Agriculture and Agri-Food Canada
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Rural Municipality of Whitehead

Information Bulletin 96-10

Soils and Terrain

An introduction to the land resource

Land Resource Unit
Brandon Research Centre

Canada

Rural Municipality of Whitehead

Information Bulletin 96-10

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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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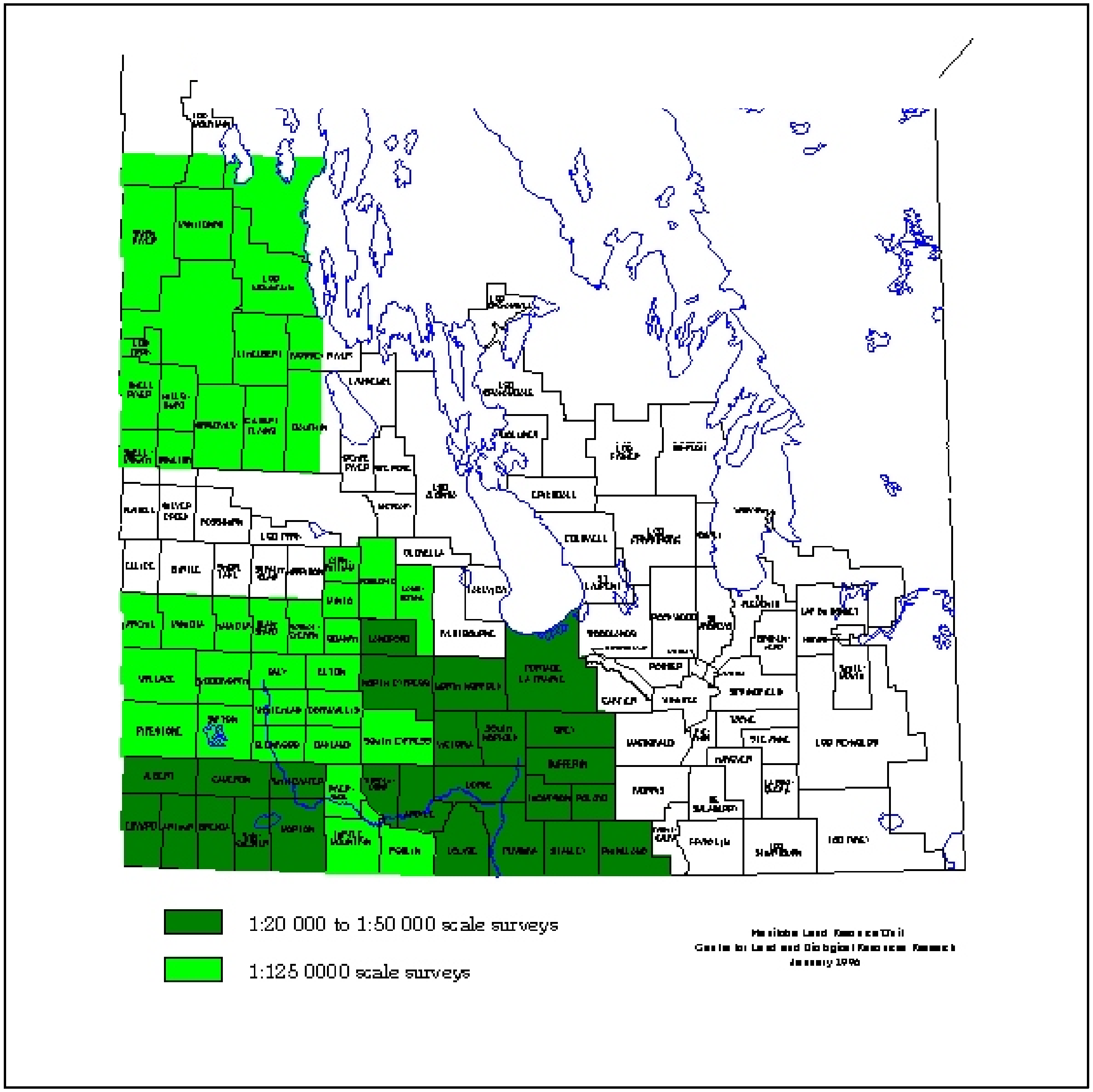


Figure 3. Rural municipalities in southern Manitoba with digital soil and terrain map information (1996).

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.

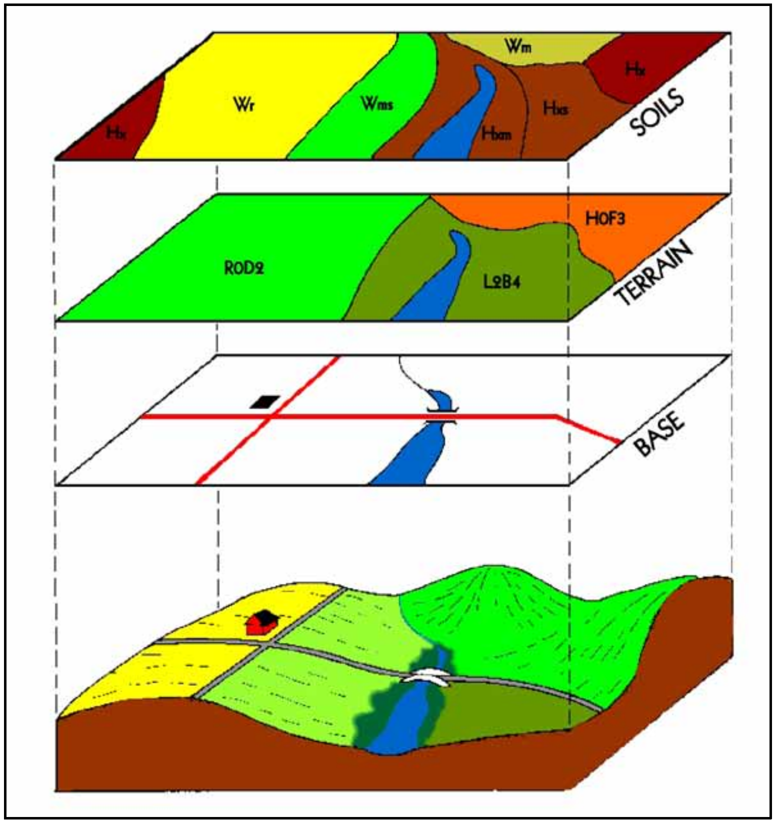


Figure 2. Soil, Terrain, and Base Map data.

