Agricultural Land Use and Management in the Rat-Marsh River Watershed

Submitted by

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

and

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A. Executive Summary

The Rat-Marsh River Watershed is approximately 218,000 hectares (ha) in size and is located in the Interlake and Lake Manitoba Plains. An Integrated Watershed Management Plan (IWMP) is being developed for this watershed by the Seine-Rat River Conservation District (SRRCD) in collaboration with Manitoba Water Stewardship and numerous other stakeholders.

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

An assessment at the watershed scale provides a snapshot in time of the various agricultural activities in the Rat-Marsh 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 key issues that have been identified through public consultation for the Rat-Marsh River IWMP: surface water quantity, quality and management, riparian degradation, wastewater management, and land clearing.

Agricultural 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, 2001, and 2005 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 risk, 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 Rat-Marsh River IWMP study area has a diverse landscape. Drastic differences in land use exist between different areas within the watershed. The western portion of the watershed is characterized by intensive agricultural use, while the eastern portion is characterized by vast areas of forest, wetland, and provincial crown land. Agricultural land use also varies considerably in the watershed, with respect to soil types, cropping practices, crop types, livestock types, and sizes of livestock operations. From 1991 to 2006, there were fewer but larger farms located in the study area. Crop production is important throughout the entire watershed, and dominates the landscape in the western portion of the watershed. Livestock production, including a large number of hog operations, is predominant in the central and northern portions of the watershed. During this 15-year period, there was an overall increase in grasslands, forages, and treed/forested areas (suggesting some encroachment) and decreases noted in the area of annual cropland (cereals in particular). The number of farms which have adopted alternative tillage practices (including conservation and zero-tillage) has remained relatively low in comparison to those using conventional tillage methods.

Analysis of land cover over a 12-year period corresponds with the Census data analyses, particularly the decrease in the area of annual cropland and increases in grasslands. Areas were identified and mapped within the watershed where the combination of annual cropping and landscape risk factors such as wind erosion, water erosion, agricultural capability, drainage, and salinity 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, annual cropland, forested areas and forage to determine how they relate to the issues of flooding and natural area conservation. Due to data limitations, all spatial analyses using land cover and soils data require further verification for accuracy assessment.

The interest and willingness of producers within the watershed to address environmental issues is demonstrated by their participation in environmental programs through the Agricultural Policy Framework (APF) and more recently under Growing Forward. Program participation in the Environmental Farm Plan (EFP) Program and the Canada-Manitoba Farm Stewardship Program (CMFSP) were analyzed in this report. Participation in both programs was strong; 208 beneficial management practice (BMP) projects were completed with financial and technical assistance through the CMFSP. Nearly 50% of these projects were non-point source crop related BMP projects, with the remaining 50% of BMPs divided amongst other categories.

Recommendations provided in this report focused on the IWMP study questions that are within the mandates of AESB/ MAFRI-knowledge units. Suggested recommendations addressing wildlife habitat changes included the adoption of BMPs that support natural habitat development that are site specific (buffer establishment adjacent to annual crop production, undeveloped road allowances, and the development of conservation corridors) and landscape related (sustainable woodlot management options and sustainable rotational grazing). With respect to riparian areas, recommendations include further incorporation of the riparian health predictive model within other creeks in the watershed and additional educational initiatives that support land management which leads to healthy riparian condition. Potential indicators were also identified for each recommendation to evaluate progress on issues in the future.

B. Acknowledgements

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

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

MAFRI: Land Use Planning Knowledge Centre of the Policy and Agri-Environment Section: Gauer, E., Schindler, D.

C. Preface

In 2010, the Seine-Rat River Conservation District (SRRCD) was designated as the Watershed Planning Authority to develop a comprehensive Integrated Watershed Management Plan (IWMP) for the Rat-Marsh 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 Rat-Marsh 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 Rat-Marsh River IWMP study area is located mainly within the region defined by Manitoba Water Stewardship as encompassing watershed “05OE”, situated along the Rat River south of Winnipeg (***Figure 1***). Small portions of watersheds “05OC”, “05OD”, “05PH”, and “05OH” also fall within the IWMP boundary. The Rat-Marsh River IWMP study area is approximately 218,000 ha in size and consists of an area situated between Winnipeg and the Canada-US border. The western boundary of the watershed is situated along the Red River and extends east into the Rural Municipality of Piney. The Marsh River drains the western portion of the watershed, and flows into the Rat River just south of where the Rat River enters the Red River. The eastern portion of the watershed is drained primarily by the Rat River and its tributaries, the Sand River and Joubert Creek. St Malo Lake, an artificial waterbody created by damming the Rat River, is located near the town of St Malo. Some of the communities located within the study area include St Pierre Jolys, St Malo, Grunthal, Otterburne, Zhoda, Woodridge, and Piney. The watershed also includes St Malo Provincial Park, the Pansy AESB Community Pasture, and the Sandilands Provincial Forest.

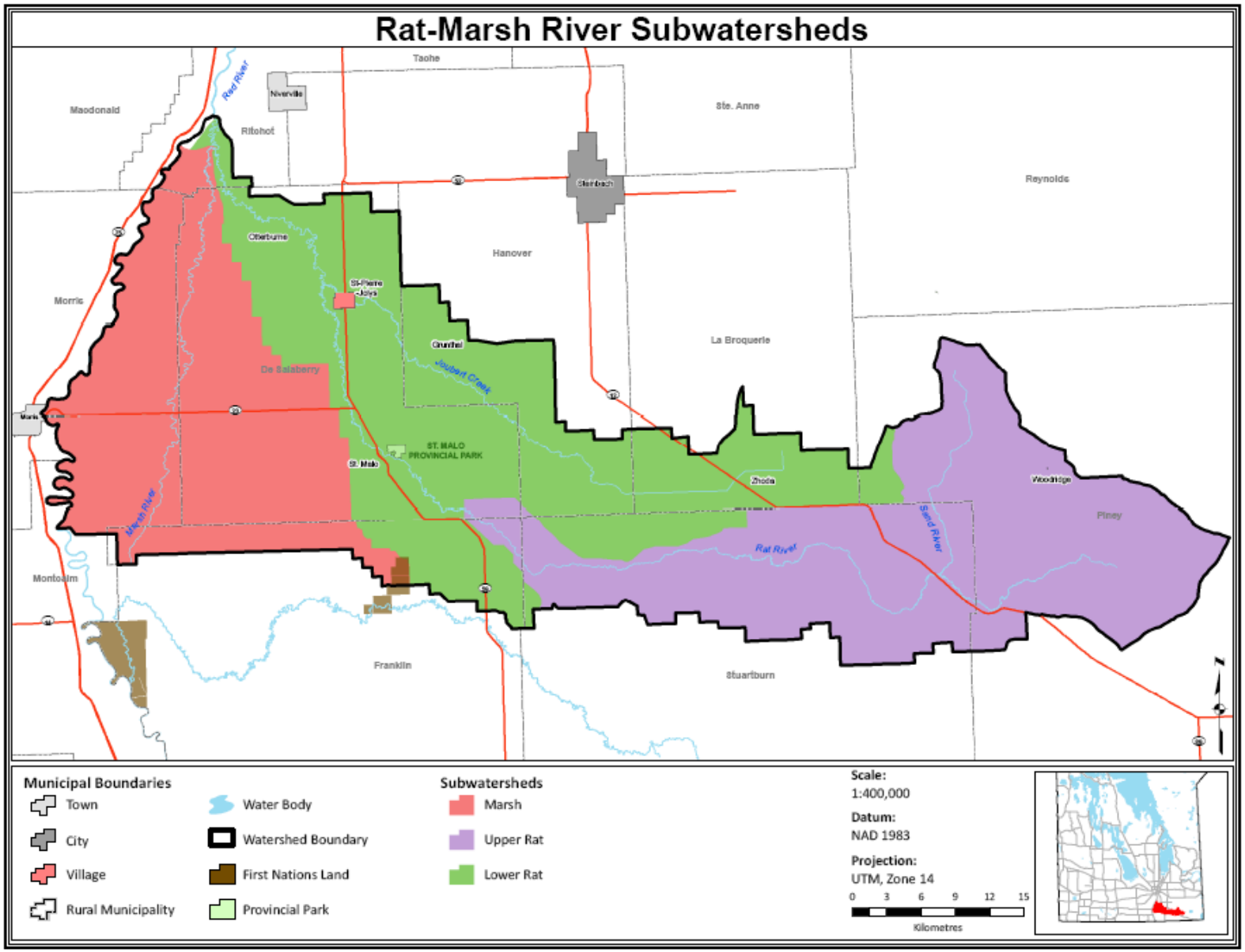
Small changes in elevation occur throughout the watershed, with values ranging from 398 meters above sea level in the RM of Piney, down to 226 meters above sea level in the western portion of the watershed in the Red River valley. Land in the watershed is diverse, including areas considered prairie, boreal plain and boreal shield in the western, central and eastern areas of the watershed, respectfully. Each of these regions has distinct land uses, resulting in a watershed with very different management regimes across the landscape including cropland, pastureland, and forestry.

Objective

Understanding the current state and trends in agricultural land use and management practices along with landscape characteristics is essential for developing an IWMP. Agricultural land use and associated land cover can influence watershed processes and impact issues like water quality and hydrological flow within the watershed. Knowledge of these factors will support the development of sustainable land use strategies that will lead to a healthier and more ecologically functioning landscape. AESB and MAFRI have partnered to undertake an assessment of the changes in agricultural activities and their potential impacts within the watershed, focusing on the major issues identified in the 2010 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 from 1994, 2001 and 2005.**
- **Land cover data in combination with landscape risk factors pertaining to the soil and water resource.**
- **The impact of recent federal and provincial initiatives, policies and regulations impacting agricultural land management and land use planning activities in the watershed.**

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



E. Agricultural Land Use and Management

i. Current Agricultural Land Use of the Rat-Marsh River IWMP study area

a) Agricultural Profile

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

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

Agricultural activities were analyzed for the Marsh, Lower Rat and Upper Rat subwatersheds (***Figure 1***). The Marsh subwatershed includes data that was further interpolated from a census subwatershed that fell partially within the boundary of the IWMP. In addition, a small area of land in the northwest corner of the watershed was not included in the agricultural profile because it was part of a larger census subwatershed, most of which fell outside of the Rat-Marsh IWMP boundary. Due to the relatively low number of farms in the Upper Rat subwatershed, a some of the production information in that watershed was suppressed to individual confidentiality.

The Marsh subwatershed comprises the western portion of the study area including the Marsh River and its associated tributaries and drains. This subwatershed is characterized by almost exclusively by cropland. The Lower Rat subwatershed comprises the central portion of the watershed and includes Joubert Creek and the lower end of the Rat River, up to the point where it spills into the Red River. Land use is a mixture of cropland and livestock production and the subwatershed also includes a number of protected areas with no agricultural use. The Upper Rat subwatershed comprises the eastern portion of the study area and includes the Rat River's tributaries. These include the headwaters of the Rat River, the Sand River, and the numerous wetlands associated with each. A large portion of the watershed is crown Provincial Forest used for recreation and forestry, though a significant amount of livestock production and small area of cropland also occurs in the subwatershed. ***Table 1*** lists these subwatersheds with their respective sizes and proportion of the IWMP study area.

Table 1: Subwatershed areas of the Rat-Marsh River IWMP study area*

Subwatershed	Area (hectares)	Percent of IWMP study area
Marsh	59,000	27%
Lower Rat	82,200	38%
Upper Rat	76,700	35%
Unclassified	165	0%
IWMP Boundary	**218,000**	

* Subwatershed area totals are approximate due to the nature of the image analysis procedure.

Land Use and Land Management

Marsh Subwatershed:
According to 2006 Census of Agriculture data, 87% of farmland in the Marsh subwatershed was dedicated to annual crop production and 10% to pasture, alfalfa, hay, and fodder crops. Very little natural cover (around 1% or 700 ha) is present on farmland within the watershed. Cereals made up nearly 50% of cultivated land while 15% was seeded to forage. Oilseeds, comprising mainly of canola and some flax and sunflowers, made up 25% of the cultivated land. Conservation tillage was practiced on over 25% of cultivated land, while conventional tillage was the most widely adopted practice occurring on 70% of all cultivated land. Only 5% of cultivated land was managed using zero tillage. Fifteen hog farming operations were reported with a total of 48,580 pigs; an average of 3,560 per farm. A number of large poultry farms (15 operations) were located in the subwatershed, totalling 304,400 birds. Beef production was less common than in other areas of the watershed, with 20 farms reporting nearly 900 head. The total number of cattle and calves was approximately 2,320 animals. Fifteen farms reported a total of 140 horses and ponies.

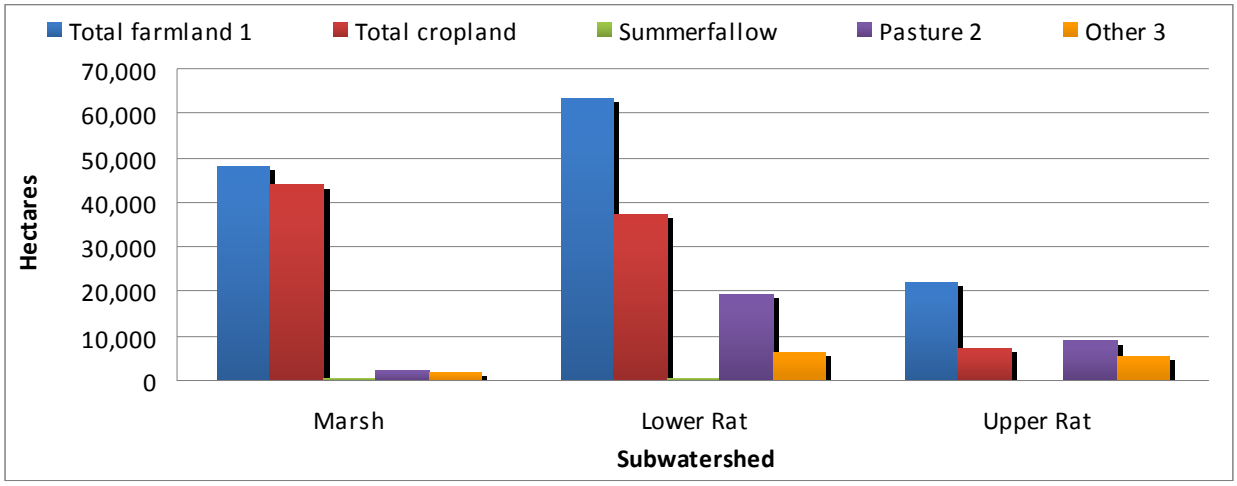
Lower Rat Subwatershed:
Forty-one percent of the farmland in the subwatershed was dedicated to annual crop production, and nearly 50% to pasture, alfalfa, hay, and fodder crops. Cereals made up 42% of the cultivated area, oilseeds (canola, flax, and sunflowers) over 15%, and forages just over 30%. In terms of land management practices, conventional tillage made up almost 65% of total cultivated land. Management of cultivated land using alternative practices was less common in the subwatershed, with conservation and zero-tillage practiced on only 35% and 1% of the land, respectfully. Livestock production in the Lower Rat was characterized by intensive hog and poultry operations. Over fifty hog farms each reported an average of approximately 4,500 animals per operation. Forty poultry farms reported a total of over 581,700 birds. 130 farms reported beef production in the subwatershed, managing 6,470 head; an average of 50 head per farm. The total number of cattle and calves reported was over 20,570 animals. Sixty-five farms reported a total of 390 horses and ponies.

Upper Rat Subwatershed:
Only a small portion of the subwatershed was dedicated to agriculture (29%). In 2006, only 6% of this farmland was dedicated to annual crop production, and almost 70% to pasture, alfalfa, hay, and fodder crops. Twenty-two percent of the farmland within the watershed was classified as other land (including woodlands, wetlands, etc). Cereals made up 10% of the cultivated area, while forages made up the majority of cultivated area, at 82%. For this reason, tillage was restricted mainly to conventional practices (79%). Conservation and zero-tillage data were suppressed, but together accounted for only 21% of cultivated land. Fifty farms reported beef production in the subwatershed, managing almost 2,800 animals; an average of 55 head per farm. Total cattle and calves reported in the subwatershed totalled 6,060 animals. Fifteen farms reported 80 horses and ponies. Approximately five farms reported poultry, combined for a total of only 5,700 birds. Approximately five farming operations reported hogs; 16,750 head were reported, more than 3,400 per farm.

Cropland makes up the majority of farmland in the Marsh subwatershed (92%), but substantially less in Lower Rat and Upper Rat (59% and 32%, respectfully). The two subwatersheds in the east have higher proportions of pasture and other land, including woodlands and wetlands. Thirty percent of farmland in the Lower Rat subwatershed is dedicated to pasture and 10% to other land, while 42% of farmland in the Upper Rat is dedicated to pasture and nearly one

quarter to other land. Summerfallow made up a small proportion of farmland in the entire watershed, less that 1% in each of the three subwatersheds (***Figure 2***).

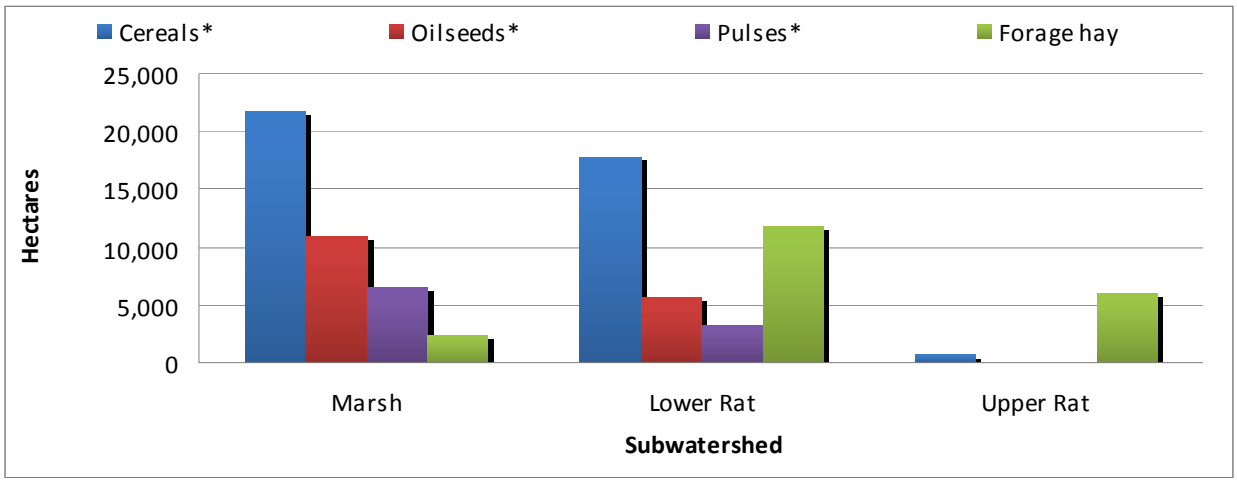
Figure 2: Distribution of agricultural land in the Rat-Marsh River Watershed (2006 Census of Agriculture)



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

With respect to the distribution and types of crops grown in 2006, cereals were the dominant crop in the watershed (mainly wheat, but also some oats and barley). As one moves west to east, forage crops become more abundant on the increasingly poorer soils, as exemplified by the high proportion of forage crops in the Lower Rat and Upper Rat subwatersheds. Cereals made up nearly 50% of the total crop area in Marsh and Lower Rat. In these two subwatersheds, oilseeds made up between 15-25% and pulses 8-15% of total farmland. Oilseed and pulse crops in the Upper Rat subwatershed were either absent or uncommon and therefore data was suppressed to protect producer confidentiality. Forage crops dominated cropland in Upper Rat, made up one third of cropland in Lower Rat, and comprised only 5% of cropland in the Marsh subwatershed. (***Figure 3***)

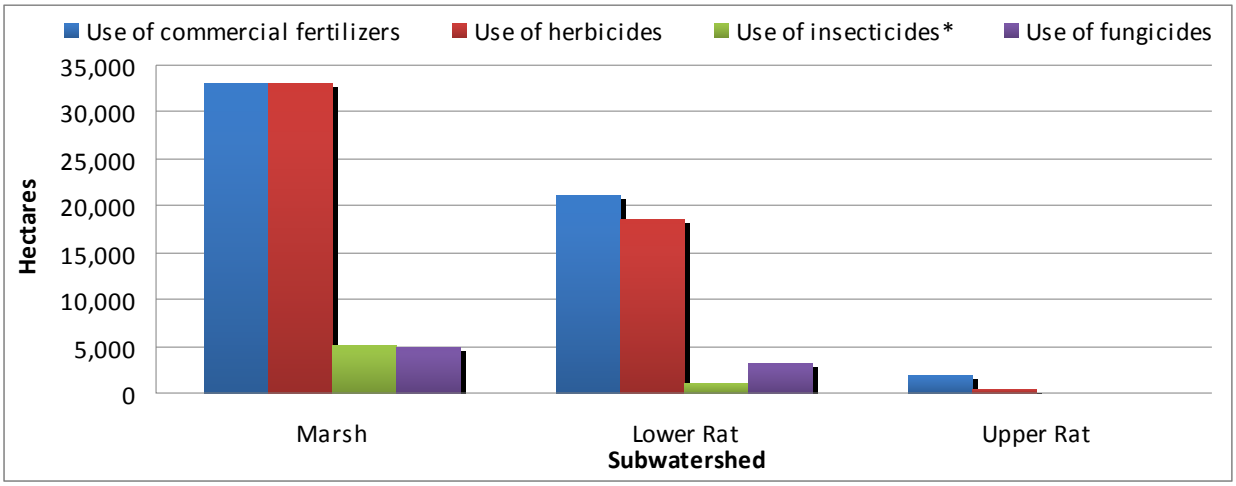
Figure 3: Distribution of the main crop types grown in the Rat-Marsh River Watershed (2006 Census of Agriculture)



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

Crop inputs were widely used in the Marsh and Lower Rat subwatersheds, but were not commonly applied to crops in the Upper Rat subwatershed, likely due to the higher proportion of forage crops in the area (***Figure 4***). Commercial fertilizers and herbicides were applied to approximately 75% of cropland in Marsh and 50%-55% in Lower Rat. Insecticides and fungicides were used to a much lesser extent in both subwatersheds. Commercial fertilizers and herbicides were applied to 27% and 7% of cropland in the Upper Rat subwatershed. Fungicides were not applied in this subwatershed at all, and insecticides were applied sparingly, which resulted in suppression of the available data. These results indicate that risk of contamination of waterways by fertilizers and pesticides is an issue risk mainly along the Marsh River and Rat River west of St-Pierre Jolys, where the majority of cropland is located within the Lower Rat subwatershed.

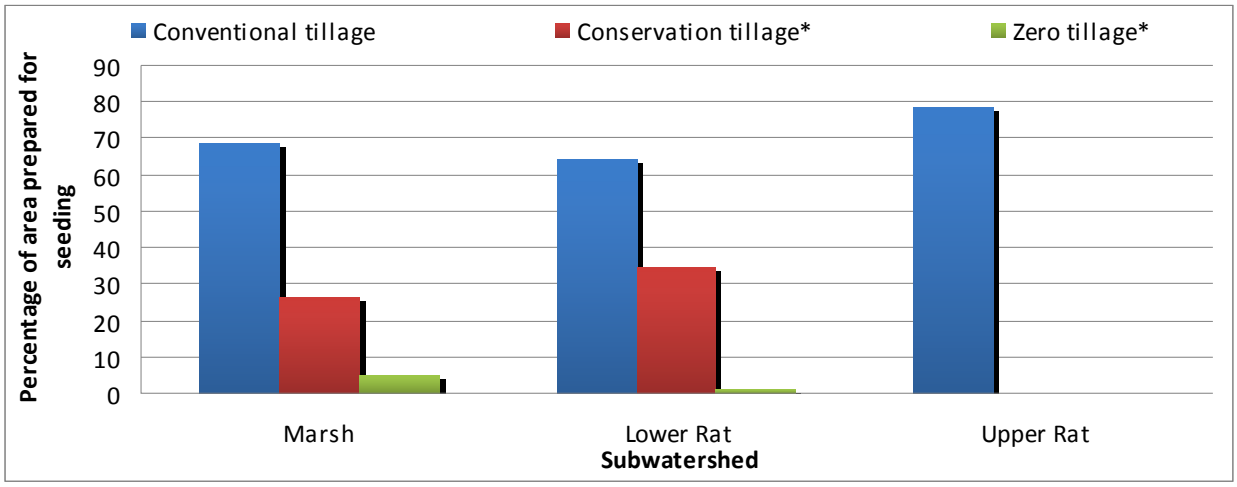
Figure 4: Area treated to crop inputs in the 2005 crop year in the Rat-Marsh River Watershed (2006 Census of Agriculture)



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

There is a low to moderate risk of wind and water erosion on a majority of the watershed where annual cropland occurs. With respect to seedbed preparation, conventional tillage practices were common in the Rat-Marsh River Watershed (***Figure 5***). Conservation and zero-tillage accounted for only 31%, 36% and 21% of tilled land in the Marsh, Lower Rat, and Upper Rat subwatersheds, respectfully. Individual values of conservation and zero-tillage percentages could not be determined in the Upper Rat subwatershed due to suppression of census data.

Figure 5: Tillage practices in the Rat-Marsh River Watershed (2006 Census of Agriculture)



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

Figures 6 and ***7*** summarize livestock numbers in the Rat-Marsh River Watershed. A high number of cattle and hog operations are located in the watershed, particularly in the Lower Rat subwatershed. Intensive hog operations make up a large proportion of livestock production in the subwatershed, where 50 farms consisting of over 231,630 pigs were located. Similarly sized hog operations were located in the Upper Rat and Marsh subwatersheds, but fewer operations were present. More poultry farms were located in the Marsh and Lower Rat subwatersheds, as reflected in their total numbers of birds (304,400 and 581,700, respectfully). Upper Rat had less than 6,000 birds in total. More than 70% of cattle and calves in the watershed were located in the Lower Rat subwatershed. Approximately 20% of cattle and calves were located in the Upper Rat, with the remaining 10% located on farms within the Marsh subwatershed. In all three subwatersheds, beef cows made up less than half of the total cattle and calf numbers.

Figure 6: Total pig and poultry numbers in the Rat-Marsh River Watershed (2006 Census of Agriculture)

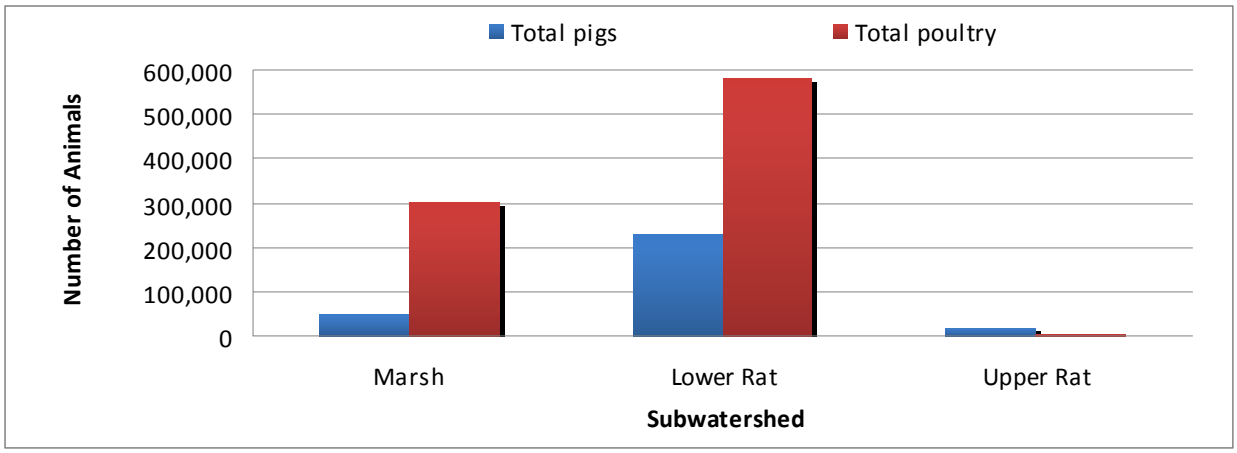
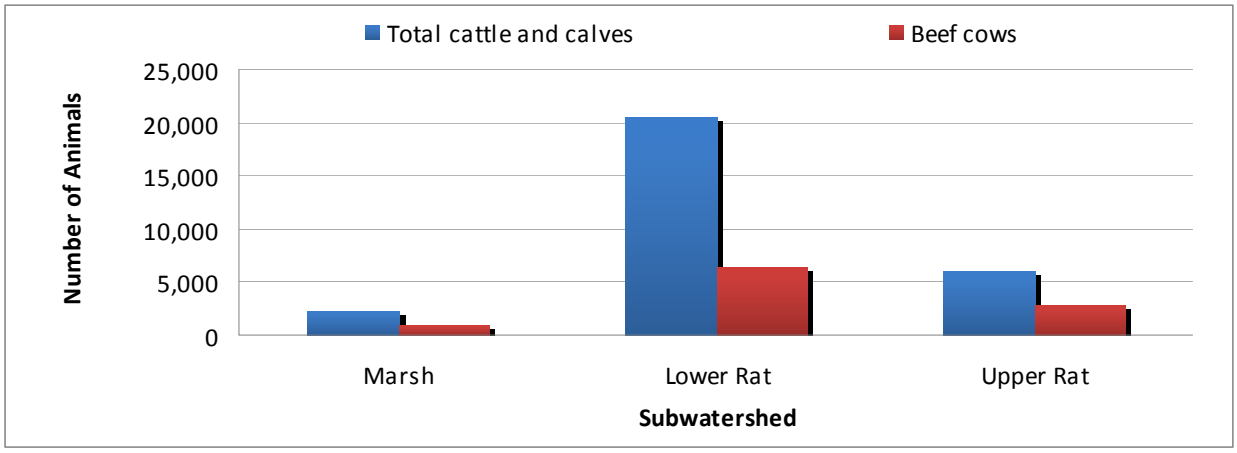


Figure 7: Total cattle numbers in the Rat-Marsh River Watershed (2006 Census of Agriculture)



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***, hog operations had the highest contribution to animal units in the watershed and accounted for over 50% of total AU. The growth of the hog industry in this watershed in recent years have raised concerns regarding manure spreading (and associated land clearing). This has resulted in the introduction of provincial manure management regulations and designated special management zones. Cattle and calf operations contributed nearly as many animal units (37% of the entire watershed). Since beef production consists mainly of cow/calf operations, manure nitrogen and phosphorous tend to be deposited directly onto pastureland by the animals during the grazing season. Depending on the winter management regime natural deposition of manure onto pastureland may continue over the winter season or may be accumulated on concentrated wintering sites. The vast majority of AU produce in the watershed were from livestock in the Lower Rat subwatershed.

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

Livestock Type	Total AU by subwatershed			Total Animal Units	Percentage of Watershed's Total AU
	Marsh	Lower Rat	Upper Rat		
Total Cattle and Calves	1,784	15,565	4,246	21,594	37%
Total Pigs	4,009	24,135	877	29,021	50%
Total Poultry	2,046	3,565	13	5,624	10%
Total Horses and Ponies	137	391	79	607	1%
Other livestock - sheep, goats, bison, elk	8	770	22	801	1%
TOTAL AU	7,983	44,425	5,238	57,647	

* 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 8 and ***9*** 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 assists with the targeting of livestock related beneficial management practices. The average herd size of cattle/calves and beef cows are similar between the four subwatersheds, and lower than other watersheds in Manitoba. These values range from approximately 90 to 115 pairs (cow/calf) and 40-55 head (beef cows) per farm (***Figure 8***). Pig herd size was also similar between subwatersheds, ranging from 3,270 to 4,500 per farm, which was quite high compared to other watersheds in Manitoba (***Figure 9***). Poultry flock size varied greatly between subwatersheds. Marsh had an average flock size of more than 21,700 birds, Lower Rat approximately 14,900, and Upper Rat approximately 800. These values must be observed with caution, however, because barns that were empty on census day would have had no inventory to report and may have resulted in lower numbers being reported.

