Decision Support Tool For Turtle Mountain Conservation District Watershed Planning

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This report provides the Rural Municipality of Winchester and the Rural Municipality of Turtle Mountain with valuable tools and knowledge that will assist them in making informed decisions regarding sustainable agricultural and rural development, protecting the water and soil resource.

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Abstract

Declining water quality in the Turtle Head Creek Watershed and the Long River Watershed has heightened local concern regarding the potential impacts of landuse activities on water quality and sedimentation in Killarney Lake and the Deloraine Reservoir. An accurate picture of current land use practices in the watershed is needed by the Turtle Mountain Conservation District and the Rural Municipalities of Turtle Mountain and Winchester to make informed decisions regarding water quality.

A geographical information system (GIS) was used to integrate and analyse resource data, such as soils information, demographic data such as the location and numbers of livestock data, and farm management and practices data such as tillage schemes to spatially display information regarding the potential impact of land management practices on water quality.

Current management practices of fall tillage and direct access watering of cattle commonly occur in both watersheds and have the potential to increase sedimentation and impact water quality. Other management plans commonly used by local producers such as grassed runways, rotational grazing and manure management plans may limit sedimentation in the watershed.

Results of this project do not determine the extent of which these activities contribute to sedimentation and water quality issues, rather results indicate current practices that may affect water quality. Focussing resources on promotion and demonstration of management practices such as remote water systems and reduced tillage, the Turtle Mountain Conservation District and the RMs of Turtle Mountain and Winchester can encourage landowners to implement sustainable land management practices. Determining the extent of impact of various land management practices will require future field level assessment and surveys.

Table of Contents

List of Tables

List of Maps

1.0 Introduction

As crop and livestock production intensifies, the need to utilize information and expertise in land and water resource management becomes more evident. Local governments and other decision makers are under pressure to make decisions on agricultural operations which must reflect sustainability in terms of environmental, social and economic issues. Resource based data for land use planning, although not complete, is advanced enough to be immediately useful by local governments in their decision making. Social and economic considerations are equally important, but will require additional data and development to be integrated into local decision making.

Within the Turtle Mountain Conservation District a community based planning committee has formed to address water quality in Killarney Lake. Similar concerns regarding water quality have arisen in Turtle Head Creek, the primary tributary for the Deloraine Reservoir. For the Turtle Mountain Conservation District and participating rural municipalities including the Rural Municipalities of Turtle Mountain and Winchester, to make informed decisions regarding water quality issues in Killarney Lake and the Deloraine Reservoir, additional information of land use practices and activities within the watershed is needed. Local decision makers also require the ability to acquire, interpret, and distribute information to promote sustainable land practices within the rural municipalities and entire watershed.

Geographic Information Systems (GIS) is a relatively new tool that can assist local governments in making sustainable resource development decisions regarding the livestock industry. GIS allows the user to spatially display information and produce maps in an accurate and timely fashion. Using this tool can help local governments and planning districts find the appropriate solutions to resolve complicated resource planning issues and to ensure sustainable development of the agricultural industry.

2.0 Project Description and Objectives

To effectively analyze how land use practices within local watersheds affect sedimentation and water quality in Killarney Lake and the Deloraine Reservoir, the Turtle Mountain Conservation District (TMCD) and the Rural Municipalities of Turtle Mountain and Winchester needed to develop capabilities that allow for the acquisition and utilization of information for decision making. With the collection of agricultural data through a survey, demographic and resource information were combined into a geographic information system (GIS) and analyzed to create map products that spatially illustrated land use practices and management. This analysis provided baseline information of current land use practices within the Turtle Head Creek and Long River Watersheds. This information will provide insight into the potential contributions of land use practices to declining water quality and increased sedimentation in Killarney Lake and the Deloraine Reservoir and assist in the development of programs to address water quality concerns.

At completion, the project delivered

i. a methodology that supports resource based decision making by local governments to deal with declining water quality and sedimentation problems

ii. a demonstrated capacity among participating local governments to utilize advanced decision making tools on their decision making

iii. reports for each participating project partner that includes hard copy (tabular and map form) results of analysis

iv. digital products and data for continued analysis by the Turtle Mountain Conservation District and the Rural Municipalities of Turtle Mountain and Winchester.

