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Rural Municipality of Turtle Mountain

Information Bulletin 96-7

Soils and Terrain

An introduction to the land resource

Land Resource Unit
Brandon Research Centre

Canada

Rural Municipality of Turtle Mountain

Information Bulletin 96-7

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PREFACE

This is one of a new series of information bulletins for individual rural municipalities of Manitoba. They serve to introduce the newly developed digital soil and terrain databases, and illustrate several typical derived map products for agricultural land use planning applications. The bulletins will also be available in diskette format for selected rural municipalities.

Information contained in this bulletin may be quoted and utilized with appropriate reference to the originating agencies. The authors and originating agencies assume no responsibility for the misuse, alteration, re-packaging, or re-interpretation of the information.

This information bulletin serves as an introduction to the land resource information available for the municipality. More detailed information, including copies of the primary soil and terrain maps at larger scales, may be obtained by contacting:

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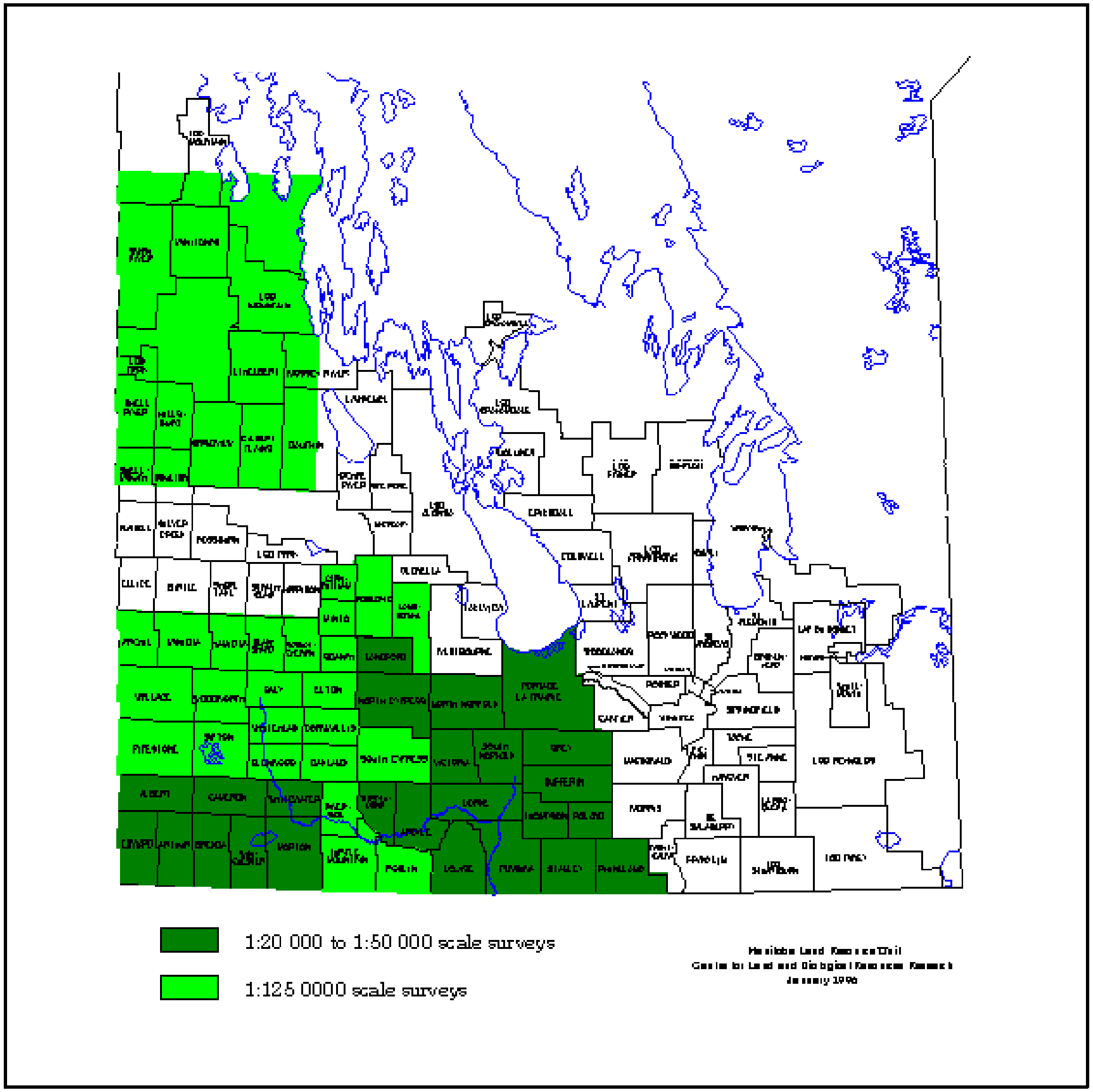


Figure 3. Rural municipalities in southern Manitoba with digital soil and terrain map information (1996).

INTRODUCTION

This information bulletin is one of a new series prepared for selected rural municipalities in southern Manitoba (Figure 1). A brief overview of the soil and terrain database information assembled for each municipality is presented, as well as a set of maps derived from the data for typical agricultural land use and planning applications.

The soil and terrain maps and databases were compiled and registered using the computerized Geographic Information System (GIS) facilities of the Manitoba Land Resource Unit. These GIS databases were used to create the generalized interpretive maps and statistics contained in this report.

LAND RESOURCE DATA

The soil and terrain (landscape) information were obtained as part of a larger project to provide a uniform level of land resource information for agricultural and regional planning purposes throughout Agro-Manitoba. This information was compiled and analyzed in digital form, using Geographic Information System (GIS) techniques. Three distinct layers of information were used, as shown in Figure 2.

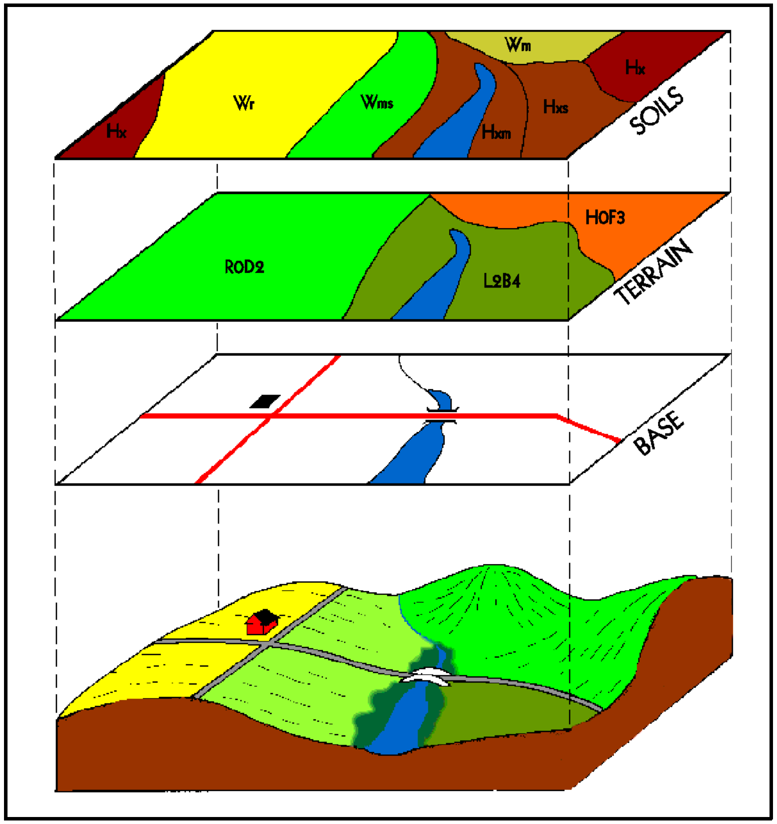


Figure 2. Soil, Terrain, and Base Map data.

