Soils of the Municipality of Killarney-Turtle Mountain

Report No. D90 2011

Canada

Growing Forward

Manitoba

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

Additional Poster-Sized Maps Included with Report:

- 1:50,000 Soil Series Map for the Study Area
- 1:50,000 Dryland Agricultural Capability Map

Part 1 General Description of the Study Area

1.1 Location and Extent

The Rural Municipality (RM) of Killarney-Turtle Mountain (KTM) covers an area of approximately 9.7 townships (94,410 hectares or 233,292 acres inclusive of road allowances) bordering the United States of America in the south, and neighbouring the rural municipalities of Morton, Riverside and Roblin in the west, north and east, respectively (Map 1). The Rural Municipality of KTM includes Township 1, 2, 3 and 4 in ranges 16 to 18 west of the Principal Meridian. The study area also includes the previously surveyed Killarney Study Area (Soil Survey Report No. D22, Michalyna and Holmstrom, 1980).

This report contains soil resource information and maps at a scale of 1:50,000 for an area formerly covered in the reconnaissance survey (1:126,720) of the South Central Map Sheet Areas, Report No. 4, 1943 (Ellis and Shafer, 1943).

1.2 Landscape and Surface Deposits

The study area is situated in the Boissevain Plain, corresponding to the Waskada Till Plain in the Reconnaissance Soil Survey of South-Central Manitoba, Report No. 4 (Ellis and Shafer, 1943). The area occurs just below the Turtle Mountain uplands on the southwest, and the Pelican Lake and Pembina Channel on the northeast, and ranges in elevation from approximately 635 to 460 meters above sea level resulting in a general gradient of 0.43 percent. Numerous incised channels and intermittent streams follow the general gradient northerly and easterly from the Turtle Mountain uplands towards the Pelican Lake. Some of the larger channels are the result of glacial melt-water flow during the retreat of the ice mass approximately 10 to 12 thousand years ago.

Four major landforms are commonly seen in the RM: hummocky, rolling, undulating and level. The hummocky landform is a very complex sequence of slopes extending from somewhat rounded depression or kettles of various sizes to irregular to conical knolls or knobs. The rolling landform has a slope greater than five percent and a slope length over 1.6 km (wavelike pattern). The undulating landform has a gentle slope that ranges from two to five percent. The level landform has a slope less than two percent. The undulating landscape is dominant, decorated by hummocky glacial moraine. Potholes in irregular shapes and sizes can be seen anywhere in the surveying area, but most of them are found in the north side of the Pembina River and in Township 3 Range 16.

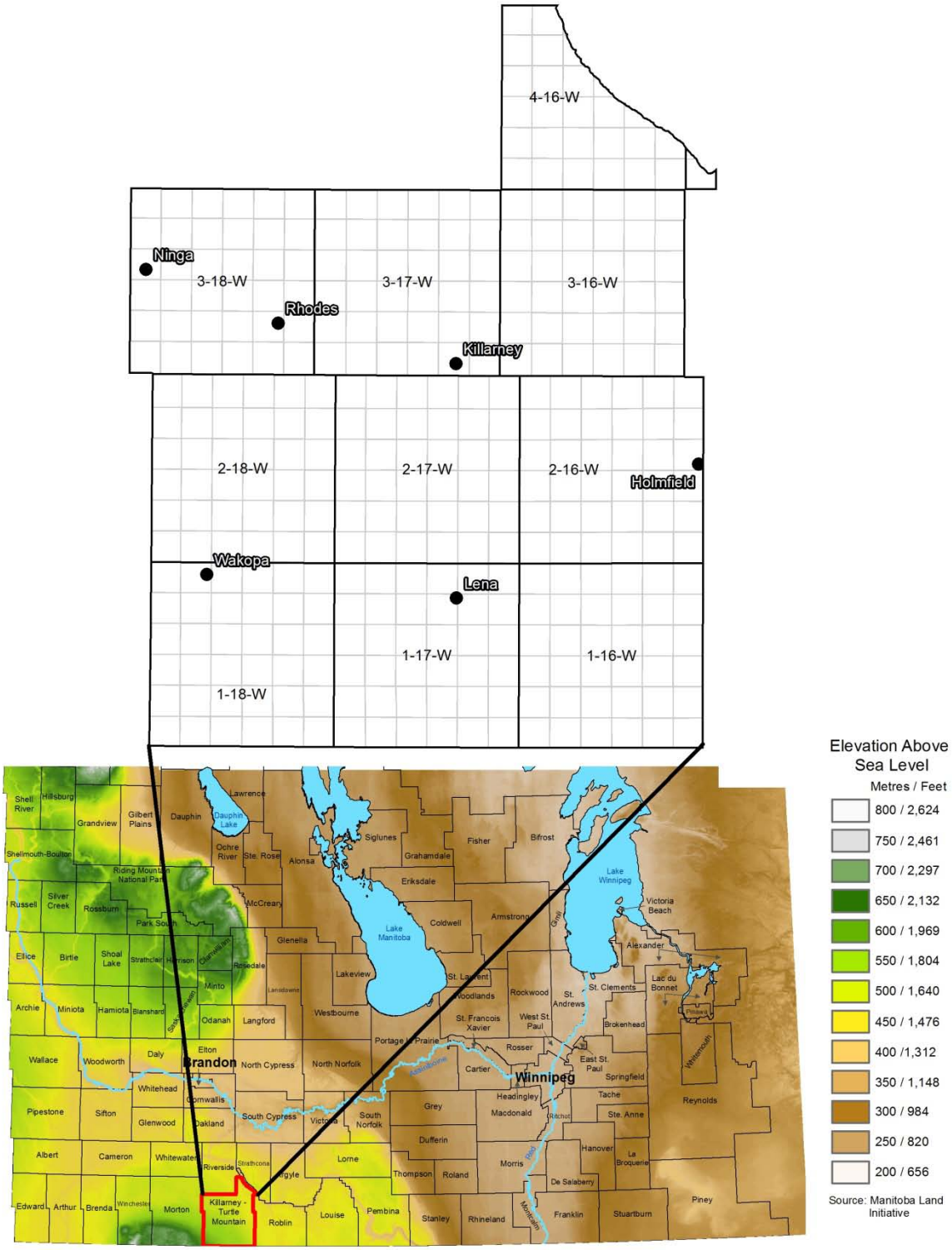
The underlying bedrock in the study area consists of cretaceous shale of the Riding Mountain formation at depths of 25 to 30 meters below ground surface. The dominant unconsolidated deposit overlying the cretaceous shales is strongly calcareous, loamy textured glacial till.

During the recession and waning of the continental ice mass from the south, the ice front remained rather stationary for a period in the area immediately to the north (Michalyna and Holmstrom, 1980). Water from the melting ice and surface runoff from the east side of the Turtle Mountain flowed northeasterly toward the Pembina River. Sediments were deposited as a thin veneer over till, resulting in large areas of lacustrine deposits over glacial till. This also modified the glacial till landscape from the common rolling and/or hummocky to a gently undulating landform.

1.3 Soils

Soil parent material is mainly thin lacustrine sediments overlying strongly calcareous, mixed glacial till and comprises 46.6 percent of the surveyed area (Table 1). Soils developed directly on mixed glacial till comprises 31.8 percent of the surveyed area whereas those derived from deep lacustrine comprise only 7.35 percent of the surveyed area. Soils from lacustrine over sandy and/or gravelly fluvial sediments overlying glacial till are mostly distributed in the areas close to Pelican Lake and along the Pembina and Long Rivers. They occur in an irregular strip that crosses Township 1, Range 17 to Township 2, Range 16.

Map 1. Location of the Study Area: Rural Municipality of Killarney-Turtle Mountain



The loamy lacustrine soils overlying glacial till are classified as dominantly Waskada Association. They account for approximately 75 percent of all observed lacustrine over till parent material or 34.9 percent of the soil in the study area. The Waskada Association includes three well drained soil series (Waskada - Orthic Black Chernozem, Dalny – Calcareous Black Chernozem, and Maskawata – Rego Black Chernozem), with three imperfectly drained soil series (Two Creeks – Gleyed Black Chernozem, Glenlorne – Gleyed Eluviated Black Chernozem, and Montgomery – Gleyed Rego Black Chernozem) and two poorly drained soil series (Villette and Deloraine). The poorly drained soils are usually found in depressions or close to sloughs.

Soils derived directly from mixed glacial till are classified as well drained Black Chernozems (Ryerson, Medora and Hathaway series), imperfectly drained Gleyed Chernozems (Coatstone and Regent soil series) and Gleyed Eluviated Black Chernozem (Hazeldean soil series). The poorly drained Gleysols include the Ewart and Tilston soil series. The Orthic Dark Gray Chernozem (Horton or Horton with the drainage variant) is found in the southwest corner of the Rural Municipality of KTM, where deciduous trees are predominant around 635 meters above sea level, approximately 200 meters higher than the northeast plain close to Pelican Lake.

Deep lacustrine soils have a wide range in texture. They range from loamy fine sand (coarse) to clay (fine). The most common soil texture groups of lacustrine deposits are moderately fine and medium, ex. Elva and Cameron Association soils. The Elva Association accounts for 41.4 percent and the Cameron Association accounts for 35.5 percent of the total lacustrine deposited soils, making up to 3.04 and 2.62 percent of the total surveyed areas, respectively.

Soils derived from alluvium deposits are located in river beds or on terraces well above present streams. Soil texture ranges from medium to fine. Gleyed Cumulic Regosol soils including Liege, Neelin and Rego Humic Gleysol such as Graham and Leighton occur in the study area. All alluvium soils comprise 5.6 percent of surveyed lands.

Soils developed from fluvial related materials, either lacustrine over fluvial over till, lacustrine over fluvial, fluvial over till, or directly on fluvial sediments, are found in the areas close to Pelican Lake and strips along the Pembina River in Township 3 Range 16 and the Long River in Township 2 Range 16. Some of these soils also occur in the southeast sections of Township 1 Range 18 and southwest sections of Township 1 Range 17.

Table 1. Soil Parent Material and their Proportions in the Study Area

Parent material (0 to 100cm)	% of RM
Lacustrine over glacial till	46.59
Glacial till	31.78
Lacustrine	7.35
Alluvium	5.63
Lacustrine over fluvial over till	2.82
Lacustrine over fluvial	2.45
Fluvial sediment	1.17
Fluvial over till	0.15
Water body, eroded slope, and unclassified urban area	2.06
Total	100.0

Part 2 Methodology

2.1 Mapping and Map Scale

Detailed soil mapping at a 1:50,000 scale (approx. 2 cm equals one km) was completed for the Municipality of KTM. Approximately 9 inspections per section of land or a soil inspection of 1 site per 28 to 30 hectares (1 site per 70 acres) was conducted and soil profiles were examined to a depth of one metre. Additional soil inspections occurred in complex soil areas to help locate boundaries between different soil series or variable soil phases.

Boundaries delineating the various soil series are completed by digitizing using Geographic Information Systems (GIS) and 3-dimensional viewing software. This allows higher positional accuracy of soil polygons and contrast features.

2.2 Map Units

The information from soil inspection sites forms the basis for delineating soil boundaries on a map. Each geographic area enclosed by these soil boundaries is referred to as a soil polygon. Each soil polygon is named according to the soil series that are present in the polygon.

A soil series is defined as a naturally occurring soil body so that any profile within that body has a similar number and arrangement of horizons whose colour, texture, structure, consistence, reaction and composition are within a narrowly defined range. If a soil has properties that vary slightly from the prescribed range of the series, a soil series **variant** is established.

A soil polygon can contain up to three named soil series. The collective name or label of a soil polygon is referred to as a map unit.

A map unit represents portions of the soil landscape that have characteristics and properties varying within narrow limits that are determined by the intensity of the survey.

A map unit contains one or more than one soil or non-soil plus a certain proportion of unnamed and un-described inclusions. Map units are delineated on the basis of the types and relative proportions of their soils or non-soils, as well as on the basis of external criteria such as slope, stoniness, erosion or salinity. Some examples of a non-soil include water or bedrock.

2.3 Simple and Compound Map Units

There are two major types of map units: simple and compound. The difference between a simple and compound map unit is the proportion and contrast of their components.

A **Simple Map Unit** contains predominantly one soil or non-soil. Its components vary as follows: the predominant component comprises at least 65 percent with up to 35 percent of non-limiting, similar components (components that are alike in most properties and behaviour), or up to 25 percent of non-limiting dissimilar components (components that do not affect management of the map unit but have a significant number of properties that vary from the predominant component), or up to 15 percent of limiting, dissimilar components (components which have many contrasting properties and usually affect management differently).

A **Compound Map Unit** contains predominantly more than one soil or non-soil (or a combination of both). The proportions of the two major components in a compound map unit, for example, may vary from one considerably exceeding the other to both being approximately equal. Complementary to the definition of a single map unit, the proportions of components vary according to their areal extent and contrasting characteristics as they may affect soil management or use. Major components vary as follows: if other components are similar and non-limiting no single component represents more than 65 percent; or if other components are dissimilar and non-limiting no single component represents 75 percent or more; or if other components are dissimilar and limiting no single component represents 85 percent or more.

For the purpose of describing compound map units, components are considered dominant if they occupy over 40 percent of the unit. They are considered significant between 15-40 percent and minor if they occupy less than 15 percent. Minor components are described only if they are highly contrasting.

2.4 Phases

It is often desirable to indicate a condition or quality of soil property or landscape feature that deviates significantly from the normal definition of map units using a map unit symbol. These variations or phases of soil properties and landscape features, varying from delineation to delineation, significantly affect soil behaviour and land management or use.

Soil properties that are commonly used as phase criteria include texture, depth, surface peat, salinity and physical disruption. Properties of land that are used include slope, wind and water erosion, stoniness, rockiness and altered drainage.

The four properties are identified below the soil series symbol. They are severity of erosion, slope class, degree of stoniness and salinity. The degree or magnitude of each is designated in Figure 1.

The convention employed to indicate these features in the map symbol is as follows:

If none of the above properties are observed to be significant, the map symbol representing the normal or unaffected soil series is used alone without modifiers (example in Figure 1).

If one or more phase features are recognized, the appropriate letter or number is placed below the soil series symbol in one of four designated locations in the map unit symbol. The designated order is erosion, slope class, stoniness and salinity. If a particular feature is not observed to be significant, an x is used in its appropriate designated location in the map symbol (Figure 1).

An example of a compound unit is as follows: 70 percent consists of Waskada (WKD^{7}) series having no erosion (x), very gently sloping topography (c), no stones at the surface (x), no salinity (x), and 30 percent Montgomery (MOT^{3}) series having no erosion (x), very gently sloping topography (c), no stones (x) and no (x) salinity (Figure 1). If all the phases and features have an x designation, the four (x) phases are not shown in the map symbol.

2.5 Soil Sampling and Analyzing

A total of 1942 surface and subsurface soil samples were collected and analyzed for texture (particle size), pH, organic carbon, electrical conductivity (EC) and calcium carbonate content. Soil cation exchangeable capacity (CEC) was also determined in detailed soil profile samples.

The brief of methodologies of laboratory analyses used to determine soil characteristics are:

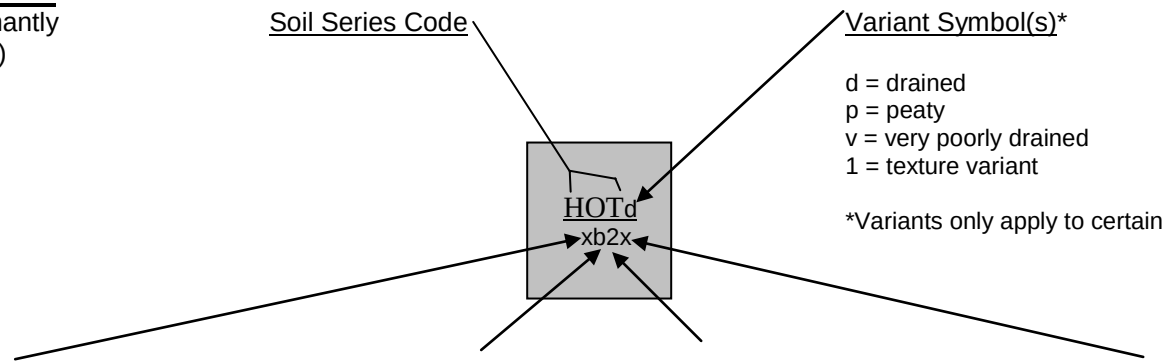
Calcium carbonate: Calcimeter using 1M HCl
CEC: Ammonia electrode
EC: Saturated paste
pH: 2:1 water to soil ratio
Organic carbon: Walkley-Black method
Particle size: Pipette method

Figure 1. Map Unit Symbol

Soil series maps contain labels similar to those shown in the grey boxes below. A description of each kind of label is indicated below.

Simple Map Units

(contain predominantly 1 soil or non-soil)



d = drained
p = peaty
v = very poorly drained
1 = texture variant

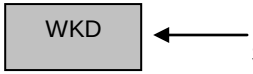
*Variants only apply to certain soil series

Degree of Erosion
x = non-eroded or minimal
1 = slightly eroded
2 = moderately eroded
3 = severely eroded
o = overblown/overwash

Topography (Slope Class)
x = level to nearly level: 0 - .5%
b = nearly level: >.5 – 2%
c = very gently sloping: >2 – 5%
d = gently sloping: >5 – 9%
e = moderately sloping: >9 – 15%
f = strongly sloping: >15 – 30%
g = very strongly sloping: >30 – 45%
h = extremely sloping: >45 -70%

Degree of Stoniness (Surface Covered)
x = non-stony: <.01%
1 = slightly stony: >.01 - .1%
2 = moderately stony : >.1 – 3%
3 = very stony: >3 – 15%
4 = exceedingly stony: >15 -50%
5 = excessively stony: >50%

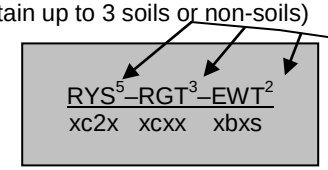
Degree of Salinity Condition (mS/cm)
x = non-saline: 0 – 4
s = weakly saline: >4 – 8
t = moderately saline: >8 – 16
u = strongly saline: >16



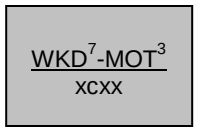
Soil Code with a phase of xxxx (The denominator shown in the above example is referred to as the 'phase')

Compound Map Units

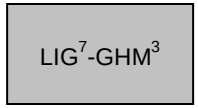
(Contain up to 3 soils or non-soils)



Percent of soil series found in map polygon to be multiplied by 10 (50+30+20=100%)



2 Soil Series with the same phase



2 soil series, both with a phase of xxxx

Part 3 Soil Development and Classification

3.1 Introduction

This section of the report describes the main characteristics of the soils and their relationship to the factors of soil development. Soil development is related to the regional climate and the degree of leaching, translocation and accumulation of soluble and colloidal fractions of the soil. Soil drainage also plays a significant role in soil development. Soils in the RM of KTM have developed under a cool subhumid boreal climate which provides sufficient moisture and heat for development of aspen-oak groves, tall prairie grasses and associated herbs. Consequently, the majority of soils in the area are Chernozemic soils.

3.2 Classification

Soils in the study area are classified according to the Canadian System of Soil Classification (SCWG, 1998). This system is hierarchical employing five levels of generalization or categories of classification. Beginning with the most generalized, these categories are the order, great group, subgroup, family (association) and series. The classification is based on measurable soil properties that can be observed in the field, or can be inferred from other properties observable in the field. The properties selected as criteria for the higher categories are the result of soil genesis or of factors that affect soil genesis. Properties utilized to differentiate soils at the lower levels of family and series affect management. The five levels of generalization are defined as follows:

Order - Soil orders are defined on the basis of soil properties of the pedon that reflect the nature of the soil environment and the effects of the dominant soil forming process. An example is a Chernozem in which soils with dark coloured surface horizons develop under sub-humid climate and dominantly grassland environments.

Great Group - Each order is subdivided into great groups based on differences in the strength of dominant processes or a major contribution of a process in addition to a dominant one. Such processes result in particular kinds, arrangements and degrees of expressions of pedogenic horizons. An example is a Luvic Gleysol in which the dominant process is considered to be gleying but clay translocation is also a major process.

Subgroup - Subgroups are subdivisions of great groups and are defined according to the kind and arrangement of horizons that indicate the conformity to the central concept of the great group ex. Orthic, intergrades toward soils in other orders, ex. Gleyed or special features such as carbonate accumulation in B-horizons.

Family - Families are established within a subgroup based on the similarity of physical and chemical properties that affect management. The properties that are considered important for recognizing families are particle size distribution, mineralogy, soil climate, soil reaction and thickness of solum.

Series - The series consists of soils that formed in a particular kind of material and have horizons with colour, texture, structure, consistence, thickness, reaction and chemical composition that are similar in differentiating characteristics and in arrangement in the soil profile.

The classification of soils in the study area in relation to parent material, texture and drainage is shown in Table 2. The proportion of soils in terms of land area and surface texture in the RM of KTM is listed in Table 3. Each individual soil series is described in detail in Appendix 2.

Table 2-1. Relationship between Soil Series, Soil Drainage, Parent Material and Soil Classification

Soil Drainage	*Classification*	Glacial till	Lacustrine over (< 5 cm gravelly lens) over glacial till				Lacustrine and fluvial materials over glacial till			
		Medium to Mod. Fine (VFSL, L, SiL, to SCL, CL, SiCL)	Coarse (FS, LS, LFS)	Mod. Coarse (VFS, LVFS, FSL)	Medium (L, VFSL, SiL, Si)	Mod. Fine (SCL, CL, SiCL)	Coarse (FS, LS, LFS)	Mod. Coarse (VFS, LVFS, FSL)	Medium (VFSL, L, SiL, Si)	Mod. Fine (SCL, CL, SiCL)
Well to Mod. well drained	Orthic Black Chernozem	Ryerson (RYS)	Margaret (MRE)	Langvale (LGV)	Waskada (WKD)	Bearford (BEF)	Pendennis (PDN)	Griswold (GWD)	Newstead (NWS)	Hartley (HLY)
	Calc. Black Chernozem	Medora (MDO)	Dunrea (DUR)	Nesbitt (NBT)	Dalny (DNY)					
	Rego Black Chernozem	Hathaway (HHY)	Rhodes (RHD)	Fairbiurn (FBU)	Maskawata (MAW)					
	Rego D. Gray Chernozem	Oskar (OSK)								
	Orthic D. Gray Chernozem	Horton (HOT)								
	Orthic Gray Luvisol	Turtle Mountain (TUM)								
Imperfectly drained	Gleyed Black Chernozem	Regent (RGT)	Ashdown (AHW)	Ashbury (AHY)	Two Creeks (TWC)	Desford (DFD)	Eramosh (EMH)		Bower (BOW)	
	Gleyed El. Bl. Chernozem	Hazeldean (HZD)			Glenlorne (GNO)				Bannerman (BNM)	
	Gleyed Rego Bl. Chernozem	Coatstone (CSE)	Terence (TRC)	Mentieth (MNH)	Montgomery (MOT)	Croll (CLL)	Carnige (CRG)	Cauldwell (CDW)	Alexander (AXD)	
Poorly Drained	Orthic Humic Gleysol	Stoney Creek (SYE)			Villette (VLT)					
	Humic Luvic Gleysol	Tilston (TLT)								
	Rego Humic Gleysol	Ewart (EWT) or Wakopa (WKP)		Gains-borough (GGH)	Deloraine (DRI)	Wassewa (WSW)			Bella Lake (BEL)	

Soil texture abbreviations: C = clay, Co = coarse, F = fine, H = heavy, L = loam(y), S = sand(y), Si = silt(y), and V = very.

Table 2-2. Relationship between Soil Series, Soil Drainage, Parent Material and Soil Classification

Soil Drainage	Classification	Lacustrine							Alluvium	
		Coarse (FS, LS LFS)	Mod. Coarse (VFS, LVFS, FSL).	Medium (VFSL, L, SiL, Si)	Mod. Fine (SCL, CL, SiCL)	Fine (SC, SiC, C)	Medium over Coarse	Mod. Fine to Fine. Strongly calcareous, mod. saline	Medium (VFSL, L, SiL, Si)	Mod. Fine to Fine (SCL, CL, SiCL to SC, SiC, C)
Well to mod. Well drained	Cumulic Regosol								Melita (MLT)	
	Orthic Black Chernozem	Stanton (STU)	Lyleton (LYT)	Cameron (CMR)	Elva (ELV)		Mather (MTR)			
	Calc. Black Chernozem	Deleau (DLU)	Kemnay (KMY)	Schaffner (SFR)						
	Rego Black Chernozem	Scarth (SCH)	Maon (MON)	Argue (ARG)						
Imperfectly Drained	Gl. Cumulic Regosol								Liege (LIG)	Neelin (NEI)
	Gleyed Black Chernozem	Lauder (LUD)	Denbow (DBW)	Underhill (UHL)	Goodlands (GOL)	Agnew (AGW)	Badger Creek (BDC)	Marshy Lake (MYK)		
	Gleyed El. Bl. Chernozem			Hayfield (HYF)	Minto (MTO)					
	Gleyed Rego Black Chernozem	Souris (SOU)	Switzer (SWZ)	Hartney (HRY)	Cranmer (CME)	Pipestone (PPT)	Wawanesa (WWS)	Whitewater (WIW)		Coulter (COU)
Poorly Drained	Orthic Humic Gleysol	Bell creek (BEC)		Sanger (SGR)	Naples (NPS)					
	Humic Luvic Gleysol			Orthez (OHZ)	Bunclody (BCY)					
	Rego Humic Gleysol	Oak Lake (OKL)	Plum Lake (PAK)	Emblem (EBL)	Fairfax (FFX)	Cromer (CRM)	Martinville (MNV)	Rebecca (RCC)	Graham (GHM)	Leighton (LGT)

Table 2-3. Relationship between Soil Series, Soil Drainage, Parent Material and Soil Classification

Soil Drainage	*Classification*	Fluvial Outwash	Lacustrine over Fluvial Outwash				Fluvial Outwash over Glacial Till
		Coarse (FS, LS, LFS) gravelly deltaic & outwash materials	Coarse (FS, LS, LFS)	Mod. Coarse (VFS, LVFS, SL, FSL)	Medium (VFSL, L, SiL, Si)	Mod. Fine (SCL, CL, SiCL)	Coarse (FS, LS, LFS), gravelly outwash deposits over mixed till
Well to mod. well drained	Orthic Black Chernozem	Bede (BED)	Chaucer (CUC)	George Lake (GGK)	Dromore (DOM)		Bernice (BIC)
	Calc. Black Chernozem	Broomhill (BOH)			Breadon (BRO)		Adelpha (APH)
	Rego Black Chernozem	Jackson Creek (JKE)					
	Orthic D. Gray Chernozem	Butler (BUR)					
Imperfectly drained	Gleyed Black Chernozem	Cartwright (CWG)	Methvin (MHV)	Ninette (NTT)	Glenview (GLN)		Turtlehead (TUA)
	Gleyed Rego Bl. Chernozem	Napinka (NPK)	Reston (RST)	Linklater (LIK)	Gopher Creek (GPE)	Leon (LEO)	Glenora (GLO)
Poorly drained	Rego Humic Gleysol	Partridge (PDG)		Pierson (PIS)	William (WIL)		Bosshill (BSH)

Table 3. Soils and Surface Texture of the Study Area

Soil code	Soil name	Drainage	Surface texture	Textural group of soil profile	Total area		% of RM
					ha	ac	
AHY	Ashbury	Imperfect	Loamy very fine sand	Moderately coarse	14	35	0.01
ARG	Argue	Well	Loam	Medium	155	384	0.16
AXD	Alexander	Imperfect	Loam	Medium	1,091	2,696	1.16
BED	Bede	Rapid	Loamy sand	Coarse to very coarse	405	1,001	0.43
BEF	Bearford	Well	Clay loam	Moderately fine	3,157	7,802	3.34
BEL	Bella Lake	Poor	Loam	Medium	239	591	0.25
BIC	Bernice	Well	Loamy sand	Coarse to very coarse	59	145	0.06
BOW	Bower	Imperfect	Loam	Medium	141	349	0.15
BRO	Breadon	Well	Loam	Medium	143	354	0.15
CLL	Croll	Imperfect	Clay loam	Moderately fine	4,787	11,830	5.07
CME	Cranmer	Imperfect	Clay loam	Moderately fine	1,781	4,400	1.89
CMR	Cameron	Well	Loam	Medium	993	2,453	1.05
COU	Coulter	Imperfect	Clay loam to clay	Moderately fine to fine	115	284	0.12
CSE	Coatstone	Imperfect	Loam to clay loam	Medium to moderately fine	6,116	15,113	6.48
CWG	Cartwright	Imperfect	Loamy sand	Coarse to very coarse	164	405	0.17
DFD	Desford	Imperfect	Clay loam	Moderately fine	1,466	3,622	1.55
DNY	Dalny	Well	Loam	Medium	813	2,009	0.86
DOM	Dromore	Well	Loam	Medium	1,196	2,955	1.27
DRI	Deloraine	Poor	Loam	Medium	1,954	4,829	2.07
EBL	Emblem	Poor	Loam	Medium	274	677	0.29
ELV	Elva	Well	Clay loam	Moderately fine	554	1,370	0.59
ELV[1]	Elva (texture)	Well	Clay	Fine	58	144	0.06
EWT	Ewart	Poor	Loam to clay loam	Medium to moderately fine	1,874	4,630	1.98
FBU	Fairburn	Well	Loamy very fine sand	Moderately coarse	15	37	0.02
FFX	Fairfax	Poor	Clay loam	Moderately fine	560	1,383	0.59
GGH	Gainsborough	Poor	Loamy very fine sand	Moderately coarse	14	35	0.01
GGK	George Lake	Well	Fine sandy loam	Moderately coarse	56	137	0.06
GHM	Graham	Poor	Loam	Medium	1,373	3,393	1.45
GLN	Glenview	Imperfect	Loam	Medium	171	422	0.18
GLO	Glenora	Imperfect	Loamy sand	Coarse to very coarse	79	195	0.08
GNO	Glenlorne	Imperfect	Loam	Medium	101	249	0.11
GOL	Goodlands	Imperfect	Clay loam	Moderately fine	531	1,313	0.56
GPE	Gopher Creek	Imperfect	Loam	Medium	559	1,383	0.59
HHY	Hathaway	Well	Loam to clay loam	Medium to moderately fine	6,711	16,583	7.11
HLY	Hartley	Well	Clay loam	Moderately fine	33	82	0.04
HOT	Horton	Well	Loam to clay loam	Medium to moderately fine	1,110	2,744	1.18
HRY	Hartney	Imperfect	Loam	Medium	701	1,733	0.74
HZD	Hazeldean	Imperfect	Loam to clay loam	Medium to moderately fine	63	156	0.07
JKE	Jackson Creek	Rapid	Loamy sand	Coarse to very coarse	451	1,116	0.48
LEO	Leon	Imperfect	Clay loam	Moderately fine	160	395	0.17
LGT	Leighton	Poor	Clay loam to clay	Moderately fine to fine	746	1,843	0.79
LGV	Langvale	Well	Loamy very fine sand	Moderately coarse	367	907	0.39

ELV[1] = a texture variant of Elva.

Table 3. Soils and Surface Texture of the Study Area (continued)

Soil code	Soil name	Drainage	Surface texture	Textural group of soil profile	Total area		% of RM
					ha	ac	
LIG	Liege	Imperfect	Loam	Medium	1,911	4,721	2.02
MAW	Maskawata	Well	Loam	Medium	584	1,442	0.62
MDO	Medora	Well	Loam to clay loam	Medium to moderately fine	1,370	3,385	1.45
MLT	Melita	Well	Loam	Medium	172	426	0.18
MON	Maon	Well	Loamy very fine sand	Moderately coarse	47	116	0.05
MOT	Montgomery	Imperfect	Loam	Medium	5,874	14,515	6.22
MTR	Mather	Well	Loam	Medium	150	370	0.16
MYK	Marshy Lake	Imperfect	Clay loam to clay	Moderately fine to fine	15	38	0.02
NEI	Neelin	Imperfect	Clay loam to clay	Moderately fine to fine	1,003	2,478	1.06
NPK	Napinka	Imperfect	Loamy sand	Coarse to very coarse	68	169	0.07
NWS	Newstead	Well	Loam	Medium	1,126	2,782	1.19
OSK	Oskar	Well	Loam to clay loam	Medium to moderately fine	99	244	0.10
PDG	Partridge	Poor	Loamy sand	Coarse to very coarse	11	28	0.01
PPT	Pipestone	Imperfect	Clay	Fine	277	684	0.29
RGT	Regent	Imperfect	Loam to clay loam	Medium to moderately fine	1,449	3,580	1.53
RYS	Ryerson	Well	Loam to clay loam	Medium to moderately fine	10,816	26,726	11.46
SCH	Scarth	Well	Loamy fine sand	Coarse	42	103	0.04
SFR	Schaffner	Well	Loam	Medium	270	667	0.29
TLT	Tilston	Poor	Loam to clay loam	Medium to moderately fine	81	201	0.09
TUM	Turtle Mountain	Well	Loam to clay loam	Medium to moderately fine	82	201	0.09
TWC	Two Creeks	Imperfect	Loam	Medium	2,669	6,596	2.83
UHL	Underhill	Imperfect	Loam	Medium	83	205	0.09
VLT	Villette	Poor	Loam	Medium	256	633	0.27
WIL	William	Poor	Loam	Medium	189	466	0.20
WIW	Whitewater	Imperfect	Clay loam to clay	Moderately fine to fine	210	519	0.22
WKD	Waskada	Well	Loam	Medium	20,706	51,165	21.93
WKP	Wakopa	Poor	Loam to clay loam	Medium to moderately fine	229	565	0.24
WSW	Wassewa	Poor	Clay loam	Moderately fine	1,209	2,987	1.28
WWS	Wawanesa	Imperfect	Loam	Medium	113	279	0.12
$ER	Eroded Slope	Rapid			980	2,421	1.04
$UL	Unclassified land	-			66	164	0.07
$UR	Urban land	-			428	1,057	0.45
$ZZ	Water	-			475	1,174	0.50
Total	**-**	**-**	**-**	**-**	**94,410**	**233,292**	**100.0**

Waskada is the dominant soil series in the study area, followed by Ryerson and Hathaway. These three soils account for approximately 21.9, 11.4, and 7.1 percent of the total land in the RM of KTM, respectively.

Part 4 Agricultural Use and Management Interpretations of Soils

4.1 Introduction

These sections provide predictions for the performance or soil suitability ratings for various land uses based on soil and landscape characteristics, laboratory data and on soil behaviour under specified conditions of land use and management. Suitability ratings or interpretations for various land use applications are intended to serve as guides for planners and managers.

The management of soil and landscape data using Geographic Information System (GIS) technology enables rapid and more quantitative analysis of natural soil variability than is possible using manual techniques. The areal distribution of various soil components and properties that occur in complex landscapes can be highlighted in a mapped form and can thereby assist in planning and managing the soil resource. Such single factor maps and interpretative maps illustrate the distribution of individual soil properties and indicate the degree of soil limitation or potential for agricultural use and environmental applications.

A series of derived and interpretive maps are included in this section to assist in the interpretation of the soil resource information for the study area. The GIS uses the 1:50, 000 scale soil map and related soil analysis and landscape information to generate these colour thematic maps.

The maps portray a selection of individual soil properties or landscape conditions for map unit delineations. Combinations of soil properties or landscape features affecting land use and management are derived as specific interpretations. Derived maps portray specific interpretations based on the dominant condition in each map polygon.

Soil properties determine to a great extent the potential and limitations for both dryland and irrigation agriculture. In this section, interpretive soil information is provided for agricultural land use evaluations such as soil capability for agriculture and irrigation suitability.

4.2 Soil Capability for Agriculture

The soil capability rating for agriculture is based on an evaluation of both the soil characteristics and landscape conditions that influence the soil suitability and limitations for agricultural use (Anon, 1965) (Appendix 1, Section A).

The class indicates the general suitability of the soils for agriculture. The first three classes are considered capable of sustained production of common field crops, the fourth is marginal for sustained arable agriculture, the fifth is suitable only for improved permanent pasture, the sixth is capable of use only for native pasture while the seventh class is for soils and land types considered incapable of use for arable agriculture or permanent pasture.

Soil capability subclasses identify the soil properties or landscape conditions that may limit use or be a hazard. The various kinds of limitations recognized at the subclass level are defined in Appendix 1, Section B.

Class 1 soils in the map area have level to very gently sloping topography; are deep and well to moderately well drained with no major limitations for crop use.

Class 2 soils include the imperfectly drained soils with a wetness limitation (2W) and the well-drained and imperfectly drained soils having a topographic limitation (2T). The 2 to 5% slopes associated with the 2T soils may increase cultivation costs over that of a smooth landscape and increase the risk of water erosion.

Class 3 soils have a moderately severe limitation associated with gently sloping topography (5 to 9%) resulting in a moderate risk of water erosion.

Class 4 soils are poorly drained with a severe restriction to the growth of crops or choice of crops. The timing of cultivation or choice of crops is severely limited because of the wetness limitation.

Class 5 soils have very severe limitations as a result of excess water (5W) or moisture limitation (5M). This Class includes the lower, depressional areas of the poorly drained soils.

Class 6 soils in the study area have an extremely severe limitation due to soil erosion (6E), which restricts cropping to production of perennial forages.

Class 7 soils in the KTM, which have no capability for arable culture, are resulted from severe soil erosion and steep slopes.

A summary table of agriculture capability as affected by soil characteristics and landscape is showed in Table A1 of Appendix 1. In the RM of KTM class 2 land is dominant, accounting for 70.9 percent, followed by class 3 (13.2 %) and class 5 (10.5%). Class 4 and class 6 total 0.92 and 0.68 percent, respectively (Table 4).