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 airphoto 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 provide 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 Whitehead covers 6.0 Townships (approximately 58 000 ha) in south-western Manitoba. The Town of Alexander is the largest population centre in the municipality. Land use is predominantly agriculture.

Soils in the RM of Whitehead have been mapped (1:126 720 scale) previously in the Reconnaissance Soil Survey of the Rossburn and Virden Map Sheet Areas (Ehrlich et al., 1956). More detailed information for part of the RM is reported in the Soils of the Brandon Region Study Area (Michalyna et al., 1976).

Based on climatic data from Brandon Airport (Environment Canada, 1982) the mean annual temperature is 1.5°C; mean annual precipitation is 450 mm; frost-free period is 108 days; and degree days above 5ºC is 1642. The seasonal moisture deficit for the period May to September is 250 to 300 mm and effective growing degree days (EGDD) above 5ºC from seeding to first frost in fall is above 1500. This parameter provides an indication of heat energy available for crop growth (Agronomic Interpretations Working Group, 1995).

The municipality is situated within the Antler River-Lake Souris Plain (Lake Souris Basin in published soil reports). A major physiographic feature of the area is associated with the Assiniboine River which crosses the northern portion of the RM in a broad valley, 1.6 to 3.3 km wide and eroded some 45 to 60 m below the land surface. Elevation varies from 435 masl in the southwest part of the RM to 350 m in the Assiniboine River Valley. Surface deposits are mainly fluvial and lacustrine sediments which range in texture from gravelly sands to clay. Relief throughout the municipality is generally less than 3 m with slopes less than 9%. Local areas of steeper slopes occur, particularly along the valley walls. Surface forms are dominantly hummocky and undulating.

The soils in the RM are dominantly Orthic Black Chernozems, with Gleyed Black Chernozems in imperfectly drained lower slope positions. Rego Humic Gleysol soils have developed in areas of poor drainage with high seasonal water tables. Recent floodplain deposits in the Assiniboine Valley are characterized by Cumulic Regosol soils.

Soil of the Carroll association have developed on loam to clay loam lacustrine deposits. Agriculture capability is class 1 to 2 on the better drained soils with level to gently undulating terrain, and class 3 or 4 on soils with steeper slopes or with appreciable erosion. Risk of water erosion is moderate to severe on the well drained sites depending upon topography. Imperfectly drained Carroll soils are considered class 2 to 3W (depending on the level of salinity), and class 5W in the poorly drained positions.

Beresford soils are similar to Carroll clay loam soils, differing mainly in the occurrence of stony glacial till within one meter of the surface. These soils are characterized by undulating to hummocky topography with moderate to strong slopes. Agriculture capability of these soils is class 3 to 4T, depending on the slope and degree of erosion; irrigation suitability is fair due to salinity and topography. The potential for adverse environmental impact when irrigated is low. Risk of water erosion is moderate to severe depending on the topography.

Fine sandy loam textured soils of the Souris and Stockton Associations are developed on dominantly imperfectly drained, sandy lacustrine sediments. Agriculture capability is mainly 2M to 3M due to periodic droughtiness; irrigation suitability is good to fair (class 2 to 3). The dominant land use is production of cereal and forage crops with some grazing. Poorly drained soils of the Stockton and Souris Associations are rated in agriculture capability class 5W; land use is mainly production of native hay and grazing. Local areas of the Stockton Duned phase have an agriculture capability of class 5 to 6, depending on the topography class. The Souris and Stockton soils have a low risk of water erosion but the risk of erosion by wind is high if surface cover is minimal.

Soils of the Harding Association developed on imperfectly drained clayey lacustrine sediments occur in the south central portion of the RM. These soils have an agriculture capability of class 2W and suitability for irrigation is poor. Risk of water erosion is low. Local areas of soil salinity occur; the Harding saline phase has an agriculture capability of class 3N. Local soil areas with poor drainage in this association are rated as class 5W for agriculture.

Soils of the Marringhurst Association developed on well to moderately well drained stratified sandy to gravelly sand fluvial deposits occur in the northern portion of the RM, adjacent to the Assiniboine Valley. These soils have low water retention capacity and rapid permeability. Agriculture capability is class 5M due to droughtiness and irrigation suitability is poor. The Marringhurst soils have a high potential for environmental impact under irrigation. Risk of water erosion is low but the risk of erosion by wind is high if surface cover is minimal. Land use is mainly forage production and grazing.

The steep side slopes of the Assiniboine Valley are mapped as the Eroded Slopes Complex. Agriculture capability is mainly class 6T and 7T; native woodland, wildlife habitat and limited natural grazing are the major land use. The valley terraces and bottom lands are characterized by Cumulic Regosol soils of the Assiniboine Association. These soils range in texture from sandy loam to clay; agriculture capability varies from class 2 to 4 and irrigation suitability ranges from good to poor depending on the frequency of flooding. Land use is mainly cereal and forage production.

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.