Base Layer

Digital base map information includes the municipality and Township boundaries, and major streams, roads and highways. The soil and terrain layers were added and aligned ("georeferenced") to the digital base map. Major rivers and lakes from the base layer were also used as common boundaries for the soil and terrain map layers. Water bodies larger than 25 ha in size were digitized as separate polygons.

Terrain Layer

A separate terrain layer was produced for municipalities for which only reconnaissance scale soil map coverage was available. This was compiled by aerial photo-interpretation techniques, using recent 1:50 000 scale stereo air photo coverage. The terrain information was transferred from the photographs onto the standard RM base and digitized in the GIS. Where the soil and terrain boundaries coincided, such as along prominent escarpments and eroded stream channels, the new terrain line was used for both layers. The terrain line, delineated from modern airphoto interpretation, was considered more positionally accurate than the same boundary portrayed on the historical reconnaissance soil map. Each digital terrain polygon was assigned the following legend characteristics:

Surface form
Slope class
Slope length class
Percent wetlands
Wetland size
Erosional modifiers
Extent of eroded knolls
Polygon number

The first four legend fields are considered differentiating, that is, a change in any of these classes defines a new polygon.

Soil Layer

The most detailed soil information currently available was selected as the data source for the digital soil layer for each rural municipality.

Comprehensive detailed soil maps (1:20 000 to 1:50 000 scale) have been published for many rural municipalities. Where they were available, the individual soil map sheets were digitized and compiled as a single georeferenced layer to match the digital RM base. Map polygons have one or more soil series components, as well as slope and stoniness classes. Soil database information was produced for each polygon, to meet national standards (MacDonald and Valentine, 1992). Slope length classes were also added, based on photo-interpretation.

Older, reconnaissance scale soil maps (1:126 720 scale) represented the only available soil data source for many rural municipalities. These maps were compiled on a **soil association** basis, in which soil landscape patterns were identified with unique surficial geological deposits and textures. Each soil association consists of a range of different soils ("associates") each of which occurs in a repetitive position in the landscape. Each polygon digitized from the reconnaissance soil map was assigned the following legend characteristics:

Map symbol and modifier (overprinted symbol)
Soil Association or Complex name
Soil series and modifier codes
Polygon number

A modern soil series that best represents the soil association was identified for each soil polygon. The soil and modifier codes provided a link to additional databases of soil properties. In this way, both detailed and reconnaissance soil map polygons were related to soil drainage, surface texture, and other soil properties to produce various interpretive maps.

SOIL AND TERRAIN OVERVIEW

The Rural Municipality (RM) of Turtle Mountain covers 9.5 Townships (approximately 94 000 ha) in south-western Manitoba. Agriculture is the dominant land use in the municipality, consisting mainly of production of cereal, oilseed and forage crops.

The Town of Killarney is the largest population centre in the municipality. Soils in the municipality have been mapped previously in the the Reconnaissance Soil Survey of South-Central Manitoba (Ellis and Shafer, 1943). More detailed soil information is provided at a scale of 1:20 000 for the Soils of the Killarney Area (Michalyna and Holmstrum, 1980).

Climatic characteristics for the Boissevain Plain are based on data from Boissevain (Environment Canada, 1982). Mean annual temperature is 2.7EC; mean annual precipitation is 502 mm; frost-free period is 121 days and growing degree days above 5ºC is 1756. The average moisture deficit between May to September is 200 to 250 mm and the effective growing degree days (EGDD) accumulated above 5ºC for the same period is greater than 1500. This parameter provides an indication of heat energy available for crop growth (Agronomic Interpretations Working Group, 1995)

Increased elevation in the Turtle Mountain Upland results in a cooler climate than the surrounding plain. Based on data from the Peace Gardens (Environment Canada, 1982), mean annual temperature decreases from the surrounding area to 1.7EC; mean annual precipitation is 696 mm; frost-free period decreases to 99 days and growing degree days above 5ºC is 1575. There is a slight moisture deficit of 150 to 200 mm; the effective growing degree days (EGDD) between May and September is 1300 to 1400 (Agronomic Interpretations Working Group, 1995). Major land uses consist of livestock production, recreation and wildlife habitat.

The majority of the RM is represented by the Boissevain Plain (referred to as the Waskada Till Plain in published soil reports) with an average elevation of approximately 470 m. Relief in this area is generally less than 3 m and surface forms are dominantly hummocky, undulating, and ridged with slopes up to 9%. A portion of the Turtle Mountain Upland occurs in the southwestern corner of the municipality. This prominent wooded upland rises 200 m above the Boissevain Plain and is characterized by hummocky surface forms with up to 20 m local relief and slopes commonly exceeding 15%.

The soils of the Boissevain Plain consist of Black Chernozems in well to imperfectly drained areas and Humic Gleysols in poorly drained depressions. Slightly higher elevations in the Turtle Mountain are cooler, dominantly forest covered and characterized by Orthic Dark Gray Chernozemic soils in association with well drained Luvisolic soils at higher elevations. Gleysolic soils occur in depressional sites with poor drainage.

The soils of the Boissevain Plain are developed on strongly calcareous loam to clay loam glacial till derived from shale, limestone, and granitic rock materials. Approximately 70% of the total RM is represented by the Waskada Association which is comprised of Undulating, Rolling, Modified and Smooth topographic phases. Dominant soils are Orthic Black Chernozems in well drained positions with minor inclusions of Gleyed Black soil in lower slope positions and Gleysolic soils in depressional positions. An area of imperfectly drained soils belonging to the Waskada Association (modified phase) occurs along the eastern boundary of the RM (Tp. 2 and 3, Rge. 16W). Generally Waskada soils range in agricultural capability from 2 to 3 with topography being the most determining factor. Some localized areas of class 5 to 7 do occur but are restricted to landscapes of severe soil erosion or wetness. Irrigation suitability for this area ranges from Good to Fair due to the uneven terrain. The potential for environmental impact under irrigation is low to moderate with local areas rated as poor. Risk of water erosion on the Waskada soils varies from moderate to severe depending upon slope gradients. However, Waskada Modified soils have a lower risk of water erosion due to decreased slope gradient and imperfect drainage.

Several small areas (< 5% of the RM) consist of imperfectly drained soils of the Cartwright Association, developed on coarse substrata of gravel and water-worked till. These soils are similar to the Waskada Modified phase with respect to agricultural capability, irrigation suitability and risk of water erosion.

The Pembina Valley is a large melt water channel along the north-eastern boundary of the municipality. Pelican Lake, one of a series of lakes that occurs within the Pembina Valley is located along this border. The steeply sloping valley walls remain in native vegetation and are in class 6 and 7T. Local areas of glacial till adjacent to this valley have been extensively modified by glacial melt water. These areas are mapped as the Heaslip Complex and represent about 6% of the RM area. Heaslip soils vary in surface texture due to the local sorting action of water. Agricultural capability of the Heaslip Association is generally class 3 and 4, due to a low water holding capacity. Suitability for irrigation is fair to poor and potential environmental impact is moderate to high. However, the rapid permeability and slight relief common to these soils decreases the risk of water erosion when compared to adjacent Waskada soils.