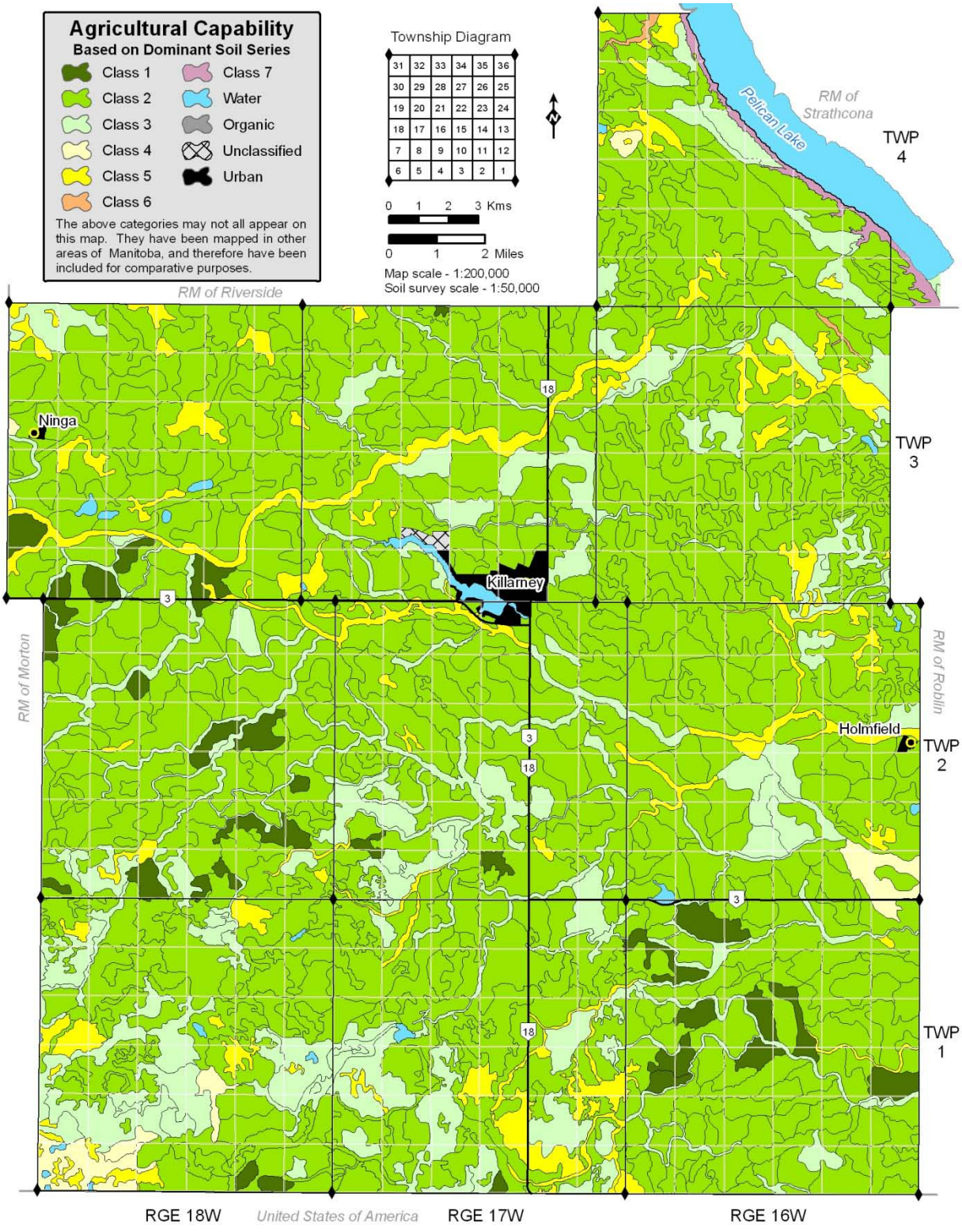
The most limiting factors in Class 2 lands are topography (2T=27.4%) and excess water (2W=17.6%) in the study area (Table 4). Soils grouped as Class 3 are due to topography (3T=3.9%) or inundation by streams (3I=3.09%), although other factors such as moisture, salinity, and erosion are also present. Class 4 soils are not commonly observed in the KTM, while Class 5 is caused predominantly by excess water (5W=7.3%). Soils in Class 6 and 7 are considered as either severely eroded lands or steep slopes (Table 4).

An interpretative map (Map 2) depicts the rating of the dominant soil series and landscape features for each polygon. The nature of the subclass limitations and the rating of subdominant soil and landscape components are not shown at the scale of this map. However, subdominant soil components, the nature of the subclass limitations, and total acreage of this type of soil are indicated in Table A2 of Appendix 1. A poster-sized agricultural capability map (1:50,000) is also included with this report.

Table 4. Ag Capability of Land in the KTM

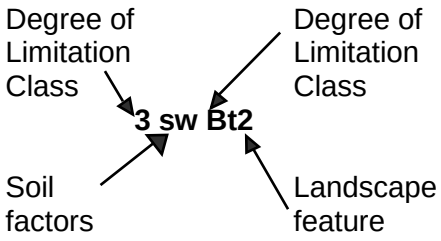
Agricultural Capability Class		Total area		% of RM
		ac	ha	
1		5,654	2,288	2.42
2	2IT	425	172	0.18
	2IW	284	115	0.12
	2M	4,418	1,788	1.89
	2MT	603	244	0.26
	2P	415	168	0.18
	2T	63,845	25,837	27.37
	2TE	615	249	0.26
	2TP	988	400	0.42
	2W	41,084	16,626	17.61
	2WT	18,226	7,376	7.81
	2X	34,496	13,960	14.79
3	3I	7,198	2,913	3.09
	3M	6,640	2,687	2.85
	3MT	591	239	0.25
	3N	5,839	2,363	2.50
	3T	9,106	3,685	3.90
	3TE	1,376	557	0.59
4	4M	1,008	408	0.43
	4N	42	17	0.02
	4T	941	381	0.40
	4TE	153	62	0.07
5	5IW	5,236	2,119	2.24
	5M	2,263	916	0.97
	5W	17,023	6,889	7.30
6	6E	1,581	640	0.68
7	7TE	840	340	0.36
Water/urban/ unclassified		2,394	969	1.03

Map 2. Agricultural Capability Map of the RM of KTM



4.3 Irrigation Suitability

The rating guidelines in this section are derived from "An Irrigation Suitability Classification System for the Canadian Prairies" (ISC, 1987). The irrigation suitability rating of the soils is based on soil and landscape characteristics. It does not consider factors such as method of water application, water availability, water quality or economics of this type of land use.



Soil properties considered important for evaluating irrigation suitability are: texture, soil drainage, depth to water table, salinity and geological uniformity.

Landscape features considered important for rating irrigation suitability are topography and stoniness.

The irrigation suitability of the soil and landscape characteristics in the study area assists in making initial irrigation plans. The next step involves on site field investigation to examine the depth to water table, salinity and geological uniformity to a depth of 3 m. Drainability, drainage outlet requirement, organic matter status and potential for surface crusting are other factors to consider. This assessment also considers potential impact of irrigation on non-irrigated areas as well as on the irrigated area.

The most limiting soil property and landscape feature are combined to determine the placement of a land area in one of 16 classes of irrigation suitability which are grouped and described by 4 ratings: **Excellent, Good, Fair** and **Poor**. (Table A3 of Appendix 1). The guidelines are listed in Table A4 and A5 of Appendix 1, respectively.

An example of an irrigation suitability class rating with subclass limitations is shown:

A maximum of 3 codes is used to identify the subclass rating. Salinity (s) and drainage class (w) are soil factors that contribute to the soil rating of 3 or Moderate. The landscape limitation due to complex topography (t2) is Slight or (B). As the soil factor (3 or Moderate) is more limiting than the landscape feature (B or Slight), the general rating for this land area (3B) is fair (Appendix 1, Table A3 to A5).

A summary of soils and their interpretive classification for irrigation suitability is provided in Table 5. The subdominant soil series and phases are considered when generating the data in Table 5. Approximately half of the land in KTM is classified as good or excellent for irrigation suitability. Thirty seven percent of lands are in category of “fair”, of which, 79.4 percent (sum of 3w A, 3w Bi and 3w Bt2) are due to drainage problems. If soil drainability is improved, those soils can be upgraded to the “good” category. Poor drainage also results in “poor” irrigation suitability (Table 5). Among 12.4 percent of “poor” irrigation suitability soils, approximately 9.7 percent are either due to poor drainage or rapid drainage.

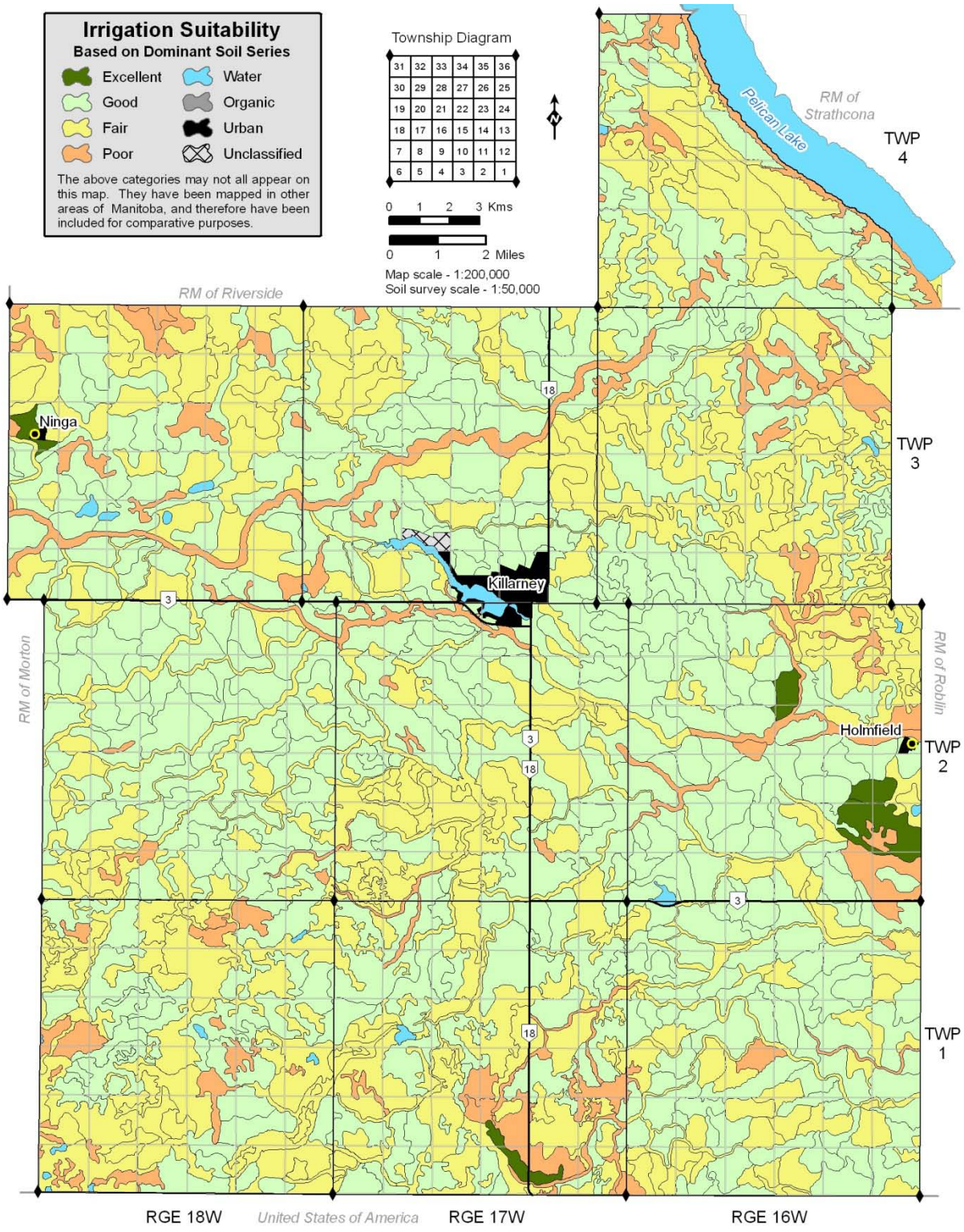
An interpretative map (Map 3) illustrates the rating of the dominant soil series and landscape features for each polygon. It shows that most land in Township 1 range 17 and 18, Township 3 range 16 and 18 are not suitable for irrigation, and these soils are either classified as “fair” or “poor”.

Table 5. Soil Irrigation Suitability in the RM of KTM

Irrigation class	Soil & landscape features	Total area		% of RM
		ac	ha	
Excellent	1 A	2,399	971	1.03
Good (48.5%)	1 Bt2	1,208	489	0.52
	2g Bt2	326	132	0.14
	2gk Bt2	82	33	0.03
	2gm Bt2*	3,289	1,331	1.41
	2k Bt2*	1,794	726	0.77
	2kx A	37,829	15,309	16.22
	2kx Bt2	63,011	25,500	27.01
	2m Bt2*	2,456	994	1.05
	2w Bt2*	2,137	865	0.92
	2x Bt2*	946	383	0.41
Fair (37.1%)	1 Ct2	17	7	0.01
	2g Ct2	44	18	0.02
	2gm Ct2	25	10	0.01
	2kx Ct2	11,473	4,643	4.92
	2m Ct2	566	229	0.24
	3kw Bt2*	158	64	0.07
	3mx Bt2*	195	79	0.08
	3s A	84	34	0.04
	3sw A	4,329	1,752	1.86
	3sw Bt2	912	369	0.39
	3w A	43,648	17,664	18.71
	3w Bi	5,656	2,289	2.42
	3w Bt2	19,457	7,874	8.34
Poor (12.4%)	4gm A	143	58	0.06
	4kx A	783	317	0.34
	4kx Ct2	44	18	0.02
	4m A	1,181	478	0.51
	4m Bt2	1,413	572	0.61
	4m Ct2	1,137	460	0.49
	4m Dt2	1,374	556	0.59
	4sw A	42	17	0.02
	4w A	16,721	6,767	7.17
	4w Bt2	586	237	0.25
	4w Ci	5,236	2,119	2.24
	4w Ct2	193	78	0.08
Water, urban and unclassified		2,394	969	1.03

Note: Bt2* also includes landscape feature class A.

Map 3. Irrigation Suitability in the RM of KTM



4.4 Soil Suitability for Irrigated Potato Production

An evaluation of soil properties and landscape features was used to generate a 5 class rating of land for irrigated potato production. Soil properties considered are: texture, soil drainage, salinity and sodicity. Landscape features that were considered relate to the impact of slope and stoniness. The most suitable soil and landscape conditions occur in **Class 1** and the least desirable conditions occur in **Class 5**. Details regarding the criteria applied in the suitability rating are described in Tables A6 and A7 of Appendix 1.

Assumptions:

This evaluation examines soil and landscape factors that are important for irrigated production of potatoes for processing. Production of seed and table potatoes with irrigation may not be impacted to the same degree by soil conditions such as stoniness and texture.

Stoniness hinders soil preparation and interferes with harvesting and increases the chances of potato bruising during harvest.

Deep, well drained sandy loam to loam soils exhibit favorable properties for the production of high quality potatoes. Clay soils with impeded internal soil drainage have a severe limitation to potato production because of reduced oxygen supply and increased incidence of fungal diseases. An increased risk of delayed spring tillage and planting and crop harvesting due to wet conditions can occur on fine textured soils.

Slope or topography reduces uniform water infiltration and increases the potential for soil erosion and nutrient loss.

This evaluation of soil and landscape properties does not incorporate additional factors that must be assessed for sustainable irrigated production of potatoes.

The environmental impact of intensive management practices on soil and water quality; the supply of good quality water, and the suitability of climatic conditions for optimum potato production must all be evaluated.

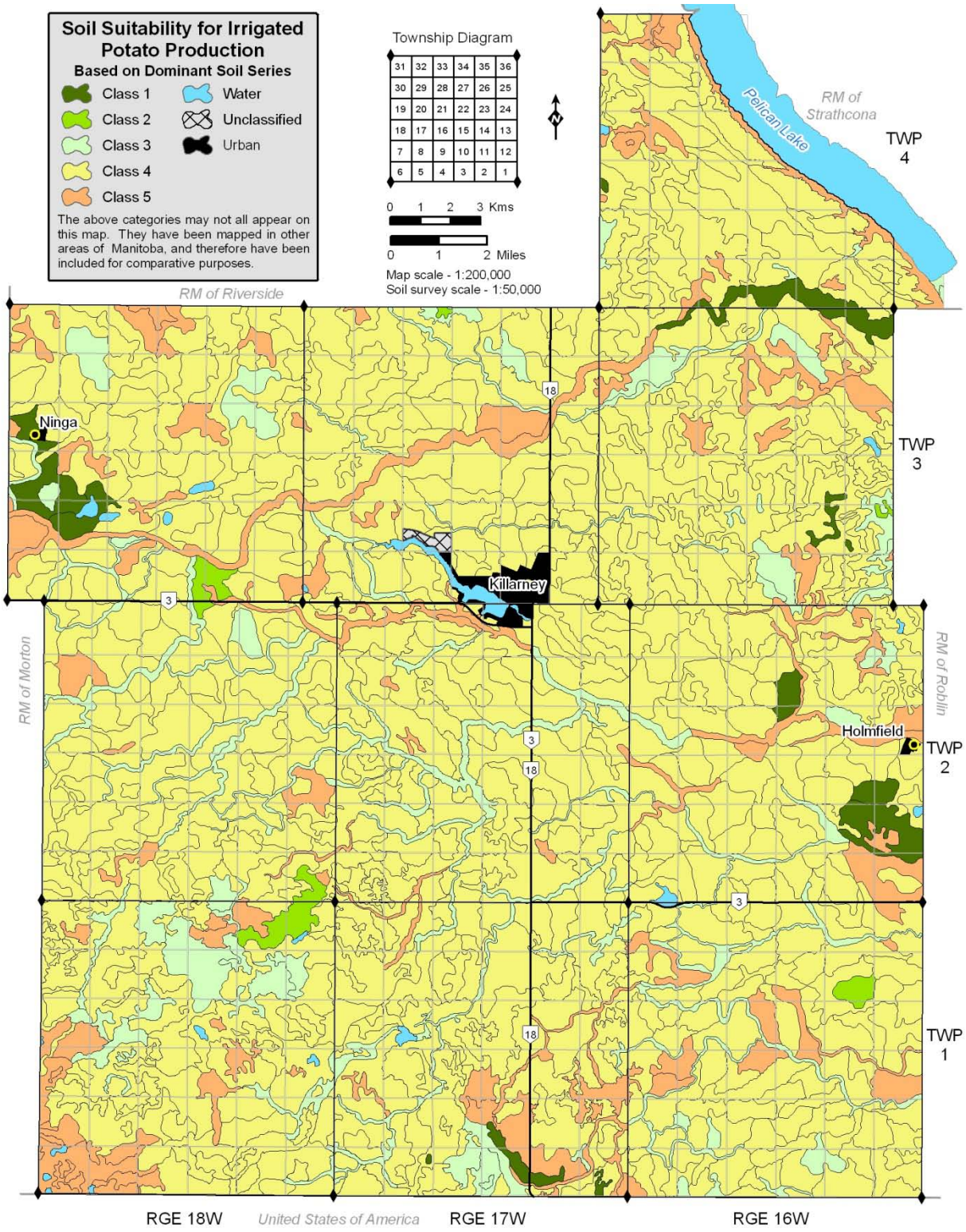
Integration of related databases in a GIS environment can be used to create a map that depicts the rating of the dominant soil and landscape feature for each soil polygon. The nature of the subclass limitations and the rating of subdominant soil and landscape components are not shown at this scale. An interpretative map (Map 4) illustrates the rating of the dominant soil series and landscape features for each polygon.

Lands in the RM of KTM are basically not suitable for potato production (Table 6). Approximately 88 percent of soils fall into either class 4 or class 5 category. This is mainly due to unsuitable soil texture and topography. Soil salinity also plays a role in degrading soil suitability for irrigated potato production.

Table 6. Soil Irrigation Suitability for Potato Production in the KTM

Potato Suitability Class	Total Acres	Total Hectares	% of RM
Class 1	3,615	1,463	1.55
Class 2	1,473	596	0.63
Class 3	20,374	8,245	8.73
Class 4	170,846	69,139	73.23
Class 5	34,592	13,999	14.83
Water/urban/ unclassified	2,394	969	1.03

Map 4. Soil Suitability for Irrigated Potato Production in the RM of KTM



4.5 Soil Texture

Mineral particles in soil are grouped according to size into sand (2 - 0.05 mm in diameter), silt (0.05 - 0.002mm) and clay (less than 0.002 mm). The proportion of individual mineral particles present in a soil is referred to as texture. Soil texture is described by means of 13 textural classes defined according to the relative proportions of sand, silt and clay (Figure 2). The presence of larger particles (diameter is greater than 2mm) in soil is recognized as:

gravelly - particles ranging from 0.2 to 7.5 cm in diameter

cobbly - rock fragments ranging from 7.5 to 25 cm in diameter

stony - rock fragments ranging from 25 to 60 cm in diameter or if flat 38 to 60 cm long

Figure 2. Soil Texture Triangle

Soil texture strongly influences the soil's ability to retain moisture, soil fertility and ease or difficulty of cultivation. Water moves easily through coarse-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 soil moisture conditions. Textural class names are grouped as coarse, medium and fine (Table 7).

Table 7. Soil Texture Group

Texture group		Texture	
		Class	Symbol
Coarse	Very coarse	Very coarse sand	VCoS
		Coarse sand	CoS
		Medium sand	S or MS
	Coarse	Fine sand	FS
		Loamy coarse sand	LCoS
		Loamy sand	LS or LMS
		Loamy fine sand	LFS
	Mod. coarse	Very fine sand	VFS
		Loamy very fine sand	LVFS
		Coarse sandy loam	CoSL
		Sandy loam	SL or MSL
		Fine sandy loam	FSL
Medium	Medium	Very fine sandy loam	VFSL
		Loam	L
		Silt loam	SiL
		Silt	Si
Fine	Mod. fine	Sandy clay loam	SCL
		Clay loam	CL
		Silty clay loam	SiCL
	fine	Sandy clay	SC
		Silty clay	SiC
		Clay	C
	Very fine	Heavy clay (>60 %)	HC

Particle analysis showed that among 834 soil samples collected from the A horizon in the study area, 433 samples were loam, accounting for 52 percent (Figure 3), and approximately 30 percent was either clay loam or sandy clay loam, indicating soil texture in the KTM is suitable for holding water and retaining plant nutrients. Soil tilth is not a problem.

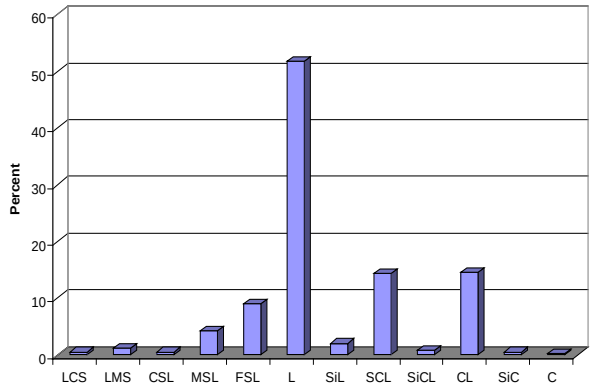


Figure 3. Soil Texture Analysis in the KTM

Based on soil polygons, the different texture groups and their proportions in terms of land area in the KTM are listed in Table 8. Soil texture is determined in the laboratory and those delineated from soil polygons show the same trend, i.e. medium soil texture is dominant in the study area, while moderately fine texture makes up about 21 percent.

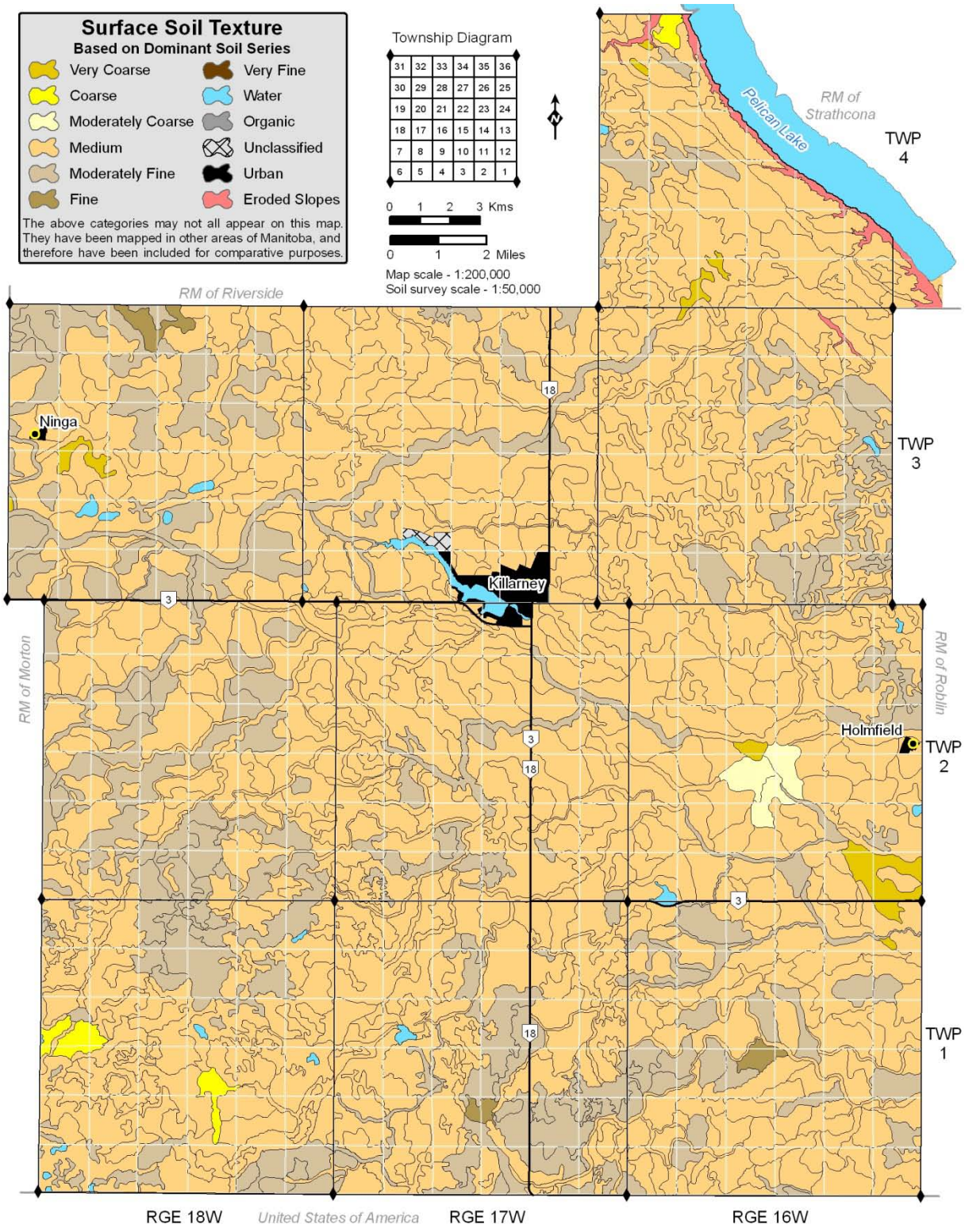
Table 8. Soil Texture Group and their Proportions in the KTM

Texture Group	Total area		% of RM
	ac	ha	
Very Coarse	1,861	753	0.80
Coarse	1,295	524	0.56
Moderately Coarse	1,270	514	0.54
Medium	173,957	70,398	74.57
Moderately Fine	49,270	19,939	21.12
Fine	828	335	0.35
Water/urban/ Unclassified*	4,814	1,948	2.06

*: including severely eroded slope.

Surface soil texture shown in Map 5 illustrates the textural group of the dominant soil for each polygon.

Map 5. Soil Surface Texture in the RM of KTM



4.6 Soil Drainage

Soil drainage refers to the frequency and duration of periods when the soil is free of saturation. Excessive water content in soil limits the free movement of oxygen and decreases the efficiency of nutrient uptake. Delays in spring tillage and planting are more frequent in depressional or imperfectly to poorly drained areas of a field. Improved surface drainage and underground tile drainage are management considerations that can reduce excessive moisture conditions in soils. The majority of poorly drained soils remain in the native state supporting vegetation associated with wetlands and marsh. Five soil drainage classes are indicated below.

Rapidly drained - water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow can occur on steep slopes during heavy rainfall. Soils have low water storage capacity and are usually coarse in texture.

Well-drained - excess water is removed from the soil, flowing downward readily into underlying pervious material or laterally as subsurface flow.

Imperfectly drained - water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. The source of moisture includes precipitation and/or groundwater.

Poorly drained - water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time when the soil is not frozen. The main water source is subsurface flow and/or groundwater in addition to precipitation.

Very poorly drained - water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time that the soil is not frozen. Excess water is present in the soil throughout most of the year.

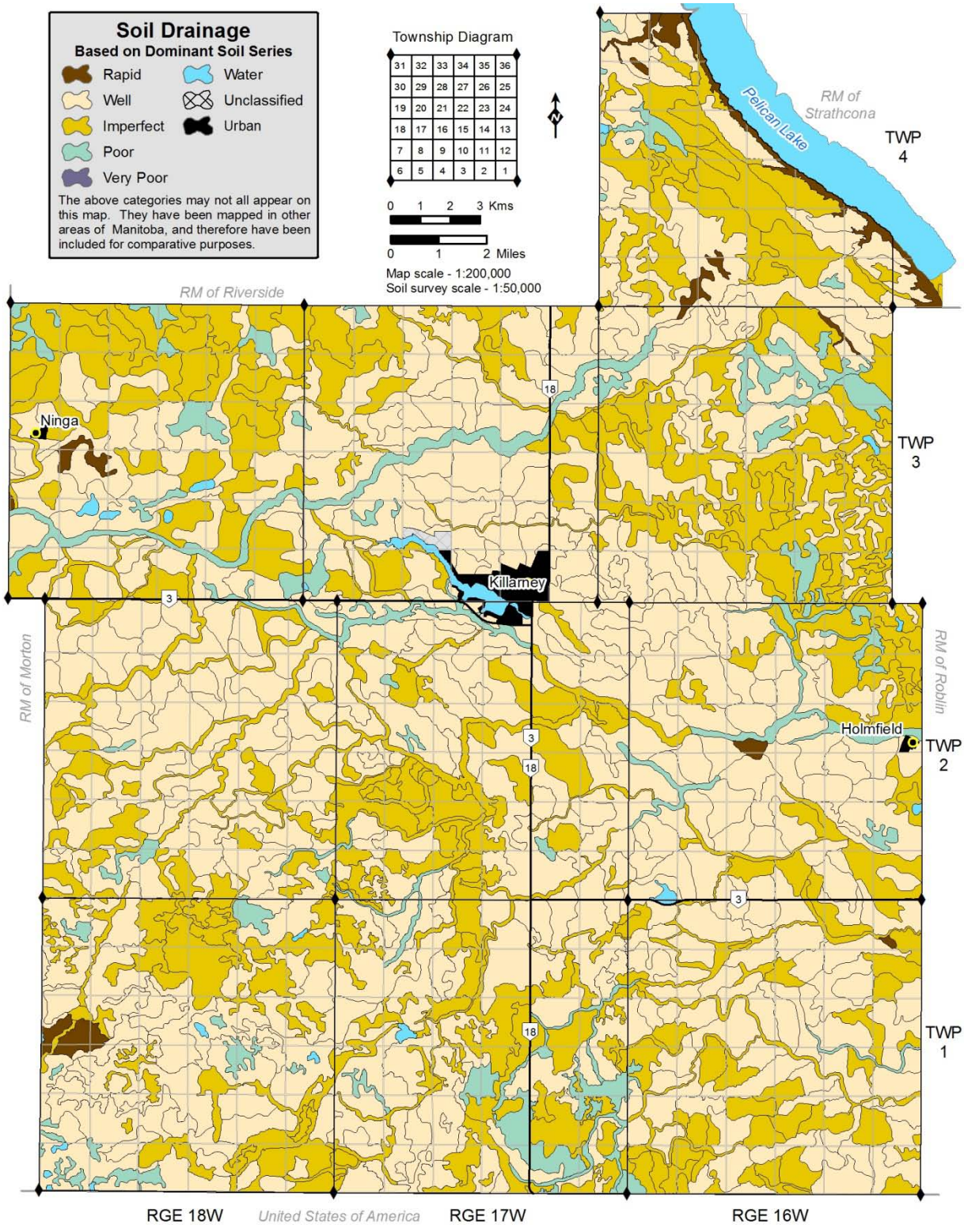
Soil drainage in Table 9 indicates that over half the soils in the RM of KTM are well drained. The imperfectly drained soils comprise one third of lands in the RM. The very poorly drained soils in the RM are included in the “poor” category but this kind of soil occurs in a relatively small area.

Table 9. Soil Drainage Classes in the KTM

Drainage Class	Total area		% of RM
	ac	ha	
Rapid	4,537	1,836	1.94
Well	125,594	50,826	53.84
Imperfect	78,505	31,770	33.65
Poor	22,262	9,009	9.54
Water/urban/ unclassified	2,394	969	1.03

The soil drainage map (Map 6) shows that well drained soils can be found throughout the RM but appear concentrated in Township 2 range 16 and 18, Township 3 range 17. The imperfectly drained soils are found southeast of Township 1 range 17 and most parts of Township 3 range 16 and range 18. The drainage map illustrates only the dominant soil for each polygon.

Map 6. Soil Drainage in the RM of KTM



4.7 Soil Erosion

Erosion is defined as the detachment and movement of soil particles by water, wind, ice or gravity. Soil erosion by water is the main concern on undulating and hummocky soil landscapes in the agricultural region of Manitoba. Soil loss resulting from rainfall-runoff is usually due to combinations of raindrop splash, sheet, and rill, gully and channel bank erosion. Sheet and rill erosion are usually least apparent in the landscape but, often the most damaging since it causes gradual thinning of the soil profile over the entire slope. Sheet erosion tends to occur on upper slopes and ridges whereas the more visible rills form in the area of concentrated runoff on mid and lower slopes. The deposition of eroded soil at the base of slopes or in ditches constitutes additional losses and costs attributed to erosion.

Wind erosion has its largest influence on sandy (coarse) textured, cultivated soils on relatively level landscapes. However, all soils are subject to wind erosion if vegetation or crop residues do not cover the soil surface. Continuous cropping and minimum or zero tillage to maximize residue cover will reduce the risk of erosion. Row crops such as potatoes produce low amounts of residue therefore, seeding annual crops like fall rye and winter wheat will help to protect the soil surface during the critical post harvest period until the establishment of groundcover the following spring.

The impact of soil erosion on soil loss and lowered productivity is not easily measured. In addition to nutrient loss from soil erosion there is physical deterioration of the soil resulting in lower water holding and infiltration capacity, and poorer surface structure. Crops are thus susceptible to more frequent and severe water stress and lower crop yields occur.

The ratings of soil erosion are generally classified into three classes.

Slightly eroded - soil with a sufficient amount of the A horizon removed that ordinary tillage will bring up and mix the B-horizon or lower horizons.

Moderately eroded - soil with the entire A horizon and a part of the B or lower horizons removed.

Severely eroded - soils which have practically all of the original surface soil removed and the tilled layer consists mainly of C-horizon material. This condition occurs on knolls and steep upper slope positions.

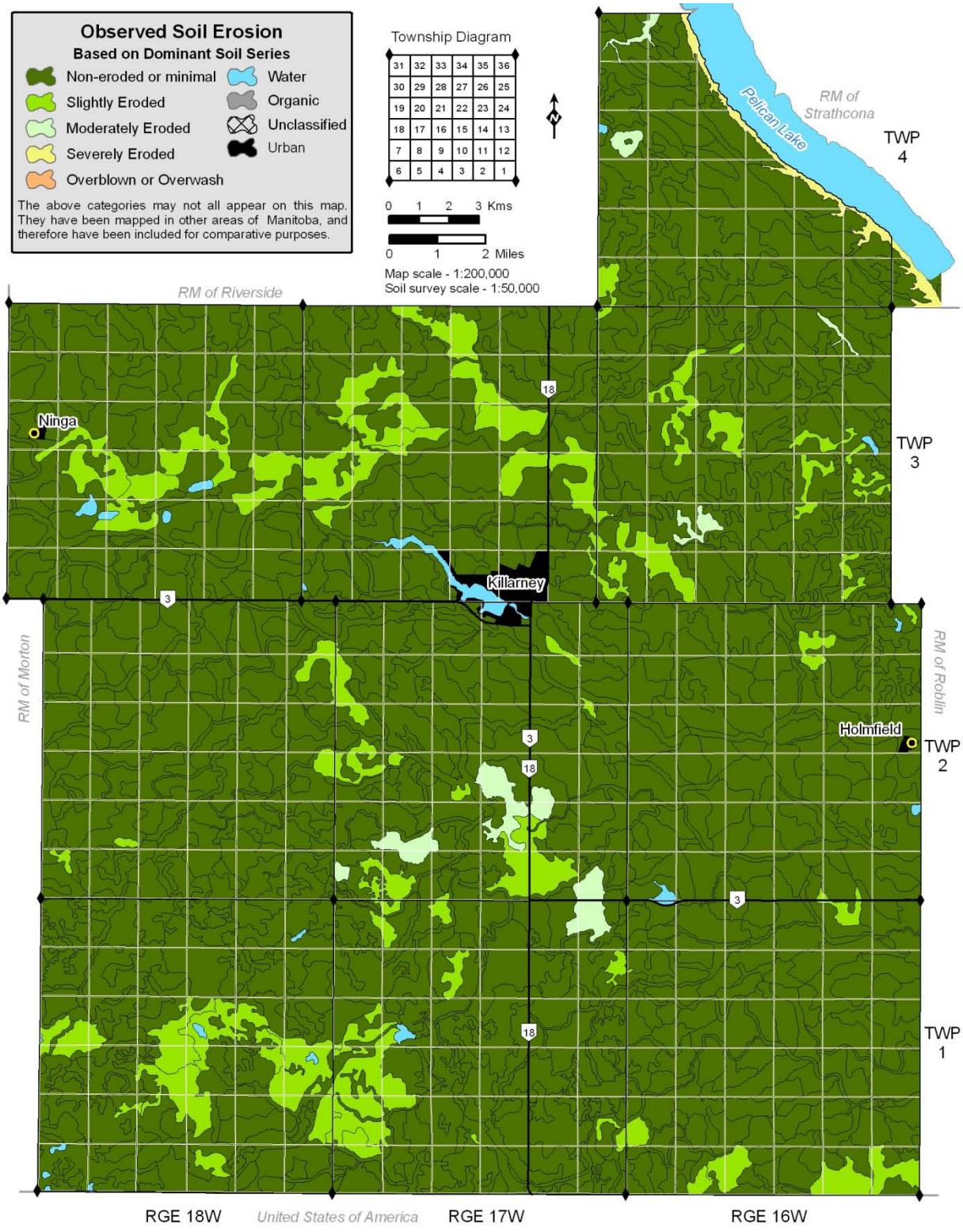
In general, soil erosion in the KTM is not severe. Approximately, nine tenth of the study area has minimal or non-eroded lands (Table 10). The eroded areas (slight, moderate and severe) account for about 10 percent, mainly occurring in or close to creeks, on steep slopes or on knolls of the glacial till.

Table 10. Soil Erosion Classes in the KTM

Observed Erosion Class	Total area		% of RM
	ac	ha	
Non-eroded or minimal	206,255	83,469	88.41
Slightly	19,896	8,052	8.53
Moderately	3,369	1,364	1.44
Severely	1,374	556	0.59
Water/urban/ unclassified	2,395	969	1.03

The degree of observed soil erosion shown on Map 7 is based on the dominant soil for each polygon.

Map 7. Soil Erosion Observed in the RM of KTM



4.8 Topography

Slope describes the steepness of the landscape surface. The degree and length of slope are important topographic factors affecting the potential for surface runoff and infiltration of precipitation.

Ten slope classes are used to denote the dominant but not necessarily most severe slopes within a mapping unit (Table 11).

Table 11. Slope Classes Used in Soil Map

Slope Class	Slope Description	% Slope
x	Level	0 - 0.5
b	Nearly level	>0.5 - 2.0
c	Very gently sloping	>2.0 - 5.0
d	Gently sloping	>5.0 - 9.0
e	Moderately sloping	>9.0 -15.0
f	Strongly sloping	>15.0-30.0
g	Very strongly sloping	>30.0-45.0
h	Extremely sloping	>45.0-70.0
i	Steeply sloping	>70.0-100
j	Very steeply sloping	>100

The topography in most lands of the RM of KTM is very gentle (Table 12). Some lands have slopes between five and nine percent. The steep slopes are usually found in the area close to creeks or lakes and the Turtle Mountain area in the southwest corner of the RM.

