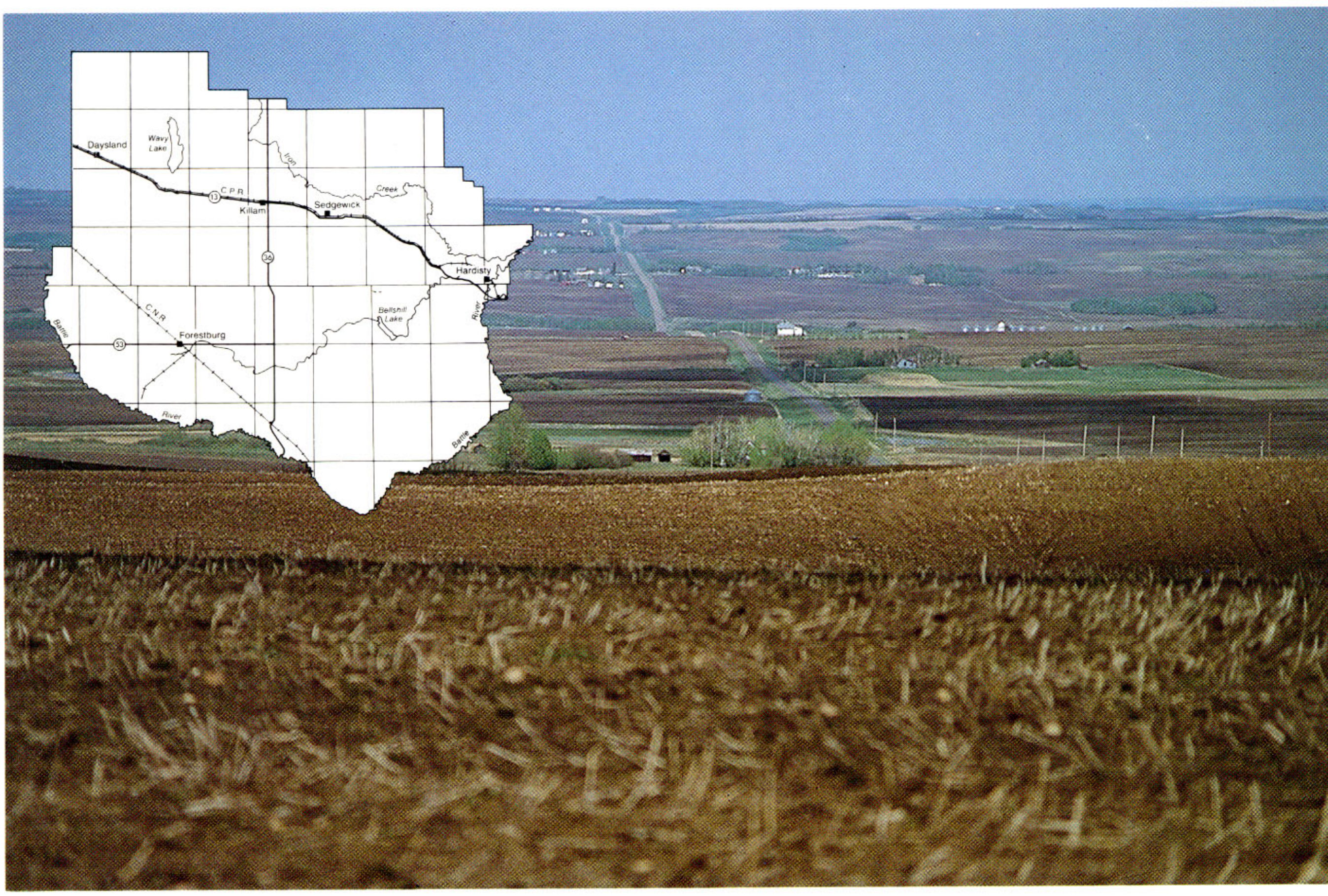
Soil survey of the

# County of Flagstaff, Alberta

Alberta Soil Survey Report No. 51





Agriculture Canada

Research Branch

ALBERTA RESEARCH COUNCIL

Terrain Sciences Department

Soil survey of the

# County of Flagstaff, Alberta


R.A. MacMillan and W.L. Nikiforuk
A.T. Rodvang


## Alberta Soil Survey Report No. 51


Soil mapping by

W.L. Nikiforuk, A.T. Rodvang,
R.A. MacMillan, K.M. Riddell,
L.D. Perrott, D.A. Gower

Geological investigations by

C.M. Mougeot, D.M. Borneuf

Report compilation and
digital map production by:

J. Lutz, R.M. Krzanowski


*Cover:*
Landscape in the
County of Flagstaff.
(photo: R.A. MacMillan)


RESEARCH BRANCH, AGRICULTURE CANADA
TERRAIN SCIENCES DEPARTMENT, ALBERTA RESEARCH COUNCIL
EDMONTON, ALBERTA, CANADA 1988

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# Acknowledgments

The soil survey of the County of Flagstaff was conducted by the Alberta Soil Survey, which is a cooperative venture of the Alberta Research Council, Terrain Sciences Department and Agriculture Canada, Alberta Pedology Unit. Important funding and direction was supplied by Alberta Agriculture, Land Use and Land Classification Branches. The following persons and organizations are recognized for their assistance and cooperation during the course of this project. K.M. Riddell, L.D. Perrott, D.A. Gower and M.D. Fawcett assisted in field mapping and sampling. J. Lutz compiled, checked, digitized and produced the computer-plotted soil maps and initial report figures and helped assemble and edit the report. R.M. Krzanowski installed the digital mapping capability and produced the computer-plotted maps and tabular areal summaries. J.M. Beres, W.C. McKean and A. Schwartzer conducted the laboratory analysis. L. Bradley supervised cartographic production of final maps and figures. C.D.W. Gietz, R.D. Hite and K.E. Parrish edited and prepared the report for final publication. W.W. Pettapiece acted as final field correlator and provided advice on mapping, correlation, report design and legend development. J. Tajek contributed evaluations of the soil units for susceptability to water erosion. K. Pohjakas provided contract supervision for Alberta Agriculture and contributed interest and support. J.A. Shields, Western Correlator, Land Resource Research Institute, Ottawa, reviewed field work and assisted in project planning. R.J. Fessenden supervised project design and administrative review. G.M. Coen completed the external technical review of the manuscript. Mr. and Mrs. L. George rented accommodation to the survey team for the duration of the project. T. Dietzler, B. Friedel and B. Lee provided local assistance and liason with the county administration.

# Summary


This report and the accompanying maps summarize the results of the soil survey of the County of Flagstaff. The county covers over 400 000 ha in the Eastern Alberta Plains physiographic region of east-central Alberta. Most of the county is characterized by nearly level to gently undulating topography with deranged drainage and numerous small depressions and sloughs. Steeper topography occurs in the eastern third of the county in areas of hummocky moraine and incised meltwater scour channels.

The underlying bedrock is composed of soft sandstone, shale and mudstone belonging to the Upper Cretaceous age Horseshoe Canyon, Bearpaw and Belly River formations. Commercially valuable deposits of coal occur within the Horseshoe Canyon Formation in the southwest portion of the county.

The dominant surface deposits are till deposited as undulating moraine in the flatter western portion of the county and as hummocky moraine or a thin morainal veneer to blanket over rolling bedrock in the upland areas of the eastern third of the county. Significant deposits of coarser-textured glaciofluvial materials occur near Sedgewick, Hardisty and Flagstaff Hill.

Surface water bodies and subsurface hydrogeology contribute to drainage in the Battle River Basin. Most surface waters occur as isolated, semi-permanent ponds and sloughs in small, scattered, depressions. Larger, named lakes occupy 2400 ha in the county. Surface drainage is disrupted and not well developed with the exception of the Iron Creek drainage area. The most important groundwater aquifers in the county are associated with buried valley channels. They provide high yields of high quality potable water. Bedrock aquifers provide lower yields of highly mineralized waters.

The continental climate has moderately warm summers and cold winters. Under these conditions, the dominant ecological system is a tension zone between aspen groves and rough fescue grassland.

Most of the soils in the county develop on till and belong to the Chernozemic or Solonetzic orders. There is a gradual change in surface color from black to dark brown traversing the county from north to south. Solonetzic soils occupy approximately 17 percent of the area and are found on level terrain in the western third of the county, and in areas of high water table or shallow depth to bedrock in the central and southern portions of the county. Coarser-textured sandy loam and loamy sand soils occupy about 11 percent of the area and are found near Sedgewick, Hardisty, Flagstaff Hill and along eastern portions of the Battle River valley. Gleysolic, Regosolic, Luvisolic and Organic soils are less extensive within the county.

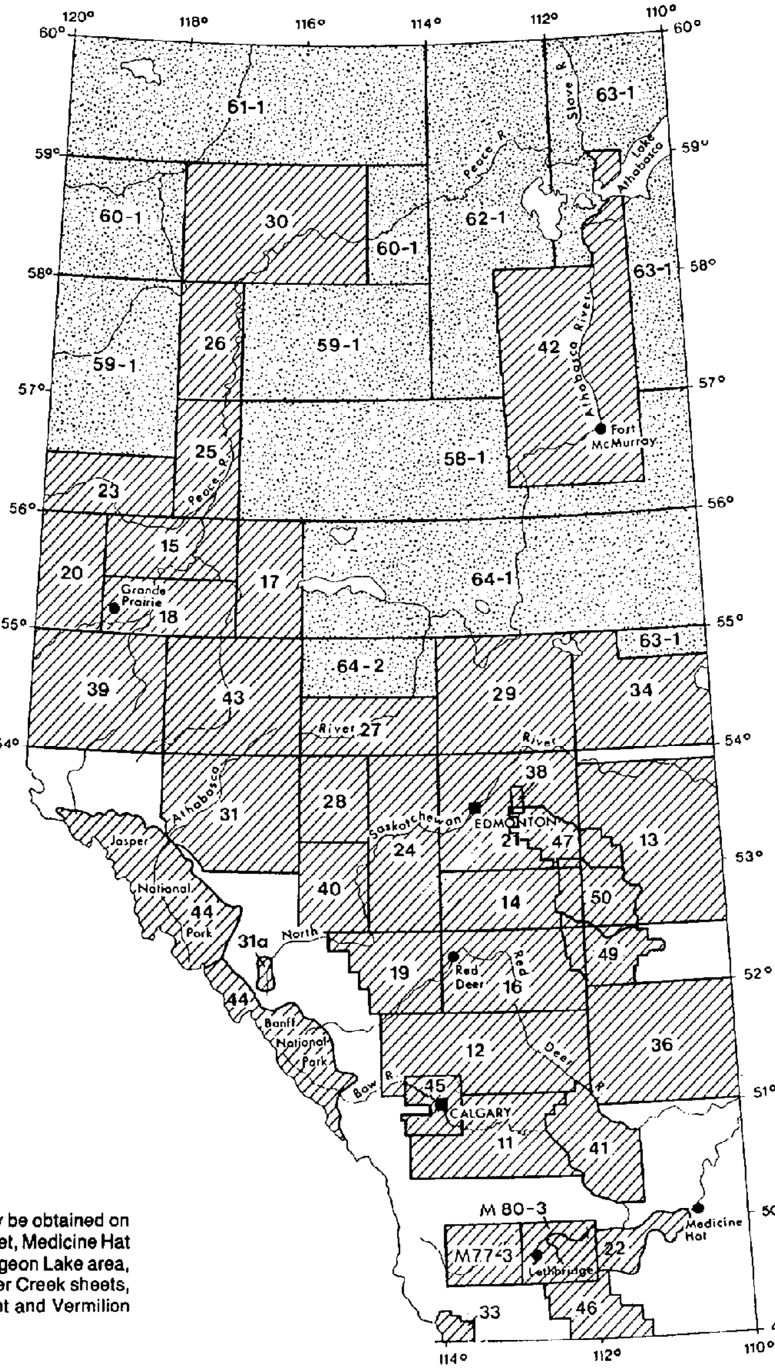
About 320 000 ha or 80 percent of the county is cultivated. The main crops are wheat, oats, barley, rye, flax and canola. Livestock production is an important secondary activity. Over 66 percent of the county (269 500 ha) is occupied by high quality soils with a Land Capability Classification for arable agriculture of 3 or better. Solonetzic soils occupy approximately 17 percent of the county (66 900 ha). The majority of Solonetzic soils are rated suitable or marginally suitable for improvement by deep ploughing. Other Solonetzic soils are unsuitable for deep ploughing because of high water table levels or adverse groundwater conditions. Water erosion is not a severe problem in the county, except on steeper topography associated with meltwater channels and hummocky moraine. About 8 percent of the county (31 500 ha) is estimated to have very severe to extreme potential for losses (from bare soil) by water erosion.

# Part 1 - General description of the area

## Introduction

The soil survey of the County of Flagstaff was initiated in 1985 in response to a need, expressed by Alberta Agriculture, for improved information in the Solonetzic soil belt of east-central Alberta. The updated information is required to help assess the potential for improvement of Solonetzic soils by deep plowing. It was also needed to assist in evaluating soil degradation potential in the region and to upgrade the land resource information base.

Soil surveys have been an ongoing endeavor in Alberta since the early 1920s (figure 1). Although they have varied in scale and style over the years, all soil surveys have had a common purpose: to gather and evaluate information required to effectively manage soil and land resources. The early surveys, particu-




**LEGEND**

| | |
|---|---|
| 11 | Blackfoot and Calgary sheets |
| 12 | Rosebud and Banff sheets |
| 13 | Wainwright and Vermilion sheets |
| 14 | Peace Hills sheet |
| 15 | Rycroft and Watino sheets |
| 16 | Red Deer sheet |
| 17 | High Prairie and McLennan sheets |
| 18 | Grand Prairie and Sturgeon Lake sheets |
| 19 | Rocky Mountain House sheet |
| 20 | Beaverlodge and Blueberry Mountain sheets |
| 21 | Edmonton sheet |
| 22 | St. Mary and Milk River project |
| 23 | Cherry Point and Hines Creek area |
| 24 | Buck Lake and Wabamun Lake area |
| 25 | Grimshaw and Notikewin area |
| 26 | Hitchkiss and Keg River area |
| 27 | Whitecourt and Barrhead area |
| 28 | Chip Lake area |
| 29 | Tawatinaw map sheet 83I |
| 30 | Mount Watt and Fort Vermilion area |
| 31 | Hinton-Edson area 83F |
| 31a | North Saskatchewan River Valley |
| 33 | Waterton Lakes National Park |
| 34 | Sand River sheet |
| 35 | Two Hills county |
| 36 | Oyen sheet |
| 38 | Elk Island National Park |
| 38a | M77-3 NW Lethbridge |
| 38b | M80-3 NE Lethbridge |
| 39 | Wapiti Map area |
| 40 | Brazeau Dam |
| 41 | Newell county |
| 42 | Athabasca oil sands area |
| 43 | Iosegun sheet |
| 44 | Banff-Jasper National Parks |
| 45 | Calgary Urban Perimeter |
| 46 | Warner county |
| 47 | County of Beaver |
| 49 | County of Paintearth |
| 50 | County of Flagstaff |
| 58-1 | Preliminary |
| 59-1 | Preliminary |
| 60-1 | Preliminary |
| 61-1 | Preliminary |
| 62-1 | Preliminary |
| 63-1 | Preliminary |
| 64-1 | Preliminary |
| 64-2 | Preliminary |

Note: Reports published prior to 1942 are out of print but may be obtained on loan from the Alberta Soil Survey. These include: Macleod sheet, Medicine Hat sheet, Sounding Creek sheet, Peace River, High Prairie, Sturgeon Lake area, Rainy Hills sheet, Sullivan Lake sheet, Lethbridge and Pincher Creek sheets, Milk River sheet, Rosebud and Banff sheets, and Wainwright and Vermilion sheets.