Figure 8: Average number of cattle per farm in the Rat-Marsh River Watershed (2006 Census of Agriculture)

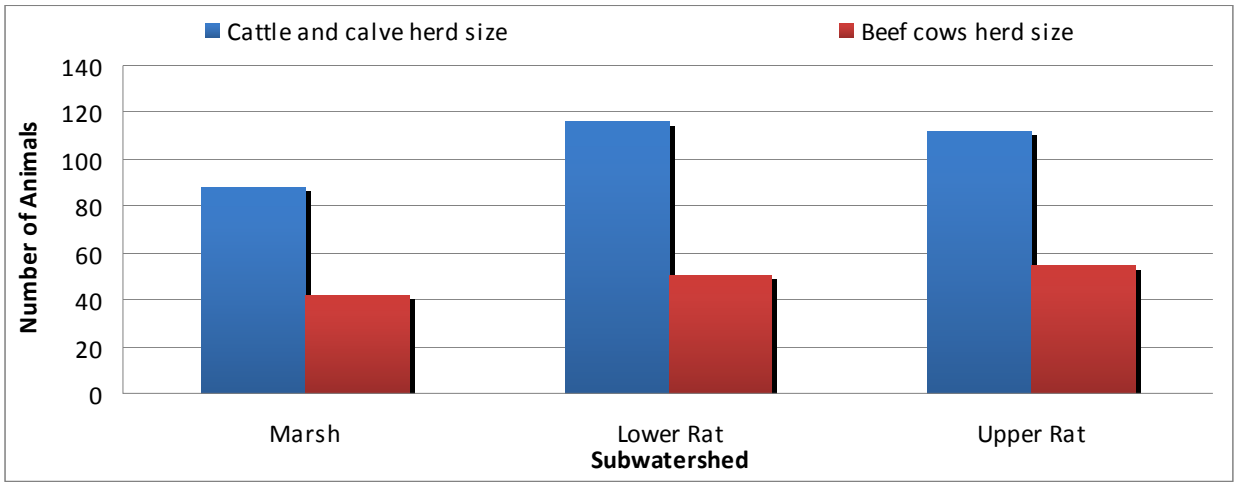
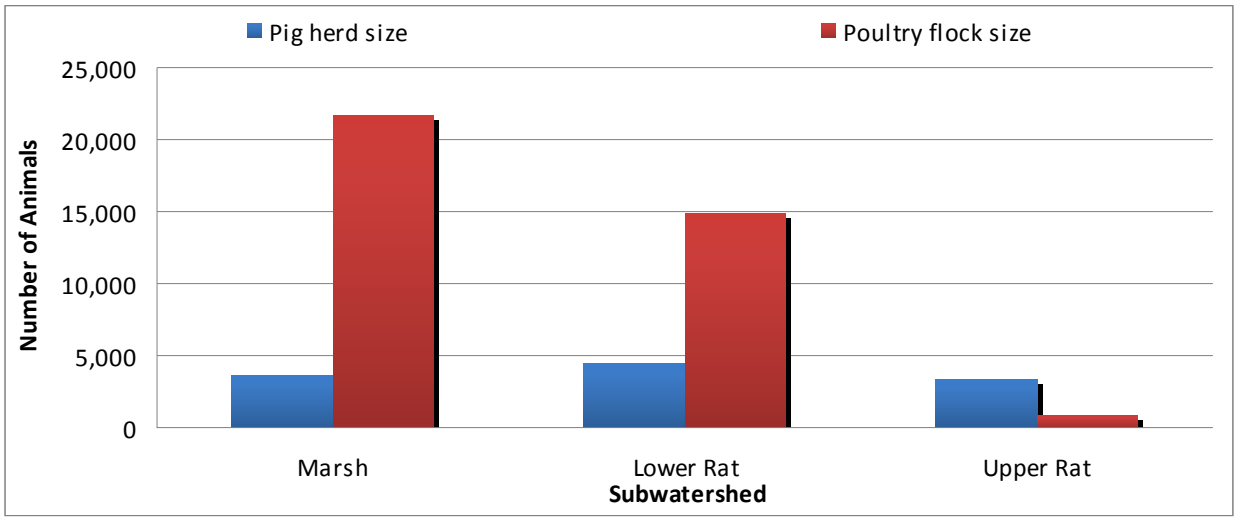


Figure 9: Average number of pigs and birds per farm in the Rat-Marsh River Watershed (2006 Census of Agriculture)



Farm Financial Characteristics

Marsh Subwatershed:
In 2006, 125 farms were reported within the Marsh subwatershed, with 81% 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 $3,600 per hectare of farmland (or almost $1,374,300/farm). Livestock-related expenses were $320/ha of farmland and crop-related expenses were over $160/ha of cropped land and summerfallow. Per farm, net cash income was estimated to be almost $63,200 and the sales to expense ratio was reported to be 1.19 (farm operations received $1.19 gross revenue for every $1 of agricultural expense).

Lower Rat Subwatershed:
In 2006, 295 farms were reported within the Lower Rat subwatershed, with 77% of the subwatershed area being used for farming. The average farm size was approximately 210 ha/farm (530 acres/farm) with an average capital investment of $5 per hectare of farmland (or $1,067,600/farm). Livestock-related expenses were nearly $950/ha of farmland and crop-related expenses were $120/ha of cropped land and summerfallow. Net cash income per farm was estimated to be almost $85,800 and the sales to expense ratio was reported to be 1.25 (farm operations received $1.25 gross revenue for every $1 of agricultural expense).

Upper Rat Subwatershed:
In 2006, 70 farms were reported within the Upper Rat subwatershed, with only 29% of the subwatershed area being use for farming. The average farm size was approximately 310 ha/farm (770 acres/farm) and farms had an average capital investment of $1,600 per hectare (over $511,200 per farm). Average livestock-related expenses were over $210/ ha of farmland, while crop-related expenses were approximately $30/ha of cropped land and summerfallow. Net cash income per farm was estimated to be almost $31,300 and the sales to expense ratio was reported to be 1.25 (farm operations received $1.25 gross revenue for every $1 of agricultural expense).

The Lower Rat subwatershed was larger than the other subwatersheds in farmland area and had approximately thirty percent more farms as the Lower Rat and Marsh subwatersheds (***Figure 10***). Additionally, the larger subwatershed had, on average, smaller farms (approximately 200ha/farm) in comparison to the smaller subwatersheds (approximately 300-380ha/farm). This lower farm size may be reflected in the high number of intensive hog operations, which are smaller than most cattle or field crop operationsfound in the Lower Rat. Farm financial activity indicates that farms in the Marsh and Lower Rat subwatersheds tended to have higher sales and expenses in contrast to the Upper Rat (***Figure 11***). Net cash income was highest in Lower Rat and lowest in Upper Rat. The majority of farm financial activity in the watershed occurs in Lower Rat subwatershed, which is likely attributable to its large size and high number of farms (***Figure 12***).

Figure 10: Total number of farms and average farm size in the Rat-Marsh River Watershed (2006 Census of Agriculture)

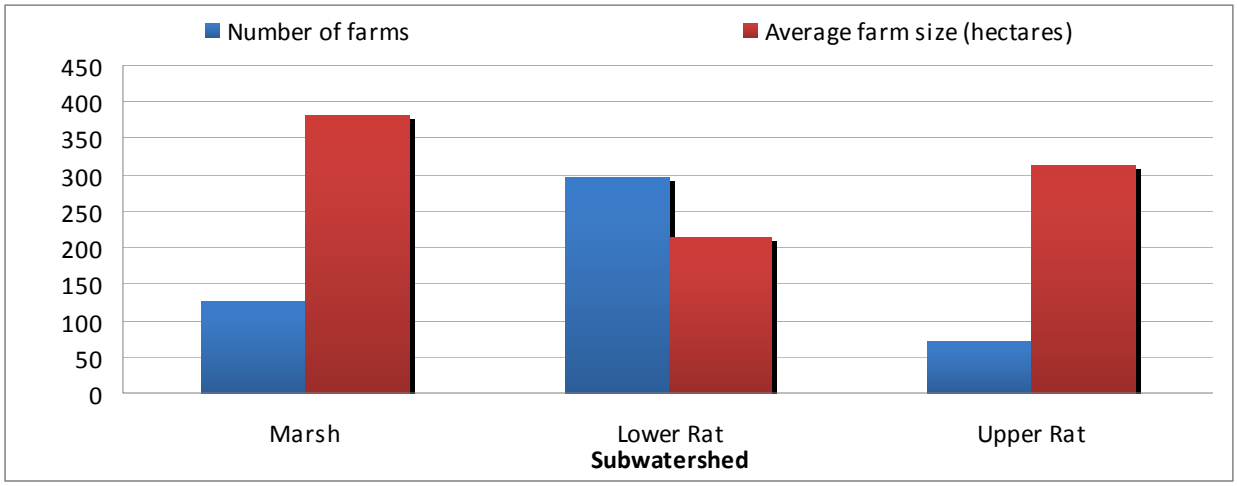


Figure 11: Summary of farm average financial activity for the 2005 calendar year in the Rat-Marsh River Watershed (2006 Census of Agriculture)

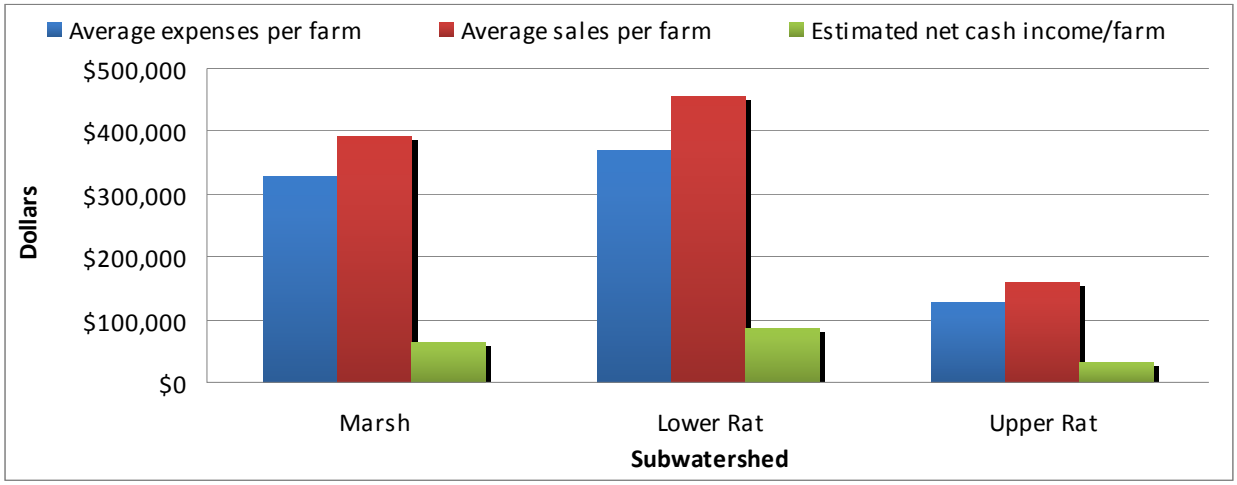
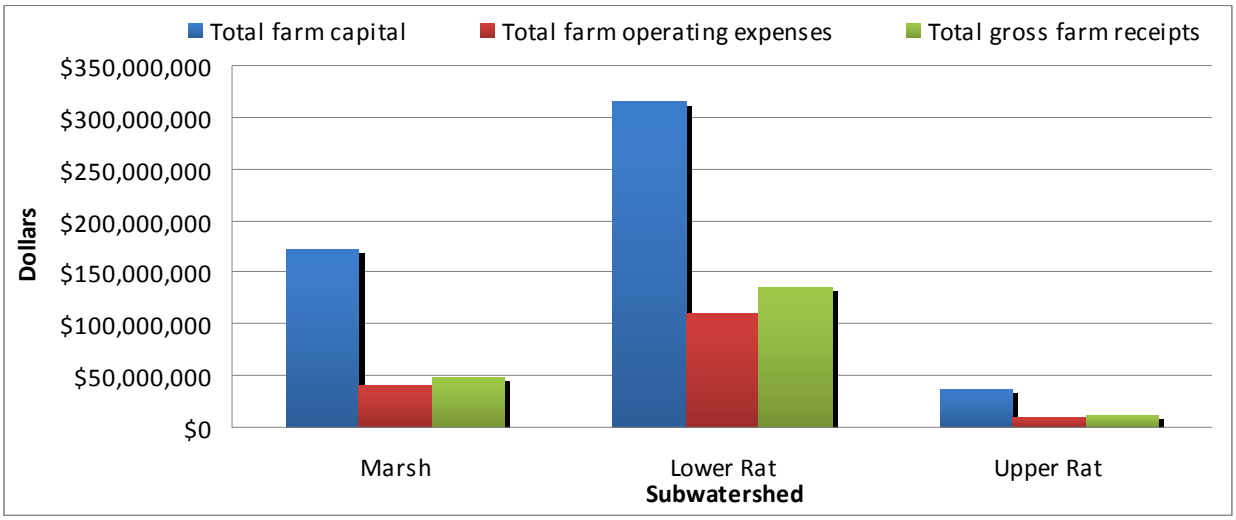
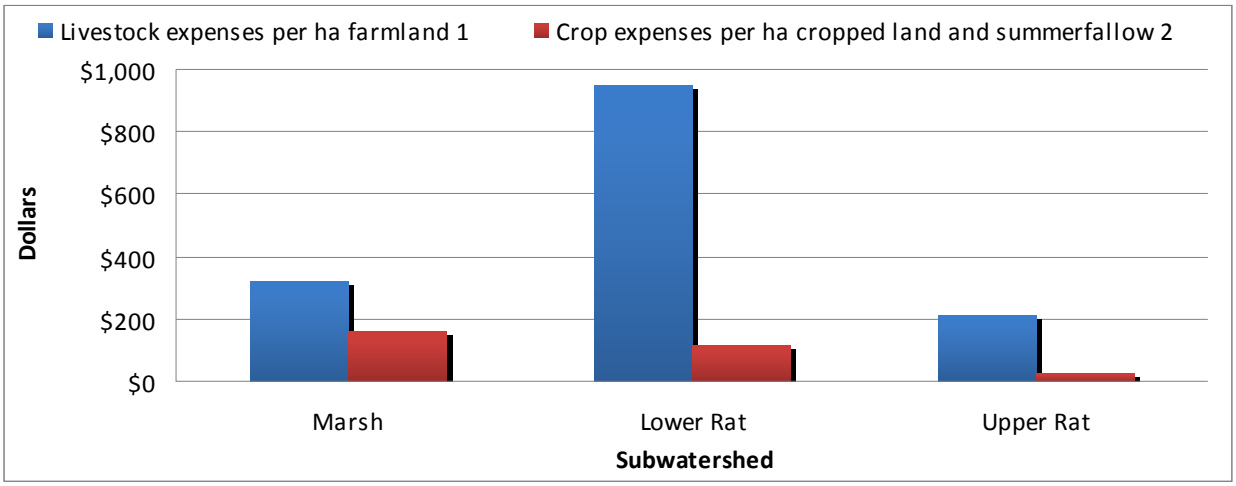


Figure 12: Summary of financial activity for the 2005 calendar year in the Rat-Marsh River Watershed (2006 Census of Agriculture)



Livestock and crop-related expenses reported for the 2005 calendar year have been determined on a per hectare basis. ***Figure 13*** indicates the Lower Rat subwatershed had the highest livestock expenses while Upper Rat subwatershed had the lowest. This is attributable to the high number of intensive hog operations in the Lower Rat subwatershed, which generally require only a small area of land to operate. With respect to crop-related expenses, producers in the Marsh subwatershed reported the highest expenses per hectare of cropped land and summerfallow. A closer look at crop input costs indicates fertilizer costs were approximately twice as high as pesticide expenses in the Marsh and Lower Rat subwatershed, but were substantially more than pesticide expenses in the Upper Rat subwatershed. Seed and plant expenses were similar to pesticide costs in Marsh and Lower Rat subwatersheds, but were considerably higher than pesticides costs in the Upper Rat subwatershed (***Table 3***).

Figure 13: Average livestock and crop-related expenses per hectare for the 2005 calendar year in the Rat-Marsh 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 Rat-Marsh River Watershed (2006 Census of Agriculture)

Subwatershed name	Dollars spent on fertilizer per hectare applied	Dollars spent on pesticides per hectare applied
Marsh	$105	$48
Lower Rat	$99	$49
Upper Rat	$66	$62

2006 Agriculture Profile Summary

- Approximately 61% of the land in the watershed was owned and managed by farm operations.
- Agricultural activities were quite unique within each of the subwatersheds. The vast majority of land within the Marsh subwatershed was dedicated to annual cropland. On the other hand, the Lower Rat subwatershed was characterized by a mixture of both crops and livestock production. Despite its large area, only a small portion of the Upper Rat subwatershed was used for agricultural activities. Of this farmland, most was used for pasture, but a relatively large portion of cropland was present as well.
- Crop production is an important agricultural practice in the watershed. Approximately 66% of the farmland in the watershed was dedicated to crop production. This percentage was drastically higher in Marsh, and slightly lower in the other two subwatersheds. Fertilizers and herbicides were applied to 64% and 59% respectfully, of cultivated land in the watershed. Average crop inputs costs differed greatly between each of the subwatersheds.
- Conventional tillage was the most common form of residue management in the watershed, utilized on over 67% of cultivated land. Conservation and zero–tillage are practiced less in the watershed than in other watersheds in Manitoba. Conservation tillage was practiced on approximately 29% of cultivated land and zero-tillage was practiced on less than 10% in the watershed.
- Livestock production was concentrated in the Lower Rat subwatershed and was characterized by numerous smaller cattle operations, as well as intensive hog and poultry operations. Land used for livestock production (pastures and seeded forage for hay) ranged from as low as 4% in the Marsh subwatershed to as high as 42% in the Upper Rat subwatershed. With respect to livestock herd and flock sizes, farms in all three subwatersheds reported similar numbers (with the exception of poultry in the Upper Rat subwatershed, which was relatively low).

b) 2005 Land Cover Summary

Land cover data used in this analysis was derived from 30 metre resolution LANDSAT Thematic Mapper satellite imagery taken on July 13, 2005. The land cover data provides information on the spatial extent of general types of land cover within a given area at that point in time. Further details on the land cover data, and the constraints associated with this data, are provided in ***Appendix C***.

- Annual Cropland is the predominant land cover type in the watershed, accounting for one third of the total land cover (***Table 4*** and ***Figure 14***). The vast majority of the total annual cropland is located within the Marsh subwatershed, west of HWY59, in the Red River Valley (***Figure 15***). Another large area of annual cropland is present in the northwest corner of the Lower Rat subwatershed near St Pierre-Jolys, and small isolated patches are scattered throughout the eastern portion of the watershed.
- Forested areas are the second most common land cover class comprising 33% (71,738 ha) of the watershed. These areas dominate the eastern half of the watershed, a significant portion of which is located on provincial crown land in the Rural Municipalities of Piney and Stuartburn.
- Grassland/pasture make up a large portion of the study area (18%) and make up most of the area in the central portion of the watershed. These lands are commonly found associated with forested areas and wetlands.
- Approximately 9% (20,072 ha) of the watershed was classified as wetlands. These wetlands are located primarily on crown land in the eastern portion of the watershed.
- Very little land is dedicated to forage crops (4,503 ha or 2%), which are scattered throughout annual cropland in the western portion of the watershed.
- Less than 1% of the watershed is classified as water.

Table 4: 2005 Land Cover by Subwatershed (hectares)*

Subwatershed	Annual Cropland	Trees	Water	Grassland/ Pasture	Wetlands [1]	Forage	Urban	Total
Marsh	50,132	1,403	341	2,674	106	2,273	2,025	58,954
Lower Rat	23,031	23,402	496	26,186	4,239	2,218	2,723	82,295
Upper Rat	950	46,933	552	11,184	15,727	12	1,304	76,661
IWMP Boundary	**74,113**	**71,738**	**1,389**	**40,043**	**20,072**	**4,503**	**6,052**	**217,910**

* Subwatershed 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.

Figure 14: Distribution of Land Cover within the Rat-Marsh River Watershed in 2005

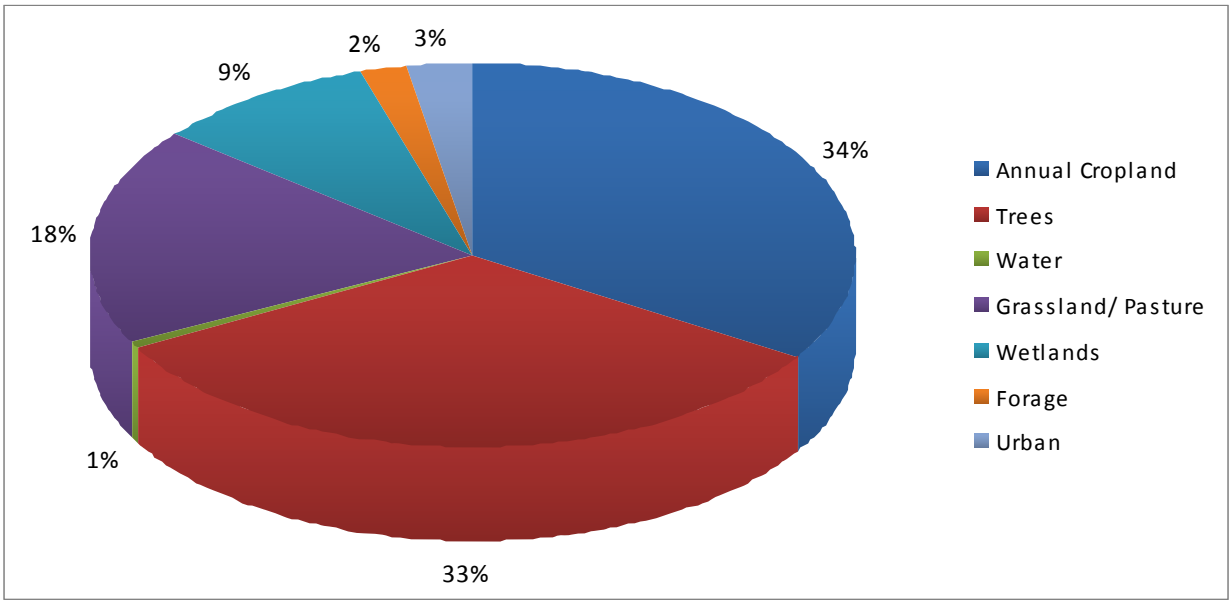
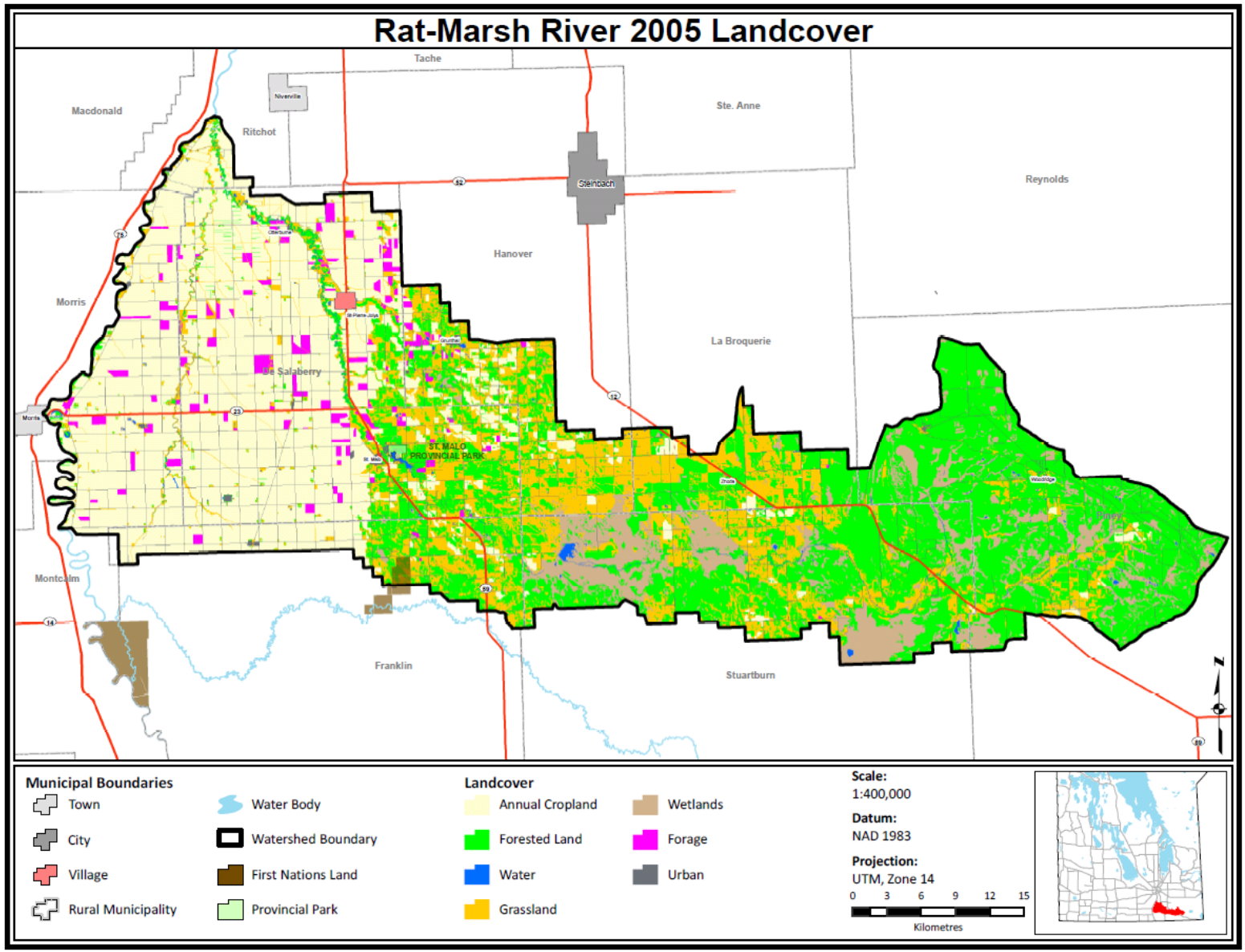


Figure 15: 2005 Land Cover in the Rat-Marsh River Watershed*



ii. Agricultural Land Use Trends

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

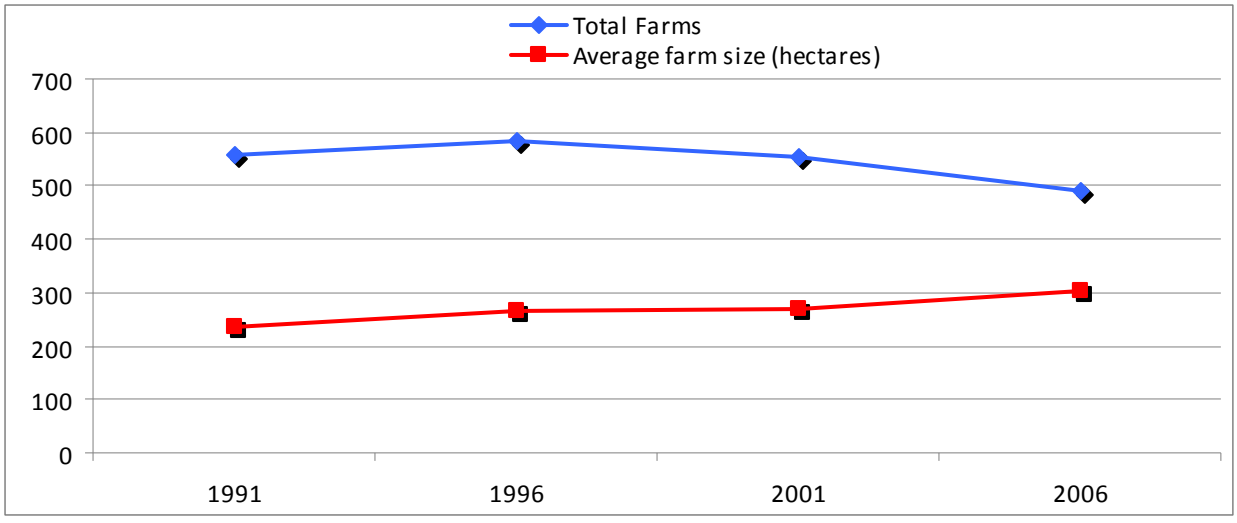
Additionally, there are many factors that influence decisions made on individual farms. In order to understand if changes are the result of adaptation in farming systems and/or practices, or are due to weather, market and other conditions, it is important to also be aware of events and conditions. As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

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

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

Number of Farms and Farmed Area
Even though it rose slightly between 1991 and 1996, the total number of farms in the watershed fell from 555 to 490 over the 15 year period, a decrease of nearly 12% (***Figure 16***). As expected with a decreasing number of farms, average farm size increased steadily from 240 ha in 1991 to 300 ha in 2006.

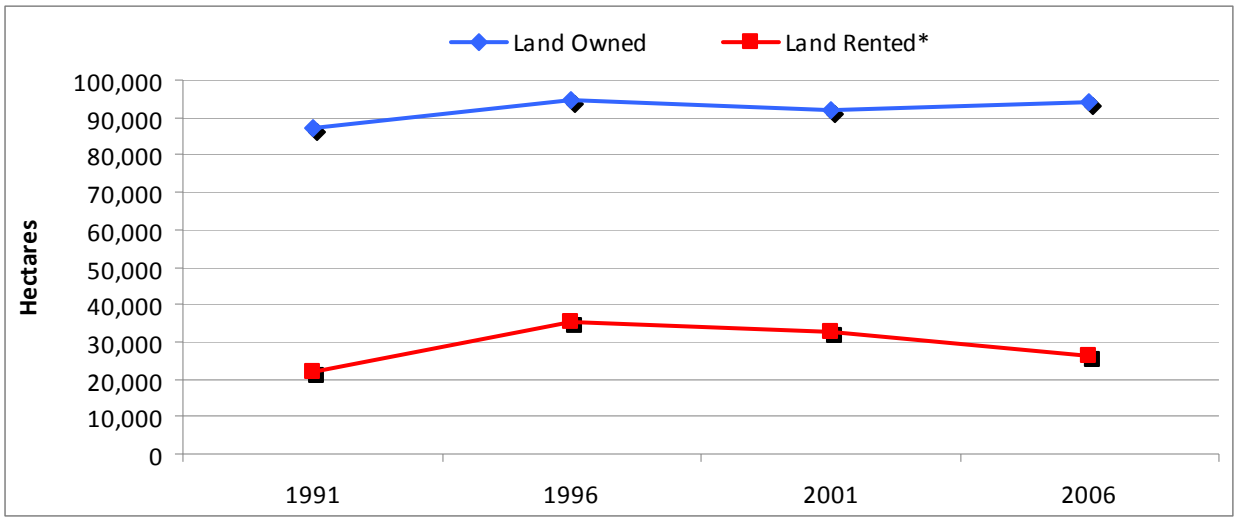
Figure 16: Total number of farms and average farm size in hectares in the Rat-Marsh River Watershed from 1991 to 2006



Land Tenure

The area of owned land increased slightly from 1991 to 2006 (***Figure 17***). Rented lands rose dramatically between 1991 and 1996, and then began to decline over the next ten years to 26,080 ha, only slightly higher than the area of rented land in 1991. The changes noted from 1996-2001 are attributed to the repeal of the Western Grain Transportation Act (WGTA) that was recognized as a driver for the increase in farm sales for that period.

Figure 17: Owned versus rented lands in the Rat-Marsh River Watershed from 1991 to 2006

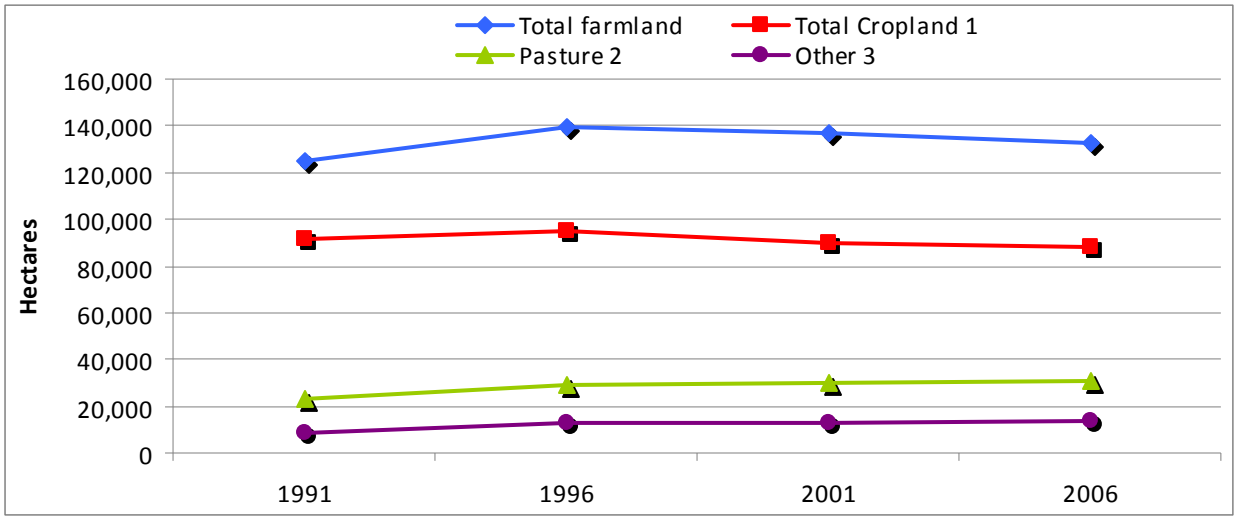


* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

Farmland Usage

The area of farmland increased by nearly 14,500 ha between 1991 and 1996, and was followed by a gradual decrease up to 2006. Over the 15 year period, the total area of farmland increased by approximately 8,000 ha or 6% (***Figure 18***). Despite an overall increase in farmland, the total area of cropland declined from 91,600 ha in 1991 to 88,100 ha in 2006; a decrease of 3,500 ha. Pastureland (both natural and improved) increased in area by approximately 7,300 ha over 15 years. Specifically, the area of natural pasture increased by 4,900 ha, and tame pasture increased in area by approximately 2,400 ha. Other land, mainly characterized by woodland and wetlands, increased by 4,500 ha (or approximately 50%) between 1991 and 2006.

