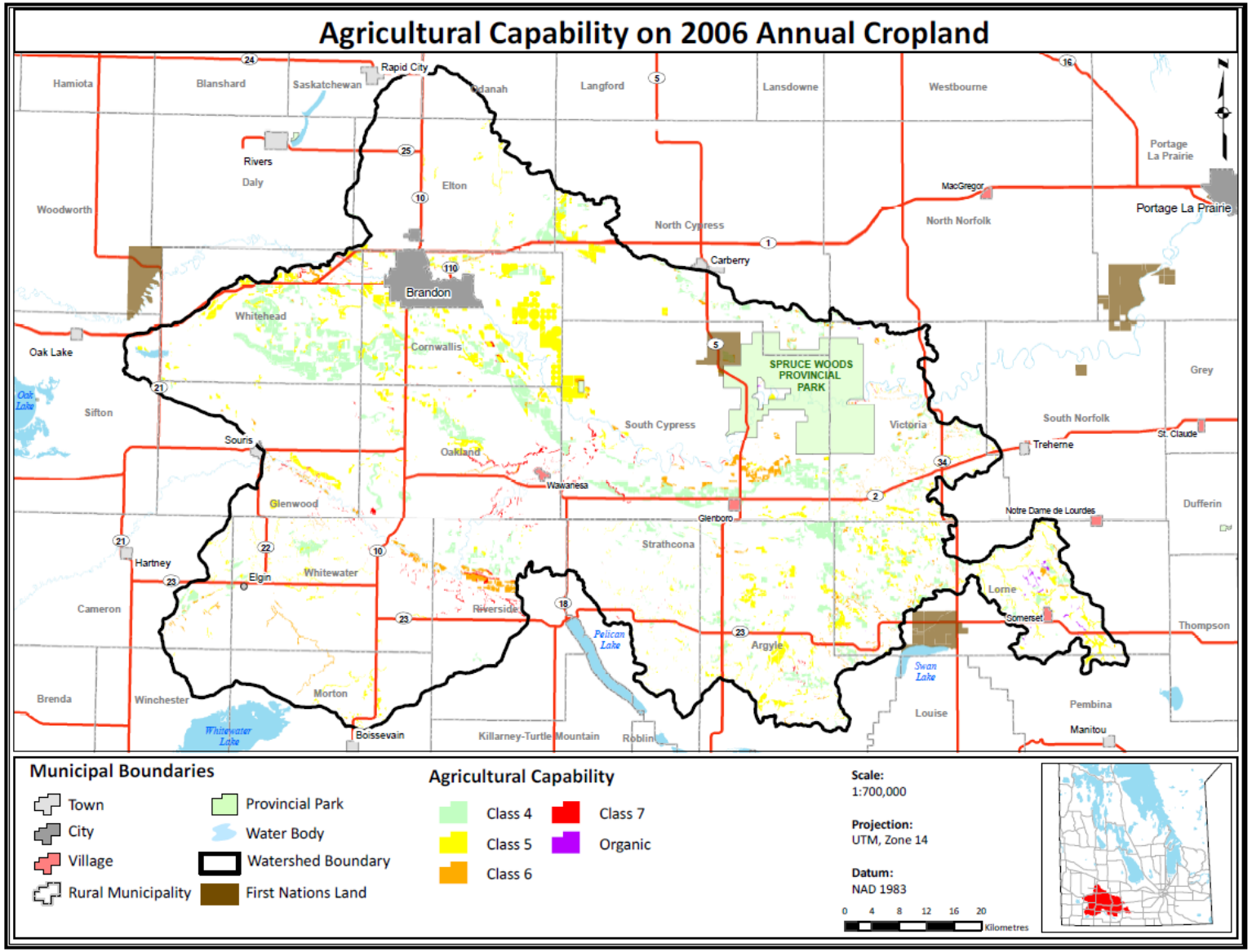
- The total amount of annual cropland in the watershed has decreased since 1994. These decreases are reflected on all soil classes, with a majority of the decreases noted on Class 2, 3 and 4 lands.

Table 7: Agricultural Capability in the Central Assiniboine and Lower Souris River Watershed Study Area

Class[1]	Total Area in IWMP (ha)[5]	1994 Annual Cropland (ha)[3]	2006 Annual Cropland (ha)[2]	Distribution of Annual Cropland in 2006 (%)	1994 to 2006 Change in Annual Cropland Area (ha)[4]
Class 1	36,452	31,571	29,010	8%	-2,561
Class 2	260,236	200,719	185,566	51%	-15,153
Class 3	145,576	97,553	86,560	24%	-10,992
Class 4	71,926	40,485	31,954	9%	-8,530
Class 5	89,077	28,806	24,419	7%	-4,387
Class 6	92,561	7,649	5,274	1%	-2,375
Class 7	19,511	1,991	1,760	0%	-231
Organic	12,812	296	232	0%	-64
Unclassified	3,233	225	121	0%	-103
Water	8,305	422	335	0%	-87
TOTAL	**739,688**	**409,716**	**365,232**	**100%**	**-44,484**

1. Agricultural Capability is based on the CLI Rating of the dominant soil series for each soil polygon
2. Annual Cropland taken from the 2006 Land Cover (from Landsat Imagery captured on August 15, 2006)
3. Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on May 26, 1994)
4. Figures are derived from the total area of annual cropland in 2006 minus total annual cropland in 1994 in each Class

Figure 37: Agricultural Capability on Annual Cropland in the Central Assiniboine and Lower Souris 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 Central Assiniboine and Lower Souris River IWMP:

- Approximately 37% of land is considered to have soils with a moderate, high, or severe wind erosion risk (***Table 8***).
- A larger portion of the watershed (58%) is considered to have a negligible to low risk of wind erosion.

On Annual Cropland with respect to wind erosion risk:

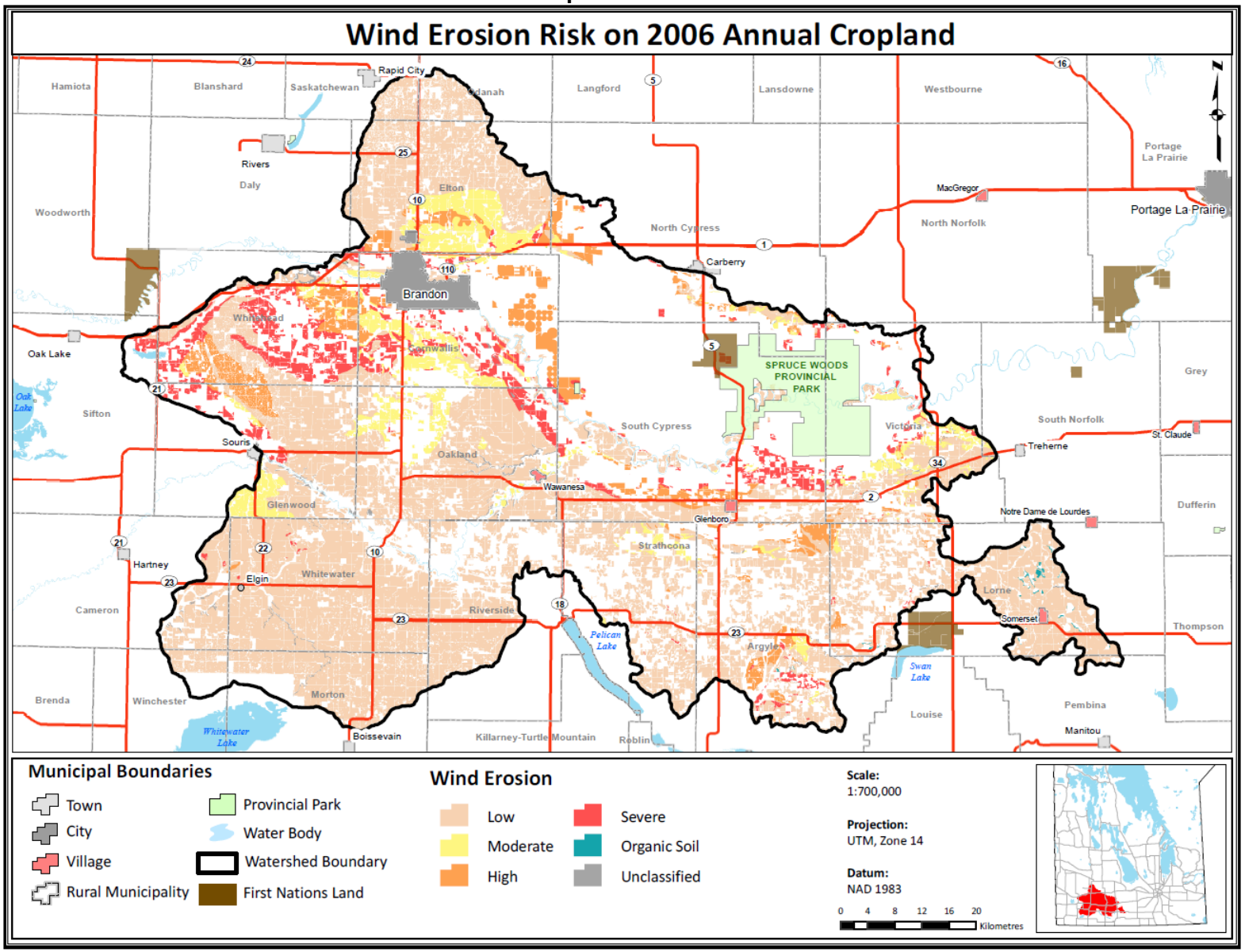
- Based on the 2006 land cover data, approximately 23% of the annual cropland was located on soils with moderate, high, to severe risk for wind erosion (***Table 8***).
- These areas are situated in the north western portion of the watershed surrounding the city of Brandon, and along portions of the Assiniboine River (***Figure 38***). In general, they are associated with sandy, coarse-textured soils.

Table 8: Wind Erosion Risk in the Central Assiniboine and Lower Souris River watershed study area from 2006 Land Cover [1]

Wind Erosion[1]	Total Area in IWMP (ha)	1994 Annual Cropland (ha)[3]	2006 Annual Cropland (ha)[2]	Distribution of Annual Cropland in 2006 (%)	1994 to 2006 Change in Annual Cropland Area (ha)[4]
Negligible	2,978	1,309	1,181	0%	-128
Low	425,958	302,726	274,657	75%	-28,069
Moderate	52,910	35,073	31,933	9%	-3,140
High	64,192	31,081	27,196	7%	-3,885
Severe	153,307	35,430	26,832	7%	-8,598
Organic Soil	13,066	494	426	0%	-68
Water	8,305	422	335	0%	-87
Unclassified	19,064	3,187	2,674	1%	-514
TOTAL	**739,779**	**409,722**	**365,234**	**100%**	**-44,488**

1. Wind Erosion Risk is based on the weighted wind erosion rating for each soil polygon and assumes bare soil.
2. Annual Cropland taken from the 2006 Land Cover (from Landsat Imagery captured on August 15, 2006)
3. Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on May 26, 1994)
4. Figures are derived from the total area of annual cropland in 2006 minus total annual cropland in 1994 in each Risk Class

Figure 38: Risk of Wind Erosion Risk on 2006 Annual Cropland in the Central Assiniboine and Lower Souris 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 Central Assiniboine and Lower Souris River IWMP:

- An examination of the watershed shows that approximately 38% of the study area (283,700 ha) has a moderate to severe risk to water erosion. Thirteen percent of the watershed is identified as having a severe water erosion risk (***Table 9***).