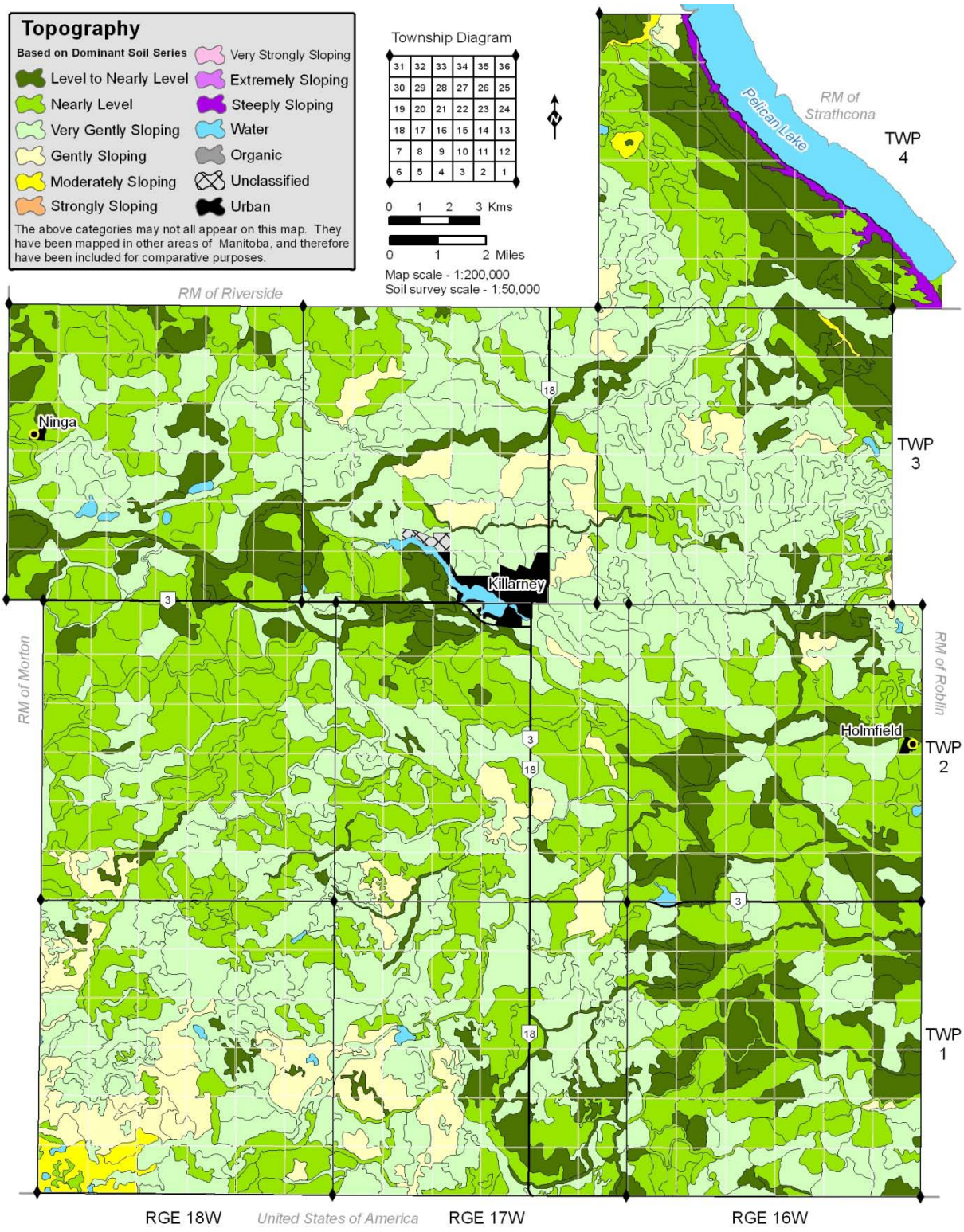
The gently undulating landform was formed by water from the melting ice and surface runoff from the east side of the Turtle Mountain as it flowed northeasterly toward the Pembina River. Sediments were deposited as a thin veneer over till and modified the commonly seen glacial till landscape into a gently undulating landform.

Table 12. Different slopes and their proportions in the KTM

Topography (slope classes)	Total area		% of RM
	ac	ha	
x	43,182	17,475	18.51
b	82,008	33,188	35.15
c	90,832	36,759	38.93
d	11,388	4,608	4.88
e	2,111	854	0.90
f	535	216	0.23
i	839	340	0.36
Water/urban/ Unclassified	2,394	969	1.03

Topography classes shown on Map 8 are based on the dominant soil for each polygon.

Map 8. Topography in the RM of KTM



4.9 Stoniness

Soils with stones can hinder tillage, planting and harvesting operations. The degree of stoniness is described by 5 classes. Class 1 stoniness is not considered a limitation for soil capability since there is little or no hindrance to cultivation and clearing is generally not required. Although stone clearing can be a mechanized procedure, it presents a management cost that does not occur in non-stony soils.

Size and amount describe rock fragments.

Gravel sized fragments are rounded or angular, 0.2 to 7.5 cm in diameter.

Cobbles are 7.5 to 25 cm in diameter and **stones** are 25 to 60 cm in diameter or if flat 38 to 60 cm long. The classes of stoniness are defined as follows:

Stones 0 or x. (Non-stony) - Land having less than 0.01% of surface occupied by stones.

Stones 1. (Slightly stony) - Land having 0.01 to 0.1% of surface occupied by stones. Stones are 15 to 30 cm in diameter, 10 to 30 m apart. The stones offer only slight to no hindrance to cultivation.

Stones 2. (Moderately stony) - Land having 0.1 to 3% of surface occupied by stones. Stones are 15 to 30 cm in diameter, 2 to 10 m apart. Stones cause some interference with cultivation.

Stones 3. (Very stony) - Land having 3 to 15% of surface occupied by stones. Stones are 15 to 30 cm in diameter, 1 to 2 m apart. There are sufficient stones to constitute a serious handicap to cultivation.

Stones 4. (Exceedingly stony) - Land having 15 to 50% of surface occupied by stones. Stones are 15 to 30 cm in diameter, 0.7 to 1.5 m apart. There are sufficient stones to prevent cultivation until considerable clearing has been done.

Stones 5. (Excessively stony) - Land having more than 50% of surface occupied by stones. Stones are 15 to 30 cm in diameter, less than 0.7 m apart. The land is too stony to permit cultivation until considerable clearing has occurred.

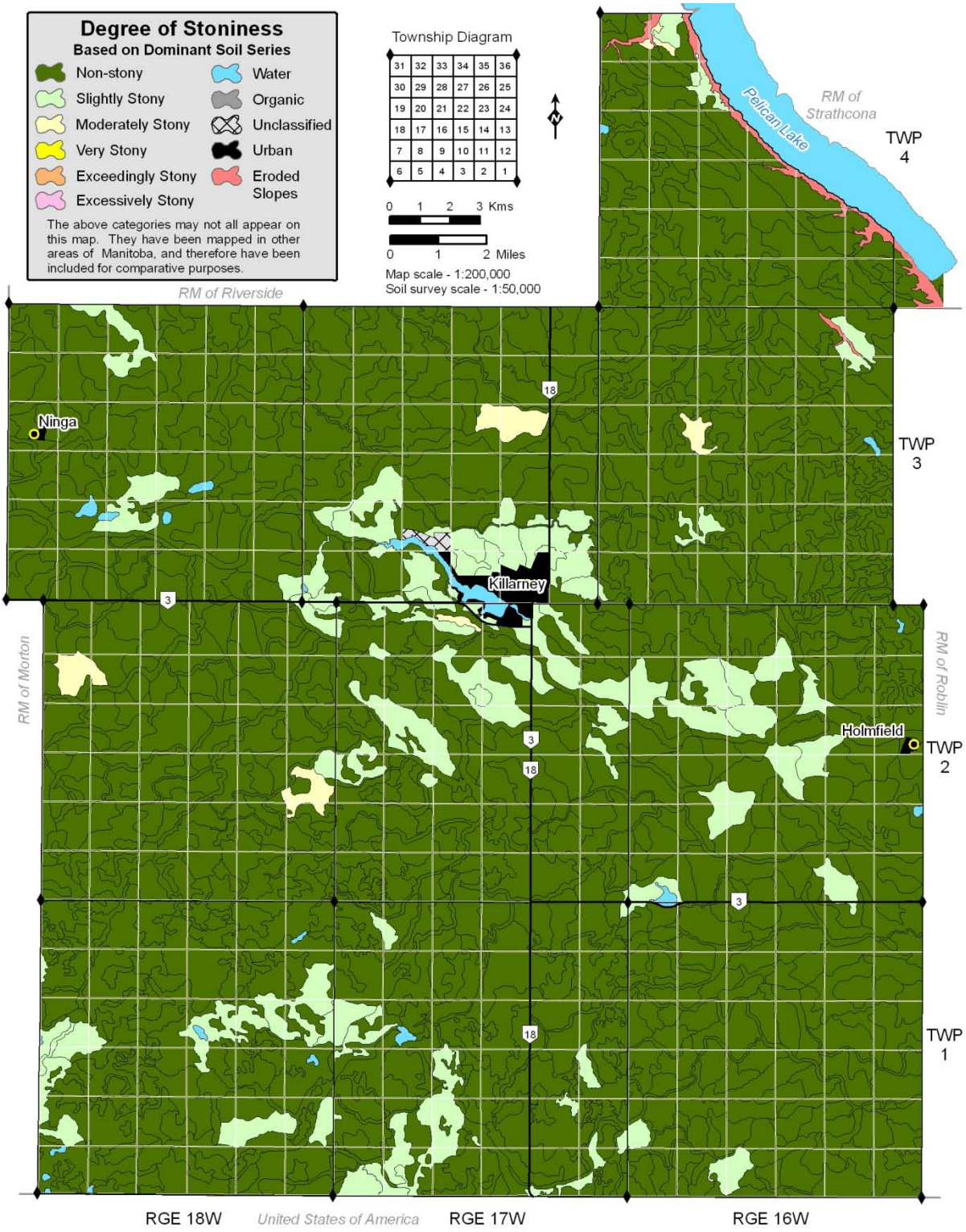
The RM of KTM is not considered stony. Slightly and moderately stony soils account for approximately 10 percent of the study area (Table 13). Slightly stony lands are found in Killarney area, extending to the southeast along the Long River. Also, there are slightly stony lands in south end of Stony Creek and northwest of the Boux Creek. Some previous stony fields have been improved since producers have been removing stones from their fields since the early 1970s. This notation is based on the comparison of the soil survey of Killarney Study Area, 1980 with this soil survey.

Table 13. Stoniness Classes in the KTM

Degree of Stoniness	Total area		% of RM
	ac	ha	
Non-stony	209,374	84,731	89.75
Slightly stony	19,381	7,843	8.31
Moderately stony	2,139	865	0.92
Very stony	0	0	0.00
Exceedingly stony	0	0	0.00
Excessively stony	0	0	0.00
Water/urban /unclassified	2,395	969	1.03

The degree of stoniness shown on Map 9 is based on the dominant soil for each polygon.

Map 9. Degree of Stoniness in the RM of KTM



4.10 Soil Chemical Properties

4.10.1 Soil Salinity

Saline soils have a high concentration of soluble salts (those which dissolve in water). The salts include sodium sulphate, magnesium sulphate, calcium sulphate, sodium chloride, magnesium chloride, calcium chloride and others.

The primary effect of salts in soils is the deprivation of water to plants. If the soil solution becomes too high in salts, the plants slowly starve, though the supply of water and dissolved nutrients in the soil may be sufficient.

In saline soils, crops usually grow poorly or not at all. At certain times of the year the salts may precipitate out on the surface of the soil leaving a white crust. Generally plants which are affected by soil salinity have a bluish-green appearance. Common field weeds such as Russian Thistle, Kochia, and Wild Barley often occur in areas of high salt concentration. In uncultivated areas plants such as Samphire, Desert Salt Grass and Greasewood are frequently dominant species (Henry et al, 1987).

Soil salinity is difficult to manage because it is influenced by soil moisture conditions. In wet years, there is sufficient leaching and dissolving of salts so that salts are not visible on the surface and some crop growth may be possible. In dry years, increased evaporation dries out the soil and draws salts up to the soil surface, producing a white crust.

Field instrumentation, using a non-contacting terrain conductivity meter (EM-38 or a Dual EM) can determine whether or not soluble salts are present.

Identification of salt affected areas and the selection of a salt tolerant crop is the most important management practices available to farmers.

A saline soil is defined as a soil with an electrical conductivity (EC) of the saturation extract greater than 4 milli-Siemens/cm (mS/cm), the exchangeable sodium percentage is less than 15, and the pH is usually less than 8.5.

Approximate limits of salinity classes are:

Class	EC mS/cm
Non-saline (x)	0 to 4
Weakly saline (s)	>4 to 8
Moderately saline (t)	>8 to 16
Strongly saline (u)	>16

Note: mS/cm is equivalent to dS/m

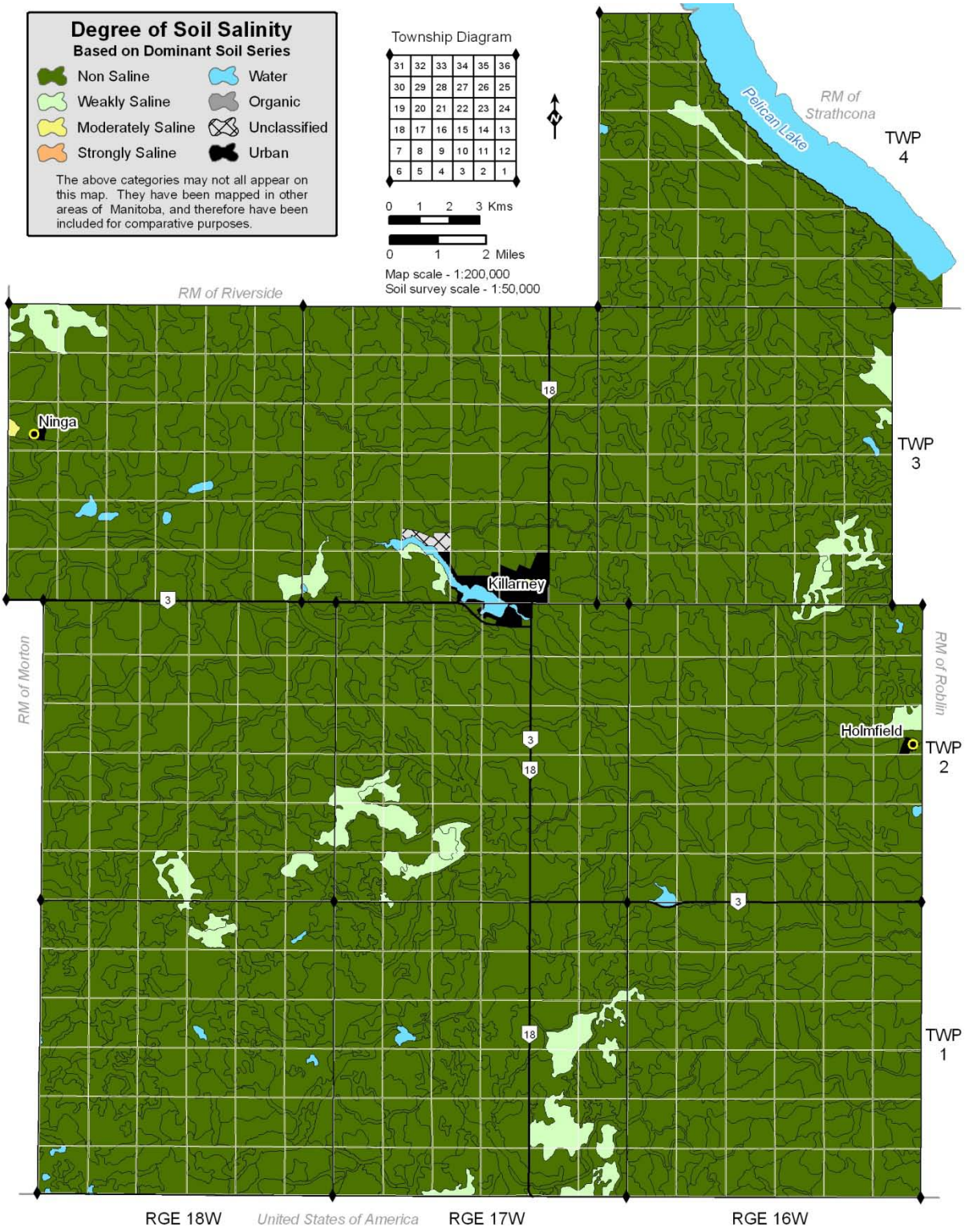
Soil salinity is not a problem for most soils in the RM of KTM (Table 14). Weakly or moderately saline soils are noted in the southeast of Township 1 Range 17, the southwest corner of Township 2 Range 17, and the southeast portion of Township 3 Range 16.

Table 14. Soil Salinity Classes in the KTM

Class of Salinity	Total area		% of RM
	ac	ha	
Non-saline	223,996	90,648	96.02
Weakly saline	6,856	2,775	2.94
Moderately saline	42	17	0.02
Water/urban/ Unclassified land	2,395	969	1.03

The class of salinity shown on Map 10 is based on the dominant soil for each polygon.

Map 10. Soil Salinity in the RM of KTM



4.10.2 Soil Cation Exchange Capacity, Organic Carbon, pH and $CaCO_3$

Cation exchange capacity (CEC) is a measure of the amount of ions that can be adsorbed, in an exchangeable fashion on the negative charge sites of the soil (Bache, 1976). CEC is used as a measure of fertility. Larger CEC values indicate that a soil has a greater capacity to hold cations. Prairie soils are generally high in CEC. The ploughed A horizons, regardless of containing carbonate (Apk) or salts (Apks), have a CEC value over 30 cmol per kilogram soil (Table 15). The CEC value declines dramatically with the depths. Calcium and magnesium are dominant cations in all horizons.

Soil organic carbon (SOC) in A horizon (507 samples) was lowest in the Rego soils, particularly in those soils derived directly from glacial till parent material. For example, the SOC averaged 2.68 percent (26.8 g per kg) in the Hathaway (HHY) series (Table 16). Whereas Maskawata soils (MAW) developed from lacustrine over glacial till have 3.99 percent SOC. The A horizon in the Hathaway soil is either eroded away or incorporated with underlying C horizon, thus resulting in a lower SOC concentration. In contrast, Orthic soils have a similar soil texture and soil drainage conditions, and developed from lacustrine over till (Waskada) or deep lacustrine (Cameron), and have a relatively higher SOC content since these soils are incorporated with the B horizon if part of A horizon is eroded. SOC in the B horizon is much higher than in the C horizon (Table 17). If Hathaway and Coatstone (Rego soils), or Ryerson and Regent (Orthic soils) are compared, imperfectly drained soils result in higher SOC concentrations.

Soil pH in the A horizon ranges from 4.05 to 8.21. Large variations are due to different chemical processes occurring in the A horizon. Soil carbonate is leached out in well drained soils (Ryerson, Waskada, Cameron, etc.) and results in lower pH values. While Dalny, Medora, and Schaffner (similar soil texture, but derived from different parent materials), have a Ca accumulation process, they have higher pH values.

Soil carbonate contents depend heavily on soil parent materials and chemical processes occurring in the A horizon. For example, both Hathaway and Bella Lake soils are high in carbonate concentration, but higher carbonate levels in Hathaway soils are due to the C horizon being incorporated with the A horizon, whereas high concentration of carbonate in Bella Lake soils are caused by carbonate accumulation in poorly drained conditions.

Table 15. CEC Values in Selected Soils

Soil name	Horizon	CEC	Dominant cation (%)	
		cmol/kg	Ca	Mg
Croll (CLL)	Apk	38.6	67.6	20.2
	ACkgj	20.0	85.1	9.15
	Ckgj	12.9	94.4	3.95
Desford (DFD)	Ap	33.6	70.1	26.7
	Bmgj	28.6	64.8	32.1
	Ckgj	17.5	42.6	53.8
Marsh Lake (MYK)	Apks	30.7	41.2	49.0
	Bmgjks	18.6	76.3	19.7
	Ckgjs	11.7	87.2	10.4

Table 16. Soil Chemical Properties in A Horizon from Selected Soils in the RM of KTM

Soil code	Soil name	Organic carbon (%)				Soil pH				Ca carbonate (%)				Electrical conductivity (mS/cm)			
		#	Min	Max	Ave	#	Min	Max	Ave	#	Min	Max	Ave	#	Min	Max	Ave
ARG	Argue	9	0.43	5.41	3.09	4	6.86	7.61	7.34	9	0.60	21.60	7.11	-	-	-	-
AXD	Alexander	6	3.29	7.43	4.97	6	7.20	8.06	7.61	6	0.00	24.40	8.45	3	2.58	9.53	5.48
BEF	Bearford	115	0.27	6.96	4.07	40	5.21	7.51	6.74	17	0.00	6.00	0.94	4	5.46	10.93	8.28
BEL	Bella Lake	1	5.50	5.50	5.50	1	7.84	7.84	7.84	1	28.70	28.70	28.70	1	6.75	6.75	6.75
BRO	Breadon	8	3.42	6.33	4.44	6	6.62	7.63	7.15	7	0.00	15.60	2.80	-	-	-	-
CLL	Croll	78	1.76	9.96	4.25	34	4.83	8.02	7.36	56	0.00	25.40	3.73	30	1.09	16.95	8.01
CME	Cranmer	11	2.91	9.65	5.02	6	7.04	7.78	7.55	11	0.00	17.18	4.37	3	5.48	9.70	7.74
CMR	Cameron	11	2.20	9.35	4.18	11	6.07	7.70	6.92	7	0.00	5.80	1.34	1	1.55	1.55	1.55
CSE	Coatstone	36	2.23	7.08	4.21	24	5.48	8.08	7.13	31	0.00	12.40	3.79	5	1.54	18.65	7.42
DFD	Desford	43	0.54	6.44	4.28	26	6.00	7.79	7.25	26	0.00	12.00	2.62	11	059	9.84	4.97
DNY	Dalny	25	1.45	6.40	3.55	12	7.13	7.81	7.45	21	0.20	8.80	2.84	5	0.64	2.78	1.36
DOM	Dromore	9	2.58	5.93	3.60	5	6.66	7.60	7.29	5	0.00	10.00	3.32	-	-	-	-
ELV	Elva	20	1.82	7.35	3.91	8	6.23	7.46	7.06	4	0.00	3.80	2.05	2	0.95	1.06	1.01
GLN	Glenview	7	4.03	6.87	5.55	6	6.68	7.63	7.31	6	1.00	3.70	1.83	6	1.92	9.71	4.20
GOL	Goodlands	11	3.00	7.82	4.72	4	7.03	8.11	7.56	10	0.60	7.20	3.46	4	1.94	9.68	4.82
GPE	Gopher C.	4	2.79	7.86	6.13	5	7.40	8.15	7.71	5	2.00	25.86	12.87	4	0.70	10.71	3.57
HHY	Hathaway	87	0.62	6.23	2.68	61	5.69	8.07	7.37	82	0.00	30.30	9.83	-	-	-	-
HRY	Hartney	2	2.90	5.76	4.33	1	7.76	7.76	7.76	1	19.06	19.06	19.06	1	4.63	4.63	4.63
JKE	Jackson C.	13	1.52	7.75	4.23	11	6.81	7.63	7.23	10	0.00	11.50	3.81	-	-	-	-
LEO	Leon	8	3.35	6.21	4.43	6	7.29	8.01	7.53	7	0.00	23.50	8.19	4	2.52	13.64	6.05
MAW	Maskawata	26	1.63	7.91	3.99	14	5.09	7.73	6.57	14	0.00	11.90	4.15	3	1.84	7.51	4.20
MDO	Medora	36	1.54	10.02	3.47	27	6.97	8.01	7.36	37	0.00	13.60	3.56	4	1.02	6.55	3.21
MOT	Montgomery	12	3.17	7.85	5.24	12	6.83	7.79	7.30	10	0.00	15.85	4.29	2	0.91	6.04	3.48
MYK	Marshy Lake	4	3.25	4.74	3.76	1	7.63	7.63	7.63	3	0.00	2.00	1.17	3	7.0	9.67	8.10
PPT	Pipestone	5	2.21	8.48	4.11	4	7.25	7.67	7.45	5	0.00	7.26	3.52	3	0.98	5.19	3.52
RGT	Regent	17	1.89	7.93	4.12	14	5.81	7.66	6.83	10	0.00	25.90	5.16	5	0.63	5.84	3.34
RYS	Ryerson	68	1.64	6.16	3.81	54	4.05	8.07	6.64	31	0.00	16.20	2.55	2	1.34	7.38	4.36
SFR	Schaffner	7	3.39	6.18	4.49	2	7.05	7.37	7.21	5	0.00	2.10	0.90	-	-	-	-
TWC	Two Creeks	6	3.27	5.90	4.45	5	6.96	8.21	7.45	5	0.00	11.30	3.50	3	0.84	10.98	7.06
WIW	Whitewater	8	2.45	9.32	5.97	2	7.48	8.09	7.79	7	0.73	24.20	10.82	4	0.70	14.45	6.23
WKD	Waskada	65	1.92	15.26	4.28	53	4.08	7.96	6.49	28	0.00	14.90	1.93	5	0.74	4.13	2.38

Table 17. Soil Chemical Properties in B and C Horizon from Selected Soils in the RM of KTM

Soil code	Soil name	Organic C (%) in B horizon				Ca carbonate (%) in B horizon				Organic C (%) in C horizon				Ca carbonate (%) in C horizon			
		#	Min	Max	Ave	#	Min	Max	Ave	#	Min	Max	Ave	#	Min	Max	Ave
ARG	Argue	-	-	-	-	-	-	-	-	3	0.38	0.65	0.55	-	-	-	-
AXD	Alexander	-	-	-	-	-	-	-	-	-	-	-	-	9	0.00	36.10	19.08
BEF	Bearford	13	0.83	3.41	1.45	6	0.0	3.7	1.4	6	0.36	1.04	0.62	67	0.00	37.70	18.19
BRO	Breadon	-	-	-	-	2	2.4	4.4	3.4	-	-	-	-	13	5.50	40.10	19.20
CLL	Croll	-	-	-	-	-	-	-	-	4	0.19	0.68	0.34	31	0.00	41.00	16.45
CME	Cranmer	-	-	-	-	-	-	-	-	-	-	-	-	8	0.00	35.25	20.70
CMR	Cameron	5	0.72	1.74	1.12	2	0.0	0.0	0.0	-	-	-	-	8	0.00	23.60	15.39
CSE	Coatstone	-	-	-	-	-	-	-	-	3	0.40	1.05	0.68	37	0.00	40.50	24.79
DFD	Desford	14	0.31	3.42	1.47	21	0.0	32.4	9.1	6	0.33	2.98	1.19	31	2.90	40.60	20.94
DNY	Dalny	9	0.62	1.98	1.24	22	0.0	27.1	9.4	3	0.35	0.69	0.57	26	7.80	51.20	19.37
DOM	Dromore	2	1.32	1.45	1.39	2	0.0	0.0	0.0	-	-	-	-	12	0.00	24.00	14.27
ELV	Elva	4	0.71	2.46	1.83	2	0.0	3.8	1.9	1	0.93	0.93	0.93	20	0.00	26.20	15.36
GLN	Glenview	4	1.13	1.90	1.55	5	0.0	17.3	7.7	-	-	-	-	12	0.00	36.00	17.50
GOL	Goodlands	3	1.53	2.05	1.71	4	6.5	18.9	12.2	1	0.06	0.06	0.06	9	2.10	18.40	11.62
GPE	Gopher C.	-	-	-	-	-	-	-	-	-	-	-	-	4	9.40	55.07	28.07
HHY	Hathaway	-	-	-	-	-	-	-	-	18	0.24	1.72	0.68	106	6.40	36.20	20.16
HRY	Hartney	-	-	-	-	-	-	-	-	-	-	-	-	2	29.15	29.15	29.15
JKE	Jackson C.	-	-	-	-	-	-	-	-	-	-	-	-	10	11.10	32.00	21.62
LEO	Leon	-	-	-	-	-	-	-	-	-	-	-	-	8	6.70	40.80	23.90
MAW	Maskawata	-	-	-	-	-	-	-	-	-	-	-	-	20	0.00	50.00	24.38
MDO	Medora	14	0.68	2.44	1.67	27	0.0	28.0	9.3	3	0.70	2.13	1.31	34	3.10	39.70	21.69
MOT	Montgomery	1	3.31	3.31	3.31	2	3.0	5.4	4.2	-	-	-	-	21	7.60	34.90	20.66
MYK	Marshy Lake	1	1.18	1.18	1.18	3	7.4	20.7	16.2	-	-	-	-	3	9.70	20.90	15.33
NWS	Newstead	-	-	-	-	1	7.7	7.7	7.7	-	-	-	-	3	5.40	11.00	9.03
PPT	Pipestone	-	-	-	-	-	-	-	-	-	-	-	-	4	26.43	39.49	32.18
RGT	Regent	2	1.42	3.09	2.26	3	0.0	40.3	18.8	2	0.48	1.29	0.89	14	13.00	42.20	24.92
RYS	Ryerson	30	0.57	2.85	1.30	16	0.0	7.7	0.9	8	0.44	0.91	0.66	60	0.00	49.30	23.34
SFR	Schaffner	1	2.15	2.15	2.15	6	0.7	11.7	8.0	-	-	-	-	6	11.60	48.30	22.00
TWC	Two Creeks	5	0.67	1.97	1.07	-	-	-	-	1	0.84	0.84	0.84	6	6.10	29.93	19.37
WIW	Whitewater	-	-	-	-	5	0.0	24.0	10.8	-	-	-	-	5	15.60	29.80	25.70
WKD	Waskada	23	0.61	3.82	1.38	11	0.0	27.6	2.6	7	0.22	0.85	0.48	53	0.00	37.70	17.74

Part 5 Soil Suitability for Selected Engineering and Recreational Uses

5.1 Introduction

This section provides information that can be used by engineers and land use planners. It is intended to supplement the information on the soil map with additional data on engineering properties of soils.

5.2 Soil Suitability for Selected Engineering Uses

The criteria used to evaluate soil suitability for selected engineering and related recreational uses are adopted from guides found in Coen et al (1977), and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture (USDA, 1971), and the Canada Soil Survey Committee (CSSC, 1973).

The evaluation of soil suitability for engineering and recreation uses is based on both internal and external soil characteristics. Four soil suitability classes are used to evaluate both mineral and organic soils. These ratings express relative degrees of suitability or limitation for potential uses of natural or essentially undisturbed soils. The long-term effects of the potential use on the behaviour of the soil are considered in the rating.

The four suitability class ratings are defined as follows:

(G) Good - Soils in their present state have few or minor limitations that would affect the proposed use. The limitations can easily be overcome with minimal cost.

(F) Fair - Soils in their present state have one or more moderate limitations that would affect the proposed use. These moderate limitations can be overcome with special construction, design, planning or maintenance.

(P) Poor - Soils in their present state have one or more severe limitations that can severely affect the proposed use. To overcome these severe limitations, the removal of the limitation would be difficult or costly.

(V) Very Poor - Soils have one or more unfavourable features for the proposed use and the limitation is very difficult and expensive to overcome, or the soil would require such extreme alteration that the proposed use is economically impractical.

The basic soil properties that singly or in combination with others affect soil suitability for selected engineering and recreation uses are provided in Table 18. These subclass designations serve to identify the kind of limitation or hazard for a particular use.

In assessing soil suitability for various engineering uses, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed soil properties. For example, if the suitability is "Good" for all but one soil property and it is estimated to be "Very Poor", then the overall rating of the soil for that selected use is "Very Poor". Suitability of individual soil properties, if estimated to be "Fair" or "Poor", can be accumulative in their effect for a particular use. Judgement is required to determine whether the severity of the combined effects of several soil properties on suitability for a particular use will result in downgrading an evaluation. This is left to the discretion of the interpreter. It is incorrect to assume that each of the major soil properties influencing a particular use has an equal effect. Class limits established for rating the suitability of individual soil properties take this into account. For a selected use, therefore, only those soil properties, which most severely limit that use, are specified.

Table 18. Codes Used to Identify Subclass Limitations in Evaluating Soil Suitability for Selected Engineering Uses in Table A8 of Appendix 1

Code	Description
a	subgrade properties
b	thickness of topsoil
c	coarse fragments on surface
d	depth to bedrock
e	erosion or erodibility
f	susceptibility to frost hazard
g	contamination hazard of groundwater
h	depth to seasonal water table
i	flooding or inundation
j	thickness of slowly permeable material
k	permeability or hydraulic conductivity
l	shrink-swell properties
m	moisture limitations or deficit
n	salinity or sulphate hazard
o	organic matter
p	stoniness
q	depth to sand or gravel
r	rockiness
s	surface texture
t	topographic slope class
u	moist consistence
w	wetness or soil drainage class
z	permafrost

The suitability ratings of soils for ten selected engineering uses are shown in Table A8 of Appendix 1. When using these interpretations, consideration must be given to the following assumptions:

1. Soil ratings do not include site factors such as proximity to towns and highways, water supply, aesthetic values, etc.

2. Soil ratings are based on natural, undisturbed conditions.

3. Soil suitability ratings are usually given for the entire soil depth, but for some uses they may be based on the limitations of an individual soil horizon or layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1 to 2 metres, but in some soils, reasonable estimates can be given for soil material at greater depths.

4. Poor and very poor soil ratings do not imply that a site cannot be changed to remove, correct or modify the limitations.

5. Interpretations of map units do not eliminate the need for on-site evaluation by qualified professionals. Due to the variable nature of soils and the scale of mapping, small, unmappable inclusions of soils with different properties may be present in an area where a development is planned.

Guides for evaluating soil suitability for engineering uses are presented in Tables of A9 to A18 of Appendix 1.

5.3 Soil Suitability for Selected Recreational Uses

This section provides interpretations of the soil suitability for recreational development. All types of soil can be used for recreational activities of some kind.

Soils and their properties contribute to the determination of the type and location of recreational facilities. Wet soils are not suitable for campsites, roads, playgrounds or picnic areas. Soils that pond and dry out slowly after heavy rains present problems where intensive use is planned. It is difficult to maintain grass cover for playing fields and golf courses on droughty soils. The feasibility of many kinds of outdoor activities are determined by many basic soil properties such as depth to bedrock, stoniness, topography or land pattern, and the ability of the soil to support vegetation of different kinds as related to its natural fertility.

The suitability of the various soil series and phases for selected recreational uses is shown in Table A8 of Appendix 1. The four classes, Good, Fair, Poor and Very Poor are defined in the section on Engineering Uses. Subclasses are the same as described in Table 18. Guides for evaluating soil suitability for recreational uses are presented in Tables of A19 to A22 of Appendix 1.

Appendix 1

A: Definitions of the Agricultural Capability Classes

Class 1

Soils in this Class have no important limitations for crop use. The soils have level or gently sloping topography; are deep, well to imperfectly drained and have moderate water holding capacity. The soils are naturally well supplied with plant nutrients, easily maintained in good tilth and fertility. Soils are moderately high to high in productivity for a wide range of cereal and special crops.

Class 2

Soils in this Class have moderate limitations that reduce the choice of crops or require moderate conservation practices. The soils have good water holding capacity and are either naturally well supplied with plant nutrients or are highly responsive to the addition of fertilizer. They are moderate to high in productivity for a fairly wide range of crops. The limitations are not severe and good soil management and cropping practices can be applied without serious difficulty.

Class 3

Soils in this Class have moderately severe limitations that restrict the range of crops or require special conservation practices. The limitations in Class 3 are more severe than those in Class 2 and conservation practices are more difficult to apply and maintain. The limitations affect the timing and ease of tillage, planting and harvesting, the choice of crops and maintenance of conservation practices. The limitations include one or more of the following: moderate climatic limitation, erosion, structure or permeability, low fertility, topography, overflow, wetness, low water holding capacity or slowness in release of water to plants, stoniness and depth of soil to consolidated bedrock. Under good management, these soils are fair to moderately high in productivity for a fairly wide range of field crops.

Class 4

Soils in this Class have severe limitations that restrict the choice of crops or require special conservation practices or both. These soils have such limitations that they are only suited for a few crops or the yield for a range of crops may be low, or the risk of crop failure is high. The limitations may seriously affect such farm practices as the timing and ease of tillage, planting and harvesting, and the application and maintenance of conservation practices. These soils are low to medium in productivity for a narrow range of crops but may have higher productivity for a specially adapted crop. The limitations include the adverse effects of one or more of the following: climate, accumulative undesirable soil characteristics, low fertility, reduced storage capacity or release of soil moisture to plants, structure or permeability, salinity, erosion, topography, overflow, wetness, stoniness, and depth of soil to consolidated bedrock.

Class 5

Soils in this Class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. These soils have severe soil, climatic or other limitations and are not capable of sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame perennial forage species. Feasible improvement practices include clearing of bush, cultivation, seeding, fertilization and water control. Some soils in Class 5 can be used for cultivated field crops provided intensive management is used. Some of these soils are also adapted to special crops requiring soil conditions unlike those needed by the common crops.

Class 6

Soils in this Class are capable only of producing perennial forage crops and improvement practices are not feasible. Class 6 soils have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic or other limitations as to make impractical the application of improvement practices

that can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents the use of farm machinery, or because the soils are not responsive to improvement practices, or because stock watering facilities are inadequate.

Class 7

Soils in this class have no capability for arable culture or permanent pasture because of extremely severe limitations. Bodies of water too small to delineate on the map are included in this class. These soils may or may not have a high capability for forestry, wildlife and recreation.

B: Agricultural Capability Subclass Limitations

C - Adverse climate: This subclass denotes a significant adverse climate for crop production as compared to the "median" climate which is defined as one with sufficiently high growing season temperatures to bring field crops to maturity, and with sufficient precipitation to permit crops to be grown each year on the same land without a serious risk of partial or total crop failures.

D - **Undesirable soil structure and/or low permeability:** This subclass is used for soils difficult to till, or which absorb water very slowly or in which the depth of rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

E - **Erosion:** Subclass E includes soils where damage from erosion is a limitation to agricultural use. Damage is assessed on the loss of productivity and on the difficulties in farming land with gullies.

F - Low fertility: This subclass is made up of soils having low fertility that either is correctable with careful management in the use of fertilizers and soil amendments or is difficult to correct in a feasible way. The limitation may be due to lack of available plant nutrients, high acidity or alkalinity, low exchange capacity, high levels of carbonates or presence of toxic compounds.

I - Inundation by streams or lakes: This subclass includes soils subjected to inundation causing crop damage or restricting agricultural use.

L - **Coarse wood fragments:** In the rating of organic soils, woody inclusions in the form of trunks, stumps and branches (>10 cm diameter) in sufficient quantity to significantly hinder tillage, planting and harvesting operations.

M - Moisture limitation: This subclass consists of soils where crops are adversely affected by droughtiness owing to inherent soil characteristics. They are usually soils with low water-holding capacity.

N - **Salinity:** Designates soils, which are adversely affected by the presence of soluble salts.

P - **Stoniness:** This subclass is comprised of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations. Stony soils are usually less productive than comparable non-stony soils.

R - **Consolidated bedrock:** This subclass includes soils where the presence of bedrock near the surface restricts their agricultural use. Consolidated bedrock at depths greater than 1 metre from the surface is not considered as a limitation, except on irrigated lands where a greater depth of soil is desirable.

T - **Topography:** This subclass is made up of soils where topography is a limitation. Both the percent of slope and the pattern or frequency of slopes in different directions are important factors in increasing the cost of farming over that of smooth land, in decreasing the uniformity of growth and maturity of crops, and in increasing the hazard of water erosion.

W - Excess water: Subclass W is made up of soils where excess water other than that brought about by inundation is a limitation to their use for agriculture. Excess water may result from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.

X - **Cumulative minor adverse characteristics:** This subclass is made up of soils having a moderate limitation caused by the cumulative effect of two or more adverse characteristics which singly are not serious enough to affect the class rating.