Figure 18: Farmland usage trends in the Rat-Marsh River Watershed from 1991 to 2006

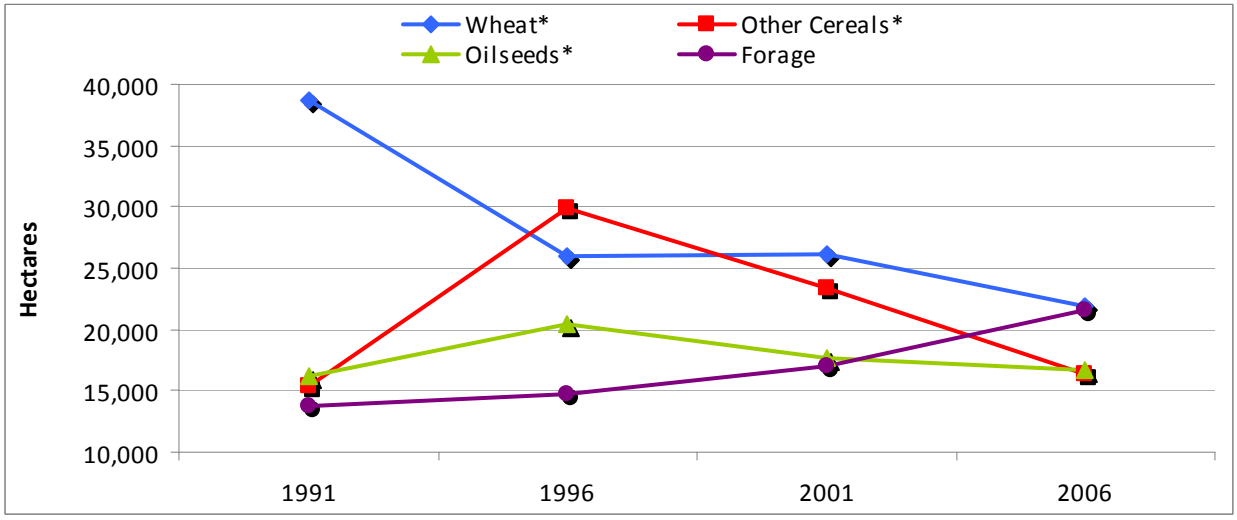


[1] Total cropland includes all field crops, vegetables, fruit and nuts, and sod
[2] Pasture includes tame pasture and natural areas used for pasture
[3] Other land refers to all other land uses including farmyard, woodlot, wetland, Christmas tree, etc.

Cropping Practices

The types and amounts of crops grown within the watershed fluctuated between 1991 and 2006; but some trends can be determined from the data (***Figure 19***). There was a steady decrease in the area of land seeded to wheat, with a total decrease of almost 16,800 ha over the fifteen year period. Land seeded to other cereals increased drastically between 1991 and 1996, but slowly declined to 1991 levels over the next 10 years. The area dedicated to oilseed production remained fairly static over this time period with a small overall increase of approximately 500 ha. The area of forage crops increased every year from 13,700 ha in 1991 to 21,500 ha in 2006, and increase of over 57%. Local knowledge indicates that the cropping changes are largely due to the influence of WTGA, particularly the increase in forage from annual crop.

Figure 19: Major crop types in the Rat-Marsh River Watershed from 1991 to 2006

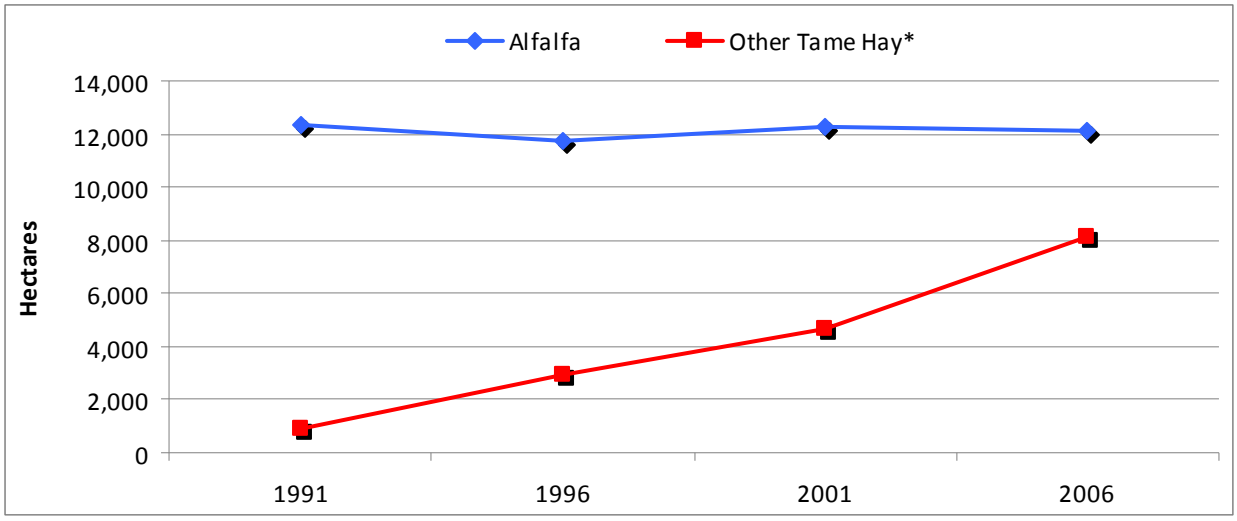


* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

Alfalfa and Hay Production

Forage production, both alfalfa and other tame forages, increased steadily over 15 years, and as of 2006 forage production made up approximately 23% of the total cropland in the watershed in 2006 (***Figure 20***). These increases are attributable to increases in the area of other tame hay, as the area of cropland planted to alfalfa remained fairly consistent between 1991 and 2006.

Figure 20: Alfalfa and tame hay trends in the Rat-Marsh River Watershed from 1991 to 2006



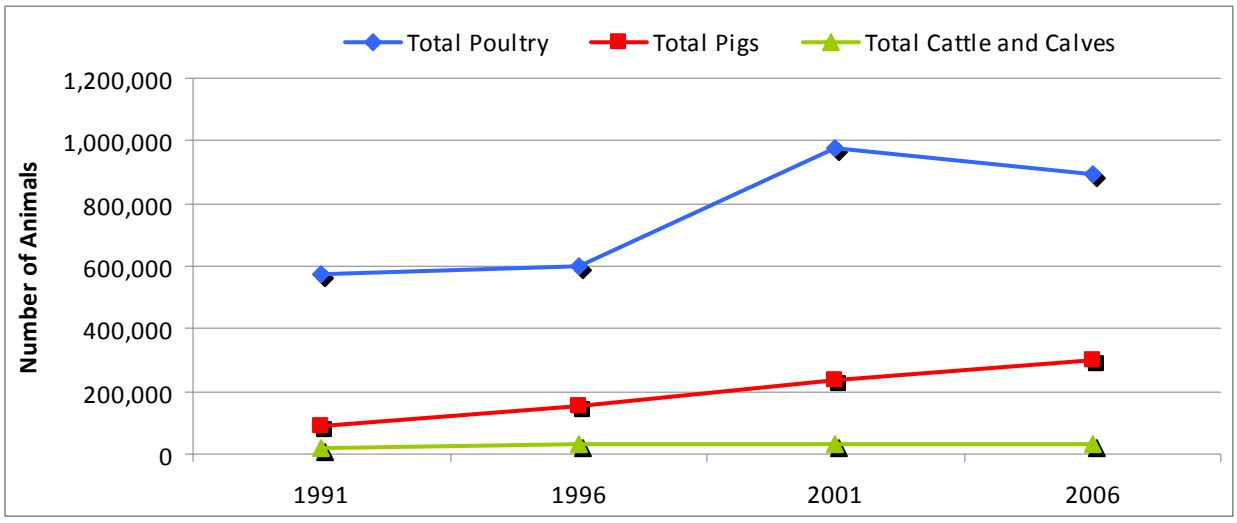
* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

Livestock Production

Livestock production increased in the watershed between 1991 and 2006 (***Figure 21***). In the fifteen years, the total number of pigs increased rapidly from 89,070 in 1991 to 297,560 in 2006, an increase of nearly 235%. This growth is concentrated mainly in the central portion of the watershed, in the RMs of Hanover and La Broquerie. Cattle numbers also rose during this time, with an increase of over 35%. This increase took place primarily between 1991 and 1996, followed by a 10-year period of almost no growth. The number of poultry in the watershed peaked in 2001 at almost 975,700 birds, and dropped by almost 85,000 over the next five years. Overall, the number of birds in the watershed increased by 55% between 1991 and 2006. It should be noted that census data regarding poultry must be interpreted with caution however. Broiler and turkey inventories reflect the total number of birds on Census day. Depending on the operation, this number may be zero for farms that were empty on Census day and had no inventory to report, and underreporting may have occurred.

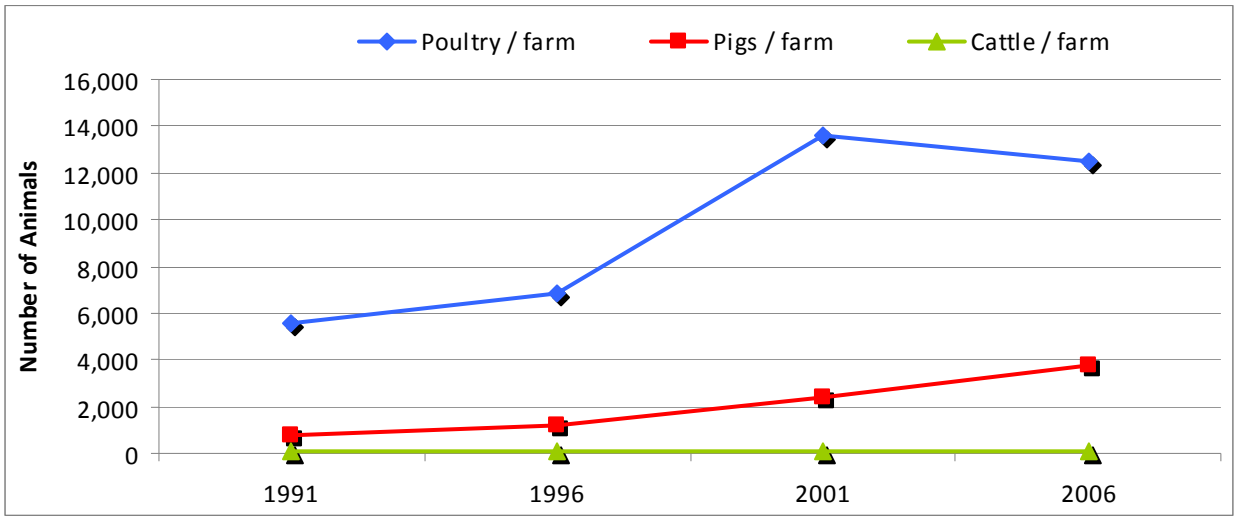
The average number of livestock/birds per farming operation has increased in a fashion very similar to overall livestock numbers. Cattle herd size and pig herd size increased steadily from 1991 to 2006 (***Figure 22***). The average cattle herd size increased by 30 head per farm during the 15-year period. Hog herd size saw the largest proportional increase of all livestock types, with an increase of nearly 415%. Poultry flock size increased from 1996 to 2001 and then decreased slightly in 2006 to 12,400 birds per farm. Increases in the size flocks and herds is likely attributable to the decreasing number of farms and growth of individual operations within the watershed, as well as the economic viability of these sectors between 1991 and 2006.

Figure 21: Major livestock productions trends in the Rat-Marsh River Watershed from 1991 to 2006*



* Number of livestock on farm recorded on the day of Census.

Figure 22: Average number of livestock per farm reporting in the Rat-Marsh River Watershed from 1991 to 2006

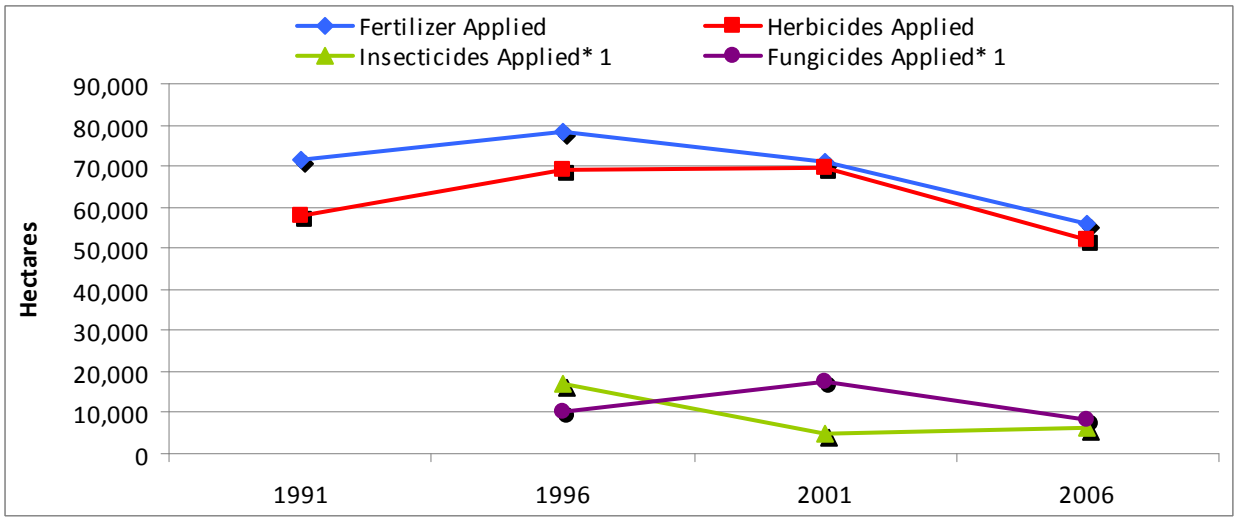


Land Management

Fertilizer and Pesticide Usage

The area of application of crop inputs increased between 1991 and 1996 (***Figure 23***), but fell to values lower than 1991 levels by 2006. In 2006, approximately 56,200 ha and 52,100 ha of land were treated with fertilizer and herbicides, respectfully. This is equivalent to 63% (fertilizer) and 59% (herbicide) of total cropland. Use of insecticides and fungicides in the watershed was relatively low in comparison to the use of fertilizers and herbicides. The area of application of insecticides and fungicide inputs has decreased between 1996 and 2006; however, data was suppressed, so values provided are estimates.

Figure 23: Fertilizer, herbicide, insecticide, and fungicide use in the Rat-Marsh River Watershed from 1991 to 2006



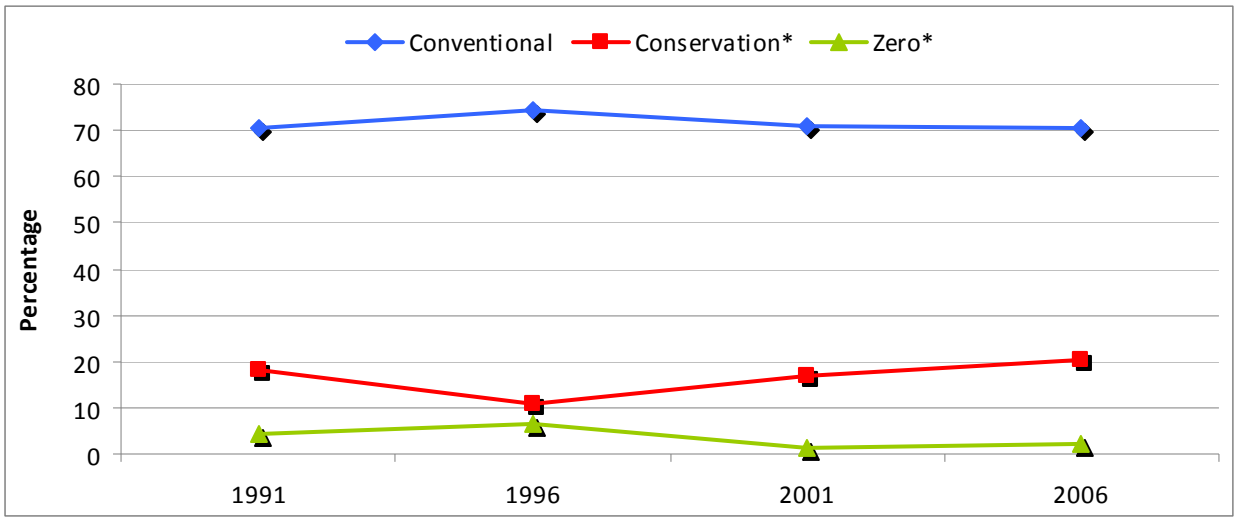
[1] Data for insecticides and fungicides is not available for the 1991 Census year

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

Tillage Practices

Unlike other agricultural watersheds in Manitoba, management of crop residue has remained unchanged in the watershed (***Figure 24***). Conventional tillage has remained the dominant form of tillage in the watershed and is practiced on around 70% of cultivated land. Alternative tillage practices have also remained fairly static since 1991. Over the 15-year period, the percentage of land prepared with conservation or zero-tillage has remained below 20% and 10%, respectfully. That being said, alternative tillage data was suppressed and was actually slightly higher than what is presented.

Figure 24: Trend of tillage practices in the Rat-Marsh River Watershed from 1991 to 2006

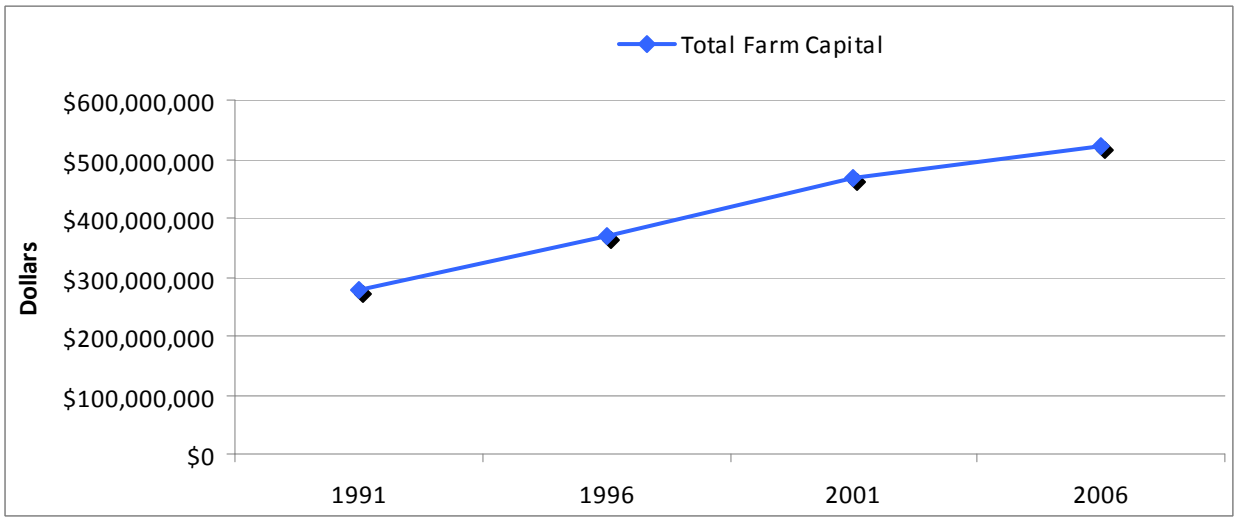


* Data has been suppressed by Statistics Canada to preserve landowner confidentiality

Financial Characteristics

A steady increase of total farm capital occurred in the watershed over the fifteen year period. Farm capital nearly doubled from $277 million in 1991 to over $524 million in 2006 (***Figure 25***).

Figure 25: Total farm capital in the Rat-Marsh River Watershed from 1991 to 2006*



*Inflation has not been accounted for in total farm capital

b) Changes in Land Cover – 1994, 2001, 2005

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***.

Summary of Land Cover Change

An analysis of land cover data from 1994, 2001 and 2005 satellite imagery showed similar results to those obtained using Census of Agriculture data (***Table 5***, ***Figure 26***). Although there are some inherent limitations in analyzing land cover data to determine changes in land use, some general changes can be noted:

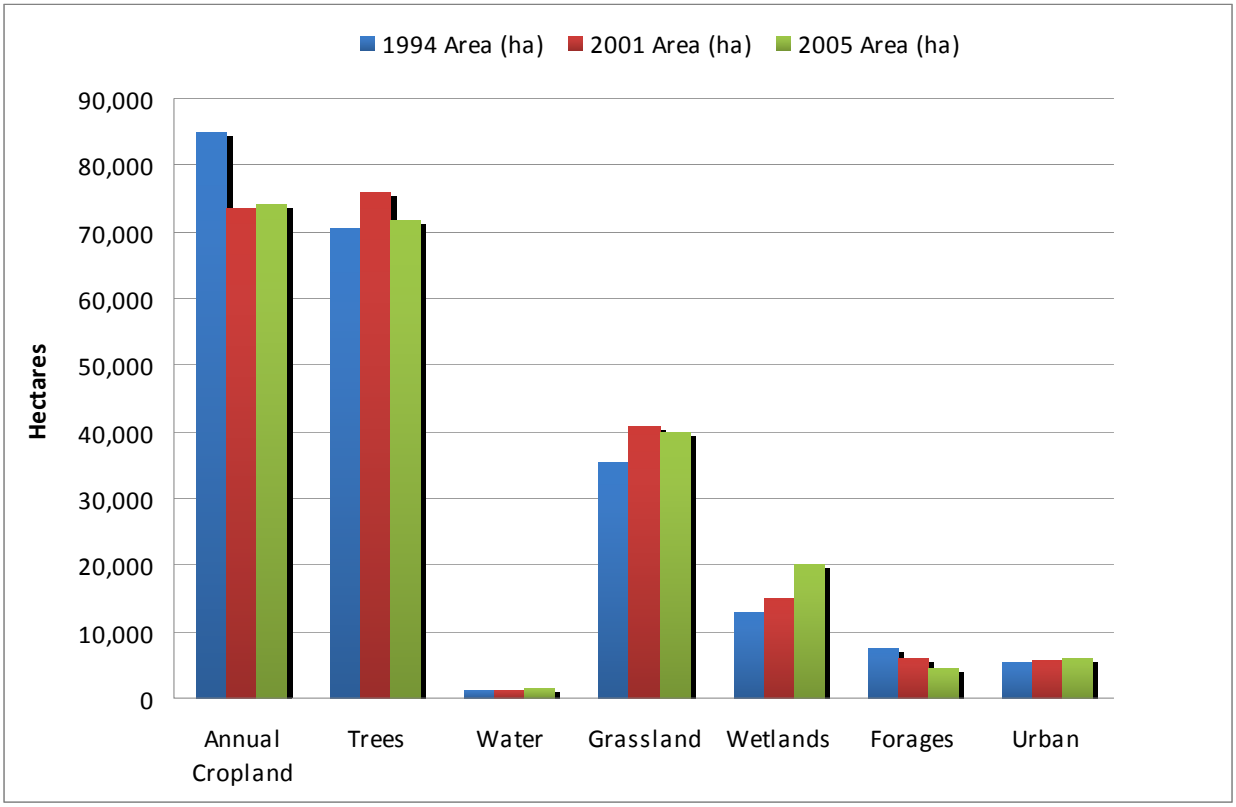
- Annual cropland and forage were the only two land cover classes to decrease in area. Annual cropland exhibited the largest change in area during the 12-year period (from 85,000 ha in 1994 to 74,000 ha in 2005). Losses to both land cover classes were located across the entire watershed, but were highly predominant in the eastern portion.
- Grassland area saw a large increase in the central portion of the watershed, mainly due to land converted from annual crops and forages. Despite these significant gains, a relatively large amount of grassland was lost to encroachment from adjacent forested areas.
- The area of wetlands increased by a significant amount over the 12-year period. In particular, a large area of in the RM of Stuartburn previously classified as forest in 1994 was classified as wetlands in 2005. In addition to this area, numerous smaller fragments of forested land were later classified as wetlands in the RM of Piney.
- Overall, the area of natural cover within the watershed increased drastically over the 12-year period. These changes were especially evident in the portion of the watershed east of HWY59.
- Wetland and open water classifications may not be accurately estimated due to fluctuations in precipitation amounts and classification effort differences between years. Additionally, some wetlands may also be difficult to quantify due to their small size in conjunction with the relatively coarse resolution of LANDSAT data. In the Rat-Marsh River study area, total precipitation levels and total rainfall levels recorded for the watershed were higher than the 30 year average during the 2001 and 2005 (see ***Appendix P)***. This may have resulted in a higher than expected area of wetlands.

Table 5: Change in land cover from 1994 to 2005*

Land Cover	1994 Area (ha)	2001 Area (ha)	2005 Area (ha)	Change from 1994 to 2001 (ha)	Change from 2001 to 2005 (ha)	Overall Change from 1994 to 2005 (ha)
Annual Cropland	85,023	73,533	74,113	-11,490	580	-10,910
Trees	70,502	75,998	71,738	5,496	-4,260	1,237
Water	1,207	1,242	1,389	36	147	182
Grassland	35,500	40,857	40,043	5,357	-814	4,543
Wetlands	12,885	14,908	20,072	2,023	5,164	7,187
Forages	7,481	5,875	4,503	-1,606	-1,372	-2,978
Urban	5,437	5,624	6,052	187	428	615
Totals	**218,034**	**218,036**	**217,910**			

* 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

Figure 26: Comparison of change in land cover from 1994 to 2005*



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

iii. Other Agricultural Land Use Trends/Impacts

Agricultural land use is constantly changing due to factors such as climate, markets, crop rotation or changes in agricultural production systems (livestock versus crop production). The previous section summarized the overall change in land cover from 1994 to 2005. Using a more detailed examination of the land cover classes from 1994 and correlating this to data collected from the 2005 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 28*** identifies parcels of land that underwent changes to or from annual cropland between 1994 and 2005.

In the Rat-Marsh River IWMP:

- Conversion from annual cropland to other land cover types occurred throughout most of the watershed, while new cropland was localized mainly with the Rural Municipalities of De Salaberry and Hanover (***Figure 28***).
- The total area of annual cropland decreased by over 10,900 ha (12.8%) in the watershed between 1994 and 2005 (***Table 5***). Along with forage, annual cropland was the only land cover type to decrease in area within the watershed. Cropland losses were attributable primarily to forages in the west and grassland/pasture in the east (***Figure 27***).
- A large area of annual cropland in 1994 was classified as grassland and pasture in 2005. During this time, 10,300 ha of annual cropland were converted to grasslands and 1,100 ha of grassland were converted to annual cropland, resulting in a net conversion of 9,200 ha of annual cropland to grassland.
- Most of the new annual cropland present in 2005 had been converted from lands previously classified as forage in 1994 (3,600 ha). A slightly higher area of annual cropland was converted to forage during this time (3,700 ha), resulting in a net conversion of 85 ha of cropland to forage.
- There was a net conversion of 1,300 ha from annual cropland to other types of natural cover (including treed areas and wetlands).
- Annual Cropland decreases likely are attributed to the Green Cover (approximately 440 ha) and the Permanent Cover Program (PCP) (approximately 2,350 ha) introduced in the early 1990s to encourage the conversion of marginal lands from annual cropping production to perennial cover. The repeal of the Western Grain Transportation Act (WGTA) also influenced the conversion of annual cropland to forage production on marginal lands. Impacts of the PCP and the removal of the WGTA coupled with favourable exchange rates (higher Canadian dollar versus United States dollar) led to accelerated land conversion of both viable lower class and prime agricultural land to forages.

Figure 27: Total change in area of annual cropland, in relation to other land cover types, in the Rat-Marsh River IWMP study area (from 1994 to 2005)

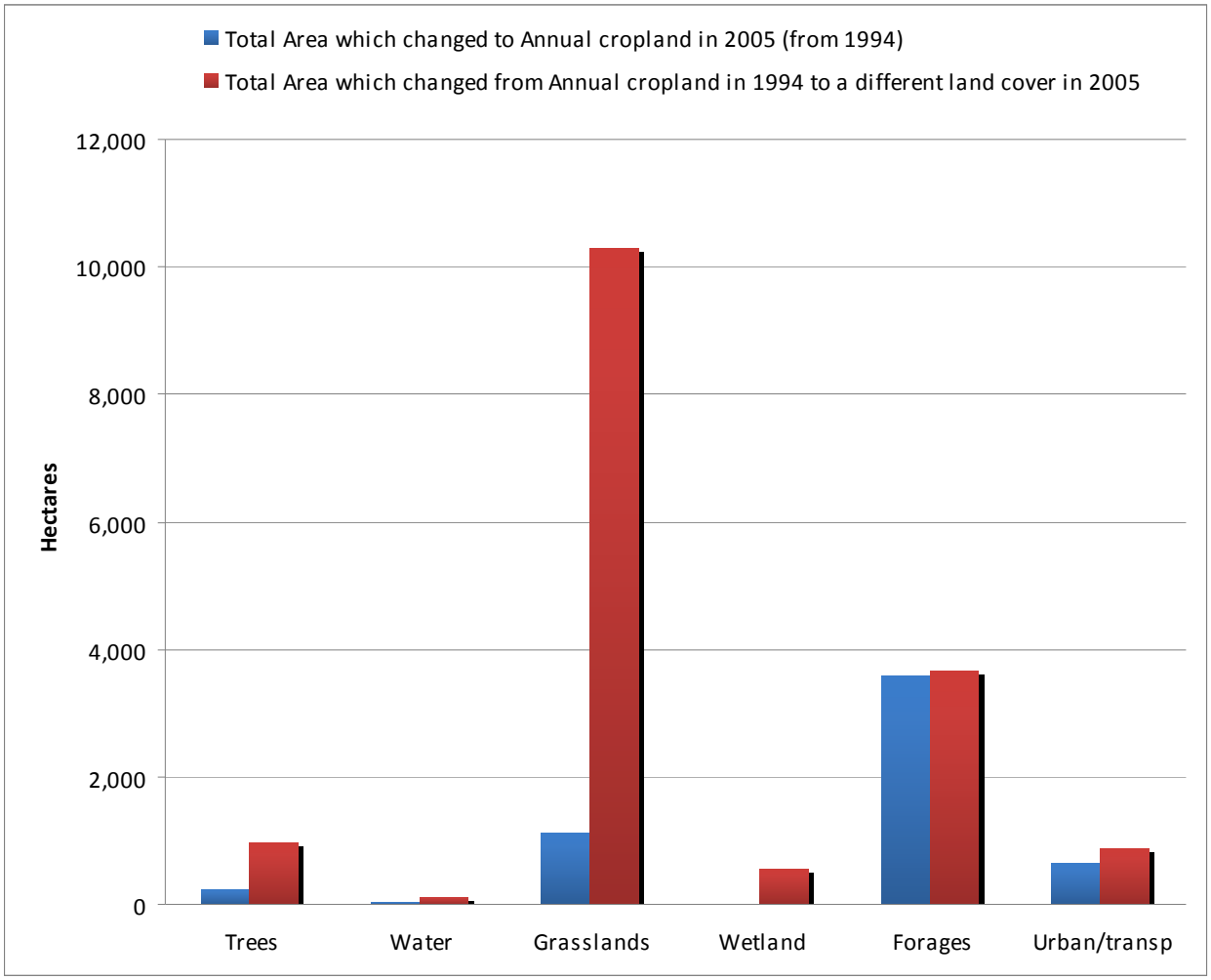
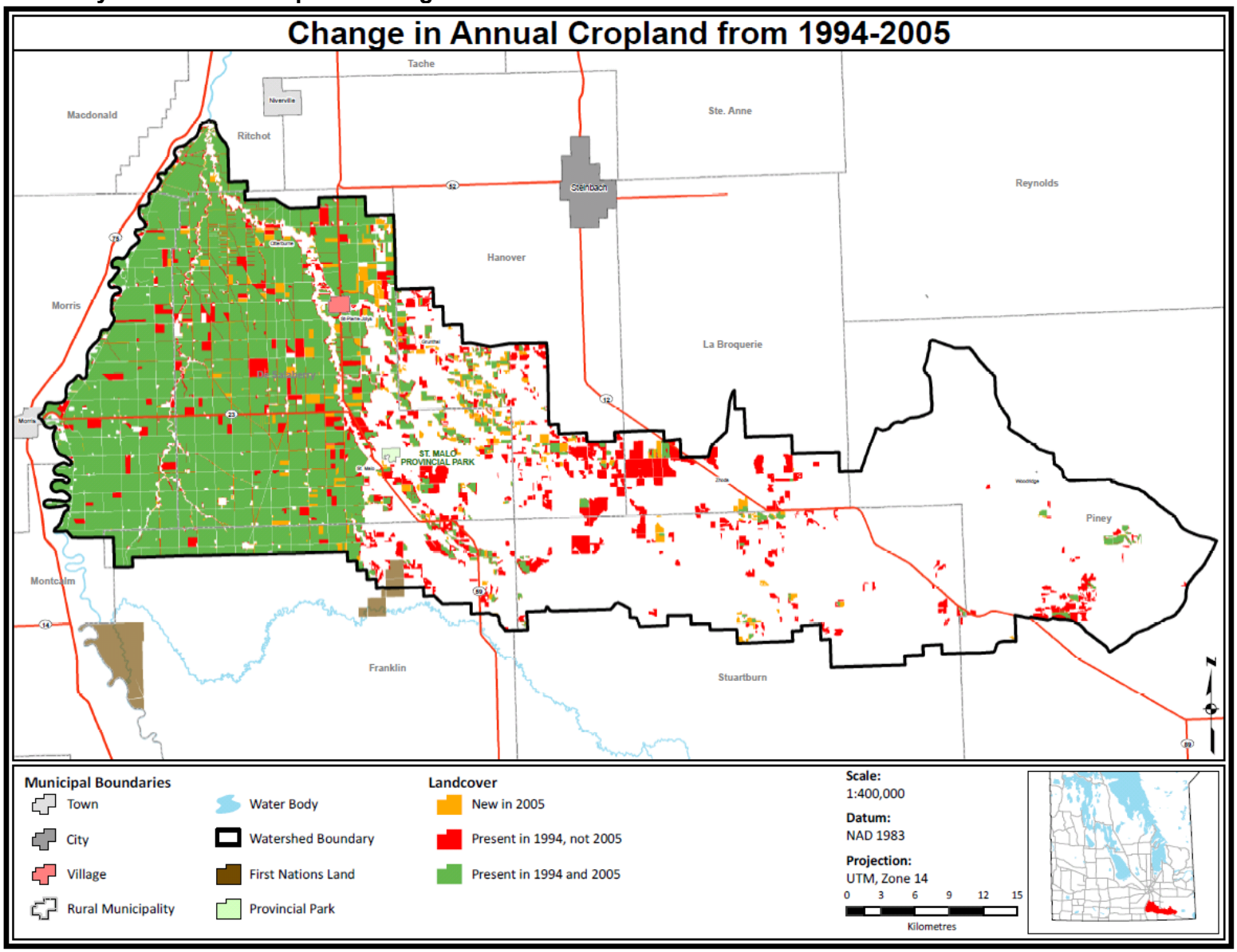


Figure 28: Analysis of annual cropland changes between 1994 and 2005 land cover data



Changes in Grassland Area

Analyzing changes in grassland cover can be useful to understand potential risks associated with the loss of natural cover in the watershed. Grasslands can also be beneficial for reducing runoff and enhancing flood mitigation. ***Figure 30*** identifies parcels of land that underwent changes to or from grassland between 1994 and 2005.