On Annual Cropland with respect to water erosion risk:

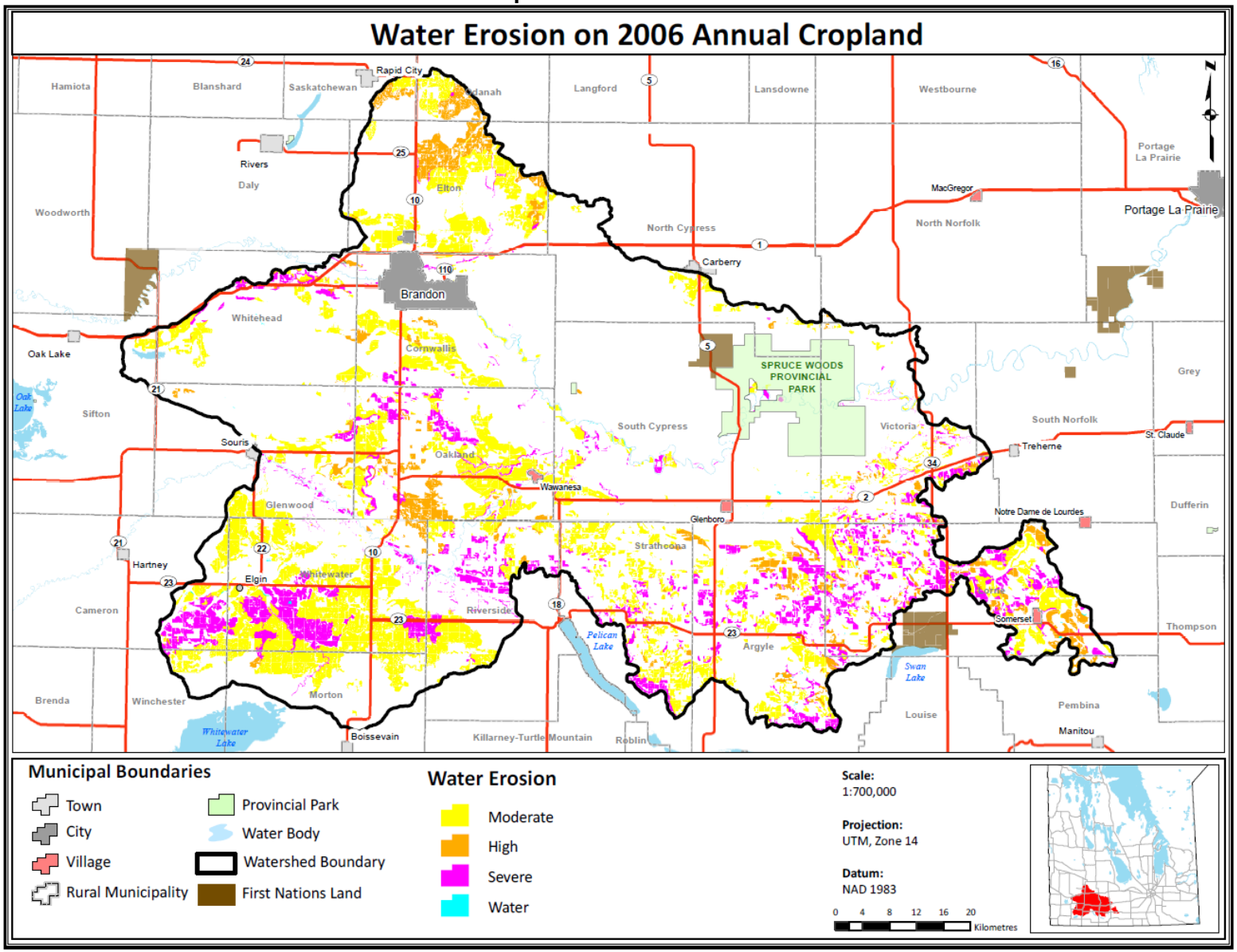
- Analysis of 2006 land cover shows that approximately 46%, (167,900 ha) of the annual cropland hectares was located on soils with a moderate, high, or severe water erosion risk.
- Most of the soils with high or the severe risk of water erosion are located in the southern portion of the watershed south of Highway 2 (***Figure 39***) and north of Brandon. Cropland with severe risk of water erosion is concentrated around the Souris River and its tributaries, Oak Creek, and the Cypress River.

Table 9: Water Erosion Risk in the Central Assiniboine and Lower Souris River watershed study area from 2006 Land Cover

Water Erosion[1]	Total Area in IWMP (ha)	1994 Annual Cropland (ha)[3]	2006 Annual Cropland (ha)[2]	Distribution of Annual Cropland in 2006 (%)	1994 to 2006 Change in Annual Cropland Area (ha)[4]
Negligible	205,732	79,207	66,800	18%	-12,406
Low	238,764	143,115	129,989	36%	-13,126
Moderate	151,721	114,809	105,573	29%	-9,235
High	36,122	25,037	22,277	6%	-2,760
Severe	95,811	46,902	40,136	11%	-6,766
Water	8,305	422	335	0%	-87
Unclassified	3,233	225	121	0%	-103
TOTAL	**739,688**	**409,716**	**365,232**	**100%**	**-44,484**

1. Water Erosion Risk is based on the weighted average USLE predicted soil loss within each soil polygon, assuming bare unprotected soil.
2. Annual Cropland taken from the 2006 Land Cover (from Landsat Imagery captured on August 15, 2006)
3. Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on May 26, 1994)
4. Figures are derived from the total area of annual cropland in 2006 minus total annual cropland in 1994 in each Risk Class

Figure 39: Risk of Water Erosion on 2006 Annual Cropland in the Central Assiniboine and Lower Souris 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 water levels during heavy precipitation events. High water levels could lead to a flood or near-flood stage, thereby increasing the risk for water erosion 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 Central Assiniboine and Lower Souris River IWMP:

- Analysis of the soil drainage shows that the majority (approximately 69% or 507,300 ha) of the study area is well to rapidly drained (***Table 10***).
- A smaller area of land in the watershed is imperfect to very poorly drained (30% or 218,200 ha).
- Most of the imperfectly drained soils are located in the western portion of the watershed. There is also a smaller area of imperfectly drained soil in the vicinity of Glenboro.

On Annual Cropland with respect to soil drainage:

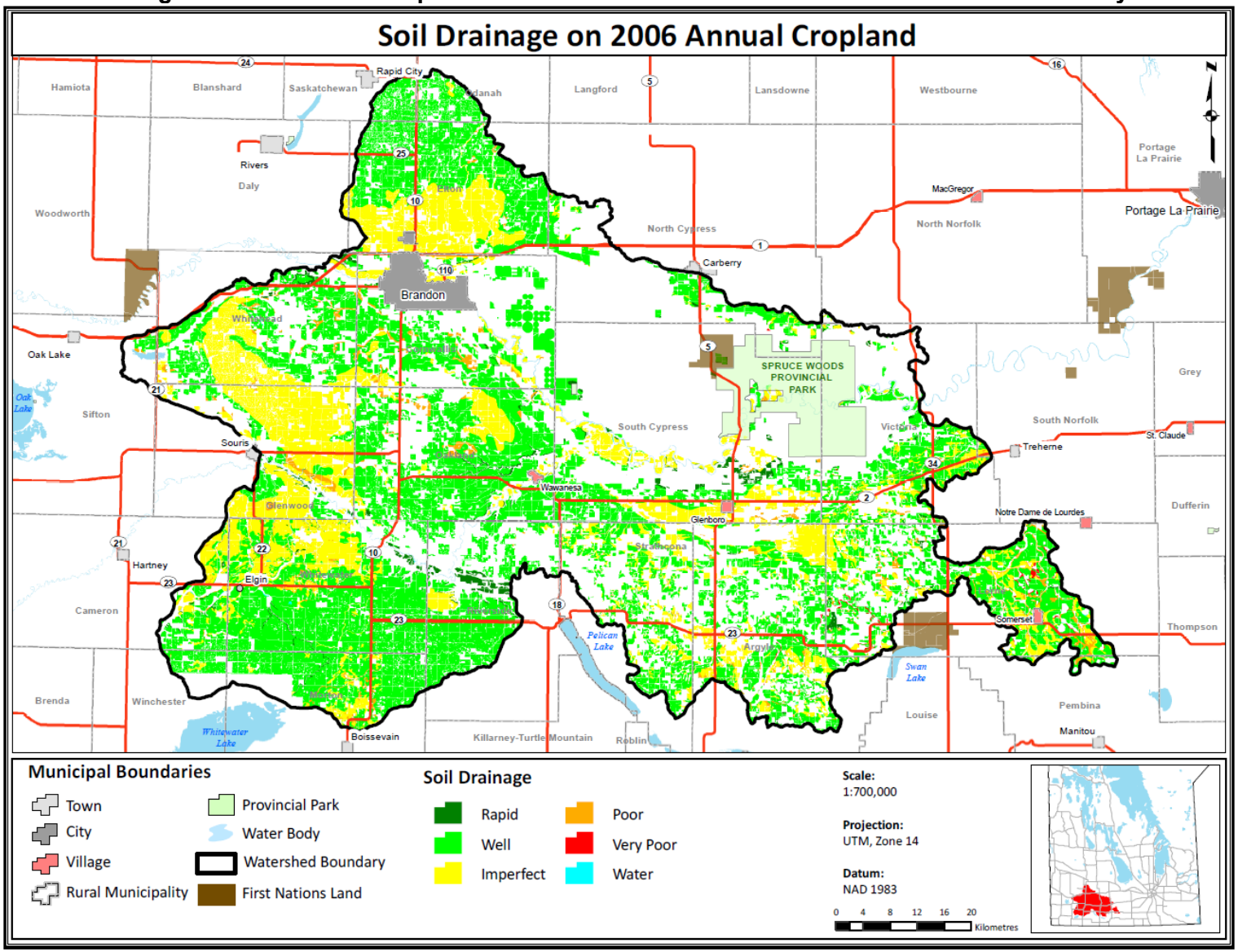
- Most of the annual cropland in 2006 was located on well drained soils in the west and northwest portion of the watershed (***Figure 40***).
- The percentage of annual cropland on very poor to imperfectly drained soil has remained consistent between 1994 and 2006, even with a decrease in annual cropland area (approximately 44,400 ha) during that time.

Table 10: Soil Drainage Classes in the Central Assiniboine and Lower Souris River Watershed

Drainage Class[1]	Total Area in IWMP (ha)	1994 Annual Cropland (ha)[3]	2006 Annual Cropland (ha)[2]	Distribution of Annual Cropland in 2006 (%)	1994 to 2006 Change in Annual Cropland Area (ha)[4]
Rapid	104,221	9,061	6,748	2%	-2,313
Well	403,059	272,777	245,119	67%	-27,657
Imperfect	166,464	113,288	102,033	28%	-11,255
Poor (Improved)	0	0	0	0%	0
Poor	37,065	12,956	10,096	3%	-2,859
Very Poor	14,667	845	685	0%	-161
Unclassified	3,233	225	121	0%	-103
Water	8,305	422	335	0%	-87
TOTAL	**737,015**	**409,574**	**365,138**	**100%**	**-44,436**

1. Drainage Class is based on the CLI Rating of the dominant soil series for each soil polygon
2. Annual Cropland taken from 2006 Land Cover (from Landsat Imagery captured on August 15, 2006)
3. Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on May 26, 1994)
4. Figures are derived from the total area of Annual cropland in 2006 minus total Annual cropland in 1994 in each class

Figure 40: Soil Drainage on 2006 Annual Cropland in the Central Assiniboine and Lower Souris 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. Clay soils are usually fertile because they have a greater capacity to retain nutrients than sandy soils. However, they transmit water very slowly and are therefore susceptible to saturation from excess moisture conditions (PFRA, 2005).

Soil texture in the Central Assiniboine and Lower Souris River watershed can have a bearing on groundwater management and potential risk of contamination. 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 Central Assiniboine and Lower Souris River IWMP:

- Loamy textured soils make up the largest portion of the watershed at 65% or 480,200 ha (***Table 11)***.
- Approximately 23% (69,700 ha) of the watershed has sandy textured soils, which are located almost exclusively along the edge of the Assiniboine Delta Aquifer and the area southwest of Brandon (***Figure 41***).
- Very little soil in the watershed is considered to be organic soil (2% or 14,400 ha).