Table A1. Dryland Agriculture Capability Guidelines for Manitoba*

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7
Subclass Limitations	No significant limitations in use for crops.	Moderate limitations that restrict the range of crops or require moderate conservation practices.	Moderately severe limitation that restrict the range of crops or require special conservation practices.	Severe limitations that restrict the range of crops or require special conservation practices or both.	Very severe limitations that restrict soil capability to produce perennial forage crops, and improvement practices are feasible.	Soils are capable only of producing perennial forage crops, and improvement practices are not feasible.	No capability for arable culture or permanent pasture.
Climate (C)	All Ecodistricts[1] within ARDA boundary not explicitly listed under 2C and 3C.	Ecodistricts: 664, 666, 668, 670, 671, 672, 674, 675, 676, 677, 714, 715, 716	Ecodistricts: 356, 357, 358, 359, 363, 366, 663, 665	None within ARDA boundary			
Consolidated Bedrock (R)				> 50 -100 cm	20 - 50 cm	< 20 cm	Surface bedrock Fragmental over bedrock
Moisture limitation[2] (M)		Stratified loams Moderate moisture holding capacity	Loamy sands Low moisture holding capacity	Sands Very low moisture holding capacity	Skeletal sands Very severe moisture deficiency	Stabilized sand dunes	Active sand dunes
Topography[3] (T)	a, b (0 - 2%)	c (> 2 - 5%)	d (> 5 - 9%)	e (> 9 - 15%)	f (> 15 - 30%)	g (> 30 - 45%) Eroded slope complex	h (> 45 - 70%) i (> 70 - 100%) j (> 100%)
Structure and/or Permeability (D)	Granular clay	Massive clay or till soils[4] Slow permeability	Solonetzic intergrades Very slow permeability	Black Solonetz Extremely slow permeability			
Salinity[5] (N) **0 - 60 cm depth** **60 - 120 cm depth**	NONE < 2 dS/m < 4 dS/m	WEAK 2 - 4 dS/m 4 - 8 dS/m	MODERATE (s) > 4 - 8 dS/m > 8 - 16 dS/m	STRONG (t) > 8 - 16 dS/m > 16 - 24 dS/m	VERY STRONG (u) [6] > 16 - 24 dS/m > 24 dS/m		Salt Flats
Inundation[7] (I)	No overflow during growing season	Occasional overflow (1 in 10 years)	Frequent overflow (1 in 5 years) Some crop damage	Frequent overflow (1 in 5 years) Severe crop damage	Very frequent (1 in 3 years) Grazing > 10 weeks	Very frequent Grazing 5 - 10 weeks	Land is inundated for most of the season
Excess Water (W)	Well and Imperfectly drained		Loamy to fine textured Gleysols with improved drainage	Coarse textured Gleysols with improved drainage	Poorly drained, no improvements	Very Poorly drained	Open water, marsh
Stoniness (P)	Nonstony (0) and Slightly Stony (1)	Moderately Stony (2)	Very Stony (3) [8]	Exceedingly Stony (4) [9]		Excessively Stony (5)	Cobbly Beach Fragmental
Erosion[10] (E)		Moderate erosion (2)	Severe wind or water erosion (3) lowers the basic rating by one class to a minimum rating of Class 6 [11].				
Cumulative minor adverse Characteristics[12] (X)							

* Based on the Canada Land Inventory Soil Capability Classification for Agriculture (1965), with modifications made for soil application at larger mapping scales.

1 Smith, R.E., H. Veldhuis, G.F. Mills, R.G. Eilers, W.R. Fraser, M. Santry, 1996. Terrestrial Ecoregions and Ecodistricts of Manitoba, An Ecological Stratification of Manitoba's Natural Landscapes. Agriculture and Agri-Food Canada, Research Branch, Brandon Research Centre, Manitoba Land Resource Unit, Winnipeg, MB. Report and Provincial Map at scale of 1:1.5m.

2 With the exception of Class 2, ratings as indicated are based on the assumption of a single parent material, using the most readily drained representative of each textural class. Prevailing climatic conditions within the Ecodistrict, soil drainage and stratification will affect the moisture limitation accordingly.

3 Topographic classes are based on the most limiting slope covering a significant portion of an area of complex, variable slopes. Map units with long, unidirectional slopes may be considered equivalent or one class worse due to an increased erosion hazard.

4 Extremely calcareous loamy till soils with a high bulk density (>1.7 g/cm^3) are rated 3D.

5 Soil Salinity is reported in DeciSiemens/metre (dS/m). Soil will be classed according the most saline depth. For example, if a soil is non-saline from 0-60 cm but moderately saline from 60 - 120 cm, the soil will be classed as moderately saline (3N).

6 Strongly saline (u) soils are rated 5N with the exception of poorly and very poorly drained soils, which are rated 6NW.

7 Inundation may be listed as a secondary subclass for some fluvial soils. In this case, inundation is not class determining, but may become a limitation if the soil is otherwise improved.

8 Extremely calcareous loamy till soils with a high bulk density (>1.7 g/cm^3) and stony 3 are rated 4DP (4RP if depth to bedrock is 50 - 100 cm).

9 Stony 4 soils will be rated 4P unless their primary physical composition is sandy skeletal or their parent material is till. In either or both of these cases, the soil will be rated 5P.

10 If erosion is moderate, a subclass of E is assigned as a secondary limitation, but the basic rating is not lowered. If erosion is severe, the basic soil rating is downgraded by one class, and E becomes the primary limitation. For example, if a soil has a basic rating of 4T, the presence of moderate erosion will result in a rating of 4TE. If erosion is severe, the rating will be lowered to 5ET. Erosion will be the sole limitation only if the basic rating has a subclass of X. For example, a soil with a rating of 3X will be assigned a rating of 3E if moderate erosion is present.

11 The rating is not lowered from Class 6 based on erosion. A rating of 6TE indicates a soil with g topography and either moderate or severe erosion.

12 Use only for soils with no other limitation except climate. The subclass represents soils with a moderate limitation caused by the cumulative effect of two or more adverse characteristics which are singly not serious enough to affect the rating. Because the limitation is moderate, soils may only be downgraded by one class from their initial climate limitation. Therefore, a soil with a climate limitation of 2C and 2 or more minor adverse characteristics will be rated as 3X. This symbol is always used alone.

Table A2-1. Ag Capability and Irrigation Suitability of Soils with Different Phases

Soil code / phase	Soil name	Drainage	Surface texture	Agriculture capability	Irrigation suitability			Total area	
					Class	General rating	Rating for potatoes	ha	ac
AHY/xbxx	Ashbury	Imperfect	LVFS	2M	3w A	Fair	4	14	35
ARG/xbxx	Argue	Well	L	2X	1 A	Excellent	1	119	294
ARG/xcxx	Argue	Well	L	2T	1 Bt2	Good	1	10	25
ARG/xxxx	Argue	Well	L	2X	1 A	Excellent	1	27	67
AXD/xbxs	Alexander	Imperfect	L	3N	3sw A	Fair	4	17	42
AXD/xbxx	Alexander	Imperfect	L	2M	3w A	Fair	4	138	341
AXD/xxxs	Alexander	Imperfect	L	3N	3sw A	Fair	4	89	220
AXD/xxxx	Alexander	Imperfect	L	2M	3w A	Fair	4	848	2,095
BED/1c1x	Bede	Rapid	LS	5M	4m Bt2	Poor	5	114	282
BED/xbxx	Bede	Rapid	LS	5M	4m A	Poor	5	89	220
BED/xc2x	Bede	Rapid	LS	5M	4m Bt2	Poor	5	20	49
BED/xcxx	Bede	Rapid	LS	5M	4m Bt2	Poor	5	124	306
BED/xd1x	Bede	Rapid	LS	5M	4m Ct2	Poor	5	37	91
BED/xxxx	Bede	Rapid	LS	5M	4m A	Poor	5	19	47
BEF/1cxx	Bearford	Well	CL	2T	2kx Bt2	Good	4	32	79
BEF/xb1x	Bearford	Well	CL	1	2kx A	Good	4	42	104
BEF/xbxx	Bearford	Well	CL	1	2kx A	Good	4	1,272	3,143
BEF/xcxx	Bearford	Well	CL	2T	2kx Bt2	Good	4	999	2,469
BEF/xdxx	Bearford	Well	CL	3T	2kx Ct2	Fair	4	23	57
BEF/xxxx	Bearford	Well	CL	1	2kx A	Good	5	788	1,947
BEL/xbxx	Bella Lake	Poor	L	5W	4w A	Poor	5	122	301
BEL/xxxx	Bella Lake	Poor	L	5W	4w A	Poor	5	117	289
BIC/xb2x	Bernice	Well	GRLS	5M	4gm A	Poor	5	10	25
BIC/xx2x	Bernice	Well	GRLS	5M	4gm A	Poor	5	7	17
BIC/xxxx	Bernice	Well	GRLS	5M	4gmA	Poor	5	41	101
BOW/xbxx	Bower	Imperfect	L	2M	3w A	Fair	4	41	101
BOW/xcxx	Bower	Imperfect	L	2MT	3w Bt2	Fair	4	78	193
BOW/xxxx	Bower	Imperfect	L	2M	3w A	Fair	4	23	57
BRO/xbxx	Breadon	Well	L	3M	2gm A	Good	3	94	232
BRO/xc2x	Breadon	Well	L	3M	2gm Bt2	Good	5	40	99
BRO/xcxx	Breadon	Well	L	3M	2gm Bt2	Good	3	10	25
CLL/xb1x	Croll	Imperfect	CL	2W	3w A	Fair	4	152	376
CLL/xbxs	Croll	Imperfect	CL	3N	3sw A	Fair	4	586	1,448
CLL/xbxx	Croll	Imperfect	CL	2W	3w A	Fair	4	2,592	6,405
CLL/xc1s	Croll	Imperfect	CL	3N	3sw Bt2	Fair	4	29	72
CLL/xcxx	Croll	Imperfect	CL	2WT	3w Bt2	Fair	4	779	1,925
CLL/xxxs	Croll	Imperfect	CL	3N	3sw A	Fair	4	39	96
CLL/xxxx	Croll	Imperfect	CL	2W	3w A	Fair	4	609	1,505
CME/1cxx	Cranmer	Imperfect	CL	2WT	3w Bt2	Fair	3	15	37
CME/xbxs	Cranmer	Imperfect	CL	3N	3sw A	Fair	4	58	143
CME/xbxx	Cranmer	Imperfect	CL	2W	3w A	Fair	3	458	1,132
CME/xcxs	Cranmer	Imperfect	CL	3N	3sw Bt2	Fair	4	12	30
CME/xcxx	Cranmer	Imperfect	CL	2WT	3w Bt2	Fair	3	1,101	2,721
CME/xxxx	Cranmer	Imperfect	CL	2W	3w A	Fair	3	136	336

Table A2-2. Ag Capability and Irrigation Suitability of Soils with Different Phases

Soil code / phase	Soil name	Drainage	Surface texture	Agriculture capability	Irrigation suitability			Total area	
					Class	General rating	Rating for potatoes	ha	ac
CMR/1c1x	Cameron	Well	L	2T	1Bt2	Good	4	24	59
CMR/1cxx	Cameron	Well	L	2T	1 Bt2	Good	1	39	96
CMR/xb1x	Cameron	Well	L	2X	1 A	Excellent	4	20	49
CMR/xbxx	Cameron	Well	L	2X	1 A	Excellent	1	448	1,107
CMR/xcxx	Cameron	Well	L	2T	1 Bt2	Good	1	416	1,028
CMR/xdxx	Cameron	Well	L	3T	1 Ct2	Fair	4	7	17
CMR/xxxx	Cameron	Well	L	2X	1 A	Excellent	1	39	96
COU/xbxx	Coulter	Imperfect	CL/C	2IW	3w A	Fair	3	115	284
CSE/1cxx	Coatstone	Imperfect	L/CL	2WT	3w Bt2	Fair	4	25	62
CSE/xb1x	Coatstone	Imperfect	L/CL	2W	3w A	Fair	4	199	492
CSE/xbxs	Coatstone	Imperfect	L/CL	3N	3sw A	Fair	4	174	430
CSE/xbxx	Coatstone	Imperfect	L/CL	2W	3w A	Fair	4	2,891	7,144
CSE/xc1x	Coatstone	Imperfect	L/CL	2WT	3w Bt2	Fair	4	129	319
CSE/xcxs	Coatstone	Imperfect	L/CL	3N	3sw Bt2	Fair	4	178	440
CSE/xcxx	Coatstone	Imperfect	L/CL	2WT	3w Bt2	Fair	4	1,899	4,693
CSE/xx1x	Coatstone	Imperfect	L/CL	2W	3w A	Fair	4	7	17
CSE/xxxx	Coatstone	Imperfect	L/CL	2W	3w A	Fair	4	615	1,520
CWG/xxxx	Cartwright	Imperfect	GRLS	4M	4m A	Poor	5	164	405
DFD/xb1x	Desford	Imperfect	CL	2W	3w A	Fair	4	18	44
DFD/xbxs	Desford	Imperfect	CL	3N	3sw A	Fair	4	203	502
DFD/xbxx	Desford	Imperfect	CL	2W	3w A	Fair	4	728	1,799
DFD/xcxs	Desford	Imperfect	CL	3N	3sw Bt2	Fair	4	85	210
DFD/xcxx	Desford	Imperfect	CL	2WT	3w Bt2	Fair	4	338	835
DFD/xxxx	Desford	Imperfect	CL	2W	3w A	Fair	4	93	230
DNY/xbxx	Dalny	Well	L	2X	2kx A	Good	4	385	951
DNY/xcxx	Dalny	Well	L	2T	2kx Bt2	Good	4	354	875
DNY/xdxx	Dalny	Well	L	3T	2kx Ct2	Fair	4	26	64
DNY/xxxx	Dalny	Well	L	2X	2kx A	Good	4	48	119
DOM/1dxx	Dromore	Well	L	3MT	2gm Ct2	Fair	4	10	25
DOM/xbxx	Dromore	Well	L	3M	2gm A	Good	3	586	1,448
DOM/xc1x	Dromore	Well	L	3M	2gm Bt2	Good	4	65	161
DOM/xcxx	Dromore	Well	L	3M	2gm Bt2	Good	3	343	848
DOM/xxxx	Dromore	Well	L	3M	2gm A	Good	3	193	477
DRI/xbxx	Deloraine	Poor	L	5W	4w A	Poor	5	97	240
DRI/xx1s	Deloraine	Poor	L	5W	4w A	Poor	5	102	252
DRI/xxxs	Deloraine	Poor	L	5W	4w A	Poor	5	73	180
DRI/xxxx	Deloraine	Poor	L	5W	4w A	Poor	5	1,683	4,159
EBL/xbxx	Emblem	Poor	L	5W	4w A	Poor	5	65	161
EBL/xcxx	Emblem	Poor	L	5W	4w Bt2	Poor	5	35	86
EBL/xxxx	Emblem	Poor	L	5W	4w A	Poor	5	173	427
ELV/xbxx	Elva	Well	CL	1	2k A	Good	2	54	133
ELV/xcxx	Elva	Well	CL	2T	2k Bt2	Good	2	370	914
ELV/xxxx	Elva	Well	CL	1	2k A	Good	2	130	321
ELV[1]/xxxx	Elva (texture)	Well	C	1	4kx A	Poor	5	58	143

ELV[1]: a texture variant of Elva.

Table A2-3. Ag Capability and Irrigation Suitability of Soils with Different Phases

Soil code / phase	Soil name	Drainage	Surface texture	Agriculture capability	Irrigation suitability			Total area	
					Class	General rating	Rating for potatoes	ha	ac
EWT/xbxs	Ewart	Poor	L/CL	5W	4w Bt2	Poor	5	79	195
EWT/xbxx	Ewart	Poor	L/CL	5W	4w A	Poor	5	122	301
EWT/xxxs	Ewart	Poor	L/CL	5W	4w A	Poor	5	113	279
EWT/xxxx	Ewart	Poor	L/CL	5W	4w A	Poor	5	1,560	3,855
FBU/xxxx	Fairburn	Well	LVFS	3M	2x A	Good	4	15	37
FFX/xbxx	Fairfax	Poor	CL	5W	4w A	Poor	5	14	35
FFX/xcxx	Fairfax	Poor	CL	5W	4w Bt2	Poor	5	6	15
FFX/xxxx	Fairfax	Poor	CL	5W	4w A	Poor	5	540	1,334
GGH/xxxx	Gainsborough	Poor	LVFS	5W	4w A	Poor	5	14	35
GGK/xbxx	George Lake	Well	FSL	4M	2m A	Good	3	56	138
GHM/xbxx	Graham	Poor	L	5IW	4w Ci	Poor	5	413	1,021
GHM/xxxx	Graham	Poor	L	5IW	4w Ci	Poor	5	960	2,372
GLN/xbxx	Glenview	Imperfect	L	2M	3w A	Fair	3	97	240
GLN/xcxx	Glenview	Imperfect	L	2MT	3w Bt2	Fair	3	62	153
GLN/xxxx	Glenview	Imperfect	L	2M	3w A	Fair	3	11	27
GLO/xbxx	Glenora	Imperfect	GRLS	4M	3mx A	Fair	5	34	84
GLO/xcxx	Glenora	Imperfect	GRLS	4M	3mx Bt2	Fair	5	13	32
GLO/xxxx	Glenora	Imperfect	GRLS	4M	3mx A	Fair	5	32	79
GNO/xbxx	Glenlorne	Imperfect	L	2W	3w A	Fair	4	5	12
GNO/xcxx	Glenlorne	Imperfect	L	2WT	3w Bt2	Fair	4	50	124
GNO/xxxx	Glenlorne	Imperfect	L	2W	3w A	Fair	4	46	114
GOL/xbxs	Goodlands	Imperfect	CL	3N	3sw A	Fair	4	133	329
GOL/xbxx	Goodlands	Imperfect	CL	2W	3w A	Fair	3	213	526
GOL/xcxs	Goodlands	Imperfect	CL	3N	3sw Bt2	Fair	4	14	35
GOL/xcxx	Goodlands	Imperfect	CL	2WT	3w Bt2	Fair	3	135	334
GOL/xxxx	Goodlands	Imperfect	CL	2W	3w A	Fair	3	36	89
GPE/xbxx	Gopher Creek	Imperfect	L	2M	3w A	Fair	3	375	927
GPE/xcxx	Gopher Creek	Imperfect	L	2MT	3w Bt2	Fair	3	102	252
GPE/xxxx	Gopher Creek	Imperfect	L	2M	3w A	Fair	3	82	203
HHY/1c1x	Hathaway	Well	L/CL	2T	2kx Bt2	Good	4	435	1,075
HHY/1c2x	Hathaway	Well	L/CL	2TP	2kx Bt2	Good	5	234	578
HHY/1cxx	Hathaway	Well	L/CL	2T	2kx Bt2	Good	4	3,164	7,818
HHY/1d1x	Hathaway	Well	L/CL	3T	2kx Ct2	Fair	4	171	423
HHY/1d2x	Hathaway	Well	L/CL	3T	2kx Ct2	Fair	5	32	79
HHY/1dxx	Hathaway	Well	L/CL	3T	2kx Ct2	Fair	4	975	2,409
HHY/1exx	Hathaway	Well	L/CL	4T	2kx Ct2	Fair	5	17	42
HHY/2c1x	Hathaway	Well	L/CL	2TE	2kx Bt2	Good	4	76	188
HHY/2c2x	Hathaway	Well	L/CL	2TP	2kx Bt2	Good	5	44	109
HHY/2cxx	Hathaway	Well	L/CL	2TE	2kx Bt2	Good	4	173	427
HHY/2d1x	Hathaway	Well	L/CL	3TE	2kx Ct2	Fair	4	130	321
HHY/2d2x	Hathaway	Well	L/CL	3TE	2kx Ct2	Fair	5	27	67
HHY/2dxx	Hathaway	Well	L/CL	3TE	2kx Ct2	Fair	4	400	988

Table A2-4. Ag Capability and Irrigation Suitability of Soils with Different Phases

Soil code / phase	Soil name	Drainage	Surface texture	Agriculture capability	Irrigation suitability			Total area	
					Class	General rating	Rating for potatoes	ha	ac
HHY/2exx	Hathaway	Well	L/CL	4TE	2kx Ct2	Fair	5	62	153
HHY/xb1x	Hathaway	Well	L/CL	2X	2kx A	Good	4	34	84
HHY/xb2x	Hathaway	Well	L/CL	2P	2kx A	Good	5	48	119
HHY/xbxx	Hathaway	Well	L/CL	2X	2kx A	Good	4	17	42
HHY/xc1x	Hathaway	Well	L/CL	2T	2kx Bt2	Good	4	21	52
HHY/xcxx	Hathaway	Well	L/CL	2T	2kx Bt2	Good	4	514	1,270
HHY/xd1x	Hathaway	Well	L/CL	3T	2kx Ct2	Fair	4	46	114
HHY/xd2x	Hathaway	Well	L/CL	3T	2kx Ct2	Fair	5	48	119
HHY/xdxx	Hathaway	Well	L/CL	3T	2kx Ct2	Fair	4	37	91
HHY/xx1x	Hathaway	Well	L/CL	2X	2kx A	Good	4	8	20
HLY/xcxx	Hartley	Well	CL	3M	2gk Bt2	Good	4	33	82
HOT/1dxx	Horton	Well	L/CL	3T	2kx Ct2	Fair	5	34	84
HOT/1exx	Horton	Well	L/CL	4T	2kx Ct2	Fair	5	1	2
HOT/xcxx	Horton	Well	L/CL	2T	2kx Bt2	Good	4	291	719
HOT/xd1x	Horton	Well	L/CL	3T	2kx Ct2	Fair	5	114	282
HOT/xdxx	Horton	Well	L/CL	3T	2kx Ct2	Fair	4	308	761
HOT/xexx	Horton	Well	L/CL	4T	2kx Ct2	Fair	5	363	897
HRY/xbxx	Hartney	Imperfect	L	2W	2w A	Good	3	422	1,043
HRY/xcxx	Hartney	Imperfect	L	2WT	2w Bt2	Good	3	257	635
HRY/xxxx	Hartney	Imperfect	L	2W	2w A	Good	3	23	57
HZD/xc1x	Hazeldean	Imperfect	L/CL	2WT	3kw Bt2	Fair	4	27	67
HZD/xxxx	Hazeldean	Imperfect	L/CL	2W	3kw A	Fair	4	37	91
JKE/2c2x	Jackson Creek	Rapid	GRLS	5M	4m Bt2	Poor	5	28	69
JKE/xb1x	Jackson Creek	Rapid	GRLS	5M	4m A	Poor	5	50	124
JKE/xb2x	Jackson Creek	Rapid	GRLS	5M	4m Bt2	Poor	5	17	42
JKE/xbxx	Jackson Creek	Rapid	GRLS	5M	4m A	Poor	5	73	180
JKE/xc1x	Jackson Creek	Rapid	GRLS	5M	4m Bt2	Poor	5	9	22
JKE/xc2x	Jackson Creek	Rapid	GRLS	5M	4m Bt2	Poor	5	13	32
JKE/xcxx	Jackson Creek	Rapid	GRLS	5M	4m Bt2	Poor	5	247	610
JKE/xxxx	Jackson Creek	Rapid	GRLS	5M	4m A	Poor	5	15	37
LEO/xbxx	Leon	Imperfect	CL	2M	3w A	Fair	3	62	153
LEO/xxxx	Leon	Imperfect	CL	2M	3w A	Fair	3	97	240
LGT/xxxx	Leighton	Poor	CL/C	5IW	4w Ci	Poor	5	746	1,843
LGV/xb1x	Langvale	Well	LVFS	3M	2x A	Good	4	99	245
LGV/xbxx	Langvale	Well	LVFS	3M	2x A	Good	4	22	54
LGV/xcxx	Langvale	Well	LVFS	3M	2x Bt2	Good	4	138	341
LGV/xxxx	Langvale	Well	LVFS	3M	2x A	Good	4	109	269
LIG/xbxx	Liege	Imperfect	L	3I	3w Bi	Fair	3	1,212	2,995
LIG/xcxx	Liege	Imperfect	L	3I	3w Bt2i	Fair	3	610	1,507
LIG/xxxx	Liege	Imperfect	L	3I	3w Bi	Fair	3	88	217

Table A2-5. Ag Capability and Irrigation Suitability of Soils with Different Phases

Soil code / phase	Soil name	Drainage	Surface texture	Agriculture capability	Irrigation suitability			Total area	
					Class	General rating	Rating for potatoes	ha	ac
MAW/1cxx	Maskawata	Well	L	2T	2kx Bt2	Good	4	31	77
MAW/xb1x	Maskawata	Well	L	2X	2kx A	Good	4	5	12
MAW/xbxx	Maskawata	Well	L	2X	2kx A	Good	4	61	151
MAW/xc1x	Maskawata	Well	L	2T	2kx Bt2	Good	4	38	94
MAW/xcxx	Maskawata	Well	L	2T	2kx Bt2	Good	4	326	806
MAW/xxxx	Maskawata	Well	L	2X	2kx A	Good	4	123	304
MDO/xbxx	Medora	Well	L/CL	2X	2kx A	Good	4	551	1,362
MDO/xc1x	Medora	Well	L/CL	2T	2kx Bt2	Good	4	48	119
MDO/xcxx	Medora	Well	L/CL	2T	2kx Bt2	Good	4	714	1,764
MDO/xdxx	Medora	Well	L/CL	3T	2kx Ct2	Fair	4	7	17
MDO/xxxx	Medora	Well	L/CL	2X	2kx A	Good	4	51	126
MLT/xcxx	Melita	Well	L	2IT	2k Bt2	Good	1	172	425
MON/xbxx	Maon	Well	LVFS	3M	1 A	Excellent	1	47	116
MOT/1cxx	Montgomery	Imperfect	L	2WT	3w Bt2	Fair	4	17	42
MOT/xb1x	Montgomery	Imperfect	L	2W	3w A	Fair	4	15	37
MOT/xbxs	Montgomery	Imperfect	L	3N	3sw A	Fair	4	295	729
MOT/xbxx	Montgomery	Imperfect	L	2W	3w A	Fair	4	3,350	8,278
MOT/xc1x	Montgomery	Imperfect	L	2WT	3w Bt2	Fair	4	3	7
MOT/xcxs	Montgomery	Imperfect	L	3N	3sw Bt2	Fair	4	51	126
MOT/xcxx	Montgomery	Imperfect	L	2WT	3w Bt2	Fair	4	1,252	3,094
MOT/xx1x	Montgomery	Imperfect	L	2W	3w A	Fair	4	95	235
MOT/xx2s	Montgomery	Imperfect	L	3N	3sw A	Fair	5	46	114
MOT/xxxs	Montgomery	Imperfect	L	3N	3sw A	Fair	4	112	277
MOT/xxxx	Montgomery	Imperfect	L	2W	3w A	Fair	4	637	1,574
MTR/1c1x	Mather	Well	VFSL	2T	2g Bt2	Good	4	15	37
MTR/1cxx	Mather	Well	VFSL	2T	2g Bt2	Good	1	28	69
MTR/1dxx	Mather	Well	VFSL	3T	2g Ct2	Fair	4	18	44
MTR/xcxx	Mather	Well	VFSL	2T	2g Bt2	Good	3	89	220
MYK/xcxs	Marshy Lake	Imperfect	CL/C	3N	3w Bt2	Fair	5	15	37
NEI/xbxx	Neelin	Imperfect	CL/C	3I	3w Bi	Fair	3	686	1,695
NEI/xcxx	Neelin	Imperfect	CL/C	3I	3w Bt2i	Fair	3	13	32
NEI/xxxx	Neelin	Imperfect	CL/C	3I	3w Bi	Fair	3	303	749
NPK/xbxx	Napinka	Imperfect	GRLS	4M	4m A	Poor	5	65	161
NPK/xxxx	Napinka	Imperfect	GRLS	4M	4m A	Poor	5	3	7
NWS/1c1x	Newstead	Well	L	3M	2m Bt2	Good	4	16	40
NWS/xb2x	Newstead	Well	L	3M	2m A	Good	5	9	22
NWS/xbxx	Newstead	Well	L	3M	2m A	Good	4	332	820
NWS/xcxx	Newstead	Well	L	3M	2m Bt2	Good	4	101	250
NWS/xd1x	Newstead	Well	L	3MT	2m Ct2	Fair	4	229	566
NWS/xx1x	Newstead	Well	L	3M	2m A	Good	4	10	25
NWS/xxxx	Newstead	Well	L	3M	2m A	Good	4	428	1,058
OSK/1dxx	Oskar	Well	L/CL	3T	2kx Ct2	Fair	5	79	195
OSK/xcxx	Oskar	Well	L/CL	2T	2kx Bt2	Good	4	20	49
PDG/xxxx	Partridge	Poor	LS	5W	4w A	Poor	5	11	27

Table A2-6. Ag Capability and Irrigation Suitability of Soils with Different Phases

Soil code / phase	Soil name	Drainage	Surface texture	Agriculture capability	Irrigation suitability			Total area	
					Class	General rating	Rating for potatoes	ha	ac
PPT/xbxx	Pipestone	Imperfect	C	2W	4kx A	Poor	5	224	554
PPT/xdxx	Pipestone	Imperfect	C	3T	4kx Ct2	Poor	5	18	44
PPT/xxxx	Pipestone	Imperfect	C	2W	4kx A	Poor	5	35	86
RGT/1bxx	Regent	Imperfect	L/CL	2W	3w A	Fair	4	22	54
RGT/xb1x	Regent	Imperfect	L/CL	2W	3w A	Fair	4	13	32
RGT/xbxx	Regent	Imperfect	L/CL	2W	3w A	Fair	4	511	1,263
RGT/xc1x	Regent	Imperfect	L/CL	2WT	3w Bt2	Fair	4	22	54
RGT/xcxx	Regent	Imperfect	L/CL	2WT	3w Bt2	Fair	4	469	1,159
RGT/xxxx	Regent	Imperfect	L/CL	2W	3w A	Fair	4	411	1,016
RYS/1c1x	Ryerson	Well	L/CL	2T	2kx Bt2	Good	4	560	1,384
RYS/1cxx	Ryerson	Well	L/CL	2T	2kx Bt2	Good	4	595	1,470
RYS/1d1x	Ryerson	Well	L/CL	3T	2kx Ct2	Fair	4	40	99
RYS/1dxx	Ryerson	Well	L/CL	3T	2kx Ct2	Fair	4	387	956
RYS/xb1x	Ryerson	Well	L/CL	2X	2kx A	Good	4	227	561
RYS/xb2x	Ryerson	Well	L/CL	2P	2kx A	Good	5	95	235
RYS/xbxx	Ryerson	Well	L/CL	2X	2kx A	Good	4	1,235	3,052
RYS/xc1x	Ryerson	Well	L/CL	2T	2kx Bt2	Good	4	1,818	4,492
RYS/xc2x	Ryerson	Well	L/CL	2TP	2kx Bt2	Good	5	121	299
RYS/xcxx	Ryerson	Well	L/CL	2T	2kx Bt2	Good	4	4,940	12,207
RYS/xd1x	Ryerson	Well	L/CL	3T	2kx Ct2	Fair	4	101	250
RYS/xdxx	Ryerson	Well	L/CL	3T	2kx Ct2	Fair	4	336	830
RYS/xx1x	Ryerson	Well	L/CL	2X	2kx A	Good	4	91	225
RYS/xx2x	Ryerson	Well	L/CL	2P	2kx A	Good	5	26	64
RYS/xxxx	Ryerson	Well	L/CL	2X	2kx A	Good	4	246	608
SCH/xxxx	Scarth	Well	LFS	4M	2m A	Good	2	42	104
SFR/xb1x	Schaffner	Well	L	2X	1 A	Excellent	4	153	378
SFR/xbxx	Schaffner	Well	L	2X	1 A	Excellent	1	118	292
TLT/xxxx	Tilston	Poor	L/CL	5W	4w A	Poor	5	81	200
TUM/xcxx	Turtle Mountain	Well	L/CL	2T	2kx Bt2	Good	4	35	86
TUM/xdxx	Turtle Mountain	Well	L/CL	3T	2kx Ct2	Fair	4	46	114
TWC/xb1x	Two Creek	Imperfect	L	2W	3w A	Fair	4	31	77
TWC/xbxx	Two Creek	Imperfect	L	2W	3w A	Fair	4	1,356	3,351
TWC/xcxx	Two Creek	Imperfect	L	2WT	3w Bt2	Fair	4	760	1,878
TWC/xxxx	Two Creek	Imperfect	L	2W	3w A	Fair	4	522	1,290
UHL/xbxs	Underhill	Imperfect	L	3N	3s A	Fair	4	34	84
UHL/xbxx	Underhill	Imperfect	L	2W	2w A	Good	3	25	62
UHL/xxxx	Underhill	Imperfect	L	2W	2w A	Good	3	25	62
VLT/xbxx	Villette	Poor	L	5W	4w A	Poor	5	19	47
VLT/xcxx	Villette	Poor	L	5W	4w Bt2	Poor	5	20	49
VLT/xxxs	Villette	Poor	L	5W	4w A	Poor	5	17	42
VLT/xxxx	Villette	Poor	L	5W	4w A	Poor	5	200	494
WIL/xxxx	William	Poor	L	5W	4w A	Poor	5	189	467

Table A2-7. Ag Capability and Irrigation Suitability of Soils with Different Phases

Soil code / phase	Soil name	Drainage	Surface texture	Agriculture capability	Irrigation suitability			Total area	
					Class	General rating	Rating for potatoes	ha	ac
WIW/xbxs	Whitewater	Imperfect	CL/C	3N	4w A	Poor	5	120	297
WIW/xbxt	Whitewater	Imperfect	CL/C	4N	4sw A	Poor	5	17	42
WIW/xxxs	Whitewater	Imperfect	CL/C	3N	4w A	Poor	5	73	180
WKD/1cxx	Waskada	Well	L	2T	2kx Bt2	Good	4	325	803
WKD/1dxx	Waskada	Well	L	3T	2kx Ct2	Fair	4	597	1,475
WKD/xb1x	Waskada	Well	L	2X	2kx A	Good	4	845	2,088
WKD/xbxx	Waskada	Well	L	2X	2kx A	Good	4	7,199	17,789
WKD/xc1x	Waskada	Well	L	2T	2kx Bt2	Good	4	1,016	2,511
WKD/xcxx	Waskada	Well	L	2T	2kx Bt2	Good	4	8,576	21,192
WKD/xd1x	Waskada	Well	L	3T	2kx Ct2	Fair	4	13	32
WKD/xdxx	Waskada	Well	L	3T	2kx Ct2	Fair	4	223	551
WKD/xx1x	Waskada	Well	L	2X	2kx A	Good	4	282	697
WKD/xxxx	Waskada	Well	L	2X	2kx A	Good	4	1,630	4,028
WKP/xbxx	Wakopa	Poor	L/CL	5W	4w A	Poor	5	65	161
WKP/xcxx	Wakopa	Poor	L/CL	5W	4w Bt2	Poor	5	70	173
WKP/xdxx	Wakopa	Poor	L/CL	5W	4w Ct2	Poor	5	78	193
WKP/xxxx	Wakopa	Poor	L/CL	5W	4w A	Poor	5	16	40
WSW/xbxx	Wassewa	Poor	CL	5W	4w A	Poor	5	66	163
WSW/xcxs	Wassewa	Poor	CL	5W	4w Bt2	Poor	5	27	67
WSW/xxxx	Wassewa	Poor	CL	5W	4w A	Poor	5	1,115	2,755
WWS/xbxx	Wawanesa	Imperfect	L	2W	2w A	Good	3	14	35
WWS/xcxx	Wawanesa	Imperfect	L	2WT	2w Bt2	Good	3	99	245
$ER/2dxx	Eroded Slope	Rapid		6E	4m Ct2	Poor	5	12	30
$ER/2exx	Eroded Slope	Rapid		6E	4m Ct2	Poor	5	411	1,016
$ER/3fxx	Eroded Slope	Rapid		6E	4m Dt2	Poor	5	216	534
$ER/3ixx	Eroded Slope	Rapid		7TE	4m Dt2	Poor	5	340	840
$UL/xxxx	Unclassified land	-	-	-	-	-	-	66	163
$UR/xxxx	Urban land	-	-	-	-	-	-	428	1,058
$ZZ/xxxx	Water	-	-	-	-	-	-	475	1,174

Table A3. Description of Irrigation Suitability Classes

General Rating	Class	Degree of Limitation	Description
Excellent	**1A**	No soil or landscape limitations	These soils are medium textured, well drained and hold adequate available moisture. Topography is level to nearly level. Gravity irrigation methods may be feasible.
Good	**1B** **2A** **2B**	Slight soil and/or landscape limitations	The range of crops that can be grown may be limited. As well, higher development inputs and management are required. Sprinkler irrigation is usually the only feasible method of water application.
Fair	**1C** **2C** **3A** **3B** **3C**	Moderate soil and/or landscape limitations	Limitations reduce the range of crops that may be grown and increase development and improvement costs. Management may include special conservation techniques to minimize soil erosion, limit salt movement, limit water table build-up or flooding of depressional areas. Sprinkler irrigation is usually the only feasible method of water application.
Poor	**1D** **2D** **3D** **4A** **4B** **4C** **4D**	Severe soil and/or landscape limitations	Limitations generally result in a soil that is unsuitable for sustained irrigation. Some land may have limited potential when special crops, irrigation systems, and soil and water conservation techniques are used.

Table A4. Landscape Features Affecting Irrigation Suitability

Symbol	Landscape Features	Degree of Limitation			
		None (A)	Slight (B)	Moderate (C)	Severe (D)
t1	Slope - Simple %	<2	2 - 9	> 9 - 20	>20
t2	- Complex %	<5		> 5 - 15	>15
E	Relief m (Average Local)	<1	1 - 3	> 3 - 5	>5
P	Stoniness -Classes -Cover (%)	0, 1 & 2 (0 to 3%)	3 (> 3 to 15%)	4 (> 15 to 50%)	5 (>50)
I	Inundation -Frequency of Flooding (period)	1 in10 years	1 in 5 years	Every year (annual-spring)	Every year (seasonal)

* Suitability interpretations are based on the criteria for Complex slopes

Table A5. Soil Features Affecting Irrigation Suitability

Symbol	Soil Feature	Degree of Limitation			
		None (1)	Slight (2)	Moderate (3)	Severe (4)
d	Structure	Granular, Single Grained, Prismatic, Blocky, Subangular Blocky	Columnar, Platy	Massive	Massive
k	Ksat (mm/hr) (0 - 1.2 m)	> 50	50 - 15	< 15 - 1.5	< 1.5
x	Drainability (mm/hr) (1.2 - 3 m)	> 15	15 - 5	< 5 - 0.5	< 0.5
m	AWHC subhumid (mm/1.2 m) (% by volume) Subarid (mm/1.2 m) (% by volume)	 > 120 (> 10) > 150 (> 12)	 120 - 100 (10 - 8) 150 - 120 (12 - 10)	 < 100 - 75 (< 8 - 6) < 120 - 100 (< 10 - 8)	 < 75 (< 6) < 100 (< 8)
q	Intake Rate (mm/hr)	> 15	15 - 1.5	15 - 1.5	< 1.5
s	Salinity (mS/cm or dS/m) 0 - 0.6 m depth 0.6 - 1.2 m depth 1.2 - 3 m depth	 < 2 < 4 < 8	 2 - 4 4 - 8 8 - 16	 > 4 - 8 > 8 - 16 > 16	 > 8 > 16 > 16
n	Sodicity (SAR) 0 - 1.2 m depth 1.2 - 3 m depth	 < 6 < 6	 6 - 9 6 - 9	 > 9 - 12 > 9 - 12	 > 12 > 12
g	Geological Uniformity (0 - 1.2 m) (1.2 - 3m)	1 Textural Group 2 Textural Groups	2 Textural Groups Coarser below 3 Textural Groups Coarser below	2 Textural Groups Finer below 3 Textural Groups Coarser below 3 Textural Groups Finer below	3 Textural Groups Finer below
r	Depth to Bedrock (m)	> 3	3 - 2	< 2 - 1	< 1
h	Depth to Water Table (m)	> 2	2 - 1.2 (if salinity is a problem)	2 - 1.2 (if salinity is a problem)	< 1.2
w	Drainage Class	Well, Moderately Well	Imperfect	Imperfect	Poor, Very Poor, Excessive, Rapid
	*Texture (Classes) (0 - 1.2 m)	L, SiL, VFSL, FSL	CL, SiCL, SCL, SL, LVFS	C, SC, SiC VFS, FS, LS, CoSL	HC GR, CoS, LCoS, S
	*Organic Matter %	> 2	2 - 1	2 - 1	< 1
	*Surface Crusting Potential	Slight	Low	Low	Moderate

* Other important factors used to interpret type and degree of limitation but which do not present a limitation to irrigation themselves. No symbol is proposed for these factors since they will not be identified as subclass limitations.