**Figure 1.** Location map for soil surveys in Alberta.

larly those published prior to 1940, are now out of print and unavailable. Although useful for broad orientation, the data was not detailed enough to meet current planning and management requirements.

The Alberta Soil Survey has operated a program of resurvey at a scale of 1:50 000 on a county basis since 1975. Projects are selected for resurvey based on provincial priorities established by a steering committee of major users of soil survey information (the Alberta Soil/Land Inventory Coordinating Committee). The survey of the County of Flagstaff was undertaken in response to needs identified by Alberta Agriculture and was partially funded by Alberta Agriculture. Earlier surveys covering portions of the county include the Wainwright and Vermillion sheets (Wyatt et al., 1944), the Sullivan Lake sheet (Wyatt et al., 1938) and the Peace Hills sheet (Bowser et al., 1947).

## Location and extent

The County of Flagstaff is located in east-central Alberta between townships 39 to 46 and ranges 9 to 17 west of the fourth meridian (figure 2). The Battle River forms a natural geographic boundary along the south and southeast portions of the county. Remaining boundaries are defined by legal township and range lines.

The county contains approximately 6290 quarter sections and covers an area of about 4075 square kilometers. Major towns in the county include Daysland, Killam, Sedgewick, Hardisty, Forestburg, Lougheed, Strome, Heisler and Alliance. Nearby urban centers include Camrose, Wetaskiwin and Edmonton to the northwest and Lloydminster to the northeast.

## Climate

The County of Flagstaff experiences a continental climate, characterized by moderately warm summers and cold winters. Most of the county lies in agroclimatic zone 2H (figure 3) (Alberta Soils Advisory Committee, 1987). In this zone, the average rainfall is great enough (400 to 450 mm) and the average frost-free period sufficiently long (90 days) to permit all dryland crops typical to the prairie region of western Canada. The southeast corner of the county lies in agroclimatic zone 2AH. The frost-free period in this zone averages more than 90 days, but the amount of precipitation (300 to 400 mm) can limit crop growth in approximately 50 percent of crop years. Climatic variation is reflected in a gradual change in surface color of the soil from black in the north to dark brown in the drier southern portion of the county (figure 4).

Long term climatic records are available for three sites within the County of Flagstaff and for two other sites in adjacent counties (table 1). Thirty year average annual precipitation values for the area range from 385 to 455 mm. No definite pattern can be related to the precipitation normals for the observed stations. About 30 percent of the annual precipitation falls as snow. Most of the snow and the majority of severe snowstorms occur in December, January or February. Precipitation during the May to September growing season accounts for more than 68 percent of the average annual total. The mean annual temperature ranges from 1.9°C at Sedgewick to 3.0°C at the Forestburg mine site. Surface mining and thermal power operations at the Forestburg site may cause local climatic moderation. The frost-free period averages more than 90 days at all sites, but ranges from a low of 94 days at Sedgewick to a high of 137 days at Forestburg. The last spring frost occurs between mid May and early June. The first fall frost occurs in late August to mid September.

Generation of agricultural ratings using the new land capability classification for arable agriculture in Alberta (Alberta Soils Advisory Committee, 1987) requires additional climatic data not reported above. Climatic indices relevant to crop growth are defined to reflect a balance between effective moisture and effective temperature during the growing season. A growing season moisture deficit (P-PE index) is calculated as a

**Table 1.** Precipitation and temperature data for selected stations, within or near the County of Flagstaff, (1951-1980 normals)

| | | Precipitation mm | | | Temperature°C | | | |
|---|---|---|---|---|---|---|---|---|
| Station and elevation | Soil zone | Mean annual | May Sept. | snow | Jan. | July | Mean annual | Frost-free period (days) |
| Alliance (716 m) | Dark Brown | 455 | 299 | 128 | -16.2 | 17.1 | 2.5 | 107 |
| Brownfield (747 m) | Dark Brown | 445 | 285 | 144 | -16.7 | 16.8 | 2.0 | 92 |
| Forestburg (Plant Site) (671 m) | Thin Black | 385 | 283 | 71 | -15.3 | 17.7 | 3.0* | 137* |
| Sedgewick (686 m) | Thin Black | 421 | 283 | 115 | -17.1 | 17.1 | 1.9 | 94 |
| Viking (691 m) | Thin Black | 454 | 326 | 107 | -18.0 | 17.1 | 1.8 | 107 |

* Values for Forestburg plant site are probably atypical due to local microclimate effects associated with the plant.

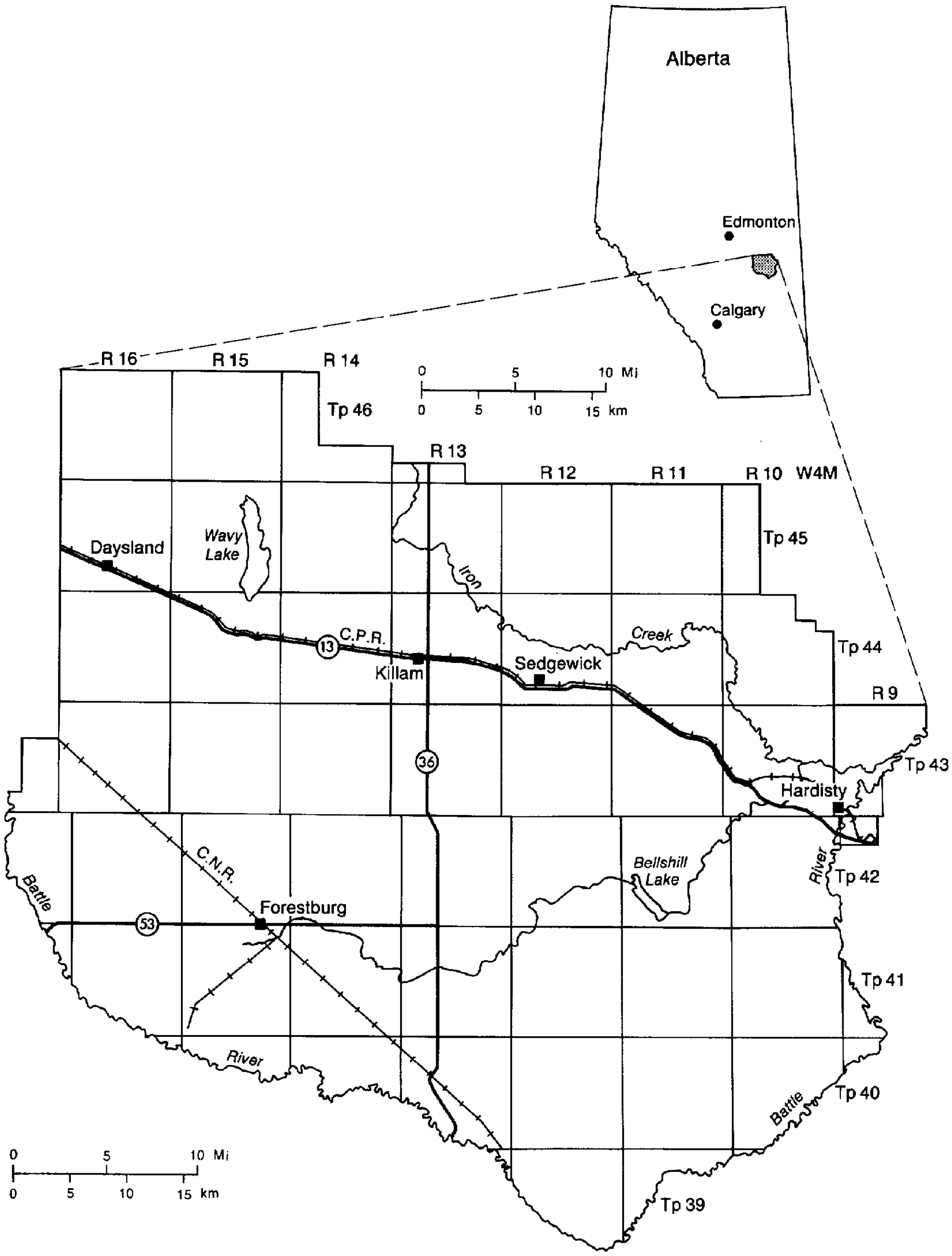



**Figure 2.** Key map of Alberta with Flagstaff projected.

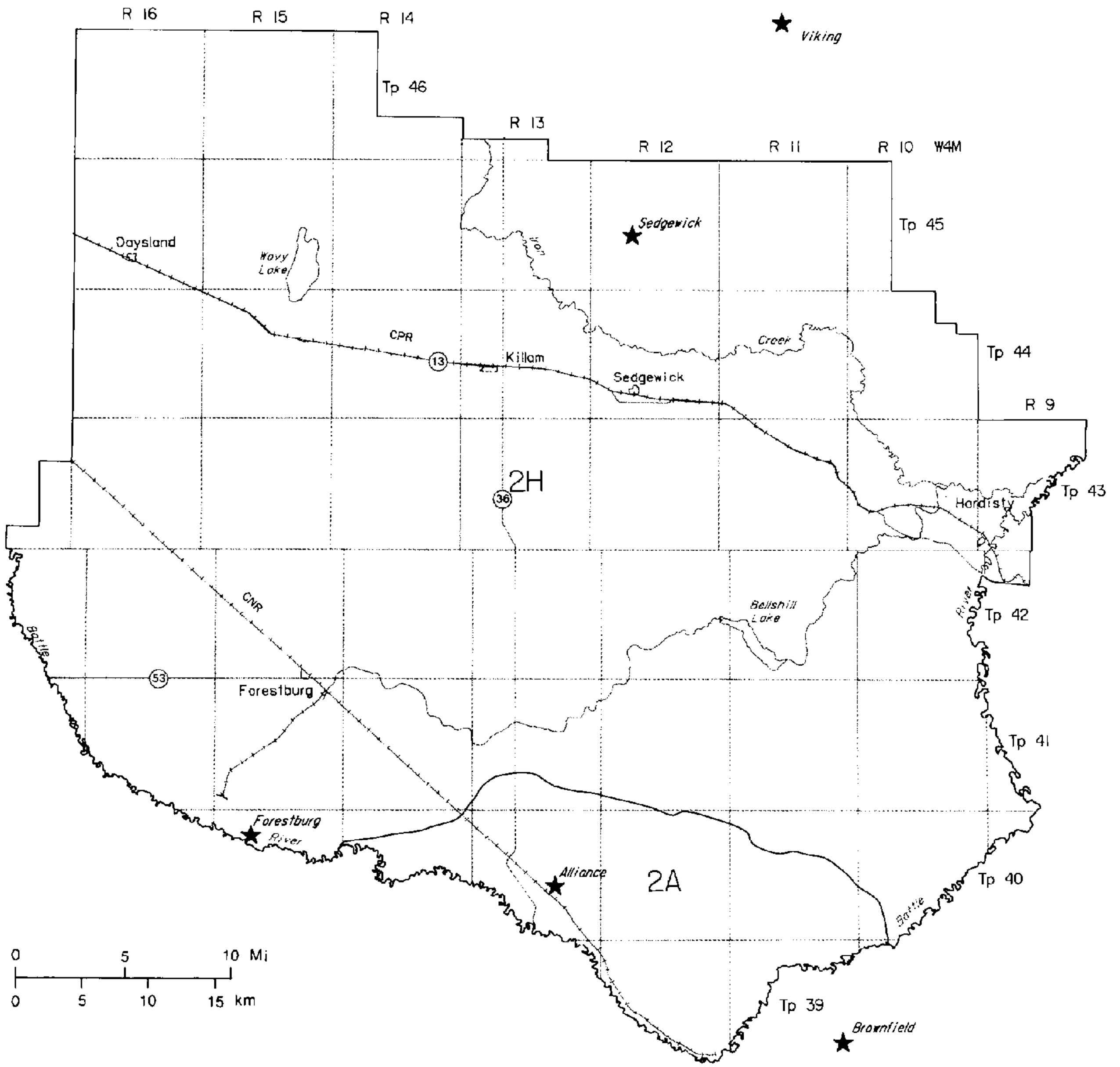



**Figure 3.** Agroclimatic zones and locations of climatic stations within or near the County of Flagstaff.

weighted difference between monthly precipitation and potential evapotranspiration for the months of May through August (table 2). The deficit for stations in the County of Flagstaff averages around 300 mm and ranges from about 200 mm in the northwest to about 300 mm in the southeast (figure 3). Effective growing degree days (EGDD) provide a measure of the heat units available for crop growth during the growing season. These are fairly constant within the county at about 1300 degree days annually. Lower values occur in the higher hummocky terrain in the east and northeast portions of the county. Spring and fall moisture balances are both negative, indicating that, in most years, there should be little long term excess moisture during seeding or harvesting. The Alberta Hail and Crop Insurance hail index for the county ranges from 4 to 8. An index of 5 is considered low, so

**Table 2.** Climatic data required for calculation of Land Capability Classification for Arable Agriculture in Alberta (ASAC, 1987)

| Station and elevation | P-PE index | Effective growing degree days 5°C EGDD 5°C | Excess spring moisture P-PE May | Excess fall moisture P-PE Sept | Hail index |
|---|---|---|---|---|---|
| Alliance | -276 | 1314 | -59 | -13 | 8 |
| Brownfield | -306 | 1263 | -59 | -18 | 4 |
| Forestburg (Plant Site) | -245 | 1536 | -59 | -16 | 6 |
| Sedgewick | -242 | 1231 | -60 | -8 | 4 |
| Viking | -239 | 1301 | -59 | -4 | 5 |

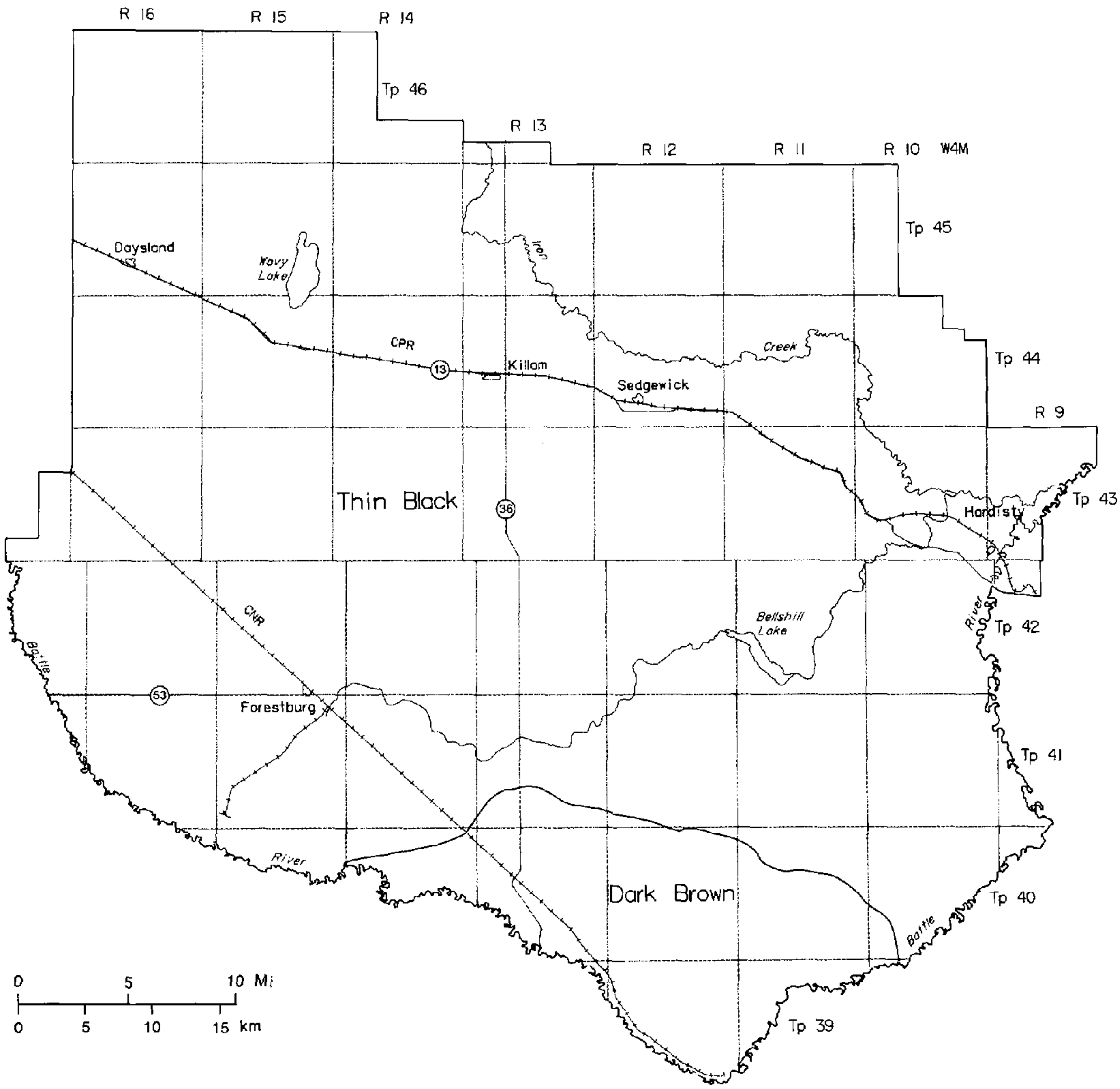



**Figure 4.** Soil zones in the County of Flagstaff.

most of the county has a low hail risk index. The highest hail risk area is along the Battle River on the west side of the county.