On Annual Cropland with respect to soil texture:

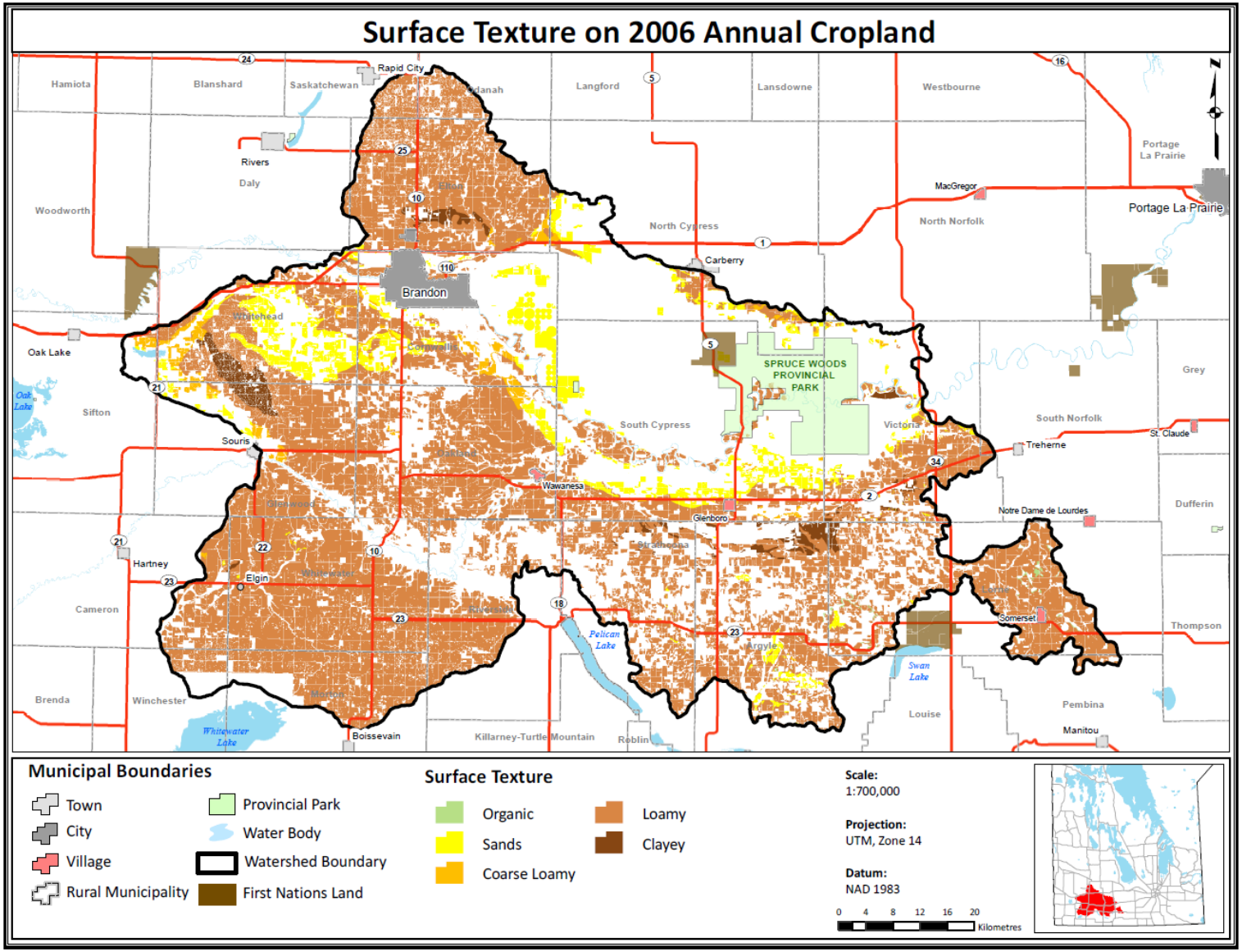
- Approximately 85% (310,000 ha) of the 2006 annual cropland was located on loamy textured soils.
- Annual Cropland decreased on all soil texture classes in the watershed, likely reflective of the overall reduction annual cropland in the watershed from 1994 to 2006 (409,700 ha in 1994 to 365,000 ha in 2006).
- The biggest decrease in annual cropland from 1994 to 2006 occurred on lands classified as loamy textured soils.
- There was a 21% (8,200 ha) decrease in annual cropland from 1994 to 2006 on sandy textured soils.
- Less than 1% of annual cropland in 2006 was located on organic soils.

Table 11: Soil Texture in the Central Assiniboine and Lower Souris River Watershed Study Area

Surface Texture[1]	Total Area in IWMP (ha)	1994 Annual Cropland (ha)[3]	2006 Annual Cropland (ha)[2]	Distribution of Annual Cropland in 2006 (%)	1994 to 2006 Change in Annual Cropland Area (ha)[4]
Organic	14,361	769	634	0%	-136
Coarse	10,459	3,028	2,167	1%	-861
Sands	170,204	39,407	31,253	9%	-8,154
Coarse Loamy	16,230	9,268	7,761	2%	-1,507
Loamy	480,162	341,373	310,029	85%	-31,344
Clayey	16,780	10,593	8,846	2%	-1,747
Rock	0	0	0	0%	0
Unclassified	3,233	225	121	0%	-103
Marsh	0	0	0	0%	0
Eroded Slopes	19,956	4,633	4,087	1%	-546
Water	8,305	422	335	0%	-87
TOTAL	**739,688**	**409,716**	**365,232**	**100%**	**-44,484**

1. Soils Surface Texture is based on the textural rating of the dominant soil series for each soil polygon
2. Annual Cropland taken from 2006 Land Cover (from Landsat Imagery captured on August 15, 2006)
3. Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on May 26, 1994)
4. Figures are derived from the total area of Annual cropland in 2006 minus total Annual cropland in 1994 in each class

Figure 41: Surface Texture on 2006 Annual Cropland in the Central Assiniboine and Lower Souris 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 crop plants. Saline soils are caused by a combination of geological, climatic and cultural conditions. The salt content of a soil can be estimated by measuring electrical conductivity (EC), which is usually expressed in deciSiemens per metre (dS/m). Salinity within the Central Assiniboine and Lower Souris 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 average 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. Similarly, fine textured soils classified as moderately and strongly saline will demonstrate higher levels of salinity under moisture deficit conditions.

In the Central Assiniboine and Lower Souris River IWMP:

- Salinity maps based on soil reconnaissance show that the majority of the watershed (almost 81% or 601,600 ha) is considered to be non-saline in nature (***Table 12*** and ***Figure 42***).
- Approximately 16% (118,200 ha) are 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 potential yield impacts.
- Only a small amount of soil in the watershed is considered to be either moderately or strongly saline (approximately 1% or 8,300 ha). These soils are located in the extreme north western and south eastern portions of the watershed (***Figure 42***).

On Annual Cropland with respect to soil salinity:

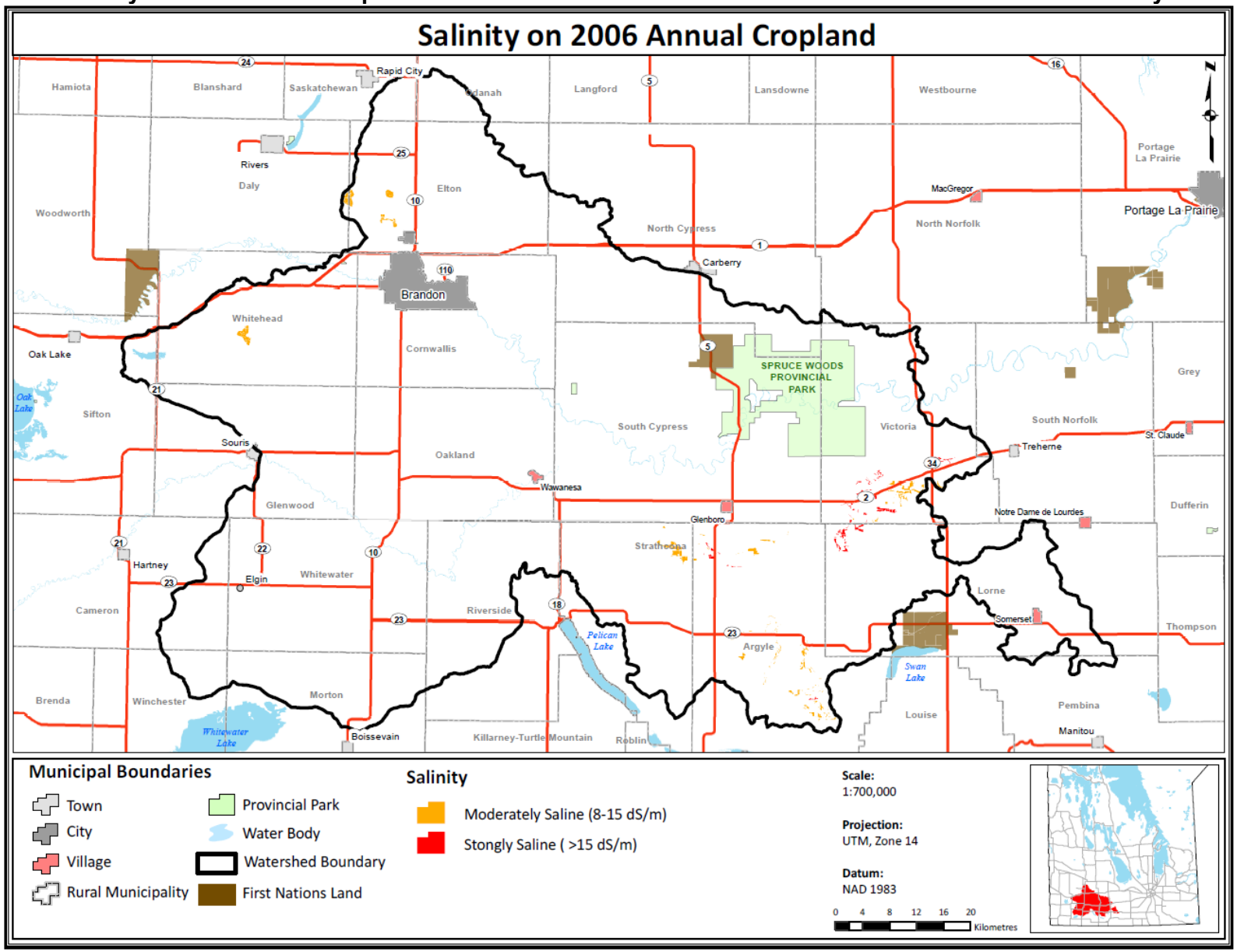
- When comparing soil salinity with annual cropland classified using land cover data, 77% (282,100 ha) of soils under annual cropland were identified as non-saline.
- Less than 1% of the annual cropland in the watershed was on moderately or strongly saline soils.

Table 12: Salinity in the Central Assiniboine and Lower Souris River Watershed Study Area

Salinity[1]	Total Area in IWMP (ha)	1994 Annual Cropland (ha)[3]	2006 Annual Cropland (ha)[2]	Distribution of Annual Cropland in 2006 (%)	1994 to 2006 Change in Annual Cropland Area (ha)[4]
Non Saline (< 4dS/m)	601,629	321,143	282,085	77%	-39,058
Weakly Saline (4-8 dS/m)	118,215	84,281	80,318	22%	-3,963
Moderately Saline (8-15 dS/m)	5,678	2,475	1,768	0%	-707
Strongly Saline (> 15 dS/m)	2,629	1,170	605	0%	-565
Unclassified	3,233	225	121	0%	-103
Marsh	0	0	0	0%	0
Eroded Slopes	0	0	0	0%	0
Water	8,305	422	335	0%	-87
TOTAL	**739,688**	**409,716**	**365,232**	**100%**	**-44,484**

1. Salinity is based on the dominant soil series for each soil polygon
2. Annual Cropland taken from 2006 Land Cover (from Landsat Imagery captured on August 15, 2006)
3. Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on May 26, 1994)
4. Figures are derived from the total area of Annual cropland in 2006 minus total Annual cropland in 1994 in each class

Figure 42: Salinity on 2006 Annual Cropland in the Central Assiniboine and Lower Souris River Watershed Study Area



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

i. Crown Land Management in the Central Assiniboine and Lower Souris River Watershed Area

Crown lands in the Central Assiniboine and Lower Souris River study area make up a small portion of the watershed, approximately 12% (89,597 ha). The vast majority of these lands is located in Spruce Woods Provincial Park and Spruce Woods Provincial Forest and are rich in natural resources. The management of these lands is protected through special interest from the Province and have designations based on their available resources, through Provincial Coding for Crown Lands (***Table 13*** and ***Figure 43***).

- There are approximately 89,597 ha of Crown Land in the watershed.
- Only 14,000 ha of crown land are available for agricultural use through the Agricultural Crown Land leasing and permitting program (See ***Appendix M***).
- The vast majority (84%) of Crown Land in the watershed is classified as having no agricultural use. This area is made up almost exclusively of the lands in Spruce Woods Provincial Park and Spruce Woods Provincial Forest.

Table 13: Crown Lands by MAFRI Crown Land Use Coding

Generalized Operation Land Use Code	Total Area (ha)	Percentage
Agricultural Use (Lease)	12,782	14%
Agricultural Use (Yearly Permits)	954	1%
Community Pastures (Managed by AESB)	67	0%
No Agriculture Use (Wildlife, Recreational)	75,693	84%
Uncoded (No Agricultural Use)	100	0%
Total	**89,597**	

The information presented in ***Table 13*** and ***Table 14*** is derived from two different datasets, which resulted in minor discrepancies in the total amount of hectares of crown land within these municipalities.

The majority of crown lands in the Central Assiniboine and Lower Souris River Watershed are located in the Rural Municipality of South Cypress (***Table 14***). Crown Land statistics are currently captured on a municipal boundary basis. As such, the statistics shown below are based on the total amount of crown land within the municipalities including areas beyond the watershed. Although the information is not available on a watershed basis, it does provide a general indication of the use and management of crown lands within the Central Assiniboine and Lower Souris River portion of the watershed.

Table 14: Crown Lands by Rural Municipality in the Central Assiniboine and Lower Souris River Watershed Study Area

Rural Municipality	Total Area (Ha)	Percentage
Glenwood	160	0%
Cornwallis	2,257	3%
Oakland	271	0%
Whitewater	275	0%
Sifton	131	0%
Brandon	146	0%
Riverside	2,091	2%
Strathcona	575	1%
North Cypress	16,379	18%
South Cypress	51,535	58%
Argyle	177	0%
Lorne	0	0%
Victoria	15,572	17%
Total	**89,569**	

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.

ii. Management Considerations on Crown Lands

a) Land Capability Classification

Table* 15** illustrates the agricultural land use capability of crown land in the Central Assiniboine and Lower Souris River Watershed. The vast majority (95%) of crown lands within the watershed have marginal to poor agricultural capabilities at Class 4 or higher (Figure* 44** and ***Table 15*)**. Most of the Class 6-7 and Organic crown lands are located within the Spruce Woods Provincial Forest and its associated wetlands.