3.0 Methods

3.1 Needs of the Rural Municipalities of Turtle Mountain and Winchester and the Turtle Mountain Conservation District

Through discussions with the Rural Municipalities of Turtle Mountain and Winchester and the Turtle Mountain Conservation District the following statements about the need and scope of the project were determined. To effectively assess and manage water quality and sedimentation in Killarney Lake and the Deloraine Reservoir, the municipalities and the conservation district wish to have a decision support tool for land use planning capable of spatially illustrating options, issues, and information relevant to decisions regarding the impact of land use activities and management practices on sedimentation and water quality. Data requirements were discussed and mutually agreed upon.

3.2 Data

Basemap Features

The basemap is a digital map that all other information is plotted or corrected to. Essentially the basemap is the frame upon which the rest of the data is placed. This information included the position of roads, lakes, rivers, streams, rail lines and other features. Basemaps used are the National Topographical Survey (NTS) sheets and the quarter section grid from Linnet Geomatics. The quarter section fabric was used to position farm operation symbols.

Landuse

Land use information was derived from satellite imagery which has a resolution of 30 m^2. 1993 satellite imagery was obtained from Radarsat International for the RM of Winchester and 1994 imagery was obtained for the RM of Turtle Mountain. The imagery was then classified by Manitoba Remote Sensing into seven groups: Annual Crop Land, Forage, Grassland, Trees, Water, Wetland, and Urban and Transportation.

Survey Information

Land owners within the watershed boundaries of the Long River and the Turtle Head Creek were contacted by staff and board members of the Turtle Mountain Conservation District to obtain information on land management and practices. Information collected from these landowners included general land use, tillage and grazing practices that were being used. A copy of the survey used by staff and board members of the TMCD is provided in Appendix 1.

Soils Information

Soils of a municipality are an important natural resource for the community. Soils information was acquired from the Reconnaissance Soil Surveys done in the 1930's and 1940's. The soils information for the RM of Winchester is at a scale of 1:40,000 and the RM of Turtle Mountain is at a scale of 1:126,720. The soils database contains information about soil texture, drainage, permeability, plus many other characteristics and interpretations. This soils information is important for making decisions about agricultural capability, risk of leaching, and suitability for many uses including agriculture, industrial, construction, and recreational.

Watershed Boundaries

The PFRA gross watershed boundaries delineate areas of the watershed for the watercourses in Manitoba. The watersheds of the Long River and the Turtle Head Creek from this map were used as the study areas for this project.

4.0 Analysis and Discussion

4.1 Turtle Head Creek

Watershed Description

Turtle Head Creek and its tributaries drain the northwestern portion of the Turtle Mountains and flow northward out onto the Boissevain Plain and into the Deloraine Reservoir on its way to Whitewater Lake. The watershed for the Turtle Head Creek starts in the Turtle Mountains and, for the purpose of this study, culminates at the Deloraine Reservoir, the water source for the town of Deloraine. The watershed begins at an elevation of 762 m above sea level (asl) and drops 229 meters over a distance of 14 kilometers to an elevation of 533 m asl at the reservoir (Map 1).

Soil Texture

Soil texture strongly influences the soils ability to retain moisture, its general level of fertility and ease or difficulty of cultivation. Water moves easily through course-textured (sandy) soils so little moisture is retained and they dry out more quickly than fine textured (clay) soils. As well, sandy soils do not retain plant nutrients as well as clay soils and are lower in natural fertility. Sandy soils often are characterized by loose or single grained structure, which is very susceptible to wind erosion. Clay soils have a high proportion of very small pore spaces which hold moisture tightly and are usually fertile because they are able to retain plant nutrients. Clay soils transmit water very slowly, and therefore these soils are susceptible to excess moisture conditions.

The majority of the soils (84%) in the Turtle Head Creek Watershed have a fine loamy texture. Another 4% of the area has coarse sands (Map 2). Table 1 gives a summary of the soil texture in the watershed.

Table 1: Summary of soil texture in the Turtle Head Creek Watershed*

Soil texture	Area (ha)	% of watershed
Fine Loamy	6459	84.4
Coarse Sands	326	4.3
Eroded Slopes	868	11.3
Total	7653	

*Area has been assigned to the dominant soil series for each soil polygon

Slope

Slope describes the steepness of the landscape surface. Slope is an important factor in erosion and drainage. The steeper the slope gradient, the greater the potential for water erosion. The main channel of Turtle Head Creek forms a relatively deep narrow valley as it descends down the slope of Turtle Mountain. The main tributary, draining the western portion of the watershed, also forms a deep narrow valley running almost parallel to the main channel. Walls of these valleys are classified by soil survey as eroded slopes (>30% slope)(Map 3). Slopes throughout the rest of the watershed area are in the range of 2% to 15%. Approximately 44% of the watershed is gently undulating with slopes ranging from 2-5% and another 27% of the area with slopes ranging 5-9% (Table 2).