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

In the Rat-Marsh River IWMP:

- There was an overall increase of nearly 4,600 ha of grassland by 2005 (***Table 5***), an increase of almost 13% from 1994 cover. Most of these gains were attributable to decreases in annual cropland, forested area, and forage cover.
- New grassland areas were concentrated in the central portion of the watershed, between HWY59 and Zhoda. Grassland losses were found generally in larger congregates in the eastern portion of the watershed and largely absent from the area west of HWY 59 (***Figure 30***).
- Tree encroachment was the primary factor responsible for the decreases in grassland cover across the watershed (***Figure 29***). Over 11,700 ha of grassland exhibited tree encroachment over the 12-year period. Only 6,600 ha of land experienced the reciprocal conversion of forested area to grassland, resulting in a net loss of over 5,000 ha of grassland to tree encroachment. Encroachment occurred as small patches scattered throughout the eastern portion of the watershed.
- A large proportion of new grasslands were converted from lands previously classified as annual cropland in 1994 (10,300 ha): this was partially offset by conversion of grassland to annual cropland (1,100 ha). These changes occurred mainly in the RMs of De Salaberry, Hanover, and La Broquerie between HWY59 and Zhoda, though a large area of cropland was also converted in the southern portion of the RM of Piney.
- Conversion to wetlands occurred primarily in the RMs of Stuartburn and Piney and conversion from forage was concentrated mainly in the central portion of the watershed.
- During the 12-year period, approximately 2,800 ha of forage had been converted to grasslands, located primarily within the central portion of the study area.
- Approximately 2,700 ha of land classified as grassland in 1994 was classified as wetlands in 2005. These new wetlands were located mainly in the RMs of Stuartburn and Piney.
- Grassland increases can again be attributed to the Green Cover (approximately 440 ha) and the Permanent Cover Program (PCP) (approximately 2,350 ha), and/or the repeal of the Western Grain Transportation Act (WGTA). This was particularly evident in the western portion of the watershed.
- Local knowledge also indicated that attempted land conversions for corn production in the 1980's in the central and eastern portions of the watershed were converted back to a permanent cover.
- Wet cycles experienced in the 1990's also attributed to lands being left to grasslands (***Appendix S***).

Figure 29: Total change in area of grassland, in relation to other land cover types, in the Rat-Marsh River IWMP study area (from 1994 to 2005)

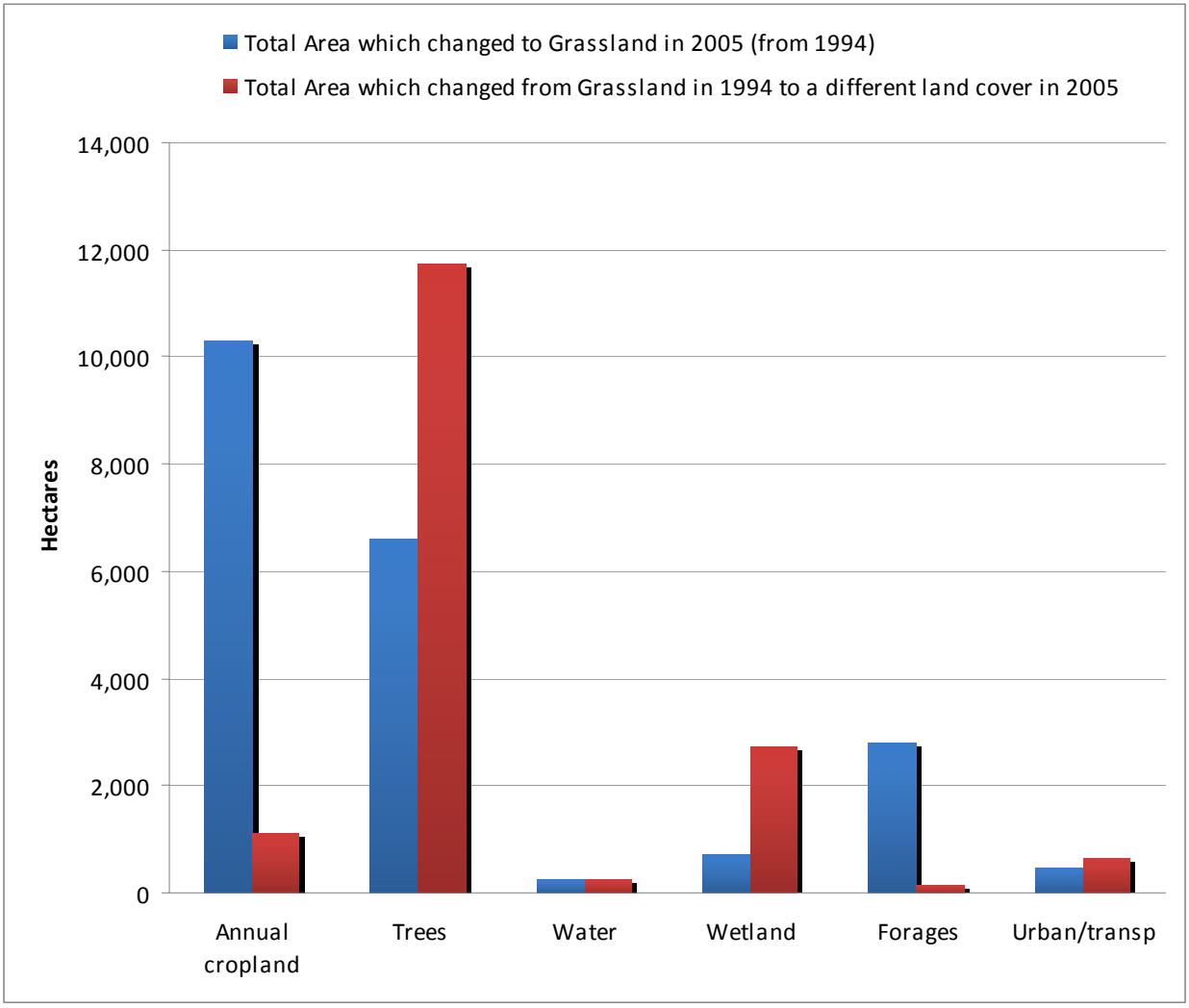
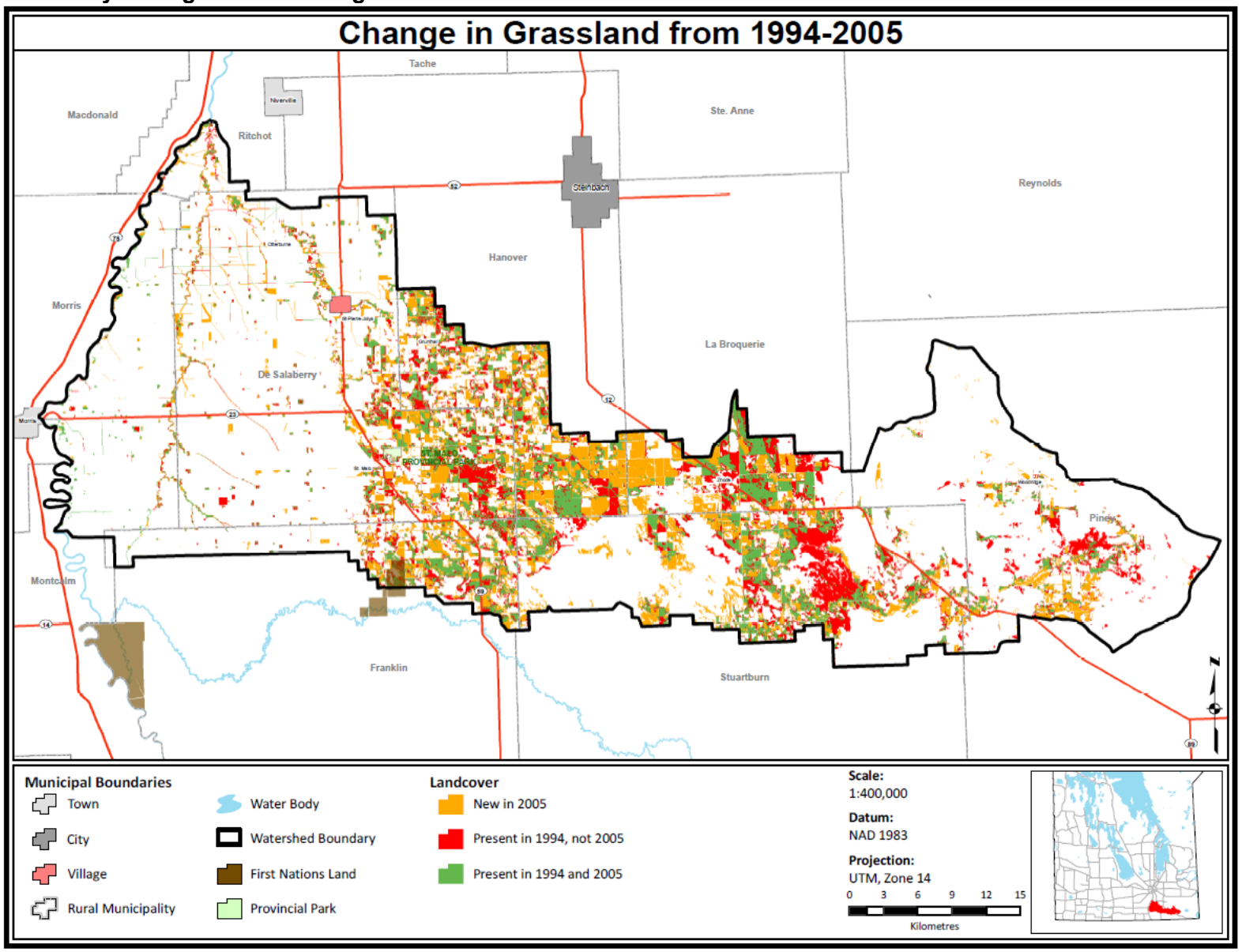


Figure 30: Analysis of grassland changes between 1994 and 2005 land cover data



Changes in Forested Areas

Changes in forested area can provide some information about impacts on flooding, water supply and quality, as well as natural cover within the watershed. ***Figure 32*** identifies parcels of land that underwent changes to or from forested areas between 1994 and 2005.

In the Rat-Marsh River IWMP:

- There was an overall increase of approximately 1,200 ha of forested area between 1994 and 2005 (***Table 5***). Changes to forested areas were associated almost entirely with grasslands and wetlands in the eastern portion of the watershed (***Figure 32***).
- Most of the new forested areas noted in 2005 were the result of previously forested areas encroaching into adjacent grasslands (in Hanover, De Salaberry, La Broquerie and Stuartburn) and wetlands (in Piney and Stuartburn) (***Figure 31***).
- 11,700 ha of grassland in 1994 were classified as forested area in 2005. Only 6,600 ha of land experienced the reciprocal conversion of forested area to grassland, resulting in a net increase of over 5,100 ha of forested area.
- 6,800 ha of wetlands in 1994 were classified as forested area in 2005. Roughly double this area (11,400 ha) experienced the reciprocal conversion of forested area to wetland, resulting in a net decrease of 4,600 ha of forested area. New wetlands were concentrated primarily into a small area in the northwest corner of the RM of Stuartburn.
- Local knowledge suggests that the increase in forested area on the west side of the watershed is primarily shelterbelt/yardbelt establishment. The loss of forested lands found in the central portions of the watershed are primarily associated with earlier brush management control through fire management and of wet cycles experienced in the 1990's.

Figure 31: Total change in forested areas, in relation to other land cover types, in the Rat-Marsh River IWMP study area (from 1994 to 2005)

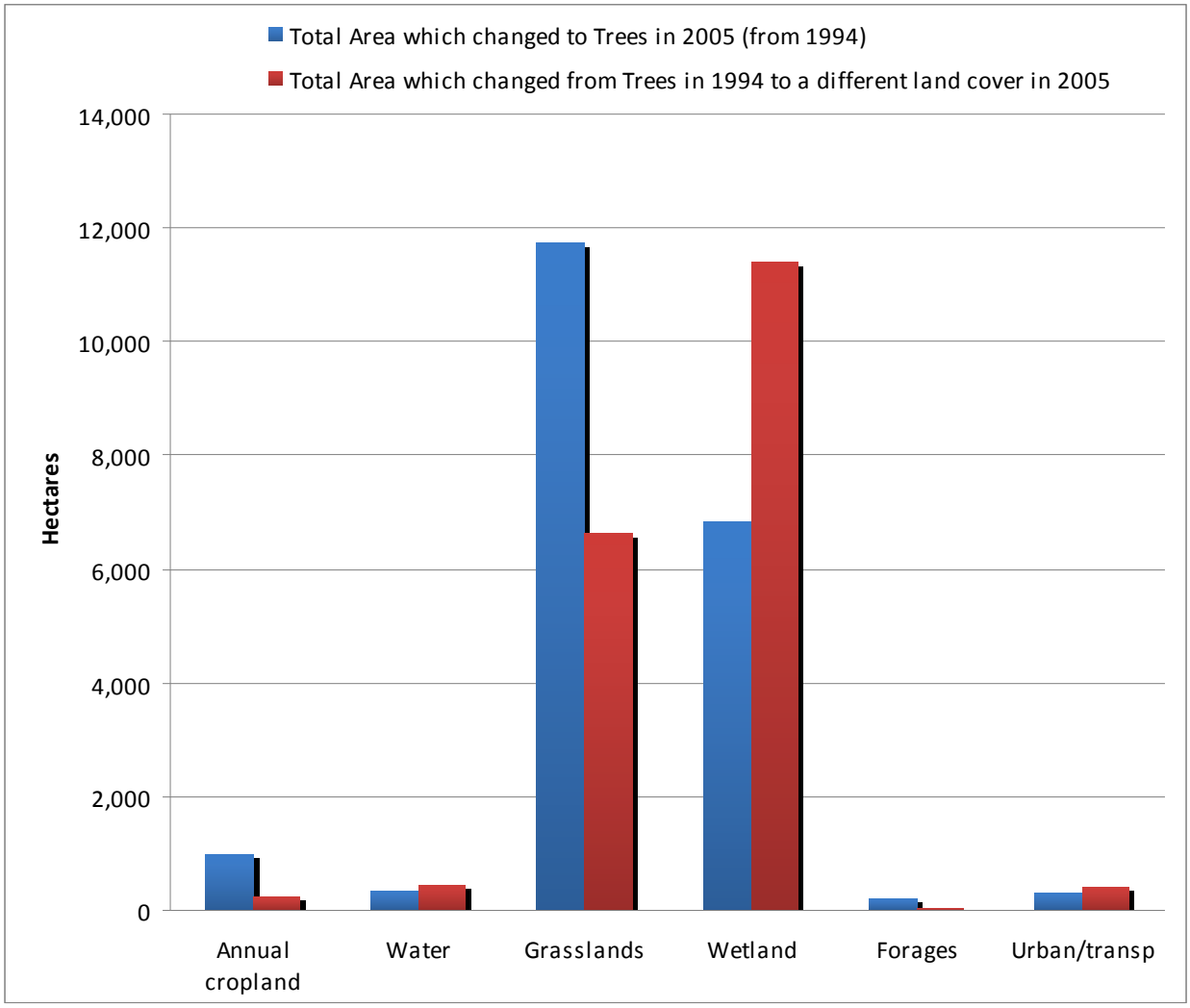
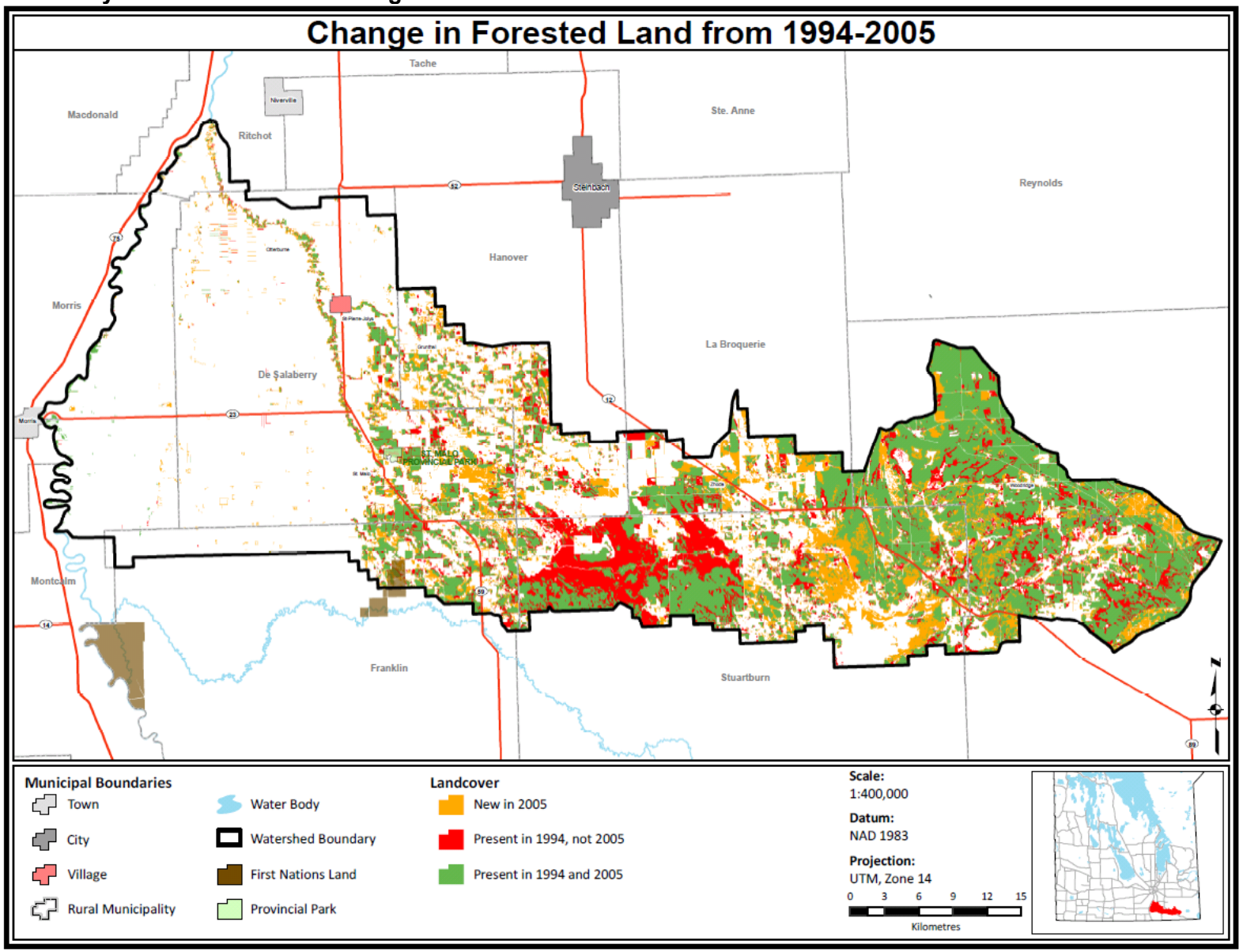


Figure 32: Analysis of forested area change between 1994 and 2005 land cover data



Changes in Forage Area

Changes in forage area can provide information regarding the conservation of natural habitat and the adoption of erosion control beneficial management practices. The conversion of natural areas to forage are less detrimental to the environment than conversion to annual cropland because they act as a form of perennial cover and provide a form of habitat to wild animals. ***Figure 34*** identifies parcels of land that underwent changes to or from forages between 1994 and 2005.

In the Rat-Marsh River lWMP:

- Analysis indicates that changes to forage area in the watershed resulted almost entirely from changes to/from annual cropland and grassland.
- Forage cover decreased in the watershed between 1994 and 2005, by nearly 40% (3,000 ha) (***Table 5***). Decrease in forage cover occurred primarily in the north central portion of the watershed, in the RMs of De Salaberry and Hanover (***Figure 34***).
- Approximately 3,600 ha of land classified as forage in 1994 was classified as annual cropland in 2005 (***Figure 33***). A similar, but slightly smaller sized area of land (3,700 ha) experienced the reciprocal conversion during the 12-year period. Most of the new forage cover in 2005 was located west of HWY59, and with little new forage found in the remainder of the watershed.
- A large amount of land classified as forages in 1994 was converted to grasslands between 1994 and 2005 (2,800 ha). This area was offset very slightly by 148 ha of grasslands converted to forage in the same time period. These changes mainly in the central, as well as eastern, portions of the watershed.
- Forage increases are attributed to the Green Cover (approximately 440 ha) and the Permanent Cover Program (PCP) (approximately 2,350 ha) introduced in the early 1990s to encourage the conversion of marginal lands from annual cropping production to perennial cover. 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. The increase to forages may be attributed to these lands being older stands of forage where grass may be the majority of the species component.

Figure 33: Total change in area of forages, in relation to other land cover types, in the Rat-Marsh River IWMP study area (from 1994 to 2005)

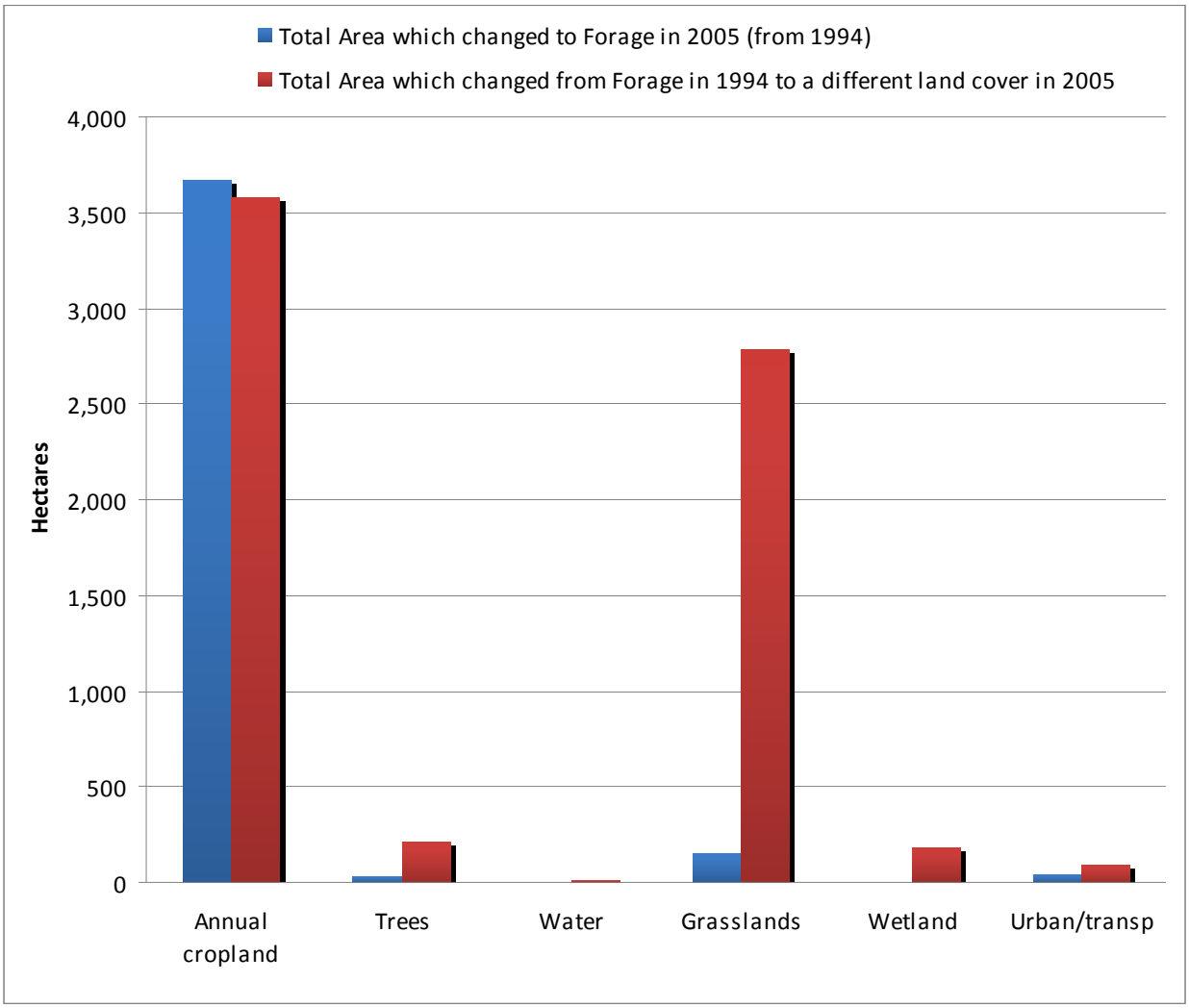
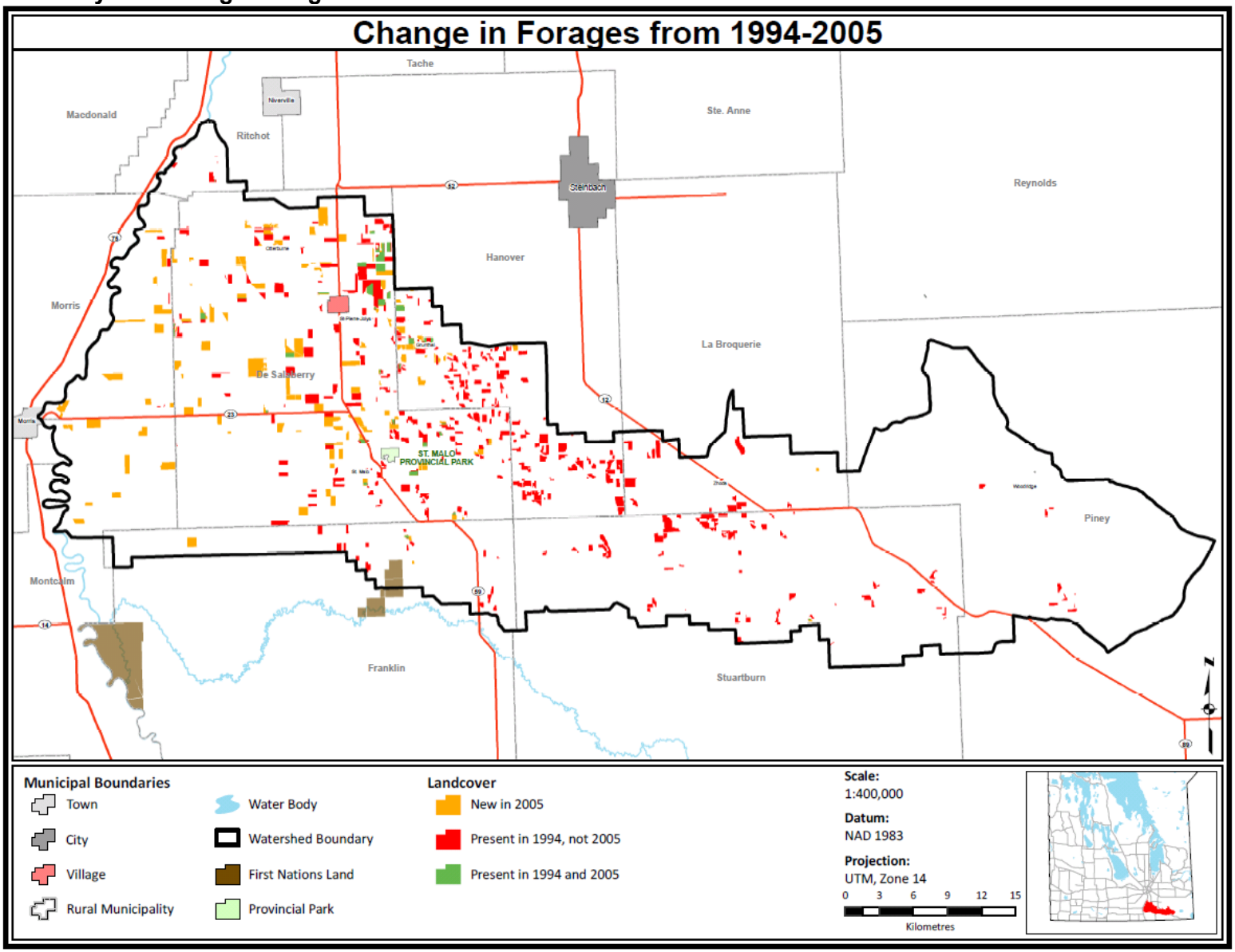


Figure 34: Analysis of forage changes between 1994 and 2005 land cover data



Changes in Wetland Area

Changes to wetlands can provide information regarding the management practices of groundwater and surface water, and act as indicators of change to natural habitat within the watershed. Wetlands serve as important habitat for wildlife and often act as water reservoirs, buffering against the detrimental effects of flooding caused by spring melt and extreme precipitation events. These areas are at particular risk in agricultural watersheds, where their value may be underestimated. ***Figure 37*** identifies parcels of land that underwent changes to or from wetlands between 1994 and 2005.