## Vegetation

The entire county lies within Rowe's (1972) Aspen Grove Forest region. Strong and Leggat (1981) recognize a gradual north to south transition (figure 5) from an Aspen Subregion dominated by aspen forest cover on noncleared land to a Groveland Subregion with significant occurrence of aspen groves alternating with open grassland.

The Groveland Subregion is a tension zone between the fescue and mixed grass ecoregions (Strong and Leggat, 1981). Natural areas have less than 15 percent tree cover and consist dominantly of aspen with some white spruce found along north-facing slopes and the Battle River escarpments. Native grassland patterns have been disturbed by human influences. Under natural conditions, the grasslands are dominated by rough fescue, Idaho fescue, June grass, spear grass, prairie smoke, sticky geranium and bedstraw. Shrub communities consisting of Saskatoon, wild rose, buck brush, snowberry and silverberry occur in protected and uncleared areas.

Natural areas within the Aspen Subregion are dominated by aspen interspersed with patches of rough fescue grassland. The understory vegetation in aspen groves consists of veiny meadow rue, bedstraw, wild strawberry, wild rose, larkspur, violet, Saskatoon, willow and fireweed.

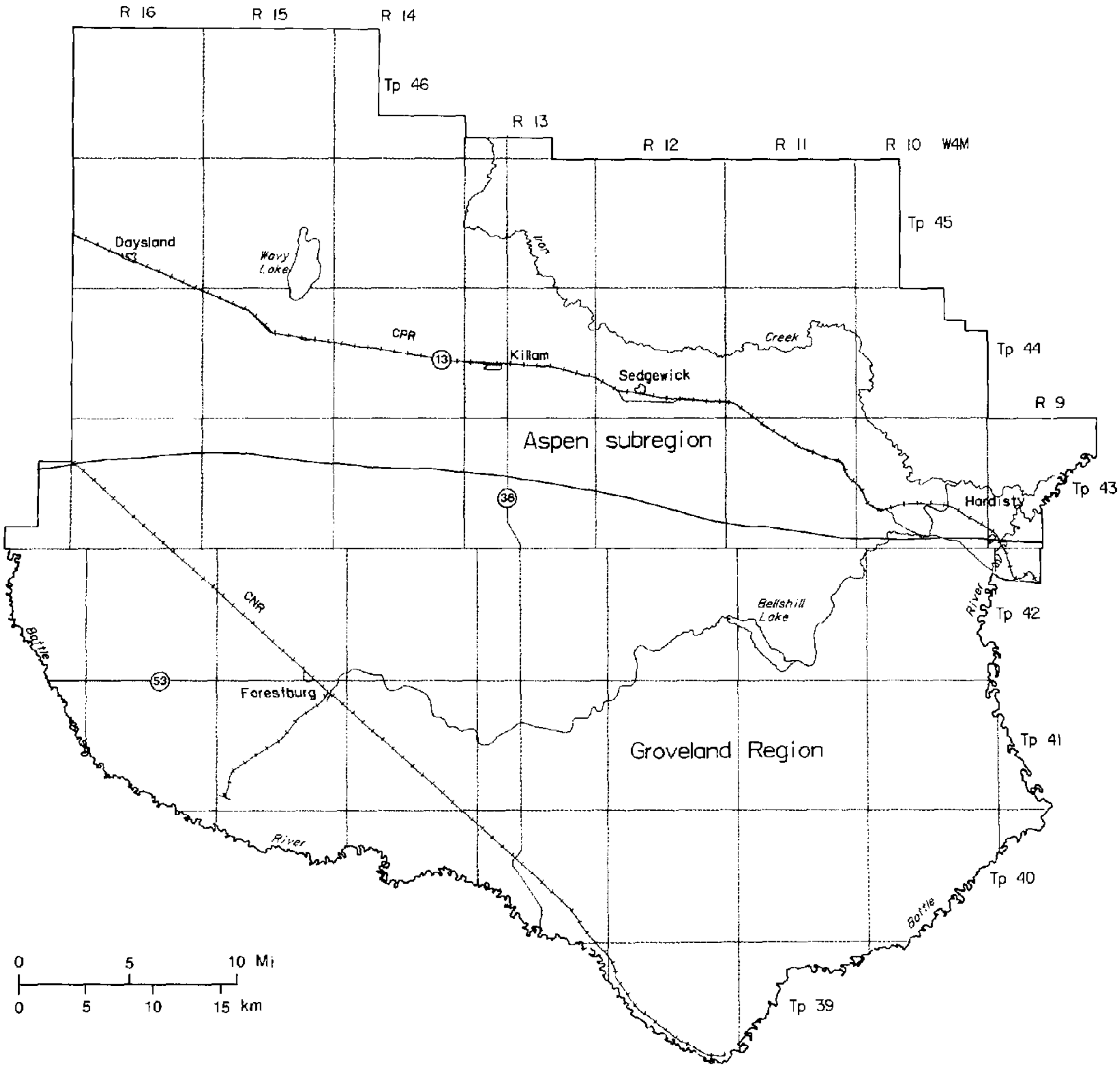



**Figure 5.** Vegetation ecoregions in the County of Flagstaff.

Extensive clearing and cultivation, and prevention of forest and prairie fires, has resulted in a disruption to natural vegetation patterns throughout the area. The county was probably dominated by grassland vegetation prior to settlement and cultivation, but suppression of fire has allowed for the encroachment of aspen vegetation. Aspen and willow groves are widely distributed in all cultivated areas, particularly in low-lying, depressional landscape positions. Bush clearing and drainage is an increasingly common activity within the county as farmers seek to improve efficiency and maximize use of available land.

## Physiography, relief and drainage

The county lies within the Eastern Alberta Plain (Bostock 1970). This region has been further subdivided into sections and districts (table 3, figure 6) based primarily on elevation and major landform characteristics (Pettapiece, 1987).

The Daysland Plain covers most of the county. It is an area of undulating moraine in which local relief is less than 5 to 10 m and elevations range from 610 to 745 m. The topography is nearly level to gently undulating and slopes rarely exceed 5 percent, except along drainage ways. The moraine is from 1 to 15 m thick, except in a number of buried valley locations where it may exceed 90 m. The landscape is dotted with lakes and many small, ephemeral water bodies that often disappear during summer.

A small extension of the Viking Upland occurs in the northeast portion of the county. It is an area of hummocky moraine where relief ranges from 5 to 15 m and elevations range from 685 to 730 m. The topography

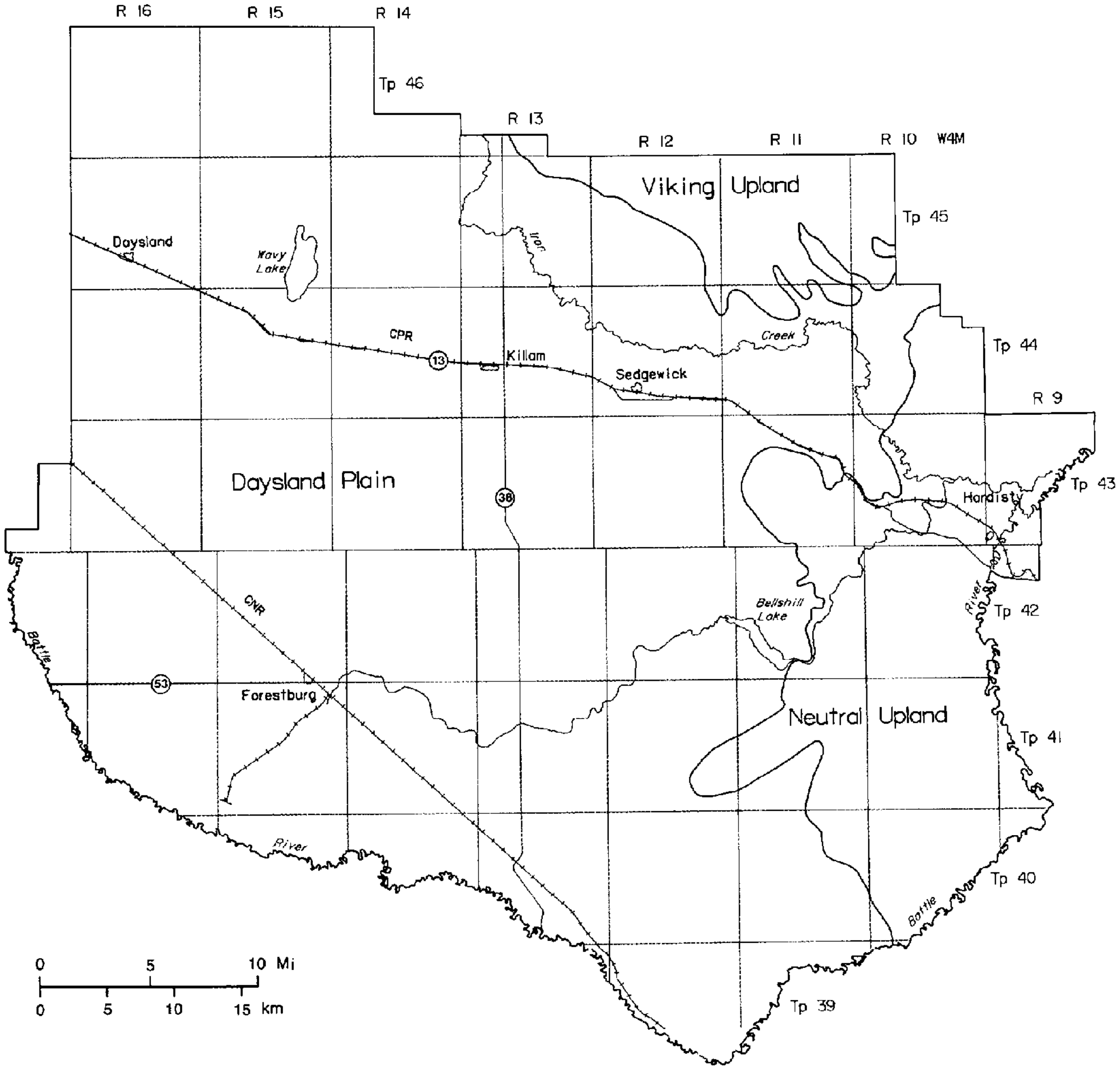



**Figure 6.** Physiographic subdivisions in the County of Flagstaff.

is characterized by short steep slopes and numerous pothole lakes. Slope gradients range from 5 to 15 percent. Morainal sediments are more than 15 m thick overlying shales and sandstones. Most of the pothole lakes are permanent and act as sites for groundwater recharge.

The Neutral Upland occupies the eastern portion of the county west of the Battle River. It is an area of rolling to steeply sloping bedrock controlled uplands where local relief reaches 40 m along drainage ways. Elevations range from 640 to 730 m except at Flagstaff Hill which exceeds 800 m. The area is dissected by several deeply incised glacial meltwater channels that contain a number of permanent lakes strung out in chains along coulees. Steep valley sides with thin morainal or colluvial veneers overlying bedrock develop along the meltwater channels. Areas have

**Table 3.** Physiographic subdivisions of the County of Flagstaff

| Region | Section | District | Landform |
|---|---|---|---|
| Eastern Alberta Plains | Sullivan Plain | Daysland Plain 610 to 730 m | morainal blanket over undulating bedrock |
| | Vermilion Uplands | Viking Upland 608 to 760m | hummocky moraine |
| | Neutral Hills Uplands | Neutral Upland 670 to 790 m | hummocky moraine and morainal blanket over rolling, ice-thrust bedrock |

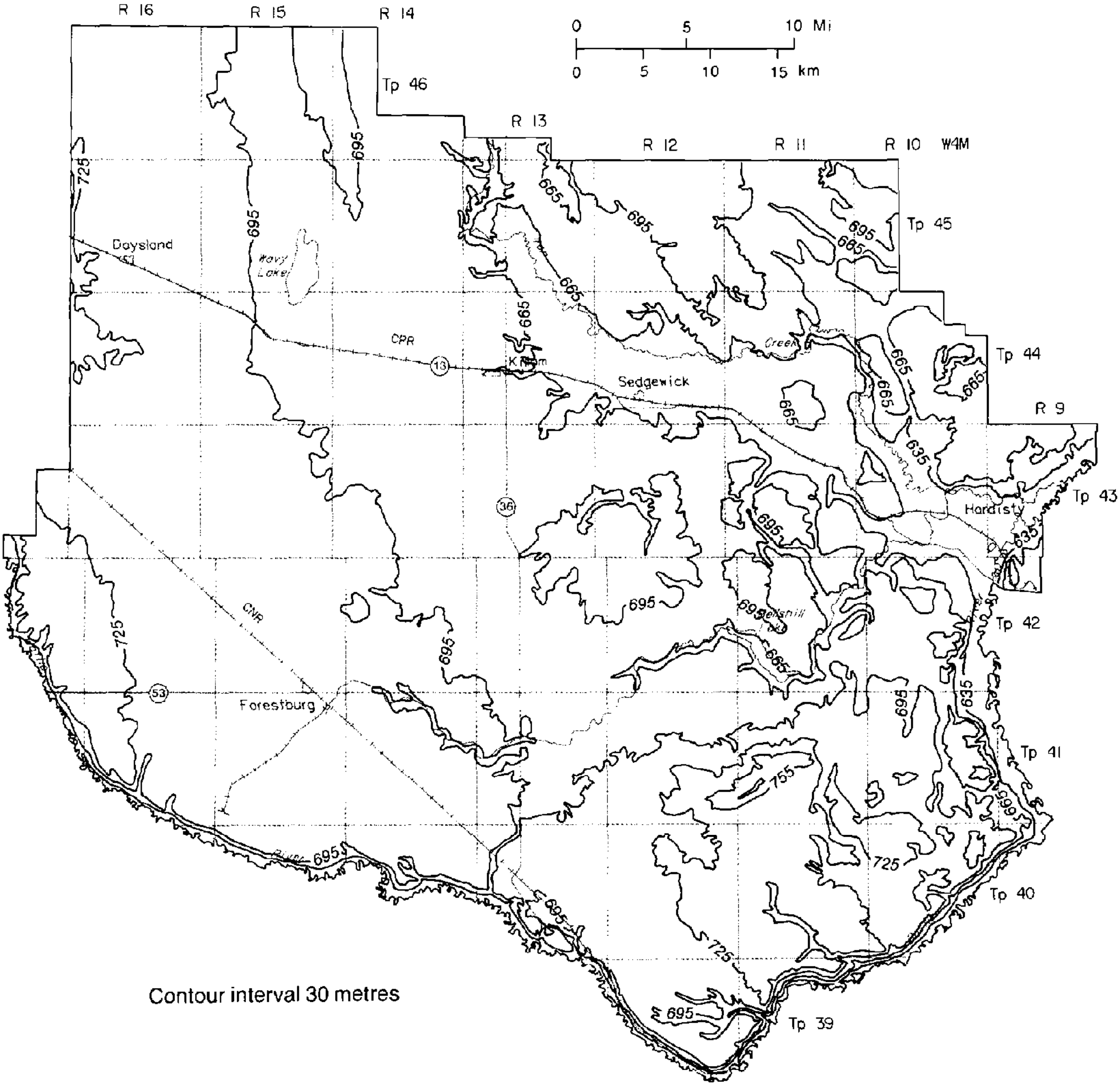



**Figure 7.** Surface elevations in the County of Flagstaff.

morainal blankets overlying bedrock on long rolling, 5 to 15 percent slopes. Ice-thrust bedrock ridges with thin veneers of stagnation moraine occur in parts of the upland, while steeply sloping hummocky landforms with morainal deposits, up to 75 m thick, occupy other portions.