Soils of the Turtle Mountain Upland were mapped previously as the Turtle Mountain Association developed on loam to clay loam textured glacial till. A major limitation to agricultural use of this area is topography, restricting land use to growth of perennial forages (class 5) and native pasture (class 6). Risk of water erosion is severe due to the steep slopes. This area is rated poor for irrigation (class 4) mainly due to topography.

DERIVED AND INTERPRETIVE MAPS

A large variety of computer derived and interpretive maps can be generated, once the soil and terrain data are stored in digital format. These maps are based on selected combinations of database values and assumptions.

Derived maps show information that is given in one or more columns in the computer map legend (such as soil texture, drainage, stoniness, or slope class).

Interpretive maps portray a more complex evaluation of information presented in the legend which was combined in a unique way to arrive at an entirely new map.

Several examples of derived and interpretive maps are included in this information bulletin. The maps have all been reduced in size and generalized (simplified), in order to portray conditions for an entire rural municipality on one page. Only interpretations based on the dominant soil and terrain conditions in each polygon are shown at such reduced scales. These generalized maps provide a useful overview of conditions within a municipality, but are not intended to apply to site specific land parcels.

The digital databases may also contain more detailed information concerning significant inclusions of differing soil and slope conditions in each map polygon, particularly where they have been derived from modern detailed soil maps. This information can be portrayed at larger map scales.

Information concerning particular interpretive maps, and the primary soil and terrain map data, can be obtained by contacting the Manitoba Land Resource Unit.

Slope Map.

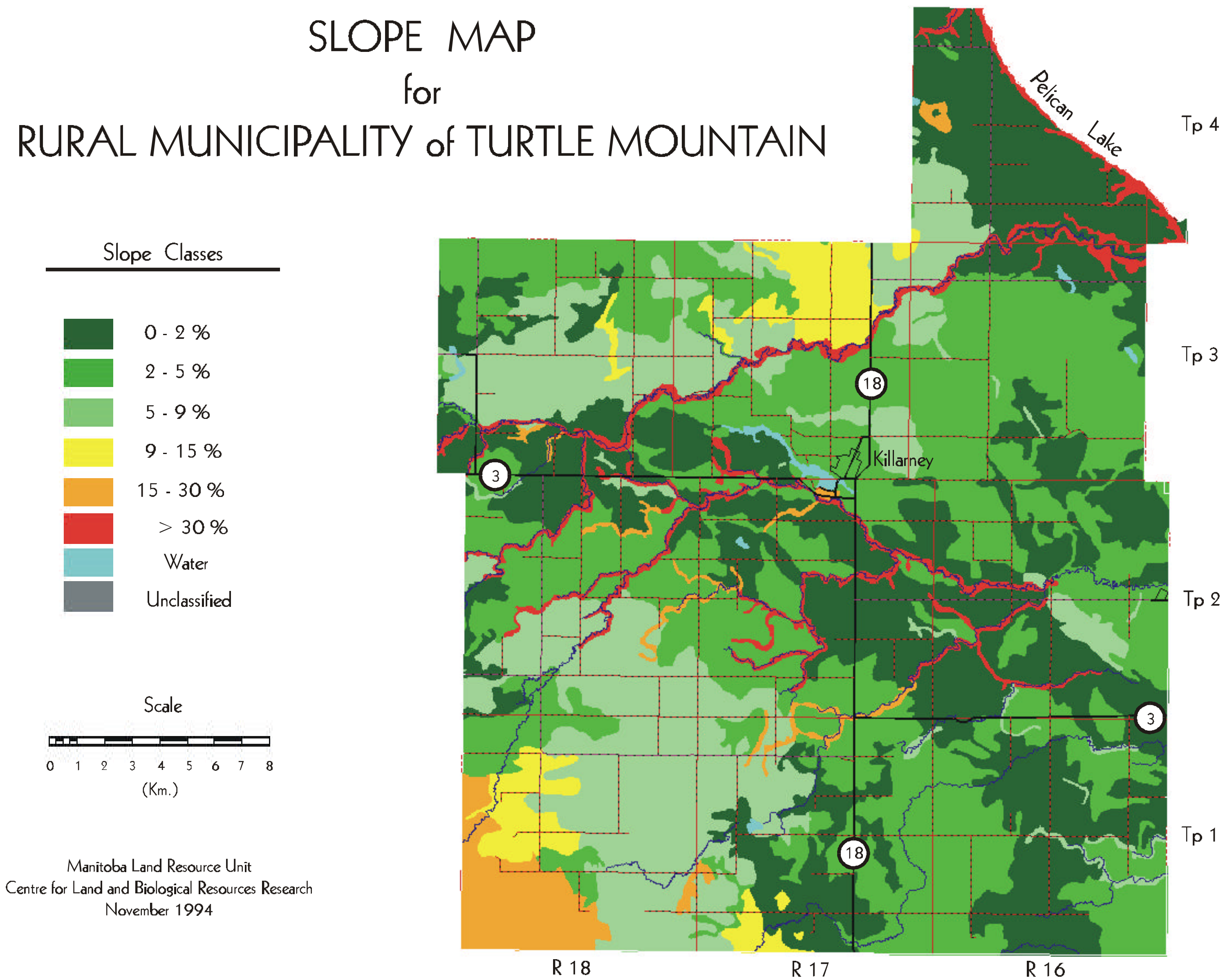
Slope describes the steepness of the landscape surface. The slope classes shown on this map are derived from the digital terrain layer database. Specific colours are used to indicate the most significant, limiting slope class for each terrain polygon in the RM. Additional slope classes can occur in each polygon area, but cannot be portrayed at this reduced map scale.

Table 1. Slope Classes[1]

Slope Class	Area (ha)	Percent of RM
0 - 2 %	28371	30.1
2 - 5 %	35816	37.8
5 - 9 %	19148	20.3
9 - 15 %	3638	3.9
15 - 30 %	3272	3.5
> 30 %	3834	4.1
Water	319	0.3
Total	94398	100.0

[1] Area has been assigned to the most significant limiting slope for each terrain polygon. Significant areas of lesser slope, and smaller areas of greater slope may occur in each terrain polygon.

SLOPE MAP for RURAL MUNICIPALITY of TURTLE MOUNTAIN



Surface Form Map.