In the Rat-Marsh River IWMP:

- The area of wetlands increased by 7,200 ha (56%) in the watershed over the 12-year period. Analysis indicates that the increase resulted primarily from conversion of land previously identified as forest and grassland (***Figure 35***). Most of these changes occurred within the RMs of Stuartburn and Piney (***Figure 36***).
- A large area of wetlands that were new in 2005 is located in the western half of the RM of Stuartburn. A large proportion of these wetlands occur on crown land with no agricultural use (protected areas, wildlife management areas, etc) and on land purchased by the Nature Conservancy of Canada.
- Approximately 11,400 ha of land classified as forested area in 1994 was classified as wetland in 2005. Around half that area of land (6,800 ha) experienced the reciprocal conversion from wetlands to trees during the same time period.
- There was an overall conversion of 2,000 ha of grasslands to wetlands during between 1994 and 2005.
- Local knowledge suggests that wetland increases would be associated with the wet cycles experienced in the 1990's (see ***Appendix S)***.

Figure 35: Total change in area of wetlands, in relation to other land cover types, in the Rat-Marsh River IWMP study area (from 1994 to 2005)

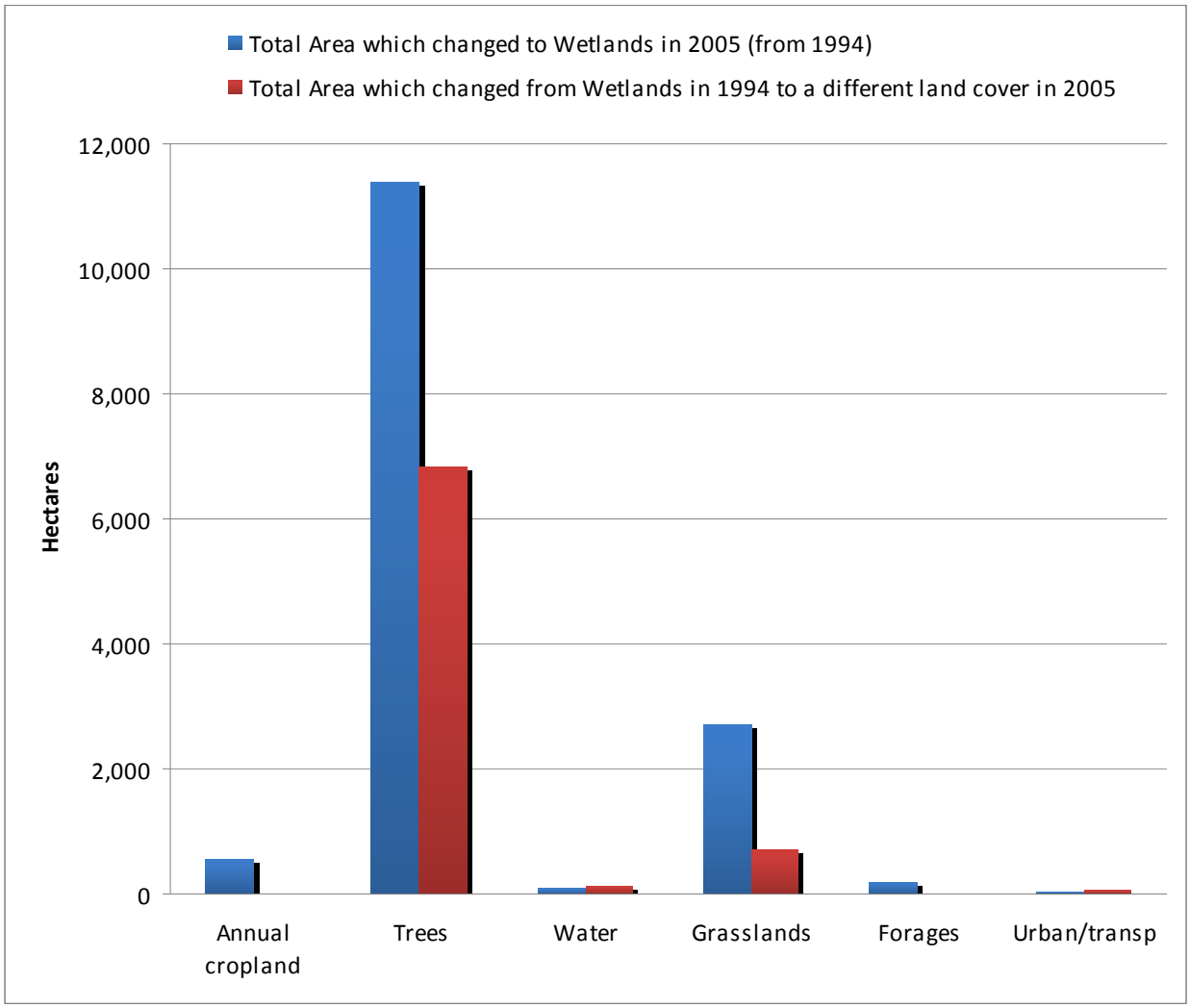
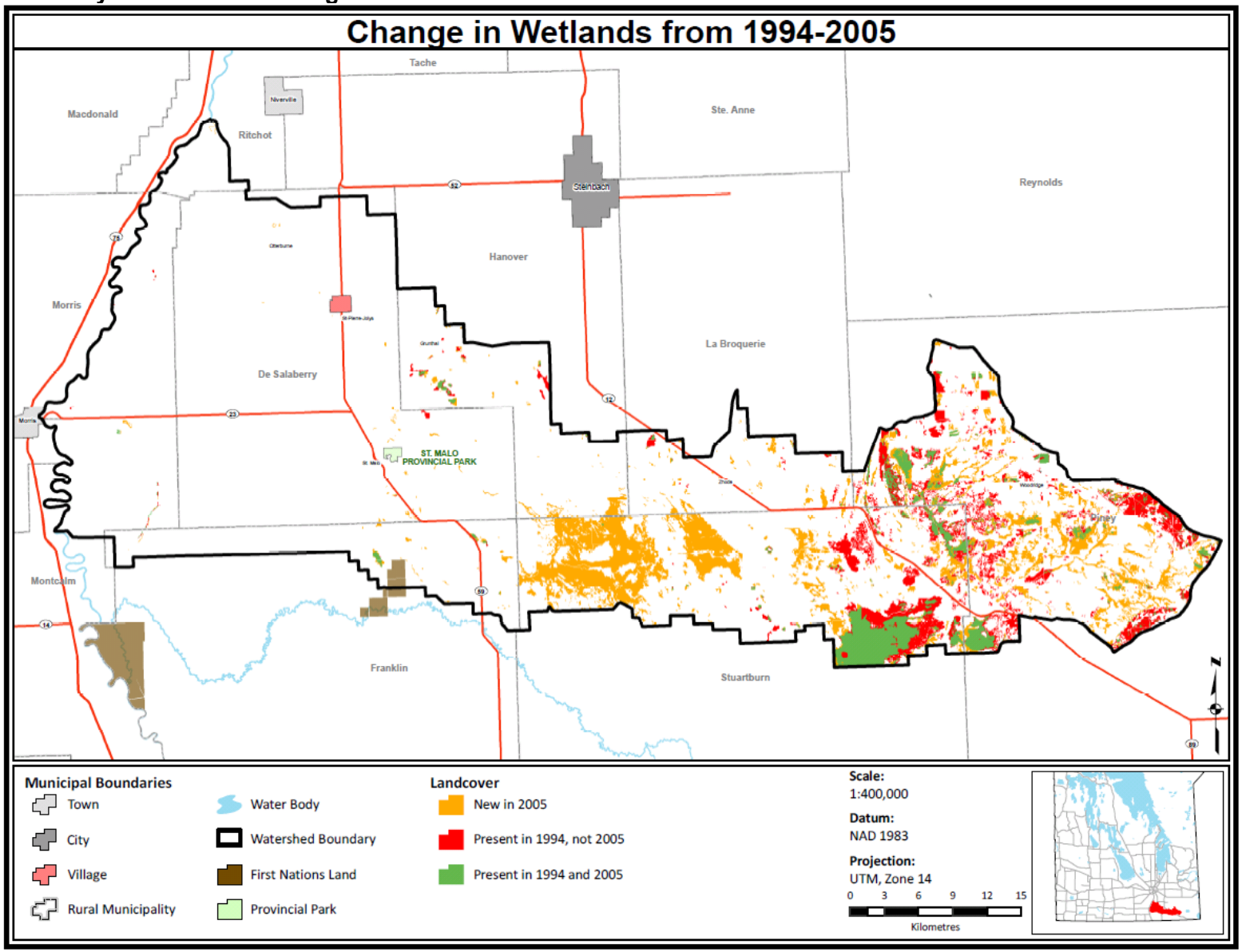


Figure 36: Analysis of wetland changes between the 1994 and 2005 land cover data



F. Agricultural Land Use and Management Considerations

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

i. Agricultural Capability Analysis

The Canada Land Inventory System (CLI) was used to classify land based on agricultural capability. The CLI is a comprehensive survey of land capability and land use aimed at providing a basis for making land-use planning decisions. Under the CLI, lands are classified according to their physical capability for agricultural use (PFRA 2005).

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

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

In the Rat-Marsh River IWMP:

- Over half of the land in the watershed is considered highly productive Class 1, 2 and 3 lands (56% or approximately 121,200 ha) (***Table 6***). The vast majority of this land is located in Red River valley in the western portion of the watershed.
- 44% (96,500 ha) of the soils in the watershed are Class 4 and lower (or organic), most of which are located in the eastern portion of the watershed, west of St Malo Provincial Park.
- A relatively significant proportion of land is considered organic soil (18,700 ha or 9%). Organic soils are found in the wetlands associated with the Rat and Sand Rivers in the RMs of Stuartburn and Piney.

On annual cropland with respect to agricultural capability:

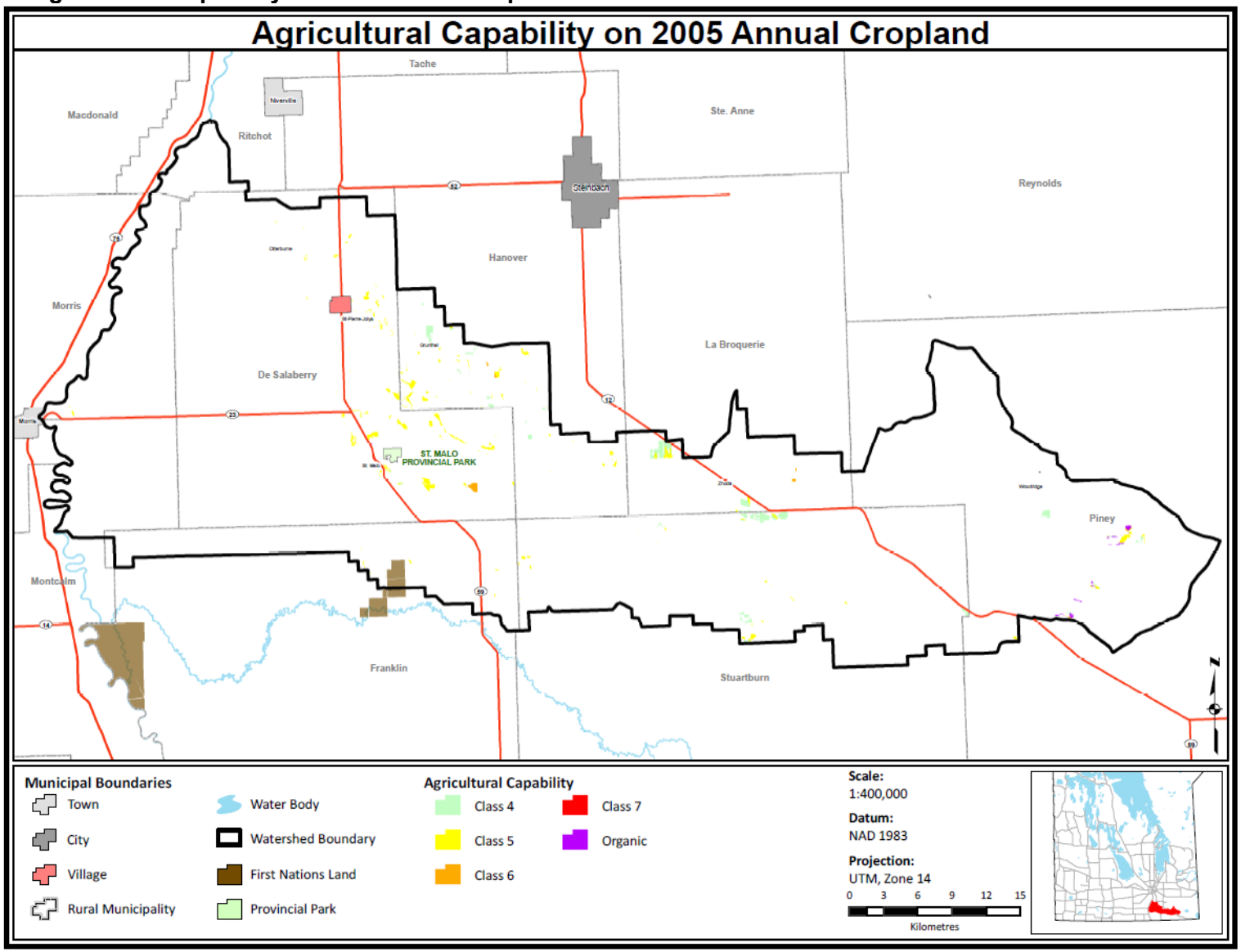
- Within the Rat-Marsh River study area, only a small amount of annual cropland is located on marginal and organic soils (2% or 1,651 ha). This number has dropped considerably since 1994, when nearly 8% (6,600 ha) of annual cropland was located on marginal or organic soils (***Table 6***). This change is due to the large decrease in land used for annual crops in the western portion of the watershed.
- Marginal lands in the Red River valley west of HWY59 were, for the most part, absent. Small patches of marginal land still used for crop production were mainly scattered between Grunthal and St Malo, with a few small patches southeast of Woodridge (***Figure 37***).

Table 6: Agricultural capability in the Rat-Marsh River Watershed study area

Class[1]	Total Area in IWMP (ha)	1994 Annual Cropland (ha)[2]	2005 Annual Cropland (ha)[3]	Distribution of 2005 Annual Cropland (%)	1994 to 2005 Change in Annual Cropland Area (ha)
Class 1	1,599	1,162	1,044	1%	-118
Class 2	51,969	35,381	33,550	45%	-1,831
Class 3	67,585	41,866	37,865	51%	-4,001
Class 4	20,276	2,687	673	1%	-2,013
Class 5	44,859	3,256	855	1%	-2,400
Class 6	12,735	440	71	0%	-370
Class 7	0	0	0	0%	0
Organic	18,651	227	52	0%	-175
Unclassified	159	2	1	0%	-1
Water	204	2	2	0%	0
TOTAL	**218,036**	**85,023**	**74,113**	**100%**	**-10,910**

[1] Agricultural Capability is based on the CLI Rating of the dominant soil series for each soil polygon
[2] Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on September 17, 1994)
[3] Annual Cropland taken from the 2005 Land Cover (from Landsat Imagery captured on July 13, 2005)

Figure 37: Agricultural capability on 2005 annual cropland in the Rat-Marsh River Watershed[1]



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

Class 4 and Lower Soils with Forest Landcover Change

Marginal lands are defined as those lands having soils with limitations that are not well suited for the production of annual crops. These are generally defined as Class 4, 5 and 6 lands. Marginal lands are best suited for forage production or left in natural vegetation. However, improvement practices such as drainage are generally required on Class 4 and 5 lands in order for forage production to be sustained. Class 6 lands have limited availability for pasture production and improvement practices are not feasible.

Analysis of land cover and soils imagery has revealed that there has been over 2,400 ha of marginal land (Class 4 or lower) that has switched from forested cover to grassland cover. Further analysis of aerial imagery has shown increases in the number of hog operations in areas where this change has occurred on larger blocks of land (> 5 ha); land has been cleared for the pasture production can receive nutrients from hog manure application. The application of nutrients from hog manure can increase pasture production on these lands. However, there are implications for the management of surface water and water quality issues that are associated with field run-off and drainage due to the loss of forest cover.

These marginal lands are also located within the provincial regulated management zones pertaining to intensive livestock operations development (See ***Appendix G***).

Manure as a Land Use Issue

Manure use as a fertilizer and soil amendment is a regulated nutrient, unlike commercial fertilizers. (**Appendix F)**. Generally, for nitrogen content, the lower the agricultural soil productivity rating, the lower the application rate. Rates of nitrogen are based on the" Residual Nitrogen" level, which is the remaining amount after the crop has grown. Phosphorus rates are based on "thresholds", or soil levels before application. As some manures are relatively high in phosphorus compared to nitrogen, to balance the application to the needs of the crop and remain within the regulatory guidelines, often a larger landbase is required than if only accounting for the nitrogen. This also means that a top - up application of nitrogen fertilizer may be required, in addition to the manure application.

Changes in the regulatory framework (2006) from being based only on nitrogen to being a combination of nitrogen and phosphorus created issues for the hog industry in particular. In the Southeast part of Manitoba, which was also experiencing excessive moisture conditions on agricultural lands, a shortage of land was created by the combination of these factors for some existing operations. Some producers decided to expand the land available for manure application by developing more pasture area where possible, to supplement grass production with manure. Where pasture lands were developed, manure application from hog barns was still regulated, along with the requirement to file a manure management plan based on soil testing. In comparison, if pastures were developed and used only for cattle grazing, with no additional hog manure-based fertilizer being added, nutrients added by the grazing of cattle were not regulated.

Local knowledge suggests that the issue of having an adequate land base for hog manure application has also been affected by the 2008 moratorium on the hog industry in the Red River area, and the recent 2011 provincial wide moratorium on expansion. The hog industry has been and will continue to contract due to market prices and the regulatory framework for manure management.

If there had been land clearing to accommodate acres for manure application, this currently no longer exists. In fact**,** the situation also favours a reduction in annual crop production, as with shrinking availability to hog manure, fertilizer production costs will increase for many southeast acres. These trends are becoming evident now but are not reflected in the statistics before 2008.

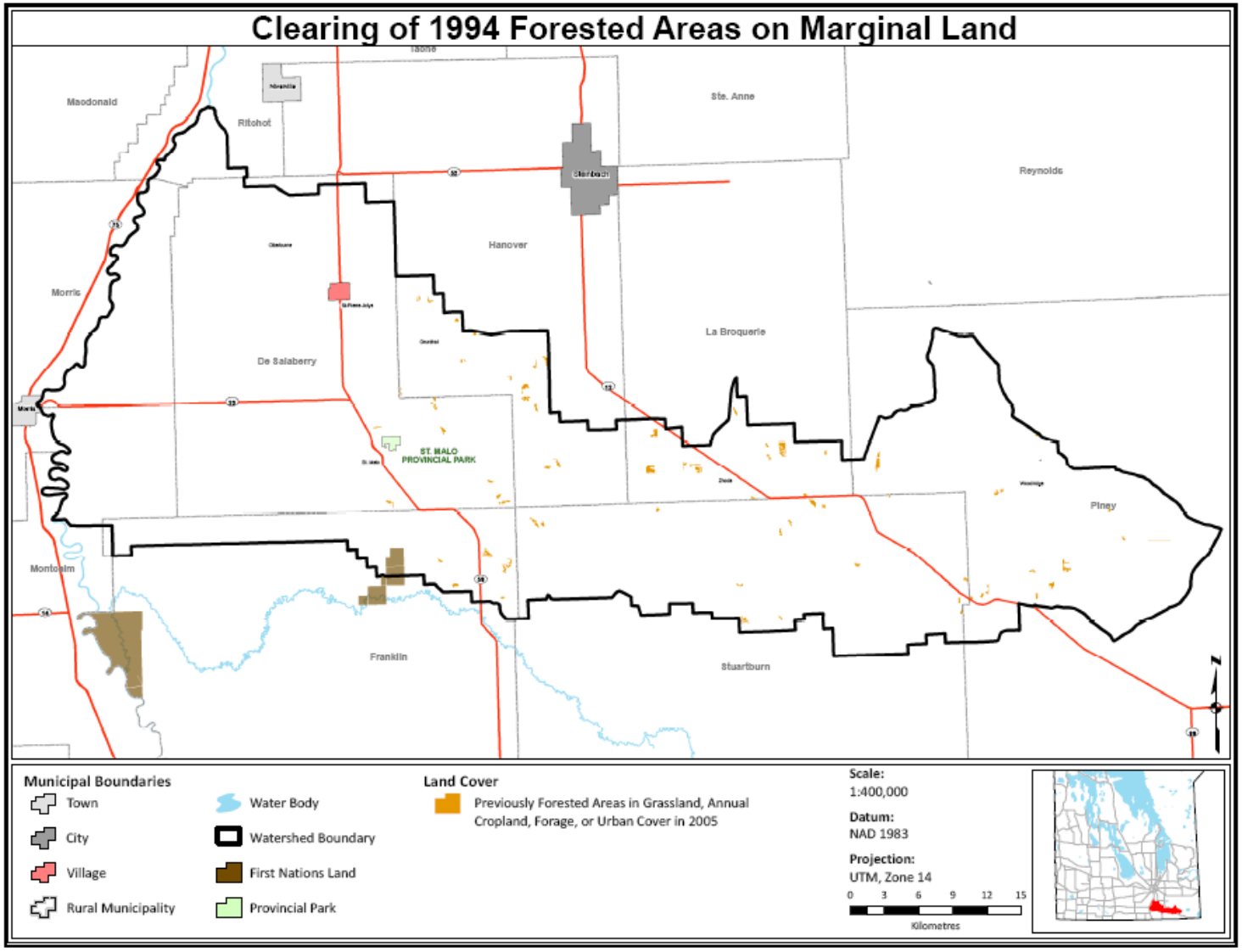
In the Rat-Marsh River IWMP:

- Approximately 2,400 ha of marginal land which was previously classified as deciduous, coniferous, and mixed wood forest was identified as grassland, annual cropland, and forage in 2005 (***Table 7***). There was an additional 200 ha that were converted to urban (including buildings and roads).
- This previously forested land represents slightly more than 1% of the entire watershed area.
- A large number of previously forested parcels were classified as agricultural cover in 2005, many of which were quite small in area (less than 1 ha). The majority of the smaller parcels are likely the result of naturally changing conditions including flooding and drought, but may also have anthropogenic influences such as changes in grazing regimes.
- Larger areas of converted forested land are likely the result of land clearing. ***Figure 38*** identifies parcels of previously forested, marginal land greater than 5 ha which were classified as agricultural land cover classes in 2005. The vast majority of this cleared land was located in the central portion of the watershed, in the RM's of Hanover and La Broquerie. The land clearing likely the result of land conversion for forage production.
- Analysis of Census data in the Lower Rat subwatershed reveals that the total number of hogs in the watershed increased between 1991 and 2005. Further analysis of aerial imagery from 1997 and 2009 confirms the increase in hog operations in these areas and suggests that the lands are being used for manure spreading. Further site specific information is needed to verify land use activity.

Table 7: Area of class 4 and lower soils with forest landcover change from 1994 to 2005

Land Cover Class in 2005	Area of land (ha)	Percentage of cleared land (ha)	Percentage of watershed (ha)
Grassland	2,400	91%	1.1%
Annual Cropland	29	1%	0.0%
Forage	4	0%	0.0%
Urban	217	8%	0.1%
TOTAL	**2,650**		

Figure 38: Cleared parcels of class 4 and lower soils with forest landcover change from1994 to 2005 in the Rat-Marsh River Watershed*



*To eliminate areas of forest loss that occurred from sources other than land clearing, only those parcels larger than 5 hectares are shown

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 H***). 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 Rat-Marsh River IWMP:

- Only a small portion (1%) of the watershed is at a negligible to low risk of wind erosion (***Table 8***); the vast majority of the area has a moderate or higher risk. The eastern portion of the watershed, which is dominated by highly-prone, sandy soils, is at a particularly high risk of wind erosion.

On annual cropland with respect to wind erosion risk:

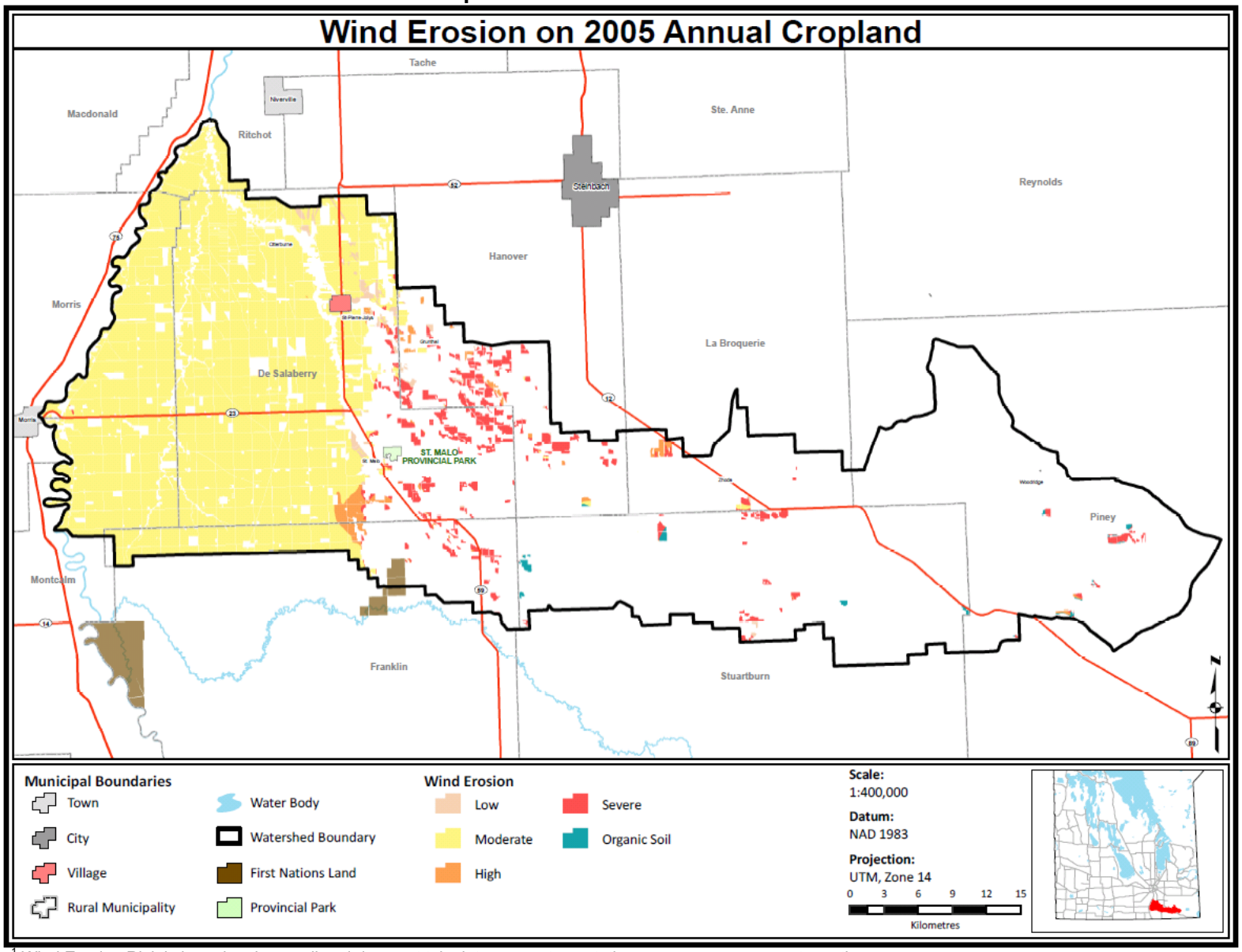
- Even though there was a high proportion of soils with a severe risk of wind erosion in the watershed, approximately 90% (66,600 ha) of annual cropland was located on soils at moderate risk for wind erosion. This is due to the fact that most annual cropland is located on predominantly clay soils within the Red River valley (***Figure 39***). The remaining 10% of annual cropland occurs on land with high to severe risk of wind erosion east of HWY59.
- Of the 10,900 ha of annual cropland converted to another land use between 1994 and 2005, roughly 50% was located on soils with a high risk of wind erosion.

Table 8: Wind erosion risk in the Rat-Marsh River Watershed study area[1]

Wind Erosion[1]	Total Area in IWMP (ha)	1994 Annual Cropland (ha)[2]	2005 Annual Cropland (ha)[3]	Distribution of 2005 Annual Cropland (%)	1994 to 2005 Change in Annual Cropland Area (ha)
Negligible	0	0	0	0%	0
Low	8,107	1,447	1,031	1%	-416
Moderate	82,514	69,625	66,612	90%	-3,012
High	9,958	2,198	1,396	2%	-802
Severe	71,587	10,081	4,792	6%	-5,290
Organic Soil	45,531	1,668	279	0%	-1,388
Water	178	2	2	0%	0
Unclassified	159	2	1	0%	-1
TOTAL	**218,036**	**85,023**	**74,113**	**100%**	**-10,910**

[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 1994 Land Cover (from Landsat Imagery captured on September 17, 1994)
[3] Annual Cropland taken from the 2006 Land Cover (from Landsat Imagery captured on July 13, 2005)

Figure 39: Wind erosion risk on 2005 annual cropland in the Rat-Marsh River Watershed[1]



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

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 occur. The analysis focuses on annual cropland from 2005 land cover data (see ***Appendix C***) in conjunction with water erosion risk (see ***Appendix I***) 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 Rat-Marsh River IWMP:

- Water erosion is a not a significant risk to the area, as less than 5% of the watershed is at a moderate to severe risk of water erosion (***Table 9***).
- The majority of the watershed has negligible risk of water erosion (76% or 166,400 ha), but there are a number of areas at low risk, located mainly adjacent to watercourses in the western portion of the watershed.

On annual cropland with respect to water erosion risk:

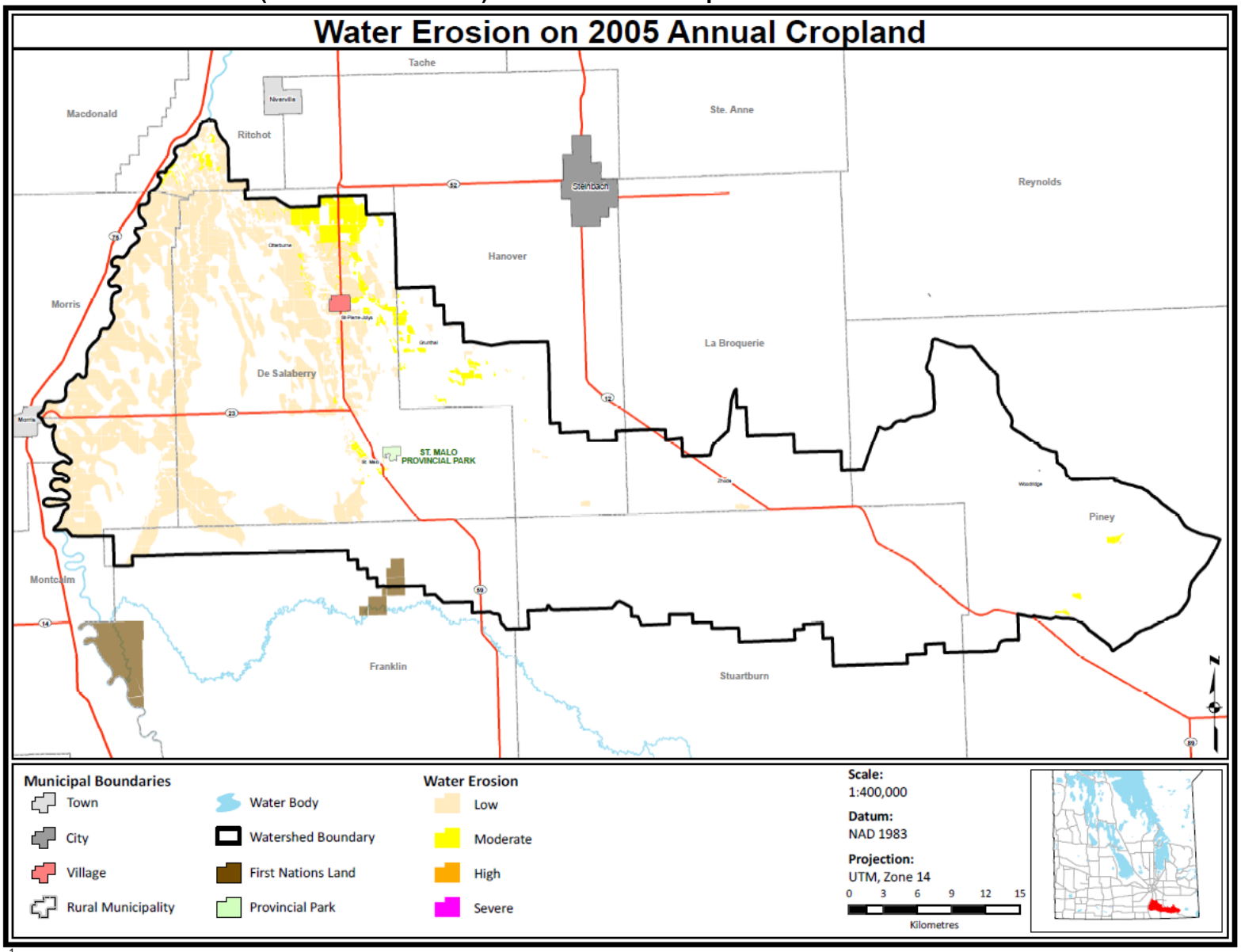
- Analysis of 2006 land cover shows that approximately 55% (40,500 ha) of annual cropland was located on soils with a negligible water erosion risk, while 41% and 5% of croplands were located on soils with moderate and high risk, respectfully.
- Annual cropland on soils with low risk was located adjacent to the Marsh and Rat Rivers, while annual cropland adjacent to Joubert Creek and around St Malo was at a moderate risk (***Figure 40***).