Elevations range from a low of 595 m where the Battle River leaves the county in the northeast to over 800 m at Flagstaff Hill in the southeast. There is a southwest to northeast regional slope with a prominent regional high in the eastern third of the county. This regional high occupies an area from Wavy Lake south to the Battle River. Local highs occur north and south of Sedgewick (figure 7). The western two-thirds of the county are fairly level. Steeper slopes develop in the dissected and hummocky topography in the eastern portion of the county.

## Bedrock geology

The County of Flagstaff is underlain by Upper Cretaceous sandstone, shale and mudstone belonging to the Horseshoe Canyon, Bearpaw and Belly River formations (figure 8). The following descriptions are extracted from Green (Alberta Research Council, 1972).

Horseshoe Canyon Formation: gray, feldspathic, clayey sandstone; gray bentonitic mudstone and carboniferous shale; concretionary ironstone beds; scattered coal and bentonite beds of variable thickness and minor ironstone beds; mainly nonmarine.

Bearpaw Formation: dark gray blocky shale and silty shale; greenish glauconitic and gray clayey sandstone, thin concretionary ironstone and bentonite beds; marine. Shale units 10 to 20 m thick are inter-

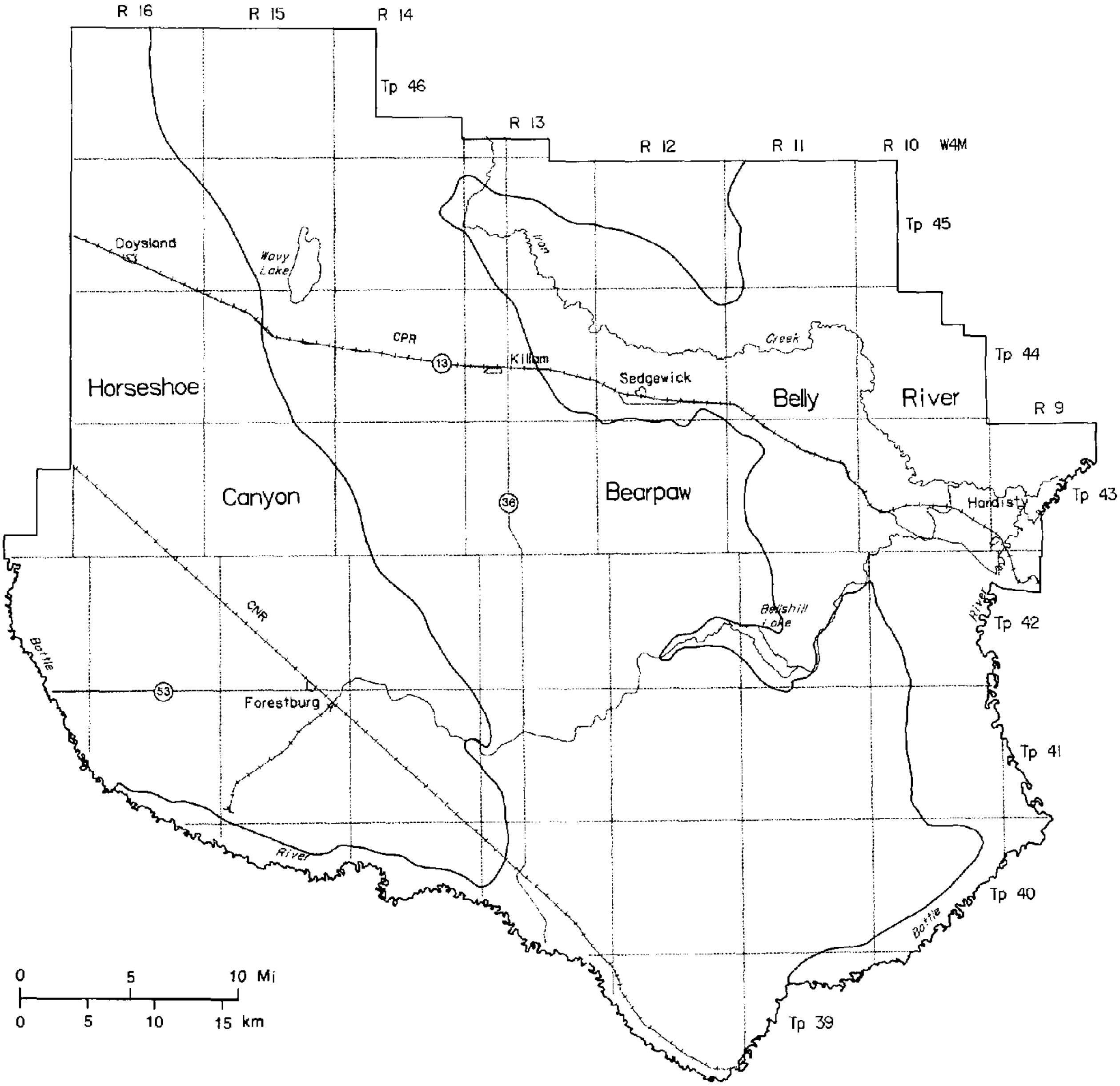



**Figure 8.** Bedrock formations in the County of Flagstaff.

bedded with sandstone and siltstone units 5 to 20 m thick.

Belly River Formation: gray to greenish gray, thick bedded feldspathic sandstone; gray clayey siltstone, gray and green mudstone; concretionary ironstone beds; nonmarine.

Surface exposures of these bedrock formations are found along the Battle River and several of the more deeply incised coulees in the eastern part of the county. The Horseshoe Canyon and Bearpaw formations underlie all but the eastern part of the county and are associated with the distribution of Solonetzic soils in the county. The topography in these areas is flat and the overlying morainal veneer is thin. A change in surface drainage pattern may be associated, in several locations, with the underlying boundary between the two formations. A noticeable change occurs across the boundary, with drainage becoming better developed and stream incision more pronounced crossing from the Horseshoe Canyon to the Bearpaw Formation. Luscar Mines extracted coal from the basal seam of the Horseshoe Canyon Formation at the Forestburg Collieries near Forestburg from 1949 to 1986. The Belly River Formation underlies the eastern part of the county. It is exposed along the Battle River where it forms unvegetated cliffs in some locations.

## Depth to bedrock

Knowledge of depth to bedrock is desirable for better understanding of conditions affecting soil formation and potential land use. Existing information was reviewed and compiled in order to produce generalized maps of

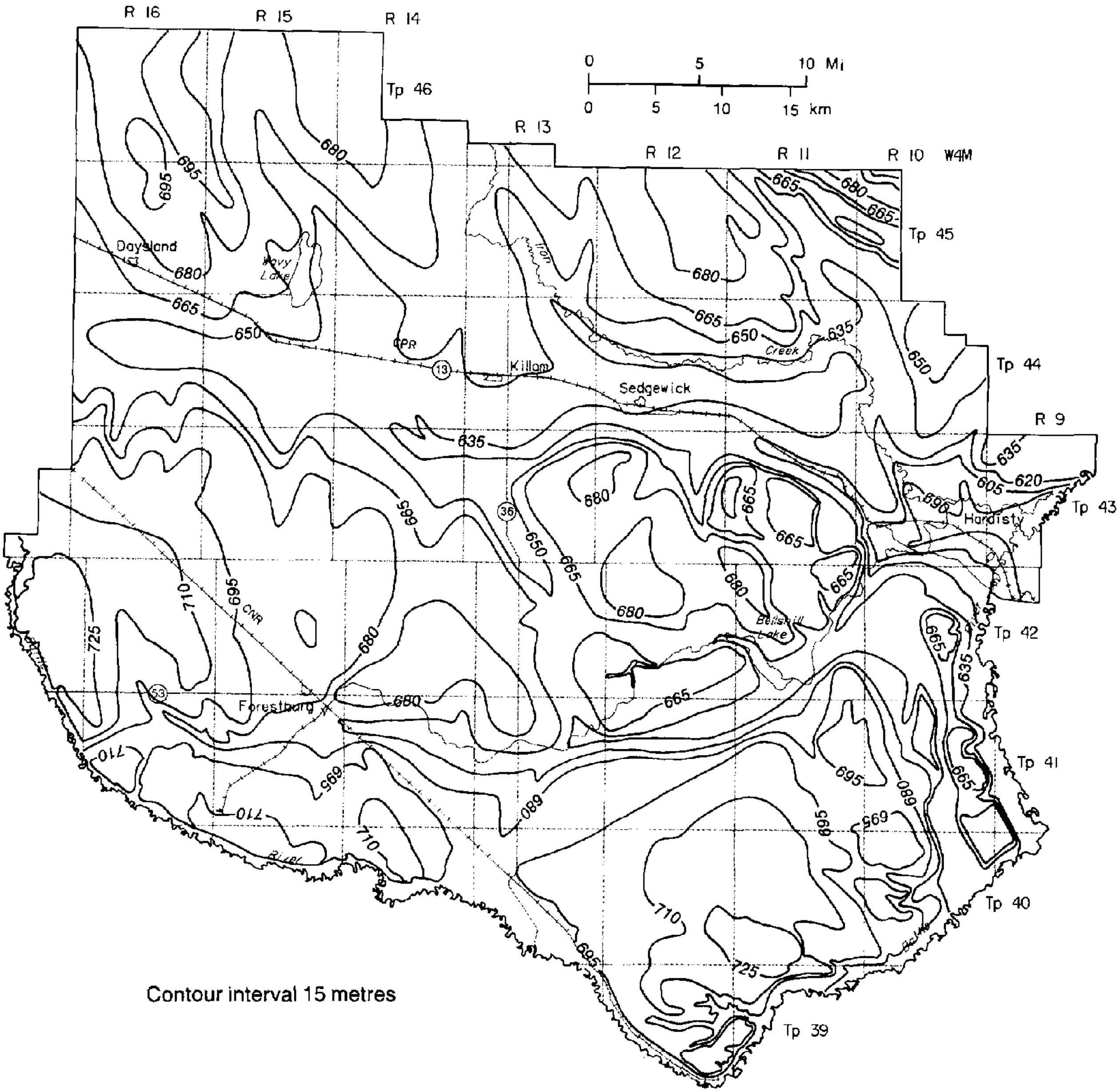



**Figure 9.** Bedrock topography map for the County of Flagstaff.

bedrock topography (figure 9) and depth to bedrock (figure 10). The bedrock topography map indicates the locations of a number of deep preglacial bedrock channels. Several of these channels are infilled with sands and gravels and are locally important aquifers. The most prominent buried channels are the Wainwright and Buffalo Lake bedrock channels. Surficial deposits overlying these channels can be 100 m thick but are, in places, less than 30 m thick. A depth to bedrock map (figure 10) was generated by subtracting bedrock topography elevations from surface topography elevations. This produced a very generalized indication of large areas where bedrock may be expected to occur within given distances of the surface. The map does not allow for accurate location of individual areas where bedrock is close to the surface. It also does not permit estimates of bedrock depth to be made to levels of precision greater than 5 m.

## Surficial geology and materials

The surficial geologic features of the County of Flagstaff are the result of glaciation. Continental glaciers originating west of Hudson Bay covered all of east-central Alberta. The Keewatin ice advanced and melted away several times during the late Wisconsin from 24 000 to about 10 000 years before present. The last advance covered central and southern Alberta in three separate, but concurrent, lobes (Shetsen, 1984). The County of Flagstaff was affected by the central lobe, which advanced from the north. Hummocky moraine along the

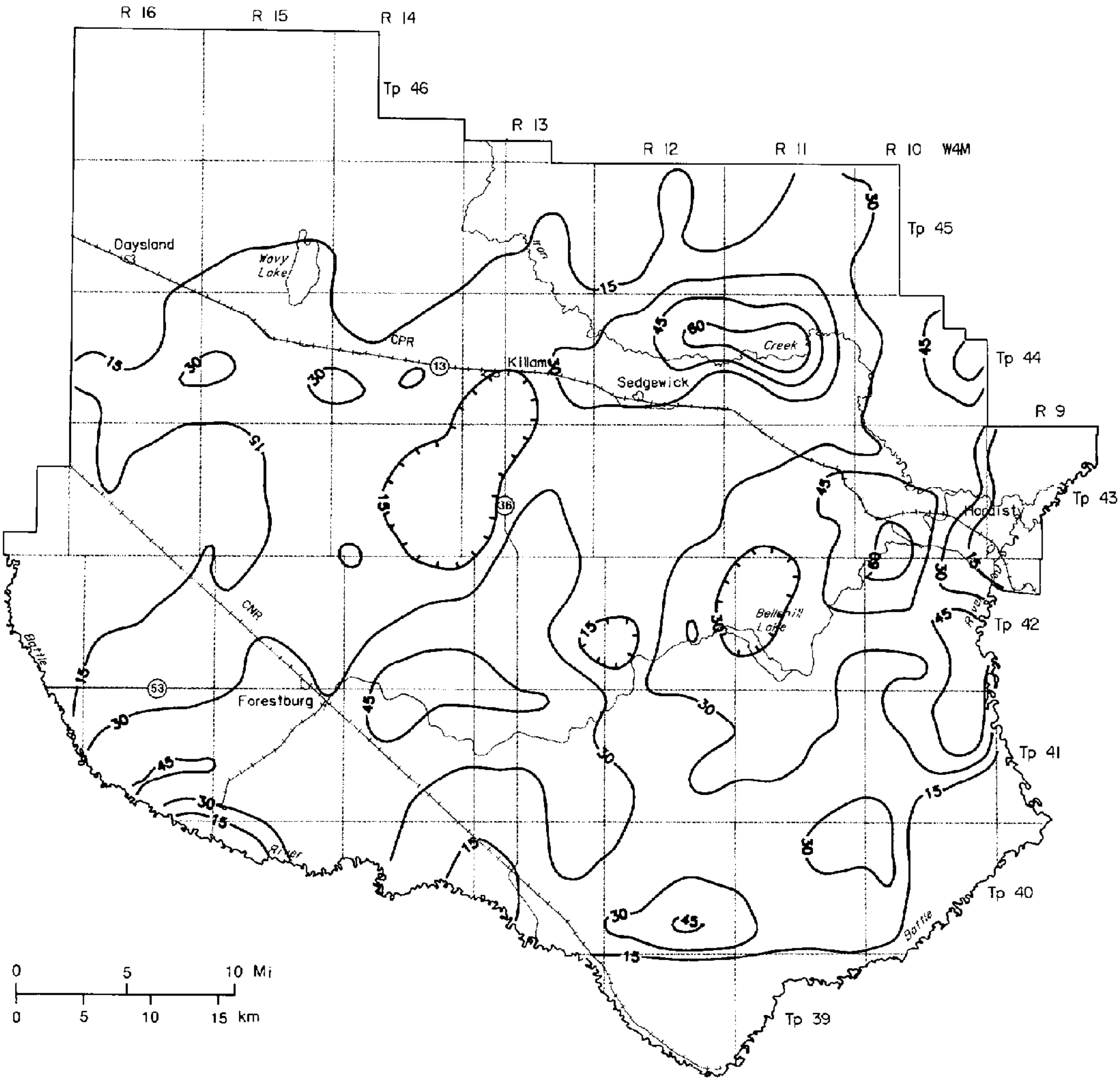



**Figure 10.** Generalized depth to bedrock map for the County of Flagstaff.

east and northeast edges of the county outlines the eastern boundary for this central lobe.