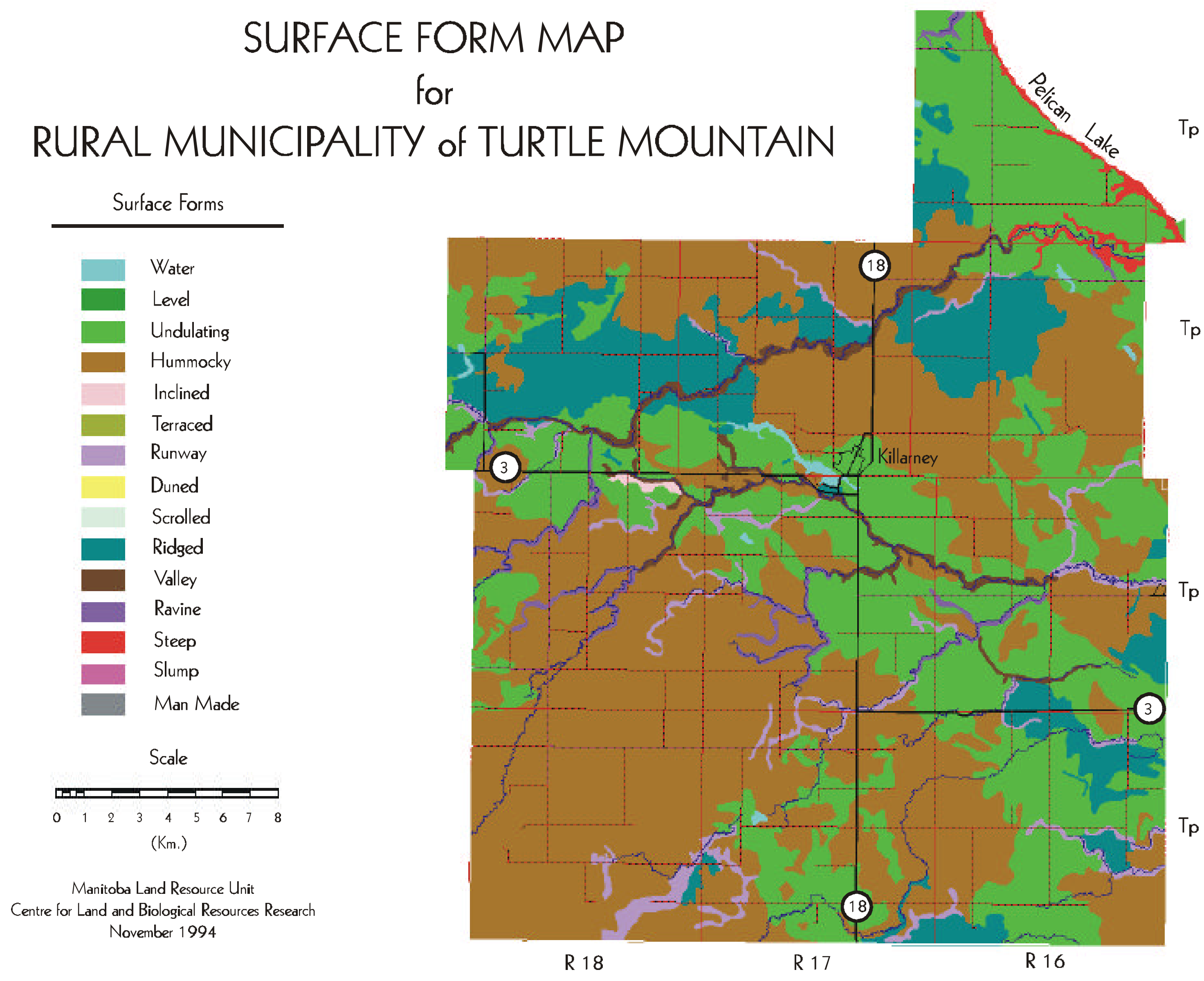
Surface forms describe the overall shape of the earth's surface. The various surface forms may exhibit a regular (or irregular) pattern of convexities and concavities, and are commonly associated with characteristic ranges of slope gradients and slope lengths. They may also imply particular modes of origin. For example, scrolled and terraced surface forms are created by river and stream deposits, while undulating and hummocky surface forms are frequently associated with glacial moraines. A description of the various surface form classes are contained in a separate Soil and Terrain Classification System Manual (Manitoba Land Resource Unit, 1996).

Surface form and slope class are two key features of the digital terrain map layer. Both of these characteristics are important controlling and influencing factors to consider for sustainable land use planning and management.

Table 2. Surface Form and Slope Classes[1]

Surface Form Slope Class	Area (ha)	Percent of RM
Hummocky	**47315**	**50.2**
C (2.0 to 5.0%)	28859	30.6
D (6.0 to 9.0%)	13444	14.2
E (10.0 to 15.0%)	2693	2.9
F (16.0 to 30.0%)	2319	2.5
Inclined	**91**	**0.1**
D (6.0 to 9.0%)	91	0.1
Ravine	**1158**	**1.2**
H (31.0 to 70.0%)	194	0.2
J (> 70.0%)	964	1.0
Ridge	**10660**	**11.3**
C (2.0 to 5.0%)	4912	5.2
D (6.0 to 9.0%)	4656	4.9
E (10.0 to 15.0%)	828	0.9
F (16.0 to 30.0%)	264	0.3
Steep	**764**	**0.8**
J (> 70.0%)	764	0.8
Undulating	**29491**	**31.3**
B (0.5 to 2.0%)	28371	30.1
C (2.0 to 5.0%)	1120	1.2
Runway	**2688**	**2.8**
C (2.0 to 5.0%)	925	1.0
D (6.0 to 9.0%)	957	1.0
E (10.0 to 15.0%)	117	0.1
F (16.0 to 30.0%)	689	0.7
Valley	**1912**	**2.0**
H (31.0 to 70.0%)	752	0.8
J (> 70.0%)	1161	1.2
Water	**319**	**0.3**
Total	**94398**	**100.0**

[1] Area has been assigned to the most significant limiting slope for each terrain polygon. Significant areas of lesser slope, and smaller areas of greater slope may occur in each terrain polygon.


SURFACE FORM MAP
for
RURAL MUNICIPALITY of TURTLE MOUNTAIN
Surface Forms
Water
Level
Undulating
Hummocky
Inclined
Terraced
Runway
Duned
Scrolled
Ridged
Valley
Ravine
Steep
Slump
Man Made
Scale
0 1 2 3 4 5 6 7 8
(Km.)
Manitoba Land Resource Unit
Centre for Land and Biological Resources Research
November 1994
Pelican Lake
Killarney
18
3
Tp 4
Tp 3
Tp 2
Tp 1
R 18
R 17
R 16

Generalized Soil Map.

All soil polygons on the original published reconnaissance maps were digitized to create the soil layer. In some cases, areas of overprinted symbols on the original maps were delineated as additional new soil polygons.

This generalized soil map has been reduced in size and simplified by grouping the original soil association polygons. The groups have been colour themed according to similar modes of origin, texture, and soil drainage. Soils derived from glacial till deposits (typically loam to clay loam in texture) have been assigned blue and green colours. Soils developed from glacial lake deposits are coloured yellow (sandy), orange (loam), or brown (clay). Sand and gravel deposits are coloured in pink.

The groups have been named after the dominant soil association, and the statistics for each group have been summarized (in bold). The original reconnaissance map symbol types and their areal extent in the municipality are shown within each group.

Table 3. Generalized Soil Association Groups

Association Group Associate	Area (ha)	Percent of RM
Eroded Slopes	**4673**	**4.9**
Er	4673	4.9
Cartwright	**3591**	**3.8**
Ct	3591	3.8
Waskada Undulating Phase	**66215**	**70.2**
Wr	26865	28.5
Ws	731	0.8
Wu	36996	39.2
Wu (degraded)	1623	1.7
Waskada Modified	**9293**	**9.9**
Wm	9293	9.9
Turtle Mountain	**3345**	**3.5**
Tm	3345	3.5
Heaslip Complex	**5402**	**5.7**
Hx	3387	3.6
Hx (gravel)	2015	2.1
Waskada Rolling Phase (s)	**368**	**0.4**
Wr (saline)	368	0.4
Waskada Modified (s)	**482**	**0.5**
Wm (saline)	482	0.5
Heaslip Complex (m)	**710**	**0.8**
Hx (meadow)	246	0.3
Hx (saline)	464	0.5
Water	**319**	**0.3**
Total	**94398**	**100.0**

SOIL ASSOCIATION MAP
for
RURAL MUNICIPALITY of TURTLE MOUNTAIN

Soil Associations

- Water
- Eroded Slopes
- Cartwright
- Waskada Undulating Phase
- Waskada Modified
- Turtle Mountain
- Heaslip Complex
- Waskada Rolling Phase (s)
- Waskada Modified Phase (s)
- Heaslip Complex (m)

s - saline
m - meadow

Scale

0 1 2 3 4 5 6 7 8
(Km.)