Table 2: Summary of surface slope in the Turtle Head Creek Watershed*

Slope range	Area (ha)	% of watershed
0-2 %	280	3.7
2-5 %	3337	43.6
5-9 %	2035	26.6
9-15 %	1133	14.8
>30 %	633	8.3
Water	235	3.1
Total	7,653 ha	

*Area has been assigned to the dominant slope in each soil polygon

Water Erosion Risk

In the soils database, using such data as slope length, slope gradient and soil erodibility, a risk for water erosion has been calculated. Areas are rated as having severe, high, moderate, low or negligible risk for erosion (Map 4). About 44% of the watershed is considered to have a moderate risk of erosion with another 42% having high to severe risk (Table 3). Areas with high to severe risk require special management practices to mitigate erosion risk, such as using minimum tillage to maintain high residue cover in early spring or growing forages to maintain a permanent cover. Cropping and residue management practices can significantly reduce this erosion risk, depending on crop rotation, soil type and landscape features.

Table 3: Summary of water erosion risk in the Turtle Head Creek Watershed*

Class	Area (ha)	% of watershed
Negligible	680	8.9
Low	165	2.2
Moderate	3349	43.8
High	1069	14
Severe	2155	28.2
Water	235	3.1
Total	7,654 ha	

*Based on the weighted average USLE predicted soil loss within each polygon, assuming a bare unprotected soil.

Land Use

Analysis of the classified satellite imagery reveals that 24% of the area in the Turtle Head Creek Watershed is annually cropped with another 2% under forages (Table 4). The majority of the remainder of watershed is either grassland (28%) or trees (39%). Most of the treed areas occur in the Turtle Mountains while the grasslands occur more in the transition zone between the Turtle Mountains and the Boissevain Plain and along the water courses (Map 5). Annual crop land becomes more common on the Boissevain Plain.

Table 4. Land use in the Turtle Head Creek Watershed*

Land Use	area (ha)	% of Watershed
Annual crop land	1830	23.9
Trees	2973	38.8
Water	137	1.8
Grassland	2102	27.5
Wetland	290	3.8
Forage	150	2
Roads/Transportation	171	2.2
Total	7,653 ha	

* From 1993 satellite imagery

Land Use on Erodible Land

The combination of steeper slopes (>9%) and loamy soil texture create some areas of high to severe risk of water erosion in the watershed, potentially contributing to sedimentation problems in the creek. Approximately 42% of the Turtle Head Creek Watershed is rated as having a high to severe risk for water erosion (Table 3). However, much of these high to severe risk areas tend to be under grassland (31%) or tree vegetation cover (37%) and are utilized as pasture for cattle (Table 5)(Map 6). This vegetation may provide adequate protection to the soil and reduce erosion, provided that the vegetation is not overgrazed. Another 24% of these highly to severely erodible areas are annually cropped. These cropped fields have an increased potential to contribute to sedimentation problems due to the lack of protection of the soil from erosion associated with increased tillage or low residue crops.

Table 5: Summary of land use on highly erodible land in the Turtle Head Creek Watershed

Land use	Area (ha)	% of highly erodible area
Annual crop land	675	24.2
Trees	1039	37.3
Water	10	0.4
Grassland	851	30.6
Wetland	73	2.6
Forage	78	2.8
Roads/Transportation	58	2.1
Total	2,784 ha	

Land Use and Farm Management Practices in Turtle Head Creek Study Area

Agriculture in the Turtle Head Creek watershed is quite diverse. Within the watershed there were 27 agricultural operations identified in the survey. Locations of farm operations were located by the quarter section where the farm operation is based. Operations located outside the boundary of the actual study area were included because they owned land within the study area and their agricultural management and practices can have a potential impact on the watershed. Of these operations, six were identified as grain farms, 11 were mixed farms, and 10 were livestock farm. One additional recreation property was also identified.

Agricultural operation type appears to be tied somewhat to location of the operation on the landscape. Livestock operations tend to be located in the upper reaches of the watershed where tress and grassland dominate, while grain operations are found primarily in the low slope areas on the edges of the watershed (Map 7). Mixed operations are generally found in the transition area between the high and low reaches of the watershed where the both grassland and cropland occur.

Livestock production is quite diverse in the watershed. While cattle is the dominant livestock type produced (16 operations), there are two dairy operations, one poultry operation and two operations that have horses as their primary livestock (Map 8) (Table 6). Beef production primarily occurs in the upper reaches and on higher slope areas of the watershed. The other livestock operations are located in the middle and lower reaches of the watershed.