Table A6. Guidelines for Assessing Land Suitability for Irrigated Potato Production under Rapid, Well and Moderately Well Drained Soil Conditions

In assessing suitability of land for irrigated potato production, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed characteristics or properties.

Characteristic or Property	Suitability Rating				
	Class 1	Class 2	Class 3	Class 4	Class 5
Texture Group*	CL CL/SF CL/SF/SC CL/FL/SF CL/LY LY/SF LY	SY,SY/SC, SY/CL, SY/LY, SY/FL, SY/SS/LY, SF, SY/UD/LY,SF/CS, SF/SC, SF/LY, SF/FL, SC/LY, SC, SF/SS/FL, CL/FL, SC/FL, CL/SS/FL, LY/FL, LY/SC, LY/LS, LY/SS/SF, LY/SS/SC, LY/FL/SF, LY/SS/LY, LY/SS/FL, FL FL/SF, FL/LY, FL/FL, FL/SY/SF, FL/SS/LY, FL/SS/FL, FL/CL	SY/SS, SY/CY/LY, SF/SS, CL/SS, SF/CY, CL/CY, SF/CY/LY, CL/CY/LY, CL/SS/CY, LY/CY, LY/SS, FL/SS	FL/CY, FL/CY/SF	SK, SS, SS/RK, SS/LY, SS/FL, SS/CY, SC/RK, SF/RK, CS, CL/RK, CL/FR, CL/FR/RK, LS/RK, LY/RK, LY/SY/RK, FL/LY/RK, CY, CY/SS, CY/SC, CY/SY, CY/SF, CY/CL, CY/LY, CY/FL, CY, CY/RK, CY/TX, CY/SS/CY, CY/LY/CY, CY/FL/CY, CY/LY/RK, CY/FL/RK, RK, TX, TX/LY, UD, UD/LY
Topography[1] (Slope)	0 - 5% (a, b, c)			> 5 - 9% (d)	> 9% (e, f, g, h, i, j)
Stoniness[2] Class	-			St. 1	St. 2, 3, 4, 5
Salinity[3] (mS/cm)	< 2		2 - 4	> 4 - 8	> 8
Soil Order and / or Subgroup			Orthic Regosol		Organic Order, Solonetzic Order, Solonetzic Subgroups

Topography[1]	Stoniness[2] (Surface covered)		Salinity[3] (mS/cm)	
< 5 % level to very gently sloping	- non-stony	< 0.01 %	very low	0 - 2
5 - 9 % gently sloping	1 slightly stony	0.01 - 0.1 %	low	> 2 - 4
> 9 % mod. to extremely sloping	2 moderately stony	> 0.1 - 3 %	weakly (s)	> 4 - 8
	3 very stony	> 3 - 15 %	moderately (t)	> 8 - 16
	4 exceedingly stony	> 15 - 50 %	strongly (u)	> 16
	5 excessively stony	> 50 %		

* SK = Skeletal
SS = Sandy Skeletal
LS = Loamy Skeletal
CS = Clayey Skeletal
SC = Sandy Coarse
SY = Sandy
SF = Sandy Fine
CL = Coarse Loamy
LY = Loamy
FL = Fine Loamy
CY = Clayey
RK = Bedrock
FR = Fragmental
UD = Undifferentiated
TX = Texture Complex

Table A7. Guidelines for Assessing Land Suitability for Irrigated Potato Production under Imperfectly, Poorly and Very Poorly Soil Conditions

In assessing suitability of land for irrigated potato production, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed characteristics or properties.

Characteristic or Property	Suitability Rating				
	Class 1	Class 2	Class 3	Class 4	Class 5
Texture Group*			SY, SY/SS, SY/SC, SY/CL, SY/LY, SC/LY, SY/SS/LY, SY/UD/LY, SC, SF, SF/SS, SF/CS, SF/LY, SF/SC, SF/FL, SY/FL, SF/SS/FL, CL, CL/SS, CL/SF, CL/LY, CL/FL, CL/SF/SC, CL/SS/FL, CL/FL/SF, LY/SS, LY/SC, LY/SF, LY/LS, LY/SS/SF, LY/SF/SC, SC/FL, LY, LY/FL, LY/SS/LY, LY/SS/FL, FL, FL/SF, FL/SS, FL/CL, FL/LY, FL/FL, FL/SY/SF, FL/SS/LY, FL/SS/FL	SF/CY, SY/CY/LYSF/ CY/LY, SF/CY/FL, CL/CY, CL/CY/LY, CL/SS/CY, LY/CY, FL/CY/SF, FL/CY	SK, SS, SS/RK, SS/LY, SS/FL, SS/CY, SC/RK, SF/RK, CS, CL/RK, CL/FR, CL/FR/RK, LS/RK, LY/RK, LY/SY/RK, FL/LY/RK, CY, CY/SS, CY/SC, CY/SY, CY/SF, CY/CL, CY/LY, CY/FL, CY CY/RK, CY/TX, CY/SS/CY, CY/LY/CY, CY/FL/CY, CY/LY/RK, CY/FL/RK, RK, TX, TX/LY, UD, UD/LY
Topography[1] (Slope)			0 - 5%	> 5 - 9%	> 9%
Stoniness[2] Class				St. 1	St. 2, 3, 4, 5
Salinity[3] (mS/cm)			< 4	4 - 8	> 8
Soil Order and / or Subgroup					Organic Order, Gleysolic Order, Solonetzic Order, Solonetzic Subgroups

Topography[1]	Stoniness[2] (Surface covered)		Salinity[3] (mS/cm)	
< 5 % level to very gently sloping	- non-stony	< 0.01 %	very low	0 - 2
5 - 9 % gently sloping	1 slightly stony	0.01 - 0.1 %	low	> 2 - 4
> 9 % mod. to extremely sloping	2 moderately stony	> 0.1 - 3 %	weakly (s)	> 4 - 8
	3 very stony	> 3 - 15 %	Moderately (t)	> 8 - 16
	4 exceedingly stony	> 15 - 50 %	Strongly (u)	> 16
	5 excessively stony	> 50 %		

* SK = Skeletal
SS = Sandy Skeletal
LS = Loamy Skeletal
CS = Clayey Skeletal
SC = Sandy Coarse
SY = Sandy
SF = Sandy Fine
CL = Coarse Loamy
LY = Loamy
FL = Fine Loamy
CY = Clayey
RK = Bedrock
FR = Fragmental
UD = Undifferentiated
TX = Texture Complex

Table A8-1. Suitability Ratings of Soils for Selected Engineering and Recreational Uses

Soil code	Soil phases	Soil name	Top soil	Sand & gravel	Road fill	Building - basement		Local roads/ streets	Sanitary trench	Land-fill area	Cover material	Sewage lagoon	Septic field	Play ground	Picnic area	Camp area	Paths & trails
						Yes	No										
AHY	xbxx	Ashbury	G	Va	Faw	Pw	Fw	Fw	Pkw	Fw	G	Fk	Ph	Fw	Fw	Fw	Fw
ARG	xxxx, xbxx	Argue	G	Va	Fa	Fa	Fa	Fa	G	G	G	Fak	Fk	G	G	G	G
ARG	xcxx	Argue	G	Va	Fa	Fa	Fa	Fa	G	G	G	Fkt	Fk	Ft	G	G	G
AXD	xxxs, xbxs	Alexander	Pn	Va	Faw	Pw	Faw	Faw	Pwg	Fwg	Fcs	Pkg	Fhg	Fnw	Fnw	Fnw	Fw
AXD	xxxx, xbxx	Alexander	G	Va	Faw	Pw	Faw	Faw	Pwg	Fwg	Fcs	Pkg	Fhg	Fw	Fw	Fw	Fw
BED	1c1x	Bede	Pbs	G	G	G	G	G	Vks	Vkg	Vcs	Vck	Gg	Pq	Fms	Fs	Fc
BED	xxxx, xbxx, xcxx	Bede	Ps	G	G	G	G	G	Vks	Vkg	Vcs	Vck	Gg	Pq	Fms	Fs	G
BED	xc2x	Bede	Ps	G	G	Fp	G	G	Vks	Vkg	Vcs	Vck	Gg	Pq	Fms	Fps	G
BED	xd1x	Bede	Ps	G	G	G	G	G	Vks	Vkg	Vcs	Vck	Gg	Pqt	Fms	Fs	G
BEF	xxxx, xbxx, xb1x	Bearford	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fak	Pk	Fs	Fs	Fs	Fs
BEF	xcxx, 1cxx	Bearford	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
BEF	xdxx	Bearford	Fst	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	Fs	Fs	Fs
BEL	xxxx, xbxx	Bella Lake	Fs	Va	Pw	Vhw	Phw	Pw	Vwg	Phw	Pw	Pkg	Vhg	Pw	Pw	Pw	Pw
BIC	xb2x	Bernice	Ps	Fx	G	Fap	Fap	G	Fs	Gg	Fcs	Pk	Pk	Pq	Fms	Fs	G
BIC	xx2x	Bernice	Ps	Fx	G	Fap	Fp	G	Fsp	Gg	Fcs	Pk	Pk	Pq	Fms	Fsp	G
BIC	xxxx	Bernice	Ps	Fx	G	Fa	G	G	Fs	Gg	Fcs	Pk	Pk	Pq	Fms	Fs	G
BOW	xxxx, xbxx	Bower	Fb	Va	Faw	Pw	Faw	Faw	Pwg	Fwg	Fcs	Pkg	Fhg	Fw	Fw	Fw	Fw
BOW	xcxx	Bower	Fb	Va	Faw	Pw	Faw	Faw	Pwg	Fwg	Fcs	Pkg	Fhg	Ftw	Fw	Fw	Fw
BRO	xbxx	Breadon	Fb	Va	G	G	Fa	Fa	Vks	Pkg	Pcq	Vak	Gg	G	G	G	G
BRO	xc2x	Breadon	Fb	Va	G	Fp	Fp	Fa	Vks	Pkg	Pcq	Vak	Gg	Ftp	G	Fp	G
BRO	xcxx	Breadon	Fb	Va	G	G	Fa	Fa	Vks	Pkg	Pcq	Vak	Gg	Ft	G	G	G
CLL	xxxx, xbxx, xb1x	Croll	Fs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fsw	Fsw	Fsw	Fsw
CLL	xcxx	Croll	Fs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Ftw	Fsw	Fsw	Fsw
CLL	xxxs, xbxx	Croll	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fnw	Fnw	Fnw	Fsw
CLL	xc1s	Croll	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Fnw	Fnw	Fnw	Fsw
CME	xxxx, xbxx	Cranmer	Fs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fsw	Fsw	Fsw	Fsw
CME	xcxx, 1cxx	Cranmer	Fs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Ftw	Fsw	Fsw	Fsw
CME	xbxs	Cranmer	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fnw	Fnw	Fnw	Fsw
CME	xcxs	Cranmer	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Fnt	Fnw	Fnw	Fsw
CMR	xcxx	Cameron	G	Va	Fa	Fa	Fa	Fa	G	G	G	Fkt	Fk	Ft	G	G	G

Table A8-2. Suitability Ratings of Soils for Selected Engineering and Recreational Uses

Soil code	Soil phases	Soil name	Top soil	Sand & gravel	Road fill	Building - basement		Local roads/ streets	Sanitary trench	Land-fill area	Cover material	Sewage lagoon	Septic field	Play ground	Picnic area	Camp area	Paths & trails
						Yes	No										
CMR	xxxx, xbxx, xb1x	Cameron	G	Va	Fa	Fa	Fa	Fa	G	G	G	Fak	Fk	G	G	G	G
CMR	1cxx, 1c1x	Cameron	Fb	Va	Fa	Fa	Fa	Fa	G	G	G	Fkt	Fk	Ft	G	G	G
CMR	xdxx	Cameron	Ft	Va	Fa	Fa	Fa	Fa	G	G	G	Pt	Fk	Pt	G	G	G
COU	xbxx	Coulter	Fs	Va	Faw	Piw	Pi	Pi	Piw	Pi	Fs	Pi	Pik	Fiw	Fsw	Pi	Fsw
CSE	xxxx, xbxx, xx1x, xb1x	Coatstone	Fbs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fw	Fw	Fw	Fw
CSE	xcxx, xc1x	Coatstone	Fbs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Ftw	Fw	Fw	Fw
CSE	xbxs	Coatstone	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fnw	Fnw	Fnw	Fw
CSE	xcxs	Coatstone	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Ftw	Fnw	Fnw	Fw
CSE	1cxx	Coatstone	Pb	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Ftw	Fw	Fw	Fw
CWG	xxxx	Cartwright	Ps	G	Fw	Pw	Fw	Fw	Vks	Vkg	Vcs	Vck	Fhg	Pg	Fsw	Fsw	Fw
DFD	xxxx, xbxx, xb1x	Desford	Fs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fsw	Fsw	Fsw	Fsw
DFD	xcxx	Desford	Fs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Ftw	Fsw	Fsw	Fsw
DFD	xbxs	Desford	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fnw	Fnw	Fnw	Fsw
DFD	xcxs	Desford	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Fnt	Fnw	Fnw	Fsw
DNY	xxxx, xbxx	Dalny	G	Va	Fa	Fa	Fa	Fa	Fs	G	G	Fak	Pk	G	G	G	G
DNY	xcxx	Dalny	G	Va	Fa	Fa	Fa	Fa	Fs	G	G	Fkt	Pk	Ft	G	G	G
DNY	xdxx	Dalny	Ft	Va	Fa	Fa	Fa	Fa	Fs	G	G	Pt	Pk	Pt	G	G	G
DOM	xxxx, xbxx	Dromore	Fb	Faq	G	G	Fa	Fa	Vks	Pkg	Pcq	Vak	Gg	G	G	G	G
DOM	xcxx, xc1x	Dromore	Fb	Faq	G	G	Fa	Fa	Vks	Pkg	Pcq	Vak	Gg	Ft	G	G	G
DOM	1dxx	Dromore	Pb	Faq	G	G	Fa	Fa	Vks	Pkg	Pcq	Vak	Gg	Pt	G	G	G
DRI	xxxx, xbxx	Deloraine	Fb	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
DRI	xxxs, xx1s	Deloraine	Pn	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
EBL	xxxx, xbxx, xcxx	Emblem	G	Va	Pw	Vw	Pw	Pw	Vw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
ELV	xxxx, xbxx	Elva	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fak	Pk	Fs	Fs	Fs	Fs
ELV	xcxx	Elva	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
ELV[1]	xxxx	Elva (texture)	Ps	Va	Pa	Pa	Pa	Pa	Ps	G	Ps	G	Vk	Fks	Fs	Fks	Fs
EWT	xxxx, xbxx	Ewart	Fs	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
EWT	xxxs, xbxs	Ewart	Pn	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
FBU	xxxx	Fairburn	Fb	Va	Fa	Fa	G	G	G	G	G	Fk	Fk	G	G	G	G

ELV[1]: a texture variant of Elva.

Table A8-3. Suitability Ratings of Soils for Selected Engineering and Recreational Uses

Soil code	Soil phases	Soil name	Top soil	Sand & gravel	Road fill	Building - basement		Local roads/ streets	Sanitary trench	Land-fill area	Cover material	Sewage lagoon	Septic field	Play ground	Picnic area	Camp area	Paths & trails
						Yes	No										
FFX	xxxx, xbxx, xcxx	Fairfax	Fs	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
GGH	xxxx	Gainsborough	G	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
GGK	xbxx	George Lake	Fb	Fq	G	G	Fa	G	Vks	Vhk	Pcq	Vak	Gg	Fq	Fm	G	G
GHM	xxxx, xbxx	Graham	Pi	Va	Pw	Viw	Vi	Vi	Viw	Viw	Pw	Vi	Vhi	Viw	Piw	Vi	Piw
GLN	xxxx, xbxx	Glenview	Fb	Faq	Faw	Pw	Faw	Faw	Vks	Pkg	Pcq	Vak	Phg	Fw	Fw	Fw	Fw
GLN	xcxx	Glenview	Fb	Faq	Faw	Pw	Faw	Faw	Vks	Pkg	Pcq	Vak	Phg	Ftw	Fw	Fw	Fw
GLO	xxxx, xbxx, xcxx	Glenora	Pbs	Fx	Faw	Pw	Fw	Fw	Phw	Fwg	Fcs	Pk	Phk	Pq	Fsw	Fsw	Fw
GNO	xxxx, xbxx	Glenlorne	Fb	Va	Faw	Pw	Faw	Faw	Pw	Fw	G	Fak	Phk	Fw	Fw	Fw	Fw
GNO	xcxx	Glenlorne	Fb	Va	Faw	Pw	Faw	Faw	Pw	Fw	G	Fkt	Phk	Ftw	Fw	Fw	Fw
GOL	xxxx, xbxx	Goodlands	Fs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fsw	Fsw	Fsw	Fsw
GOL	xcxx	Goodlands	Fs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Ftw	Fsw	Fsw	Fsw
GOL	xbxs	Goodlands	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fnw	Fnw	Fnw	Fsw
GOL	xcxs	Goodlands	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Fnt	Fnw	Fnw	Fsw
GPE	xxxx, xbxx	Gopher Creek	Fb	Faq	Faw	Pw	Faw	Faw	Vks	Pkg	Pcq	Vak	Phg	Fw	Fw	Fw	Fw
GPE	xcxx	Gopher Creek	Fb	Faq	Faw	Pw	Faw	Faw	Vks	Pkg	Pcq	Vak	Phg	Ftw	Fw	Fw	Fw
HHY	xx1x, xbxx, xb1x	Hathaway	Fb	Va	Fa	Fa	Fa	Fa	Fs	G	G	Fak	Pk	G	G	G	G
HHY	xcxx, xc1x 1cxx, 1c1x	Hathaway	Fb	Va	Fa	Fa	Fa	Fa	Fs	G	G	Fkt	Pk	Ft	G	G	G
HHY	xb2x	Hathaway	Fbp	Va	Fa	Fap	Fa	Fa	Fps	G	Fp	Fak	Pk	Fp	G	Fp	G
HHY	1c2x	Hathaway	Fbp	Va	Fa	Fap	Fa	Fa	Fps	G	Fp	Fkt	Pk	Fpt	G	Fp	G
HHY	xdxx, xd1x 1dxx,1d1x	Hathaway	Fbt	Va	Fa	Fa	Fa	Fa	Fs	G	G	Pt	Pk	Pt	G	G	G
HHY	xd2x,1d2x	Hathaway	Fbt	Va	Fa	Fap	Fa	Fa	Fps	G	Fp	Pt	Pk	Pt	G	Fp	G
HHY	1exx	Hathaway	Pt	Va	Fa	Fat	Fat	Fat	Fs	Ft	Ft	Vt	Pk	Vt	Fst	Fst	Fs
HHY	2cxx, 2c1x	Hathaway	Vb	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
HHY	2dxx, d1x	Hathaway	Vb	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	Fs	Fs	Fs

Table A8-4. Suitability Ratings of Soils for Selected Engineering and Recreational Uses

Soil code	Soil phases	Soil name	Top soil	Sand & gravel	Road fill	Building - basement		Local roads/ streets	Sanitary trench	Land-fill area	Cover material	Sewage lagoon	Septic field	Play ground	Picnic area	Camp area	Paths & trails
						Yes	No										
HHY	2c2x	Hathaway	Vb	Va	Fa	Fap	Fa	Fa	Fps	G	Fps	Fkt	Pk	Fpt	Fs	Fps	Fs
HHY	2d2x	Hathaway	Vb	Va	Fa	Fap	Fa	Fa	Fps	G	Fps	Pt	Pk	Pt	Fs	Fps	Fs
HHY	2exx	Hathaway	Vb	Va	Fa	Fat	Fat	Fat	Fs	Ft	Ft	Vt	Pk	Vt	Fst	Fst	Fs
HLY	xcxx	Hartley	Fs	Vax	Fa	Fa	Fa	Fa	Fsg	G	Fcs	Fkt	Gg	Fqt	Fs	Fs	Fs
HOT	xdxx, xd1x 1dxx	Horton	Fbt	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	G	G	G
HOT	xcxx	Horton	Fb	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Ft	G	G	G
HOT	xexx, 1exx	Horton	Pt	Va	Fa	Fat	Fat	Fat	Fs	Ft	Fst	Vt	Pk	Vt	Fst	Fst	G
HRY	xxxx, xbxx	Hartney	G	Va	Faw	Pw	Faw	Faw	Pw	Fw	G	Fak	Ph	Fw	Fw	Fw	Fw
HRY	xcxx	Hartney	G	Va	Faw	Pw	Faw	Faw	Pw	Fw	G	Fkt	Ph	Ftw	Fw	Fw	Fw
HZD	xxxx	Hazeldean	Fs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fsw	Fsw	Fsw	Fsw
HZD	xc1x	Hazeldean	Fs	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fkt	Phk	Ftw	Fsw	Fsw	Fsw
JKE	xxxx, bxxx xcxx, xc1x	Jackson Creek	Ps	G	G	G	G	G	Vks	Vkg	Vcs	Vck	Gg	Pq	Fms	Fs	G
JKE	xb2x, xc2x	Jackson Creek	Ps	G	G	Fp	G	G	Vks	Vkg	Vcs	Vck	Gg	Pq	Fms	Fsp	G
JKE	2c2x	Jackson Creek	Pbs	G	G	Fp	G	G	Vks	Vkg	Vcs	Vck	Gg	Pq	Fms	Fsp	G
LEO	xxxx, xbxx	Leon	Fs	Fq	Fw	Pw	Faw	Faw	Vks	Pkg	Pcq	Vk	Fhg	Fsw	Fsw	Fsw	Fsw
LGT	xxxx	Leighton	Pi	Va	Pw	Viw	Vi	Vi	Viw	Viw	Pw	Vi	Vhi	Viw	Piw	Viw	Piw
LGV	xxxx, xbxx, xb1x	Langvale	G	Va	Fa	Fa	G	G	Fs	G	G	Fk	Fk	G	G	G	G
LGV	xcxx	Langvale	G	Va	Fa	Fa	G	G	Fs	G	G	Fkt	Fk	Ft	G	G	G
LIG	xxxx, xbxx	Liege	Fi	Va	Faw	Piw	Pi	Pi	Piw	Pi	G	Pi	Phi	Fiw	Fw	Pi	Fw
LIG	xcxx	Liege	Fi	Va	Faw	Piw	Pi	Pi	Piw	Pi	G	Pi	Phi	Fit	Fw	Pi	Fw
MAW	xxxx, xbxx, xb1x	Maskawata	Fb	Va	Fa	Fa	Fa	Fa	Fs	G	G	Fak	Pk	G	G	G	G
MAW	xcxx, xc1x, 1cxx	Maskawata	Fb	Va	Fa	Fa	Fa	Fa	Fs	G	G	Fkt	Pk	Ft	G	G	G
MDO	xxxx, xbxx	Medora	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fak	Pk	Fs	Fs	Fs	Fs
MDO	xcxx, xc1x	Medora	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
MDO	xdxx	Medora	Fst	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	Fs	Fs	Fs
MLT	xcxx	Melita	G	Va	Fa	Fa	Fa	Fa	Fi	Fi	G	Fak	Fk	Ft	G	Fi	G
MON	xbxx	Maon	G	Va	G	G	G	G	Pk	Pk	G	Pk	G	G	G	G	G

Table A8-5. Suitability Ratings of Soils for Selected Engineering and Recreational Uses

Soil code	Soil phases	Soil name	Top soil	Sand & gravel	Road fill	Building - basement		Local roads/ streets	Sanitary trench	Land-fill area	Cover material	Sewage lagoon	Septic field	Play ground	Picnic area	Camp area	Paths & trails
						Yes	No										
MOT	xxxx, xx1x xbxx, xb1x	Mont-gomery	Fb	Va	Faw	Pw	Faw	Faw	Pw	Fw	G	Fak	Phk	Fw	Fw	Fw	Fw
MOT	xcxx, xc1x, 1cxx	Mont-gomery	Fb	Va	Faw	Pw	Faw	Faw	Pw	Fw	G	Fkt	Phk	Ftw	Fw	Fw	Fw
MOT	xxxs, xbxs	Mont-gomery	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	G	Fak	Phk	Fnw	Fnw	Fnw	Fw
MOT	xcxs	Mont-gomery	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	G	Fkt	Phk	Fnt	Fnw	Fnw	Fw
MOT	xx2s	Mont-gomery	Pn	Va	Faw	Pw	Fpw	Faw	Pw	Fw	Fp	Fak	Phk	Fnp	Fnw	Fnw	Fw
MTR	xcxx, 1cxx, 1c1x	Mather	Fb	Pa	Fa	Fa	Fa	Fa	Vks	Fkg	Pq	Vkg	Gg	Ftq	G	G	G
MTR	1dxx	Mather	Fb	Pa	Fa	Fa	Fa	Fa	Vks	Fkg	Pq	Vkg	Gg	Pt	G	G	G
MYK	xcxs	Marshy Lake	Pn	Va	Pa	Paw	Pa	Pa	Psw	Fw	Ps	Ft	Vk	Fnt	Fnw	Fnw	Ps
NEI	xxxx, xbxx, xcxx	Neelin	Fs	Va	Faw	Piw	Pi	Pi	Piw	Pi	Fs	Pi	Pik	Fiw	Fsw	Pi	Fsw
NPK	xxxx, xbxx	Napinka	Ps	G	Fw	Pw	Fw	Fw	Vks	Vkg	Vcs	Vck	Fhg	Pq	Fsw	Fsw	Fw
NWS	xxxx, xbxx, xx1x	Newstead	Fb	Pax	Fa	Fa	Fa	Fa	Fg	Gg	Fc	Pkg	Gg	G	G	G	G
NWS	xcxx, 1c1x	Newstead	Fb	Pax	Fa	Fa	Fa	Fa	Fg	Gg	Fc	Pkg	Gg	Ft	G	G	G
NWS	xd1x	Newstead	Fbt	Pax	Fa	Fa	Fa	Fa	Fg	Gg	Fc	Pkt	Gg	Pt	G	G	G
NWS	xb2x	Newstead	Fbp	Pax	Fa	Fa	Fa	Fa	Fpg	Gg	Fcp	Pkg	Gg	Fp	G	Fp	G
OSK	1dxx	Oskar	Fbt	Va	Fa	Fa	Fa	Fa	G	G	G	Pt	Pk	Pt	G	G	G
OSK	xcxx	Oskar	Fb	Va	Fa	Fa	Fa	Fa	G	G	G	Fkt	Pk	Ft	G	G	G
PDG	xxxx	Partridge	Pb	G	Pw	Vhw	Phw	Pw	Vwg	Vhk	Vcs	Vhk	Vhg	Pqw	Pw	Pw	Pw
PPT	xxxx, xbxx	Pipestone	Ps	Va	Pa	Paw	Pa	Pa	Psw	Fw	Ps	G	Vk	Pks	Psw	Pks	Ps
PPT	xdxx	Pipestone	Ps	Va	Pa	Paw	Pa	Pa	Psw	Fw	Ps	Pt	Vk	Pst	Psw	Pks	Ps
RGT	xxxx, xbxx, xb1x	Regent	Fb	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fw	Fw	Fw	Fw
RGT	1bxx	Regent	Fb	Va	Fap	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Pk	Fw	Fw	Fw	Fw
RGT	xcxx, xc1x	Regent	Fb	Va	Faw	Pw	Faw	Faw	Pw	Fw	Fs	Fak	Phk	Fwt	Fw	Fw	Fw
RYS	xxxx, xbxx xx1x, xb1x	Ryerson	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fak	Pk	G	G	G	G
RYS	xcxx, xc1x	Ryerson	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Ft	G	G	G
RYS	1c1x, 1cxx	Ryerson	Fb	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Ft	G	G	G
RYS	1dxx, 1d1x	Ryerson	Fbt	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	G	G	G
RYS	xx2x, xb2x	Ryerson	Fps	Va	Fa	Fap	Fa	Fa	Fps	G	Fps	Fak	Pk	Fp	G	Fp	G

Table A8-6. Suitability Ratings of Soils for Selected Engineering and Recreational Uses

Soil code	Soil phases	Soil name	Top soil	Sand & gravel	Road fill	Building - basement		Local roads/ streets	Sanitary trench	Land-fill area	Cover material	Sewage lagoon	Septic field	Play ground	Picnic area	Camp area	Paths & trails
						Yes	No										
RYS	xc2x	Ryerson	Fps	Va	Fa	Fap	Fa	Fa	Fps	G	Fps	Fkt	Pk	Fpt	G	Fp	G
RYS	xdxx, xd1x	Ryerson	Fst	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	G	G	G
SCH	xxxx	Scarth	Ps	Pa	G	G	G	G	Vks	Vk	Pq	Vk	Gg	Fms	Fms	Fs	G
SFR	xbxx, xb1x	Schaffner	G	Va	Fa	Fa	Fa	Fa	G	G	G	Fak	Fk	G	G	G	G
TLT	xxxx	Tilston	Fb	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
TUM	xcxx	Turtle Mountain	Fs	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Fkt	Pk	Fst	Fs	Fs	Fs
TUM	xdxx	Turtle Mountain	Fst	Va	Fa	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk	Pt	Fs	Fs	Fs
TWC	xxxx, xbxx, xb1x	Two Creeks	Fb	Va	Faw	Pw	Faw	Faw	Pw	Fw	G	Fak	Phk	Fw	Fw	Fw	Fw
TWC	xcxx	Two Creeks	Fb	Va	Faw	Pw	Faw	Faw	Pw	Fw	G	Fkt	Phk	Ftw	Fw	Fw	Fw
UHL	xxxx, xbxx	Underhill	G	Va	Faw	Pw	Faw	Faw	Pw	Fw	G	Fak	Ph	Fw	Fw	Fw	Fw
UHL	xbxs	Underhill	Pn	Va	Faw	Pw	Faw	Faw	Pw	Fw	G	Fak	Ph	Fnw	Fnw	Fnw	Fw
VLT	xxxx, xbxx, xcxx	Villette	Fb	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
VLT	xxxs	Villette	Pn	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Vw	Pw	Pw
WIL	xxxx	William	Fb	Pah	Pw	Vhw	Phw	Pw	Vwg	Vhk	Pqw	Vkg	Vhg	Pw	Pw	Pw	Pw
WIW	xxxs, xbxs	Whitewater	Pn	Va	Pa	Paw	Faw	Faw	Pw	Fw	Fs	G	Vk	Fnw	Fnw	Fnw	Fsw
WIW	xbxt	Whitewater	Vn	Va	Pa	Paw	Faw	Faw	Pw	Fw	Fs	G	Vk	Pn	Pn	Pn	Fsw
WKD	xxxx, xx1x xbxx, xb1x	Waskada	G	Va	Fa	Fa	Fa	Fa	Fs	G	G	Fak	Pk	G	G	G	G
WKD	xcxx, xc1x	Waskada	G	Va	Fa	Fa	Fa	Fa	Fs	G	G	Fkt	Pk	Ft	G	G	G
WKD	1cxx	Waskada	Fb	Va	Fa	Fa	Fa	Fa	Fs	G	G	Fkt	Pk	Ft	G	G	G
WKD	1dxx	Waskada	Fbt	Va	Fa	Fa	Fa	Fa	Fs	G	G	Pt	Pk	Pt	G	G	G
WKD	xdxx, xd1x	Waskada	Ft	Va	Fa	Fa	Fa	Fa	Fs	G	G	Pt	Pk	Pt	G	G	G
WKP	xxxx, xbxx, xcxx	Wakopa	Fs	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
WKP	xdxx	Wakopa	Fst	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Pht	Vh	Pwt	Pw	Pw	Pw
WSW	xxxx, xbxx	Wassewa	Fs	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
WSW	xcxs	Wassewa	Pn	Va	Pw	Vw	Pw	Pw	Vhw	Pw	Pw	Ph	Vh	Pw	Pw	Pw	Pw
WWS	xbxx	Wawanesa	Fb	Pa	Faw	Pw	Faw	Faw	Vks	Fwg	Pq	Vkg	Fhg	Fw	Fw	Fw	Fw
WWS	xcxx	Wawanesa	Fb	Pa	Faw	Pw	Faw	Faw	Vks	Fwg	Pq	Vkg	Fhg	Fwt	Fw	Fw	Fw

Table A9. Guide for Assessing Soil Suitability as Source of Topsoil

The term "topsoil" includes soil materials used to cover barren surfaces exposed during construction, and materials used to improve soil conditions on lawns, gardens, flower beds, etc. The factors to be considered include not only the characteristic of the soil itself, but also the ease or difficulty of excavation, and where removal of topsoil is involved, accessibility to the site.

Symbol[1]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	**Moist Consistence[2]**	Very friable, friable	Loose, firm	Very firm	Cemented
i	**Flooding**	None	May flood occasionally for short periods	Frequent flooding (every year)	Constantly flooding
w	**Wetness[2]**	Wetness is not determining if better than very poorly drained.			Very poorly drained and permanently wet soils
t	**Slope**	≤5 % (a, b, c)	> 5 - 9% (d)	> 9 - 15% (e)	> 15% (f, g, h, i, j)
p	**Stoniness[2]**	Stones > 10 m apart (Class 0 and 1)	Stones > 2 - 10 m apart (Class 2)	Stones 0.1 - 2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
c	**Coarse fragments[2] (% by volume)**	≤ 3%	> 3 - 15%	> 15 - 35%	> 35%
s	**Texture[2]**	SL, FSL, VFSL, L, SiL; SC if 1:1 clay is dominant	SCL, CL, SiCL; SC if 2:1 clay is dominant; C and SiC if 1:1 clay is dominant	S, LS; SiC and C if 2:1 clay is dominant. organic soils[3]	Marl, diatomaceous earth
b	**Depth of Topsoil[4]**	> 40 cm	> 15 - 40 cm	8 - 15 cm	< 8 cm
n	**Salinity of Topsoil[5]**	EC < 1	EC 1 - 4	EC > 4 - 8 (s)	EC > 8 (t, u)

Revised 2011

1 The symbol is used to indicate the property affecting use.
2 For an explanation of texture, consistence, stoniness, coarse fragments and soil drainage classes, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
3 Non-woody organic materials are assessed as good sources for topsoil if mixed with or incorporated into mineral soil.
4 The remaining soil material (at least 8 cm) must be reclaimable after the uppermost soil is removed.
5 EC = Electrical Conductivity (milliSiemens/cm).

Additional Notes:
Well drained Till soils with erosion 1, rated as **Fb** for depth of topsoil; erosion 2 rated as **Pb** for depth of topsoil; and erosion 3 rated as **Vb** for depth of topsoil.
Well drained Luvisols and Dark Gray Chernozems with erosion 2 or 3 rated as **Vb** for depth of topsoil.
Regosols rated as **Vb** for depth of topsoil.
Poorly drained Organic soils rated as **Vw** for topsoil and Organic soils, drained phase, are rated as **Ps** for topsoil.

Table A10. Guide for Assessing Soil Suitability as Source of Sand and Gravel

The purpose of this table is to provide guidance for assessing the probable supply as well as quality of the sand or gravel for use as road base material and in concrete. The interpretation pertains mainly to the characteristics of substratum to a depth of 150 cm, augmented by observations made in deep cuts as well as geological knowledge where available.

Symbol[1]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	**Unified Soil Group** [2]	GW GP SW SP	GW - GM GP - GM SW - SM SP - SM	GM GW - GC GP - GC SM SW - SC SP -SC	All other groups and bedrock (ML, CL, OL, MH, CH, OH, PT)
h	**Depth to Seasonal Water Table**	Not class determining if deeper than 50 cm		< 50 cm	
q	**Depth to Sand and Gravel**	< 25 cm	25 - 75 cm [3]	> 75 cm [3]	
p	**Stoniness**[4]	Not class determining if stones > 0.5 m apart (Class 0, 1, 2 and 3)		Stones 0.1 - 0.5 m apart (Class 4)	Stones < 0.1 m apart (Class 5)
d	**Depth to Bedrock**	> 100 cm	50 - 100 cm	< 50 cm	
x	**Thickness of sand and gravel**	> 100 cm	50 - 100 cm	< 50 cm	

Revised 2011

1 The symbol is used to indicate the property affecting use.
2 Shaly gravels rated as Poor (Pa). Meanings of the definition letters can be found at http://en.wikipedia.org/wiki/Unified_Soil_Classification_System
3 Rated good if it is known that the underlying gravel or sand deposit is thick (> 100 cm).
4 For an explanation of stoniness and rockiness, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).

Table A11. Guide for Assessing Soil Suitability as Source of Roadfill

Fill material for building or roads are included in this use. The performance of the material when removed from its original location and placed under load at the building site or road bed are to be considered. **Since surface materials are generally removed during road or building construction their properties are disregarded**. Aside from this layer, **the whole soil to a depth of 150-200 cm should be evaluated.** Soil materials which are suitable for fill can be considered equally suited for road subgrade construction.

Symbol[1]	Property Affecting Use[2]	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	**Subgrade[3]** **a.) AASHO Group Index[4]** **b.) Unified Soil Group**	< 5 GW, GP, SW, SP SM, GC[5] and SC[5]	5 - 8 CL (with P.I.[6] <15) and ML	> 8 CL (with P.I.[6] of 15 or more), CH and MH[7]	 OL, OH and PT
l	**Shrink-swell potential**	Low	Moderate	High	
f	**Susceptibility to frost action[8]**	Low	Moderate	High	
t	**Slope**	≤15% (a, b, c, d, e)	> 15 - 30% (f)	> 30 - 45% (g)	> 45% (h, i, j)
p	**Stoniness[9]**	Stones > 2 m apart (Class 0, 1 and 2)	Stones > 0.5 - 2 m apart (Class 3)	Stones 0.1 - 0.5 m apart (Class 4)	Stones < 0.1 m apart (Class 5)
r	**Rockiness[9]**	Rock exposures > 35 m apart and cover < 10% of the surface	Rock exposure > 10 - 35 m apart and cover 10 - 25% of the surface	Rock exposure 3.5 - 10 m apart and cover > 25 - 50% of the surface	Rock exposure < 3.5 m apart and cover > 50 - 90% of the surface
w	**Wetness[9]**	Excessively drained to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
d	**Depth to Bedrock**	> 100 cm	> 50 - 100 cm	20 - 50 cm	< 20 cm
h	**Depth to Seasonal Water Table**	> 150 cm	> 75 - 150 cm	50 - 75 cm	< 50 cm

Revised 2011

1 The symbol is used to indicate the property affecting use.
2 The first, three properties pertain to soil after it is placed in a fill; the last six properties pertain to soil in its natural condition before excavation for road fill.
3 This property estimates the strength of the soil material, that is, its ability to withstand applied loads.
4 Use AASHO group index only where laboratory data are available for the kind of soil being rated; otherwise, use Unified Soil Groups.
5 Downgrade suitability rating to fair if content of fines is more than about 30 percent.
6 P.I. means plasticity index.
7 Upgrade suitability rating to fair if MH is largely kaolinitic, friable, and free of mica.
8 Use this property only where frost penetrates below the paved or hardened surface layer and where moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front.
9 For an explanation of stoniness, rockiness and soil drainage classes, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).