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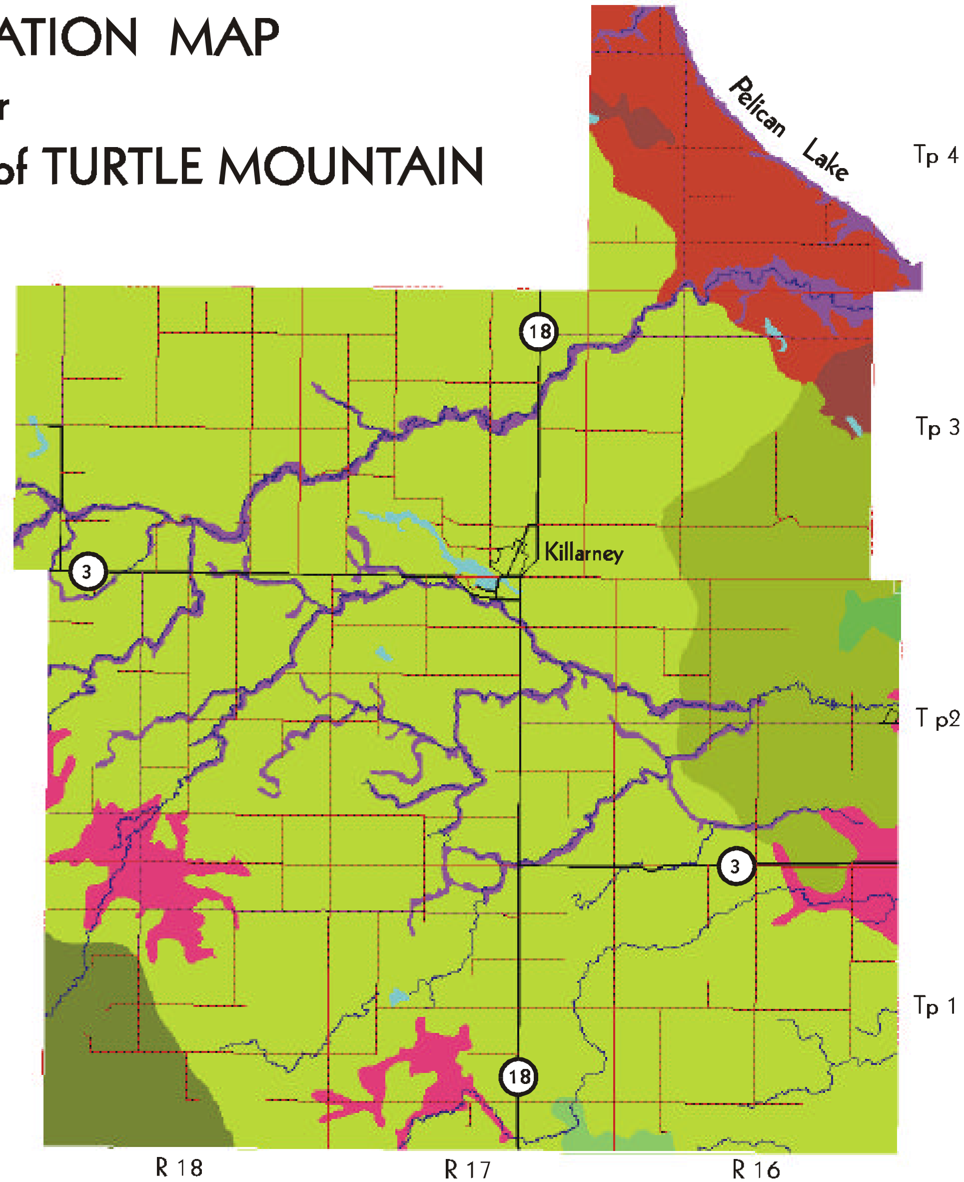
November 1994



Agricultural Capability Map.

This evaluation utilizes the 7 class Canada Land Inventory system (CLI, 1965). Classes 1 to 3 represent the prime agricultural land, classes 4 and 5 represent marginal lands, and classes 6 and 7 are considered unsuitable for dryland agriculture.

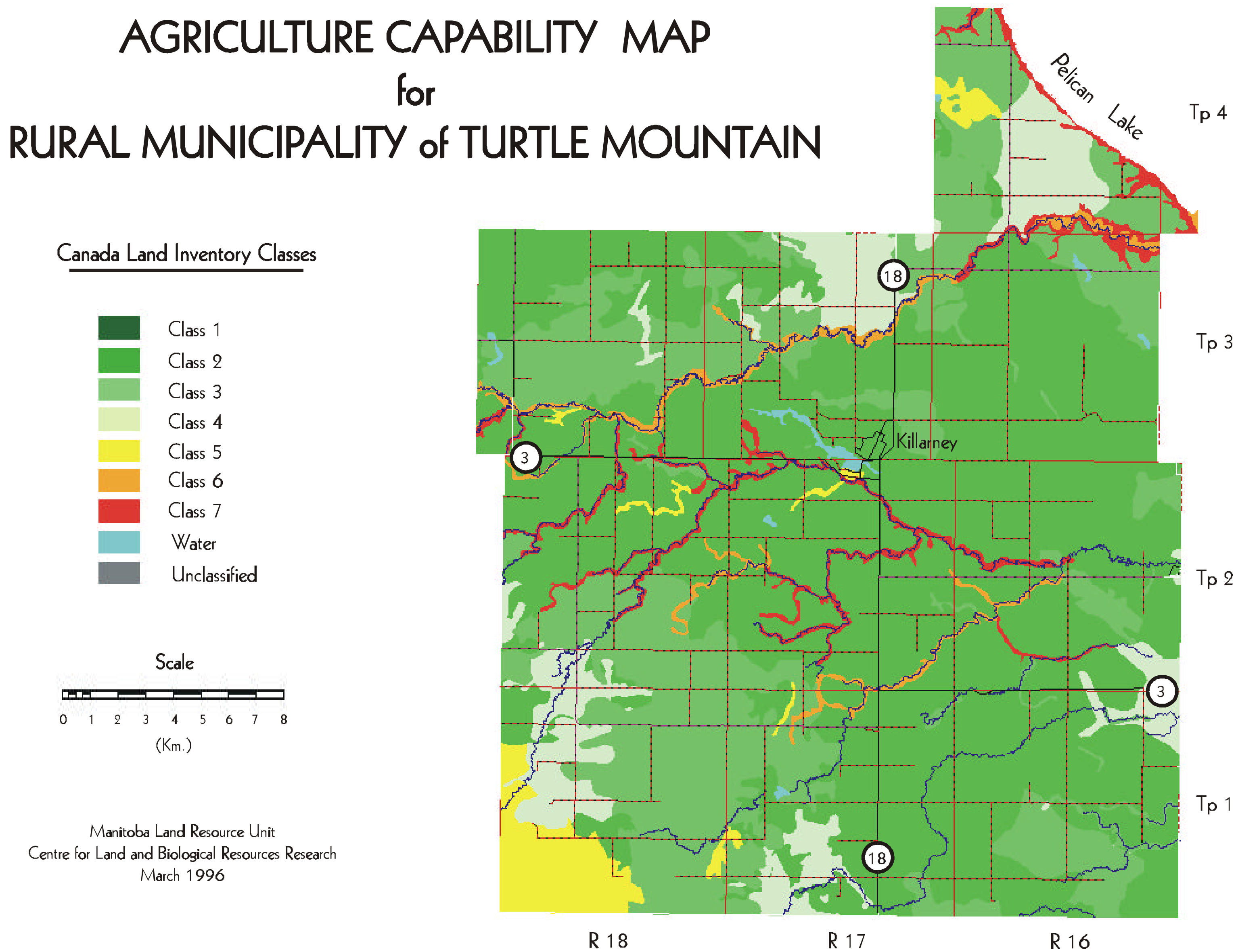
This generalized interpretive map is based on the dominant modern soil type for the soil polygon, in combination with the dominant slope class identified from the terrain polygon layer. The nature of the CLI subclass limitations and the classification of subdominant components cannot be portrayed at this generalized map scale.