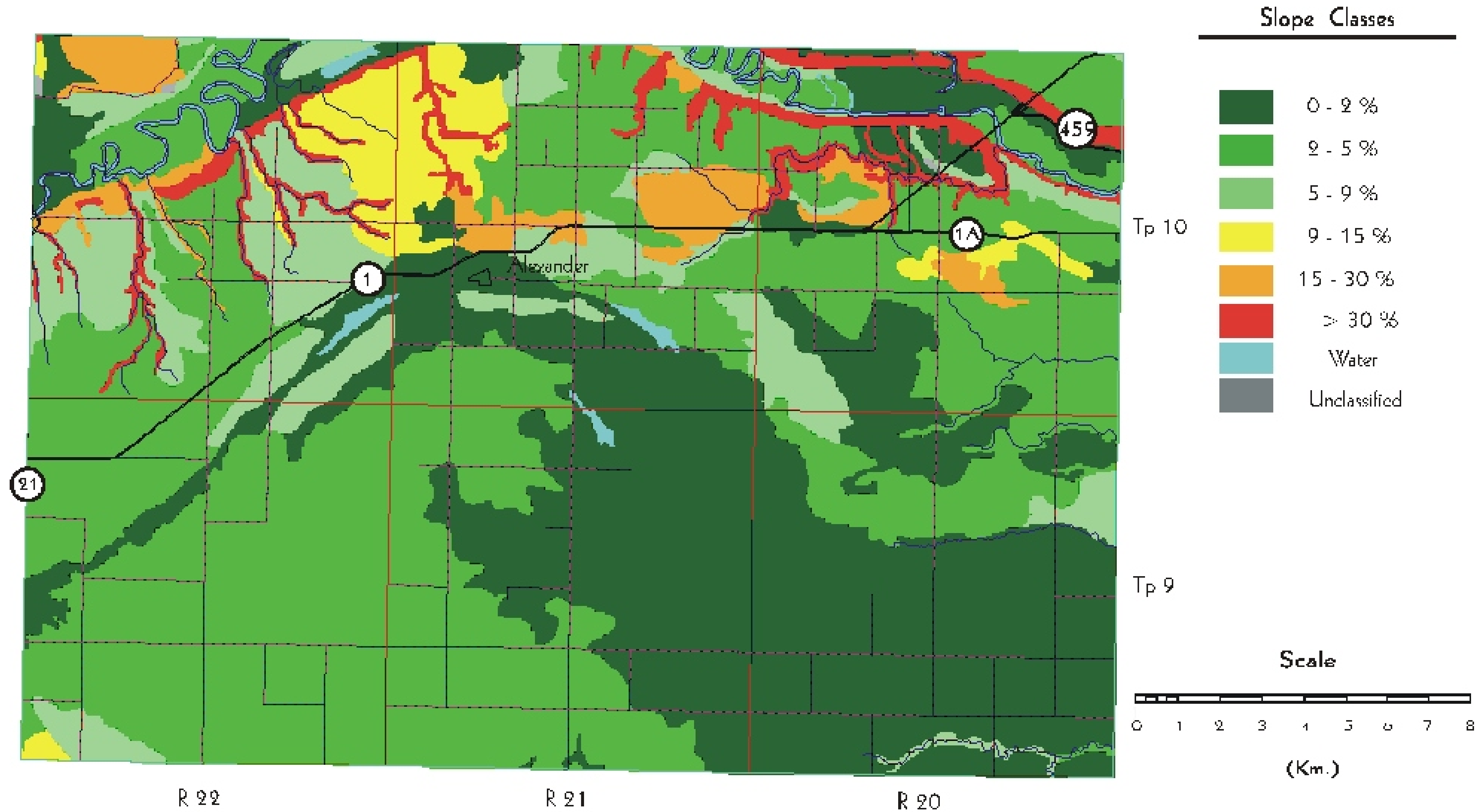
Slope describes the steepness of the landscape surface. The slope classes shown on this map are derived from the digital terrain layer database. Specific colours are used to indicate the most significant, limiting slope class for each terrain polygon in the RM. Additional slope classes can occur in each 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 %	18850	32.4
2 - 5 %	26197	45.1
5 - 9 %	5976	10.3
9 - 15 %	2121	3.6
15 - 30 %	2122	3.6
> 30 %	2234	3.8
Water	620	1.1
Unclassified	27	0.0
Total	58145	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.

Rural Municipality of Whitehead Slope Map



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Centre for Land and Biological Resources Research
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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).