Table 15: Agricultural Capability of Crown lands in the Central Assiniboine and Lower Souris River Watershed Study Area*

Agricultural Capability	Total Area (ha)	Percentage of Study Area
Class 1-3	4,751	5%
Class 4-5	14,973	17%
Class 6-7	60,598	68%
Organic	8,287	9%
Water	987	1%
Unclassified	0	0%
TOTAL	**89,595**	

* Table does not include other categories and reflects a smaller area of Crown lands in the watershed.

Figure 43: Crown Land Characterization Coding in the Central Assiniboine and Lower Souris River Watershed Area

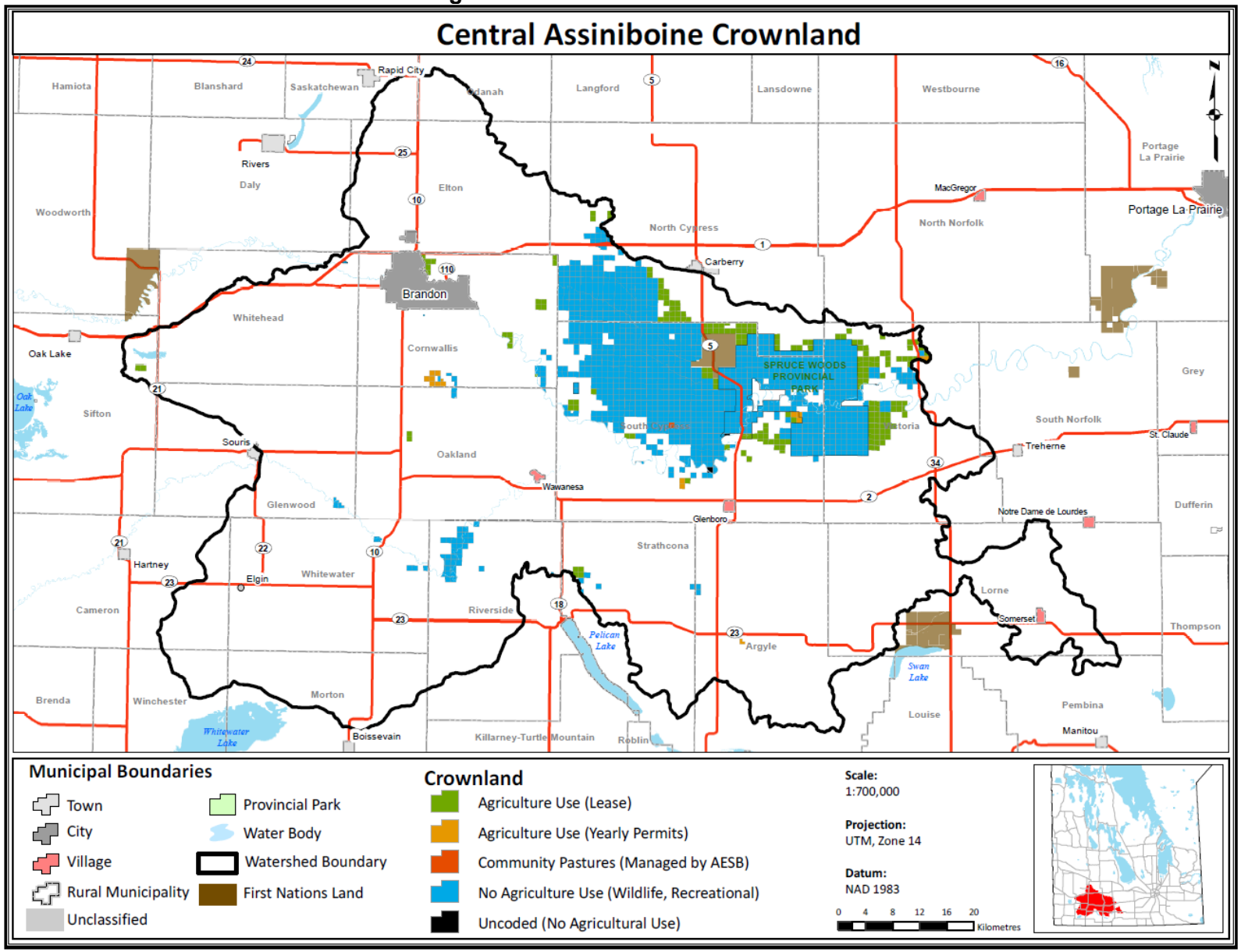
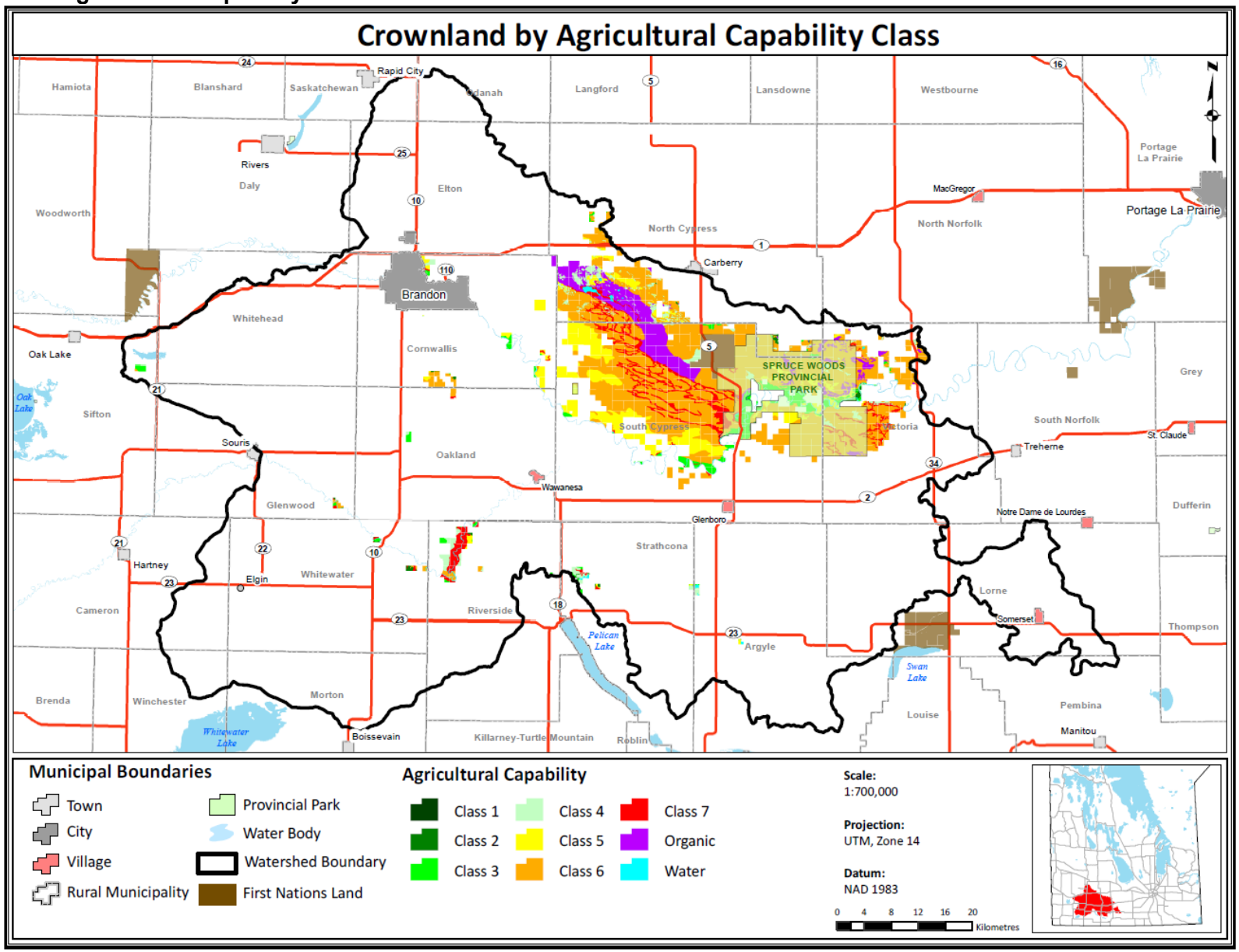


Figure 44: Agricultural Capability of Crown Lands in the Central Assiniboine and Lower Souris River Watershed



b) Woody Species Encroachment on Crown Lands

As noted in Section E iii, there was an overall increase of almost 11,000 ha of grassland between 1994 and 2006 in the watershed. On crown land within the watershed, 3,460 ha of grassland were lost to tree encroachment (***Table 16***).

The largest change from grassland to forested areas took place on lands with no agricultural use (wildlife and recreation), although some encroachment was also observed on agricultural land (leased). Very little tree encroachment took place on other crown lands, although the total area of other crown land types was quite low.

It would seem to indicate that lands with wildlife or recreational use have not yet reached equilibrium in terms of woody species encroachment, and that areas for wildlife and recreational use (Spruce Woods Provincial Park and Spruce Woods Provincial Forest) are continuing to expand. This trend was also observed using land cover data in the change to forested areas analysis (***Figure 33***).

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

Table 16: Change in Grassland to Trees on Crown Lands (1994-2006)

Generalized Operation Land Use Code	Total Area (ha)	Area that changed from grassland in 1994 to trees in 2006 (ha)	% Change	% Change / year
Agricultural Use (Lease)	12,782	409	3%	0.2%
Agricultural Use (Yearly Permits)	954	23	2%	0.2%
Community Pastures (Managed by AESB)	67	0	0%	0.0%
No Agriculture Use (Wildlife, Recreational)	75,693	3025	4%	0.3%
Uncoded (No Agricultural Use)	100	2	2%	0.2%
Total	**89,597**	**3460**	**4%**	**0.3%**

iii. 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 the watershed, have participated in the EFP process to gain an improved understanding of the potential environmental risks associated with agriculture, as well as, those on their own farms. Potato growers within this watershed contracted for processing complete an environmental farm plan as part of the processing industry's requirements. The EFP process also allowed producers to develop an action plan that outlines how potential risks on their farms can be addressed through the adoption of beneficial management practices (BMPs). Financial and technical support has been offered to producers wishing to adopt BMPs through the Canada Manitoba Farm Stewardship Program (CMFSP) between 2003 and 2009. This program offered 30 different BMPs to producers that had completed an EFP. For a list and description of the BMPs see ***Appendix 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 Central Assiniboine and Lower Souris River watershed are proactive and that addressing environmental issues are high on their priorities.

In the Central Assiniboine and Lower Souris River Watershed study area, a total of 801 BMP projects were completed by producers (***Table 17***). Of the 801 completed, 374 of the projects were categorized as Non Point Source – Crop Related BMPs.

The top three BMP categories adopted by producers in the study area through the CMFSP were Improved Cropping Systems, Wintering Site Management, and Product and Waste Management. More specifically, the top three BMP practices adopted were precision farming applications, improved on-farm storage and handling of agricultural products, and equipment modification on pre seeding/post seeding implements (row crops). Irrigation has been highlighted as an important issue in the watershed by some local residents. Of the 40 irrigators reported in the watershed through the Census of Agriculture, less than 10 projects related to irrigation were adopted.

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	Central Assiniboine and Lower Souris River IWMP
Point Source - Livestock Manure Related [1]	14
Point Source - Other (Petroleum, Nutrients from Feed, Pesticides, etc.) [2]	117
Non Point Source - Livestock Related [3]	164
Non Point Source - Crop Related [4]	374
Non Point Source - Crop Related (Irrigation) [5]	8
Non Point Source - Crop Related (Pesticides) [6]	57
Soil Erosion - Soils at Risk [7]	40
Biodiversity [8]	27
Total	801

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

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***).

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.

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

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

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 agri-environmental programs that may stem from IWMP implementation are likely to have considerable levels of participation in this region.