Table 9: Water erosion risk on annual cropland in the Rat-Marsh River Watershed study area

Water Erosion[1]	Total Area in IWMP (ha)	1994 Annual Cropland (ha)[2]	2005 Annual Cropland (ha)[3]	Distribution of 2005 Annual Cropland (%)	1994 to 2005 Change in Annual Cropland Area (ha)
Negligible	166,362	49,399	40,521	55%	-8,878
Low	43,520	31,678	30,248	41%	-1,430
Moderate	7,464	3,884	3,341	5%	-543
High	328	58	1	0%	-57
Severe	0	0	0	0%	0
Water	204	2	1	0%	-1
Unclassified	159	2	2	0%	0
TOTAL	**218,036**	**85,023**	**74,113**	**100%**	**-10,910**

[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 1994 Land Cover (from Landsat Imagery captured on September 17, 1994)
[3] Annual Cropland taken from the 2005 Land Cover (from Landsat Imagery captured on July 13, 2005)

Figure 40: Water erosion risk (Moderate to Severe) on 2005 annual cropland in the Rat-Marsh 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 has classified soils for their drainage capacity using a five class system (see ***Appendix J***).

Improved drainage indicates areas where networks of surface drains can accelerate surface runoff to reduce the duration of surface ponding and provide greater flexibility to crop management. While these drains effectively move water off fields and decrease the amount of standing water in agricultural fields, other adverse effects need to be considered. The drains facilitate water moving off fields more quickly than under natural run off conditions, resulting in river channels being filled to high levels during heavy precipitation events. High water levels could lead to a flood or near-flood stage, thereby increasing the risk for water erosion or property damage. Unlike natural and undisturbed watercourses, man-made drainage systems tend not to have healthy riparian buffers associated with them. Insufficiently sized (or a complete absence of) riparian buffers may result in an increased risk of nutrient and sediment loading into watercourses. Riparian areas and perennial vegetation on adjacent lands are able to trap and store sediment and nutrients from field runoff during the growing season, reducing the risk of contaminating surface water.

In the Rat-Marsh River IWMP:

- Analysis of the soil drainage shows that the majority (approximately 71% or 155,600 ha) of land in the study area is imperfectly to poorly drained (***Table 10***).
- There are pockets of very poorly drained, organic soils in the central and eastern portions of the watershed, located in the wetlands of Stuartburn and Piney and along the Sand River.
- The extreme eastern portion of the watershed is located on sandy soils and is well drained.

On annual cropland with respect to soil drainage:

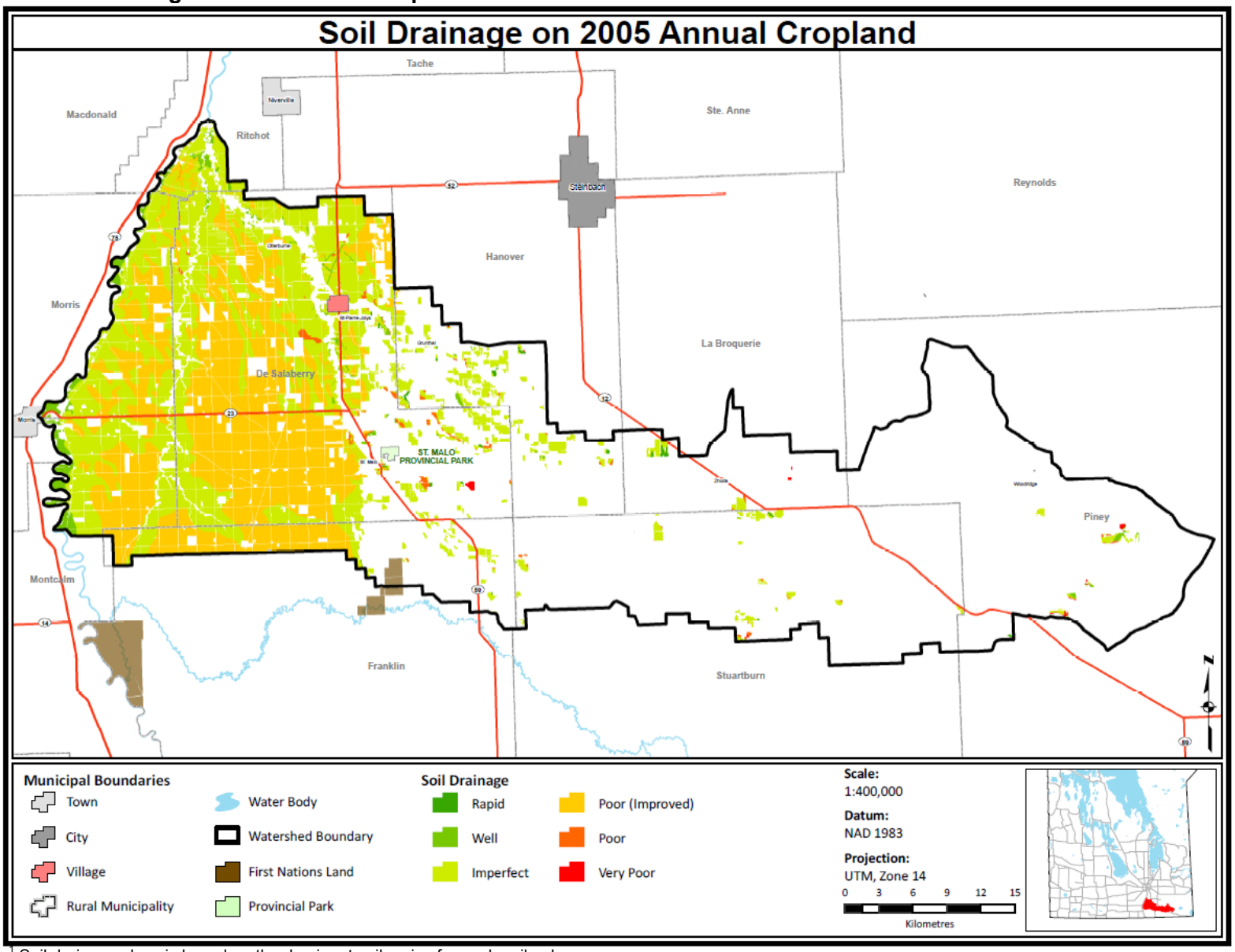
- Most of the annual cropland in 2006 was located on imperfect (50%) to poorly (improved) (46%) drained soils.
- The annual cropland located in close proximity to watercourses (Sand, Rat, and Red Rivers and Joubert Creek) occurs on most of the imperfectly drained land (***Figure 41***). Annual cropland located in areas further from watercourses generally had poor drainage, which has been improved by a series of drains constructed in the area.
- Only a small portion of annual cropland (1% or 700 ha) was located on poor to very poorly drained soils, scattered mainly in the area surrounding St Malo and St Pierre Jolys.
- Between 1994 and 2005, a large proportion of cropland on poorly and very poorly drained soils was abandoned for other land uses. This land was located mainly in the central portion of the watershed.

Table 10: Soil drainage classes in the Rat-Marsh River Watershed

Drainage Class[1]	Total Area in IWMP (ha)	1994 Annual Cropland (ha)[2]	2005 Annual Cropland (ha)[3]	Distribution of 2005 Annual Cropland (%)	1994 to 2005 Change in Annual Cropland Area (ha)
Rapid	5,877	558	208	0%	-350
Well	24,558	2,387	1,863	3%	-524
Imperfect	96,437	43,259	37,172	50%	-6,087
Poor (Improved)	39,120	35,748	34,130	46%	-1,619
Poor	20,068	2,336	604	1%	-1,732
Very Poor	31,612	731	133	0%	-597
Unclassified	159	2	1	0%	-1
Water	204	2	2	0%	0
TOTAL	**218,036**	**85,023**	**74,113**	**100%**	**-10,910**

[1] Drainage Class is based on the CLI Rating of the dominant soil series for each soil polygon
[2] Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on September 17, 1994)
[3] Annual Cropland taken from 2005 Land Cover (from Landsat Imagery captured on July 13, 2005)

Figure 41: Soil drainage on 2005 annual cropland in the Rat-Marsh River Watershed[1]



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

v. Soil Texture Analysis

Soil surface texture strongly influences the soil's ability to retain moisture, its general level of fertility, and the ease or difficulty of cultivation. For example, water moves easily through coarse-textured (sandy) soils, with little moisture being retained resulting in these soils drying out more quickly than fine-textured (clayey) soils. Sandy soils are often characterized as having a loose or single-grained structure which is very susceptible to wind erosion whereas clay soils have a high proportion of very small pore spaces that are capable of retaining moisture and more resistant to wind erosion. Clay soils are usually more fertile because they have a greater capacity to retain nutrients than sandy soils. However, they transmit water very slowly and are therefore susceptible to saturation from excess moisture conditions (PFRA 2005).

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

In the Rat-Marsh River IWMP:

- The predominant soil textures in the watershed are clays (37% or 80,200 ha) and sands (39% or 84,700 ha) (***Table 11***).
- The Red River valley, where the majority of the watershed's annual cropland occurs, is characterized by clay soils. The sandy soils of the watershed are located east of HWY59.
- Large patches of organic soil are present in the central and eastern part of the watershed. These soils are located primarily under wetlands and around the Sand River, and make up a relatively large proportion of total land (31,200 ha) in the watershed (***Figure 42***).

On annual cropland with respect to soil texture:

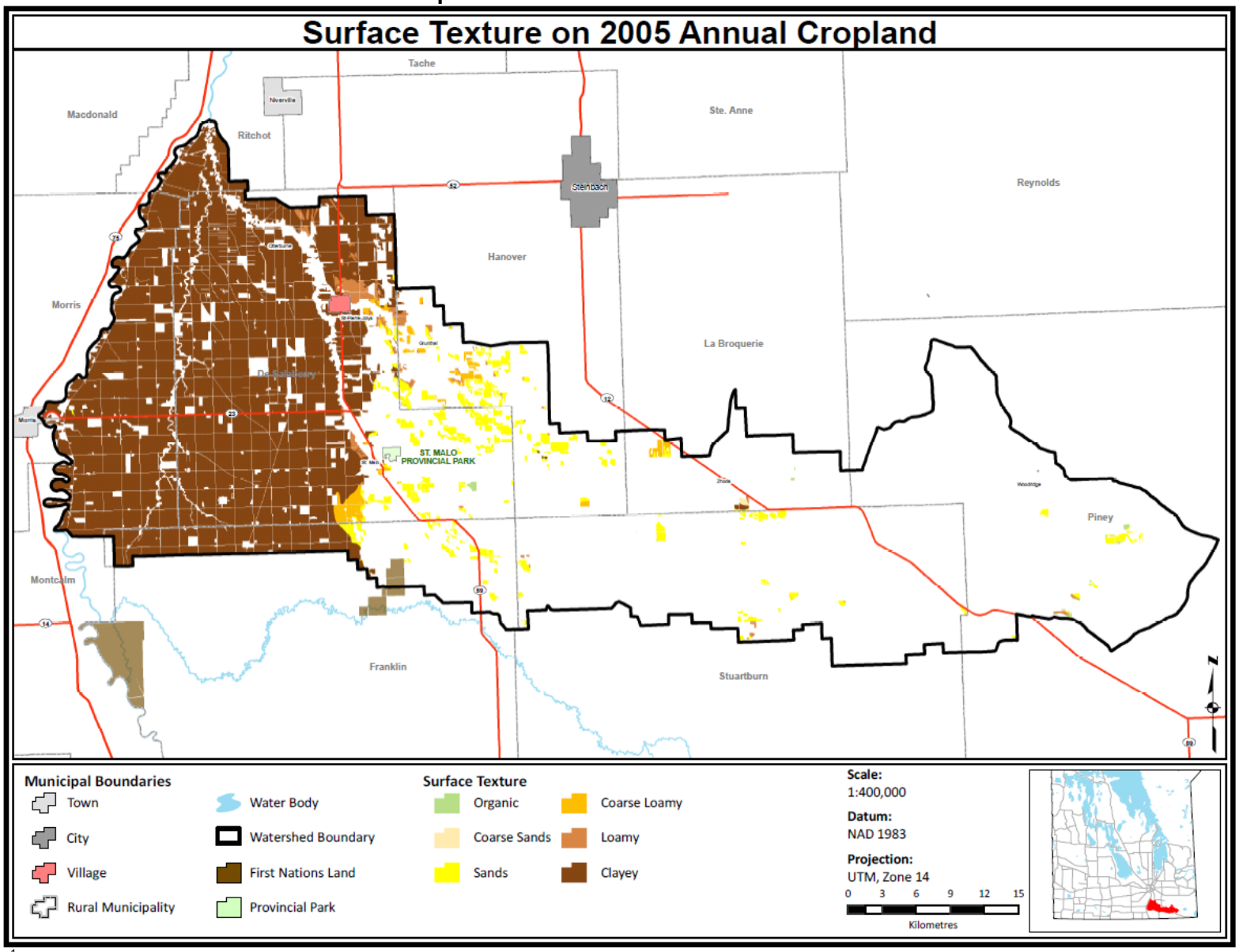
- Nearly 90% (66,000 ha) of annual cropland identified in 2006 was located on clayey textured soils. A small amount of annual cropland (4%) was located on loams and coarse loams, with the remaining cropland occurring on sandy soils.
- More than half of the annual cropland located on sandy soils in 1994 had been converted for other land uses by 2005. These tracts of land were located almost entirely east of HWY59.

Table 11: Soil texture in the Rat-Marsh River Watershed study area

Surface Texture[1]	Total Area in IWMP (ha)	1994 Annual Cropland (ha)[2]	2005 Annual Cropland (ha)[3]	Distribution of 2005 Annual Cropland (%)	1994 to 2005 Change in Annual Cropland Area (ha)
Organic	31,164	664	114	0%	-550
Coarse Sands	227	22	54	0%	32
Sands	84,720	11,151	5,090	7%	-6,061
Coarse Loamy	9,233	1,854	1,342	2%	-512
Loamy	12,082	2,294	1,468	2%	-826
Clayey	80,248	69,035	66,041	89%	-2,993
Unclassified	159	2	1	0%	-1
Water	204	2	2	0%	0
TOTAL	**218,036**	**85,023**	**74,113**	**100%**	**-10,910**

[1] Soils Surface Texture is based on the textural rating of the dominant soil series for each soil polygon
[2] Annual Cropland taken from the 1994 Land Cover (from Landsat Imagery captured on September 17, 1994)
[3] Annual Cropland taken from 2005 Land Cover (from Landsat Imagery captured on July 13, 2005)

Figure 42: Surface texture on 2005 annual cropland in the Rat-Marsh River Watershed [1]



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

vi. Riparian Health

Riparian zones are those areas immediately adjacent to water bodies and play a vital role in watershed health. Properly functioning riparian zones help to protect surface water quality by acting as a natural filter that reduces sedimentation and nutrient loading caused by water runoff and bank erosion. They also help to mitigate the effects of floods and provide important habitat for wildlife and plant species. Unhealthy or non-functioning riparian zones fail to provide these essential ecosystem services. Riparian resource information adds value to the IWMP process, as it provides an overview of the ecological health of and the impact of land-use on riparian areas. This information can assist in determining those areas where land management changes can provide the greatest improvement for water quality, soil health and biodiversity, and aids in the targeting of riparian-related BMPs to improve the health of the watershed.

Case Study – Joubert Creek

In 2009, a number of government and non-government organizations (including AAFC and MAFRI) partnered to develop and validate a new, cost-effective way of classifying riparian zones and to evaluating riparian health in agricultural watersheds. On-the-ground health assessments were conducted and utilized to validate a Riparian Health Predictive Model which is capable of estimating riparian condition using remote sensing. More information on the methodology and utilization of the model can be found in ***Appendix O***.

As part of the project's field validation requirement, riparian condition along Joubert Creek was evaluated in 2010 and 2011. Joubert Creek is a perennial watercourse in the northern portion of the Rat-Marsh River watershed and runs east to west into the Rat River. It is located just outside of the Red River valley and cuts through a relatively flat landscape utilized primarily for pasture and cropland. This particular creek was chosen as a study site for a number of reasons, but primarily because it was identified by the conservation district as a priority waterway and there was active participation from local landowners.

Field assessments along Joubert Creek revealed that the functionality and health of the system varied by location, but overall was good. After applying this information to the predictive model, it was estimated that approximately 75% of the stream was in proper functioning condition, 14% of the creek was functional at risk, and 11% of the creek was non-functional (***Table 12***).

Table 12: Health classification of Joubert Creek as determined by Riparian Health Predictive Model

Health Classification	Number of Riparian Polygons	Total Riparian Area (ha)	Percentage of Riparian Area
Proper Functioning Condition	418	390	75%
Functional at Risk	130	74	14%
Non-functional	173	57	11%
TOTAL	**721**	**520**	

Riparian Health in the Rat-Marsh River Watershed

Results obtained from the Joubert Creek study are isolated and independent from other watercourses. That being said, assumptions can be made as to the functionality of other watercourses in the watershed. The Rat River and Joubert Creek are very similar systems. Both watercourses are similarly sized and are located on land with very similar characteristics in terms of soils characteristics and topology. Farming practices and management are also very similar along the two; composed mainly of pasture and forage cropland, as well as some annual cropland. Based on the common characteristics of Joubert Creek and the Rat River, it would be expected that the condition of the two systems is also similar.

On the other hand, the Marsh River differs from Joubert Creek in a numerous aspects. It is located within the Red River Valley, which has significantly different landscape characteristics than the eastern portion of the watershed. Additionally, farming along the Marsh River is characterized almost exclusively by annual cropping, which is vastly different than farming practices along Joubert Creek. As such, riparian health of the Marsh River cannot be inferred from results obtained on Joubert Creek.

No two watercourses are completely identical, so inferring the health of one from another can only provide an estimate as to the functionality of the system. To properly grade riparian health in the watershed and determine areas which may be non-functional, more work is required on targeted watercourses in the area. This includes an independent, more in-depth investigation of functionality along the Rat River, as well as an examination of health along the Marsh River and St Malo Lake, which can not be inferred from lessons learned along Joubert Creek.

Further investigation of riparian areas within the watershed may be conducted through various means. Local knowledge can be used to determine those areas which are at high risk of impairment and warrant on-the-ground health assessments. Alternatively, newer methodologies, such as the Riparian Health Predictive Model developed on Joubert Creek, could be utilized to develop a more comprehensive record of riparian health throughout the whole watershed.

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

i. Crown Land Management in the Rat-Marsh River Watershed Area

- Crown Lands in the Rat-Marsh study area make up a large proportion of the watershed, approximately 24% (52,100 ha) (***Table 13***).
- The vast majority (42,600 ha) of Crown Land has no agricultural use. These lands are made up mostly of provincial forest in the east and wildlife management areas in the central and eastern portion of the watershed (***Figure 44***).
- Crown Land used for agriculture is located mainly in the central portion of the watershed and includes leased land (4,900 ha), the AESB Pansy Community Pasture (3,000 ha), and yearly permitted land (1,600 ha).
- Crown Land is located predominantly in the rural municipalities of Piney (56%) and Stuartburn (36%). Smaller tracts of crown land are also located in the rural municipalities of De Salaberry, Franklin, Hanover, and La Broquerie (***Table 14***).

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

Table 13: Crown Lands based on MAFRI crown land use coding in the Rat-Marsh River Watershed study area

Generalized Operation Land Use Code	Total Area (ha)	Percentage
Agricultural Use (Lease)	4,860	9%
Agricultural Use (Yearly Permits)	1,606	3%
Community Pastures (Managed by AESB)	2,956	6%
No Agriculture Use (Wildlife, Recreational)	42,648	82%
Uncoded (No Agricultural Use)	0	0%
Total	**52,070**	100%

Table 14: Area of Crown Lands by rural municipality in the Rat-Marsh River Watershed study area

Rural Municipality	Total Area (Ha)	Percentage
De Salaberry	545	1%
Franklin	259	0%
Hanover	1,809	3%
La Broquerie	1,631	3%
Montcalm	0	0%
Morris	0	0%
Piney	29,279	56%
Ritchot	0	0%
Stuartburn	18,547	36%
Total	**52,070**	100%

ii. Management Considerations on Crown Lands

a) Land Capability Classification

The agricultural land use capability of crown land in the Rat-Marsh River Watershed is illustrated in ***Table 15***. The majority (92%) of Crown Lands within the watershed have marginal to poor agricultural capabilities at Class 4 or higher (including organic soil). Only 8% (4,200 ha) of Crown Land is considered prime agricultural land (Class 1-3), and is located primarily in the AESB Pansy Community Pasture, as well as a small area south of Woodridge in the Sandilands Provincial Forest (***Figure 45***).

Table 15: Agricultural capability of Crown Lands in the Rat-Marsh River Watershed study area

Agricultural Capability	Total Area (ha)	Percentage of Study Area
Class 1-3	4,180	8%
Class 4-5	27,926	54%
Class 6-7	7,425	14%
Organic	12,410	24%
Water	26	0%
Unclassified	0	0%
TOTAL	**51,968**	**100%**

b) Woody Species Encroachment on Crown Lands

As noted in Section E iii, there was an overall increase of approximately 4,600 ha of grassland in the watershed between 1994 and 2005. On Crown Land within the watershed, this was not the case, as 2,100 ha of grassland were lost to tree encroachment (**Table 16**). Encroachment occurred on all types of Crown Land found in the watershed. Even though it represented a much smaller area of land, agricultural use exhibited more than 60% of tree encroachment.

Woody species encroachment is a function of management (e.g. grazing), weather (rainfall), drainage, and financial pressures in the industry. In general terms, the primary woody species encroaching on grassland tend to be poplar and willow, but included coniferous in the far eastern portion of the watershed.

Table 16: Encroachment of Trees into Grassland on Crown Lands (1994-2005)

Generalized Operation Land Use Code	Total Area (ha)	Area that changed from grassland in 1994 to trees in 2005 (ha)	% Change
Agricultural Use (Lease)	4,860	736	15%
Agricultural Use (Yearly Permits)	1,606	209	13%
Community Pastures (Managed by AESB)	2,956	321	11%
No Agriculture Use (Wildlife, Recreational)	42,648	832	2%
Uncoded (No Agricultural Use)	0	0	0%
Total	**52,070**	**2,097**	**4%**

Figure 43: Crown Land characterization coding in the Rat-Marsh River Watershed

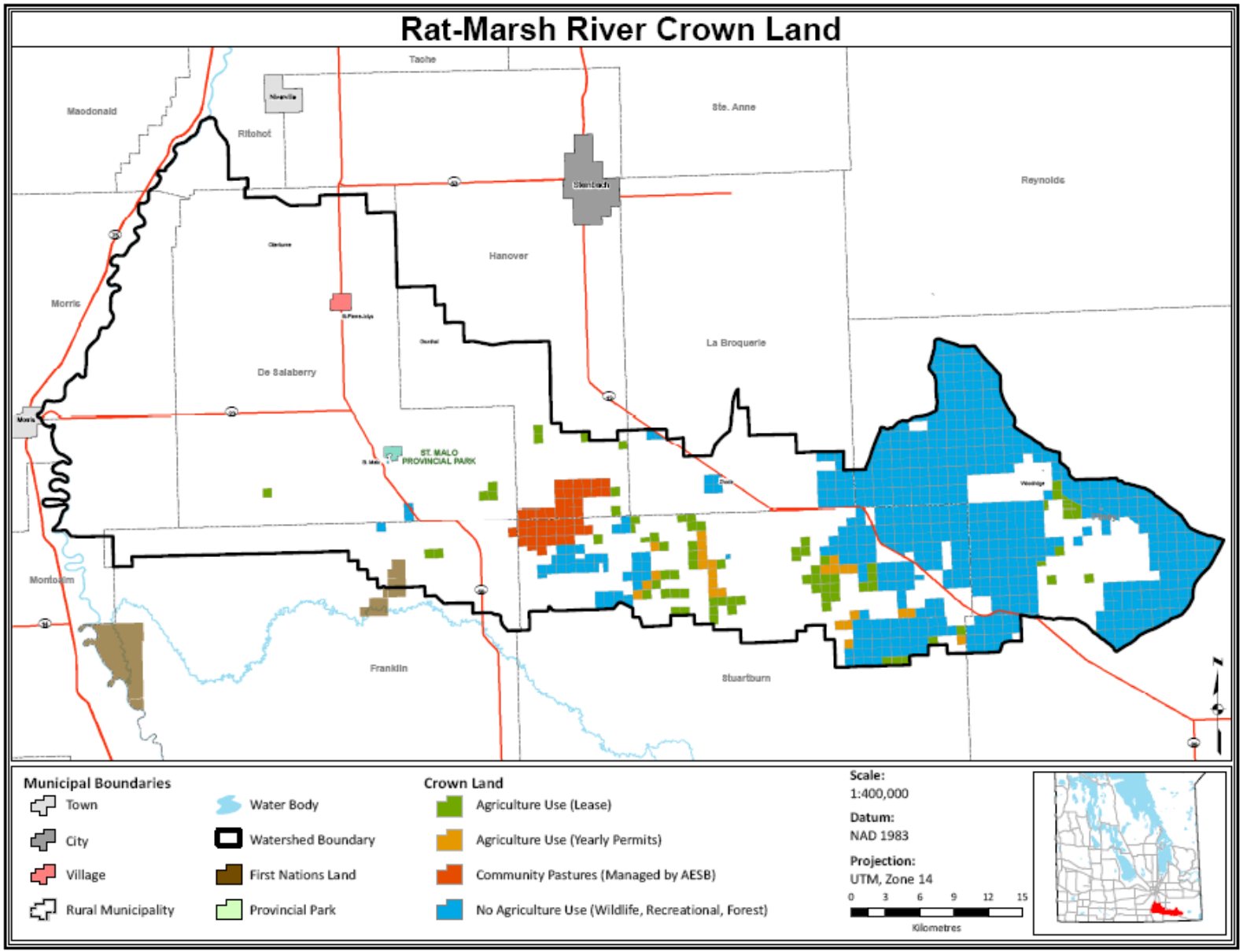
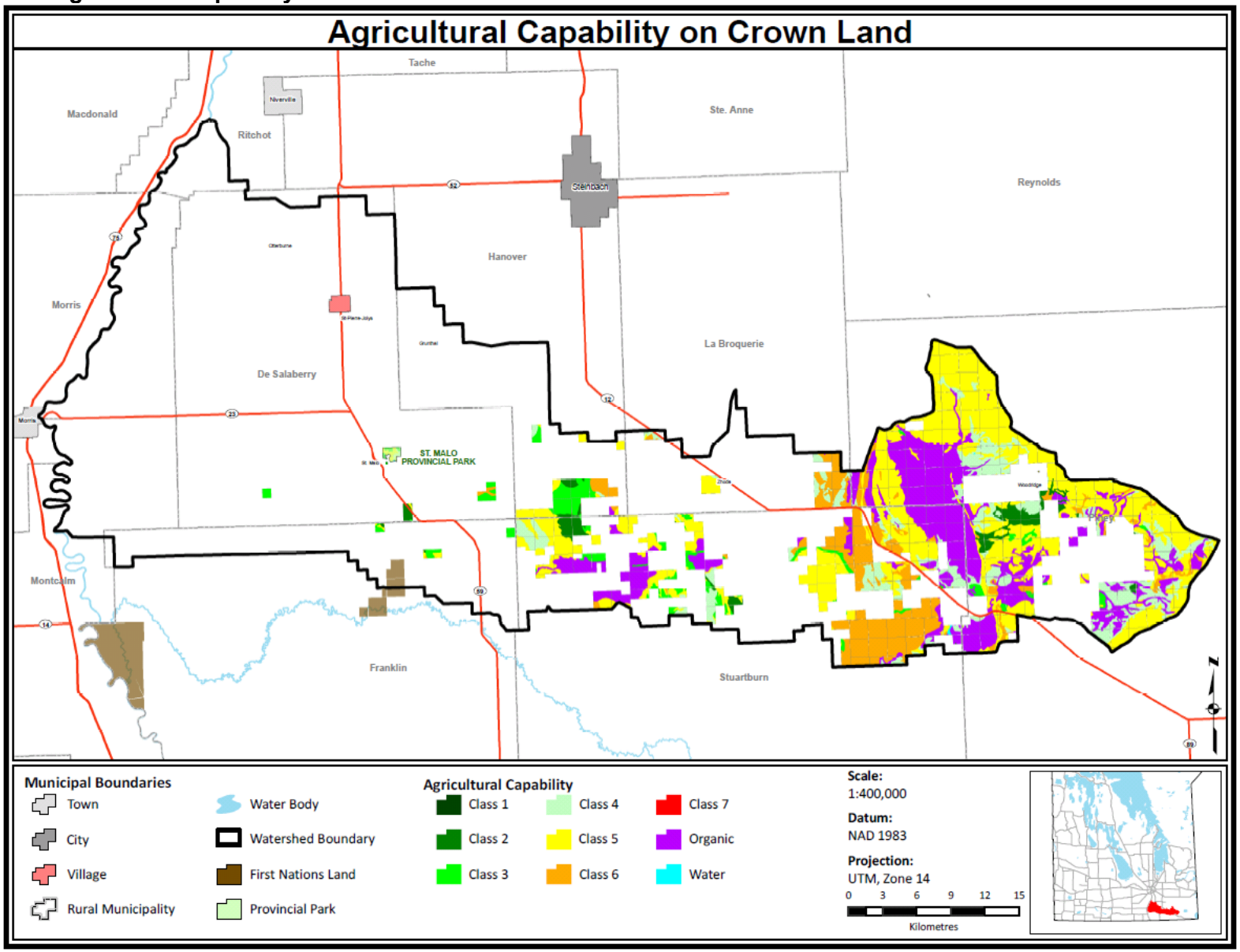


Figure 44: Agricultural capability of Crown Land in the Rat-Marsh River Watershed



ii. Recent Federal-Provincial Programs

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

In 2003, the Agricultural Policy Framework (APF) was launched as a new national approach to support agricultural activities associated with business risk management, food safety and quality, science and innovation, environment, and skill development. In support of priorities related to soil, air, water and biodiversity, various environmental initiatives were introduced across Canada including Environmental Farm Planning and the National Farm Stewardship Program. Environmental Farm Planning (EFP) is an awareness and planning tool used to enhance producers' understanding of potential on-farm environmental risks and to develop action plans for how these risks can be addressed. Many producers in Manitoba, including those in the watershed, have participated in the EFP process to gain an improved understanding of the potential environmental risks associated with agriculture, as well as, those on their own farms. The EFP process helped producers to develop an action plan that outlines how potential risks on their farms can be addressed through the adoption of beneficial management practices (BMPs). Financial and technical support has been 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 Q***).

Participation in the Environmental Farm Plan Program is aggregated by municipalities in the study area in ***Appendix R***. 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 as well, indicating that producers in the Rat-Marsh River Watershed are proactive and that addressing environmental issues is high on their priorities.

In the Rat-Marsh River Watershed study area, a total of 208 BMP projects were completed by producers (***Table 17***). Of the 208 completed, 101 of the projects were categorized as Non Point Source – Crop Related BMPs.

The top three BMP categories adopted by producers in the study area were Improved Cropping Systems, Product and Waste Management, and Nutrient Management Planning. More specifically, the top three BMPs adopted were precision farming applications, improved on-farm storage and handling of agricultural products, and equipment modification on pre-seeding/seeding/post-seeding implements.