Table A12. Guide for Assessing Soil Suitability for Permanent Buildings[1]

This guide applies to undisturbed soils to be evaluated for single-family dwellings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundation requirements; but soil slope, susceptibility to flooding and other hydrologic conditions, such as wetness, that have effects beyond those related exclusively to foundations are considered as well. Also considered are soil properties, particularly depth to bedrock, which influence excavation, landscaping and septic tank absorption fields.

Symbol[2]	Property Affecting Use	Degree of Soil Suitability[3]			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[4]	With Basements: Very rapidly, rapidly and well drained Without Basements: Very rapidly, rapidly well and moderately well drained	With Basements: Moderately well drained Without Basements: Imperfectly drained	With Basements: Imperfectly drained Without Basements: Poorly drained	With Basements: Poorly, and very poorly drained Permanently wet soils Without Basements: Very poorly drained Permanently wet soils.
h	Depth to Seasonal Water Table	With Basements: > 150 cm Without Basements: > 75 cm	With Basements: > 75 - 150 cm Without Basements: > 50 - 75 cm	With Basements: 25 - 75 cm Without Basements: 25 - 50 cm	With Basements: < 25 cm Without Basements: < 25 cm
i	Flooding	None	None	Occasional flooding or ponding (once in 5 years)	Frequent flooding or ponding (every year)
t	Slope[5]	≤ 9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)
a	Subgrade[6] a.) AASHO Group Index[7] b.) Unified Soil Group	< 5 GW, GP, SW, SP, GC, SM and SC	5 - 8 CL (with P.I.[8] < 15) and ML	> 8 CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and PT
f	Potential Frost Action[9, 13]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[4]	Stones > 10 m apart (Class 0 to 1)	Stones > 2 - 10 m apart (Class 2[10])	Stones 0.1 - 2 m apart (Class 3[10] to 4)	Stones < 0.1 m apart (Class 5[10])
r	Rockiness[4,11]	Rock exposure > 100 m apart and cover < 2% of the surface	Rock exposure 30 - 100 m apart and cover 2 - 10% of the surface	Rock exposure < 30 m apart and cover > 10% of the surface	Rock exposure too frequent to allow location of permanent buildings
d	Depth to Bedrock[11]	With Basements: > 150 cm Without Basements: > 100 cm	With Basements: > 100 - 150 cm Without Basements: 50 - 100 cm	With Basements: 50 - 100 cm Without Basements: < 50 cm	With Basements: < 50 cm

Revised 2011

1 By halving the slope limits, this table can be used for evaluating soil suitability for buildings with large floor areas, but with foundation requirements not exceeding those of ordinary three-storey dwellings.

2 The symbol is used to indicate the property affecting use.

3 Some soils are assessed as fair or poor sites from an aesthetic or use standpoint, but they will require more site preparation and/or maintenance.

4 For an explanation of rockiness, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).

5 Reduce the slope limits by one half for those soils subject to hillside slippage.

6 This property estimates the strength of the soil, that is, its ability to withstand applied loads. When available, AASHO Group Index values from laboratory tests were used; otherwise the estimated Unified Soil Groups were used.

7 Group Index values were estimated from information published by the Portland Cement Association (PCA, 1962), pp. 23 - 25.

8 P.I. means plasticity index.

9 Frost heave only applies where frost penetrates to the assumed depth of the footings and the soil is moist. The potential frost action classes are taken from the United States Army Corps of Engineers (1962), pp. 5 - 8. Use **z** for permanently frozen soils.

10 Rate one class better for building without basements.

11 Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment such as backhoes.

Table A13. Guide for Assessing Soil Suitability for Local Roads and Streets[1]

This guide applies to soils to be evaluated for construction and maintenance of local roads and streets. These are improved roads and streets having some kind of all-weather surfacing, commonly asphalt or concrete, and are expected to carry automobile traffic all year. They consist of: (1) the underlying local soil material (either cut or fill) called the subgrade; (2) the base material of gravel, crushed rock, lime or soil cement, stabilized soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They are also graded to shed water and have ordinary provisions for drainage. With the probable exception of the hardened surface layer, the roads and streets are built mainly from the soil at hand, and cuts and fills are limited, usually less than 2 metres. Excluded from consideration in this guide are highways designed for fast moving, heavy trucks.

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth of bedrock, stoniness, rockiness, and wetness affect the ease of excavation, and the amount of cut and fill to reach an even grade.

Symbol[2]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	**Wetness**[3]	Very rapidly, rapidly, well and moderately well drained	Imperfectly drained	Poorly and very poorly drained	Permanently wet soils
i	**Flooding**	None	Infrequent (once in 5 years)	Occasional (once in 2 - 4 years)	Frequent (every year)
t	**Slope**	≤ 9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)
d	**Depth to Bedrock**[4]	> 100 cm	50 - 100 cm	< 50 cm	
a	**Subgrade**[5] **a.) AASHO Group Index**[6] **b.) Unified Soil Group**	< 5 GW, GP, GC[7], SW, SP, SM, and SC[7]	5 - 8 CL (with P.I.[8] < 15) and ML	> 8 CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and PT and loose sand with high organic matter
f	**Susceptibility to Frost Heave**[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	**Stoniness**[3]	Stones > 2 m apart (Class 0 to 2)	Stones > 0.5 - 2 m apart (Class 3)	Stones 0.1 - 0.5 m apart (Class 4)	Stones < 0.1 m apart (Class 5)
r	**Rockiness**[3]	Rock exposures > 100 m apart and cover < 2% of the surface	Rock exposures 30 -100 m apart and cover 2 - 10% of the surface	Rock exposures < 30 m apart and cover >10% of the surface	Rock exposures too frequent to permit location of roads and streets

Revised 2011

1 These guidelines, with some adjustment of slope and rockiness limits, will also be useful for assessing soils for use as parking lots.
2 The symbol is used to indicate the property affecting use.
3 For an explanation of stoniness, rockiness and soil drainage classes, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
4 Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery.
5 This property estimates the strength of soil materials as it applies to roadbeds. When available, AASHO Group Index values from laboratory tests were used; otherwise, the estimated Unified Soil Groups were used. The limitations were estimated assuming that the roads would be surfaced. On unsurfaced roads, rapidly drained, very sandy, poorly graded soils may cause washboard or rough roads.
6 Group index values were estimated from information published by the Portland Cement Association (PCA, 1962) pp. 23 - 25.
7 Downgrade to moderate if content of fines (less than 200 mesh) is greater than about 30 percent.
8 P.I. means plasticity index.
9 Frost heave is important where frost penetrates below the paved or hardened surface and moisture movement by capillary action sufficient to form ice lenses at the freezing point. The susceptibility classes are taken from the United States Army Corps of Engineers (1962) pp. 5 - 8.

Table A14. Guide for Assessing Soil Suitability for Trench-type Sanitary Landfills[1]

The trench-type sanitary landfill, involves the daily burial of dry garbage and trash in an open trench that is covered with a layer of soil material. Suitability of the site is dependent upon the potential for pollution of water sources through groundwater contact with the refuse, or leachate arising from the site. Those properties affecting ease of excavation of the site must be supplemented with geological and hydrological knowledge to provide subsurface soil and groundwater data to a depth of at least 3 to 4.5 m, a common depth of landfills.

Symbol[2]	Property Affecting Use	Degree of Soil Suitability			
		Good - G[3]	Fair - F	Poor - P	Very Poor - V
h	**Depth to Seasonal High Water Table**	Not class determining if deeper than 180 cm		100 - 180 cm	< 100 cm
w	**Wetness**[4]	Not class determining if better than imperfectly drained		Imperfectly drained	Poorly and very poorly drained or permanently wet soils
i	**Flooding**	None	Rare	Occasional (Once in 2 - 4 years)	Frequent (Every year)
k	**Permeability**[4,5,8]	< 5 cm/hr	< 5 cm/hr	5 - 15 cm/hr	> 15 cm/hr
t	**Slope**	≤ 15% (a, b, c, d, e)	> 15 - 30% (f)	> 30 - 45% (g)	> 45% (h, i, j)
s	**Soil Texture**[4,6] **(dominant to a depth of 150 cm)**	Si, SiL, L, SCL, VFSL, SL, LVFS, LFS, VFS	SiCL[7], CL, SC, LS	SiC, C	Muck, peat, sand (CoS, MS, FS) and gravel
d	**Depth to Hard Bedrock**	> 150 cm	> 150 cm	100 - 150 cm	< 100 cm
	Rippable Bedrock	> 150 cm	100 - 150 cm	100 - 150 cm	< 100 cm
p	**Stoniness**[4]	Stones > 10 m apart (Class 0 and 1)	Stones > 2 - 10 m apart (Class 2)	Stones 0.1 - 2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
r	**Nature of Bedrock**	Impermeable			Highly permeable, fractured, easily soluble.

Revised 2011

1 Based on soil depth (120 cm) commonly investigated in making soil surveys.
2 The symbol is used to indicate the property affecting use.
3 If probability is high that the soil material to a depth of 3 to 4.5 m will not alter a rating of good or fair, indicate this by an appropriate footnote, such as "Probably good to a depth of 3.5 m", or "Probably fair to a depth of 3.5 m".
4 For an explanation of stoniness, texture and soil drainage classes, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
5 Reflects ability of soil to retard movement of leachate from the landfills; may not reflect a limitation in arid and semiarid areas.
6 Reflects ease of digging, moving (workability) and trafficability in the immediate area of the trench where there may not be surfaced roads.
7 Soil high in expansive clays may need to be given a suitability rating of poor.
8 Contamination hazard (**g**) may apply at high permeability.

Table A15. Guide for Assessing Soil Suitability for Area-type Sanitary Landfills

In the area-type sanitary landfill, refuse is placed on the surface of the soil in successive layers. The daily and final cover material is generally imported. A final cover of soil material at least 60 cm thick is placed over the fill when it is completed.

The soil under the proposed site should be investigated to determine the probability that leachates from the landfill may penetrate the soil and thereby pollute water supplies.

Symbol[1]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	**Depth to Seasonal Water Table[2]**	> 150 cm	> 100 - 150 cm	50 - 100 cm	< 50 cm
w	**Wetness[2,3]**	Rapid to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
i	**Flooding**	None	Rare	Occasional (Once in 2 - 4 years)	Frequent (Every year)
k	**Permeability[4,5,6]**	Not class determining if less than 5 cm/hr		5 - 15 cm/hr	> 15 cm/hr
t	**Slope**	≤ 9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)

Revised 2011

1 The symbol is used to indicate the property affecting use.
2 Reflects influence of wetness on operation of equipment.
3 For an explanation of drainage, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
4 Reflects ability of the soil to retard movement of leachate from landfills; may not reflect a limitation in arid and semiarid areas.
5 Due to possible groundwater contamination, impermeable bedrock is considered poor and permeable bedrock is rated very poor.
6 Contamination hazard (**g**) may apply at high permeability and/or proximity of the site to water supplies.

Table A16. Guide for Assessing Soil Suitability as Cover Material for Area-type Sanitary Landfills

The term cover material includes soil materials used to put a daily and final covering layer in area-type sanitary landfills. This cover material may be derived from the area of the landfill or may be brought in from surrounding areas.

Symbol[1]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	**Moist Consistence[2]**	Very friable, friable	Loose, firm	Very firm	Cemented
s	**Texture[2,3]**	Si, SiL, SCL, L, VFSL, FSL, LVFS, VFS	SiCL, CL, SC, LFS, LS	SiC, C	Muck, peat, sand, gravel
d	**Depth to bedrock[4]**	> 150 cm	> 100 - 150 cm	50 - 100 cm	< 50 cm
c	**Coarse fragments[2] (% by volume)**	≤ 15%	> 15 - 35%	> 35%	
p	**Stoniness[2]**	Stones > 10 m apart (Class 0 and 1)	Stones > 2 - 10 m apart (Class 2)	Stones 0.1 - 2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
t	**Slope**	≤ 9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)
w	**Wetness[2]**	Not class determining if better than poorly drained.		Poorly drained	Very poorly drained or permanently wet soils.
q	**Depth to Sand and Gravel**	> 1.5 m	1 - 1.5 m	< 1 m	

Revised 2011

1 The symbol is used to indicate the property affecting use.
2 For an explanation of consistence, texture, coarse fragments, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
3 Soils having a high proportion of non-expansive clays may be given a suitability rating one class better than is shown for them in this table.
4 Thickness of material excluding topsoil, which will be stockpiled (see guide for topsoil).

Table A17. Guide for Assessing Soil Suitability for Reservoirs and Sewage Lagoons

Factors affecting the ability of undisturbed soils to impound water or sewage and prevent seepage, are considered for evaluating the suitability of soils for reservoir and lagoon areas. This evaluation considers soil both as a vessel for the impounded area and as material for the enclosing embankment. As the impounded liquids could be **potential sources of contamination of nearby water supplies**, e.g. sewage lagoons, the landscape position of the reservoir as it affects risk of flooding must also be considered.

Symbol[1]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	**Depth to Water Table[2]**	> 150 cm	> 100 - 150 cm	50 - 100 cm	< 50 cm
i	**Flooding[3]**	None	None	Subject to infrequent flooding (once in 50 years)	Subject to frequent high level flooding
k	**Soil Permeability**	< 0.05 cm/hr	0.05 - 0.5 cm/hr	> 0.5 - 5 cm/hr	> 5 cm/hr
t	**Slope**	≤ 2% (a, b)	> 2 - 5% (c)	> 5 - 9% (d)	> 9% (e, f, g, h, i, j)
o	**Organic Matter**	≤ 2 %	> 2 - 10%	> 10 - 30%	> 30%
c	**Coarse Fragments[4] < 25 cm in diameter, (% by volume)**	≤ 20%	> 20 - 35%	> 35%	
p	**Stoniness[4], >25 cm diameter, (% of surface area)**	≤ 3% (Class 0, 1 and 2)	> 3 - 15% (Class 3)	> 15 - 50% (Class 4)	> 50% (Class 5)
d	**Depth to Bedrock[5]**	> 150 cm	> 100 - 150 cm	50 - 100 cm	< 50 cm
j	**Thickness of Slowly Permeable Layer**	> 100 cm	> 50 - 100 cm	50 - 25 cm	< 25 cm
a	**Sub-grade Unified Soil Group**	CH	GC, SC and CL	GM, SM, ML & MH	GW, GP, SW & SP, OL, OH & PT

Revised 2011

1 The symbol is used to indicate the property affecting use.
2 If the floor of the lagoon has nearly impermeable material at least 50 cm thick, disregard depth to water table.
3 Disregard flooding if it is not likely to enter or damage the lagoon (flood waters have low velocity and depth less than 150 cm).
4 For an explanation of coarse fragments and stoniness classes, see the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
5 Surface exposures of non rippable rock are rated poor. If underlying bedrock is impermeable, rating should be one class better.

Table A18. Guide for Assessing Soil Suitability for Septic Tank Absorption Fields

This guide applies to soils to be used as an absorption and filtering medium for effluent from septic tank systems. A subsurface tile system laid in such a way that effluent from the septic tank is distributed reasonably uniformly into the natural soil is assumed when applying this guide. A rating of poor need not mean that a septic system should not be installed in the given soil, but rather, may suggest the difficulty, in terms of installation and maintenance, which can be expected.

Symbol[1]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	**Fair - F**	**Poor - P**	**Very Poor - V**
k	**Permeability**[2,7]	Rapid to moderately rapid	Moderate	Slow	Very Slow
	Percolation Rate[3] **(Auger hole method)**	≤ 8 - 18 min/cm (> 3.3 - 7.5 cm/hr)	> 18 - 24 min/cm (2.5 - 3.3 cm/hr)	> 24 min/cm (< 2.5 cm/hr)	
h	**Depth to Seasonal Water Table**[4]	> 150 cm [5]	> 100 - 150 cm	50 - 100 cm	< 50 cm
i	**Flooding**	Not subject to flooding	Not subject to flooding	Subject to occasional flooding (once in 5 years)	Floods every year
t	**Slope**	≤ 9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)
d	**Depth to Hard Rock, bedrock or other impervious materials**	> 150 cm	> 100 - 150 cm[6]	50 - 100 cm	< 50 cm

Revised 2011

1 The symbol is used to indicate the property affecting use.
2 The suitability ratings should be related to the permeability of soil layers at and below depth of the graded filter bed (50 - 75 cm depth).
3 Soils having a percolating rate less than about 8 min/cm are likely to present a pollution hazard to adjacent waters. This hazard must be noted, but the degree of hazard must, in each case, be assessed by examining the proximity of the proposed installation to water bodies, water table, and related features**. The symbol g is used to indicate this condition.** Refer to U.S. Dept. of Health, Education and Welfare (1969) for details of this procedure.
4 Seasonal means for more than one month. It may, with caution, be possible to make some adjustment for the severity of a water table limitation in those cases where seasonal use of the facility does not coincide with the period of high water table.
5 A seasonal water table should be at least 100 cm below the bottom of the trench at all times for soils rated Good (U.S. Dept. of Health, Education and Welfare, 1969). The depths used to water table are based on an assumed tile depth of 50 cm. Where relief permits, the effective depth above a water table or rock can be increased by adding appropriate amounts of fill.
6 Where the slope is greater than 9%, a depth to bedrock of 100 - 150 cm is assessed as Poor.
7 Contamination hazard (**g**) may apply at high permeability, e.g. (Gg).

Table A19. Guide for Assessing Soil Suitability for Playgrounds

This guide applies to soils to be used intensively for playgrounds, football, badminton, and for other similar organized games. These areas are subject to intensive foot traffic. A nearly level surface, good drainage, and a soil texture and consistence that provide a firm surface generally are required. The most desirable soils are free of rock outcrops and coarse fragments.
Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	**Wetness**[2]	Rapidly, well and moderately well drained soils with no ponding or seepage. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional ponding or seepage for short duration and imperfectly drained soils. Water table below 50 cm during season use.	Imperfectly drained soils subject to ponding or seepage, and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	**Flooding**	None during season of use.	Occasional flooding. May flood once every 2 - 3 years during season of use.	Floods every year during season of use.	Prolonged flooding during season of use.
k	**Permeability**	Very rapid to moderate	Moderately slow and slow	Very slow	
t	**Slope**	≤ 2% (a, b)	> 2 - 5% (c)	> 5 - 9% (d)	> 9% (e, f, g, h, i, j)
d	**Depth to Bedrock**	> 100 cm	50 - 100 cm[3]	< 50 cm[3]	
c	**Coarse fragments on surface**[2]	Relatively free of coarse fragments	≤ 20% coarse fragments	> 20% coarse fragments	
p	**Stoniness**[2]	Stones > 10 m apart (Class 0 to 1)	Stones > 2 - 10 m apart (Class 2)	Stones 0.1 - 2 m apart (Class 3, 4)	Stones < 0.1 m apart (Class 5)
r	**Rockiness**[2]	Rock exposures > 100 m apart and cover < 2% of the surface	Rock exposures 30 - 100 m apart and cover about 2 - 10% of the surface	Rock exposures < 30 m apart and cover > 10% of the surface	Rock outcrops too frequent to permit playground location
s	**Surface Soil Texture**[2,4]	L, VFSL, FSL, SL, LVFS, VFS	SiL, CL, SiCL, SCL, LFS, LS, FS	SiC, C, SC[5], Si, S	Peaty soils; S and LS subject to blowing
q	**Depth to Sand or Gravel**[6]	> 100 cm	50 - 100 cm	< 50 cm	
m	**Useful Moisture**[7]	Water storage capacity[8] >15.0 cm and/or adequate rainfall and/or low evapotranspiration	Water storage capacity[8] 7.5 - 15 cm and/or moderate rainfall and/or moderate evapotranspiration	Water storage capacity[8] < 7.5 cm and/or low rainfall and/or high evapotranspiration	
n	**Salinity**[9]	EC < 4 mS/cm	EC 4 - 8 mS/cm (s)	EC > 8 - 16 mS/cm (t)	EC > 16 mS/cm (u)

1 The symbol is used to indicate the property affecting use.
2 See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada 2007).
3 Downgrade to a very poor suitability rating if the slope is greater than 5%.
4 Surface soil texture influences soil ratings as it affects foot trafficability, surface wetness, dust, and maintenance. Adverse soil textures may be partially or completely overcome with the addition of topsoil.
5 Moderately well and well drained SiC, C and SC soils may be rated fair.
6 Depth to sand or gravel is considered a limitation if the levelling operations expose sand or gravel, thereby bringing about adverse surface textures and undesirable amounts of coarse fragments. The addition of topsoil after the levelling process would overcome this limitation.
7 This property attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.
8 Consult glossary for definitions of terms used.
9 EC = Electrical conductivity (milliSiemens/cm, mS/cm or deciSiemens/m, or dS/m).

Table A20. Guide for Assessing Soil Suitability for Picnic Areas

This guide applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to the access roads. Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Property affecting use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	**Wetness**[2]	Very rapidly, rapidly, well and moderately well drained soils not subject to seepage or ponding. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils not subject to seepage or ponding. Water Table above 50 cm for short periods during season of use	Imperfectly drained soils subject to seepage or ponding. Poorly drained soil. Water table above 50 cm and often near surface for a month or more during season of use.	Very poorly drained and permanently wet soils.
i	**Flooding**	None during season of use.	May flood 1 or 2 times per year for short periods during season of use.	Floods more than 2 times during season of use.	Prolonged flooding during season of use.
t	**Slope**	≤ 9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)
s	**Surface Soil Texture**[2,3]	L, VFSL, FSL, SL, LVFS, VFS	SiL, CL, SiCL, SCL, LFS, LS, FS and sand other than loose sand.	SiC, C, SC[4], Si	Peaty soils; loose sand subject to blowing.
c	**Coarse Fragments on Surface**[2]	< 20%	20 - 50%	> 50%	
p	**Stoniness**[2]	Stones > 2 m apart (Class 0 to 2)	Stones > 1 - 2 m apart (Class 3)	Stones 0.1 - 1 m apart (Class 4)	Stones < 0.1 m apart (Class 5)
r	**Rockiness**[2,5,6]	Rock exposure roughly > 30 - 100 m or more apart and cover < 10% of the surface.	Rock exposure roughly 10 - 30 m apart and cover 10 - 25 % of the surface.	Rock exposure < 10 m apart and cover > 25% of the surface.	Rock exposure too frequent to permit location of picnic areas.
m	**Useful Moisture**[7]	Water storage capacity[8] > 15 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5 - 15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] < 7.5 cm and/or low rainfall and/or high evapotranspiration.	
n	**Salinity**[9]	EC < 4 mS/cm	EC 4 - 8 mS/cm (s)	EC > 8 - 16 mS/cm (t)	EC > 16 mS/cm (u)

1 The symbol is used to indicate the property affecting use.

2 See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada 2007). Coarse fragments for the purpose of this rating include gravel and cobbles. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

3 Surface soil texture influences soil ratings as it affects foot trafficability, dust and soil permeability.

4 Moderately well and well drained SiC, C and SC soils may be rated fair.

5 Very shallow soils are rated as having severe or very severe limitations for stoniness or rockiness.

6 The nature and topography of the bedrock exposures may significantly alter these ratings. As such, on-site investigations will be necessary in map units containing bedrock when these are considered as possible sites.

7 This property attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

8 Consult glossary for definitions of terms used.

9 EC = Electrical conductivity (milliSiemens/cm, mS/cm or deciSiemens/m, or dS/m).

Table A21. Guide for Assessing Soil Suitability for Camp Areas

This guide applies to soils to be used intensively for tents and camp trailers and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and levelling for campsites and parking areas. The soil should be suitable for heavy foot traffic by humans and limited vehicular traffic. Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of site.

Back country campsites differ in design, setting and management but require similar soil attributes. These guides should apply to evaluations for back country campsites but, depending on the nature of the facility, the interpreter may wish to adjust the criteria defining a given degree of limitation to reflect the changed requirement. For example, small tent sites may allow rock exposures greater than 10 m apart to be considered slight limitations.

Symbol[1]	Property Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	**Wetness**[2]	Very rapidly, rapidly, well and moderately well drained soils with no seepage or ponding. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils with no seepage or ponding. Water table below 50 cm during season of use	Imperfectly drained soils subject to seepage or ponding and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	**Flooding**	None	Very occasional flooding during season of use. (Once in 5 - 10 years)	Occasional flooding during season of use. (Once in 2 - 4 years)	Flooding during every season of use.
k	**Permeability**	Very rapid to moderate	Moderately slow and slow	Very slow	
t	**Slope**	≤ 9% (a, b, c, d)	> 9 - 15% (e)	> 15 - 30% (f)	> 30% (g, h, i, j)
s	**Surface Soil Texture**[2,3]	L, VFSL, FSL, SL, LVFS, VFS	SiL, CL, SiCL, SCL, LFS, LS, FS and sand other than loose sand.	SiC, C, SC[4], Si	Peaty soils: loose sand subject to blowing.
c	**Coarse Fragments on Surface**[2,5]	< 20%	20 - 50%	> 50%	
p	**Stoniness**[2,6]	Stones > 10 m apart (Class 0 and 1)	Stones > 2 - 10 m apart (Class 2)	Stones 0.1 - 2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
r	**Rockiness**[2,6]	No rock exposures	Rock exposures 10 m apart and cover 25% or less of the area.	Rock exposures < 10 m apart and cover > 25% of the area.	Rock exposures too frequent to permit campground location.
n	**Salinity**[7]	EC < 4 mS/cm	EC 4 - 8 mS/cm (s)	EC > 8 - 16 mS/cm (t)	EC > 16 mS/cm (u)

Revised 2011

1 The symbol is used to indicate the property affecting use.
2 See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).
3 Surface soil texture influences soil rating as it affects foot trafficability, dust, and soil permeability.
4 Moderately well and well drained SiC, C and SC soils may be rated fair.
5 Coarse fragments for the purpose of this table include gravels and cobbles. Some gravelly soils may be rated as having slight limitations if the content of gravel exceeds 20% by only a small margin, providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.
6 Very shallow soils are rated as having a limitation for rockiness and/or stoniness.
7 EC = Electrical conductivity (milliSiemens/cm, mS/cm or deciSiemens/m, or dS/m).

Table A22. Guide for Assessing Soil Suitability for Paths and Trails

It is assumed that the trails will be built at least 45 cm wide and that obstructions such as cobbles and stones will be removed during construction. It is also assumed that a dry, stable tread is desirable and that muddy, dusty, worn or eroded trail treads are undesirable. Hiking and riding trails are not treated separately, but as the design requirements for riding trails are more stringent, a given limitation will be more difficult to overcome. Poor or very poor suitability does not indicate that a trail cannot or should not be built. It does, however, suggest higher design requirements and maintenance to overcome the limitations.

Symbol[1]	Property[2] Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	**Texture**[3,4]	L, VFSL, FSL, SL, LVFS, LFS, LS, VFS	CL, SiCL, SiL, SCL	SiC, C, SC[5], Si, FS, S	Peaty soils; loose sand subject to blowing
c	**Coarse Fragment Content**[4,6]	< 20%	20 - 50%	> 50%	
p	**Stoniness**[4]	Stones > 2 m apart (Class 0 to 2)	Stones > 1 - 2 m apart (Class 3)	Stones 0.1 - 1 m apart (Class 4)	Stones < 0.1 m apart (Class 5)
w	**Wetness**[4]	Very rapidly, rapidly well, and moderately well drained soils. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage and ponding and imperfectly drained soils. Water table may be above 50 cm for short periods during season of use.	Poorly and very poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Permanently wet soils.
r	**Rockiness**[4,7]	Rock exposures > 30 m apart and cover < 10% of the surface.	Rock exposures 10 - 30 m apart and cover 10 - 25% of the surface.	Rock exposures < 10 m apart and cover > 25% of the surface.	Rock exposures too frequent to permit location of paths and trials.
t	**Slope**[8]	≤ 15% (a, b, c, d, e)	> 15 - 30% (f)	> 30 - 45% (g)	> 45% (h, i, j)
i	**Flooding**	Not subject to flooding during season of use.	Floods 1 or 2 times during season of use.	Floods more than 2 times during season of use.	Subject to prolonged flooding during season of use.

Revised 2011

1 The symbol is used to indicate the property affecting use.

2 The properties affecting use listed in this table are those which have been shown to cause significant differences in trail response. Elevation, aspect, position on slope, and snow avalanching may have slight affects or influence trail management and should be considered in the final site evaluation. Items such as vegetation, fauna, and scenic value are not considered in the guidelines.

3 Texture refers to the soil texture which will form the tread texture. This is the surface texture on level areas but may be a subsurface texture on slopes. Textural classes are based on the less than 2 mm soil fraction. Texture influences soil ratings as it influences foot trafficability, dust, design or maintenance of trails, and erosion hazards.

4 See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Soil and Landscape Management Section, Manitoba Agriculture, Food and Rural Initiatives and Land Resource Unit, Agriculture and Agri-Food Canada, 2007).

5 Moderately well and well drained SiC, C and SC soils may be rated fair.

6 Coarse fragments for the purpose of this table, include gravels and cobbles. Gravels tend to cause unstable footing when present in high amounts, and are also associated with increased erosion. Cobbles (and stones) must be removed from the trail tread, increasing construction and maintenance difficulties. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix or (b) the fragments are less than 2 cm in size.

7 The type of rock outcrop (flat lying vs cliffs), and the orientation of the structure (linear cliffs vs massive blocks) can greatly alter the degree of the limitation. Each site with a Rockiness limitation based on the percent rock outcrop above should be evaluated on its own merits and the degree of limitation should then be modified appropriately if necessary.

8 Slope in this context refers to the slope of the ground surface, not the slope of the tread.

Appendix 2

Soil Series Descriptions (alphabetical order in soil code)

Ashbury Series (AHY)

The Ashbury series consists of imperfectly drained, Gleyed Black Chernozem soils of the Mentieth Association, developed on thin (25 to 100 cm), moderately calcareous, moderately coarse textured (VFS, LVFS, SL, FSL) lacustrine sediments overlying strongly calcareous medium to moderately fine textured (VFSL, L SiL to SCL, CL, SiCL) glacial till. The profile may contain a very thin (less than 5 cm) pebble line at the till contact. Ashbury soils generally occur on lower slope positions in areas of gently sloping topography. They have moderate permeability and slow surface runoff. The proximity of the underlying till causes these soils to be imperfectly drained. The occurrence of salinity is rare in these soils. The surface texture is usually loamy very fine sand.

This soil is characterized by a dark gray Ap horizon 10 to 15 cm thick, occasionally a dark gray Ah horizon, 5 to 10 cm thick, a gray brown to brown Bmg horizon, 20 to 25 cm thick and a white Cca horizon, 18 to 25 cm thick, immediately overlying a yellowish brown II Ckg horizon.

Argue Series (ARG)

The Argue series consists of well drained Rego Black Chernozem soils of the Cameron Association, developed on deep (> 100 cm), strongly calcareous, medium textured (VFSL, L, SiL) lacustrine sediments. These soils are moderately well drained and occur in areas of level to very gently sloping topography. Surface runoff is generally slow with moderately slow permeability. Argue soils are typically non-stony and cultivated. The water table usually occurs at approximately 2.4 metres during the growing season. These soils are occasionally eroded to the extent that cultivation occurs into the Ck and Cca horizons, thereby incorporating lime into the Ap. As a result of erosion and cultivation, Argue soils can sometimes be recognized by a light or buff colored soil pattern in the field and on air photographs. The Apk horizon in cultivated soils is usually very dark gray to dark gray and 7 to 15 cm thick while in the uncultivated state the Ahk may be 20 to 30 cm thick and very dark grayish brown to light yellowish brown in color. The Ck horizon is usually dark grayish brown to light yellowish brown in color. In the native condition the vegetation consists of brome grass, willows and small shrubs. A representative profile description for the Argue series is presented below.

Apk - 0 to 13 cm, black (10YR 2/1 moist), dark gray (10YR 4/1 dry) silt loam; moderately fine granular; firm, moist; slightly hard when dry; abrupt, wavy boundary; strongly calcareous; mildly alkaline.
Ck1 - 13 to 20 cm, light gray (10YR 7/2 moist), white (10YR 8/1 dry) silty clay loam; moderately coarse granular; firm, moist, hard, dry; clear, irregular boundary; extremely calcareous; moderately alkaline.
Ck2 - 20 to 50 cm, light olive brown (2.5Y 5/4 moist), light gray (2.5Y 7/2 dry) silt loam; weak, fine granular; very friable, moist; soft, dry; clear, smooth boundary; very strongly calcareous; moderately alkaline.
Ck3 - 50 cm +, light olive brown (2.5Y 5/4 moist); light gray (2.5Y7/2 dry); silt loam; weak, fine granular; very friable.

Alexander Series (AXD)

The Alexander series consists of imperfectly drained, carbonated Gleyed Rego Black Chernozem soils of the Newstead Association developed on thin (25-96 cm) strongly calcareous, medium to moderately fine) textured lacustrine sediments overlying strongly calcareous, medium to moderately fine textured (VFSL, L, SiL to SCL, CL, SiCL) glacial till. A coarse textured (FS, LCoS, LFS) layer (5-76 cm) of gravel and sand occurs at the contact. Alexander soils are characterized by gently undulating topography, fine sandy loam surface texture, moderately slow surface runoff and moderately rapid permeability. The underlying glacial till restricts downward drainage and the coarse layer at the till contact allows for some lateral flow of water. Both conditions cause this soil to be imperfectly drained. Some iron staining and mottling occurs in the soil profile which is usually associated with restricted drainage. The occurrence of salinity in these soils is rare. It is occasionally cultivated, but most often it is left as native land or

pasture. Alexander soils occur in areas of complex surface deposits usually in the transition areas between glacial till and lacustrine deposits.

Bede Series (BED)

The Bede series consists of well drained Orthic Black Chernozem soils of the Bede Association, developed on strongly calcareous, coarse textured (sand and gravel) deltaic, beach and outwash deposits. This soil commonly has complex, very gently sloping topography, good drainage, very rapid permeability and minimal surface runoff. The depth of water table is estimated to be at about 3 metres during the growing season. This soil is non-saline and when cropped, tends to be droughty for most of the growing season. Most cereal crops and even some deep rooting forage crops can be severely affected by early summer heat and lack of moisture because of the low water holding capacity of the soil.

The surface texture of this soil ranges from a sandy loam to loamy sand grading to coarser materials with depth. The soil profile usually consists of a black Ah horizon 5 to 10 cm thick, a very dark brown Bm horizon 15 to 20 cm thick and a pale brown, very coarse textured C horizon. The Bm horizon is usually well developed as indicated by the strong prismatic to sub-angular blocky structure. A transitional BC and a prominent Cca horizon are also common in these soils. A representative Bede soil is described below (Soils of the Boissevain - Melita Area, Manitoba Soil Survey Report No. 20, 1978).

Ah - 0 to 13 cm, black (10YR 2/1 moist), very dark gray (10YR 3/1 dry) loamy sand; structureless single grained to weak medium granular; loose; abrupt, smooth boundary; non-calcareous; pH 7.3.
Bm - 13 to 30 cm, dark brown (10YR 3/3 moist), dark brown to brown (10YR 4/3 dry) sandy loam; weak, medium prismatic breaking to medium subangular blocky; very friable, moist; loose, dry; abrupt, smooth boundary; non-calcareous; pH 7.1.
BC - 30 to 38 cm, reddish brown (5YR 4/4 moist), yellowish brown (10YR 5/6 dry) gravelly sandy loam; weak medium prismatic breaking to weak, medium subangular blocky; very friable, moist; loose, dry; clear, smooth boundary; moderately calcareous; pH 7.4.
Cca - 38 to 48 cm, grayish brown to light brownish gray (10YR 5/2 to 6/2 moist), light gray (10YR 7/2 dry) gravelly, sandy loam; weak, fine granular; very friable, moist; loose, dry; clear, smooth boundary; strongly calcareous; pH 7.5.
Ck - 48 cm +, yellowish brown (10YR 5/4 moist), light gray (10YR7/2 dry) gravelly coarse sand; structureless to amorphous; loose; moderately calcareous; pH 7.6.

Bearford Series (BEF)

The Bearford series consists of well drained Orthic Black Chernozem soils of the Croll Association, developed on thin (25 to 100 cm), strongly calcareous, moderately fine textured, lacustrine deposits overlying strongly calcareous, medium to moderately fine textured glacial till. A very thin (less than 5 cm) pebble line may be evident at the contact. This soil has simple very gently sloping topography, a clay loam or sandy clay loam surface texture, moderate permeability and moderate surface runoff. The depth to water table is estimated to be 3 metres during the growing season. This soil is non-stony and is generally cultivated. An increase in the concentration of soluble salts near the contact zone of the underlying till is an occasional feature of these soils.
A detailed morphologic description and analytical data for a weakly saline profile of the Bearford series is presented:

Ap - 0 to 18 cm, black (10YR 2/1 moist), very dark gray to dark gray (10YR 3.5/1 dry) clay loam; amorphous; friable, moist; abrupt, smooth boundary; pH 7.4.
Bm - 18 to 43 cm, very dark grayish brown(10YR 3/2 moist), grayish brown to dark grayish brown (10YR 4.5/2 dry) silty clay loam; moderate medium prismatic breaking to moderate medium subangular blocky; friable, moist; clear, wavy boundary.
BC - 43 to 53 cm, grayish brown to dark grayish brown (10YR 4.5/2 moist), brown to pale brown (10YR 5.5/3 dry) clay loam; moderate medium prismatic breaking to moderate medium subangular blocky; friable when moist; clear, wavy boundary; moderately calcareous; pH 8.0.

Ccas - 53 to 71 cm, brown to pale brown (10YR 5.5/3 moist), light gray (10YR 7/2 dry) clay loam; amorphous; friable when moist; gradual wavy boundary; strongly calcareous; pH 8.1.
II Csk1 - 71 to 109 cm, light olive brown (2.5Y 5/4 moist), very pale brown (10YR 7/3 dry) clay loam; amorphous; friable when moist; strongly calcareous; pH 9.2.
II Csk2 - 109 cm +, light olive brown (2.5Y 5/4 moist), light gray (10YR 6.5/2 dry) clay loam; amorphous; friable when moist; strongly calcareous; pH 8.1.

Bella Lake Series (BEL)

Bella Lake series consists of poorly drained, Rego Humic Gleysol carbonated soils of the Newstead Association developed on thin (25 to 95 cm), strongly calcareous, medium to moderately fine textured lacustrine sediments overlying strongly calcareous, medium to moderately fine textured glacial till. A coarse textured layer (5 to 75 cm) occurs at the contact. This soil is characterized by a fine sandy loam surface texture, nearly level to depressional topography, a water table at approximately 1.5 m during the growing season, slow surface runoff and moderate permeability. The proximity of the less permeable underlying till and the depressional topography cause this soil to be poorly drained for most of the year. This weakly carbonated soil is rarely saline. The natural vegetation is hydrophytic. Bella Lake soils commonly occur in drainage channels of creeks and streams.

The Bella Lake series closely resembles the Deloraine series of the Waskada Association. The major difference from the Deloraine series is the presence of the coarse gravelly layer at the till contact.