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 cover (132,258 ha) of the watershed was classified as trees, water, or wetlands. Trees were the third most predominant land cover type in the watershed with 13% (or 93,123 ha) of total cover. Grassland/pasture was the second most common land cover type and made up 24% (or 175,490 ha) of the watershed (**Table 4, Figures 13 and 14, Pages 23-25**). • **Farmland Usage-Census Trends (1991-2006)** - A substantial drop in total farmland area (nearly 29,800 ha) was observed between 1991 and 2006. Pasture (both natural and improved) and other land saw little change from 1991 to 2001, but increased from 2001 to 2006 by 21,200 ha (18%) and 8,800 ha (22%), respectfully. Collectively, natural areas (pasture and other areas) have increased within the watershed over the fifteen year period (**Figure 17, Page 28).** • **Number of Farms with Irrigation -Census Trends (1991-2006) -** The number of farm operations reporting irrigation use increased from 30 in 1991 to 35 in 2006. Farms using irrigation peaked in both 1996 and 2001 with 45 farms reporting both years. Both the number of potato farm operations and the number of farms using irrigation declined from 2001 to 2006 (**Figure 20, Page 30**). • **Forages-Census Trends (1991-2006)** - Area in forages increased by 60% over fifteen years, with 63,400 ha of cropped land planted to forages in 2006 **(Figure 18, Page 29).** • **Annual Cropland- Census Trends (1991-2006)** Forage production made up just over 15% of the total cropland in the watershed in 2006. This value has increased over 15 years, as both alfalfa and other tame forages rose during this time (**Figure 19, Page 29).** • **Native Pasture and Other Land Trends - Census Trends (1991-2006)** -Native pasture area decreased by 5,200 ha, but remained a large portion of the total farmland area at approximately 100,000 ha. The area of other land (the vast majority of which is comprised by woodlands and wetlands) remained relatively static from 1991 to 2001, but saw a large increase between 2001 and 2006 (a fifteen year increase of 9,200 ha) **(Figure 21, Page 31).** • **Land Cover – 1994, 2000, and 2006** - **(Table 5, Page 35)** (a) **Annual Cropland** - The largest change in land cover was observed in annual cropland, where there was a decrease of approximately 44,000 ha (from 410,000 to 365,000 ha). These changes have been linked mainly to increases in grasslands and forage. (b) **Natural Areas -** The area of natural areas, including grassland/pasture and forested land, increased between 1994 and 2006. (c) **Forage -** The land cover classification with the largest increase in area was forages, which increased 28,600 ha over the 13-year period. (d) **Other Classes -** Other land cover classifications increased in area from 1994 to 2006 (except wetlands, which had a very small decrease of 121 ha). • **Changes to Annual Cropland** - Most of the changes to annual cropland cover occurred within the Assiniboine and Souris subwatersheds. Conversion from cropland to other land cover was distributed equally across the entire watershed, while conversion to cropland was concentrated in the northern portion of the Assiniboine subwatershed **(Figure 29, Page 38).** • **Changes to Grassland Area -** There was an overall increase of almost 11,000 ha of grassland in 2006 in the watershed, an increase of almost 7% from 1994 cover. Conversion of cropland to grassland was the primary factor responsible for the increase in grassland cover. Over 29,000 ha of cropland were converted to grassland over the 13-year period. Around 13,000 ha of land experienced the reciprocal conversion of grassland to annual cropland, resulting in a net increase of 16,500 ha. New grassland areas were distributed equally throughout the watershed. Loss of grassland (primarily to annual cropland) was concentrated in the Assiniboine subwatershed, some of which was converted to irrigated land **(Figure 31, Page 41).** • **Change in Forested Area -** There was an overall increase of approximately 2,100 ha of forested areas in 2006 in the watershed when compared to 1994. The largest change to forested cover was in respect to grasslands. Forest encroachment resulted in conversion of 6,500 ha of grassland. The reciprocal conversion of forested area to grassland was 3,700 ha. Most of the new forested areas noted for 2006 resulted from encroachment of previously forested areas into adjacent grasslands near Spruce Woods Provincial Park. Much of the forested land lost to other cover types was located in the extreme northern portion of the Assiniboine subwatershed. **(Figure 33, Page 44).** • **Change in Forage Area-** Forage cover increased dramatically in the watershed by nearly 325% between 1994 and 2006. Analysis indicates that conversion from annual cropland was primarily responsible for the increased forage cover in the watershed **(Figure 35, Page 47)**. **AWiFS change (Figure 36, Table 6, Page 49-50)** • **Grassland land cover change from 1994** (a) The majority of lands that had changed from grasslands in 1994 to annual cropland in 2009 were identified as cereals (28,248 ha). Many of the hectares identified were dispersed throughout the watershed as small fragments. (b) 800 ha that were identified as grasslands in 1994 were later identified as potatoes in 2009. This area is isolated to a region that is south west of Brandon. • **Forested Areas land cover change from 1994** (a) Approximately 4,217 ha of land previously classified as forest cover are now identified as cereals (approximately 3,200 ha) and canola/rapeseed (approximately 1,000 ha) in 2009. Many of the hectares identified were dispersed throughout the watershed as small fragments and along the Assiniboine and Souris Rivers. (b) Lands identified as potato production in 2009 was less than 100 ha. • **Agricultural Capability –** 40% (297,000 ha) of the soils in the watershed are Class 4 and lower. The amount of land being annually cropped on class 4 and lower has decreased since 1994. This is reflected on all classes, with a majority of the decreases noted on Class 2, 3 and 4 lands (**Table 7, Page 52**). • **Crown Lands** - There are approximately 89,597 ha of crown land in the watershed. The vast majority (84%) of crown land in the watershed is classified as having no agricultural use. This area is made up almost exclusively of the lands in Spruce Woods Provincial Park and Spruce Woods Provincial Forest. There was a loss of 3,460 ha of grassland to tree encroachment, the majority of which occurred on crown lands with No Agricultural Use (**Table 13-16, Figure 44, Page 68-72**). • **BMP Adoption -** Of the 801 completed, 27 of the projects were categorized as Biodiversity BMPs. **(Table 17, Page 74).** • **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 on wetlands -** Total Annual Rainfall and Precipitation amounts exceeded the 30 year average 4 out of 6 years. Levels recorded for the 2006 year in the watershed were lower than the 30 year average (see **Appendix Q, Page 113*).*** ***Data Gaps Identified:*** *(a) Most of the lands identified as class 4 or lower are located in areas with reconnaissance soil data (scale of 1:126,720).* *(b) Census Trends are derived on a volunteer basis.* *(c) Land cover Analysis is developed using a 30 meter pixel, which makes the identification of smaller wetlands difficult. Native Grasslands are not distinguished from tame grass under the Grassland category.* *(d) Species at Risk data is not available for analysis.*	**Site Specific BMP Implementation for Wildlife Habitat** - Promote BMPs and provide technical assistance that encourages a continued healthy level of 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 the BMPs which maintain and enhance natural cover. Encourage sustainable land management practices on soils with lower agricultural capability that maintain wildlife capability	Areas in the watershed that are: • class 4 or lower and are adjacent to Spruce Woods Provincial Park, Assiniboine River, Souris River Valley or suitable wetland habitat Entire Study Area	Proportion of watershed area: • with annual cropland on Class 4 and lower lands, • that is wetland or treed, • that is grassland/pasture or forage land cover Number of BMPs implemented that have a wildlife benefit. Change in number of restored wetlands. Number of educational initiatives presented

* 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 substantial drop in total farmland area (nearly 29,800 ha) was observed during the period between 1991 and 2006. (**Figure 17, Page 28).** • **Number of Farms reporting Irrigation -Census Trends (1991-2006) -** The number of farm operations reporting irrigation use increased from 30 in 1991 to 35 in 2006. Farms using irrigation peaked in both 1996 and 2001 with 45 farms reporting both years. Both the number of farms reporting potatoes and the number of farms using irrigation showed declines from 2001 to 2006 (**Figure 20, Page 30**). • **Land trends (Census trends 1991-2006) -** Irrigated land increased from 1991 to 2006 by 90%, an increase of approximately 3,500 ha. However, irrigated land made up a very small portion of total crops in the watershed (**Figure 21, Page 31**). • **Changes to Annual Cropland** - Most of the changes to annual cropland cover occurred within the Assiniboine and Souris subwatersheds. Conversion from cropland to other land cover types was distributed equally across the entire watershed, while conversion to cropland appeared to be concentrated in the northern portion of the Assiniboine subwatershed**. (Figure 29, Page 38).** **AWiFs change (Figure 36, Table 6, Page 49-50)** • **Grassland land cover change from 1994** (a) The majority of lands that had changed from grasslands in 1994 to annual cropland in 2009 were identified as cereals (28,248 ha). Many of the hectares identified were dispersed throughout the watershed as small fragments. (b) 800 ha that were identified as grasslands in 1994 were later identified as potatoes in 2009. These lands are located in a region that is southwest of Brandon. • **Forested Areas land cover change from 1994** (a) Approximately 4,217 ha identified as cereal production (approximately 3,200 ha.) and canola/rapeseed (approximately 1,000 ha) in 2009. Many of the hectares identified were dispersed throughout the watershed as small fragments and along the Assiniboine and Souris Rivers. (b) Lands identified as potato production in 2009 were less than 100 ha. **ADA Equivalent Agri- Environmental Farm Plan – Report listed** (a) Water License Allocations- As of May 1st, 2005, allocations for the Assiniboine Basin of the Assiniboine Delta Aquifer were at 15,254 acre-feet/year. The Assiniboine West, Epinette Creek North and South are fully or nearly fully allocated. Any updates should be consulted with the Department of Water Stewardship. (b) Water Quality- 80% of the wells monitored over the Assiniboine Delta Aquifer had nitrate concentration below the Canadian Drinking Water Quality Guidelines (for 2000) (c) Projected Water Demands- projected water demands over the aquifer will increase 3,500 acre-feet/year, based on a population increase to its communities by 15 % growth. • **BMP Adoption -** Of the 801 completed through CMFSP, 131 of the projects were categorized as Point Source type BMPs. There were less than 10 projects that were completed as Non-Point Source -Crop Related (Irrigation) **(Table 17, Page 74).** ***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 Trends are derived on a volunteer basis.* *(c) Land cover Analysis is developed on 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. And, 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 risk areas like recharge areas, high water table areas and contamination sources in or near these areas) **Communication/Education Strategies –** (a) Presentation of technical findings from previous plans to stakeholders regarding irrigation change (ADA Plan, Assiniboine Delta EAEP, etc.) (b) Continual education and communication of annual 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 low agricultural capability. **BMP Adoption** that encourages recharge and protects 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 promote 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 located in recharge areas and high water table areas and/or have 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 various stakeholders and the presence of presentation 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, • 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*
How can soil salinity be addressed in this watershed?	**Salinity issue in the watershed and factors influencing salinity** • **Salinity Extent** - Salinity maps based on soil reconnaissance show that the majority of the watershed (almost 81% or 601,600 ha) is considered to be non-saline in nature ***(Table 12, Page 66).*** • Approximately 16% (118,200 ha) of the watershed are considered weakly saline (< 4 dS/m). Only a small amount of soil in the watershed is considered to be either moderately or strongly saline (approximately 1% or 8,300 ha). These soils are located in the extreme north western and south eastern portions of the watershed (***Table 12, Page 66***). • **Salinity on Annual Cropland** - 77% (282,100 ha) of soils under annual cropland were identified as non-saline. This number has decreased very slightly since 1994 levels (1%) Less than 1% of the annual cropland in the watershed was on moderately or strongly saline soils (***Table 12, Page 66***). **Factors affecting the change in Salinity:** • **Land Cover – 1994, 2000, and 2006** - **(Table 5, Page 35)** (a) **Annual Cropland** - The largest change in land cover was observed in annual cropland, where there was a decrease of approximately 44,000 ha (from 410,000 to 365,000 ha). These changes have been linked mainly to increases in grasslands and forage. (b) **Natural Areas-** The total area of natural areas, including grassland/pasture and forested land, increased between 1994 and 2006. (c) **Forage-** The land cover classification with the largest increase in area was forages, which increased 28,600 ha over the 13-year period. (d) **Other Classes- O**ther land cover classifications increased in area from 1994 to 2006 (except wetlands, which had a very small decrease of 121 ha). • **Change in Forage Area-** Forage cover increased dramatically in the watershed by nearly 325% from 1994 to 2006. Analysis indicates that conversion from annual cropland was primarily responsible for the increased forage cover in the watershed. • **Changes to Annual Cropland** - Most of the changes to annual cropland cover occurred within the Assiniboine and Souris subwatersheds. Conversion from cropland to other land cover was distributed equally across the entire watershed, while conversion to cropland appeared to be concentrated in the northern portion of the Assiniboine subwatershed**. (Figure 29, Page 38).** • **Soil Drainage -** A smaller area of land in the watershed is imperfect to very poorly drained (30% or 218,200 ha). Most of the imperfectly drained soils are located in the western portion of the watershed. The percentage of annual cropland on very poor to imperfectly drained has remained the same from 1994 to 2006 despite the decrease in annual cropland hectares for 2006 (approximately 44,400 ha) (***Table 10, Figure 40, Page 60-61***). • **Cultivation practices Census Trends (1991-2006)-** Conservation and Zero Tillage make up 55-75% of the land management practices in the watershed **(Figure 25, Page 33**). • **Zero Tillage Census Trends (1991-2006)** -The area of land managed with zero tillage increased steadily over the fifteen year period. In fact, zero tillage land area increased nearly eight fold from 4% to 31% of all cultivated land. This increase was met conversely with a dramatic decrease in the usage of conventional tillage from 65% of cultivated land to 31% **(Figure 25, Page 33)**. • **Forage Production Census Trends (1991-2006)** -Forage production made up just over 15% of the total cropland in the watershed in 2006. This value has increased over 15 years, as both alfalfa and other tame forages rose during this time **(Figure 19, Page 29)**. • **Farmland Usage-Census Trends (1991-2006)** - A substantial drop in total farmland area (nearly 29,800 ha) was observed during the period between 1991 and 2006. Pasture (both natural and improved) and other land saw little change from 1991 to 2001, but increased from 2001 to 2006 by 21,200ha (18%) and 8,800ha (22%), respectfully. Collectively, natural areas (pasture and other areas) increased within the watershed over the fifteen year period (**Figure 17, Page 28).** • **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**- Total Annual Rainfall and Precipitation amounts exceeded the 30 year average 4 out of 6 years. Levels recorded for the 2006 year in the watershed were lower than the 30 year average (see ***Appendix Q, Page 113)*.** ***Data Gaps Identified:*** *(a) Most of the lands identified as saline are located in areas with reconnaissance soil data (1:126,720 scale, some has been identified the soil map scale of 1:50,000).* *(b) Census Trends are derived on a volunteer basis.* *(c) Land cover Analysis is developed on a 30 meter pixel. Native Grasslands are not distinguished from tame grass under the Grassland category.*	**Analysis did not identify salinity as a broad watershed scale issue. And, as with any land use activities, localized salinity issues should be addressed and recommendations provided at a site specific scale.** **Inventory of Salinity Development –** Identify and record areas where salinity is developing and infrastructure development contributing to salinity. **Identify the groundwater recharge areas in the watershed.** **Communication/Education Strategies –** (a) Create an awareness and understanding of the causes of salinity (change in drainage, infrastructure development, etc.) (b) Present technical findings from previous plans to stakeholders that relate to salinity issues in the watershed (ADA Plan, Assiniboine Delta EAEP, etc.) (c) Create an awareness and understanding of impact and limitations of land conversion to special crops, particularly on fine textured Class 2 and 3 slightly to moderately saline soils, (d) Continue to encourage producers to develop or update environmental farm plans. **BMP Support -** Encourage environmental initiatives that demonstrate the benefits and encourage adoption of BMPS that address salinity development. These include: (a) Promote the adoption of BMPs that lead to a decrease in salinity development including the adoption of riparian buffers, a management regime for healthy buffers, increase the size of buffers near specific streams, and nutrient management planning. (b) Encourage conversion of saline soils to high water use and saline tolerant forage production, (c) Introduce BMPs for more saline tolerant crop species, (d) Financial incentives for further change of land management practices for annual cropland on Class 4 or lower soils.	Entire Study Area, particularly those areas that are prone to salinity development	The number of kilometres of riparian area that is unhealthy or needing improvement Number of workshops presented or amount of extension material received Change in the area of the watershed that : • have implemented BMPs to reduce salinity (e.g. forages for salinity management plans, buffer strips, soil testing, etc) • amount of cropland occurring on saline soils reduced, • area of land planted to a saline tolerant crop, • amount of Class 4 or lower lands in annual crop production, • number of farmers adopting Salinity Management Plans.