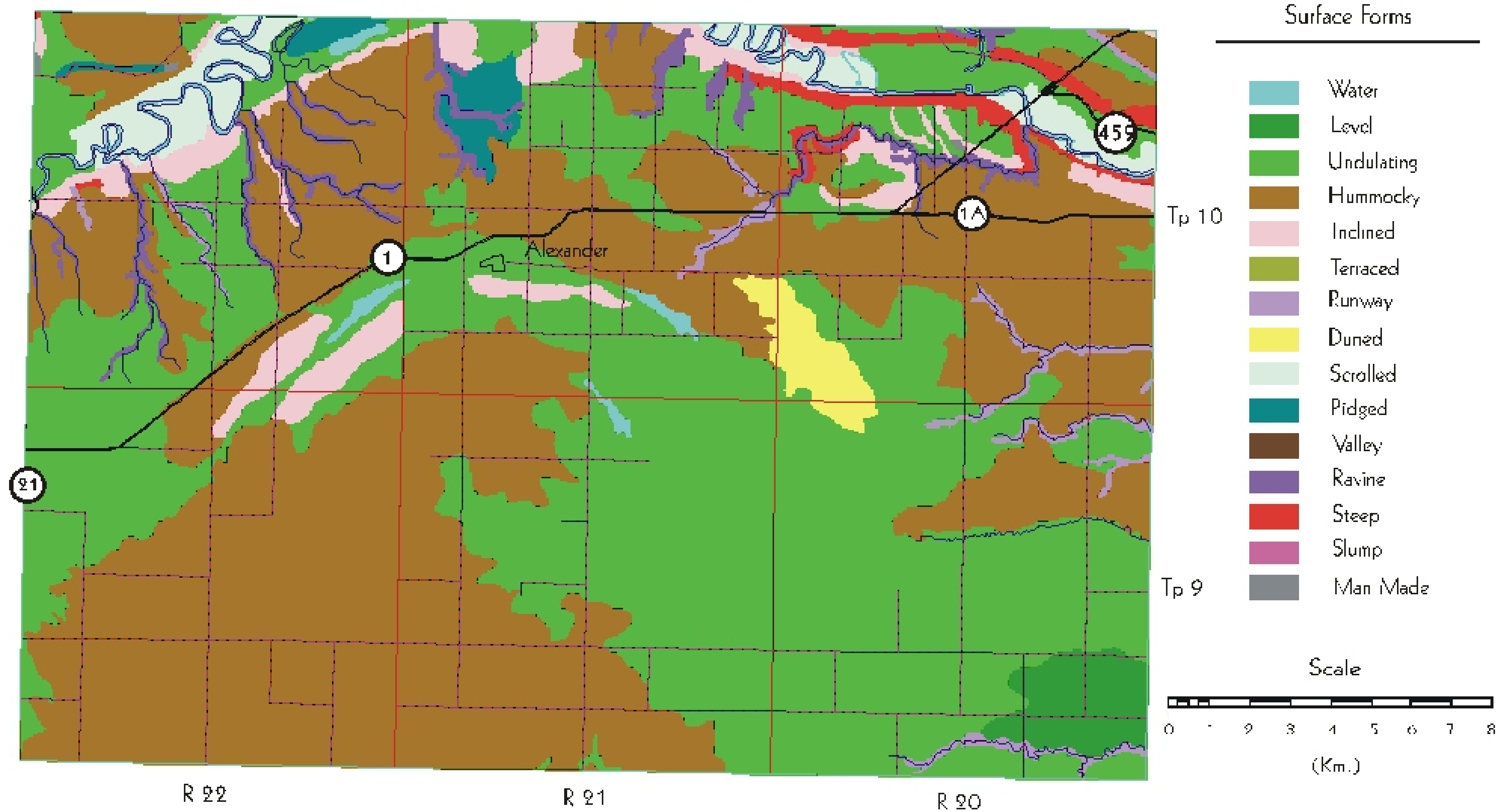
Surface form and slope class are two key features of the digital terrain map layer. Both of these characteristics are important controlling and influencing factors to consider for sustainable land use planning and management.

Table 2. Surface Form and Slope Classes[1]

Surface Form / Slope Class	Area (ha)	Percent of RM
Scrolled	**5477**	**6.3**
C (2.0 to 5.0%)	5477	6.3
Duned	**407**	**0.5**
C (2.0 to 5.0%)	92	0.1
D (6.0 to 9.0%)	315	0.4
Hummocky	**26012**	**29.9**
C (2.0 to 5.0%)	13379	15.4
D (6.0 to 9.0%)	9088	10.4
E (10.0 to 15.0%)	1487	1.7
F (16.0 to 30.0%)	2059	2.4
Inclined	**5375**	**6.2**
E (10.0 to 15.0%)	1198	1.4
F (16.0 to 30.0%)	3151	3.6
H (31.0 to 70.0%)	1027	1.2
Level	**415**	**0.5**
B (0.5 to 2.0%)	415	0.5
Ravine	**1916**	**2.2**
H (31.0 to 70.0%)	294	0.3
J (> 70.0%)	1622	1.9
Man Made	**6**	**0.0**
Ridged	**3971**	**4.6**
C (2.0 to 5.0%)	1042	1.2
D (6.0 to 9.0%)	1337	1.5
E (10.0 to 15.0%)	16	0.0
F (16.0 to 30.0%)	198	0.2
H (31.0 to 70.0%)	151	0.2
J (> 70.0%)	1227	1.4
Steep	**2939**	**3.4**
J (> 70.0%)	2939	3.4
Terraced	**104**	**0.1**
F (16.0 to 30.0%)	104	0.1
Undulating	**37652**	**43.2**
B (0.5 to 2.0%)	24386	28.0
C (2.0 to 5.0%)	13266	15.2
Runway	**1255**	**1.4**
C (2.0 to 5.0%)	438	0.5
D (6.0 to 9.0%)	336	0.4
E (10.0 to 15.0%)	19	0.0
F (16.0 to 30.0%)	462	0.5
Water	**1561**	**1.8**
Total	**87091**	**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.

Rural Municipality of Whitehead Surface Form Map



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March 1996

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.