Table 6: Summary of Livestock Operations in the Turtle Head Creek Watershed.

Livestock	**Number of Operations**
Cattle	16
Dairy	2
Chickens	1
Horses	2

In the survey, producers were asked to estimate the amount of what they consider to be native land that they own and indicate whether this land is being used or is idle. Of those producers that reported owning native land, most indicated that the native land was located upland and that it was being used. For the purpose of this study, it is assumed that if native land is being used, it would be for pasture. A percentage of pasture that is native land was calculated using this assumption. In the Turtle Head Creek Study Area, a large portion of the pasture in the upper reaches of the watershed is considered by the producer to be native lands. While native lands as a percentage of pasture acres decline north of the Turtle Mountains, native lands are prominent along the river itself (Map 9). One farm reported having more native land than pasture, indicating that some of this native area is not being used as pasture.

Potential Impacts from Tillage

Sediment from soil erosion can affect the health of streams and rivers. Excessive sedimentation can fill in reservoirs, reducing the holding capacity of the reservoirs thus reducing the amount of water that is available. Excessive sediment can also destroy fish habitat in rivers and streams. As well, sediment particles can carry pesticides and nutrients into streams, lakes and reservoirs affecting water quality.

Some degree of erosion is natural in all landscapes, however certain land uses can increase the erodibility of the soil within a landscape. Soil texture (loams are more susceptible than clays or sands), slope length and slope steepness are factors which determine the erodibility of a soil. Other factors that will affect soil erosion are the amount and intensity of rainfall, and vegetation cover. Of these factors, the only one that producers have any control over is vegetation cover, through tillage and crop selection.

From the survey that was completed in the Turtle Head Creek Watershed, it is apparent that certain agricultural practices may increase the potential for soil erosion and with it water quality problems in the watershed. In the survey, tillage systems (conventional, conservation and zero till) were not defined for the producers. As such, the results are dependent on what the producers considered their own tillage practice to be. Fourteen producers surveyed considered themselves conventional tillage farmers, with two producers considering themselves conservation tillers and one zero-till producer (Map 10). Ten of the conventional tillers and the two conservation tillers practice fall tillage (Table 7). Fall tillage may leave the soil susceptible to erosion during spring runoff depending on the frequency of tillage passes, the implement used, and the type and amount of crop residue.

Table 7: Fall tillage in the Turtle Head Creek Watershed.

Farm System	Total Farms	Total Farms Reporting Fall Tillage
Conventional tillage	14	10
Conservation tillage	2	2
Zero tillage	1	0

Water erosion on cultivated land can be mitigated through maintaining vegetative or residue cover and through the development of grassed waterways in areas subject to gully formation. Grassed waterways spread water out over a larger area and provide vegetation for the water to interact with. The result of these actions is to slow the water down, effectively reducing the amount of energy the water has available to erode the soil. Survey results indicated that 11 of the 17 producers that have cropland also have grassed waterways. All producers felt that their grassed waterways effectively dealt with their erosion problems.

Potential Impacts from Livestock Production

Livestock production can potentially affect the health of rivers and lakes in two ways. First, though grazing implies that the ground is always covered by vegetation, overgrazed pastures provide considerably less protection than a healthy pasture against soil erosion, increasing the potential for sedimentation occurring in adjacent water bodies. To avoid overgrazing it is necessary to provide a period during the growing season for the vegetation to recover from being grazed. Secondly, livestock production also produces manure. Manure contains pathogens and nutrients such as nitrogen and phosphorous which has the potential to reduce water quality of adjacent water bodies and groundwater. Proper manure management is essential to protect water quality. This entails proper livestock wintering site management, managing livestock's contact with water sources, proper management of manure packs and their distribution onto fields (as a source of fertilizer) and proper management of manure produced in intensive livestock operations.

More than half of the livestock producers (12) in the watershed rotate their pastures in some form implying that rest is being provided to these pastures. However, all producers allow direct access to surface water as a means of providing water to their cattle. This management practice is a potential source of both sediment and nutrient contamination of surface waters as hoof action can cause slumping of banks of rivers and creeks. Livestock defecation in the creek could be a source of nutrient contamination.

Another potential source of contamination comes from improper handling of livestock manure from intensive livestock operations and wintering sites. Manure should be a tested for nutrient content and applied according to the requirements of the crop being grown, taking into consideration the nutrient content that exists in the soil. Of the four producers managing livestock in a confinement situation, two follow a manure management plan indicating attention is being given to the disposal of manure pack.