Table 4. Agricultural Capability[1]

Class Subclass	Area (ha)	Percent of RM
2	**52847**	**56.0**
2T	32811	34.8
2X	20036	21.2
3	**25243**	**26.7**
3	810	0.9
3M	3285	3.5
3MN	464	0.5
3MT	9	0.0
3N	851	0.9
3T	18210	19.3
3W	1615	1.7
4	**8281**	**8.8**
4	158	0.2
4M	4635	4.9
4T	3488	3.7
5	**3036**	**3.2**
5	334	0.4
5T	2472	2.6
5W	230	0.2
6	**1784**	**1.9**
6	324	0.3
6T	1460	1.5
7	**3208**	**3.4**
7T	2889	3.1
Water	**319**	**0.3**
Total	**94398**	**100.0**

[1] Based on **dominant** soil and slope of the respective soil and terrain maps.

AGRICULTURE CAPABILITY MAP
for
RURAL MUNICIPALITY of TURTLE MOUNTAIN



Irrigation Suitability Map.

Irrigation suitability is a four class rating system. Classes are **Excellent, Good, Fair, and Poor**. Irrigation ratings are based on an assessment of the most limiting combination of soil and landscape conditions. Soils in the same class have a similar relative suitability or degree of limitation for irrigation use, although the specific limiting factors may differ. These limiting factors are described by subclass symbols at detailed map scales. The irrigation rating system does not consider water availability, method of application, water quality, or economics of irrigated land use.

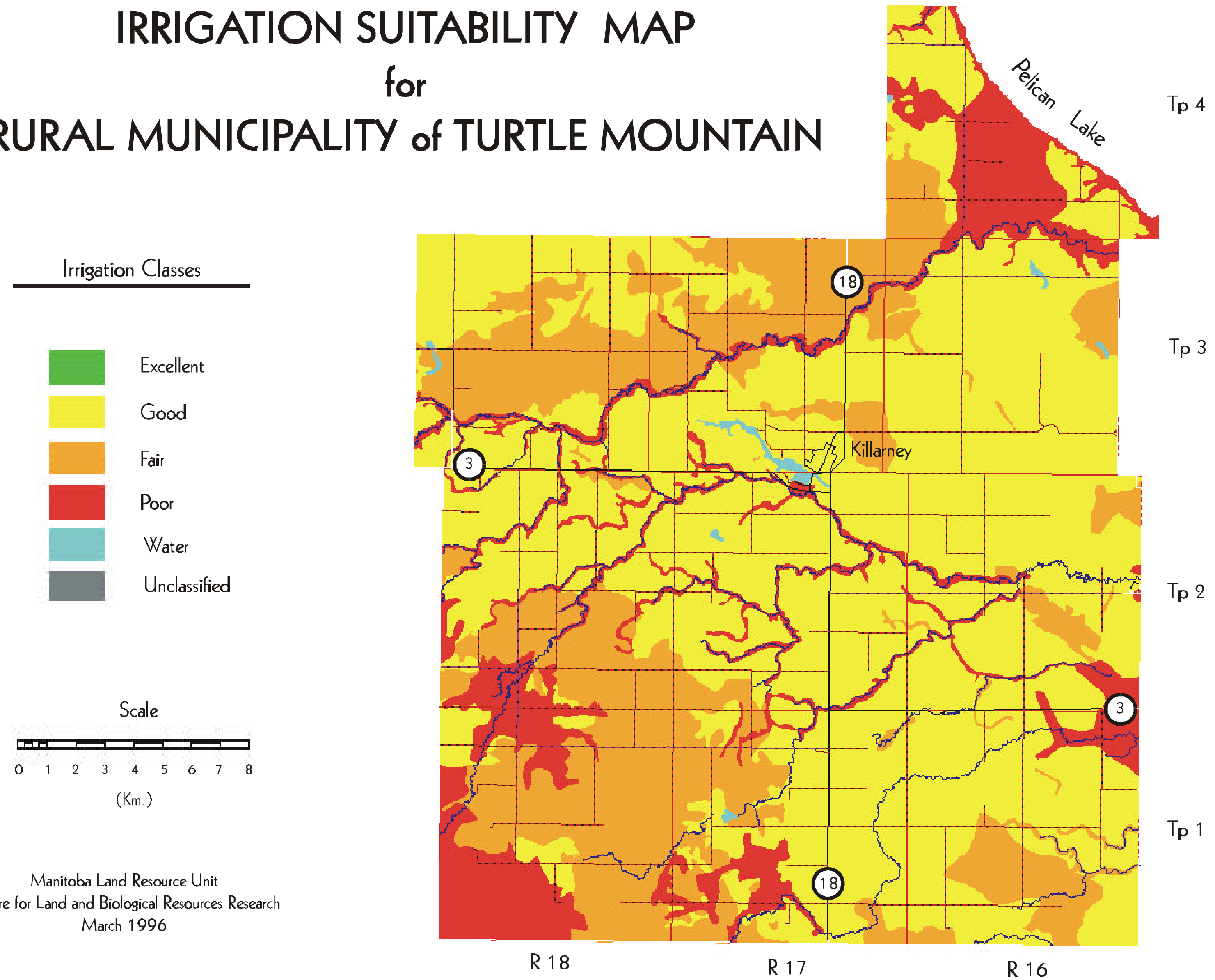
This generalized interpretive map is based on the dominant soil series for each soil polygon, in combination with the dominant slope class from the terrain layer database. The nature of the subclass limitations, and the classification of subdominant components is not shown at this generalized map scale.

Table 5. Irrigation Suitability[1]

Class	Area (ha)	Percent of RM
Excellent	0	0.0
Good	56132	59.5
Fair	24645	26.1
Poor	13302	14.1
Organic	0	0.0
Water	319	0.3
Unclassified	0	0.0
Total	94398	100.0

[1] Based on **dominant** soil and slope of the respective soil and terrain maps.

IRRIGATION SUITABILITY MAP for RURAL MUNICIPALITY of TURTLE MOUNTAIN



Manitoba Land Resource Unit
Centre for Land and Biological Resources Research
March 1996

Potential Environmental Impact Under Irrigation

A major concern for land under irrigated crop production is the possibility that surface and/or groundwater may be impacted. The potential environmental impact assessment provides a relative rating of land into 4 classes (minimal, low, moderate and high) based on an evaluation of specific soil factors and landscape conditions that determine the impact potential.