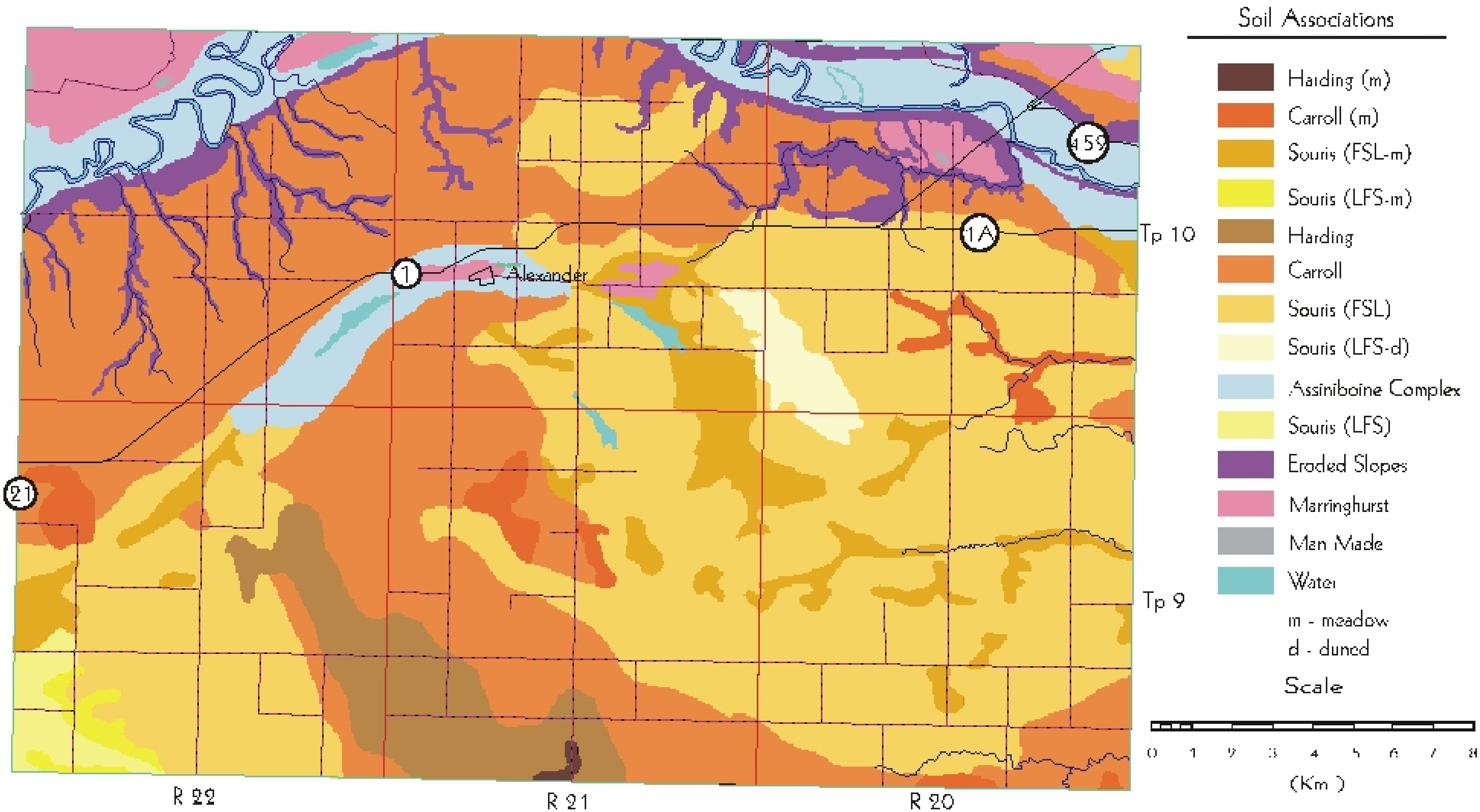
This generalized soil map has been reduced in size and simplified by grouping the original soil association polygons. The groups have been colour themed according to similar modes of origin, texture, and soil drainage. Soils derived from glacial till deposits (typically loam to clay loam in texture) 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 the groups 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
Harding (m)	**62**	**0.1**
Hc (meadow)	62	0.1
Carroll (m)	**1140**	**2.0**
Bd (meadow)	88	0.2
Bd (saline)	261	0.4
Ccl (saline)	365	0.6
Cl (meadow)	322	0.6
Cl (saline)	105	0.2
Souris (FSL - m)	**3065**	**5.3**
Sfsl (meadow)	3065	5.3
Souris (LFS - m)	**302**	**0.5**
Slfs (meadow)	302	0.5
Harding	**2510**	**4.3**
Hc	2510	4.3
Carroll	**18350**	**31.6**
Bd	6019	10.4
Ccl	7740	13.3
Ccl/T	554	1.0
Ccl/t	4037	6.9
Souris (FSL)	**21859**	**37.6**
Cl	7531	13.0
Sfsl	14328	24.6
Souris (LFS - d)	**625**	**1.1**
Slfs (duned)	625	1.1
Assiniboine Complex	**4180**	**7.2**
As	2491	4.3
As (meadow)	430	0.7
As (wooded)	176	0.3
Bcx	1083	1.9
Souris (LFS)	**565**	**1.0**
Slfs	565	1.0
Eroded Slopes	**2888**	**5.0**
Er	2888	5.0
Marringhurst	**1955**	**3.4**
Ma	1955	3.4
Man Made	**27**	**0.0**
Water	**620**	**1.1**
Total	**58145**	**100.0**

Rural Municipality of Whitehead Generalized Soil Map



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

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.