Bernice Series (BIC)

The Bernice series consists of well drained Orthic Black Chernozem soils of the Bernice Association, developed on thin (25 to 100 cm) moderately to strongly calcareous, coarse textured (FS, LCoS, LS, LFS), gravelly deltaic and outwash deposits overlying strongly calcareous, medium to moderately fine textured, glacial till. These soils occur in transition areas between the deep outwash deposits and glacial tills mainly in the northeastern corner of the Killarney-Turtle Mountain map and in the western portion of the Boissevain-Melita map area near the western edge of the Souris Basin. The topography is gently undulating, permeability is moderately rapid, and surface runoff is low. Bernice soils are well drained although the proximity of the underlying glacial till restricts downward drainage.

Bower Series (BOW)

The Bower series consists of imperfectly drained Gleyed Black Chernozem soils of the Newstead Association, developed on thin (25 to 100 cm), strongly calcareous, medium to moderately fine textured, lacustrine sediments overlying strongly calcareous, medium to moderately fine textured, glacial till. A coarse textured layer (5 to 75 cm) thick occurs at the contact. Bower soils are characterized by a fine sandy loam surface texture, gently undulating topography, moderately slow permeability and slow surface runoff. Bower soils are imperfectly drained and generally occur in areas adjacent to creeks and ephemeral stream channels. The coarse textured layer may impede downward percolation and facilitate lateral water flow both of which will affect the moisture status of this soil. Although many of these soils are used for cereal crops, crop growth is more variable than on soils of uniform texture. This variability is attributed to the presence of the coarse textured layer which may inhibit root development and thereby render the plants more susceptible to moisture stress during dry periods. The degree to which the crops are affected will likely increase with increasing thickness of this coarse stratum.

Breadon Series (BRO)

The Breadon series consists of well drained Calcareous Black Chernozem soils of the Dromore Association, developed on thin (25 to 100 cm), strongly calcareous, medium textured (VFSL, L, SiL), lacustrine sediments overlying course textured, gravelly, deltaic beach and outwash deposits. Breadon soils are characterized by a dominantly loam surface texture, nearly level to gently undulating topography, moderate permeability, and low surface runoff. The average depth to water table during the growing season is estimated to be greater than 2.1 metres. As a result of their drainage characteristics and topographic position, these soils tend to be non-saline and moderately susceptible to drought during periods of low precipitation. However, they are less droughty and more fertile than the very similar Broomhill Series because they have a significantly thicker and finer textured surface layer.

Croll Series (CLL)

The Croll series consists of imperfectly drained Gleyed Carbonated Rego Black Chernozem soils of the Croll Association developed on thin (25 to 100 cm), strongly calcareous, moderately fine textured (SCL, CL, SiCL), discontinuous aeolian and lacustrine mantle overlying strongly calcareous, medium to moderately fine textured, glacial till. The surface texture is dominantly clay loam, the topography is gently undulating, permeability is slow and runoff is moderate. This soil is imperfectly drained and may be weakly saline. The estimated depth to water table during the growing season is 2 metres. The Croll series is associated with the imperfectly drained Gleyed Calcareous Black Chernozem Desford series and the well drained Bearford series.

Cranmer Series (CME)

The Cranmer series consists of imperfectly drained Gleyed Rego Black Chernozem (carbonated) soils, developed on deep, strongly calcareous, fine loamy lacustrine sediments. These soils usually have a clay loam surface texture, nearly level to very gently sloping topography, and slow to moderate permeability and surface runoff. This soil can be weakly to moderately saline and is imperfectly drained. The estimated depth to water table during the growing season is less than 2 m. Most of these soils are cultivated and, depending on the degree of salinity, produce good crops.

The soil is characterized by black Ap horizons 10 to 20 cm thick, black to dark gray AC horizons 18 to 25 cm thick and brown to yellowish brown Ccagj horizons. The C horizons are occasionally stratified and banded.

The Cranmer series resembles the imperfectly drained soils of the Elva Association except that the Cranmer series is not underlain by glacial till. Cranmer is equal to the Prodan series of climatic subregion Gt2.

Cameron Series (CMR)

The Cameron series consists of well drained, Orthic Black Chernozem soils of the Cameron Association, developed on deep, strongly calcareous, loamy lacustrine sediments. These soils have dominantly a loam surface texture, very gently sloping to gently undulating topography, moderately rapid permeability, and moderate surface runoff. This soil is moderately to well drained with an estimated depth to water table of 3 m during the growing season. These soils are non-saline, non-stony, fertile agricultural soils.

Cameron soils generally occupy slightly higher landscape positions than the Hartney and Denbow soils and are commonly found in close association with Lyleton soils. Cameron soils with low amounts of crop residue are quite susceptible to erosion.

A modal Cameron soil has a black Ap horizon 5 to 15 cm thick, a very dark gray Ah horizon 5 to 12 cm thick, a dark grayish brown Bm horizon 15 to 20 cm thick, a light gray Cca horizon 7 to 12 cm thick and an olive yellow Ck horizon. In Gt2 climatic subregion these soils equal the Fairland series.

Coulter Series (COU)

The Coulter series consists of imperfectly drained, Gleyed Carbonated Rego Black Chernozem soils developed on deep, moderately calcareous, moderately fine to fine textured (SCL, CL, SiCL to SiC, C), recent alluvial sediments. These soils have nearly level to depressional topography, clay loam surface texture, moderately slow permeability and a moderate surface runoff. The Coulter series is associated with the poorly drained Leighton series. Drainage is imperfect and the estimated depth to water table during the growing season is 2 to 3 metres. These soils may be weakly saline and non-stony and are used for crop production. A detailed description of a representative profile is presented below (Soils of the Boissevain - Melita Area, 1978).

Apk - 0 to 23 cm, black to very dark gray (10YR 2.5/1 moist), very dark gray to dark gray (10 3.5/1 dry) clay to clay loam; weak, medium prismatic breaking to moderate medium blocky; friable when moist; clear, smooth boundary; moderately calcareous.

Ahkgj - 23 to 46 cm, black to very dark gray (10YR 2.5/1 moist), very dark gray to dark gray (10YR 3.5/1 dry); clay loam; medium prismatic breaking to moderate medium blocky; friable when moist; clear, smooth boundary; moderately calcareous.
Ccagj - 46 to 56 cm, gray to light gray (10YR 6/1 moist), very pale brown (10YR 7/3 dry) clay loam; structureless; friable when moist; clear, smooth boundary; strongly calcareous.
Ckg - 56 cm +, grayish brown (2.5Y 5/2 moist); gray (10YR 5.5/1 dry); clay loam; structureless; friable when moist; moderately calcareous; moderately alkaline.

Coatstone Series (CSE)

The Coatstone series consists of imperfectly drained, Gleyed Rego Black Chernozem, carbonated soils of the Ryerson Association, developed on deep, strongly calcareous, medium to moderately fine textured, glacial till. The till is composed of material derived from shale, limestone and granitic rock. The surface 25 cm may vary slightly in texture. Coatstone soils usually have a clay loam surface texture, very gently sloping topography, moderately slow permeability, and moderate surface runoff. They are imperfectly drained and occasionally slightly stony. They may be weakly to moderately saline. The estimated depth to water table is 1.5 m. Coatstone soils usually occur in intermediate to level positions between the better drained Ryerson and Medora soils and the poorer drained Ewart, Tilston and Stoney Creek soils. Gleyed Calcareous Black Chernozem soils are closely associated with Coatstone soils and may be found in the same vicinity. In undisturbed areas where native vegetation exists aspen is quite common.

Coatstone soils are characterized by black Apk horizons 8 to 13 cm thick, dark gray AC horizons 5 to 10 cm thick, weakly mottled light brownish gray Ccagj horizons 10 to 13 cm thick, and gleyed prominently iron mottled, brown to yellowish brown Ckg horizons.

Cartwright Series (CWG)

The Cartwright series consists of imperfectly drained Gleyed Black Chernozem soils of the Bede Association developed on strongly calcareous, deep, coarse textured (FS, LCoS, LS, LFS), gravelly, deltaic, beach and outwash deposits. The solum is usually developed in a thin coarse sandy loam to loamy sand surface layer. The soil has gently undulating topography, rapid permeability and very slow surface runoff. These soils have imperfect drainage as a result of a high water table which is estimated at less than 1 metre for much of the growing season. These soils commonly occur in level areas of large kettled, outwash deposits or in stream channels. Some of these soils are cultivated but most are used for native hay and pasture (Soils of the Boissevain - Melita Area, 1978). A representative profile description is presented below.

Ah - 0 to 23 cm, very dark gray (10YR 3/1 moist), very dark grayish brown to dark grayish brown (10YR 3.5/2 dry) sand; weak, fine granular; loose; mildly alkaline; non-calcareous; clear, smooth boundary.
Bmgj - 23 to 46 cm, dark grayish brown (10YR 4/2 moist), dark yellowish brown (10YR 4/4 dry) gravelly, sand; weak, fine granular; loose; some dark brown (7.5YR 4/4 dry) iron concretions; moderately alkaline; non-calcareous; clear, smooth boundary.
BC - 46 to 61 cm, brown (10YR 5/3 moist), light gray (10YR7/2 dry) gravelly sand; structureless single grained; loose; moderately alkaline; moderately alkaline; moderately calcareous; diffuse, wavy boundary.
Ckgj - 61 cm +, brown (10YR 5/3 moist), light gray (10YR7/2 dry) gravelly fine sand; structureless; loose; moderately alkaline; moderately calcareous.

Desford Series (DFD)

The Desford series consists of imperfectly drained, Gleyed Black Chernozem soils of the Croll Association, developed on thin (25 to 100 cm), strongly calcareous, moderately fine textured, discontinuous lacustrine mantle overlying strongly calcareous medium to moderately fine textured glacial till. A very thin (less than 5 cm) gravelly stratum may occur at the contact. This soil has a clay loam surface texture, depressional to gently undulating topography, slow permeability and slow surface runoff. The estimated depth to water table is 2 metres during the growing season. It is occasionally saline, non-stony and generally cultivated.

Associated soils are the well drained Bearford series, the imperfectly drained Croll series, and the poorly drained Wassewa series. The Desford series resembles the Goodlands series of the Elva Association. The only difference is the Desford series is underlain by glacial till (Soils of the Boissevain - Melita Area, 1978). Analytical data and a representative profile description are presented below.

Ap - 0 to 15 cm, very dark gray (10YR 3/1 moist), very dark gray to dark gray (10YR 3.5/1 dry) clay loam; strong, moderate platy; friable when moist, very hard when dry; abrupt, smooth boundary; pH 7.3.

Bmgj - 15 to 38 cm, black (10YR 2/1 moist), dark gray to gray (10YR 4.5/1 dry) silty clay; moderate medium granular; firm when moist, hard when dry; gradual, wavy boundary; pH 7.3.

II Cksgj - 38 cm +, dark gray (2.5Y 4/2 moist), grayish brown (10YR 5/2 dry) silty clay loam; amorphous.

Dalny Series (DNY)

The Dalny series consists of well drained, Calcareous Black Chernozem soils of the Waskada Association developed on thin (25 to 100 cm), strongly calcareous, medium textured (VFSL, L, SiL), discontinuous eolian and lacustrine sediments overlying strongly calcareous, medium to moderately fine textured, glacial till; a very thin (< 5 cm) gravelly stratum may occur at the contact. These soils have a very fine sandy loam to loam surface texture, gently undulating topography, slow permeability, and moderate surface runoff. The soil is non-stony and is used for crop production. This series is associated with the well drained Maskawata and Waskada series and the imperfectly drained Two Creeks and Montgomery series of the Waskada Association. The Dalny series resembles the Schaffner series of the Cameron Association; the only difference is that the Dalny series is underlain by glacial till (Soils of the Boissevain - Melita Area, 1978). A morphological description of a representative profile is presented below.

Ap - 0 to 15 cm, black (10YR 2/1 moist), very dark gray to dark gray (10YR 3.5/1 dry) very fine sandy loam; moderate fine granular; friable when moist, slightly hard when dry; abrupt, smooth boundary.
Ah - 15 to 20 cm, black (10YR 2/1 moist), very dark gray to dark gray (10YR 3.5/1 dry) very fine sandy loam; moderate fine granular; friable when moist, slightly hard when dry; clear, wavy boundary.
Bmk - 20 to 41 cm, very dark grayish brown (10YR3/2 moist), dark gray (10YR 4/1 dry) very fine sandy loam; strong fine granular; friable when moist, slightly hard when dry; abrupt, wavy boundary; weakly calcareous.
II Cca - 41 to 56 cm, pale brown (10YR 6/3 moist), white (10YR 8/2 dry) silt loam; weak fine granular; firm when moist, hard when dry; gradual, smooth boundary; very strongly calcareous.
II Ck - 56 cm +, light olive brown (2.5Y 5/4 moist), very pale brown (10YR 7/3 dry) silt loam; firm when moist, slightly hard when dry; strongly calcareous.

Dromore Series (DOM)

The Dromore series consists of well drained, Orthic Black Chernozem soils of the Dromore Association, developed on thin (25 to 100 cm), strongly calcareous, medium to moderately fine textured (VFSL, L, SiL to SCL, CL, SiCL), lacustrine sediments overlying coarse textured (FS, LCoS, LS, LFS), gravelly, deltaic beach and outwash deposits. This soil has a fine sandy loam to loam surface texture, gently undulating topography, moderately rapid permeability, and low surface runoff. This soil is very slightly stony, well drained, and non-saline. This soil occurs in areas adjacent to outwash deposits and is usually cultivated. The presence of the underlying gravel tends to make these thin soils somewhat droughty during periods of low precipitation.

Dromore, shaly variant (DOM1) are underlain by shaly, gravelly deposits. Dromore soils are characterized by black Ap horizons 10 to 15 cm thick, very dark brown Bm horizons 15 to 25 cm thick overlying a coarse textured II C horizon. The Dromore series resembles the Newstead series of the Newstead Association. The difference is the Newstead Association is underlain by glacial till.

Deloraine Series (DRI)

The Deloraine series consists of poorly drained, carbonated Rego Humic Gleysol soils of the Waskada Association, developed on thin (25 to 100 cm), strongly calcareous, medium textured (VFSL, L, SiL), discontinuous eolian and lacustrine sediments overlying strongly calcareous, medium to moderately fine textured, glacial till. These soils have a loam surface texture, nearly level topography, slow permeability, and very slow runoff. They occur in depressions and stream channels. The estimated depth to water table during the growing season is usually less than 1 metre. Flooding and surface ponding are a common occurrence. They are rarely cultivated and usually support hydrophytic vegetation such as cattails, bullrushes and horsetail.

Emblem Series (EBL)

The Emblem series consists of poorly drained carbonated Rego Humic Gleysols of the Cameron Association developed on deep, strongly calcareous, loamy lacustrine sediments. These soils usually have depressional to level topography, loam surface textures; moderate permeability and very slow surface runoff. These soils are poorly drained due to a combination of depressional topography and high groundwater levels. The estimated depth to water table is less than 1.5 m during the growing season. These soils occur in drainage channels and depressions and are frequently flooded by ponded or flowing water. Emblem soils support hydrophytic vegetation, are non-stony and rarely cultivated.

Elva Series (ELV)

The Elva series consists of well drained, Orthic Black soils of the Elva Association, developed on deep, strongly calcareous, moderately fine textured (SCL, CL, SiCL), lacustrine sediments. This soil has a clay loam surface, nearly level to gently undulating topography, slow to moderate permeability, and moderate surface runoff. Elva soils are moderately well or well drained, non-saline, non-stony, generally cultivated and have an estimated depth to water table of 2 to 3 m during the growing season. These are highly productive soils. They occur generally in the Souris Basin in the vicinity of Elva and Hartney and have a limited occurrence in the Whitewater Basin area. This soil is associated with the imperfectly drained Goodlands, Cranmer, Minto and Ninga series; and the poorly drained Naples, Bunclody and Fairfax series (Soils of the Boissevain - Melita Area, 1978).

Eroded Slope Complex (ERX) or ($ER)

This soil complex includes all the land occupied by the eroded slopes of river valleys and walls, incised stream channels and ravines that have down-cut through the surface deposits and shale bedrock. These are generally well drained, strongly to steeply sloping landforms that have variable soil development on materials that are variable in composition, depending on the nature of the surrounding deposits. Due to its complexity, this is a miscellaneous land type rather than a unit of normal soil. These areas are typically influenced by mass wasting processes such as slump, creep, solifluction and erosion.

The soils range from Orthic Black Chernozems to Regosols. The slopes are characterized by numerous major seepage zones where the water table intersects the slope walls or scarps, generally in the mid to lower slopes. The maintenance of vegetation on the Eroded Slopes is essential for their stability.

Ewart Series (EWT)

The Ewart series consists of poorly drained, carbonated Rego Humic Gleysol soils of the Ryerson Association, developed on deep, strongly calcareous, medium to moderately fine textured glacial till, composed of material derived from shale, limestone, and granitic rock. This soil is usually developed in a considerable thickness of sediments which have been washed into the bottom of depressions. The surface texture, although variable is dominantly clay loam; the topography is depressional to nearly level; permeability is slow and surface runoff if any, is very slow. These soils are poorly drained with a very high water table which occurs at or near the surface most of the year. Surface vegetation usually consists of water hemlock (Cicuta spp.), Mint (Mentha arvensis), slough grass (Beckmannia syzigachne), Cattails and Reeds. This soil is occasionally moderately to strongly saline, depending on location, non-stony and is rarely cultivated.

Ewart soils are characterized by black, Ah horizons 10 to 20 cm thick, light gray Cca horizons 20 to 28 cm thick and gray brown iron mottled Ck horizons. These soils are commonly, weakly stratified.

Fairburn Series (FBU)

The Fairburn series consists of well drained, Rego Black Chernozem soils of the Mentieth Association, developed on thin (25 to 100 cm) moderately calcareous, moderately coarse textured (VFS, LVFS, SL, FSL), lacustrine sediments overlying strongly calcareous, medium to moderately fine textured, glacial till.

A very thin (less than 5 cm) gravelly stratum may occur at the contact. Fairburn soils have loamy very fine sandy surface textures, nearly level topography, moderate permeability and moderate surface runoff. Drainage is good and the estimated depth to water table is 3 metres. These soils are non-stony, non-saline, usually cultivated, somewhat droughty and moderately susceptible to erosion. Fairburn soils are commonly found in close association with Nesbitt soils (Soils of the Boissevain - Melita Area, 1978).

Fairfax Series (FFX)

The Fairfax series consists of poorly drained, Carbonated Rego Humic Gleysols of the Elva Association; developed on deep, strongly calcareous, moderately fine textured (SCL, CL, SiCL), lacustrine sediments. These soils have a clay loam surface texture, nearly level to depressional topography, slow permeability, and very slow surface runoff. These soils are poorly drained with the water table at or near the surface most of the year. Surface ponding and flooding are very common. These soils are not cultivated and generally support a lush growth of hydrophytic vegetation such as Cattails, Reeds, and Slough Grass; some Willows may also occur (Soils of the Boissevain - Melita Area, 1978).

Gainsborough Series (GGH) or (GEK)

The Gainsborough series consists of poorly drained, Carbonated Rego Humic Gleysols of the Mentieth Association, developed on thin (25 to 100 cm), moderately calcareous, moderately coarse textured lacustrine sediments, overlying strongly calcareous, medium to moderately fine textured glacial till. A very thin (less than 5 cm), gravelly stratum may occur at the contact. This soil has nearly level to depressional topography, a sandy loam surface texture, moderately slow permeability and no surface runoff. This soil is poorly drained as a result of its depressional landscape position and high groundwater level. The estimated depth of water table is less than 1 metre during most of the growing season. The surface of these soils occasionally dries out during later summer but is usually saturated by fall rains before freeze up. The vegetation consists of hydrophytic reeds, grasses and willows. Gainsborough soils generally occur in depressions and stream channels and are frequently flooded and ponded.

This soil is associated with the well drained Langvale, Nesbitt and Fairburn series and the imperfectly drained Ashbury and Mentieth series. The Gainsborough series resembles the Plum Lake series of the Lyleton Association. The only difference is the Plum Lake series is not underlain by glacial till (Soils of the Boissevain - Melita Area, 1978).

George Lake Series (GGK)

George Lake series consists of Orthic Black Chernozem soils of the George Lake Association, developed on thin (25 to 100 cm), weakly to moderately calcareous, moderately coarse textured (VFS, LVFS, FSL), lacustrine sediments overlying coarse textured, deltaic, beach and out-wash deposits. This soil has a loamy very fine sand surface texture, very gently sloping, complex topography, good drainage, rapid permeability and low surface runoff. This soil is non-saline, non-stony and usually cultivated. This soil is closely associated with Bede soils but is not as coarse and generally has a deeper profile. The Ap horizon is dark gray to dark grayish brown and ranges from 15 to 20 cm thick. Occasionally an Ah horizon is present and is usually black to very dark gray and 3 to 5 cm thick. A deep, dark brown Bm horizon 20 to 30 cm thick is common overlying a coarse, stratified yellowish brown II Ck horizon. The George Lake series is associated with the imperfectly drained Ninette and Linklater series, and the poorly drained Pierson series. The George Lake series resembles the Griswold series except

that it is underlain by glacial till (Soils of the Boissevain - Melita Area, 1978). A description of a representative profile is presented below.

Ap - 0 to 20 cm, very dark gray (10YR 3/1 moist), dark brown to brown (10YR 3.5/1 dry) fine sandy loam; weak, medium granular; slightly plastic; loose when dry; friable when moist; abrupt, smooth boundary; non-calcareous.
Ah - 20 to 23 cm, black (10YR 2/1 moist), very dark gray (10YR 3/1 dry) sandy loam; weak, medium granular; slightly plastic, loose when dry, friable when moist; clear, smooth boundary; non-calcareous.
Bm - 23 to 51 cm, dark brown to brown (10YR 3.5/3 moist), dark grayish brown to grayish brown (10YR 4.5/2 dry) sandy loam; weak, medium prismatic to weak, fine granular; slightly plastic; friable when moist; clear, wavy boundary; non-calcareous.
II Ck1 - 51 to 101 cm, yellowish brown (10YR 5/4 moist), light brownish gray (10YR 6/2 dry) course sandy, gravel; structureless; non-plastic; moderately calcareous; abrupt, smooth boundary.
II Ck2 - 101 cm +, pale brown (10YR 6/2 moist), very pale brown (10YR 7/3 dry), gravel; moderately calcareous; some staining and iron concretions present.

Graham Series (GHM)

The Graham series consists of poorly drained, carbonated, Rego Humic Gleysols of the Melita Association, developed on deep, moderately calcareous, medium textured (VFSL, L, SiL), recent alluvial sediments. These deposits are stratified and contain numerous dark colored bands of former surface horizons in the profile. Graham soils generally occur the channels of Pembina and Long Rivers and in the Souris River channel south of Melita and in the vicinity of Gainsborough, Antler and Graham Creeks that empty into the Souris River from the west. Graham soils have complex gently undulating topography, a silt loam surface texture, slow permeability and very slow surface runoff. Surface ponding and flooding are a common occurrence on Graham soils. The vegetation consists mainly of hydrophytic species and many of these soils are used only for pasture.

Associated soils are the well drained Melita series and the imperfectly drained Liege series. The Graham series of the Melita Association resembles the Leighton series of the Coulter Association. They are both alluvial deposits. The major difference between the two is that the Melita Association consists of stratified medium textured sediments while the Coulter Association consists of more uniform, moderately fine textured.

Glenview Series (GLN)

The Glenview series consists of imperfectly drained Gleyed Black Chernozem soils of the Dromore Association, developed on thin (25 to 100 cm), strongly calcareous, medium textured (VFSL, L, SiL), lacustrine sediments overlying coarse textured (FS, LCoS, LFS), gravelly deltaic outwash deposits. The dominant surface texture is loam; the topography is nearly level; permeability is moderate; and runoff is moderate. These soils are non-saline and cultivated.

The Glenview is associated with the well drained Dromore series and resembles the Bower series except that the Bower series is underlain by glacial till (Soils of the Boissevain - Melita Area, 1978).

Glenora Series (GLO)

The Glenora series consists of imperfectly drained, carbonated, Gleyed Rego Black Chernozem soils of the Bernice Association developed on thin (25 to 100 cm), moderately to strongly calcareous, coarse textured, gravelly deltaic and outwash deposits overlying strongly calcareous medium to moderately fine textured glacial till. This soil has a coarse sandy surface texture, nearly level to gently sloping topography, rapid permeability and slow surface runoff. The imperfect drainage is due to high water table and the proximity of the underlying less permeable glacial till. Lateral groundwater flow through these soils is common. Gleyed Calcareous Black Chernozem soils may be found in close association with Glenora soils which commonly occur in the vicinity of outwash deposits and in glacial stream channels that have eroded through till deposit. The Glenora series resembles the Napinka series of the Bede Association. The only difference is the Glenora is underlain by glacial till.

Glenlorne Series (GNO)

The Glenlorne series consists of imperfectly drained Gleyed Eluviated Black Chernozem soils of the Waskada Association, developed on thin (25 to 100 cm), strongly calcareous, medium textured, discontinuous eolian and lacustrine sediments overlying stronger calcareous medium to moderately fine textured glacial till. A very thin (less than 5 cm), gravelly stratum or pebble line may occur at the contact. This soil has smooth to level topography, very fine sandy loam to loam surface texture, slow permeability, and slow surface runoff. The estimated depth to water table during the growing season is less than 2 metres. This soil is non-saline non-stony and usually cultivated. It is frequently flooded and ponded in the spring and after heavy rains. Although these soils are cultivated, they are generally not productive as the crops are adversely affected by periodic, excessive wetness.

Glenlorne soil is characterized by a black Ap horizon, 13 to 15 cm thick, a gray to light gray Ae horizon, 3 to 5 cm thick, a very dark grayish brown, gleyed, Bt horizon, 20 to 30 cm thick, a grayish brown, gleyed, iron stained and mottled Cca horizon, 13 to 18 cm thick. A grayish brown, gleyed, weakly mottled II Ckgj is also present. Associated soils include the well drained Waskada and Maskawata series, the imperfectly drained Montgomery and Two Creeks series, and the poorly drained Deloraine series. The Glenlorne series resembles the Hayfield series of the Cameron Association. The only difference is the Glenlorne series is underlain by glacial till. A description of a representative profile is presented below:

Ap - 0 to 15 cm, black (10YR 2/1 moist), very dark gray to dark gray (10YR 3/1 dry) silt loam; medium granular; friable when moist, soft when dry; abrupt, smooth boundary; weakly calcareous; pH 7.4.
Ae - 15 to 20 cm, dark gray (10YR 4/1 moist), gray to light gray (10YR 6/1 dry) silt loam; weak, fine platy; very friable when moist, soft when dry; clear, wavy boundary; pH 7.3.
Btgj1 - 20 to 25 cm, very dark grayish brown (2.5Y 3/2 moist); grayish brown (2.5Y 5/2 dry); clay loam; weak, fine granular; firm when moist; slightly hard when dry; smooth boundary; pH 7.2.
Btgj2 - 25 to 36 cm, very dark brown (10YR 2/2 moist), very dark grayish brown (10YR 3/2 dry) clay loam; medium blocky breaking to weak, fine subangular blocky; very firm when moist, hard when dry; clear, wavy boundary; pH 7.3.
Btgj3 - 36 to 43 cm, gray grayish brown (2.5Y 4/2 moist); olive gray (5Y 5/2 dry) clay loam; weak, fine granular; firm when moist; slightly hard when dry; clear, smooth boundary; pH 7.3.
Ckgj - 43 to 61 cm, dark grayish brown to grayish brown (2.5Y 4.5/2 moist), grayish brown (2.5Y 5/2 dry) loam; few, fine, faint iron and manganese mottles; weak, fine granular; friable when moist, soft when dry; abrupt, smooth boundary; moderately calcareous; pH 7.5.
Ccagj - 61 to 76 cm, grayish brown (2.5Y 5/2 moist), light gray (2.5Y 7/2 dry) silt loam; few, fine, faint iron mottles; moderate fine granular; firm when moist, soft when dry; abrupt, smooth boundary; few, gypsum crystals present; strongly calcareous; pH 7.6.
II Ckgj - 76 cm +, grayish brown (2.5Y 5/2 moist), light brownish gray (2.5 6/2 dry) loam, few, fine faint light yellowish brown (2.5Y 6/6 dry), iron mottles; weak, fine granular; firm when moist, slightly hard when dry; moderately calcareous; pH 7.5.

Goodlands Series (GOL)

The Goodlands series consists of imperfectly drained, Gleyed Black Chernozem soils of the Elva Association, developed on deep, strongly calcareous, moderately fine textured (SCL, CL, SiCL), lacustrine sediments. The surface texture is clay loam, the topography is nearly level to gently sloping, permeability is slow and runoff is slow. Depth to water table is estimated at 2 metres during the growing season. This soil is usually non-stony, and may be weakly to moderately saline in subsurface horizons.

This soil is characterized by black to very dark gray Ap horizons 10 to 25 cm thick, black to very dark brown gleyed Bm horizons 13 to 20 cm thick, very dark gray to dark gray gleyed BC horizons 18 to 25 cm thick and gleyed, light olive brown to pale olive C horizons (Soils of the Boissevain - Melita Area, 1978). Analytical data and a representative profile description are presented:

Ap - 0 to 25 cm, very dark gray (10YR 3/1 moist), very dark gray to dark gray (10YR 3.5/1 dry) clay loam; moderate medium subangular blocky breaking to moderate fine subangular blocky; friable when moist; abrupt, smooth boundary; non-calcareous; pH 6.7.
Btjgj - 25 to 41 cm, black to very dark brown (10YR 2/1.5 moist), very dark gray to dark gray (10YR 3.5/1 dry) silty clay loam; weak medium prismatic breaking to weak fine subangular blocky; friable when moist; irregular boundary; pH 7.6.
BC - 41 to 64 cm, very dark gray to dark gray (10YR 3.5/1 moist), gray (10YR 5/1 dry) silty clay loam; weak fine subangular blocky; friable when moist; diffuse irregular boundary; moderately calcareous; pH 8.3.
Cksgj - 64 cm +, light olive brown (2.5Y 5/4 moist), pale olive (5Y 6/3 dry); silty clay loam; weak fine granular; friable, when moist; very strongly calcareous; weakly saline; pH 8.5.

Gopher Creek Series (GPE)

The Gopher Creek series is the imperfectly drained, carbonated, Gleyed Rego Black Chernozem soils of the Dromore Association, developed on thin (25 to 100 cm), strongly calcareous, medium textured (VFSL, L, SiL), lacustrine sediments overlying coarse textured (FS, LCoS, LFS), gravelly deltaic and outwash deposits. This soil is characterized by nearly level topography, moderately slow permeability, and low surface runoff. The dominant surface texture is very fine sandy loam. Some of these soils are cultivated and some are used as pasture. The estimated depth to water table during the growing season is 2 metres.

Associated soils are the well drained Dromore and Breadon series, the imperfectly drained Glenview series, and the poorly drained William series. The Gopher Creek series resembles the Alexander series except that the Alexander series is underlain by glacial till (Soils of the Boissevain - Melita Area, 1978).

Hathaway Series (HHY)

The Hathaway series consists of well drained Rego Black Chernozem soils of the Ryerson Association, developed on deep, strongly calcareous, medium to moderately fine textured glacial till. The till is composed mainly of mixed materials derived from shale, limestone and granitic rocks. The surface horizons are usually very thin as a result of erosion by wind, water and cultivation. These soils have a loam to clay loam surface texture, gently undulating topography, moderate permeability and rapid surface runoff. Hathaway soils usually occur in the upper slope and knoll positions, and usually have a lighter gray surface color than adjacent, deeper soils. The light color is due to carbonates. Depth to water table ranges from 2 to 3 metres. These soils are usually strongly calcareous and low in organic matter. This soil is characterized by a gray non-leached Apk horizon 10 to 20 cm thick, a dark gray to gray AC horizon 20 to 50 cm thick overlying a light yellowish brown Ck horizon. Morphological data for a representative profile are presented below.

Apk - 0 to 20 cm, black (10YR 2/1, moist), gray (10YR 5/1, dry), loam; weak, fine, subangular blocky, very friable; clear smooth boundary; strongly calcareous; pH 7.8.

AC - 20 to 50 cm, dark gray (10YR 4/1, moist), gray (10YR 5/1, dry), loam; weak, fine subangular blocky, very friable; clear irregular boundary; strongly calcareous; pH 8.2.

Ck - 50 to 76 cm, yellowish brown to light yellowish brown (10YR 5.5/4, moist), light yellowish brown (10YR 6/4, dry), loam; weak fine subangular blocky, very friable; clear smooth boundary; strongly calcareous; pH 8.1.

Ckgj1 - 76 to 100 cm, dark yellowish brown to yellowish brown (10YR 7/4, dry), loam; weak fine subangular blocky, very friable; clear smooth boundary; strongly calcareous; pH 7.9.

Ckgj2 - 100 to 160 cm, dark yellowish brown to yellowish brown (10YR 4.5/4, moist), pale brown (10YR 6/3, dry), loam; weak medium subangular blocky, friable; strongly calcareous; common, medium prominent, dark red (10YR 3/6), iron concretions; pH 7.8.

Hartley Series (HLY)

The Hartley series consists of well drained, Orthic Black Chernozem soils of the Hartley Association, developed on thin (25 to 97 cm), strongly calcareous, moderately fine textured (SCL, CL, SiCL), lacustrine sediments overlying strongly calcareous, medium to moderately fine textured till. A coarse textured gravel layer (5 to 76 cm thick) occurs at the contact. The soil has a sandy clay loam to clay loam surface texture, gently undulating topography, moderately low permeability, and rapid surface runoff. The soil is moderately well drained, non-saline and cultivated.

Horton Series (HOT)

The Horton Series is the well drained, Orthic Dark Gray Chernozem member of the Horton Association, developed on deep, strongly calcareous, medium to moderately fine textured glacial till deposits composed of shale, limestone and granitic rock. These well drained soils have moderate permeability and rapid surface runoff. The depth to water table is in the range of 4.3 to 6.1 metres. The topography is undulating to moderately rolling and consists dominantly of complex slopes. The native vegetation consists of Balsam Poplar (*Populus balsamifera*), Hazel nut, grasses and shrubs. Many of these soils are cultivated; however in the undisturbed sites they are characterized by a thin black Ahe horizon 0 to 5 cm thick, a grayish brown Ahe horizon 8 to 10 cm thick, a dark brown to brown Bt horizon 15 to 20 cm thick, and a brown to pale brown BC horizon 13 to 15 cm thick. In some cases a brown Ck horizon is present immediately above a dark yellowish brown to pale brown Cca horizon 15 to 18 cm thick. A pale brown Ck horizon constitutes the soil parent material.

The Horton Association is related to the Ryerson Association. They are both found on the same parent material but the Ryerson Association (Chernozemic) is found at lower elevations while the Horton Association (degraded Chernozemic) is found at higher elevations in the Turtle Mountains. A representative profile description is presented below.

LFH - 3 to 0 cm

Ah - 0 to 5 cm, black (10YR 2/1, moist), dark grayish brown (10YR 4/2, dry), loam; moderate medium to fine subangular blocky; very friable when moist; clear wavy boundary; pH 6.3.

Ahe - 5 to 15 cm, very dark grayish brown (10YR 3/2, moist), grayish brown (10YR 5/2, dry), clay loam; moderate medium granular; friable when moist; clear wavy boundary; pH 6.5.

Bt1 - 15 to 28 cm, dark brown (10YR 3/3, moist), brown (10YR 5/3, dry), clay loam; moderate fine subangular blocky; friable when moist, clear wavy boundary; pH 6.7.

Bt2 - 28 to 36 cm, dark brown (10YR 3/3, moist), brown (10YR 4.5/3, dry), clay loam; moderate coarse blocky to moderate medium blocky; firm when moist; clear wavy boundary; pH 6.9.

BC - 36 to 51 cm, dark brown (10YR 3/3, moist), brown to pale brown (10YR 5.5/3, dry), clay loam; moderate coarse blocky to moderate, medium to fine blocky; firm when moist; gradual irregular boundary; moderately calcareous; pH 7.6.

Ck1 - 51 to 74 cm, brown (10YR 4.5/3, moist), brown to pale brown (10YR 5.5/3, dry), clay loam; strong medium subangular blocky; friable when moist; gradual irregular boundary; moderately calcareous; pH 7.7.

Cca1 - 74 to 86 cm, dark yellowish brown to yellowish brown (10YR 4.5/4, moist), pale brown (10YR 6/3, dry), silt loam; moderate coarse subangular blocky to moderate medium subangular blocky; friable when moist; strongly calcareous; pH 7.8.

Cca2 - 86 to 97 cm, dark yellowish brown to yellowish brown (10YR 4.5/4, moist), very pale brown (10YR 7/3, dry) to white (10YR 8/1, dry), clay loam; moderate coarse subangular blocky to moderate medium subangular blocky; friable when moist; strongly calcareous; gradual irregular; pH 7.9.

Ck2 - 97 to 130 cm, brown (10YR 4.5/3, moist), pale brown (10YR 6/3, dry), loam; strong coarse subangular blocky; friable when moist; moderately calcareous; pH 7.9 (carbonates follow old root channels and cracks).

Hartney Series (HRY)

The Hartney series consists of the imperfectly drained, Gleyed Rego Black Chernozem carbonated member of the Cameron Association developed on deep, strongly calcareous, loamy lacustrine sediments. This soil has level to very gently sloping complex topography, moderate permeability, slow surface runoff and a loam surface texture. The estimated depth to water table is less than 2 m during the growing season. This soil is used for crop production.

Hartney soils are characterized by black Apk horizons 10 to 12 cm thick, dark gray AC horizons 5 to 7 cm thick, light olive gray Cca horizons 7 to 10 cm thick overlying a pale olive to pale yellow Ckgj, horizon.

Hazeldean Series (HZD)

The Hazeldean series is the imperfectly drained, Gleyed Eluviated Black Chernozem member of the Ryerson Association, developed on deep, strongly calcareous, medium to moderately fine textured glacial till composed of mixed materials derived from shale, limestone and granitic rocks. These soils are generally located in elevated, depressional positions with very gently sloping topography, moderate permeability and very little surface runoff. The dominant surface texture is clay loam. Surface water frequently ponds on these soils for short periods of time. The depth of water table ranges from ground surface in the spring to 3 m in January with an average of 1.5 m during the growing season. These soils contribute the major portion of the ponded surface waters to the groundwater zone. Transmittance of this water through the profile leaches the soluble salts, carbonates and some clay minerals, resulting in the development of the Ae and Bt horizons.

The profiles of these soils consists of thick black Ah or Ap horizons 10 to 36 cm thick overlying a strongly developed, weakly stained, platy structured Aegj horizon 15 to 18 cm thick. The underlying dark gray Btgj horizon is 41 to 61 cm thick, weakly stained with prominent iron mottles and has a strong coarse subangular blocky structure. The parent material is dark yellowish brown, weakly stained and weakly calcareous. Hazeldean soils are commonly developed in sediments laid down in shallow depressions in glacial deposits. However, these sediments are not as deep as those in wetter depressions characterized by Tilston soils. Many Hazeldean soils are cultivated but in the undisturbed sites the native vegetation consists primarily of mesophytic perennials such as the common horsetail, *Equissetum arvense* L. Because the surface of these soils is generally dry during periods of low rainfall much of the native vegetation is destroyed by cultivation. Cultivated crops can occasionally be grown but generally do not yield well. Hazeldean soils occur in close association with Regent and Coatstone soils. A description of a representative profile is presented below.

Ap - 0 to 28 cm, black (10YR 2/1, moist), dark gray (10YR 4/1, dry), silt loam; loose, moist; abrupt smooth boundary; non calcareous; pH 7.5.

Aegj - 28 to 38 cm, grayish brown (10YR 5/2, moist), light brownish gray (10YR 6/2, dry), silt loam; moderate medium platy, very friable; abrupt smooth boundary; non-calcareous; pH 7.1.