Soil factors considered are those properties that determine water retention and movement through the soil; topographic features are those that affect runoff and redistribution of moisture in the landscape. Specifically considered are: soil texture, hydraulic conductivity, salinity, geological uniformity, depth to watertable and topography. The risk of altering surface and subsurface soil drainage regimes, soil salinity or the potential for runoff, erosion or flooding is determined by specific criteria for each property.

Use of this rating is intended to serve as a warning of potential environmental concern. It may be possible to design and/or give special consideration to soil-water-crop management practices that will mitigate any adverse impact.

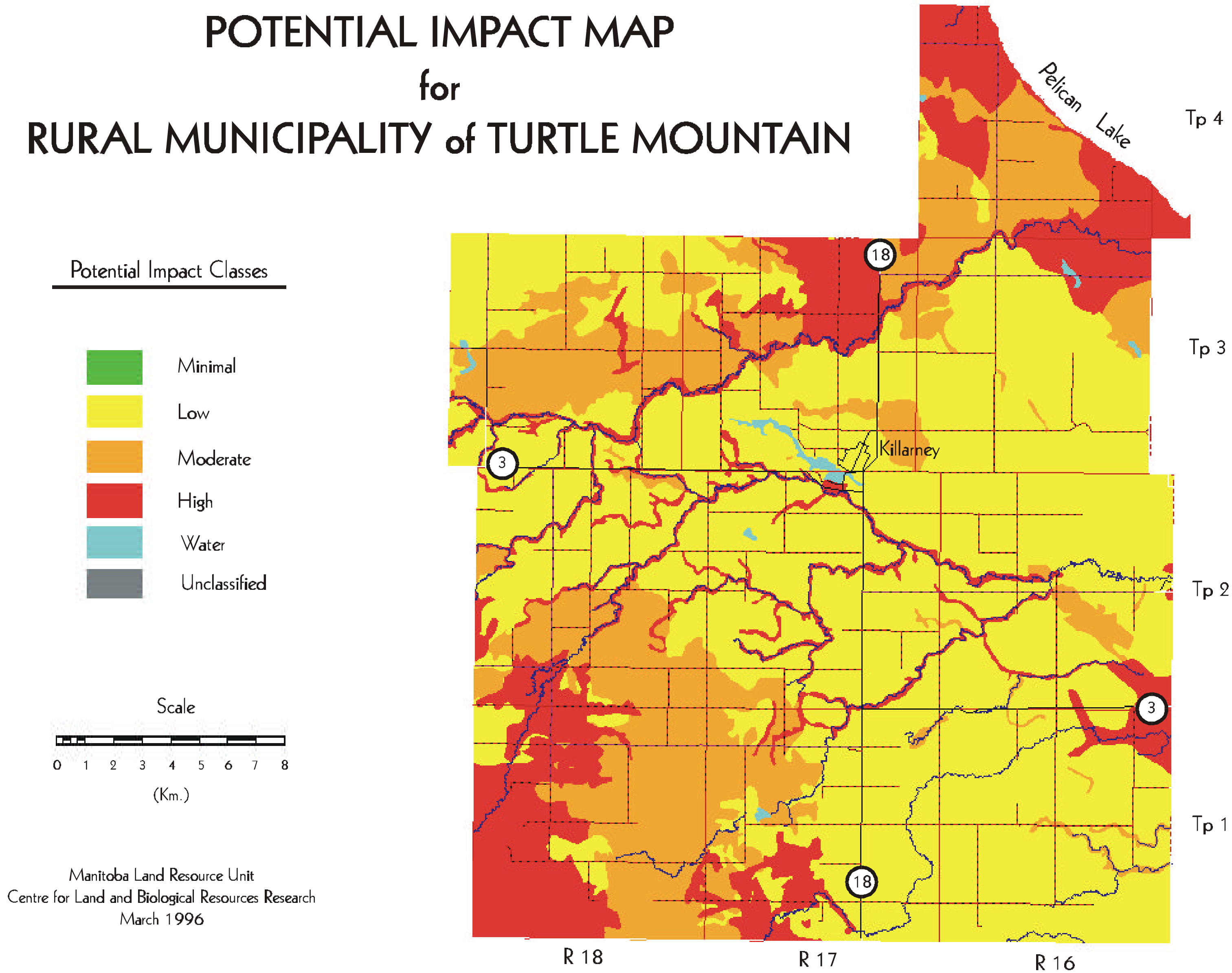
This generalized interpretive map is based on the dominant soil series for each soil polygon, in combination with the dominant slope class from the terrain layer database. The nature of the subclass limitations, and the classification of subdominant components is not shown at this generalized map scale.

Table 6. Potential Environmental Impact Under Irrigation[1]

Class	Area (ha)	Percent of RM
Minimal	**0**	**0.0**
Low	**55313**	**58.6**
Moderate	**20927**	**22.2**
High	**17839**	**18.9**
Organic	**0**	**0.0**
Water	**319**	**0.3**
Unclassified	**0**	**0.0**
Total	**94398**	**100.0**

[1] Based on **dominant** soil, slope gradient, and slope length of the respective soil and terrain maps.

POTENTIAL IMPACT MAP for RURAL MUNICIPALITY of TURTLE MOUNTAIN



Water Erosion Risk Map.

The risk of water erosion was estimated using the universal soil loss equation (USLE) developed by Wischmeier and Smith (1965). The map shows 5 classes of soil erosion risk based on bare unprotected soil:

negligible
low
moderate
high
severe

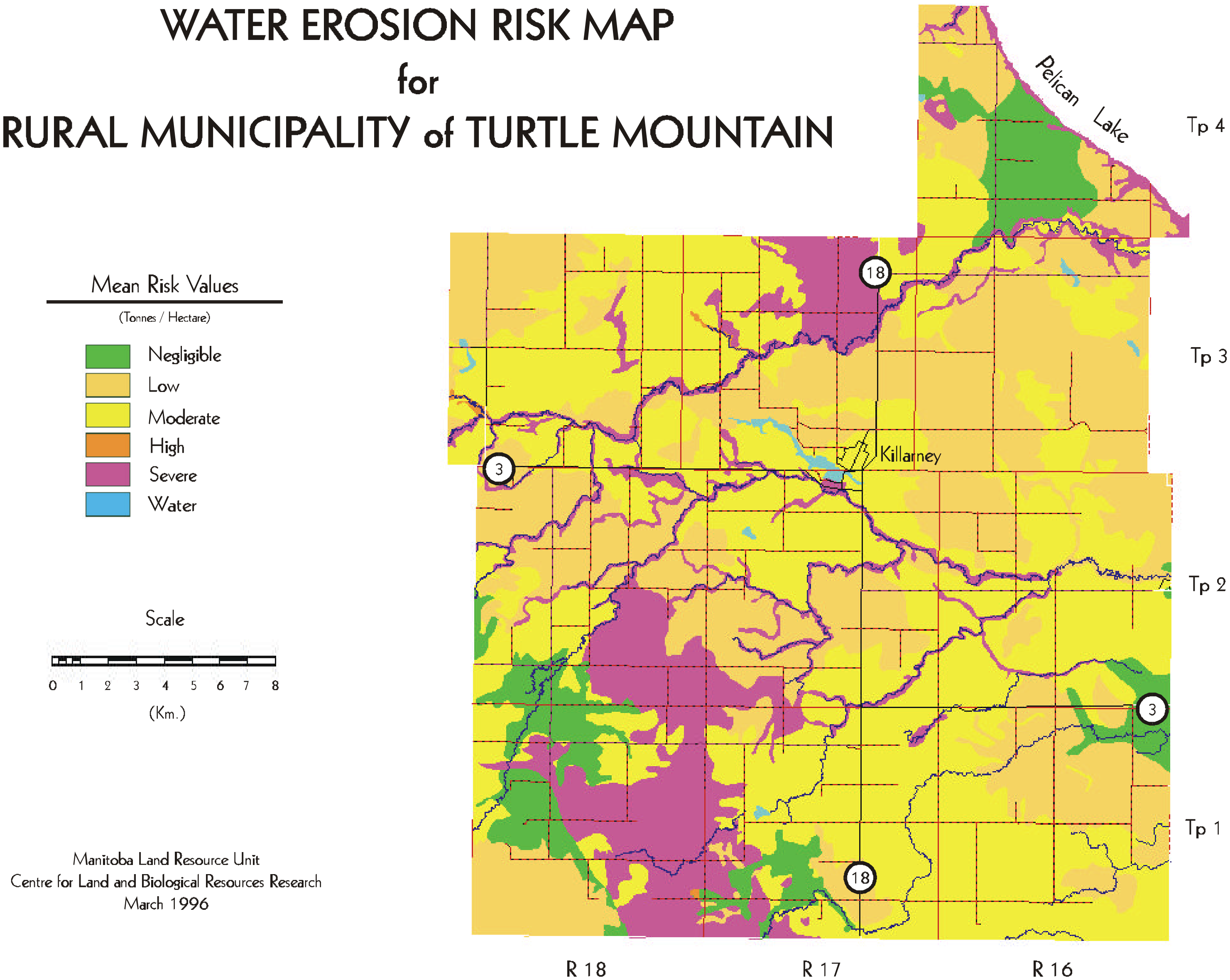
Cropping and management practices will significantly reduce this risk depending on crop rotation program, soil type, and landscape features.

Table 7. Water Erosion Risk[1]

Class	Area (ha)	Percent of RM
Negligible	**6884**	**7.3**
Low	**32040**	**33.9**
Moderate	**40768**	**43.2**
High	**120**	**0.1**
Severe	**14267**	**15.1**
Water	**319**	**0.3**
Unclassified	**0**	**0.0**
Total	**94398**	**100.0**

[1] Based on **dominant** soil, slope gradient, and slope length of the respective soil and terrain maps.

WATER EROSION RISK MAP for RURAL MUNICIPALITY of TURTLE MOUNTAIN



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ADDENDUM

Land Use Map.

The land use classification of the RM has been interpreted from LANDSAT satellite imagery, using supervised computer classification techniques. Many individual spectral signatures were classified and grouped into the seven general land use classes shown here. Although land use changes over time, and some land use practices on individual parcels may occasionally result in similar spectral signatures, this map provides a general representation of the current land use in the RM.

The following is a brief description of the land use classes are:

Annual Crop Land - land that is normally cultivated on an annual basis.

Forage - perennial forages, generally alfalfa or clover with blends of tame grasses.

Grasslands - areas of native or tame grasses, may contain scattered stands of shrubs.

Trees - lands that are primarily in tree cover.

Wetlands - areas that are wet, often with sedges, cattails, and rushes.

Water - open water-lakes, rivers streams, ponds, and lagoons.

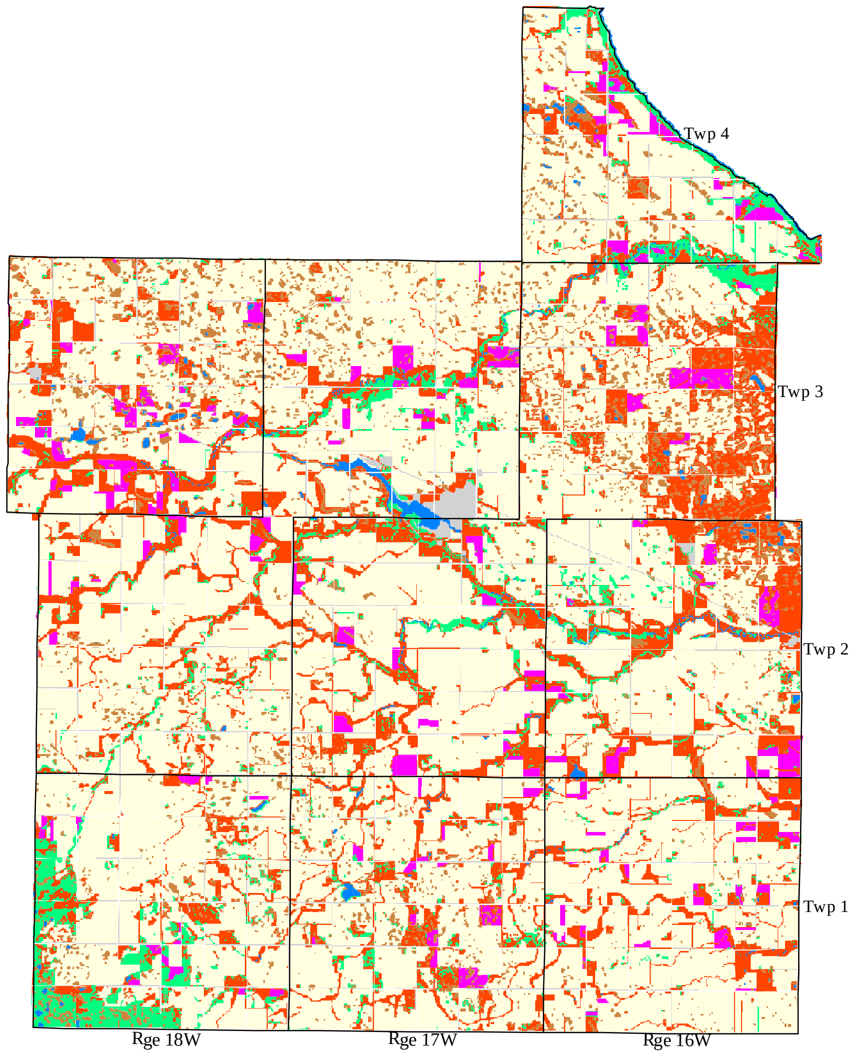
Urban and Transportation - towns, roads, railways, quarries.

Table 10. Land Use[1]

Class	Area (ha)	Percent of RM
Annual Crop Land	**61362**	**64.6**
Forage	**2944**	**3.1**
Grasslands	**15253**	**16.1**
Trees	**4016**	**4.2**
Wetlands	**4888**	**5.1**
Water	**840**	**0.9**
Urban and Transportation	**5723**	**6.0**
Total	**95026**	**100.0**

[1] Land use information (1995) and map supplied by Prairie Farm Rehabilitation Administration. Areas may vary from previous maps due to differences in analytical procedures.

RURAL MUNICIPALITY OF TURTLE MOUNTAIN LAND USE



Reference:

Satellite imagery obtained from RSI. Landsat TM (30m pixel resolution) Date of image: Annual Crop Land and Forage May 26, 1994. All other classes May 9, 1988. Classification by Manitoba Remote Sensing Centre.

LAND USE

- Annual Crop Land
- Trees
- Water
- Grassland
- Wetlands
- Forage
- Urban & Transportation
- Municipal Boundary

0 5 10 15 Km

Scale 1:225,000