4.2 Long River Watershed

Watershed Description

The upper reaches of the Long River are located on the northeast slope of the Turtle Mountains. It flows northeast onto the Boissevain Plain and into Killarney Lake. The Long River Watershed begins south of the Canada/United States border in the Turtle Mountains. For this study, the watershed area was defined as starting at the border and culminating at Killarney Lake (Map 11). The highest elevation in the study watershed occurs in the Turtle Mountains at 693 meters above sea level (asl). Within the next 7 kilometers of this area, land elevation drops 99 m off the escarpment and then continues to drop another 99 m over the next 20 km to reach an elevation of 495 m asl at Killarney Lake.

Soil Texture

Soil texture strongly influences the soils ability to retain moisture, its general level of fertility and ease or difficulty of cultivation. Water moves easily through course-textured (sandy) soils so little moisture is retained and they dry out more quickly than fine textured (clay) soils. As well, sandy soils do not retain plant nutrients as well as clay soils and are lower in natural fertility. Sandy soils often are characterized by loose or single grained structure, which is very susceptible to wind erosion. Clay soils have a high proportion of very small pore spaces which hold moisture tightly and are usually fertile because they are able to retain plant nutrients. Clay soils transmit water very slowly, therefore these soils are susceptible to excess moisture conditions.

The majority of the soils in the Long River Watershed have a fine loamy texture (86%), with a smaller areas of coarse sands (8 %) (Map 12). Table 8 provides a summary of the soil texture in the watershed.

Table 8: Summary of soil texture in the Long River Watershed*

Soil texture	Area (ha)	% of watershed
Fine Loamy	11551	85.6
Coarse Sand	1115	8.3
Eroded Slopes	651	4.8
Total	13502	

*Area has been assigned to the dominant soil series for each soil polygon

Slope

Slope describes the steepness of the landscape surface. Slope is an important factor in erosion and drainage. The steeper the slope gradient, the greater the potential for water erosion. The Turtle Mountain Uplands contain hummocky surface forms with slopes ranging from 9 to 30% (Map 13). Areas with slopes less than five percent gradient make up 52% of the watershed (Table 9). Eroded slopes (> 30%) occur along valleys of the Long River and its main tributaries.

Table 9: Summary of slope in the Long River Watershed*

Slope range	Area (ha)*	% of watershed
0-2 %	2429	18
2-5 %	4589	34
5-9 %	2238	16.6
9-15 %	887	6.6
15-30 %	2523	18.7
>30 %	651	4.8
Water	185	1.4
Total	13,503 ha	

*Area has been assigned to the dominant slope in each soil polygon

Water Erosion Risk

In the soils database using such data as slope length, slope gradient, soil erodibility, a risk for water erosion has been calculated. Areas are rated as having severe, high, moderate, low or negligible risk for erosion (Map 14). About 29% of the watershed is considered to have a moderate risk of erosion with another 39% having high to severe risk (Table 10). Areas with high to severe risk require special land use practices to mitigate erosion risk, such as minimum tillage and maintenance of high residue cover in early spring or these areas should not be used for annual crop production. Cropping and residue management practices can reduce the risk of water erosion, depending on crop rotation, soil type and landscape features.

Table 10: Summary of water erosion risk in the Long River Watershed*

Class	Area (ha)*	% of watershed
Negligible	1399	10
Low	2722	20
Moderate	3949	29
High	1592	12
Severe	3655	27
Water	185	1
Total	13496	

*Based on the weighted average USLE predicted soil loss within each polygon, assuming a bare unprotected soil.

Land Use

The classified 1994 satellite imagery indicates that 52% of the area in the Long River Watershed is annually cropped, with 1% of the area under forages (Table 11). These fields occur north of the Turtle Mountains on the Boissevain Plain. Another 35% of the study area is grassland (13.5%) or trees (21%). The majority of the treed areas occur in the uplands of the Turtle Mountains and the grasslands along the banks of the Long River and its tributaries (Map 15).

Table 11: Summary of land use in the Long River Watershed*

Land Use	Area (ha)	% of Watershed
Annual crop land	6966	52.2
Trees	2810	21
Water	497	3.7
Grassland	1799	13.5
Wetland	722	5.4
Forages	184	1.4
Roads	377	2.8
Total	13,355 ha	

* From 1994 satellite imagery.