The county is covered by till deposited directly by glaciers (table 4, figure 11). Other deposits of limited extent include glaciofluvial and ice-contact materials deposited in flowing meltwaters and minor occurrences of glaciolacustrine, fluvial and eolian materials. Three different tills were recognized and mapped in association with the County of Flagstaff soils. These till deposits collectively cover 75 percent of the county. The predominant till (Ts) is brownish, clay loam textured, weakly calcareous and may be non to moderately saline and sodic. This till occurs in undulating to slightly hummocky areas as a thin but continuous (1 to 15 m thick) blanket. A second till (T) is yellowish brown, clay loam to sandy clay loam textured, moderately calcareous and nonsaline. It occurs as deep deposits, greater than 15 m thick, in areas of hummocky to rolling stagnation moraine. Small areas of the county are covered by a grayish till (TR) that is clay loam to clay textured, very weakly calcareous, and moderately to strongly saline and sodic. It occurs (in areas of shallow bedrock) as a thin discontinuous veneer often less than 1 m thick.

Approximately 7 percent of the county is covered by coarser-textured glaciofluvial materials. These deposits form along former glacial meltwater channels and in crevasse fillings or eskers. The main deposits are centered around Sedgewick, northeast of Hardisty and along the southern flank of Flagstaff Hill. These deposits are sandy loam to loamy sand textured and range from 1 to 10 m thick. Thin veneers of sandy loam to loamy sand, less than 1 m thick overlying till, are common around the perimeters of these main deposits

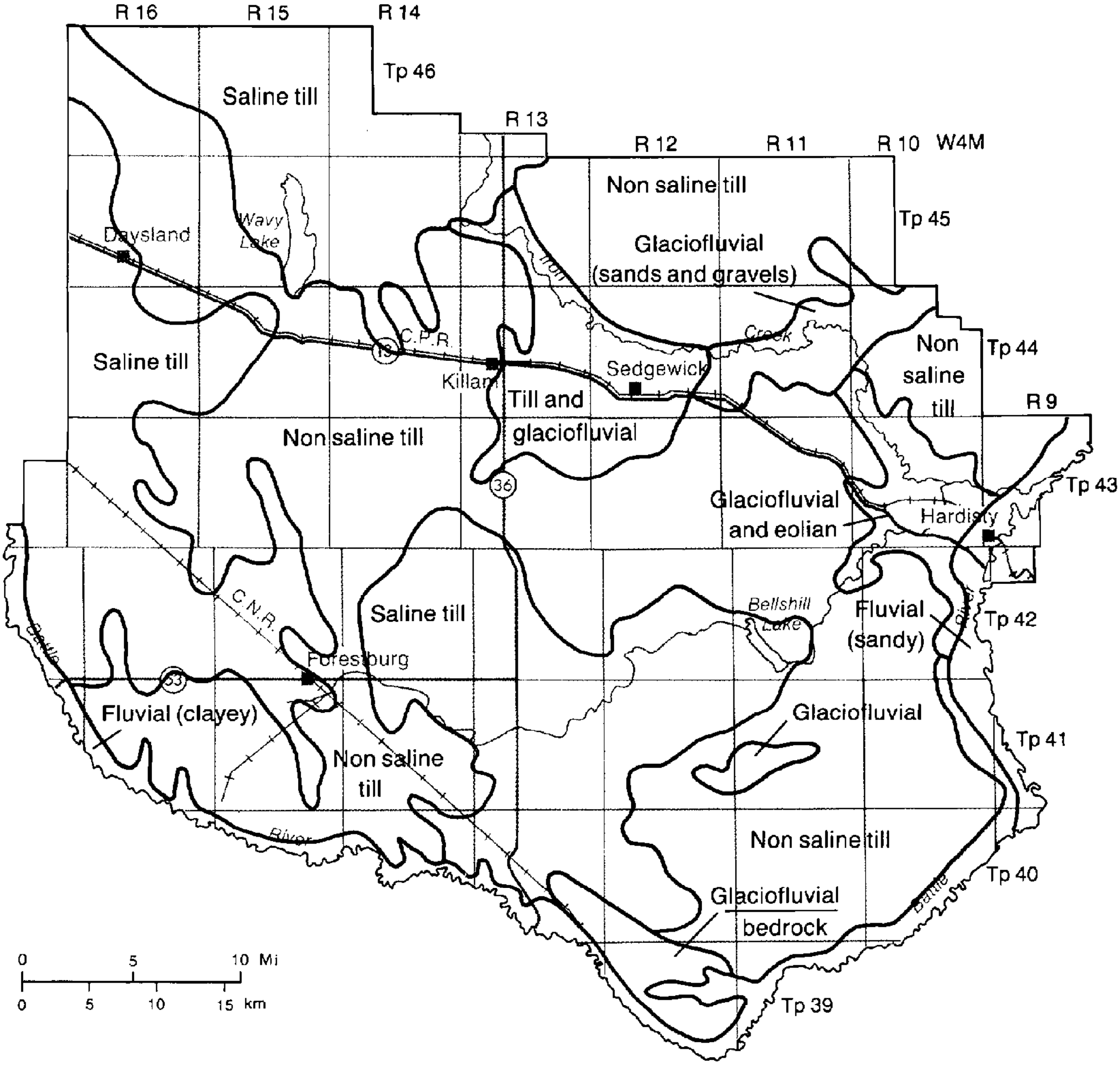



**Figure 11.** Generalized distribution of surficial deposits in the County of Flagstaff.

**Table 4.** Extent of surficial deposits in the County of Flagstaff.

| Material | Hectares | % of total |
|---|---|---|
| Till | | |
| nonsaline (Till-non) | 136 732 | 33.5 |
| slightly saline (Till-sal) | 165 527 | 40.6 |
| thin over residual (Till/rock) | 1870 | 0.5 |
| Total till | 302 902 | 74.6 |
| Ice-contact material (Till & IC) | 5945 | 1.5 |
| Glaciofluvial | 11 693 | 2.9 |
| deep sandy loams to (FG-SL) loamy sands | | |
| thin veneers of sandy (Till & FG) loam to loamy sand | 9781 | 2.3 |
| thin veneers of sandy loam (FG/r) over residual | 584 | 0.1 |
| gravelly outwash (FG-Gv) | 1459 | 0.4 |
| Total Glaciofluvial | 29 462 | 7.3 |
| Eolian sands to loamy sands (EOL-S) | 7816 | 1.9 |
| Recent fluvial | | |
| Fluvial silty clay loam (F-clayey) | 3873 | 0.9 |
| to sandy loam (F-sandy) | 6665 | 1.6 |
| Glaciolacustrine clay loam to heavy clay (LG-non) | 18 476 | 4.5 |
| nonsaline to slightly saline (LG-sal) | 18 629 | 4.6 |
| Total Glaciolacustrine | 37 105 | 9.1 |
| Organics (ZOR) | 1726 | 0.4 |
| Water (ZZZ) | 3722 | 0.9 |
| Undifferentiated (RB, ZDL,) | 14 063 | 3.4 |
| Total | 407 561 | 100.0 |

and also occur in other scattered locations. Very-coarse-textured gravelly deposits occur in a few locations along the Battle River near Hardisty and in limited amounts in scour channels, eskers and crevasse fillings throughout the county.

Some of the sandy glaciofluvial materials were reworked by wind, after their deposition, into longitudinal and crescent-shaped dunes. These highly sorted eolian materials are sandy textured and are more than 2 m thick. They occur in association with glaciofluvial materials and cover approximately 2 percent of the county.

Recent fluvial activity has deposited alluvium in stream channels and floodplains on about 3 percent of the county. The texture of the fluvial material is variable, but within the county is predominantly silty clay loam, silt loam or sandy loam textured.

Lacustrine or glaciolacustrine deposits are limited in distribution within the county and cover 9 percent of the total area. Differentiation of glaciolacustrine deposits from till during soil mapping was difficult. Much of the glaciolacustrine material in the county was included with till units in the soil map. Lacustrine and glaciolacustrine materials ranged from clay loam to heavy clay in texture and occurred as thin deposits in shallow basins and pothole lakes.

One or two small areas of organic deposits are found in the county and occupy less than 0.1 percent of the area. These organic areas are related to saturated conditions caused by high rates of groundwater flow into portions of the Iron Creek Basin.

## Hydrology

All rivers, lakes and streams in the county form part of the Battle River Basin which eventually drains into the North Saskatchewan River. The Battle River is the major surface drainage feature with lesser contributions made by Iron Creek, Driedmeat Creek and Hastings Creek (table 5) (Battle River Regional Planning Commission, 1985). These streams display meandering patterns indicative of low gradients.

There are a number of permanent water bodies in the county. Eighteen of the larger lakes are named. These lakes occupy about 2400 ha in the county (table 6) and are used for waterfowl habitat, recreation and as water sources (Battle River Regional Planning Commission, 1985).

A sampling program conducted during the summer of 1985 provided some data on surface water chemistry. Total dissolved solids (TDS) in surface water ranged from a low of 124 mg/L to a single high of over 52 000 mg/L. Over 60 percent of the 65 surface water samples had TDS concentrations below 1000 mg/L. These samples came from rain-fed surface ponds and lakes in the eastern part of the county or from water in streams or the Battle River. A further 30 percent of the sampled sites had TDS concentrations between 1000 and 5000 mg/L, and 10 percent exceeded 5000 mg/L. These higher concentrations were from permanent pothole lakes in the eastern part of the county. The highest value was from a small lake, in a meltwater channel, in the southeast of the county.

Laboratory analysis revealed the surface water could be separated into three distinct chemical types or facies, namely; calcium bicarbonate waters ($CaHCO_3$), sodium bicarbonate waters ($NaHCO_3$) and sodium sulphate waters ($NaSO_4$). Sodium sulphate waters were concentrated in the eastern portion of the county while calcium and sodium bicarbonate waters were spread evenly through the remainder of the county.

## Hydrogeology

Previous groundwater studies in the area (Le Breton, 1969; Hackbarth, 1975) provide a regional overview of groundwater flow, potential yields and groundwater chemistry in the county (figures 12 to 16). Groundwater flow is more intense in the eastern part of the county where topography is strongly developed. Groundwater recharge occurs locally on high ground and there is field evidence of saline discharge into deep depressions formed by meltwater channels. Water tables in this area are estimated to be deep (3 to 10 m) and may be deeper on the most prominent highs. Water table depths in the meltwater channels are less than 1 m. In the western half of the county, the landscape is flatter and local recharge occurs from the water table down to deeper aquifers. The water table is close to the surface over most of this area and deepens during the summer period. Saline discharge and high water tables held up

**Table 5.** Statistics for the major streams and rivers in the County of Flagstaff (Source, Battle River Regional Planning Commission, 1985)

| Watercourse | Legal location | County reference | Drainage area ($km^2$) | Mean annual discharge | Mean annual volume |
|---|---|---|---|---|---|
| Battle River | NW 3-43-17-W4 | Initial boundary point | 7 570 | 6.466 | 204 000 |
| | SE 26-43-9-W4 | Last boundary point | 15 974 | 8.019 | 253 000 |
| Driedmeat Creek | NW 30-44-16-W4 | Boundary point | 411 | 0.108 | 3 420 |
| Hastings Creek | SW 9-41-16-W4 | Confluence with Battle River | 76 | 0.065 | 2 050 |
| Iron Creek | SW 22-42-9-W4 | Confluence with Battle River | 3 536 | 0.613 | 19 300 |

by shallow bedrock are associated with areas of saline and Solonetzic soils. Potable water is extracted from both surficial sediments and upper bedrock strata in the county. The most important aquifers in the county are located in a few major buried valley systems that have been infilled with sand and gravel and then covered by till (figure 8). The Wainwright buried valley and its main tributaries cut across the northern half of the county from west to east and provide an important water supply for several municipalities. A less prominent buried valley can be traced eastward from Forestburg to Bellshill Lake and Hardisty. Twenty year safe limits of 0.38 to 1.9 L/s and 1.9 to 7.6 L/s have been reported for these buried valley aquifers. Other surficial deposits are poor aquifers with common 20 year safe yields in the range of 0.07 to 0.38 L/s. Water quality in the surficial drift aquifers is good with total dissolved solids (TDS) less than 1500 mg/L. Most surficial aquifer waters are classed as calcium bicarbonate type. Waters with TDS contents greater than 1000 to 1500 mg/L may be calcium bicarbonate-sulfate type.

Bedrock aquifers are not as productive as the surficial deposit aquifers but are important within the county. Some production is drawn from all three of the main bedrock formations that underlie the county. The bottom of the Belly River Formation represents the lower limit for productive yield of usable water.

The Belly River Formation contains the most productive bedrock aquifers, with 20 year safe yields as high as 0.38 to 1.9 L/s in the south-central part of the county. Yields from this formation in other portions of the county are from 0.07 to 0.38 L/s. Within the Bearpaw Formation, the main producing aquifers are located in the Bullwark sandstones. Most wells around Forestburg are completed in one of these sandstone strata and are reported to produce up to 1.9 L/s. Most wells in the western quarter of the county are completed in the Horseshoe Canyon Formation and have low yields in the range of 0.07 to 0.38 L/s.

Water quality and water chemistry show a pattern of change with depth. Groundwater from shallow bedrock (<45 m) is more mineralized than surficial aquifer water. TDS for this water range from 1000 to 2500 mg/L. Less mineralized waters are calcium bicarbonate or calcium bicarbonate-sulfate type, but waters with higher TDS are richer in sodium and sulfates. From 45 to 100 m, total dissolved solid content decreases and water chemistry changes, with sodium bicarbonate and sodium sulfate types displacing calcium and magnesium bicarbonate types. Undesirable sodium chloride waters are found in this depth interval in several locations within the county. Below 100 m (100 to 150 m), TDS remain similar at 1000 to 2500 mg/L but can reach 3500 mg/L. All groundwater at this depth range is sodium type, mostly sodium bicarbonate, but in places is sodium chloride type. All groundwater in this depth range is considered unfit for human consumption due to the presence of sodium chloride.

Fluoride concentrations are less than the provincial concentration limits of 1.5 mg/L in potable water aquifers in the county. Slightly elevated concentrations in the range of 1.5 to 2 mg/L are reported between 45 and 100 m depth in townships 41 and 42 (ranges 12 and 13), and between 100 and 150 m in townships 39, 40, 41, and 42 (range 13).