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*

BMP Categories	Rat-Marsh River IWMP
Point Source - Livestock Manure Related [1]	28
Point Source - Other (Petroleum, Nutrients from Feed, Pesticides, etc.) [2]	37
Non Point Source - Livestock Related [3]	17
Non Point Source - Crop Related [4]	101
Non- Point Source - Crop Related (Pesticides) [5]	18
Soil Erosion - Soils at Risk [6]	<5
Biodiversity [7]	<5
Total	208

* Refer to Appendix N for BMP description
[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, 18, 29
[5] These include BMPs 16, 20, 25
[6] These include BMPs 11, 12, 13, 15, 19, 27
[7] These include BMPs 21, 22, 23, 28

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

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

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

H. Agricultural Land Use and Management Recommendations*

Watershed Issue:
How has land clearing and wetland drainage changed the landscape in the Rat-Marsh River Watershed? To what extent has the natural cover changed over the past 30 years?

Analysis	Recommended Actions*	Target Areas*	Potential Indicators*
Influences on Natural Habitat Change –The following trends have been noted in the watershed: • **2005 Land Cover -** In 2005, approximately 43% of the land (93,200 ha) in the watershed was classified as trees, water, or wetlands. Forested areas are the second most common land cover class and make up 33% (71,738 ha) of the watershed and dominate the eastern half of the watershed. Grasslands and pasture make up a large portion of the study area (18%) and primarily in the central portion of the watershed. Approximately 9% (20,072 ha) of the watershed was classified as wetlands. These wetlands are located primarily on crown land in the eastern portion of the watershed. (**Table 4, Figures 14 and 15, Pages 23-26**). • **Farmland Usage-census trends (1991-2006)** Over the 15 year period, the total area of farmland increased by approximately 8,000 ha or 6%. Pastureland (both natural and improved) increased in area by approximately 7,300 ha over 15 years. Specifically, the area of natural pasture increased by 4,900 ha, and tame pasture increased in area by approximately 2,400 ha. Other land, characterized mainly by woodland and wetlands, increased by 4,500 ha (or approximately 50%) between 1991 and 2006 (**Figure 18**, **Page 28)** • **Forages – Census Trends (1991-2006)** – The area of forage crops increased every year from 13,700 ha in 1991 to 21,500 ha in 2006, and increase of over 57% **(Figure 19, Page 28)** • **Alfalfa and Hay Production** – **Census Trends (1991-2006)** Forage production increased steadily over 15 years and made up approximately 23% of the total cropland in the watershed in 2006 **(Figure 20, Page 29).** • **Land Cover – 1994, 2001, and 2005** - **(Table 5, Page 34)** (a) **Natural Areas-** Overall, the area of natural cover within the watershed increased drastically over the 12-year period. These changes were especially evident in the portion of the watershed east of HWY59. (b) **Annual Cropland -** Annual cropland was the land cover type exhibiting the largest change in area during the 12-year period (from 85,000 ha in 1994 to 74,000 ha in 2005). Losses to both land cover classes were located across the entire watershed, but were highly predominant in the eastern portion. (c) **Grasslands**- Grassland area saw a large increase in the central portion of the watershed (13% or 4,500 ha), mainly due to land converted from annual crops and forages. Despite these significant gains, a relatively large amount of grassland was lost to encroachment from adjacent forested areas. (d) **Wetlands-** The area of wetlands increased by a significant amount over the 12-year period (56%, or 7,200 ha). In particular, a large area of in the RM of Stuartburn previously classified as forest in 1994 was classified as wetlands in 2005. Caution should be used, however, as wetland and open water classifications may not be accurately estimated due to fluctuations in precipitation amounts, classification effort differences between years, and the relatively coarse resolution of LANDSAT data in relation to smaller wetlands. • **Changes to Annual Cropland** - A large area of annual cropland in 1994 was classified as grassland and pasture in 2005. During this time, 10,300 ha of annual cropland were converted to grasslands and 1,100 ha of grassland were converted to annual cropland, resulting in a net conversion of 9,200 ha of annual cropland to grassland. There was a net conversion of 1,300 ha from annual cropland to other types of natural cover (including treed areas and wetlands) **(Table 5 Page34, Figure 28 Page 35-37).** • **Changes to Grassland Area -** Tree encroachment was the primary factor responsible for the overall decrease in grassland cover across the watershed (over 11,700 ha). Only 6,700 ha of land experienced the reciprocal conversion of forested area to grassland, resulting in a net decrease of grassland to nearly 5,000 ha. Encroachment occurred as small patches scattered throughout the eastern portion of the watershed. Conversion to wetlands occurred primarily in the RMs of Stuartburn and Piney and conversion from forage was located mainly in the central portion of the watershed (**Table 5 Page 34**, **Figure 30 Pages 38-40**). • **Change in Forested Area –** There was an overall increase of approximately 1,200 ha of forested areas between 1993/94 and 2006. Changes to forested areas were associated almost entirely with grasslands and wetlands in the eastern portion of the watershed. Most of the new forested areas noted in 2005 were the result of previously forested areas encroaching into adjacent grasslands (5,100 ha in Hanover, De Salaberry, La Broquerie and Stuartburn) and wetlands (in Piney and Stuartburn). (**Table 5,** Page 34, **Figure 32, Page 41-43).** • **Change in Forage Area-**. Analysis indicates that changes to forage area in the watershed resulted almost entirely from changes to/from annual cropland and grassland. Forage cover decreased in the watershed between 1994 and 2005, by nearly 40% (3,000 ha). Decrease in forage cover occurred primarily in the north central portion of the watershed, in the RMs of De Salaberry and Hanover. Some of the change is attributed to programs like Permanent Cover(2,350 ha) and to Green Cover (440 ha) (**Table 5 Page 34, Figure 34 Page 44-46).** • **Change in Wetland Area-** The area of wetlands increased by 7,200 ha (56%) in the watershed over the 12-year period. Analysis indicates that increase resulted primarily from conversion of land previously identified as forest and grassland. Most of these changes occurred within the RMs of Stuartburn and Piney. A large area of wetlands that were new in 2005 is located in the western half of the RM of Stuartburn. A large proportion of these wetlands occur on crown land with no agricultural use (protected areas, wildlife management areas, etc) and on land purchased by the Nature Conservancy of Canada (**Table 5 Page 34, Figure 35 Page 47-49)**. • **Agricultural Capability –**44% (96,500 ha) of the soils in the watershed are Class 4 and lower (or organic), most of which are present in the eastern portion of the watershed, west of St Malo Provincial Park. A relatively large proportion of land is considered organic soil (18,700 ha or 9%), which is found in the wetlands associated with the Rat and Sand Rivers in the RMs of Stuartburn and Piney. Only a small amount of annual cropland is located on marginal and organic soils (2% or 1,651 ha). This number has dropped considerably since 1994, when nearly 8% (6,600 ha) of annual cropland was located on marginal or organic soils (**Table 6, Figure 37**, **Page 52-54**). • **Class 4 and Lower Soils with Forest Landcover Change -** Approximately 2,400 ha of marginal land which was previously classified as deciduous, coniferous, and mixed wood forest was identified as grassland, annual cropland, and forage in 2005 (*Table 6*). There was an additional 200 ha that were converted to urban (including buildings and roads) cover class. **(Table 7 Figure 38, Pages 54-55).** • **Crown Lands** - There are approximately 52,100 ha (24%) of Crown Land in the watershed. The vast majority (42,600 ha, 82%) of Crown Land in the watershed is classified as having some sort of agricultural use (lease, yearly permits, or Community Pasture). Approximately 2,100 ha of grassland were lost to tree encroachment. Even though it represented a much smaller area of land, agricultural land use included more than 50% of encroachment on crown lands. • On Crown Land, there was an overall loss of 7,862 ha of grassland to tree encroachment, which was concentrated in the Langford, Lakeview, and Alonsa AESB Community Pastures, as well as leased land in the northeast corner of the watershed (**Table 13-16, Figure 43, Page 69-70**). • **BMP Adoption -** Of the 208 completed under the program, less than 5 of the projects were categorized as Biodiversity BMPs **(Table 18, Page 75).** • **Timing of Land cover Imagery** -Timing of Imagery and classification definitions may affect the number (i.e. a decrease or increase) of wetlands identified and should be verified with site specific analysis (ground truthing) • **Precipitation Levels –** Precipitation levels recorded throughout the watershed can influence land cover analysis. Total Annual Rainfall amounts exceeded the 30 year average in 1993, 1999, and 2000. Conversely, 1992 and 2006 had a number of communities who witnessed Total Rainfall levels well below the 30 year average (see **Appendix P, Page 111***).*	**BMP Implementation for Wildlife Habitat** (a) **Site Specific** - Promote BMPs and provide technical assistance that encourage natural habitat (e.g. conservation corridors, protection of road allowances, wetland restoration, headwater storage options, and wildlife habitat) in key priority areas of the watershed. (b) **Landscape Related** – Promote BMPs and provide technical assistance that encourage natural habitat (e.g.Rotational Grazing systems, Agro Woodlot Management, Aspen Control Management). **Education -** Encourage environmental educational initiatives that demonstrate BMPS which maintain and enhance natural cover. (e.g EFPs) Encourage sustainable land management practices on soils with lower agricultural capability that maintain /support wildlife habitat	Areas in the watershed that are: • class 4 or lower and suitable wetland habitat, • undeveloped road allowances, • areas linking pockets of wildlife habitat. Entire Study Area	Proportion of watershed: • with annual cropland on Class 4 and lower lands, • that is wetland or treed, • that is grassland/pasture or forage Number of BMPs implemented that have a wildlife benefit. Change in number of restored wetlands. Number of educational initiatives presented. Increased Species composition (Flora and Fauna)

Data Gaps Identified:
A majority of the soils information identified in the watershed has been derived from 1:126,000 soils mapping.
Census data is collected on a volunteer basis.
Land cover Analysis is developed using a 30 meter pixel. Native Grasslands are not distinguished from tame grass under the Grassland category.

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

Watershed Issue:
The clearing of undeveloped and marginal land for spread acres for hog manure has dramatically altered the watershed landscape and remains an on-going issue and threat in this watershed. Has either organization considered an initiative to assist with the coordination and distribution of hog manure on existing agricultural land?

Analysis	Recommended Actions*	Target Areas*	Potential Indicators*
Coordination and distribution of hog manure is beyond the mandates of AESB and MAFRI. No comments or analysis of such an approach was conducted. The focus of this portion of the report will concentrate on trend analysis based on ag census, landcover, and soils information, and BMP delivery. If analysis supports the identified issue, then identified mitigations (if any) should be considered by project management team. • **Changes to Annual Cropland** - A large area of annual cropland in 1994 was classified as grassland and pasture in 2005. During this time, 10,300 ha of annual cropland were converted to grasslands and 1,100 ha of grassland were converted to annual cropland, resulting in a net conversion of 9,200 ha of annual cropland to grassland. There was a net conversion of 1,300 ha from annual cropland to other types of natural cover (including treed areas and wetlands) **(Table 5 Page 34, Figure 28 Page 35-37).** • **Changes to Grassland Area -** Tree encroachment was the primary factor responsible for the overall decrease in grassland cover across the watershed (over 11,700 ha). Only 6,700 ha of land experienced the reciprocal conversion of forested area to grassland, resulting in a net decrease of grassland to nearly 5,000 ha. Encroachment occurred as small patches scattered throughout the eastern portion of the watershed. Conversion to wetlands occurred primarily in the RMs of Stuartburn and Piney and conversion from forage was located mainly in the central portion of the watershed (**Table 5 Page 34**, **Figure 30 Pages 38-40**). • **Change in Forested Area –** There was an overall increase of approximately 1,200 ha of forested areas between 1993/94 and 2006. Changes to forested areas were associated almost entirely with grasslands and wetlands in the eastern portion of the watershed. Most of the new forested areas noted in 2005 were the result of previously forested areas encroaching into adjacent grasslands (5,100 ha in Hanover, De Salaberry, La Broquerie and Stuartburn) and wetlands (in Piney and Stuartburn). (**Table 5, Figure 33, Page 42-44).** • **Change in Forage Area-**. Analysis indicates that changes to forage area in the watershed resulted almost entirely from changes to/from annual cropland and grassland. Forage cover decreased in the watershed between 1994 and 2005, by nearly 40% (3,000 ha). Decrease in forage cover occurred primarily in the north central portion of the watershed, in the RMs of De Salaberry and Hanover (**Table 5 Page 35, Figure 34 Page 45-47).** • **Change in Wetland Area-** The area of wetlands increased by 7,200 ha (56%) in the watershed over the 12-year period. Analysis indicates that increase resulted primarily from conversion of land previously identified as forest and grassland. Most of these changes occurred within the RMs of Stuartburn and Piney. A large area of wetlands that were new in 2005 is located in the western half of the RM of Stuartburn. A large proportion of these wetlands occur on crown land with no agricultural use (protected areas, wildlife management areas, etc) and on land purchased by the Nature Conservancy of Canada (**Table 5 Page 34, Figure 35 Page 47-49)**. • **Agricultural Capability –**44% (96,500 ha) of the soils in the watershed are Class 4 and lower (or organic), most of which are present in the eastern portion of the watershed, west of St Malo Provincial Park. A relatively large proportion of land is considered organic soil (18,700 ha or 9%), which is found in the wetlands associated with the Rat and Sand Rivers in the RMs of Stuartburn and Piney. Only a small amount of annual cropland is located on marginal and organic soils (2% or 1,651 ha). This number has dropped considerably since 1994, when nearly 8% (6,600 ha) of annual cropland was located on marginal or organic soils (**Table 6, Figure 37**, **Page 52-54**). • **Class 4 and Lower Soils with Forest Landcover Change -** Approximately 2,400 ha of marginal land which was previously classified as deciduous, coniferous, and mixed wood forest was identified as grassland, annual cropland, and forage in 2005 (*Table 6*). There was an additional 200 ha that were converted to urban (including buildings and roads) cover class. **(Table 7 Figure 38, Pages 54-55).** • **Soil Drainage-** Analysis of the soil drainage shows that the majority (approximately 71% or 155,600 ha) of land in the study area is imperfectly to poorly drained. Between 1994 and 2005, a large proportion of cropland on poorly and very poorly drained soils was abandoned for other land uses. This land was located mainly in the central portion of the watershed **(Table 11 Figure 41, Page 61-63).** • **Soil Texture-** The predominant soil textures in the watershed are clays (37% or 80,200 ha) and sands (39% or 84,700 ha) **(Table 12 Figure 42, Page 64-66).** • **Crown Lands** - There are approximately 52,100 ha (24%) of Crown Land in the watershed. The vast majority (42,600 ha, 82%) of Crown Land in the watershed is classified as having some sort of agricultural use (lease, yearly permits, or Community Pasture). Approximately 2,100 ha of grassland were lost to tree encroachment. Even though it represented a much smaller area of land, agricultural land use included more than 50% of encroachment on crown lands. • On Crown Land, there was an overall loss of 7,862 ha of grassland to tree encroachment, which was concentrated in the Langford, Lakeview, and Alonsa AESB Community Pastures, as well as leased land in the northeast corner of the watershed (**Table 13-16, Figure 43, Page 69-70**). • **BMP Adoption -** Of the 208 completed under the program, approximately 26 were identified as Point Source- Livestock Manure Related **(Table 18, Page 74)**			

Data Gaps Identified:
Most of the lands identified as annual cropland with high or severe wind erosion risk are located in areas with reconnaissance soil data.
Census data is collected on a volunteer basis.
Land cover Analysis is developed using a 30 meter pixel. Native Grasslands are not distinguished from tame grass under the Grassland category.

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

Watershed Issue:
Riparian degradation is an issue in this watershed. Can you provide suggestions as to how we can manage critical riparian areas with minimal disruption to agriculture?

Analysis	Recommended Actions*	Target Areas*	Potential Indicators*
Riparian Health Predictive Model- Riparian Health Predictive Model capable of estimating riparian condition using remote sensing (**Table 12, Page 67**). • **Joubert Creek -**Field assessments along Joubert Creek revealed that the functionality and health of the system varied by location, but overall was good. After applying this information to the predictive model, it was estimated that approximately 75% of the stream was in proper functioning condition, 14% of the creek was functional at risk, and 11% of the creek was non-functional. • **Rat River -** The Rat River and Joubert Creek are very similar systems. Based on the common characteristics of Joubert Creek and the Rat River, it would be expected that the condition of the two systems is also similar • **Marsh River-** The Marsh River differs from Joubert Creek in a numerous aspects. As such, riparian health of the Marsh River cannot be inferred from results obtained on Joubert Creek. • **BMP Adoption -** Of the 208 completed under the program, approximately 17 were identified as Non Point Source- Livestock Related **(Table 18, Page 75)** • **Class 4 and Lower Soils with Forest Landcover Change -** Approximately 2,400 ha of marginal land which was previously classified as deciduous, coniferous, and mixed wood forest was identified as grassland, annual cropland, and forage in 2005 (*Table 6*). There was an additional 200 ha that were converted to urban (including buildings and roads) cover class. **(Table 7 Figure 38, Pages 54-55).**	**Riparian Health Predictive Model** - Need to do further assessment on other parts of the watershed to understand the riparian condition. **Site Specific BMP Implementation to support Healthy Riparian Areas**: (a) Alternative Watering Systems (b) Fence to manage Grazing and Improve Riparian Condition/Function (c) Native Rangeland Restoration or Establishment (d) Improved Stream Crossing (e) Buffer Design for Annual Cropland **Education -** Encourage educational initiatives that demonstrate the BMPS which show the value of health riparian areas. (e.g EFPs, Managing the Water's Edge, Buffer Tool Design for Annual Cropland)	Marsh River and other watersheds	Number of educational initiatives presented Number of Environmental Farm Plans Updated The number of alternative watering systems being incorporated in Riparian zones, The number of Buffers established in annual cropland areas Increase in the number of grazing strategies in a riparian zone that incorporate recommended BMPs. Number of educational initiatives presented by stakeholders and the presence of attendees
	Data Gaps Identified: *Most of the lands identified as annual cropland with high or severe wind erosion risk are located in areas with reconnaissance soil data.* *Census data is collected on a volunteer basis.* *Land cover Analysis is developed using a 30 meter pixel. Native Grasslands are not distinguished from tame grass under the Grassland category.*		

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

Watershed Issue: **Are there certain land use developments that should be restricted from occurring in certain areas or types of land/soil?**			
Analysis	**Recommended Actions***	**Target Areas***	**Potential Indicators***
Analysis and recommendations dealing with the issue of land use development restrictions on certain areas or types of land/soil are completed by MAFRI only.			
1. Crown and Private Rangelands: Encroachment of grazing land to protect grassland productivity needs to be controlled.	• Recommended action: Management plans which control aspen regeneration through mechanical, grazing, or cultural methods to be implemented. BMP support required in this area.	• Target Areas: Crown and Private grasslands	• Potential indicators: Land Cover changes
2. Rural residential development must be controlled, especially in the RMs of La Broquerie, and Piney to prevent fragmentation of agricultural areas and land use conflicts.	• Recommended actions: The Municipalities need to direct rural residential development to cluster areas, and not allow “Hobby Farm” development on viable agricultural land (Class 4,5,&6) which could support the livestock industry.	• Target areas: RM of La Broquerie especially, and the RM of Piney, as it faces new development opportunities of non-resource related uses, such as tourism.	• Potential Indicators: Development plan policies to protect agriculturally zoned areas from non-agricultural development.

* 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:
The project management team expressed concern over land purchases made by the Nature Conservancy of Canada over the last 10 years. This organization has continued to purchase more and more land and permanently remove it from agricultural activities. What suggestions do you have to protect farmland for producers and ensure that agriculture remains viable in the RM of Stuartburn?

Analysis	Recommended Actions*	Target Areas*	Potential Indicators*
Land acquisition from a Conservation Agency is beyond the mandate of AESB and MAFR and therefore no comments or suggestions are provided. The focus of this portion of the report will concentrate on trend analysis based on ag census, landcover, and soils information, and BMP delivery. If analysis supports the identified issue, then identified mitigations (if any) should be considered by project management team. • **Farmland Usage-census trends (1991-2006)** Over the 15 year period, the total area of farmland increased by approximately 8,000 ha or 6%. Pastureland (both natural and improved) increased in area by approximately 7,300 ha over 15 years. Specifically, the area of natural pasture increased by 4,900 ha, and tame pasture increased in area by approximately 2,400 ha. Other land, characterized mainly by woodland and wetlands, increased by 4,500 ha (or approximately 50%) between 1991 and 2006 (**Figure 19**, **Page 28)** • **Crown Lands** –(**Table 13-16, Figure 43, Page 69-70**). (a) There are approximately 52,100 ha (24%) of Crown Land in the watershed. (b) The vast majority (42,600 ha, 82%) of Crown Land in the watershed is classified as having some sort of agricultural use (lease, yearly permits, or Community Pasture). (c) Approximately 2,100 ha of grassland were lost to tree encroachment. Even though it represented a much smaller area of land, agricultural land use included more than 50% of encroachment on crown lands. (d) The majority (92%) of crown lands within the watershed have marginal to poor agricultural capabilities at Class 4 or higher (including organic soil). Only 8% (4,200 ha) of crown land is considered prime agricultural land (Class 1-3), and is located primarily in the AESB Pansy Community Pasture, as well as a small area south of Woodridge in the Sandilands Provincial Forest. • **Class 4 and Lower Soils with Forest Landcover Change -** Approximately 2,400 ha of marginal land which was previously classified as deciduous, coniferous, and mixed wood forest was identified as grassland, annual cropland, and forage in 2005 (*Table 6*). There was an additional 200 ha that were converted to urban (including buildings and roads) cover class. **(Table 7 Figure 38, Pages 54-55).**			

Data Gaps Identified:
Most of the lands identified as annual cropland with high or severe wind erosion risk are located in areas with reconnaissance soil data.
Census data is collected on a volunteer basis.
Land cover Analysis is developed using a 30 meter pixel. Native Grasslands are not distinguished from tame grass under the Grassland category.

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

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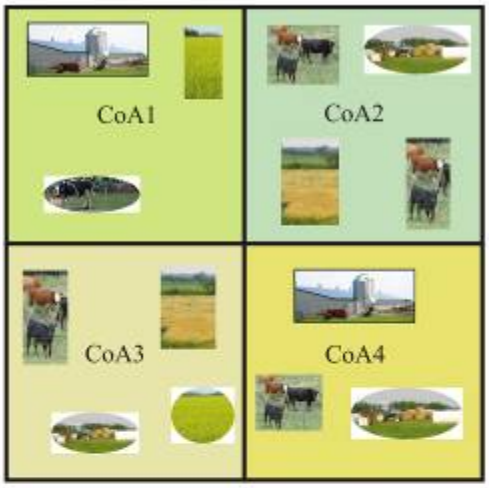
J. Appendices

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

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

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



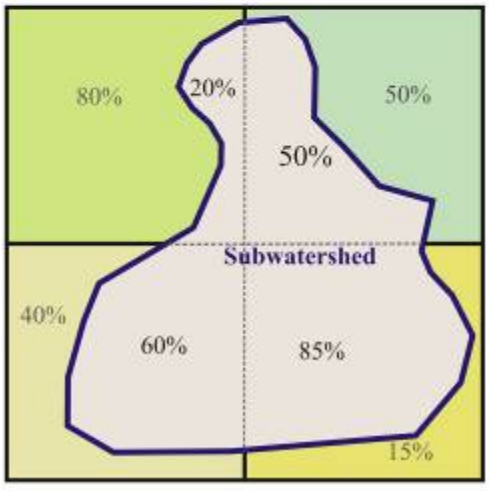
CoA is the sum of all survey forms of farms with farm headquarters located in the specific boundary

For Example - Total cattle and calves

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

CoA from Statistics Canada's geographic boundary

CoA interpolated to subwatershed boundary



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

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

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

Appendix B: Animal Unit Calculations

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

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

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

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

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

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

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

For the IWMP study area, imagery was available for the years of 1994, 2001, and most recently, 2005. Imagery was classified by the Manitoba Conservation - Manitoba Remote Sensing Centre into 16/17 (1994/2001,2005) unique land cover classes. To simplify the analysis, the 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 September 17, 1994 (a small portion along the Red River was captured October 26, 1994). Imagery for the 2001 land cover data was taken September 28, 2001 (a small portion along the Red River was captured September 3, 2001). The 2005 land cover data utilized satellite imagery that was captured on July 13, 2005.

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.

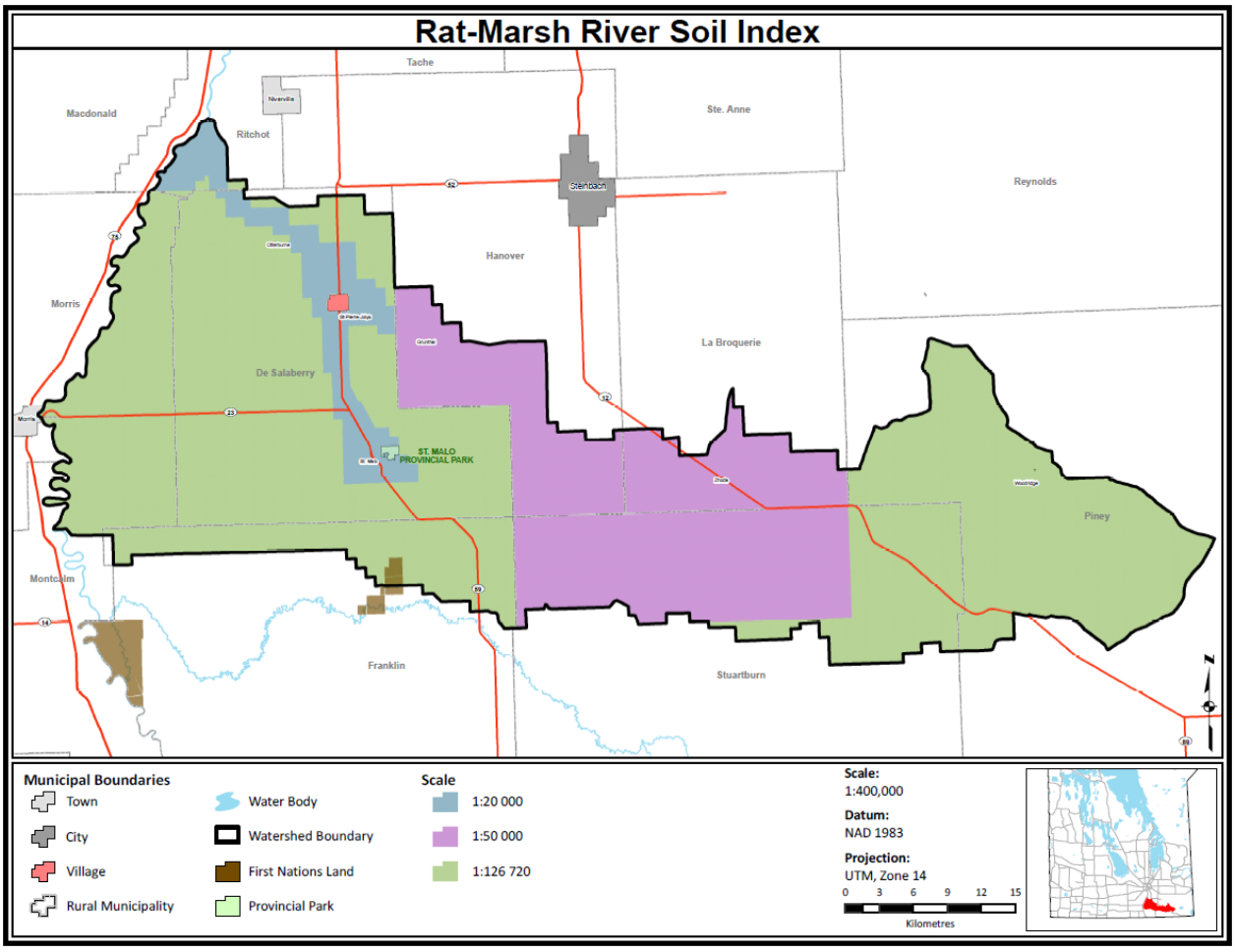
Classification Scheme: Land Cover Mapping of Manitoba	
1. Annual crop land:	Land that is normally cultivated on an annual basis.
2. Forage:	Perennial forages, generally alfalfa or clover with blends of tame grasses.
3. Grassland:	Areas of native or tame grasses, may contain scattered stands of trees
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 1994-2005, 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 Rat-Marsh River study area, soils were surveyed at a reconnaissance scale of 1:20,000, 1:50,000 and 1:126,720 (see figure following text).

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: Manure Management Regulations

Livestock Manure and Mortalities Management Regulation Under *The Environment Act*

The Livestock Manure and Mortalities Management Regulation (LMMMR) was passed in March of 1998 under *The Environment Act*. It has been amended on a number of occasions since then. The LMMMR is administered and enforced by Manitoba Conservation. The intent of the regulation is to ensure that livestock manure and mortalities are managed in an environmentally sound manner.

Key Components of the LMMMR

Definitions

Manure Storage Structure Permits

- The construction, modification or expansion of any manure storage facility in Manitoba requires a permit from Manitoba Conservation.
- Manure storage facilities must have sufficient capacity to hold all manure produced until it can be applied to the land as a fertilizer or removed from the storage facility.
    - **400 days** for earthen manure storage structures to a **max of 500 days**
    - **250 days** for steel and concrete tanks to a **max of 500 days**
- The operator must have sufficient suitable land to implement an appropriate manure management plan.
- Short term (more then 30 days) underbarn pits are considered storages and require a permit from Mb Conservation
- Treatment facilities are considered storage and require a permit from Mb Conservation

Manure Treatment

- Effluent from manure treatment facility cannot be discharged into a water body or water course (once manure always manure).

Field Storage of Solid Manure

- Solid manure is the only form of manure that can be temporarily stored on a field.
- All field storage sites must be **100 m** from any surface watercourse, sinkhole spring or well.
- Field-stored manure must be removed and disposed of no later than **November 10** of the year following the year when the manure was placed in field storage.
- After the manure is removed, the field storage area must remain empty of manure for at least **12 months** and a crop must be grown on the area to deplete it of accumulated nutrients before manure can be stored on that area again.

Composting Manure

- All manure composting sites must be **100 m** from any surface watercourse, sinkhole, spring or well and from the operation's boundaries.
    - Operations established prior to March 2004 are exempt from these setback requirements unless they expand to 300 Animal Units (AU) or more.

- Composting must be conducted in a manner that does not cause pollution of surface water, groundwater and soil.
- The composting process must be acceptable to the Director and the facilities may require a permit.
- Winter application (between November 10th and April 10th of the following year) of composted manure or composted mortalities is prohibited.
- For more information on composting manure refer to http://www.gov.mb.ca/agriculture/livestock/composting/com02s00.html

Manure Spills

- Reportable manure spills must be reported to an Environment Officer. These include:
  - all series of spills on a highway or road allowance,
  - any single spill greater than 50 L of liquid manure or 0.25 m^3 of solid manure on a highway or road allowance, and
  - any spill of 10,000 L or more.
- Any spill that leaves the boundaries of the operation or enters water must be reported.

Burning of Manure

- Burning of livestock manure is strictly prohibited unless otherwise approved by a Director.

Discharge into water

- Discharge of livestock manure into surface water, a surface water course or groundwater is strictly prohibited.

Application to Land

- Manure cannot be applied to unseeded land prior to August 15 if the land will not be seeded before the following spring.
- ***Nitrate limits***
  - Nitrogen is regulated using residual and in-season soil nitrate-N limits.
  - **Residual nitrate-nitrogen** is what is remaining in the soil after crop removal and before any additional N (fertilizer or manure) is applied for the next growing season. Under the LMMMR the nitrate limits only apply to lands that have received manure. Nitrate limits are also contained in the Nutrient Management Regulation (NMR) where they apply to all lands receiving nutrients.
    - Soil Class 1, 2, 3 (except any Class 3M and 3MW) – up to 140 lbs/ac residual nitrate-N allowed
    - Soil Class 3M, 3MW, and 4 – up to 90 lbs/ac residual nitrate-N allowed
    - Soil Class 5 – up to 30 lbs/ac of residual nitrate-N allowed
    - Soil Class 6, 7 and unimproved organic soils – No application of manure allowed
    - Note: The limits for class 5, 6, 7 and unimproved organic soils do not apply to operations in existence prior to March 2004, unless notified by the director in writing.
- ***Phosphorus thresholds***
  - **All** operations must be in P compliance by November 10th 2013.
  - Phosphorus is regulated based on **Soil Test P Thresholds**. The P thresholds were added to the LMMMR in 2006. Under the LMMMR the P thresholds only

apply to lands receiving manure. The thresholds trigger changes in management. These thresholds are also contained in the NMR where they apply to all lands receiving nutrients. Nitrogen limits still apply.