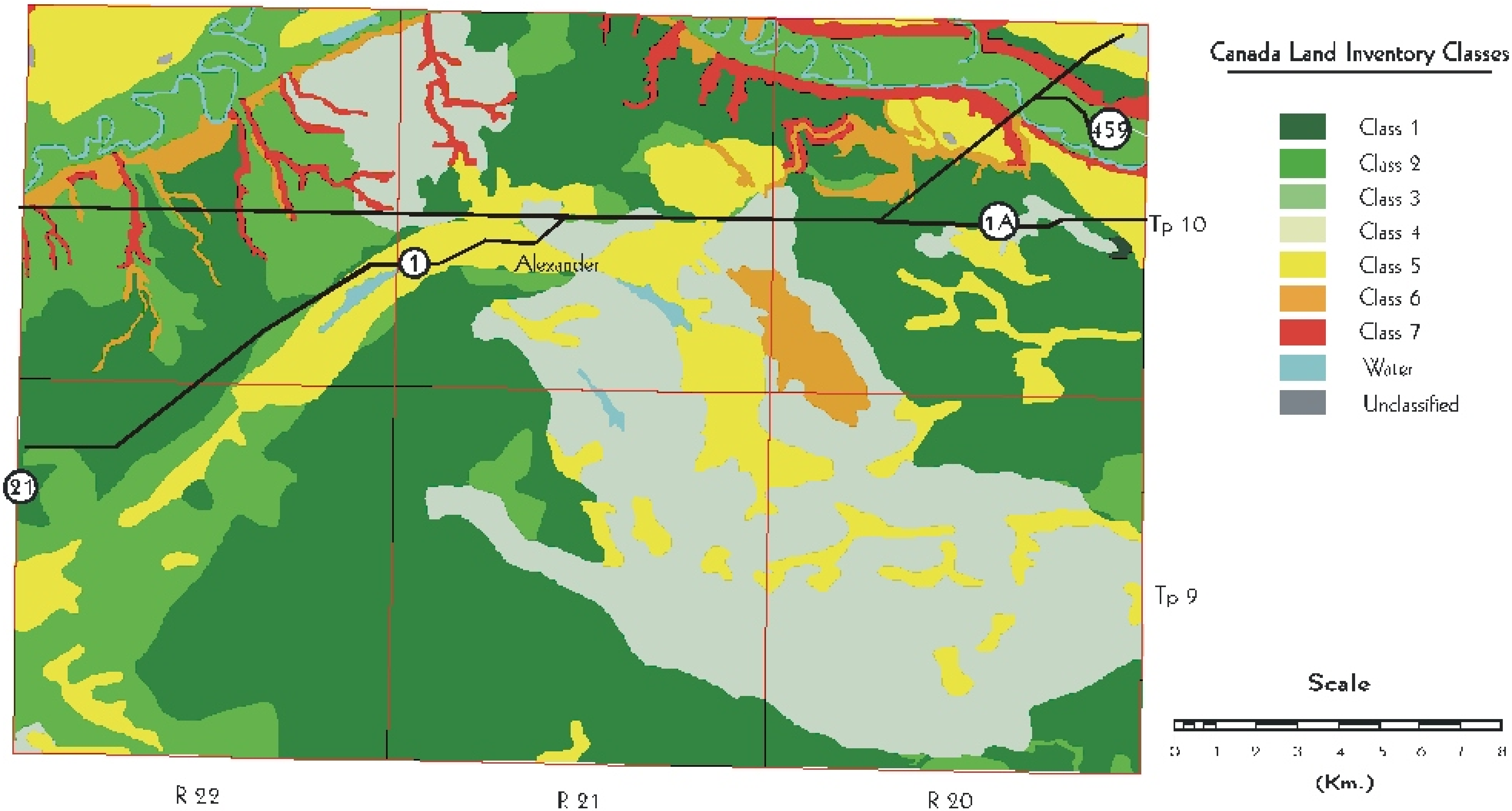
This generalized interpretive map is based on the dominant modern soil type for the soil polygon, in combination with the dominant slope class identified from the terrain polygon layer. The nature of the CLI subclass limitations and the classification of subdominant components cannot be portrayed at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

Table 4. Agricultural Capability[1]

Class Subclass	Area (ha)	Percent of RM
1	**22**	**0.0**
1	22	0.0
2	**22187**	**38.2**
2T	10954	18.9
2TW	7087	12.2
2W	2624	4.5
2X	1522	2.6
3	**9554**	**16.5**
3	154	0.3
3I	2415	4.2
3M	2822	4.9
3MT	279	0.5
3N	629	1.1
3T	3251	5.6
4	**13724**	**23.6**
4	39	0.1
4M	11701	20.2
4T	1984	3.4
5	**8430**	**14.5**
5	959	1.7
5M	2575	4.4
5MT	451	0.8
5T	964	1.7
5W	3096	5.3
5WI	385	0.7
6	**1854**	**3.2**
6M	621	1.1
6T	1233	2.1
7	**1650**	**2.8**
7	13	0.0
7T	1636	2.8
Water	**611**	**1.1**
Total	**58145**	**100.0**

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

Rural Municipality of Whitehead Agriculture Capability Map



Manitoba Land Resource Unit
Winnipeg, Manitoba
June 2003

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.