**Table 6.** Statistics for permanent standing water bodies in Flagstaff County (Source, Battle River Regional Planning Commission, 1985)

| Name | Nearest community | Area (hectares) | Present use (see below) |
|---|---|---|---|
| Bellshill | Loughheed | 340 | Waterfowl |
| Bott | Hardisty | 55 | Recreation |
| Byers | Loughheed | 90 | Waterfowl |
| Eve | Alliance | 15 | Waterfowl, water |
| Fish | Hardisty | 15 | Waterfowl |
| Flag | Alliance | 20 | Water |
| George | Forestburg | 20 | Waterfowl, water |
| Grass | Hardisty | 25 | Waterfowl, rec |
| Hardisty | Hardisty | 20 | Recreation |
| Little Flag | Hardisty | 20 | Waterfowl |
| McKay | Lougheed | 55 | Waterfowl |
| Peninsula | Lougheed | 140 | Waterfowl, water |
| Schneider | Alliance | 60 | Waterfowl, water |
| Schultz | Alliance | 95 | Waterfowl, water |
| Sedgewick | Sedgewick | 20 | Recreation |
| Thompson | Alliance | 60 | Waterfowl |
| Wavy | Strome | 1135 | Waterfowl |
| Whitewater | Killam | 15 | Waterfowl |
| Total | | 2400 | |