Landuse on Erodible Land

A combination of higher slopes (>9%) and the loamy soil texture create some areas of high to severe risk of water erosion, potentially contributing to sedimentation problems in the Long River and Killarney Lake. About 39% of the Long River Watershed study area is rated as having a high to severe risk for water erosion (Table 10). Grassland or tree cover occurs on up 53% of this high to severely erodible area (Table 12). The majority of these grassland and treed areas are located within the Turtle Mountain PFRA Pasture and along the Long River and its tributaries (Map 16). This vegetation cover may provide adequate protection to the soil to reduce the risk of erosion provided that the vegetation is not overgrazed. Another 32% of the area with high to sever risk of erosion is annually cropped. Due to lack of permanent vegetative cover, these lands could potentially contribute to sedimentation problems without mitigative land management practices such as reduced tillage, no fall tillage, adequate residue cover of at least 60%, or grassed waterways.

Table 12: Summary of land use on highly erodible lands in the Long River Watershed

Land Use	Area (ha)	% of Highly Erodible Lands
Annual crop land	1672	32.1
Trees	2052	39.4
Water	261	5
Grassland	715	13.7
Wetland	426	8.2
Forages	7	0.1
Roads	69	1.3
Total	5,202 ha	

Land Use and Farm Management Practices in the Long River Study Area

Agriculture in the Long River watershed consists mainly of grain farming, with most farmers having some cattle. Farm operations were located on the quarter section where the farm operation is based. Operations located outside of the actual study area were included because the producers owned land within the study area and their agricultural management and practices can have a potential impact on the watershed. Within the watershed there were 13 agricultural operations identified in the survey. Of these operations, four were identified as grain farms, eight were identified as mixed grain and livestock farms, and one livestock farm was identified (Map 17). Cattle is the only livestock type reported in the survey in this watershed (Map 18). A PFRA Pasture is located in the southern portion of the study area in the Turtle Mountains on which up to 1,400 cattle are pastured over the summer.

In the survey, producers were asked to estimate the amount of what they consider to be native land that they own and to indicate whether this land is being used or idle. Of those that reported owning native land, most indicated that the native land was located upland and that it was being used. For the purpose of this study, it is assumed that if native land is being used, it would be for pasture. A percentage of pasture that is native land was calculated using this assumption. In the Long River study area, a large portion of the pastures is considered by the producers to be native lands. Seven farmers reported that 75-100% of their pasture is native land (Map 19). One farm reported having more native land than pasture land indicating that some of what the producer considers native lands are not being used for pasture.

Potential Impacts of Tillage

Sediment from soil erosion can affect the health of streams and rivers. Excessive sedimentation can fill in reservoirs, decreasing the holding capacity of the reservoirs thus reducing the amount of water that is available. Excessive sediment can also destroy fish habitat in rivers and streams. As well, sediment particles can carry pesticides and nutrients into streams, lakes and reservoirs affecting quality of water.

Some degree of erosion is natural in all landscapes, however certain land uses can increase the erodibility of the soil within a landscape. Soil texture (loams are more susceptible than clays or sands), slope length and slope steepness are factors which determine the erodibility of a soil. Other factors that will effect soil erosion are amount and intensity of rainfall, and vegetation cover. Of these factors, the only one that producers have any control over is vegetation cover, through tillage and crop selection.

From the survey that was completed in the Long River Watershed, it is apparent that certain practices may somewhat increase the potential for soil erosion and with it water quality problems. In the survey, tillage systems (conventional, conservation and zero till) were not defined for producers. As such, the results are dependent on what the producers considered their own tillage practice to be. Over half (seven) of the producers surveyed considered themselves conventional tillage farmers, three considered themselves conservation tillers and two were zero tillers (Map 20). Of the farmers that identified themselves as conventional and conservation tillers, all tilled in the fall (Table 13). Fall tillage may leave the soil susceptible to erosion during spring runoff, depending on the frequency of tillage passes, implement used, and the type and amount of crop residue.

Table 13: Fall tillage in the Long River Watershed study area.

Farm System	Total Farms	Total Farms Reporting Fall Tillage
Conventional tillage	7	7
Conservation tillage	3	3
Zero tillage	2	0

Water erosion on cultivated land can be mitigated through maintaining vegetative or residue cover and through the development of grassed waterways in areas subject to gully formation. Grassed waterways spread water out over a larger area and provide vegetation for the water to interact with. The result of these actions is to slow the water down effectively reducing the amount of energy the water has available to erode the soil. The survey indicated that all 12 of the producers that have cropland also have grassed waterways. All but two of these producers felt that their grassed waterways effectively dealt with their erosion problems.