* 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 37% of annual cropland is considered to have soils with a moderate, high, or severe wind erosion risk and are situated in the north western portion of the watershed surrounding the city of Brandon, and along portions of the Assiniboine River **(*Table 8, Figure 38, Page 54-55*).** Based on the 2006 land cover data, approximately 23% of the annual cropland was located on soils with moderate, high, to severe risk for wind erosion (***Table 7***) • **Forage Production - Census Trends (1991-2006)** -Forage production made up just over 15% of the total cropland in the watershed in 2006. This value has increased over 15 years, as both alfalfa and other tame forages rose during this time **(Figure 19, Page 29)**. • **Cultivation practices - Census Trends (1991-2006) -** Conservation and Zero Tillage make up 55-75% of the land management practices in the watershed **(Figure 25, Page 33**). • **Zero Tillage - Census Trends (1991-2006)** -The area of land managed with zero tillage increased steadily over the fifteen year period. In fact, zero tillage land area increased nearly eight fold from 4% to 31% of all cultivated land. This increase was met conversely with a dramatic decrease in the usage of conventional tillage from 65% of cultivated land to 31% **(Figure 25, Page 33)**. • **BMP Adoption -** Of the 801 completed, 40 of the projects were categorized as Soil Erosion BMPs. **(Table 17, Page 74).** **Wildlife Habitat** • **Change in Forage Area-** Forage cover increased dramatically in the watershed by nearly 325% between 1994 and 2006 (an increase of over 28,500 ha in forages from 1994 to 2006 (**Table 5 – Page 35, Figure 35 - Page 47).** Analysis indicates that conversion from annual cropland was primarily responsible for the increased forage cover in the watershed. • **Changes to Annual Cropland** - Most of the changes to annual cropland cover occurred within the Assiniboine and Souris subwatersheds. Conversion from cropland to other land cover was distributed equally across the entire watershed, while conversion to cropland appeared to be concentrated in the northern portion of the Assiniboine subwatershed**. (Figure 29, Page 38).** • **Crown Lands** - There are approximately 89,597 ha of Crown Land in the watershed. The vast majority (84%) is classified as having no agricultural use. This area is made up almost exclusively of the lands in Spruce Woods Provincial Park and Spruce Woods Provincial Forest. (**Table 13-16, Figure 45, Page 68-72**). • **BMP Adoption -** Of the 801 completed, 27 of the projects were categorized as Biodiversity BMPs. **(Table 17, Page 74).** • **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 –** 40% (297,000 ha) of the soils in the watershed are Class 4 and lower. The amount of land being annually cropped has decreased since 1994. This is reflected on all classes, with a majority of the decreases noted on Class 2, 3 and 4 lands (**Table 7, Page 52**). **Irrigation Trends** • **Farmland Usage-Census Trends (1991-2006)** - A substantial drop in total farmland area (nearly 29,800 ha) occurred between 1991 and 2006. Pasture (both natural and improved) and other land saw little change from 1991 to 2001, but increased from 2001 to 2006 by 21,100ha (18%) and 8,800ha (22%), respectfully. Collectively, natural areas (pasture and other areas) have increased within the watershed over the fifteen year period (**Figure 17, Page 28).** • **Number of Farms reporting on Irrigation -Census Trends (1991-2006) -** The number of farm operations reporting irrigation use increased from 30 in 1991 to 35 in 2006. Farms using irrigation peaked in both 1996 and 2001 with 45 farms reporting both years. Both the number of farms reporting potatoes and the number of farms using irrigation showed declines from 2001 to 2006 (**Figure 20, Page 30**). • **BMP Adoption -** Of the 801 completed, 131 of the projects were categorized as Point Source type BMPs. Less than 10 projects were completed as Non-Point Source-Crop Related (Irrigation) **(Table 17, Page 74).** **AWiFs change (Figure 36, Table 6, Page 49-50)** • **Grassland land cover change from 1994** (a) The majority of lands that had changed from grasslands in 1994 to annual cropland in 2009 were identified as cereals (28,248 ha). Many of the hectares identified were dispersed throughout the watershed as small fragments. (b) 800 ha that were identified as grasslands in 1994 were later identified as potatoes in 2009. This area is isolated to a region that is south west of Brandon. • **Forested Areas land cover change from 1994** (a) Approximately 4,217 ha previously identified as forested area were identified as cereals (approximately 3,200 ha.) and canola/rapeseed (approximately 1,000 ha.) in 2009. Many of the hectares identified were dispersed throughout the watershed as small fragments and along the Assiniboine and Souris Rivers. (b) Lands identified as potato production in 2009 was less than 100 ha. **Assiniboine Delta Aquifer (ADA) Security** **ADA Equivalent Agri- Environmental Farm Plan & Assiniboine Delta Aquifer Management Plan –** Any updates should be consulted with the Department of Water Stewardship. (a) **Water License Allocations-** As of May 1st, 2005, allocations for the Assiniboine Basin of the Assiniboine Delta Aquifer were at 15,254 acre-feet/year. The Assiniboine West, Epinette Creek North and South 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 (for 2000) (c) **Projected Water Demands**- projected water demands over the aquifer will increase 3,500 acre-feet/year, based on a population increase to its communities by 15% growth. ***Data Gaps Identified:*** *(c) Most of the lands identified as annual cropland on high or severe wind erosion risk are located in areas with reconnaissance soil data.* *(d) Census Trends are derived on a volunteer basis.* *(e) Land cover Analysis is developed on a 30 meter pixel. Native Grasslands are not distinguished from tame grass under the Grassland category.*	**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 on 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 to watershed stakeholders from monitoring programs (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 is included with dialogue 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 for further site specific examination to watershed health (c) Target BMPs for the IWMP directives on a landscape approach. (d) Investigate collaboration opportunities with 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 and is supported 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 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.

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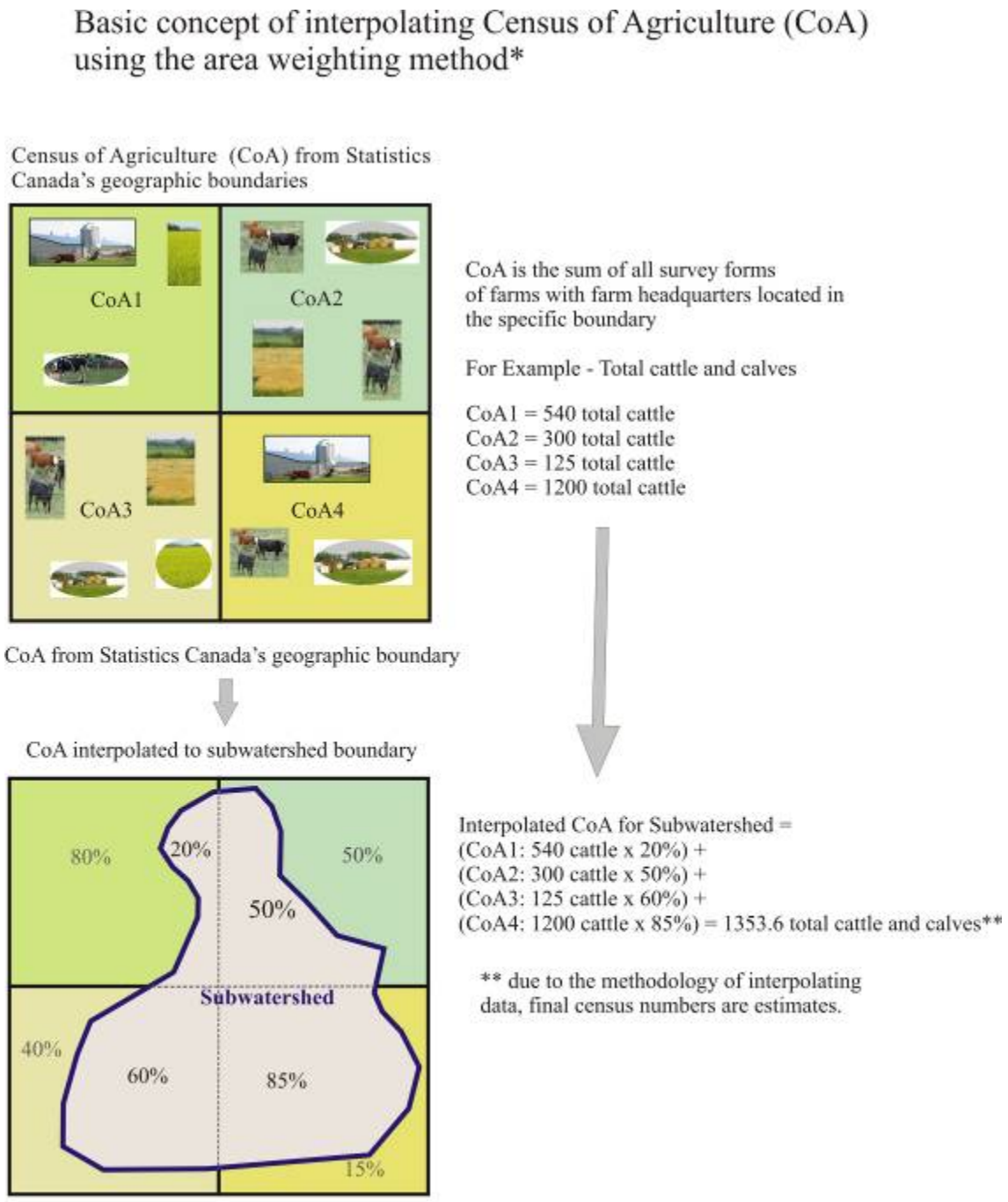
J. Appendices

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



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 1994, 2000, 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 1994 land cover used satellite imagery that was captured on May 26, 1994. Imagery for the 2000 land cover data was taken May 18, 2000. 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 forages/grasslands - As the land cover classifications could be difficult to interpret given the age of the forage stand and the reflectance of the satellite imagery for classification.
- With respect to the increased level of forages, some of the forage conversion trends may be explained through the adoption of Permanent Cover Program offered by Agriculture Canada in the early 1990s. A program summary for the Central Assiniboine and Lower Souris River Watershed study area could provide more insight toward understanding the forage trends and if they were indeed related to the Permanent Cover Program, however, the data could not be made available in time for this report. There is some indication from local contacts that the program uptake by producers was low for this watershed, however, without an actual program summary, it cannot be quantified. This information will be available for future reports or for this watershed at a later date.