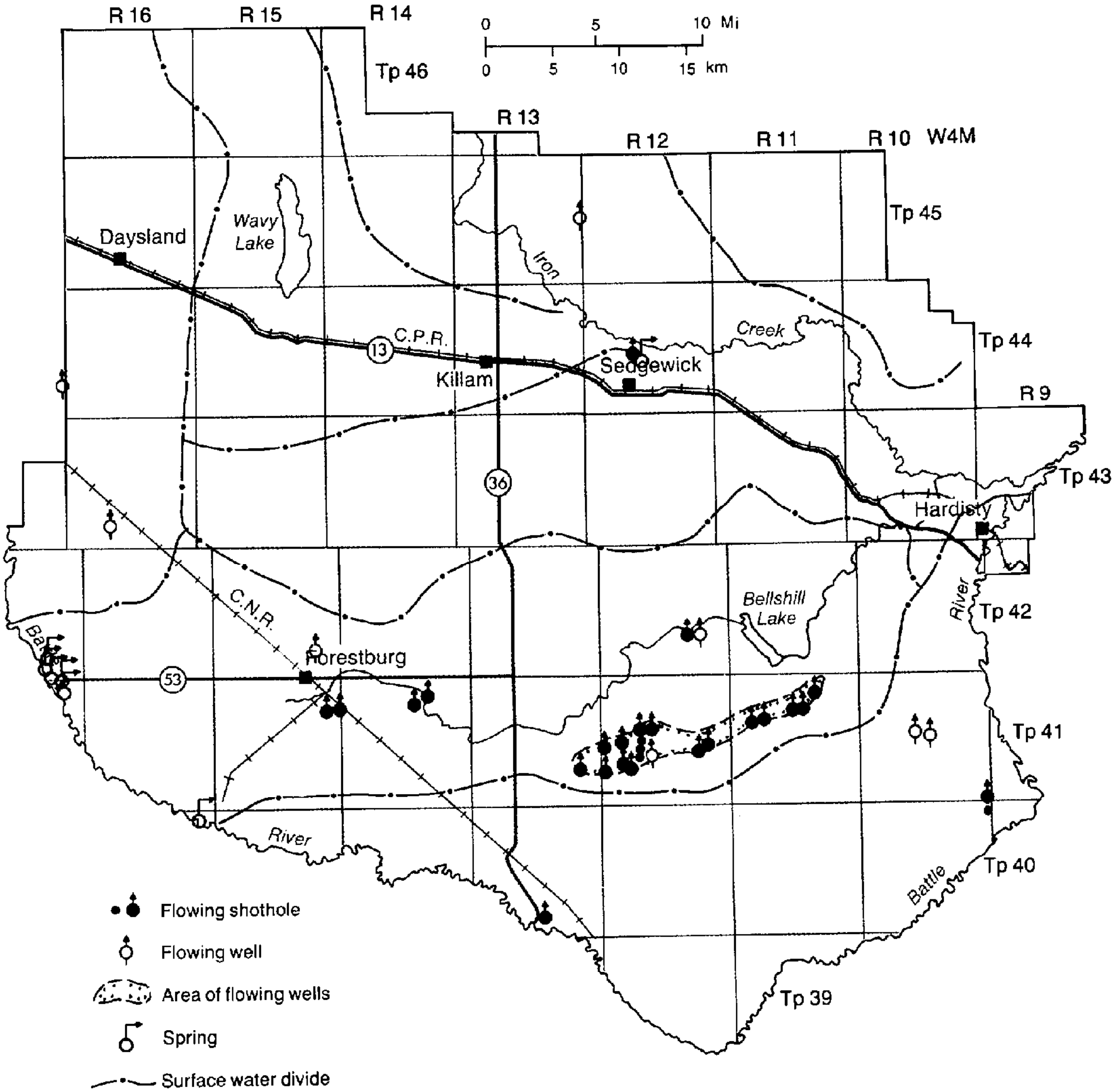



**Figure 12.** Hydrogeologic features in the County of Flagstaff.

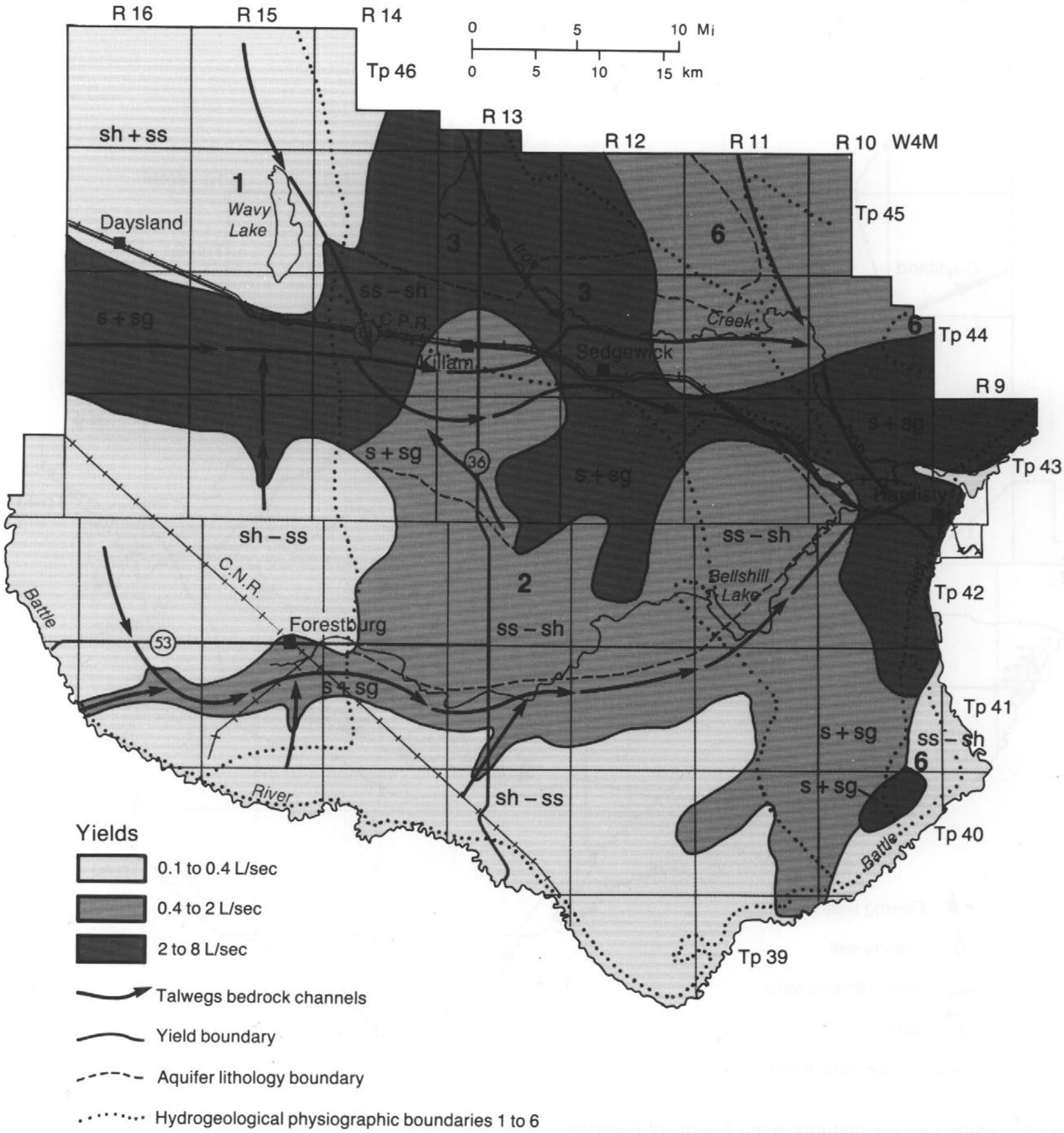



**Figure 13.** Aquifer lithology and probable yields in the County of Flagstaff.

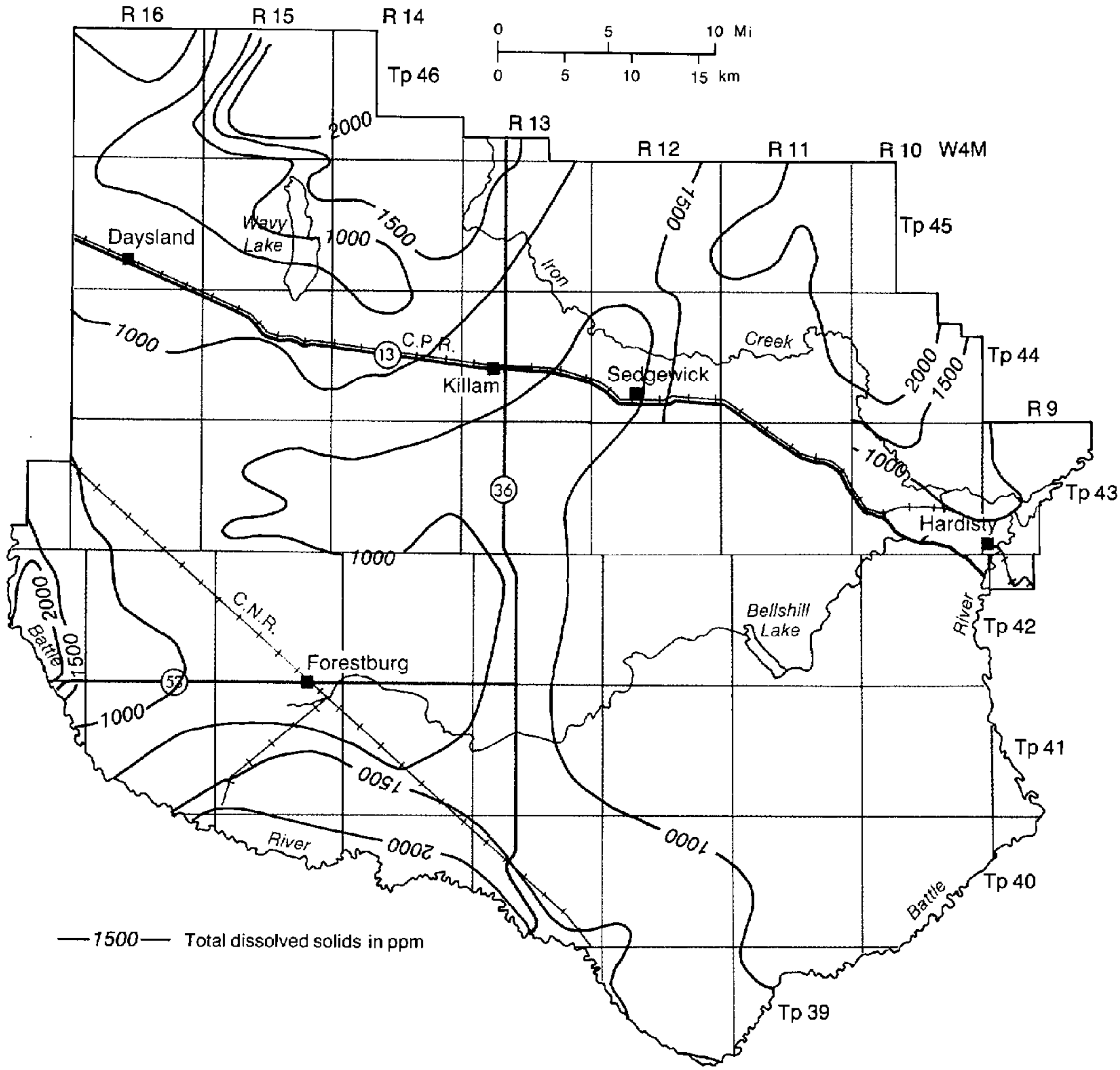



**Figure 14.** Total dissolved solids content of groundwater in the County of Flagstaff.

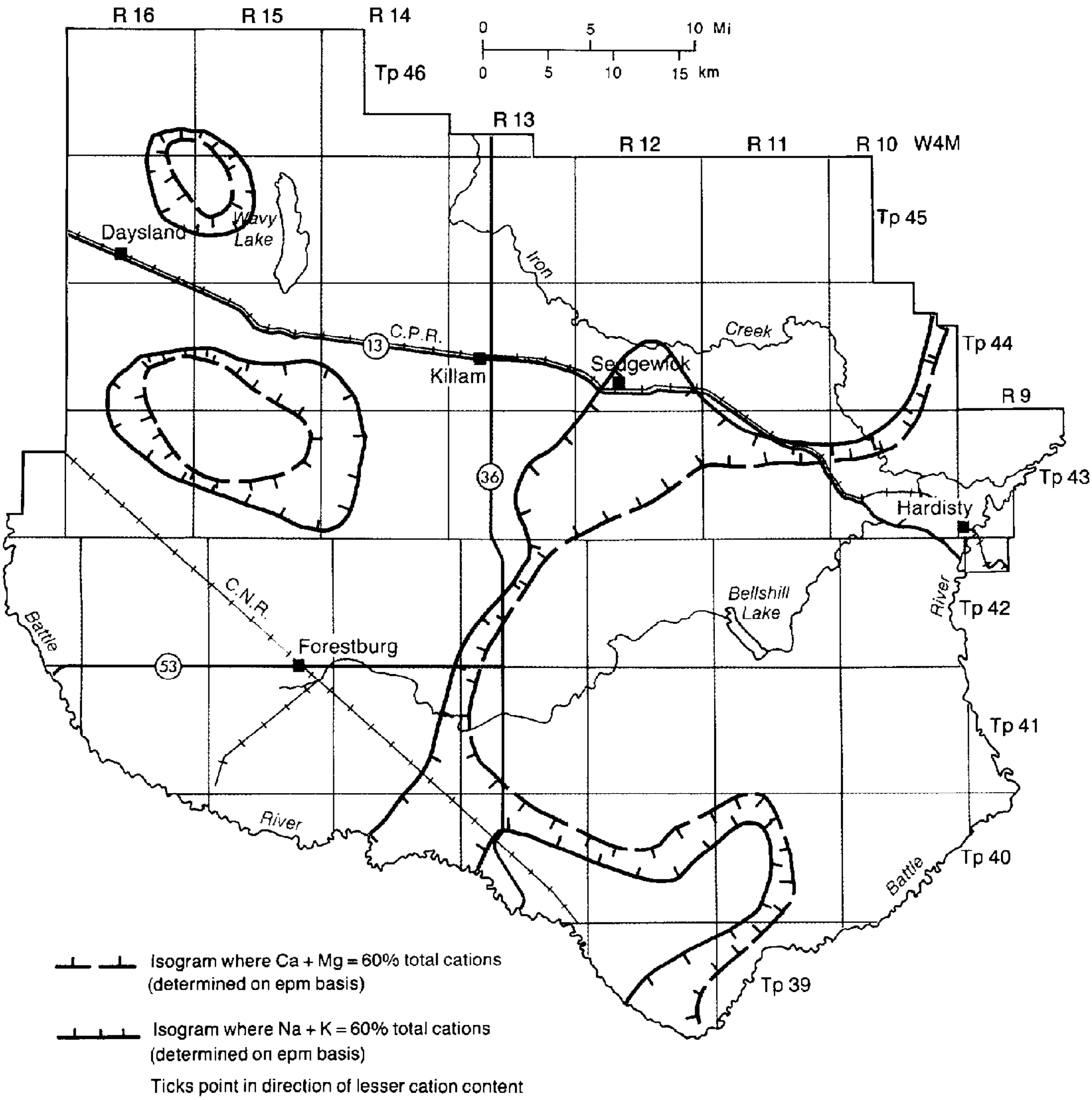



**Figure 15.** Relative cation content of groundwater in the County of Flagstaff.

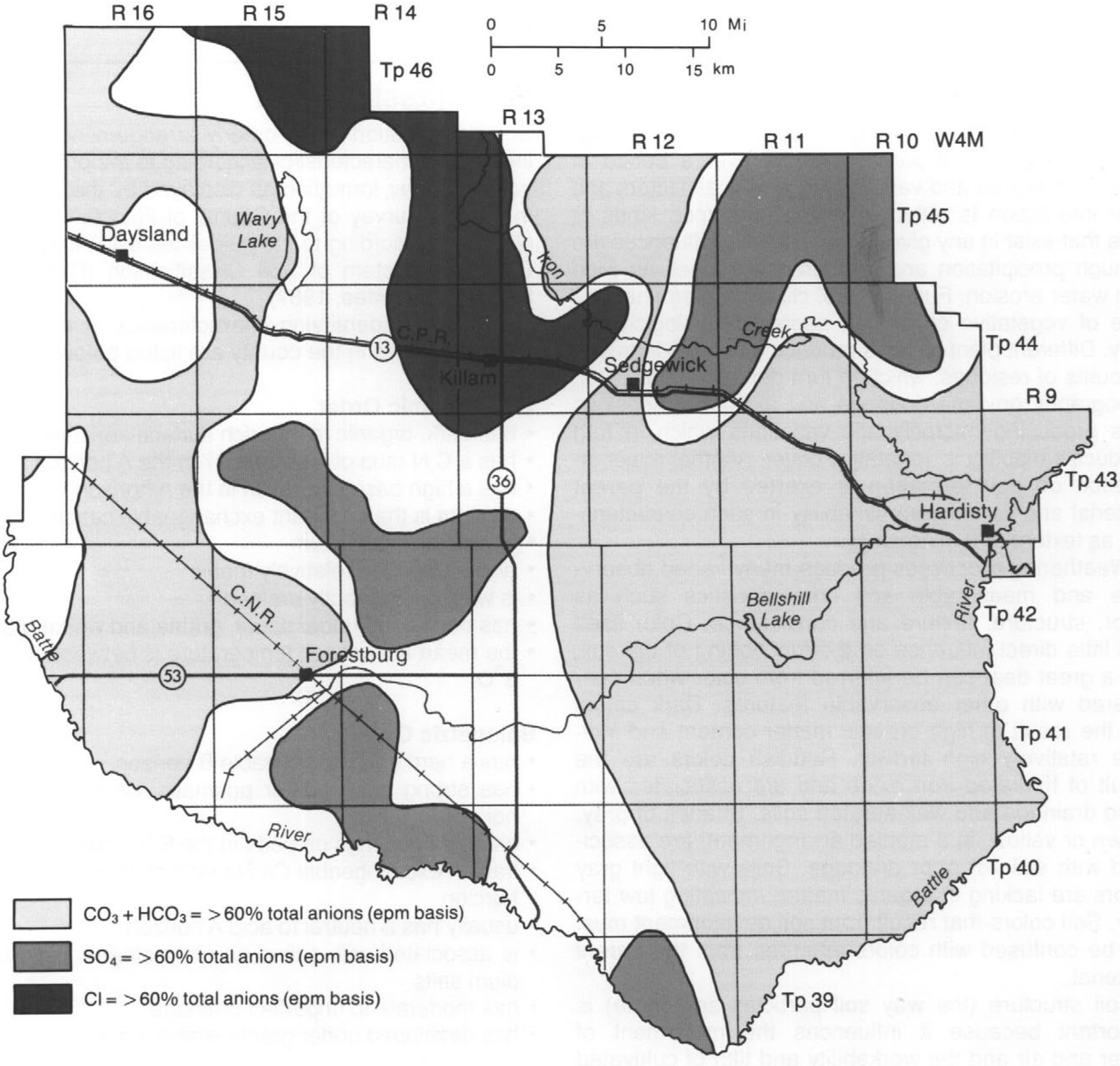



**Figure 16.** Relative anion content of groundwater in the County of Flagstaff.

# Part 2 - The soils

## Soil formation

Soil is the product of climate, vegetation, and topography acting on the parent material over a period of time. The degree and variability of any or all factors and their interaction is reflected in the numerous kinds of soils that exist in any given area. Climatic influences are through precipitation and temperature as well as wind and water erosion. Furthermore, climate determines the type of vegetative cover and degree of biological activity. Different plant species produce different kinds and amounts of residues, which in turn determine soil color. Topography governs drainage and moisture conditions thus producing microclimatic variations which in turn produce variability in vegetative cover. Another major influence on soil formation is exerted by the parent material and its inherent variability in such characteristics as texture and mineralogy.

Weathering processes produce many varied observable and measurable soil characteristics such as color, structure, texture and consistence. Color itself has little direct influence on the functioning of the soil, but a great deal can be inferred from color when considered with other observable features. Dark colors are the result of high organic matter content and indicate relatively high fertility. Reddish colors are the result of hydrated iron oxide and are associated with good drainage and well-aerated soils. Shades of gray, brown or yellow, in a mottled arrangement, are associated with soils of poor drainage. Soils with light gray colors are lacking in organic matter, indicating low fertility. Soil colors that result from soil development must not be confused with colors inherited from the parent material.

Soil structure (the way soil particles aggregate) is important because it influences the movement of water and air and the workability and tilth of cultivated soils. Other physical characteristics such as texture, moisture content and chemical characteristics, help determine the type of structure in any given soil. Soil consistence (the ability of a soil to resist structural breakdown) is important because it relates to various management practices.

These, and other features (clay films, concretions, carbonates, salts, reaction, coarse fragments, roots and pores) of the soil profile can be observed and measured, both quantitatively and qualitatively, and form a record of the kind and degree of weathering that has occurred. Thus, soils can be divided horizontally into horizons based on the fact that weathering becomes less pronounced with depth. This is referred to as the soil profile and is the basis of the soil classification system. Figure 17 depicts the major horizons into which a soil profile can be divided.

## Soil classification

Soil classification is the orderly arrangement (or grouping) of soil characteristics according to the processes involved in their formation as displayed by the soil profile. In the soil survey of the County of Flagstaff soils were classified according to the guidelines established by the Canadian System of Soil Classification (Canada Soil Survey Committee, 1987).

The major identifying characteristics of the six soil orders mapped in the county are listed below.

**Chernozemic Order**
- has dark, organic matter rich surface horizons
- has a C:N ratio of less than 17 in the A horizon
- has a high base saturation in the A horizon
- calcium is the dominant exchangeable cation
- has a brownish solum
- all horizons are relatively friable
- is well to imperfectly drained
- has developed under spear, grama and wheat grass
- the mean annual soil temperature is between $0^{o}C$ and $8^{o}C$

**Solonetzic Order**
- has a hard and impermeable B horizon
- has strong columnar or prismatic structure in the B horizon
- has dark coatings on peds in the B horizon
- has an exchangeable Ca:Na ratio of 10 or less in the B horizon
- usually has a neutral to acid A horizon
- is associated with saline parent materials high in sodium salts
- has moderate to imperfect drainage
- has developed under grama-wheat grass

**Regosolic Order**
- has weak or no profile development
- has no structural development
- is rapidly to imperfectly drained
- has a variable vegetative cover

**Gleysolic Order**
- occupies depressional position in landscape
- has dull soil colors and mottling indicative of gleying
- soil horizons are often indistinct
- has hydrophytic vegetation

**Organic Order**
- occupies depressional positions in landscape with very restricted drainage and permanently high water table

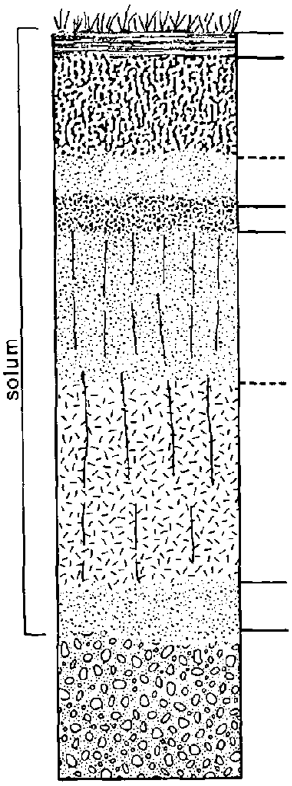



**Figure 17.** Diagram of a soil profile.

- has accumulations of organic material more than 40 cm thick
- organic materials contain 17 percent or more organic carbon by weight (30 percent organic matter)
- has hydrophytic vegetation

**Luvisolic Order**
- has a well developed textural B horizon characterized by increased clay content relative to overlying horizons and visible clay skins
- has Bt horizon with moderate to strong prismatic or blocky structure
- has whitish to grayish platy eluvial A horizon leached of clays and nutrients
- is well to imperfectly drained
- has an exchangeable Ca:Na ratio greater than 10 in the B horizon
- has developed under dominantly forest vegetation

## General soil distribution

Soils belonging to six of the Orders in the Canadian System of Soil Classification (Canada Soil Survey Committee, 1978) occur within the County of Flagstaff (table 7). They have developed on a variety of parent materials and landscapes, but are mainly found on gently undulating to hummocky till or undulating to ridged glaciofluvial sands. They occur in complex association with one another but broad general patterns of distribution can be recognized.

Approximately 10 soil series in the county belong to the Chernozemic order and have developed on moderately fine textured till. Black Chernozemic soils occupy the northern three-quarters of the county and

**Table 7.** Extent of selected groupings of soils in the County of Flagstaff

| Soil order | Group | Hectares | % of total |
|---|---|---|---|
| Chernozemic | Black (Orthic and Gleyed) | 185 805 | 45.6 |
| | Black (Solonetzic) | 47 651 | 11.7 |
| | Dark Brown (Orthic and Gleyed) | 22 744 | 5.6 |
| | Black (Solonetzic) | 3326 | 0.8 |
| Chernozemic total | | 259 526 | 63.7 |
| Solonetzic | Black (Solods and Solodized Solonetz) | 62 637 | 15.5 |
| | Dark Brown (Solods and Solodized Solonetz) | 4263 | 1.0 |
| Solonetzic total | | 66 900 | 16.5 |
| Gleysolic | Orthic Humic and Humic Luvic | 54 174 | 13.3 |
| | Solonetzic Humic | 5066 | 1.2 |
| Gleysolic total | | 59 240 | 14.5 |
| Regosolic | Orthic and Humic Regosols | 1720 | 0.4 |
| Organic | Typic and Terric Mesisol | 1726 | 0.4 |
| Undifferentiated | Water, Disturbed Land and Rough Broken | 18 449 | 4.5 |
| Total | | 407 561 | 100 |

Dark Brown soils the southern quarter. Chernozemic soils developed on coarse-textured glaciofluvial sands and gravels occupy large areas in the vicinity of Sedgewick, Hardisty and Flagstaff Hill.

Solonetzic soils and Chernozemic soils with weakly developed solonetzic features are extensive in distribution. These Solonetzic soils are rarely continuous in extent and occur as scattered patches intermixed with 'normal' Chernozemic soils. Solonetzic soils are found in the western third of the county with minor occurrences in the south-central and north-central regions.

Gleysolic soils develop in poorly drained depressions and drainage channels throughout the county. They form on moderately fine to fine textured recent lacustrine or fluvial materials and also occur on coarser-textured sands in areas of poor drainage. Many of the Gleysolic soils in the County of Flagstaff are slightly to strongly saline.

Luvisolic, Regosolic and Organic soils are found in a few scattered locations within the county. Luvisolic soils occur in wooded areas that have been under continuous tree cover. No extensive areas of Luvisolic soils were mapped, but individual profiles were encountered. Regosolic soils are associated with recent fluvial sediments on floodplains and stream channels. They also occur on well-sorted sands found in eolian areas near Hardisty and Sedgewick. Organic soils are found in one or two small areas in the Iron Creek drainage channel.

## Map symbols and legend

The purpose of soil mapping is to divide the landscape into units which differ from one another in some aspect, with particular attention being placed on soil and landscape features. These units, called map units, represent a portion of the area being mapped that is represented by a polygon or area on the soil map. The map unit is defined by the soil and landscape features that it represents. On the soils map, each map unit is identified by a map unit symbol.

The map unit symbols used in this soil survey have two major components, in a fraction format. The numerator represents the soil component and the denominator the landform component. Because all of the information gathered during the soil survey cannot be shown on the published map, a simplified map symbol is used to maintain map legibility and to refer to more detailed descriptive information in the soil map legend and soil report. All symbols are based on abbreviated codes used to identify dominant soil series.

Standard practice involves identification of soil series by names, derived from a named feature (town, post office, river, lake and so on) in the vicinity where a series is first identified. Each established series is given a unique three-letter symbol, for example HKR for the Halkirk series. When a soil area has been delineated and identified as being dominantly composed of soils belonging to the Halkirk series, that area is identified as a HKR area on the soil map. Similarly, all mapped soil areas are identified by their dominantly occurring series.

Because soil areas are never composed entirely of one series, some method is required to show variability within map units. Three general kinds of soil variability are depicted in the soil symbol and are essentially the same as those devised for the soil survey of the County of Warner (Kjearsgaard et al., 1984). These include:

1. A complex of two series. For such areas the soil unit symbol combines the first two letters of each of the two series symbols into a four letter symbol. A Halkirk-Torlea (HKR, TLA) area is identified by the HKTL symbol.
2. Areas with significant amounts of other kinds of soils. Units for such areas are designated by adding a different numeric suffix to the series symbol. The system allows for a controlled number of recognized variations. The suffix 1 is used for relatively pure units. Other numbers convey information about different combinations of included soils. The numbering scheme used for this survey is not consistent throughout the area. This is because existing legends for two adjacent areas were adapted for use in this survey and each of the existing legends used a slightly different numerical coding formula. The typical significance of numerical suffixes used in this survey is given below for the Dark Brown and thin Black soil zones.
   - a relatively pure unit; named dominant series occupy approximately 80 percent (HND1, HKTL1)
   - has significant amounts (15 to 40 percent) of Gleyed or Gleysolic soils and sloughs (HND2, HKTL2)
   - has significant amounts (15 to 40 percent) of saline and Gleysolic soils (typically mapped in minor stream courses in this survey) (HGT3, EOR3)
   - has significant amounts (20 to 40 percent) of Rego Calcareous or Eroded Chernozemic soils (HND4, EOR10)
   - has significant amounts (20 to 40 percent) of Solonetzic soils scattered throughout well-drained units (FST7, HER4)
   - has significant amounts (20 to 40 percent) of Solonetzic soils in addition to significant Gleyed or Gleysolic soils or standing water (FST9, HER5)
   - has significant amounts (20 to 40 percent) of coarse-textured soils; used in this survey to indicate the presence of significant amounts of coarse-textured, ice-contact materials (HND6, EOR6)
   - has significant amounts (15 to 30 percent)of Rego and/or Calcareous Chernozemic soils and significant amounts (15 to 30 percent) of Gleyed subgroups, Gleysolic soils and sloughs (EOR8)

3. Areas in which a certain soil phase of the dominant series is prevalent. In these units, the last letter of the series symbol is substituted with a colon and the appropriate phase symbol from the list below:
   • L - lithic phase symbol (for example HN:L 1/3)

Topographic characteristics are depicted in the denominator of the symbol by using the appropriate slope class number for the various slope classes.

This symbology has been adopted to enable correlation and information transfer among county level (level 3) soil surveys in Alberta. A wide variety of areas can be symbolized using this method. However, the number of combinations is purposely limited in order to maintain a controlled legend and to prevent unnecessary proliferation of map units with limited areal extent.