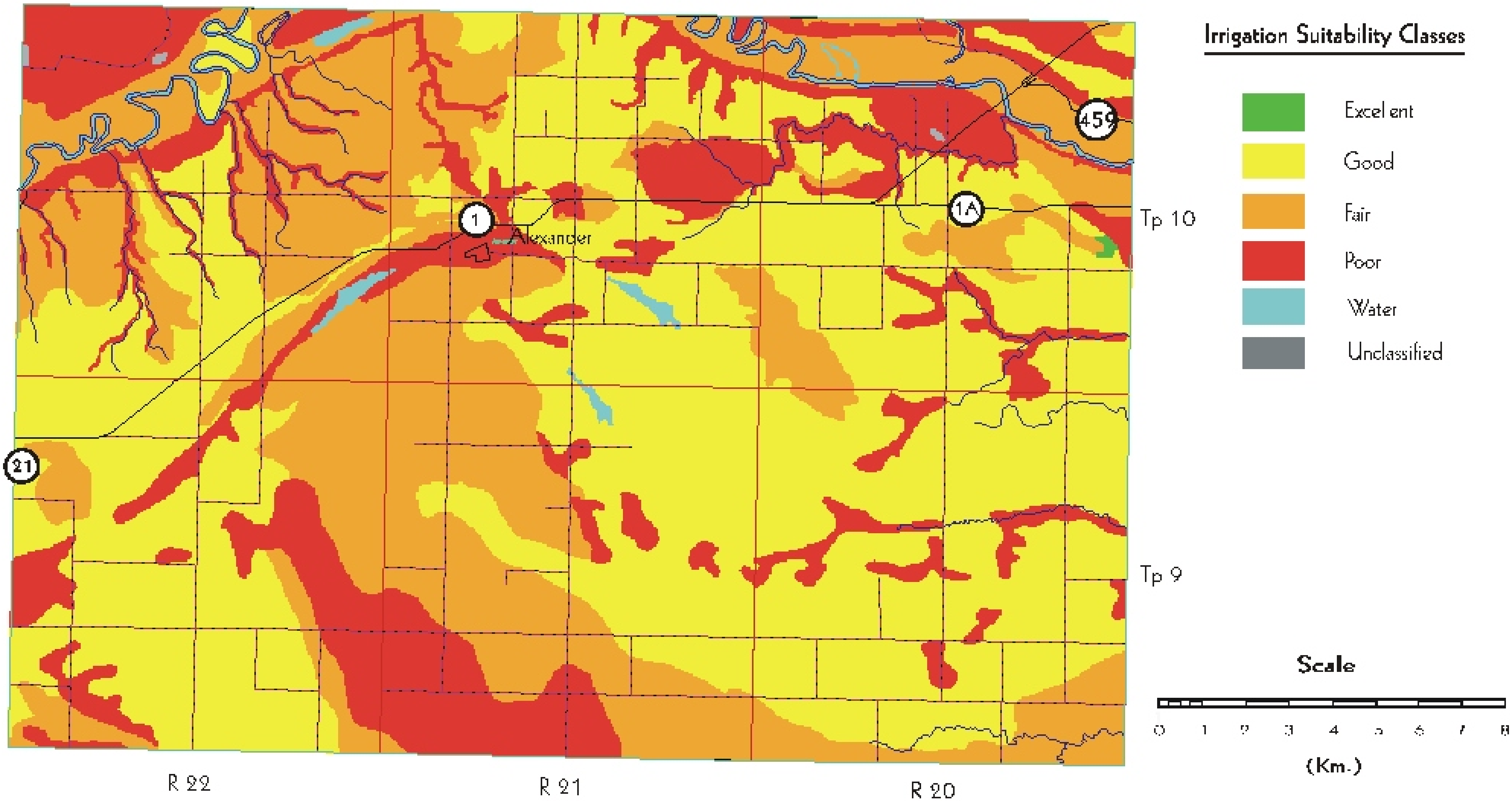
This generalized interpretive map is based on the dominant soil series for each soil polygon, in combination with the dominant slope class from the terrain layer database. The nature of the subclass limitations, and the classification of subdominant components is not shown at this generalized map scale.

Table 5. Irrigation Suitability[1]

Class	Area (ha)	Percent of RM
Excellent	22	0.0
Good	27480	47.3
Fair	17509	30.1
Poor	12488	21.5
Organic	0	0.0
Water	620	1.1
Unclassified	27	0.0
Total	58145	100.0

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

Rural Municipality of Whitehead Irrigation Suitability Map



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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.

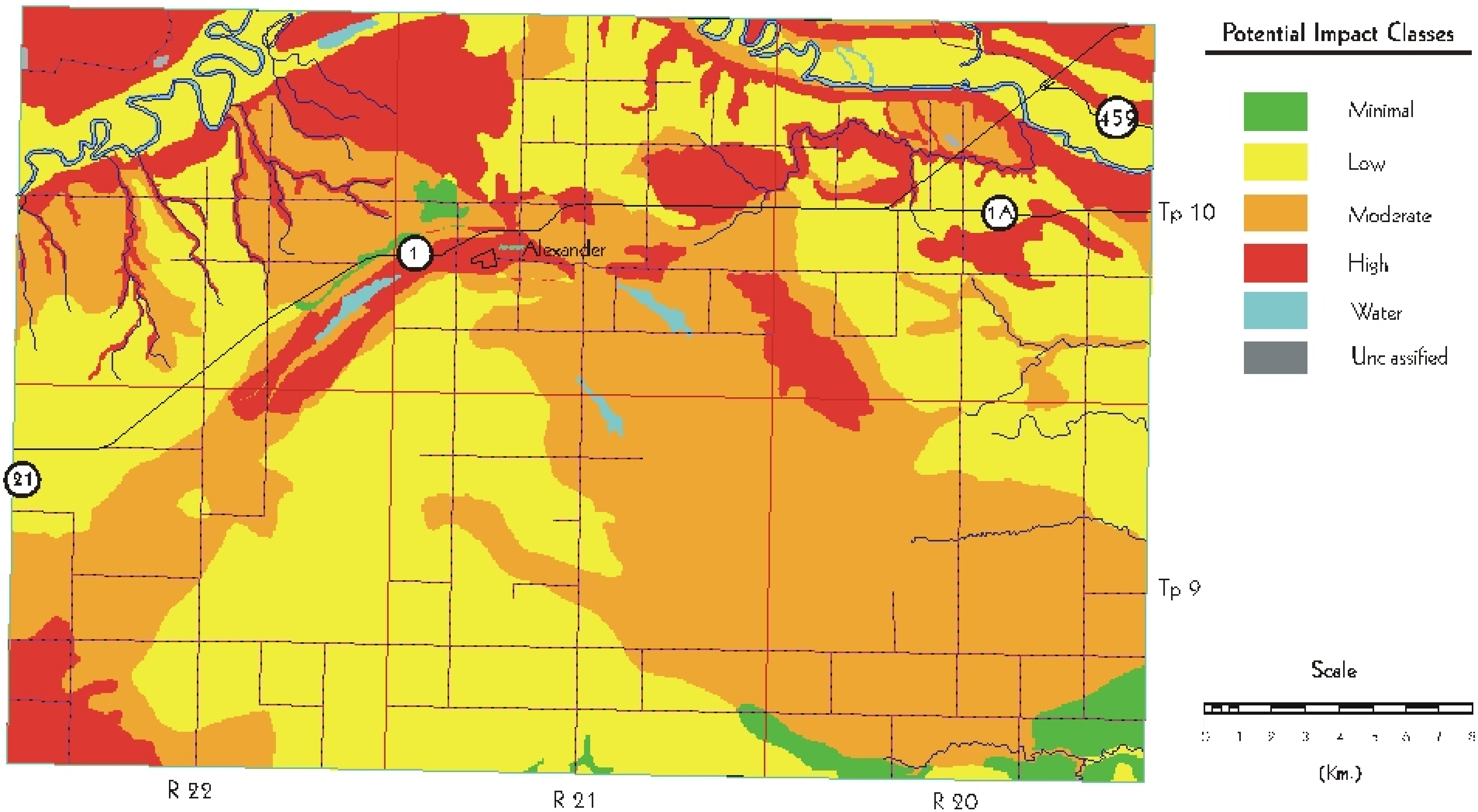
This generalized interpretive map is based on the dominant soil series for each soil polygon, in combination with the dominant slope class from the terrain layer database. The nature of the subclass limitations, and the classification of subdominant components is not shown at this generalized map scale.