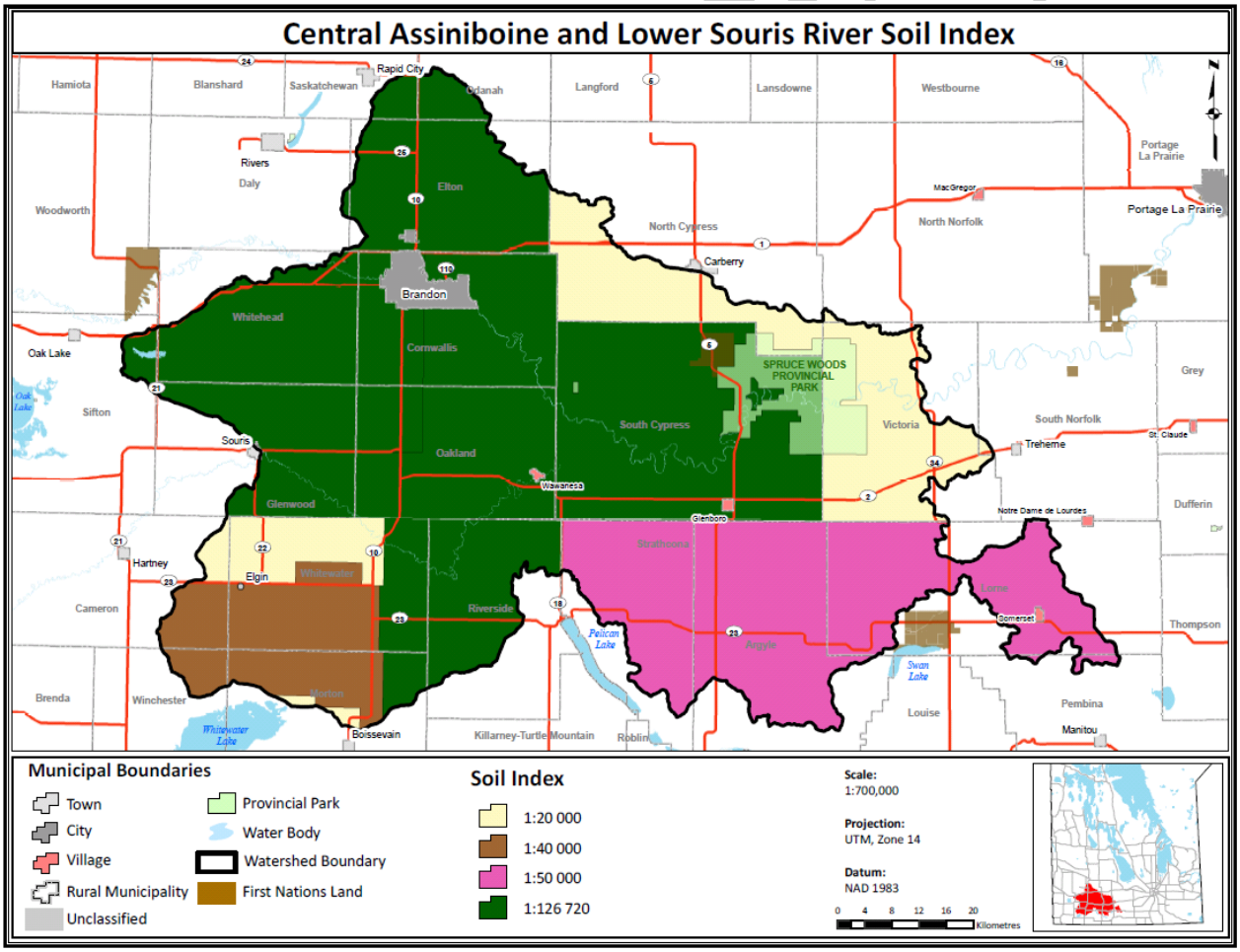
Classification Scheme: Land Cover Mapping of Manitoba	
1. Annual crop land:	Land that is normally cultivated on an annual basis.
2. Forage:	Perennial forages, generally alfalfa or clover with blends of tame grasses.
3. Grassland:	Areas of native or tame grasses, may contain scattered stands of trees
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 1994-2006, 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 Central Assiniboine and Lower Souris River study area, soils were surveyed at a reconnaissance scale of 1:20,000, 1:40,000, 1:50,000, and 1:126,720 (see figure below).

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 types reported in the 2006 Census of Agriculture (hectares)

Subwatershed	Total Farmland	Total Cropland**	Summerfallow	Pasture***	Other*
Assiniboine	183,847	127,221	3,749	37,268	15,608
Cypress	150,589	92,930	1,335	41,446	14,879
Souris	261,260	180,523	3,908	58,809	18,020

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

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

Subwatershed	Total Cropland**	Cereals	Oilseeds	Pulses	Potatoes	Forage for hay	Forage for seed	Other***
Assiniboine	127,221	68,153	34,397	3,027	1,289	19,516	916	235
Cypress	92,930	47,113	24,655	2,471	3,463	15,623	313	0
Souris	180,523	94,369	52,508	3,760	251	26,814	285	142

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

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

Subwatershed	Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides	Use of Fungicides
Assiniboine	101,010	96,953	8,808	28,416
Cypress	76,891	70,340	13,207	28,083
Souris	150,410	144,256	20,166	44,853

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
Assiniboine	$22,448,094	$10,084,860	$7,770,419	$4,592,815
Cypress	$19,875,695	$9,256,184	$6,529,863	$4,089,649
Souris	$29,319,607	$13,735,590	$10,347,626	$5,236,391

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
Assiniboine	24	32	44
Cypress	46	37	16
Souris	23	45	32

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
Assiniboine	33,709	14,198	932	27,291	3,609	100,310
Cypress	32,141	12,805	1,587	70,369	6,234	182,768
Souris	56,911	24,067	728	67,090	6,736	18,637

* 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
Assiniboine	260	233	19	16	8	31
Cypress	248	218	31	39	19	22
Souris	381	352	19	32	16	33

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
Assiniboine	130	61	49	1729	439	3254
Cypress	130	59	52	1806	325	8222
Souris	149	68	38	2072	429	573

* 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)
Assiniboine	515	357	$910,673	$96	$171	$19,075
Cypress	397	379	$1,100,554	$104	$211	$43,886
Souris	629	416	$962,977	$86	$159	$25,602

Appendix J: 2001 Census of Agriculture data

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

Subwatershed	Total Farmland	Total Cropland**	Summerfallow	Pasture***	Other*
Assiniboine	174,897	124,920	5,854	30,953	13,171
Cypress	146,421	96,147	2,257	37,685	10,332
Souris	269,856	199,267	6,703	47,711	16,175

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

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

Subwatershed	Total Cropland**	Cereals	Oilseeds	Pulses	Potatoes	Forage for hay	Forage for seed	Other***
Assiniboine	124,920	73,214	32,401	1,932	1,355	16,122	175	301
Cypress	96,147	53,914	21,527	2,707	3,521	14,557	468	0
Souris	199,267	117,165	51,089	5,664	0	22,824	432	492

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

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

Subwatershed	Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides	Use of Fungicides
Assiniboine	91,321	101,153	11,931	26,227
Cypress	73,356	75,298	11,129	17,470
Souris	159,896	163,615	17,373	38,494

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
Assiniboine	$17,282,835	$7,279,971	$6,606,940	$3,395,923
Cypress	$16,050,056	$7,130,642	$6,010,338	$2,909,076
Souris	$26,072,085	$11,555,893	$10,200,306	$4,315,887

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
Assiniboine	35	45	20
Cypress	51	39	10
Souris	36	46	18

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
Assiniboine	28,847	11,451	933	24,021	2,583	101,217
Cypress	31,435	11,070	1,614	62,552	4,735	165,367
Souris	47,227	19,115	833	53,292	3,309	51,722

* 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
Assiniboine	262	228	20	20	12	35
Cypress	270	232	41	59	31	24
Souris	393	367	24	42	23	37

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
Assiniboine	110	50	46	1232	215	2917
Cypress	117	48	39	1057	153	6919
Souris	120	52	35	1275	142	1405

* 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)
Assiniboine	526	333	$762,245	$120	$132	$15,191
Cypress	448	327	$864,966	$124	$163	$27,006
Souris	677	399	$770,175	$57	$127	$22,026

Appendix K: 1996 Census of Agriculture data

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

Subwatershed	Total Farmland	Total Cropland**	Summerfallow	Pasture***	Other*
Assiniboine	190,793	135,897	7,492	34,839	12,566
Cypress	150,360	99,222	4,131	36,752	10,255
Souris	276,428	202,014	9,974	46,659	17,781

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

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

Subwatershed	Total Cropland**	Cereals	Oilseeds	Pulses	Potatoes	Forage for hay	Forage for seed	Other***
Assiniboine	135,897	88,529	27,320	1,449	1,203	15,550	0	9
Cypress	99,222	57,514	22,000	692	3,430	13,378	0	0
Souris	202,014	129,556	42,227	5,126	0	19,656	0	0

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

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

Subwatershed	Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides	Use of Fungicides
Assiniboine	118,611	109,202	11,954	14,942
Cypress	86,756	76,744	17,095	12,183
Souris	177,082	164,576	33,951	20,168

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
Assiniboine	$16,978,630	$8,742,958	$5,250,539	$2,985,133
Cypress	$13,387,250	$6,863,019	$4,440,453	$2,083,777
Souris	$23,686,575	$12,117,207	$7,836,208	$3,733,160

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
Assiniboine	54	30	15
Cypress	64	32	4
Souris	58	34	9

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
Assiniboine	27,894	10,455	1,375	24,552	2,514	275,562
Cypress	28,674	9,300	1,868	51,844	5,568	42,341
Souris	43,843	17,086	1,496	37,864	3,344	30,694

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
Assiniboine	332	270	36	34	16	57
Cypress	265	221	55	78	40	34
Souris	431	379	42	70	38	49

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
Assiniboine	84	39	38	719	161	4818
Cypress	108	42	34	663	140	1247
Souris	102	45	36	544	88	621

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)
Assiniboine	661	288	$516,873	$130	$118	$21,006
Cypress	456	330	$679,140	$107	$130	$38,802
Souris	740	374	$587,462	$55	$112	$31,777

Appendix L: 1991 Census of Agriculture data

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

Subwatershed	Total Farmland	Total Cropland**	Summerfallow	Pasture***	Other*
Assiniboine	184,230	131,755	5,688	32,826	13,960
Cypress	159,291	103,286	1,874	43,047	11,084
Souris	282,007	209,661	7,338	50,759	14,249

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

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

Subwatershed	Total Cropland**	Cereals	Oilseeds	Pulses	Potatoes	Forage for hay	Forage for seed	Other***
Assiniboine	131,755	91,149	19,861	220	1,007	14,456	0	0
Cypress	103,286	66,317	20,312	242	2,432	10,236	0	0
Souris	209,661	152,847	35,254	616	0	14,832	39	0

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

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

Subwatershed	Use of commercial Fertilizers	Use of Herbicides
Assiniboine	111,421	97,118
Cypress	90,647	83,018
Souris	180,193	163,220

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
Assiniboine	$10,053,631	$5,320,811	$2,878,424	$1,854,396
Cypress	$9,120,956	$4,758,760	$2,955,768	$1,406,428
Souris	$14,189,521	$7,501,852	$4,587,801	$2,099,867

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
Assiniboine	67	28	5
Cypress	61	37	2
Souris	65	30	5

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
Assiniboine	21,946	8,156	1,185	24,111	2,330	209,844
Cypress	22,670	7,436	1,873	50,785	4,882	57,321
Souris	33,308	12,529	1,319	35,622	3,781	33,371

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
Assiniboine	300	247	33	45	21	82
Cypress	259	202	59	92	49	56
Souris	433	371	56	116	68	110

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
Assiniboine	73	33	36	536	112	2558
Cypress	88	37	32	555	101	1022
Souris	77	34	24	308	56	304

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)
Assiniboine	600	307	$425,425	$47	$73	$14,097
Cypress	465	343	$535,598	$74	$87	$26,390
Souris	820	344	$430,469	$35	$65	$17,657

Appendix M: Private and Crown Land Planning in the Central Assiniboine and Lower Souris 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.