Potential Impacts of Livestock Production

Livestock production can potentially affect the health of rivers and lakes in two ways. First, though grazing implies that the ground is always covered by vegetation, overgrazed pastures provide considerably less protection than a healthy pasture against soil erosion, increasing hte potential for sedimentation occurring in adjacent waterbodies. To avoid overgrazing it is necessary to provide a period during the growing season for the vegetation to recover from being grazed. Secondly, livestock production also produces manure. Manure contains pathogens and nutrients such as nitrogen and phosphorous which has the potential to reduce water quality of adjacent water bodies and groundwater. Proper manure management is essential to protect water quality. This entails proper livestock wintering site management, managing livestock's contact with water sources, proper management of manure packs and their distribution onto fields as a source of fertilizer and proper management of manure produced in intensive livestock operations.

The survey of producers found that six livestock producers rotated their pastures in some form. This implies that rest is being provided to the pastures and hence the vegetation is healthier and more robust and will therefore provide protection to the soil, reducing the potential for erosion. However, most producers allow direct access to surface water as a means of providing water to their cattle. This is a potential source of both sediment and nutrient contamination of surface waters as hoof action can cause slumping of banks of rivers and creeks. Livestock defecation in the creek could be a source of nutrient contamination.

Another potential source of contamination comes from improper handling of livestock manure from intensive livestock operations and wintering sites. Manure should be tested for nutrient content and applied according to the requirements of the crop being grown, taking into consideration the nutrient that exists in the soil. Of the seven producers managing livestock in a confined area overwinter, six follow a manure management plan indicating attention is being given to the disposal of manure pack.

5.0 Summary and Conclusion

Overall, analysis of agricultural land use within both the Turtlehead Creek Watershed and the Long River Watershed indicates a few common management practices that may lead to increased rates of sedimentation and reduced water quality in the Killarney Lake and the Deloraine Reservoir. These include the practice of fall tillage and direct access watering for livestock. In both study areas, the majority of grain farmers indicated that they practice fall tillage (Table 14). Fall tillage reduces the amount of residue cover on fields over the winter and spring when soils are most vulnerable to erosion by water. Also in both study areas, most of the livestock producers water their animals through direct access. Bank degradation and defecation in the water by livestock will increase sedimentation and nutrient loading and can reduce water quality in the waterways.

On the other hand, most producers are following several management practices that reduce the amount of sediment entering the waterways. In both study areas, those producers that consider themselves conventional tillers generally mitigate water erosion with grassed waterways. Also the majority of livestock producers have begun to embrace rotational grazing as a method of managing their pastures.

Table 14: Summary of farm management practices in the Turtle Head Creek and Long River study areas.

Description	Turtle Head Creek	Long River
Of the grain and mixed farms:		
# of conventional tillers	14/17	37175
# of farms practising fall tillage	37241	37083
# of farms using grassed waterways	37180	37206
Of the livestock and mixed farms:		
# of farms watering livestock through direct access	21/21	37111
# of farms confining livestock at some point and following a manure management plan	36928	37048
# of farms following a rotational grazing plan	37245	37050

This study is only intended to give an overview of the land management practices in the two watersheds. The exact extent that local land practices may contribute to the water quality issues in the Killarney Lake and the Deloraine Reservoir is not determined in this study. Results of the study do indicate the occurrence of certain land management practices which may increase the rate of sedimentation of these waterbodies (fall tillage, direct watering, etc). Using this information, the RM's of Turtle Mountain and Winchester and the Turtle Mountain Conservation District can encourage farmers to investigate sustainable land management practices through the promotion and demonstration of environmentally sustainable practices such as remote watering systems, reduced tillage and rotational grazing.

An improved ability to bring information together in an easily understood format not only assists in decision making, but will also facilitate public input into decisions through discussions generated when collecting information. Using GIS as a tool for displaying, integrating and interpreting information has immediate value for the RM's of Turtle Mountain and Winchester as well as the Turtle Mountain Conservation District in addressing water quality issues of the Deloraine Reservoir and Killarney Lake. By determining areas with the potential for sedimentation of the rivers and streams exist within a watershed, local groups and decision makers can target activities to these areas, including the development of demonstration projects and or programming.

5.1 Future Directions

As indicated by this project, issues of potential concern for water quality in the Deloraine Reservoir and Killarney Lake include residue management on annually cropped land and direct access of cattle to surface water bodies. The extent of the contribution that local land practices may have on these issues is not readily available through this method of survey. In order to better understand the extent of these issues, the Turtle Mountain Conservation District and local groups interested in water quality in the Deloraine Reservoir and Killarney Lake should ground truth this survey. Possible activities would be:

1. A fall residue survey of crop lands to determine the susceptibility of the land to erosion by spring runoff.
2. A riparian health assessment of grazing lands and cultivated lands.
3. A range/pasture condition surveys/assessments.
4. Water quality monitoring in the reservoir and upstream.