Btgj 1 - 38 to 46 cm, dark grayish brown (10YR 4/2, moist), gray (10YR 5/1, dry), silty clay loam; weak medium platy, friable; clear wavy boundary; non calcareous; pH 6.8.

Btgj 2 - 46 to 53 cm, black (10YR 2/1, moist), dark gray to gray (10YR 4.5/1, dry), silty clay loam; moderate medium prismatic, firm; clear wavy boundary; non calcareous; pH 6.7.

Btgj 3 - 53 to 86 cm, dark grayish brown (10YR 4/2, moist), light brownish gray (10YR 6/2, dry), clay loam; moderate medium prismatic, firm; clear wavy boundary; weakly calcareous; pH 7.2.

BC - 86 to 107 cm, pale brown (10YR 6/3, moist), very pale brown (10YR 7/3, dry), loam; moderate medium prismatic to medium blocky, friable; distinct wavy boundary; strongly calcareous; pH 7.7.

Ckg - 107 to 160 cm, light brownish gray (2.5Y 6/2, moist), very pale brown (10YR 7/3, dry), loam; coarse subangular, blocky, friable; strongly calcareous; few, fine, distinct mottles; pH 7.7.

Jackson Creek Series (JKE)

The Jackson Creek series is the well drained Rego Black Chernozem member of the Bede Association,

developed on strongly calcareous, deep, coarse textured gravelly deltaic, beach and outwash deposits. This soil has gently sloping to gently undulating topography, good drainage, rapid permeability and very slow surface runoff. The depth to water table is estimated at 2 to 3 metres during the growing season. The native vegetation consists of drought resistant herbs, grasses and shrubs. These soils are not usually cultivated; most are used as unimproved pasture. Jackson Creek soils are found in close association with Broomhill soils.

The soil is characterized by a thin, very dark gray Ah horizon 0 to 8 cm thick, a dark gray AC horizon, 5 to 8 cm thick, a white Cca horizon, 15 to 20 cm thick, overlying a pale brown, stratified parent material. A representative profile description follows:

Ahk - 0 to 8 cm, very dark gray (10YR 3/1, moist), very dark gray to dark gray (10YR 3.5/1, dry), medium sandy loam; structureless; loose when moist and dry; clear smooth boundary; moderately calcareous; pH 7.9.

AC - 8 to 13 cm, very dark grayish brown (10YR 3/2, moist), dark gray (10YR 4/1, dry), fine sandy loam; structureless; loose when moist and dry; clear smooth boundary; strongly calcareous; pH 8.0.

Cca - 13 to 38 cm, light brownish gray (2.5Y 6/2, moist), white (2.5Y 8/1, dry), coarse sandy loam; structureless; loose when moist and dry; clear smooth boundary; strongly calcareous; pH 8.1.

Ck1 - 38 to 66 cm, pale brown (10YR 6/3, moist), very pale brown (10YR 7/3, dry), coarse sand; structureless; loose when moist and dry; clear smooth boundary; strongly calcareous; pH 8.1.

Ck2 - 66 to 97 cm, strong brown to reddish brown (7.5YR 5.5/6, moist), light brownish gray (10YR 6/2, dry), coarse sand; few fine faint iron mottles; structureless; loose when moist and dry; clear smooth boundary; strongly calcareous; pH 8.0.

Ck3 - 97 cm +, yellowish brown (10YR 5/6, moist), very pale brown (10YR 7/4, dry), coarse sand; structureless; loose when moist and dry; moderately calcareous; pH 8.1.

Leon Series (LEO)

The Leon series is the imperfectly drained, carbonated, Gleyed Rego Black Chernozem member of the Leon Association, developed on thin (25 to 100 cm) moderately to strongly calcareous, moderately fine textured lacustrine sediments overlying coarse textured, gravelly deltaic beach and outwash deposits. These soils have a clay loam to light clay textured surface, nearly level topography, moderately slow to slow permeability and moderate surface runoff. The depth to water table is estimated to be less than 2 m during the growing season. Imperfectly drained Leon soils are usually cultivated. Leon soils occur in areas adjacent to the outwash deposits in the eastern part of the KTM and western part of the Boissevain-Melita map area.

Leighton Series (LGT)

The Leighton series is the poorly drained carbonated Rego Humic Gleysol member of the Coulter Association, developed on deep moderately calcareous, moderately fine to fine textured (SCL, CL, SiCL to SiC, C), recent alluvial sediments. These soils generally have a clay loam to clay surface texture, nearly level to depressional topography, slow to very slow permeability and very little surface runoff. These soils occur in channels usually in the low lying alluvial flood plains. They are poorly drained and have a water table within 1 metre for most of the growing season. Leighton soils are very susceptible to spring flooding from high river levels and after heavy rains. A few areas of Leighton soils are cultivated, but many are left as natural sites with native hydrophytic vegetation.

Langvale Series (LGV)

The Langvale series is the well drained, Orthic Black Chernozem member of the Mentieth Association, developed on thin (25 to 100 cm), moderately calcareous, moderately coarse (VFS, LVFS, SL, FSL) textured, lacustrine sediments overlying strongly calcareous, medium to moderately fine textured glacial till. The profile may contain a very thin (<5 cm), gravelly stratum or pebble line at the till contact. Langvale soils usually have a loamy very fine sand surface texture, gently undulating topography, moderate permeability and moderately slow surface runoff. The estimated depth to water level is 2 to 3

metres during the growing season. They usually occur in the well drained middle and upper slope positions in the landscape. These soils are cultivated, non-stony and non-saline. The Langvale series resembles the Lyleton series, except that the Langvale soils are underlain by glacial till.

Liege Series (LIG)

The Liege series is the imperfectly drained Gleyed Cumulic Regosol member of the Melita Association, developed on deep, moderately calcareous, loamy alluvial sediments. These deposits are stratified and contain numerous dark colored bands of former surface horizons. These soils generally have a silt loam to very fine sandy loam surface texture, nearly level to gently undulating topography, moderate permeability and moderate surface runoff. The drainage is imperfect and the estimated depth to water table is less than 2 m. These soils are very susceptible to spring flooding due to high water levels in the creeks and Souris River. Some of these soils are cultivated and produce excellent crops.

This soil is characterized by dark gray Ap horizons 7 to 12 cm thick, gleyed carbonated dark gray Ahkgj horizons 5 to 7 cm thick, gleyed gray brown Ckgj horizons overlying recurring dark gray brown Ahk horizons and light brownish gray to gray brown Ckgj horizons.

Maskawata Series (MAW)

The Maskawata series consists of well-drained Rego Black Chernozem soils of the Waskada Association, developed on thin (25 to 100 cm), strongly calcareous, medium textured, discontinuous eolian and lacustrine sediments overlying strongly calcareous, medium to moderately fine textured glacial till. The dominant surface texture is a loam or very fine sandy loam, topography is gently undulating, permeability and surface runoff moderate. They are moderately well drained soils and usually occur in the upper mild slope position. Maskawata soils are found in close association with Waskada soils. The estimated depth to water level is 3 metres during the growing season. In the cultivated state these soils are moderately eroded and in many of these soils, most of the Ah horizon has been eroded by accelerated removal by wind and water as a result of cultivation. The surface soils have a general gray color due to the incorporation of AC and Ck horizons in the Ap.

Recognition of the overlay in these soils is sometimes difficult because the underlying till is relatively stone free. The Maskawata series is similar to the Argue series of the Cameron Association, except for the underlying glacial till.

Medora Series (MDO)

The Medora series is the well to moderately well drained, Calcareous Black Chernozem member of the Ryerson Association, developed on deep, strongly calcareous, medium to moderately fine textured glacial till composed of mixed materials derived from shale, limestone and granitic rock. These soils usually have loam to clay loam surface textures, complex gently sloping to undulating topography, moderate permeability and rapid surface runoff. The depth to water table is estimated at 3 to 4 metres during the growing season. The surface is cultivated and occasionally slightly stony. These soils are moderately susceptible to erosion and in many cases much of the Ah horizon has been removed. Cultivation has incorporated some of the calcareous Bmk into the Apk horizon resulting in a light brownish gray coloring to the land surface. Medora soils commonly occur in the middle, upper slope and knoll positions.

The soil is characterized by weakly calcareous, very dark gray Apk horizons 10 to 15 cm thick, calcareous very dark grayish brown Bmk horizons 8 to 13 cm thick, light brownish gray Cca horizons 13 to 18 cm thick and light yellowish brown Ck horizons. A representative profile description of the Medora series is presented.

Apk - 0 to 10 cm, very dark brown (10YR 2/2 moist), very dark gray to dark gray (10YR 3.5/1 dry), loam; weak, fine granular; very friable when moist; soft when dry; abrupt, smooth boundary; weakly calcareous.
Bmk - 10 to 20 cm, very dark grayish brown (10YR 3/2), loam; coarse, granular breaking to fine granular; friable when moist; soft when dry; abrupt, wavy boundary; moderately calcareous.

Ck1 - 20 to 51 cm, dark grayish brown (10YR 4/2 moist), loam; weak, fine granular; firm when moist; slightly hard when dry; abrupt, smooth boundary; moderately calcareous.
Cca - 51 to 66 cm, light olive brown (2.5Y 4/4 moist), loam; weak, fine granular; firm when moist; soft when dry; abrupt, smooth boundary; strongly calcareous.
Ck2 - 66 cm +, light yellowish brown (2.5Y 6/4 moist), loam; weak, fine granular; firm when moist; slightly hard when dry; strongly calcareous.

Melita Series (MLT)

The Melita series is the well drained, Cumulic Regosol member of the Melita Association developed on deep, moderately calcareous, loamy recent alluvial sediments. These deposits are stratified and contain numerous dark colored bands of former Ah horizons in the profile. The soil has a very fine sandy loam to silt loam surface texture, nearly level to depressional topography, moderate permeability and moderate surface runoff. They are moderately well drained soils and have an estimated depth to water table of 2 m. In the uncultivated state they are covered by lush growth of native vegetation such as western snowberry, (Symphoricarpus occidentalis), elm, (Ulmus americana), maple, (Acer negundo), forbs, grasses and chokecherry. In the cultivated state these soils produce excellent crops.

The soil usually consists of thick dark gray brown Ah horizons 15 to 30 cm thick and very dark grayish brown C horizons. They also have buried surface horizons as indicated by dark bands in the profile. The Melita series corresponds with the Mowbray series in climatic subregion Gt2.

Maon Series (MON)

The Maon series is the well drained Rego Black Chernozem member of the Lyleton Association, developed on deep, moderately calcareous, coarse loamy lacustrine sediments. This soil has a loamy very fine sand surface texture, gently sloping to gently undulating topography, moderate permeability and slow surface runoff. The drainage is moderately good and the estimated depth to water table is 2 m. In the cultivated state this soil is moderately susceptible to erosion as is indicated by the gray white buff colored spots in the field where C material has been incorporated into the Ap horizon.

Montgomery Series (MOT)

The Montgomery series is the imperfectly drained, carbonated Gleyed Rego Black Chernozem member of the Waskada Association, developed on thin (25 to 100 cm), strongly calcareous, medium textured, discontinuous aeolian and lacustrine sediments overlying strongly calcareous medium to moderately fine textured glacial till. A very thin (<5cm), pebbly stratum may occur at the contact. This soil has a loamy surface texture, gently sloping to depressional topography, moderate permeability and moderate surface runoff. This soil has an estimated depth to water table within 2 metres. The cultivated surface may be slightly stony. The soil consists of very dark gray Apk horizons 10 to 20 cm thick, light gray Ccagj horizons 20 to 30 cm thick, light gray Ckgj horizons 25 to 33 cm thick overlying light brownish gray, loam to clay loam, II Ckgj horizons.

Mather (MTR)

The Mather series consists of well drained, Orthic Black Chernozem soils of the Wawanesa Association, developed on thin (25 to 100 cm), weakly to moderately calcareous, medium textured (VFSL, L, SiL) lacustrine sediments overlying moderately to strongly calcareous, coarse textured (FS, LCoS, LS, LFS) lacustrine deposits. These soils have dominantly a loam surface texture, very gently sloping to gently undulating topography, moderately rapid permeability, and moderate surface runoff. These soils are non-saline and non-stony agricultural soils. The majority of these soils are cultivated.

The Mather soil has an average Ap horizon, 17 cm thick, ranging from 9 to 22 cm, a dark grayish brown Bm horizon, 6 to 34 cm thick, and two or three C horizons. The two C horizons are very common in this soil, as a coarser C horizon underlying a finer one.

Marshy Lake Series (MYK)

The Marshy Lake series is the imperfectly drained, saline, Gleyed Black Chernozem member of the Whitewater Association, developed on deep, strongly calcareous, moderately fine to fine textured, moderately saline, stratified alluvial and lacustrine sediments. This soil has a clay loam to clay surface texture, nearly level topography, slow permeability and slow surface runoff. The drainage is imperfect and the depth to water table is estimated at 1 to 2 metres during the growing season. The soil usually cultivated although the yields and growth of most crops are severely reduced due to salinity.

Neelin Series (NEI)

The Neelin series is the imperfectly drained, Gleyed Cumulic Regosol member of the Coulter Association, developed on deep, moderately calcareous, moderately fine to fine (CL, SiCL SCL to SiC, C) textured recent alluvial sediments. Neelin soils are frequently stratified with layers ranging in texture from very fine sand to clay. The topography is level to depressional, surface runoff is very slow, and permeability is slow. The depth to water table is estimated to be within 2 metres. Some of these soils are cultivated; others are still in their native state with vegetation consisting of Elm, Oak, Poplar, and various shrubs and grasses. Soluble salts may occur to a moderate degree in some of the Neelin soils. This soil usually consists of dark gray Ah horizons less than 20 cm thick, and light brownish gray, stratified and banded Ck horizons.

Napinka Series (NPK)

The Napinka series is the imperfectly drained, carbonated, Gleyed Rego Black Chernozem member of the Bede Association, developed on deep, strongly calcareous, coarse textured (FS, LCoS, LS, LFS) gravelly deltaic, beach and outwash deposits. The topography varies from nearly level to gently sloping; permeability is rapid and surface runoff is slow. Drainage is imperfect due to seasonally high water tables estimated to be between 1 to 2 m during the growing season. Few of these soils are cultivated due to their low moisture holding capacity and low fertility. Many Napinka soils are used for pastures; however the carrying capacity for animals is low because of the poor growth of native grasses.

A typical profile consists of black Ahk horizons 13 to 20 cm thick, light gray Ccagj horizons 20 to 30 cm thick and light yellowish brown Ckgj horizons. Analytical and morphological data are presented below.

Apk - 0 to 13 cm, black (10YR 2/1 moist), dark gray (10YR 4/1 dry), medium sandy clay loam; friable, moist, abrupt smooth boundary; moderately calcareous; pH 7.9.
Ccagj - 13 to 15 cm, gray to light gray (10YR 6/1 moist), white (10YR 8/1 dry), sandy clay loam, friable when moist; clear wavy boundary: very strongly calcareous; pH 8.1.
II Ccagj - 15 to 23 cm, gray (10YR 6/1 moist), white (10YR 8/1 dry), gravelly coarse sandy clay loam, common mottles: friable, moist, very strongly calcareous; clear, wavy boundary; pH 8.1.
II Ckgj - 23 cm +, gravelly loamy very coarse sand; single grained, loose when moist, strongly calcareous: pH 8.0.

Newstead Series (NWS)

The Newstead series is the well drained, Orthic Black Chernozem member of the Newstead Association, developed on thin (25 to 95 cm), strongly calcareous, medium textured lacustrine sediments overlying strongly calcareous, medium to moderately fine textured glacial till. A coarse textured layer (5 to 75 cm) occurs at the contact. Newstead soils commonly have loam to very fine sandy loam surface textures, gently sloping to very gently sloping topography; moderate permeability and slow surface runoff. The depth to water table is at about 3 metres during the growing season. These soils commonly occur in areas adjacent to the channels where outwash material deposited on the till is covered by finer textured alluvial and lacustrine material.

A typical profile has a black Ap horizon 5 to 13 cm thick, a very dark grayish brown Bm horizon 20 to 30 cm thick, very coarse textured pale brown II Ck horizon and a light yellowish brown III Ck horizon.

Oskar Series (OSK)

The Oskar series is the well drained, Rego Dark Gray Chernozem member of the Horton Association, developed on deep, strongly calcareous, medium to moderately fine textured (VFSL, L, SiL to SCL, CL, SiCL) glacial till. These soils occur on the upper slopes of the undulating and gently rolling topography of the Turtle Mountain area. They have a clay loam surface texture, slow permeability and rapid surface runoff. They are occasionally slightly stony and some are cultivated. The undisturbed sites have native stands of Poplar, Birch and Oak. In the cultivated state they are moderately to strongly susceptible to erosion.

Partridge Series (PDG)

The Partridge series is the poorly drained, carbonated, Rego Humic Gleysol member of the Bede Association, developed on deep (>100 cm), strongly calcareous, coarse textured (FS, LCoS, LS, LFS), gravelly deltaic, beach and outwash deposits. This soil occurs in depressional positions and has moderate permeability and very slow surface runoff. The depth to groundwater is usually less than 1 metre. The native vegetation consists of Slough Grasses, Smartweed, Spear Grass and Willows. A typical profile has a black Ahg horizon 10 to 20 cm thick, a gray Ccag horizon 10 to 20 cm thick, a light brownish gray Ckg horizon with prominent iron staining and abundant mottling. Analytical and morphological data for this series are presented below.

Ahkg - 0 to 18 cm, black (10YR 2/1 moist), gray (10YR 5/1 dry), medium sandy loam; weakly coarse columnar; friable when moist; abrupt, smooth boundary; very strongly calcareous; pH 7.9.
AC - 18 to 25 cm, dark gray (10YR 4/1 moist), gray to light gray (10YR 7/1 dry), medium sandy loam; weakly coarse columnar; friable when moist; clear, broken boundary; strongly calcareous; pH 7.9.
Ckg1 - 25 to 36 cm, gray (5Y 5/1 moist), light gray (10YR 7/1 dry), medium sandy loam; structureless; very friable when moist; clear, wavy boundary; strongly calcareous; pH 7.9.
Ckg2 - 36 to 56 cm, light olive brown (2.5Y 5/4 moist), light brownish gray (10YR 6/2 dry), coarse sand, structureless; loose when moist and dry; abrupt, smooth boundary; moderately calcareous; pH 7.9.
Ckg3 - 56 to 97 cm, yellowish brown (10YR 5/6 moist), yellowish brown (10YR 5/7 dry), coarse sand; few, fine, faint iron mottles; structureless; loose when moist and dry; smooth wavy boundary; strongly calcareous; pH 8.0.
Ckg4 - 97 cm +, yellowish brown (10YR 5/8 moist), very pale brown (10YR 7/4 dry), coarse sand; few, fine, faint iron mottles; structureless; loose when moist and dry; strongly calcareous; pH 7.9.

Pipestone Series (PPT)

The Pipestone series is the imperfectly drained, carbonated, Gleyed Rego Black Chernozem member of the Pipestone Association, developed on deep (> 100 cm), weakly to moderately calcareous, fine textured (SC, SiC, C) lacustrine and alluvial sediments. These soils have nearly level topography, light clay surface texture, very slow permeability and slow surface runoff. This soil has an estimated depth to water table of 2 to 3 metres. These soils are usually cultivated and produce excellent crops. Weak to moderate salinity may be present in some areas.

The Pipestone, sand substrate variant, PPT1, differs from the modal Pipestone by having sandy sediments, commonly occurring at 75 to 100cm below the surface.

Regent Series (RGT)

The Regent series is the imperfectly drained, Gleyed Black Chernozem member of the Ryerson Association, developed on deep (> 100 cm) strongly calcareous, medium to moderately fine (VFSL, L, SiL, to CL, SiCL, SCL) textured glacial till. The till is composed of mixed materials derived from shale, limestone, and granitic rock. A thin overlay (< 25 cm) may occur on some soils. The topography is gently sloping, permeability is moderate, and surface runoff is slow. These soils occur in lower slope and depressional positions and are cultivated. Ryerson and Hazeldean soils are commonly found in close association with Regent soils. The depth to water table in Regent soils is estimated at approximately 2 metres during the growing season. These soils are occasionally weakly saline and sometimes have a few isolated stones on the surface.

A typical profile of the Regent series has a black Ap 10 to 15 cm thick, a very dark grayish brown Bmg 10 to 15 cm thick, a grayish brown to white Cca horizon 18 to 25 cm thick and a light olive brown Ck horizon. Analytical and morphological data are presented below.

Ap - 0 to 15 cm, black to very dark gray (10YR 2.5/1 moist), very dark gray to dark gray (10YR 3.5/1 dry), loam; massive; friable when moist; abrupt, smooth boundary; pH 6.3.
Bmgj - 15 to 28 cm, very dark grayish brown to dark brown (10YR 3/2.5 moist), dark yellowish brown to yellowish brown (10YR 4.5/4 dry), loam; moderate coarse to medium columnar breaking to moderate, fine subangular blocky; friable when moist; abrupt, smooth boundary; pH 6.5.
BC - 28 to 30 cm, dark brown (10YR 3/3 moist), yellowish brown to light yellowish brown (10YR 5.5/4 dry), loam; moderate, coarse to medium columnar breaking to moderate, fine subangular blocky; friable when moist; clear, irregular boundary; moderately calcareous; pH 6.3.
Ckgj - 30 cm +, yellowish brown (10YR 5/4 moist), very pale brown (10YR 7/3 dry), loam; massive; friable when moist; few, fine, faint iron mottles; strongly calcareous; pH 8.3.

Ryerson Series (RYS)

The Ryerson series is the well drained, Orthic Black Chernozem member of the Ryerson Association, developed on deep (> 100 cm), strongly calcareous, medium to moderately fine textured (VFSL, L, SiL to CL, SiCL, SCL) glacial till. Coarse fragments in the till are composed of shale, limestone, and granite rocks. The surface 25 cm may have a variable texture although the most common textures range from loam to clay loam. These soils are found in the upper and mid slope of undulating to gently rolling topography. This soil has moderate permeability and moderate surface runoff. In some areas it is slightly to moderately stony. The depth to water table is estimated at 3 to 4 metres during the growing season.

Ryerson profiles are generally thin with the entire Ah and occasionally the upper part of the Bm horizon incorporated into the Ap horizon. The Ap horizon, therefore, tends to be dark gray in color. The Bm horizon is quite variable in thickness ranging from 10 to 30 cm depending on the topography and amount of mechanical disturbance. The Bm horizons are characterized by moderate, fine prismatic to weak, moderate, medium granular structure and a dark grayish brown color. A light gray Cca horizon, 20 to 30 cm thick, commonly occurs below the Bm horizon. The pale brown to yellowish brown Ckgj horizon may contain weak concentrations of soluble salts, lime carbonates, and prominent iron mottles and concretions.

Scarth Series (SCH)

The Scarth series is the well drained, Rego Black Chernozem member of the Souris Association, developed on deep (> 100 cm), weakly to moderately calcareous, coarse textured (FS, LCoS, LFS) lacustrine sediments. This soil has a fine sand to loamy fine sand surface texture, gently undulating topography, moderate permeability, slow surface runoff and moderately good drainage. The depth to water table is estimated at 2 to 3 metres during the growing season. Most of these soils are cultivated.

Schaffner Series (SFR)

The Schaffner series is the well drained, Calcareous Black Chernozem member of the Cameron Association, developed on deep, strongly calcareous, medium textured (VFSL, L, SiL) lacustrine deposits. This soil has simple smooth topography, moderately good drainage, a fine sandy loam to loam surface texture, moderately slow permeability and slow surface runoff. The depth to water table is estimated at 2 to 3 metres and the subsoil may occasionally be weakly saline. Under cultivation, the upper part of the B horizon is usually incorporated into a very dark gray brown Ap horizon 10 to 15 cm thick. The weakly calcareous, dark grayish brown Bmk horizon generally has weak granular structure and is 10 to 15 cm thick; a grayish brown BC horizon, 5 to 13 cm thick and a stratified light yellowish brown to pale olive brown Ck horizon occur below.

Tilston Series (TLT)

The Tilston series is the poorly drained, Humic Luvic Gleysol member of the Ryerson Association, developed on strongly calcareous, medium to moderately fine textured (VFSL, L, SiL, to CL, SiCL, SCL)

glacial till. The till is composed of silts and clays with coarse fragments of shale, limestone and granitic rock. These soils occur in depressional positions which occupy higher positions in the landscape and are usually developed in stone-free clay loam sediments that have been washed into small circular depressions. The thickness of these local deposits depends largely on the surrounding topography. The permeability is moderately slow and there is no surface runoff from Tilston soils. The water table occurs at or very near the surface most of the year.

The thickness of the eluvial horizon decreases towards the center of these depressions. Tilston soils are submerged for moderately short periods of time during the year; however, during this time, they transmit a large portion of the surface water directly to the groundwater zone. As a result, the water table occurs very near the surface most of the year. The native vegetation characteristic of these soils consists of Lady's thumb, Polygonum persicaria and to a lesser extent slough grass, Beckmannia syzigachne.

Turtle Mountain Series (TUM)

The Turtle Mountain series is the well, drained Orthic Gray Luvisol member of the Turtle Mountain Association, developed on strongly calcareous, moderately fine textured (SCL, CL, SiCL) glacial till composed of silts and clays with fragment inclusions of granitic rock limestone and shale. This soil has a clay loam surface texture, irregular, moderately rolling topography and usually occurs at elevations above 2,000 feet (a.s.l.) in the Turtle Mountains. Permeability is moderate and surface runoff is rapid. A few Turtle Mountain soils are cultivated but most exist in the undisturbed state supporting native vegetation consisting of aspen, oak, hazel, birch, numerous shrubs, grasses and flowers.

This soil consists of moderately decomposed L-H horizons, 2 to 5 cm thick, light gray Ae horizons, 5 to 10 cm thick, dark brown Bt horizons, 20 to 30 cm thick, yellowish brown BC horizons, 18 to 25 cm thick and light brownish gray weakly calcareous Ck horizons.

Two Creeks (TWC)

The Two Creeks series is the imperfectly drained, Gleyed Black Chernozem member of the Waskada Association. It is developed on thin (25 to 100 cm), strongly calcareous, medium textured discontinuous eolian and lacustrine sediments overlying strongly calcareous, medium to moderately fine textured glacial till. A very thin (less than 5 cm), gravelly pebble line may occur at the contact. This soil has complex, very gently sloping topography, a very fine sandy loam to loam surface texture, moderately slow permeability and slow surface runoff. The estimated depth to water table is 2 to 3 metres during the growing season. These soils are usually cultivated.

A typical profile has a very dark gray Ap horizon, 8 to 15 cm thick, a dark grayish brown Bmgj horizon, 13 to 18 cm thick, a gleyed light gray Cca horizon, 8 to 15 cm thick and light olive brown II Ckgj horizon.

Underhill Series (UHL)

The Underhill series is the imperfectly drained, Gleyed Black Chernozem member of the Cameron Association, developed on deep, strongly calcareous, medium textured stratified lacustrine sediments. This soil has smooth, very gently sloping topography, a loam to fine sandy loam surface texture, moderate permeability and moderately slow surface runoff. The estimated depth to water table during the growing season is 1.5 metres. The surface soil is cultivated and non-stony although small pebbles may be present.

A typical profile has a black Ap horizon, 5 to 13 cm thick, a black Ah horizon, 10 to 18 cm thick, sometimes a very thin, very dark brown AB horizon, 2 to 5 cm thick, a very dark grayish brown Bmgj horizon, 10 to 18 cm thick which may have weak lime carbonates present in the lower portion. The parent material is usually stratified light yellowish brown to light brownish gray in color. Analytical and morphological data are presented below.

Ap - 0 to 13 cm, black (10YR 2/1 moist), very dark gray (10YR 3/1 dry), loam; weak, fine granular; friable when moist; soft when dry; abrupt, smooth boundary; pH 6.1.

Ah - 13 to 30 cm, black (10YR 2/1 moist), very dark gray (10YR 3/1 dry), loam; moderate, fine to medium granular; friable when moist; soft when dry; clear, smooth boundary; pH 6.5.
AB - 30 to 36 cm, very dark brown (10YR 2/2 moist), very dark grayish brown (10YR 3/2 dry), loam; moderate, fine to medium granular; friable when moist; soft when dry; clear, smooth boundary.
Bmkgj - 36 to 51 cm, very dark grayish brown (10YR 3/2 moist), brown (10YR 4/3 dry), loam; few, fine, faint dark reddish brown (5YR 3/4) iron mottles; weak, medium prismatic to moderate, medium subangular blocky; friable when moist; slightly hard when dry; clear, smooth boundary; pH 7.3.
BC - 51 to 56 cm, very dark grayish brown (10YR 3/2 moist), brown (10YR 4/3 dry) few, fine, faint dark yellowish brown to yellowish brown (10YR 4/4 to 5/6) iron mottles; loam; weak, fine granular; friable when moist; soft when dry; clear, smooth boundary; moderately calcareous; pH 7.5.
Ckgj1- 56 to 69 cm, dark grayish brown to grayish brown (10YR 4/2 to 5/2 moist), light brownish gray (10YR 6/2 dry), loam; few, fine, faint yellowish brown (10YR 5/6) iron mottles; weak, fine granular; friable when moist; slightly hard when dry; smooth, clear boundary; moderately calcareous; pH 7.6.
Ckgj2 - 69 to 100 cm, yellowish brown (10YR 5/4 to 5/6 moist), light yellowish brown (10YR 6/4 dry), loam; common, fine, faint yellowish brown (10YR 5/6) iron mottles; weak, fine granular; friable when moist; soft when dry; clear, smooth boundary; moderately calcareous; pH 7.5.

Villette Series (VLT)

The Villette series, a poorly drained, Orthic Humic Gleysol member of the Waskada Association, is developed on thin (25 to 100 cm), strongly calcareous, medium textured (VFSL, L, SiL), discontinuous eolian and lacustrine sediments overlying strongly calcareous, medium to moderately fine (VFSL, L, SiL to SCL, CL, SiCL) textured glacial till. A very thin (less than 5 cm) gravelly stratum or pebble line may occur at the contact. This soil has a very fine sandy loam to loam surface texture, nearly level to depressional topography, slow permeability and no surface runoff. These poorly drained soils occur in enclosed depressions. They are very susceptible to flooding and ponding in the early spring and after heavy summer rains. The native vegetation usually consists of hydrophytic vegetation such as slough grasses. These soils are not cultivated.

William Series (WIL)

The William series is the poorly drained, carbonated Rego Humic Gleysol member of the Dromore Association, developed on thin (25 to 100 cm), strongly calcareous, medium textured (VFSL, L, SiL) lacustrine sediments overlying coarse textured (FS, LCoS, LS, LFS) gravelly deltaic beach and outwash deposits. This soil has nearly level to depressional topography, a fine sandy loam surface texture and commonly occurs in depressions and stream channels. Permeability is moderate and surface runoff is moderate. The ground water level usually occurs within 1 metre of the surface. These soils are used mainly for pasture.

Whitewater Series (WIW)

The Whitewater series is the imperfectly drained, saline, Gleyed Rego Black Chernozem member of the Whitewater Association. It is developed on deep (> 100 cm), strongly calcareous, moderately fine to fine textured, stratified, moderately saline lacustrine sediments. Whitewater soils have a clay loam to clay surface texture, nearly level topography, slow permeability and slow surface runoff. The depth to water table ranges from 1 to 2 metres. These soils are moderately saline as is evident by the abundance of white salt crystals in the form of pseudo-mycelia in the profile. Some of these soils are cultivated but crop growth and yield are severely reduced. Analytical and morphological data for a representative profile are presented below.

Apkgj - 0 to 15 cm, black (10YR 2/1 moist), silty clay; massive, firm when moist; abrupt, smooth boundary; weakly calcareous; pH 8.1.
Ahksgj - 15 to 35 cm, black (10YR 2/1 moist), silty clay; amorphous; slightly sticky when wet; gradual, irregular boundary; weakly calcareous; pH 8.0.
II AC - 35 to 64 cm, very dark gray (10YR 3/1 moist), silty loam; amorphous; slightly sticky when wet; gradual, irregular boundary; moderately calcareous; weakly saline; pH 8.2.
II Cskg - 64 +, light brownish gray to light gray (2.5Y 6.5/2 moist), silty clay loam; amorphous; slightly sticky when wet; moderately calcareous; moderately saline; pH 8.7.

Waskada Series (WKD)

The Waskada series is the well drained, Orthic Black Chernozem member of the Waskada Association and is developed on thin (<1 m), strongly calcareous, loamy (VFSL, L, SiL) lacustrine sediments overlying strongly calcareous, loamy glacial till. A very thin (< 5 cm), gravelly pebble line may occur at the contact. These soils have complex, gently sloping topography, moderately good drainage, loam surface texture, moderate permeability and moderate surface runoff. The depth to water table is approximately 3 m during the growing season. Most of these soils are cultivated for crop production. Waskada soils usually occur in intermediate and upper slope positions. The knolls are sometimes slightly to moderately eroded. The Waskada series resembles the Cameron series of the Cameron Association. The only difference is the Waskada series is underlain by glacial till. The presence of few stones in the till makes it difficult to determine the depth of overlay.

A typical profile has very dark gray Ap horizons 10 to 15 cm thick, dark brown Bm horizons, 12 to 15 cm thick; sometimes a brown BC horizon occurs above the pale brown II Ck horizon. Analytical and morphological data are presented below.

Ap - 0 to 18 cm, very dark grayish brown (10YR 2.5/2 moist), very dark gray (10YR 3/1 dry) loam; weak, fine to medium granular; friable when moist; slightly hard when dry; abrupt, smooth boundary; pH 7.1.
Bm - 18 to 33 cm, dark brown (7.5YR 3.5/2 moist), brown (7.5YR 4.5/2 dry) loam; weak, coarse prismatic breaking to moderate, medium sub-angular blocky; friable when moist; slightly hard when dry; clear, smooth boundary; pH 7.1.
BC - 33 to 43 cm, brown (10YR 4.5/3 moist), brown (10YR 5/3 dry), silt loam; moderate, medium subangular blocky; friable when moist; hard when dry; clear, smooth boundary; moderately calcareous; pH 7.5.
II Cca - 43 to 66 cm, pale brown (10YR 6/3 moist), light gray (10YR 7/2 dry), loam till; moderate, medium granular breaking to weak, fine granular; friable when moist; hard when dry; clear, smooth boundary; strongly calcareous; pH 8.1.
II Ck - 66 cm +, grayish brown to light brownish gray (10YR 5/2 to 6/2 moist), light brownish gray to light gray (10YR 6/2 to 7/2 dry), loam till; pseudo, weak fine granular; firm when moist; hard when dry; strongly calcareous; pH 8.0.

Wakopa Series (WKP)

The Wakopa series is the poorly drained, Rego Humic Gleysol member of the Horton Association, developed on deep, strongly calcareous, medium to moderately fine textured glacial till deposits with coarse fragment inclusions of shale, limestone and granitic rock. Significant accumulations of erosional material occur in the depressions in which the profiles are commonly developed. This soil occurs above the 549 m (1800 ft a.s.l.) level in the Turtle Mountains area. This soil has a clay loam surface texture, slow permeability and no surface runoff. Surface waters remain ponded in the surface most of the year. Aquatic and hydrophytic vegetation are common.

Wassewa Series (WSW)

The Wassewa series is the poorly drained, carbonated Rego Humic Gleysol member of the Croll Association, developed on thin (25 to 100 cm), strongly calcareous, moderately fine textured (SCL, CL, SiCL), discontinuous lacustrine sediments overlying strongly calcareous, medium to moderately fine textured (VFSL, L, SiL to SCL, CL, SiCL) glacial till. A very thin (less than 5 cm), gravelly stratum may occur at the till contact. This soil has depressional topography, silty clay loam to clay loam surface texture; no surface runoff and very slow permeability. The depth to water table is estimated at less than 1 metre during the growing season. Under dry conditions these soils may be cultivated, but due to frequent flooding and surface ponding, they rarely produce a crop. In some instances, these soils may be weakly saline.

This soil has a black Ahk horizon, 10 to 25 cm thick, and a dark olive gray Ck horizon. A thin black Ap horizon may be present in some soils. A typical profile description is given below.

Apk - 0 to 15 cm, black (10YR 2/1 moist), very dark gray (10YR 3/1 dry) clay loam; weak, fine sub-angular blocky; slightly stick when wet; slightly hard when dry; abrupt smooth boundary; weakly calcareous.
Ahkg - 15 to 25 cm, black (10YR 2/1 moist), very dark gray (10YR 3/1 dry) clay loam; amorphous; slightly sticky when wet; slightly hard when dry; clear, irregular boundary; moderately calcareous.
Ckg -25 cm +, dark olive gray (5Y 3/2 moist), olive gray (5Y4/2 dry), clay loam; amorphous; slightly sticky when wet; very hard when dry; strongly calcareous.

Wawanesa Series (WWS)

The Wawanesa series is the imperfectly drained, carbonated, Gleyed Rego Black Chernozem member of the Wawanesa Association and is developed on thin (25 to 100 cm), moderately to strongly calcareous, medium textured (VFSL, L, SiL) lacustrine sediments overlying strongly calcareous, coarse textured (FS, LCoS, LFS) lacustrine deposits. This soil has a silt loam to loam surface texture, gently undulating topography, moderate permeability and slow surface runoff. The depth to water table is estimated at between 1 and 2 metres during the growing season. The proximity of the sandy subsoil causes the surface soil to remain saturated for longer periods, after rains than would normally be expected from this type of soil. The majority of these soils are cultivated.

Bibliography

Anon, 1965. Soil Capability Classification for Agriculture. The Canada Land Inventory, Report No. 2. Department of Forestry, Ottawa, Canada.

Bache, B. W. 1976. The measurement of cation exchange capacity of soils. J. Sci. Food Agric. 27: 273-280.

Coen et al., 1977. Soil Survey of Yoho National Park, Canada. Alberta Soil Survey Report No. 37, 208 pp. Alberta Institute of Pedology, University of Alberta, Edmonton, Alberta.

CSSC, 1973. Canada Soil Survey Committee. Proceedings of the Ninth Meeting of the Canada Soil Survey Committee. University of Saskatchewan, Saskatoon. 357 pp.

Ellis, J. H., and Shafer, WM. H., 1943. Report of Reconnaissance Soil Survey of South-Central Manitoba. Manitoba Soil Survey, Dominion Department of Agriculture, Provincial Department of Agriculture, and Soils Department, the University of Manitoba.

Henry, L., Harron, B. and Flaten, D., 1987. The Nature and Management of Salt-Affected Land in Saskatchewan Agdex 518, Soils and Crops Branch, Saskatchewan Agriculture

ISC, 1987. An Irrigation Suitability Classification System for the Canadian Prairies. Working Group on Irrigation Suitability Classification. Research Branch, Agriculture, LRRC, Contribution 87-83.

Land Resource Research Institute, 1981. A Soil Mapping System for Canadian: Revised. Contribution # 142, Research Branch, Agriculture Canada.

Michalyna, W. and Holmstrom, D., 1980. Soils of the Killarney Study Area. Canada-Manitoba Soil Survey, Canada Department of Agriculture, Manitoba Department of Agriculture, Department of Soil Science, the University of Manitoba.

SCWG, Soil Classification Working Group. 1998. The Canadian System of Soil Classification. Third Edition. Agric. and Agri-Food Can. Publ. 1646 (Revised). 187 pp.

USDA, 1971. Guide for Interpreting Engineering Uses of Soils. United States Department of Agriculture, Soil Conservation Service USDA, SCS - 45, 87 pp.