The watershed touches on 23 municipalities, some more than others. The RMs of North Norfolk, South Norfolk, Pembina, and Daly include limited acres around the edges of the watershed, for example. However, the area does cover a very significant size, and involves many different Development Plans or Planning Schemes.

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 12 Planning Districts, and three individual municipalities which have some or all areas included. The 12 Planning Districts are;

Mid – West	Tanner's Crossing	Brandon and Area
Souris – Glenwood	23 West	Del – Win
Morton – Boissevain	Cypress	Nor – Mac
South Central	Pembina – Manitou	Dennis County

The three individual municipalities are Oakland, which has a development plan, and Daly and Whitehead, which have some basic planning guidelines. Within these numerous development plans, environmental issues as well as agricultural land use may be dealt with in very different ways.

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

Development of Sandy Soils for Intensive Agriculture

Many development plans have large areas designated as Rural or Agricultural, with few guidelines given as to where specific types of use may be appropriate. However, all development plans are now being upgraded to include clauses specific for livestock zoning. With increasing development pressure combined with environmental awareness, there may be a need to also protect erosion prone agricultural lands.

At least one municipality has protected erosion prone soils through a development agreement on a subdivision, which placed a restriction on the use of tillage, due to the high wind erosion potential of the parcel. This was to address a very specific case.

Under the Land Rehabilitation Act, a municipality may set aside lands for pasture use, or regulate appropriate tillage practices to prevent wind erosion.

It should be recognized that Class 6 and 7 soils (Nutrient Management Zone 4, under the Water Protection Act) are not suited to fertilizer application, and even with land clearing and levelling, if possible, fertilizer application would not be allowed under the Act.

Large irrigation development projects must go through an environmental assessment process, as part of the planning requirements. The Environment Act licensing is based on the information submitted in the proposal by the proponent. This proposal presents the plan of how the project will be developed (built) and how it will be operated in the future. The environmental assessment is reviewed by Manitoba Conservation, MAFRI, and Water Stewardship. If irrigation water supplies are inadequate, or the soils is not suited to irrigation, or the project is deemed to pose significant risks to wildlife habitat, then a license may not be issued for the project . However, if risks are seen as manageable, then a license may be issued with clauses restricting or dictating how agriculture operations should proceed to protect the soil and water resources.
It should be noted that water rights licensed are tied to the land description.

Irrigation development for the potato industry is an example where good environmental stewardship is required, as well as planned. The industry recognizes the need to work with fragile soils in a sustainable fashion now and into the future. All growers contracted for processing (french fry) potatoes must complete an environmental farm plan, and follow all production standards.

The potato industry works with the growers association (Keystone Potato Producers Association), MAFRI, MWS, AESB, AAFC Research Branch, and the Manitoba Crop Diversification Centre at Carberry to investigate sustainable systems and crop rotations which will support the long term productivity of the soil.

Crown Land Management and Planning in the Central Assiniboine and Lower Souris 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.

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

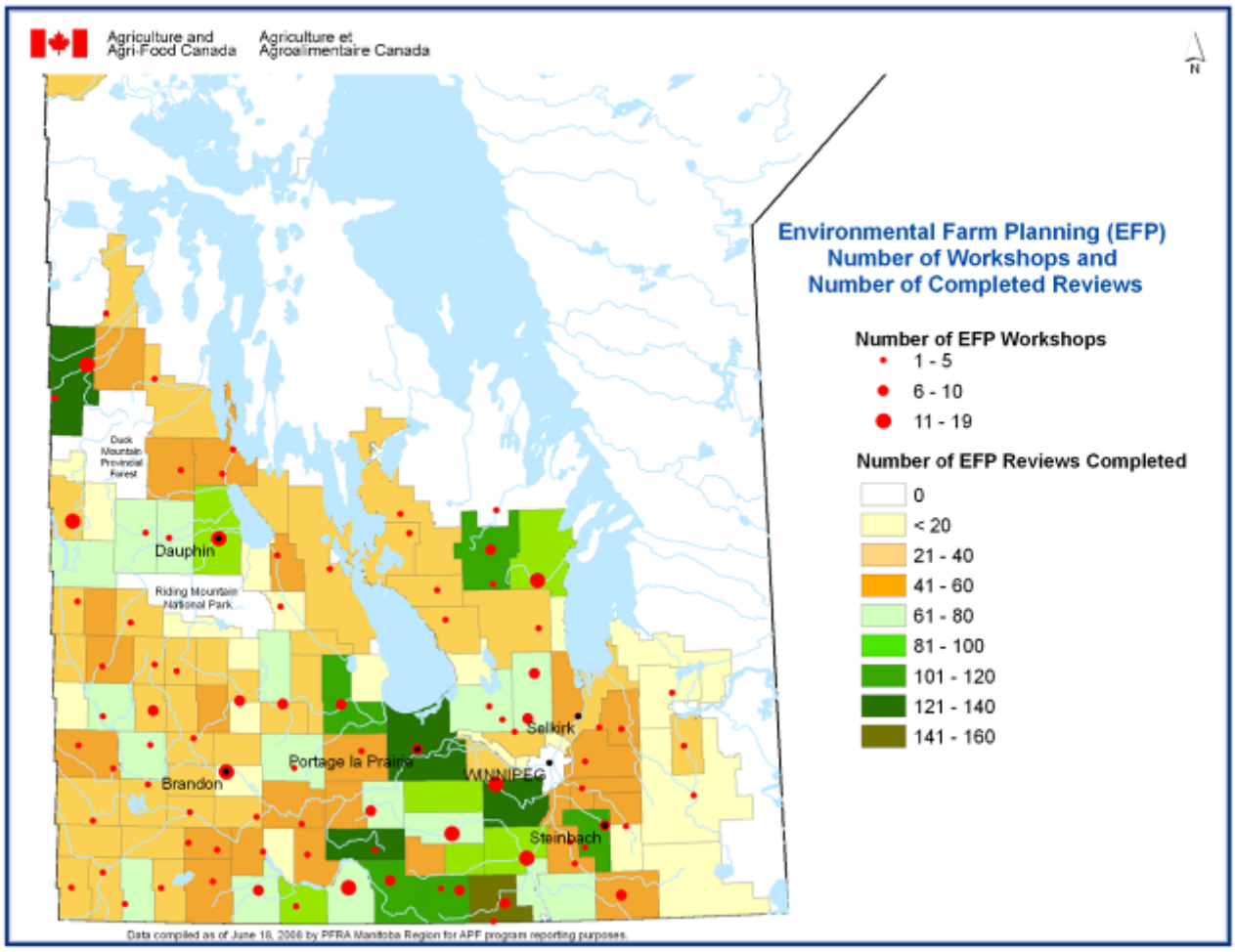
BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
09	Water Well Management					
		0902	protecting existing water wells from surface contamination			
10 10	Riparian Area Management (GREENCOVER) Riparian Area Management (GREENCOVER)	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 repellant 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 under APF



Appendix P: Growing Forward Program

Growing Forward is the foundation for coordinated federal-provincial-territorial government action to help the agriculture and agri-food sectors become more profitable, competitive and innovative. Governments are investing $1.3 billion over five years (2008 – 2013) toward *Growing Forward* programs. The funding represents $330 million more than the Agricultural Policy Framework (APF) and will be cost-shared between the Government of Canada, as well as provincial and territorial governments on a 60:40 basis.

The **Environment Suite** supports two funding avenues: Environmental Action and Environmental Information.

I. Environmental Action improves the environmental performance and sustainability of agricultural operations.

To do this, the program will provide funding for eligible Beneficial Management Practices that enhance agriculture's capacity to reduce risk to water and air quality, improve soil productivity and enhance wildlife habitat.

Programs included in Environmental Action are:

Environmental Farm Plan

The Environmental Farm Plan (EFP) Program has created opportunities for farmers to take part in a confidential self-assessment of the environmental risks and assets existing on their operations. 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 EFAP and MSAPP.

Environmental Farm Action The Environmental Farm Action Program (EFAP) is part of the federal-provincial Growing Forward suite of agricultural programs designed to support agricultural producers in reducing environmental risks specifically through beneficial management practices (BMPs). This program provides technical and financial assistance to producers to accelerate the adoption of BMPs in Manitoba to improve the environmental performance and sustainability of agricultural operations.

The EFAP provides cost-shared funding to producers to implement eligible beneficial management practices (BMPs) identified in their action plans, under such categories as:

- Increased Manure Storage Capacity;
- Improved Manure Storage and Handling;
- Solid-Liquid Separation of Manure;
- Composting of Manure;
- Farmyard Runoff Control;
- Relocation of Livestock Confinement Facilities;
- Wintering Site Management;
- Riparian Area Management;
- Improved Crop Residue Management;
- Precision Agriculture Applications; and
- Nutrient Management Planning

Additional BMP categories are available to Manitoba producers through the Manitoba Sustainable Agriculture Practices Program (MSAPP). MSAPP is the provincial climate change program for agro-Manitoba. Its main objective is to provide incentives to producers to implement practices that reduce greenhouse gas emissions from agriculture.

- Reduced Greenhouse Gas (GHG) Emissions from Manure Storage
- Manure Land Application
- Reduced Tillage
- Spring Fertilizer Application
- Perennial Cover for Sensitive Land
- Cover Crops
- Improved Pasture and Forage Quality
- Increased Perennial Legumes in Annual Crop Rotation
- Grazing and Pasture Management Planning

II. Environmental Information supports the provision of environmental information to help decision-making and improve the sustainability of agriculture.

Programs include:
Agri-Extension Environment

Activities include:
Soil Survey Program: Provide operational support (equipment, staff, etc) to create an inventory of soil properties such as pH, salinity or erosion and to map the distribution of these soil types in Manitoba to direct agricultural management practices. Farmers, government, conservation groups and commodity groups will be able to use the information to guide environmental farm planning, land-use planning, watershed management and nutrient management planning purposes.

Ecological Goods and Services Pilot Projects: The program will support research, modeling and evaluation of Environmental Goods and Services (EG&S) policy options to determine the most effective EG&S policy instrument for agro Manitoba. Different models for this program will be developed and tested on the Manitoba agro-landscape using agricultural landowners in selected pilot study areas.

Environmental Sustainability: Provides funding and technical assistance to a max of $50,000 per proponent to local producer groups and commodity organizations with an interest in agricultural sustainability to carry out applied investigation projects. The Agricultural Sustainability Initiative will support projects aimed to improve sustainable agriculture farming practices, transfer or sharing of technology and information, workshops and fact sheets. Capital items are not covered under this initiative.

Agro-Meteorology Information System: Monitors meteorology patterns throughout agro-Manitoba and develops decision-support systems through the use of real-time data dissemination that enhances risk mitigation and input efficiency tools for producers. The information uses include, but are not limited to: pest forecasting, stubble-burning authorizations and risk mitigation of weather-related threats to crop and livestock production.

Appendix Q: Annual Precipitation for weather stations located in the Central Assiniboine and Lower Souris River IWMP for selected years.*

Weather Station	Total Annual Rainfall (mm)						
	1993	**1994**	**1999**	**2000**	**2005**	**2006**	**30-year average (1971 - 2000)**
Baldur	524.8	566.3E	472.0	548.7	477.6	287.8i	411.0
Brandon A	446.0	330.3	482.3	462.4	463.6	354.4	373.1
Brandon CDA	434.0	331.2E	460.5	441.0	454.8	364.8	371.1
Cypress River	513.6	481.0	426.6	532.4	499.2	368.2	417.4
Souris [1]	349.0	348.7	485.8	433.4	M	M	389.4
Turtle Mountain 6 [1]	M	423.5	470.8	431.4	548.5	331.2i	385.4

Weather Station	Total Annual Precipitation (mm)						
	1993	**1994**	**1999**	**2000**	**2005**	**2006**	**30-year average (1971 - 2000)**
Baldur	582.8i	650.8E	592.5	667.7	657.6	401.3i	542.5
Brandon A	479.3	395.9	564.6	585.4	587.9	462.2	472.0
Brandon CDA	474.8E	399.2E	544.3	562.2	582.4	469.0	474.0
Cypress River	569.0	560.6	527.2	667.8	654.8	521.8	537.2
Souris [1]	404.0	438.7	614.0	583.4	M	M	516.2
Turtle Mountain 6 [1]	M	547.5*	561.4	567.8	672.3	463.8i	506.0

*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.