These activities could be done by interested landowners as a self assessment. The assessments should be designed in such a fashion as to point the landowner towards management changes that may be necessary in order to reduce the effect of their land use on water quality and sedimentation in the Deloraine Reservoir and Killarney Lake.

Information and data obtained in this study will remain in the hands of the RM's of Turtle Mountain and Winchester and the Turtle Mountain Conservation District. Updating data will be the responsibility of the Rural Municipalities and the Conservation District. Analysis can be provided by groups with technical expertise such as consulting companies or government agencies (such as PFRA).

6.0 Acknowledgments

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7.0 Data Sources

Quarter section grid: Linnet Geomatics International Inc., Winnipeg, Manitoba. 1:60 000, 1997

National Topographic Survey: Department of Energy, Mines and Resources, Surveys and Mapping Branch, Ottawa Canada. 1:50 000

Soils for Long River study area: Ellis, J. H. and Shafer, W. H., 1943, Reconnaissance Soil Survey of South-Central Manitoba, Soils Report No. 4, Manitoba Soil Survey, published by Manitoba Dept. of Agriculture

Soils for Turtle Head Creek study area: Ellis, J. H. and Shafer, W. H., 1935, Reconnaissance Soil Survey of South-Central Manitoba, Soils Report No. 3, Manitoba Soil Survey, published by Manitoba Dept. of Agriculture

Land Use: Satellite imagery obtained from RSI. Landsat TM (30 m pixel resolution) Date of image for RM of Turtle Mountain: annual crop land and forage September May 26, 1994. All other classes May 9, 1988. Date of image for RM of Winchester: May 14, 1993. Classification from the Manitoba Remote Sensing Centre. Winnipeg, Manitoba

Watershed Boundaries: PFRA Gross Watershed Boundaries, (Version 1.0), 1:50 000, PFRA, Regina, Saskatchewan, July, 1997.

Appendix 1:

Turtle Mountain Information Sheet

Date Collected: _______________
Name of data collector: ____
Contact Name: ____
Contact Address: ____
Farm Name: ____
Farm Address: ____
Farm Location: ____
Phone #: _________________ Fax #: ___________________
What is the size of your farm?: _________________acres
Does the Turtlehead Creek go through any of your land? “ Yes “ No
What would you classify your farming system?
“ Conventional Tillage “ Zero Tillage “ Conservation Tillage
If your farming system is conventional tillage, do you till in the fall?
“ Yes “ No
Do you seed low residue crops? (ie. lentils, potatoes, peas, canola, flax, etc.)
“ Yes “ No
If yes, approximately what percentage of crop land? _______________
Do you have any problems with water erosion? “ Yes “ No
Do you have grassed water ways? “ Yes “ No
If yes, how are you managing them?
“ pasture “ hay “ mow “ nothing
Comments:____
Do your grassed land waterways work for you? “ Yes “ No

Forage/Pasture

How many acres do you have for pasture land? ___________acres
Do you practice rotational grazing? “ Yes “ No
How do you water your livestock?
Method Check one of the boxes
“ Direct access to from a natural body of water (river, creek, etc.)
“ Off site watering (pumped to a trough)
Source Check one of the boxes
“ Dugout/Dam/Slough “ Well/Pipeline “ River, Creek, etc. “ Other_____

Wintering Practices

What type of overwintering facility do you have?
“ Corral “ Loose housing “ Pasture “ Barn
Comments:____What is the distance of the overwintering site from known drains, creeks, water bodies, etc. ______________feet
How do you water your livestock in the winter?
Method Check one of the boxes
“ Direct access to from a natural body of water (river, creek, etc.)
“ Off site watering (pumped to a trough)
Source Check one of the boxes

“ Dugout/Dam/Slough “ Well/Pipeline “ River, Creek, etc. “ Other_____
How many acres consist of native vegetation? _______________acres
Is the land: “ upland “ water
Is the land: “ idle “ used

Livestock
What type of livestock do you have on your farm?
“ Cattle “ Horses “ Hogs “ Sheep “ Chickens “ Other
Approximately how many head? ____
What is your type of operation? “ Free Range “ Confinement
How do you dispose of your manure?
“ Injection “ Surface applied “ Surface applied incorporated
Do you have a manure management plan? “ Yes “ No
Comments:____