- Olsen P <60 ppm – manure application based on crop N requirements, no restrictions on P application.
- From 60-119 ppm – apply no more than **2X the crop removal rate of P_20_5**.
- From 120-179 ppm – apply no more than **1X the crop removal rate of P_20_5**.
- Above 180 ppm – **no manure application** without written consent from the Director of Manitoba Conservation.

- ***Mutli-year Application Rates***
  - Single-year application rates of manure at 1X P_2O_5 removal rates are often not technically or economically feasible. Therefore, it is possible to apply manure at more than 1 year's crop removal of P_2O_5 provided that the next application does not occur until the subsequent crop rotation has removed all of the P_2O_5 that was applied in the multi-year application. Nitrogen limits still apply.
  - No more than **5X the crop removal rate of P_20_5** can be applied in a multi-year application rate.
    - i.e. if 5 times the crop removal rate of P_2O_5 is applied on one parcel of land in one year, manure can not be applied for at least 5 years on that same parcel of land or until the crop rotation has removed all of the P_2O_5 that was applied in the multi-year application.
- ***Setback Requirements***
  - Setback requirements for livestock manure application on land adjacent to surface waters or a groundwater feature. Setback requirements extracted from the Livestock Manure and Mortalities Management Regulation (MR 42/98) and the Nutrient Management Regulation (MR 62/2008).

Surface water or Groundwater Feature		**Manure Application Method**	**Manure Application Setback Width (metres) with Permanently Vegetated Buffer Width (metres)**	**Manure Application Setback Width (metres) with no Permanently Vegetated Buffer**	**Regulation Source for Setback Width**
Lakes	Designated as vulnerable in Nutrient Management Regulation schedule[1]	Any method	30 m setback, consisting of 30 m permanently vegetated buffer	35 m setback	Nutrient Management Regulation (MR 62/2008)
	-	Injection or low-level application followed by immediate incorporation	15 m setback, consisting of 15 m permanently vegetated buffer	20 m setback	Livestock Manure and Mortalities Management Regulation (MR 42/98)
		High-level broadcast or low-level application without incorporation	30 m setback, including 15 m permanently vegetated buffer	35 m setback	

Rivers, creeks, streams and large unbermed drains, designated as an Order 3 or greater drain on a plan of Manitoba Water Stewardship, Planning and Coordination, that shows designations of drains	Designated as vulnerable in Nutrient Management Regulation schedule[1]	Any method	15 m setback, consisting of 15 m permanently vegetated buffer	20 m setback	Nutrient Management Regulation (MR 62/2008)
	-	Injection or low-level application followed by immediate incorporation	3 m setback, consisting of 3 m permanently vegetated buffer	8 m setback	Livestock Manure and Mortalities Management Regulation (MR 42/98)
		High-level broadcast or low-level application without incorporation	10 m setback, including 3 m permanently vegetated buffer	15 m setback	
Groundwater feature[2]	-	Any method	15 m setback, consisting of 15 m permanently vegetated buffer	20 m setback	Nutrient Management Regulation (MR 62/2008)
Major wetland, bog, marsh or swamp[3] and constructed storm water retention ponds	-	Any method	3 m setback, consisting of 3 m permanently vegetated buffer	8 m setback	
Wetland, bog, marsh or swamp not defined as major	-	Any method	Distance between the water's edge and the high water mark		
Roadside ditch or an Order 1 or 2 drain	-	Any method	No direct application to ditches and Order 1 and 2 drains		

Manure Management Plans (MMPs)

- MMPs must be submitted to Manitoba Conservation by all operations that are **300 AU or greater** (see attached AU summary table).
- Operations **under 300 AU are not required to submit MMPs** unless these operations have been ordered by Manitoba Conservation to do so.
- All pig operations expanded or established after October 31, 2009 are required to register annual MMPs.
- A manure management plan contains:
    - Operation information
    - Livestock inventory in Animal Units
    - Manure Storage Systems Information
    - Fields available for manure application
    - Manure volumes and nutrient contents (lab analysis or published values suffice)
    - Soil test levels (based on lab analysis)
    - Crop nutrient requirements/removals and realistic target yields
    - Timing and method of manure and/or fertilizer application
- Manure Management Plans must be submitted annually
    - For fall fertilization the plan must be submitted before **July 10** of a crop year
    - For spring fertilization the plan must be submitted before **February 10**
    - If land was not identified in a Manure Management Plan that is already registered but will in fact receive manure, the operator has 14 days to register that parcel of land prior to manure application.

- Late filers are charged an administration fee of $100 per plan when submitted after the deadline to Manitoba Conservation.
- Manure Management Plan forms can be obtained from the Manitoba Conservation website http://www.gov.mb.ca/conservation/envprograms/livestock/index.html
- Manure Application Rate Calculator (MARC) 2008 is manure management planner software designed to:
    - provide improved record keeping for crop and livestock producers who use manure as a fertilizer;
    - offer users more flexibility in recording the types of manure they apply and the methods of application they use;
    - automatically fill out and print Manure Management Plan reports; and
    - assist producers in fulfilling regulatory requirements
- MARC forms have been approved by Conservation as acceptable Manure Management Plans. MARC can be obtained from the MAFRI website http://www.gov.mb.ca/agriculture/livestock/marc/index.html

New or expanding operations in certain areas

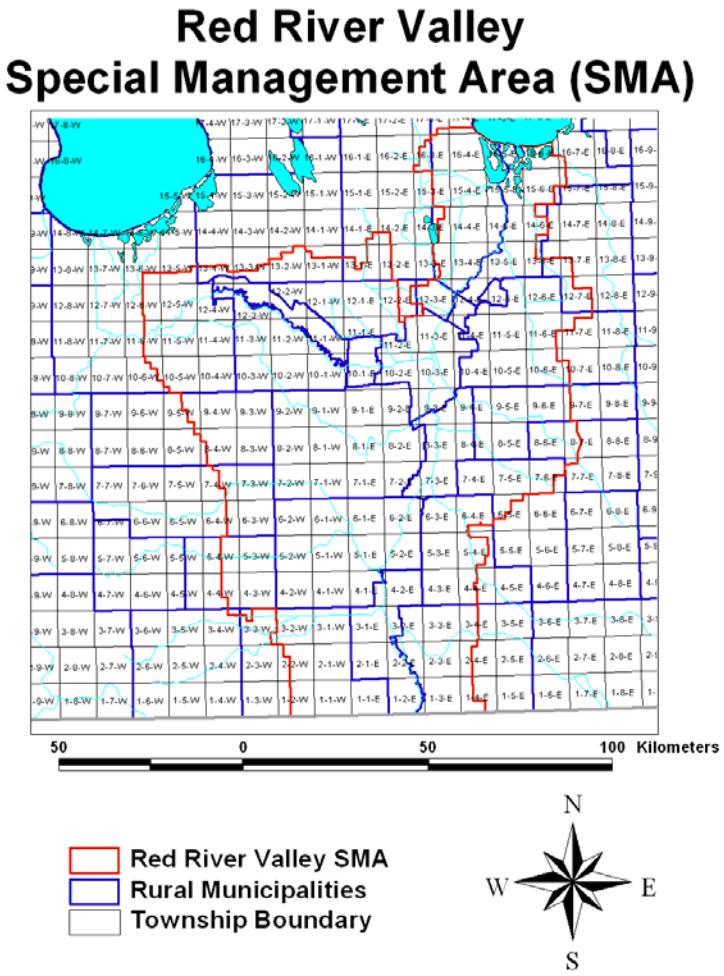
- In designated geographic areas where the amount of P in the manure produced annually is determined to be greater than 2X crop removal of P_2O_5, new and expanding operations must have enough land to apply manure at 1X crop removal of P_2O_5.
- These areas, designated by Manitoba Conservation, are delineated with a minimum size of one township (36 miles^2) based on Census information (e.g. the RMs of Hanover and La Broquerie).
- On the Manitoba Conservation website there is an interactive map producers can use if they would like to see if they are located in the moratorium areas. http://mlidata.gov.mb.ca/manmgmt/framesetup.asp

Winter Application

- Winter is defined as between **November 10th** of one year and **April 10th** of the following year.
- Operations 400 AU or greater in size are prohibited from winter application.
- Operations of 300 to 400 AU are prohibited from winter application as of **November 10th, 2010**.
- Operations of 300 AU or less are prohibited from winter application as of **November 10th, 2013**.

Red River Valley Special Management Area (RRV-SMA)

- The RRV-SMA is a regularly inundated area where special manure management practices are required.
- Manure that is applied to tilled lands in the fall (between September 10th and November 10th) must be injected or incorporated within 48 hours of application as of November 2006. This is not required for manure applied to perennial forage or no-till systems.



Disposal of Mortalities

- Mortalities can be disposed of by four methods: burial, composting, incineration, or delivery to a rendering plant.
- All mortalities must be in a secure storage room, covered container or secure location.
- If not disposed of within 48 hrs after death they must be refrigerated or continually frozen.
- Burial is prohibited for operations with 300 or more animal units.
- Operations with less than 300 AU can dispose of mortalities by burial if the pit is covered with at least **one meter** of soil and is located **100 m** from water and the operations' boundaries.
- Burning of mortalities must be done in an incinerator that has been installed and operated in compliance with the *Incinerators Regulation.*
- A mortalities-composting site must be located at least **100 m** from water or the operation's boundaries.
- In the event that the number of mortalities is beyond the operator's routine capacity for disposal (i.e. mass mortality situation), the operator must report the situation to an

environment officer and dispose of the mortalities according to instructions from an Environment Officer.

Confined Livestock Areas

- Access to surface water by livestock is prohibited in a confined area.
- Confined areas must be at least **100 m** from any surface watercourse, sinkhole, spring or well and an operation's boundaries.
- Construction, modification or expansion of a confined livestock area for 300 AU or more of livestock (except pigs) requires a permit.
- For pigs, modification or expansion of a confined area capable of housing 10 AU or more requires a permit.
- Manure must be removed from a confined livestock area at least once per year.

Registration of Manure Storage Structures

- All manure storage structures must be registered with Manitoba Conservation. If the storage was constructed under the authority of a Manitoba Conservation permit it is exempt from registration.
- Manitoba Conservation must inspect the storage before it can be registered.
- The storage may have to be repaired or modified before it is registered.
- No unregistered manure storage can be used **after November 10, 2010.**
- Application for Registration of a Manure Storage Facility Without a Permit can be found at http://www.gov.mb.ca/conservation/envprograms/livestock/pdf/app_for_registration_of_msf_sept_2006.pdf

Clean Environment Commission (CEC) Report – Environmental Sustainability & Hog Production in Manitoba

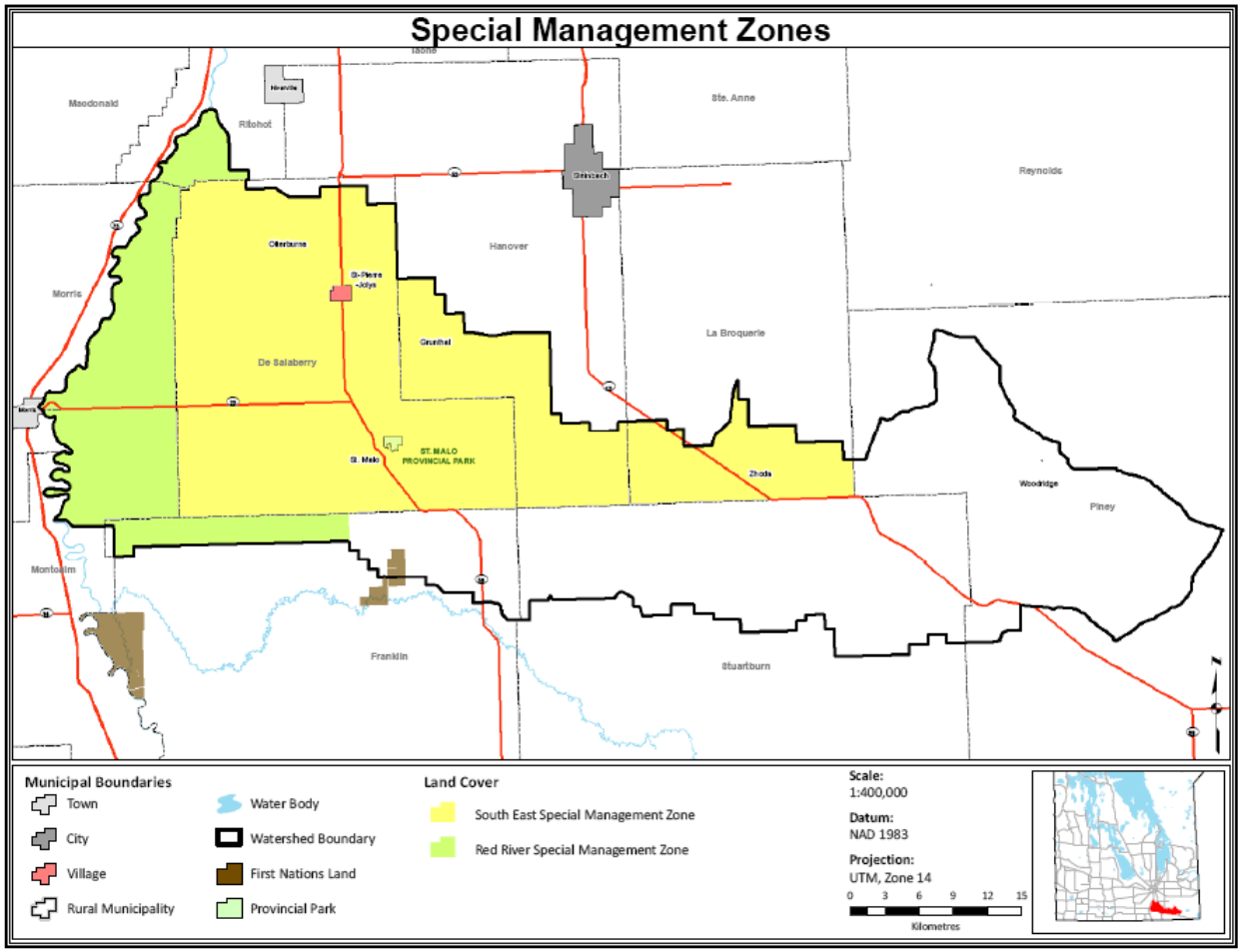
- Amendments to the LMMMR may be made as the recommendations in the CEC Report are reviewed and implemented.
- Section 15 of the CEC Report summarizes all recommendations. Recommendations pertaining to the LMMMR include: 9.1, 9.2, and 9.22 seen below. Recommendations 9.1, 9.2 and 9.22 were implemented October 2009.
- For more information regarding the CEC report refer to http://www.gov.mb.ca/conservation/hog_industry/

9.1 The phase-in dates for the Livestock Manure and Mortalities Management Regulation phosphorus provisions be adjusted so that all operators are required to be fully compliant with the regulation by **2013**.

9.2 The ban on the winter application of manure in the Livestock Manure and Mortalities Management Regulation is extended to all operations by **2013**.

9.22 The Manitoba government require all new, modified, or expanding hog production operations to register manure management plans.

Appendix G: Special Management Zones with Respect to IWMP Study Area



Appendix H: 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 I: 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 J: 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 K: 2006 Census of Agriculture data

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

Subwatershed	Total Farmland	Total Cropland*	Summerfallow	Pasture**	Other***
Marsh	47,820	43,758	238	2,209	1,616
Lower Rat	63,288	37,272	561	19,156	6,299
Upper Rat	21,925	7,110	217	9,152	5,446

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

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

Subwatershed	Cereals	Oilseeds*	Pulses*	Forage for hay	Forage for seed*	Other*
Marsh	21,699	11,033	6,585	2,480	847	143
Lower Rat	17,782	5,634	3,191	11,844	396	89
Upper Rat	767	0	0	5,986	0	0

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

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

Subwatershed	Use of Commercial Fertilizers	Use of Herbicides	Use of Insecticides*	Use of Fungicides
Marsh	33,060	32,974	5,073	4,864
Lower Rat	21,171	18,620	1,059	3,224
Upper Rat	1,928	469	0	0

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

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
Marsh	$7,097,739	$3,474,708	$2,072,518	$1,550,513
Lower Rat	$4,365,447	$2,103,030	$1,120,376	$1,142,040
Upper Rat	$202,614	$127,858	$28,893	$45,864

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*
Marsh	69%	27%	5%
Lower Rat	64%	35%	1%
Upper Rat	79%	0%	0%

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

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
Marsh	2,319	897	275	49,581	2,766	304,353
Lower Rat	20,572	6,470	2,864	231,632	40,272	581,724
Upper Rat	6,062	2,795	252	16,746	0	5,704

* 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
Marsh	26	21	5	14	5	14
Lower Rat	177	129	38	52	20	39
Upper Rat	54	51	3	5	2	7

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
Marsh	88	42	56	3,557	598	21,699
Lower Rat	116	50	75	4,498	2,003	14,863
Upper Rat	112	55	77	3,271	0	835

* 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	Average capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)	Average crop-related expenses ($/ha cropland and summerfallow)	Estimated profit ($/farm)
Marsh	$1,370,731	$317	$161	$63,241
Lower Rat	$1,068,180	$949	$115	$85,820
Upper Rat	$508,658	$213	$28	$31,256

Appendix L: 2001 Census of Agriculture data

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

Subwatershed	Total Farmland	Total Cropland*	Summerfallow	Pasture**	Other***
Marsh	54,196	48,398	1,787	1,633	2,378
Lower Rat	60,781	34,451	1,408	18,630	6,292
Upper Rat	21,700	7,199	541	9,519	4,441

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

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

Subwatershed	Cereals*	Oilseeds*	Pulses*	Forage for hay	Forage for seed*	Other*
Marsh	29,929	12,713	1,414	2,102	92	158
Lower Rat	21,168	4,953	229	9,459	76	128
Upper Rat	1,102	0	0	5,343	0	0

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

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

Subwatershed	Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides*	Use of Fungicides*
Marsh	42,443	45,322	3,408	13,402
Lower Rat	25,267	22,922	1,257	4,235
Upper Rat	3,352	1,279	0	0

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

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
Marsh	$7,809,951	$3,901,488	$2,773,679	$1,134,783
Lower Rat	$4,717,535	$2,299,289	$1,703,037	$715,209
Upper Rat	$321,673	$200,469	$62,065	$59,139

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*
Marsh	71%	26%	2%
Lower Rat	74%	24%	2%
Upper Rat	67%	0%	0%

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

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
Marsh	2,668	861	268	66,925	5,146	381,262
Lower Rat	21,175	5,452	3,085	153,940	20,180	576,347
Upper Rat	5,926	2,798	279	14,104	0	18,057

* 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
Marsh	32	24	5	21	8	14
Lower Rat	186	137	49	69	25	47
Upper Rat	64	57	7	8	3	13

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
Marsh	84	35	50	3,191	682	27,101
Lower Rat	114	40	63	2,241	794	12,395
Upper Rat	93	49	39	1,679	0	1,389

* 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	Average capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)	Average crop-related expenses ($/ha cropland and summerfallow)	Estimated profit ($/farm)
Marsh	$1,231,378	$382	$156	$59,362
Lower Rat	$781,889	$657	$132	$45,476
Upper Rat	$416,596	$218	$42	$15,545

Appendix M: 1996 Census of Agriculture data

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

Subwatershed	Total Farmland	Total Cropland*	Summerfallow	Pasture**	Other***
Marsh	56,084	51,492	1,012	2,024	1,556
Lower Rat	62,882	38,143	1,272	16,770	6,697
Upper Rat	20,520	5,420	324	10,362	4,413

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

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

Subwatershed	Cereals*	Oilseeds*	Pulses*	Forage for hay	Forage for seed*	Other
Marsh	32,500	14,236	531	1,691	79	0
Lower Rat	23,439	5,973	165	8,908	0	0
Upper Rat	1,074	148	0	4,012	0	0

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

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

Subwatershed	Use of commercial Fertilizers	Use of Herbicides	Use of Insecticides*	Use of Fungicides*
Marsh	46,962	43,158	11,370	7,590
Lower Rat	29,453	24,965	5,820	2,557
Upper Rat	1,946	878	0	0

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

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
Marsh	$7,990,895	$4,274,428	$2,420,835	$1,295,633
Lower Rat	$4,856,427	$2,642,843	$1,406,253	$807,331
Upper Rat	$175,056	$114,362	$21,833	$38,861

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*
Marsh	76%	15%	9%
Lower Rat	71%	18%	11%
Upper Rat	75%	0%	0%

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

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
Marsh	3,007	913	295	26,379	2,059	137,479
Lower Rat	19,433	5,564	3,427	123,562	12,479	446,841
Upper Rat	6,429	2,722	297	3,130	258	17,830

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
Marsh	34	24	7	18	6	15
Lower Rat	217	145	72	70	35	46
Upper Rat	68	60	9	9	6	10

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
Marsh	89	38	43	1,502	338	9,025
Lower Rat	90	38	48	1,761	354	9,678
Upper Rat	94	45	35	348	45	1,726

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

Subwatershed	Average capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)*	Average crop-related expenses ($/ha cropland and summerfallow)*	Estimated profit ($/farm)
Marsh	$984,043	$140	$152	$34,967
Lower Rat	$579,381	$466	$123	$24,546
Upper Rat	$256,044	$71	$30	$2,688

Appendix N: 1991 Census of Agriculture data

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

Subwatershed	Total Farmland	Total Cropland*	Summerfallow	Pasture**	Other***
Marsh	50,292	47,096	225	1,705	1,267
Lower Rat	57,807	38,948	715	12,705	5,439
Upper Rat	16,909	5,604	360	8,825	2,120

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

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

Subwatershed	Cereals*	Oilseeds*	Pulses	Forage for hay*	Forage for seed*	Other
Marsh	28,831	11,757	1,037	1,574	447	0
Lower Rat	23,820	4,360	416	9,204	0	0
Upper Rat	1,547	0	0	2,456	0	0

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

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

Subwatershed	Use of Commercial Fertilizers	Use of Herbicides
Marsh	42,576	36,835
Lower Rat	26,228	20,290
Upper Rat	2,629	952

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
Marsh	$4,955,190	$2,609,847	$1,559,792	$785,551
Lower Rat	$3,013,550	$1,705,985	$814,193	$493,372
Upper Rat	$151,205	$97,808	$18,731	$34,666

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*
Marsh	68%	25%	7%
Lower Rat	66%	29%	5%
Upper Rat	78%	0%	0%

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

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
Marsh	2,464	718	263	13,385	1,015	152,017
Lower Rat	14,417	3,267	3,229	72,724	10,527	416,795
Upper Rat	4,418	1,949	221	2,957	0	5,828

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

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
Marsh	35	25	8	16	6	19
Lower Rat	187	111	81	64	32	51
Upper Rat	57	49	10	12	4	13

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
Marsh	71	29	32	823	173	8,064
Lower Rat	77	29	40	1,130	324	8,206
Upper Rat	77	40	22	253	0	451

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

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

Subwatershed	Average capital investment ($/farm)	Average livestock-related expenses ($/ha farmland)	Average crop-related expenses ($/ha cropland and summerfallow)	Estimated profit ($/farm)
Marsh	$677,066	$70	$105	$30,353
Lower Rat	$476,365	$279	$76	$21,189
Upper Rat	$211,951	$51	$25	$3,668

Appendix O: Description of the Riparian Health Predictive Model

The Riparian Health Information Development Project is a partnership between numerous government and non-government organizations including Agriculture and Agri-Food Canada, Manitoba Agriculture, Food, and Rural Initiatives, Manitoba Habitat Heritage Corporation, Nature Conservancy of Canada, Manitoba Water Stewardship, Upper Assiniboine River Conservation District and Seine-Rat River Conservation District. The project aims to establish a cost-effective remote sensing methodology to develop riparian resource information for agricultural watersheds.

The Riparian Health Predictive Model is a tool that was developed as part of the project that can be used to classify riparian zones and evaluate riparian health in agricultural watersheds. The model utilizes products derived from high-resolution aerial imagery, including a vegetation classification and digital elevation model. Segmented riparian polygons were produced in an automated process, on which the model assessed health. Using vegetative and physical characteristics from each polygon, health scores were extrapolated along the entire length of Joubert Creek. These scores were divided into three broad categories and defined from as follows:

(1) Functional (healthy): All riparian functions are being performed and the reach exhibits a high level of riparian condition. Healthy, functioning riparian areas are resilient, provide a long list of benefits and values, and are stable.

(2) Functional at risk (healthy with problems): Many riparian functions are still being performed, but some clear signs of stress are apparent. The reach may not be as capable of rebounding from floods and use, it may be vulnerable to erosion and some of the potential of the riparian area has been lost. There could be problems ahead and management changes should be actively considered.

(3) Non-functional (unhealthy): Most riparian functions are severely impaired or have been lost. The reach has lost most of its resiliency, stability is compromised and much potential of the riparian area has been sacrificed. Immediate changes are necessary to keep the reach from declining further and to begin the process of healing and restoration.

The predictability and accuracy of the model were validated by conducting on-the-ground health assessments and comparing field results to results as predicted by the model. Field teams assessed a total of 65 riparian zone polygons along Joubert Creek over the summer of 2010, acquiring detailed riparian information using the Alberta Lotic Inventory. This data provided information for a Riparian Health Assessment (RHA) score. A correlation analysis revealed that a high correlation (R^2=0.9476) existed between the RHA score (on-the-ground surveys) and health scores as predicted by the model.

Appendix P: Private and Crown Land Planning in the Rat-Marsh 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 effect water management. This planning needs to support the existing community framework for economic development and land use planning. In most cases, this means,

integration of the IWMP into the existing Development Plan. The Development Plan is the local legal framework under the Provincial Land Use Policies.

All of the nine municipalities have Development Plans, with Piney and Franklin being the most recent.

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 issues (surface water quality, ground water quality, source water protection, soils and land use and habitat & wildlife) identified in the public consultations.

There are nine Different Development plans in this area, which correspond to the nine rural municipalities of Ritchot, Morris, Montcolm, De Salaberry, Hanover, Franklin, Piney, La Broquerie, & Stuartburn. All of these plans recognize the importance of agricultural lands, but some of these plans are not as strong as others in protecting the land from rural residential development. In general, there is a much greater need to protect agricultural land in the municipalities which are closer to Winnipeg. For example, the RM of La Broquerie has been highly fragmented and impacted by people wanting to live in the country, to the point that agricultural operations are quite restricted for any expansion. The RM of Hanover, under similar pressures, has strengthened their plan to specifically prevent rural residential encroachment in agricultural areas, and to direct such activity to designated areas. The RM of Piney has to balance tourism, forestry, and agricultural issues. Every municipality has different challenges to face to balance the demand for productive agricultural lands against non-resource related uses.

Crown Land Management and Planning in the Rat-Marsh 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 Q: 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

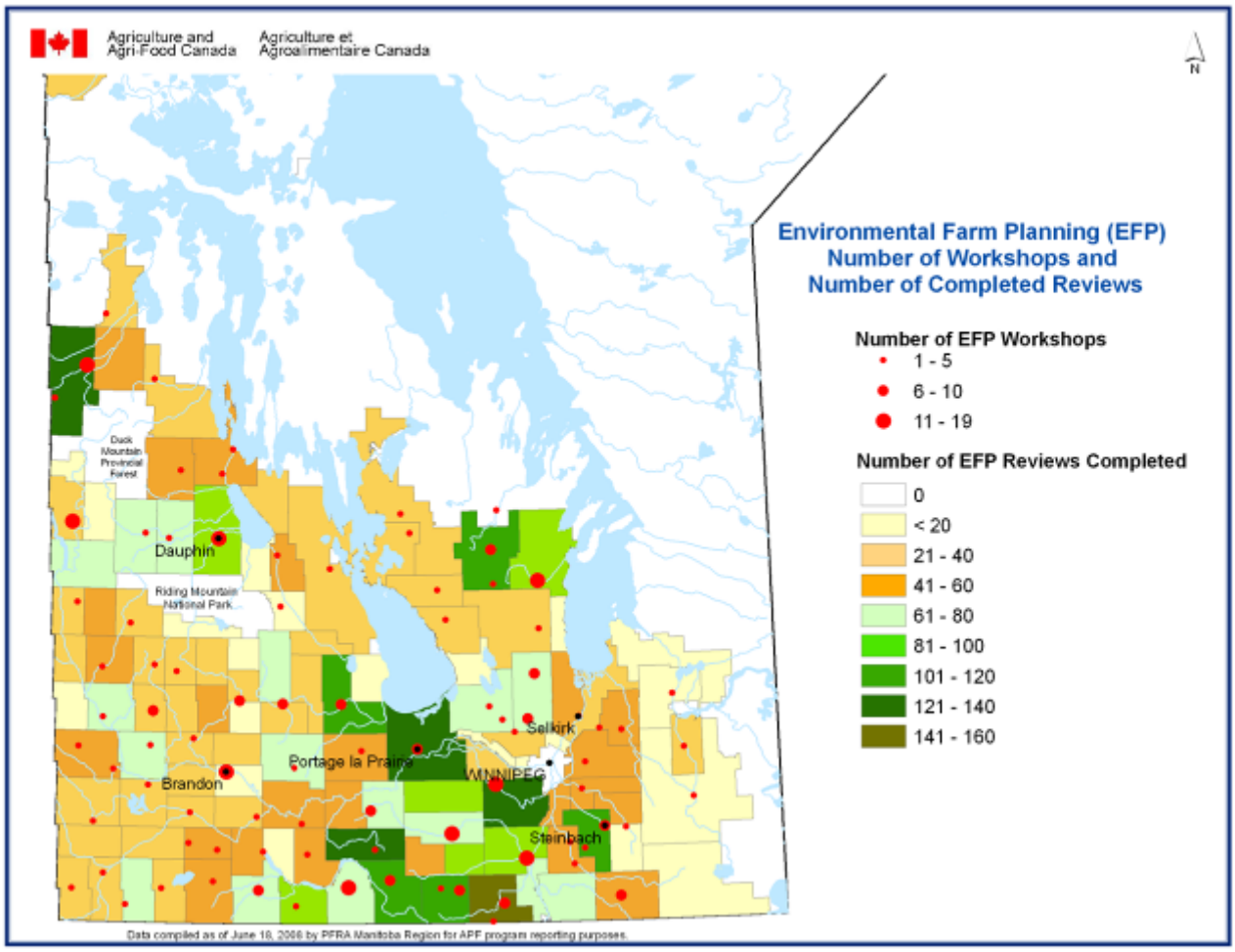
BMP Category Code	BMP Category Description	BMP Practice Code	BMP Practice Description	BMP Practice Unit Type	Cost Share	Caps
09	Water Well Management					
		0902	protecting existing water wells from surface contamination			
10 10	Riparian Area Management (GREENCOVER) Riparian Area Management (GREENCOVER)	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 R: Environmental Farm Plan Workshops and EFP Statement of Completions in Manitoba



Appendix S: Annual rainfall and total precipitation for weather stations located near the Rat-Marsh River IWMP for selected years.*

Degree of Moisture Surplus
Light Blue indicates yearly amount exceeded the 30 year average by 50 millimeters
Dark Blue indicates yearly amount exceeded the 30 year average by 100 millimeters

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

Weather Station	Total Annual Rainfall (mm)						
	1993	1994	2000	2001	2004	2005	30-year average (1971 - 2000)
Zhoda	441.2	575.2	M	M	M	M	470.4
Piney[1]	593.7E	526.5	672.8	472.6	605.2	538.8	491.1
Morris[1]	603.1	584.6	720.6	M	M	594.2	432.4
Steinbach[1]	441.8	648.3	737.6	463.8	666.4	M	440.2
Glenlea[1]	598.8E	687.3	754.7	502.2	M	M	432.1
St Malo	M	498.0i	738.7	521.2	M	587.0	M
St Pierre Jolys	M	497.5i	665.6	470.8	M	M	M
St Labre[1]	492.3	548.9	M	460.4	628.0	688.8	M

Weather Station	Total Annual Precipitation (mm)						
	1993	1994	2000	2001	2004	2005	30-year average (1971 - 2000)
Zhoda	506.6	646.8	M	M	M	M	580.6
Piney[1]	670.7E	601.0E	765.8	525.6	706.2	633.0	603.8
Morris[1]	679.7	645.4	824.0	M	M	717.4	541.4
Steinbach[1]	519.7	721.3	843.9	552.1	801.2	M	539.4
Glenlea[1]	665.8E	728.0	830.2	554.4	M	M	531.1
St Malo	M	550.6i	845.3	599.6	M	670.5	M
St Pierre Jolys	M	549.5i	762.6	529.0	M	M	M
St Labre[1]	599.7E	669.0E	M	630.0	846.0	854.8	M

*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.