Table 6. Potential Environmental Impact Under Irrigation[1]

Class	Area (ha)	Percent of RM
Minimal	1128	1.9
Low	24574	42.3
Moderate	22102	38.0
High	9695	16.7
Organic	0	0.0
Water	620	1.1
Unclassified	27	0.0
Total	58145	100.0

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

Rural Municipality of Whitehead **Potential Environmental Impact Under Irrigation**



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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

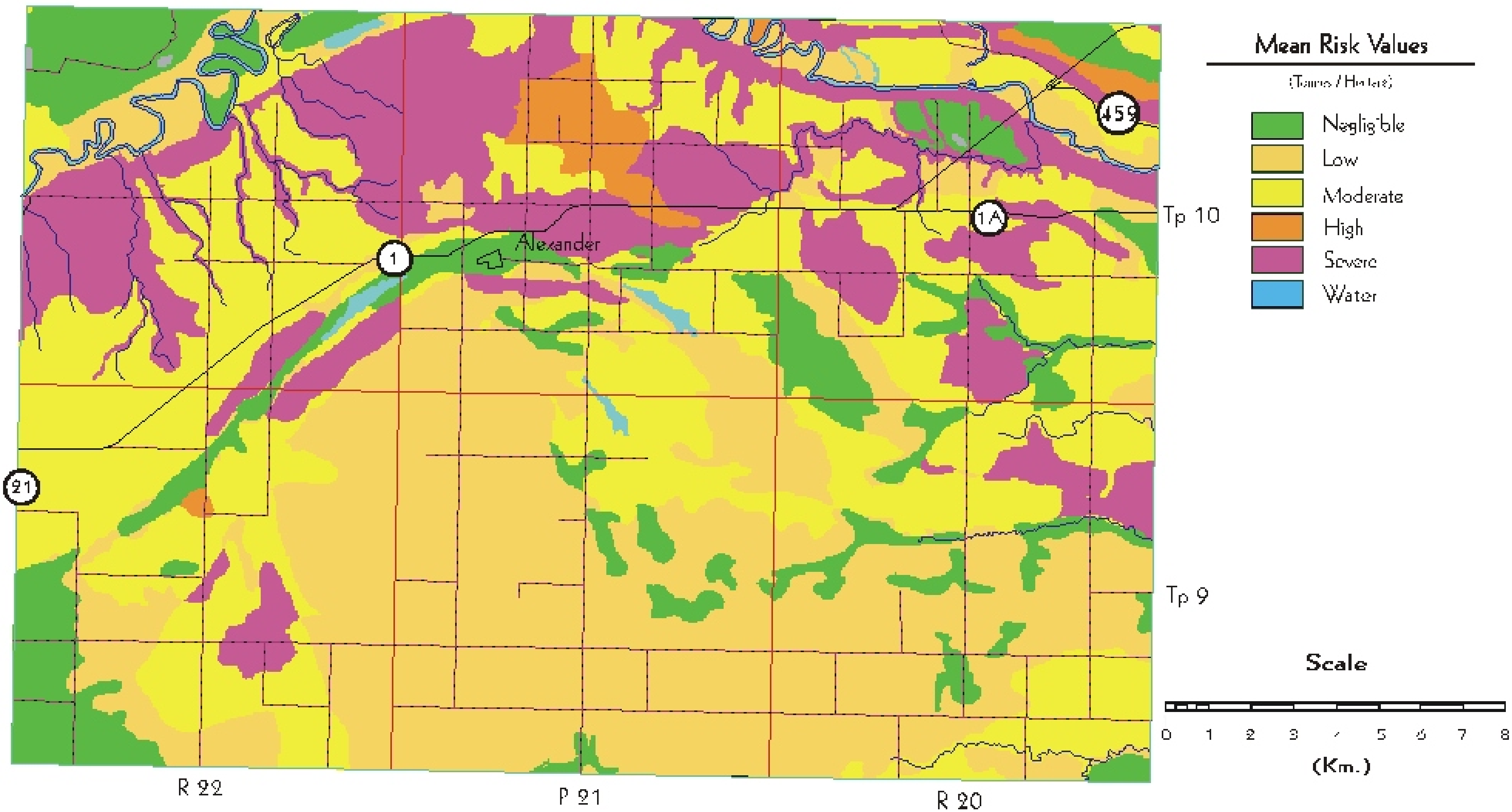
Cropping and management practices will significantly reduce this risk depending on crop rotation program, soil type, and landscape features.

Table 7. Water Erosion Risk[1]

Class	Area (ha)	Percent of RM
Negligible	7971	13.7
Low	19745	34.0
Moderate	18126	31.2
High	1119	1.9
Severe	10539	18.1
Water	620	1.1
Unclassified	27	0.0
Total	58145	100.0

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

Rural Municipality of Whitehead Water Erosion Risk Map



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

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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	36648	62.6
Forage	2426	4.1
Grasslands	12769	21.8
Trees	2405	4.1
Wetlands	1620	2.8
Water	469	0.8
Urban and Transportation	2169	3.7
Total	58506	100.0

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

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