## Mapping procedures

Mapping was done using 1:31 680 scale black and white aerial photographs taken in 1983 and 1984. Initial stereoscopic examination of the photos was carried out in the office and followed by a general field reconnaissance. This was followed by more intensive photo interpretation and ground truthing. During mapping, all roads and trails in the county were traversed. Occasional traverses by foot were necessary to verify soil and landscape conditions in areas without vehicle access. Soils were examined to the 1 m depth using a shovel and hand auger. Soil inspections were done at an intensity of approximately one recorded observation per quarter section. Each recorded observation was supplemented by information obtained from several digs to determine the local distribution and variability of different soils at each inspection site.

As the survey progressed, soil and topography boundaries were determined along the lines of traverse and projected between them using landscape features and stereoscopic examination of aerial photographs. These boundaries were drawn on a field map consisting of an aerial photograph of the township, enlarged to a scale of approximately 1:30 000. Map delineations were identified with the appropriate map unit symbol. Each completed township map was compared, checked and correlated with those of adjoining townships.

Very little soil sampling was conducted for this survey. Most soil series and map units used in this survey had been adequately characterized by recent sampling in the adjacent counties of Paintearth and Beaver (see Wells and Nikiforuk, 1988 and Howitt, 1988).

When all field data had been gathered, checked and correlated, the soil boundaries and accompanying map unit symbols were transferred to 1:50 000 scale chronar topographic base maps. These in turn were digitized and the resulting digital files were used to produce the four final 1:50 000 scale soil maps, as well as various interpretive and replacement maps for the county. Finally, this soil survey report was compiled to summarize and describe the information collected about the soils of the County of Flagstaff.

## Soil and map unit descriptions

Each of the map units delineated on the accompanying soil maps is described in detail in appendix B. These descriptions include landscape features, diagnostic soil characteristics and distinguishing features of map units. Descriptions of miscellaneous landscape units, including Alluvium, Organic and Rough Broken units, are contained in this appendix. Descriptions are arranged in alphabetical order to correspond with their order in the map legend. Summary descriptions and selected laboratory analytical characteristics of some of the soils are given in appendix A of this report.

## Land systems and land units

The County of Flagstaff can be divided into a number of smaller areas each with a distinct physiography, geology, climate, vegetation and landscape. These subdivisions are referred to as land systems (Lacate, 1969). Land systems are further subdivided into soil landscape units called land units (Pettapiece, 1971) according to observed patterns of soil occurence. Eight major land systems, each containing two or more land units were defined for the county (figure 18). Boundaries for the land systems were based initially on the physiographic, ecologic and geologic units described previously. Boundaries for land units were chosen arbitrarily to allow for convenient grouping of observed soil and landscape patterns according to the mapped distribution of major soil units.

Over 100 individual soil units were defined for the County of Flagstaff (table 8). These detailed soil units form the basis for the soil legend for the County of Flagstaff which appears on the final 1:50 000 scale soil maps (see back pocket). The legend can be used to provide specific information about individual areas within the county. Detailed descriptions of the soil series and the soil map units are provided in appendices A and B. The soil landscape units (land systems and land units) provide a convenient framework for simplified description and discussion of the soils found in the County of Flagstaff.

**Land system 1**

Land system 1 occupies the Daysland Plain in the western third of the county. It is characterized by Black Chernozemic and Solonetzic soils developed on till on level to gently undulating topography. The maximum elevation is about 740 m and the minimum is 670 m. Local relief is less than 2 m and dominant slopes average 2 to 3 percent.

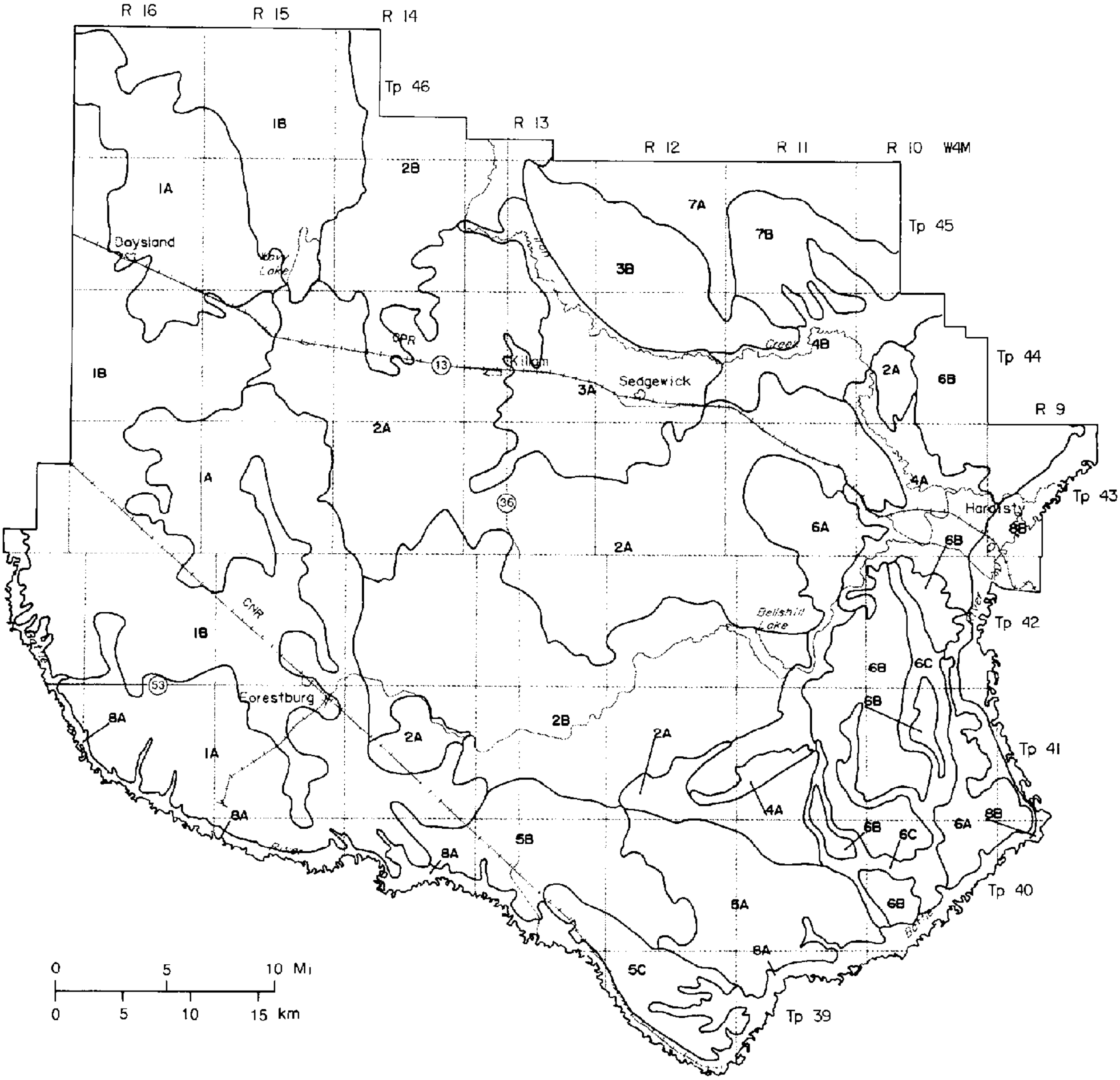



**Figure 18.** Distribution of land systems defined for the County of Flagstaff.

The underlying bedrock sediments belong to the Horseshoe Canyon Formation and consist of nonmarine shales, sandstones, bentonitic sandstones and coal beds. The overlying surficial sediments are moderately fine textured, slightly saline till. Depth to bedrock is shallow over most of the area. Drift thickness is about 1 to 10 m, except over buried bedrock channels where it can exceed 90 m.

The landscape is dotted with numerous small water bodies. Many of the water bodies are seasonal and disappear or decrease in size over the summer season, although a few of the larger water bodies persist throughout the year. The area has a deranged drainage pattern with numerous unconnected depressions and little evidence of stream incision or integrated drainage development.

The low relief, shallow depth to bedrock, and numerous unconnected depressions create favorable conditions for local groundwater recharge and for development of a high water table. The disappearance of surface water from small closed depressions and the reduction in size of larger depressions provide evidence that water table depths in depressional areas range from less than 1 m during the spring to 2 to 3 m in late summer.

The area is within the thin Black soil zone and agroclimatic zone 2H. Soils have black topsoil horizons 12 to 18 cm thick and are developed on medium-textured till. Most soils are well drained and belong to the Chernozemic or Solonetzic orders. Poorly drained Gleysolic soils occupy small depressions and disrupted

**Table 8.** Extent of soil units mapped in the County of Flagstaff

| Map unit | Size (hectares) | % of total area |
|---|---|---|
| AMIR1/3 | 528 | 0.1 |
| AMT1/3 | 1006 | 0.2 |
| AMT1/4 | 312 | 0.1 |
| AMT2/4 | 122 | .1 |
| AV2 | 2350 | 0.6 |
| AV7 | 1246 | 0.3 |
| BEAM2/2 | 3446 | 0.8 |
| BEL1/3 | 272 | .1 |
| BKF1/4 | 279 | .1 |
| CNN1/3 | 232 | .1 |
| CNOA2/2 | 1722 | 0.4 |
| DC:L1/3 | 584 | 0.1 |
| DSIR2/3 | 978 | 0.2 |
| DSJ1/2 | 559 | 0.1 |
| DUG1/2 | 86 | .1 |
| DUG2/2p | 185 | .1 |
| EOR1/3 | 30 760 | 7.6 |
| EOR1/4 | 10 647 | 2.6 |
| EOR1/5 | 21 | .1 |
| EOR2/3 | 38 907 | 9.5 |
| EOR2/4 | 6074 | 1.5 |
| EOR2/5 | 425 | 0.1 |
| EOR2/6 | 432 | 0.1 |
| EOR3/3 | 8242 | 2.0 |
| EOR6/3 | 895 | 0.2 |
| EOR6/4 | 1972 | 0.5 |
| EOR6/5 | 592 | 0.1 |
| EOR8/4 | 2514 | 0.6 |
| EOR8/5 | 7878 | 1.9 |
| EOR10/4 | 6982 | 1.7 |
| EOR10/5 | 7722 | 1.9 |
| EOR10/6 | 475 | 0.1 |
| EORO1/3 | 5776 | 1.4 |
| EORO1/4 | 1363 | 0.3 |
| EORO2/3 | 1325 | 0.3 |
| FMN1/2 | 542 | 0.1 |
| FST7/3 | 4633 | 1.1 |
| FST7/4 | 100 | .1 |
| FST9/3 | 2656 | 0.6 |
| HER4/3 | 47 603 | 11.7 |
| HER4/4 | 1764 | 0.4 |
| HER5/3 | 51 691 | 12.7 |
| HER5/4 | 1080 | 0.3 |
| HGFM1/2 | 17 274 | 4.2 |
| HGT1/2 | 3337 | 0.8 |
| HGT2/3 | 4240 | 1.0 |
| HGT3/3 | 10 623 | 2.6 |
| HKBF1/3 | 1200 | 0.3 |
| HKBF2/3 | 2022 | 0.5 |
| HKTL1/3 | 230 | .1 |
| HKTL1/4 | 50 | .1 |

**Table 8.** (continued)

| Map unit | Size (hectares) | % of total area |
|---|---|---|
| HND1/3 | 6380 | 1.6 |
| HND1/4 | 420 | 0.1 |
| HND2/3 | 6472 | 1.6 |
| HND2/4 | 186 | .1 |
| HND3/3 | 583 | 0.1 |
| HND4/4 | 310 | 0.1 |
| HND4/5 | 170 | .1 |
| HND6/3 | 435 | 0.1 |
| HND6/4 | 511 | 0.1 |
| HND6/5 | 102 | .1 |
| HNDC1/3 | 936 | 0.2 |
| HNDC1/4 | 131 | .1 |
| HNDC2/3 | 256 | .1 |
| HN:L1/3 | 398 | 0.1 |
| IRKN1/3 | 454 | 0.1 |
| IRRO1/3 | 5390 | 1.3 |
| IRRO1/4 | 630 | 0.1 |
| IRRO2/3 | 1245 | 0.3 |
| IRRO10/4 | 499 | 0.1 |
| KLM4/3 | 16 474 | 4.0 |
| KLM5/3 | 33 962 | 8.3 |
| KLM6/3 | 980 | 0.2 |
| KLM7/3 | 818 | 0.2 |
| KNA1/3 | 458 | 0.1 |
| KNA1/4 | 458 | 0.1 |
| KNIR2/3-4 | 89 | .1 |
| KPBL1/2 | 141 | .1 |
| MEDC1/3 | 326 | 0.1 |
| MESC1/3 | 169 | .1 |
| MEWW1/3 | 239 | .1 |
| MEWW1/4 | 73 | .1 |
| OAME1/3 | 468 | 0.1 |
| RB1 | 8901 | 2.2 |
| RB2 | 655 | 0.1 |
| RB4 | 2989 | 0.7 |
| RB5 | 1091 | 0.3 |
| REER1/3 | 743 | 0.2 |
| REER1/4 | 1153 | 0.3 |
| REER1/5-6 | 557 | 0.1 |
| REIR1/3 | 3283 | 0.8 |
| REIR1/4 | 1299 | 0.3 |
| REIR1/5 | 1209 | 0.3 |
| REIR1/6 | 150 | .1 |
| REIR2/3 | 636 | 0.1 |
| REIR2/4-5 | 112 | .1 |
| SUWE2/2 | 683 | 0.1 |
| TOA1/3 | 286 | .1 |
| ZDL | 1091 | 0.3 |
| ZOR | 1726 | 0.4 |
| ZZZ | 3722 | 0.9 |
| **Total** | 407 561 | 100 |

drainage channels. A large proportion of the Gleysolic soils in permanently wet depressions are slightly to strongly saline. Small, temporarily wet depressions are occupied by nonsaline Humic Luvic Gleysols.

Land system 1 is subdivided into two land units based on dominant soil characteristics and classification.

*Land unit 1A*

Land unit 1A is dominated by Chernozemic soils that exhibit either weak or no solonetzic development. Heisler and Elnora series are the principal soils in this area.

Heisler is classified as a Solonetzic Black Chernozemic developed on moderately fine textured till. It is well drained and has 10 to 20 cm of black topsoil. In dry years, subsoil salinity and the moderately strong solonetzic hardpan developed in the subsoil (Bnjt horizon) can restrict root penetration and limit moisture reserves available to growing crops. This results in a patchy or wavy pattern of crop growth in dry years.

Elnora is classified as an Orthic Black Chernozemic soil developed on the same moderately fine textured till as Heisler. The till is less saline than in Heisler soils. In many cases, Elnora soils are associated with better surface and internal drainage than Heisler soils and with greater thickness of till sediments over bedrock. Elnora soils are well drained, have 10 to 20 cm of black topsoil and do not have any development of a subsurface solonetzic hardpan (Bnt). These soils permit deeper root penetration and provide a better moisture reserve than Heisler soils during periods of drought. Crop growth on these soils is better than on adjacent Solonetzic soils.

A number of map units dominated by Heisler (HER) and Elnora (EOR) soils are defined for this area. These map units reflect changes in topography, drainage and inclusions of other minor soils. EOR1 and HER4 units are uniformly well drained and occupy higher landscape positions. EOR2 and HER5 units contain significant poorly drained soils and are found on lower landscape positions with pitted topography and numerous water-filled depressions. EOR3 units occupy drainage channels that contain a mixture of well to poorly drained soils. Haight (HGT) and Haight-Foreman (HGFM) map units identify very poor drainage and clayey soil conditions. Both these units may contain saline spots but Haight-Foreman units are saline while pure Haight units are nonsaline.

*Land unit 1B*

Land unit 1B is similar to 1A except that it is dominated by Solonetzic soils rather than by Chernozemic soils with weak solonetzic development. The higher percentage of Solonetzic soils is related to either shallower depth to bedrock or water table. Killam and Daysland series are the principal soils in the area, with lesser amounts of the Elnora, Heisler, Haight and Foreman series present.

Killam is classified as a Black Solodized Solonetz developed on moderately fine textured till. It differs from Elnora and Heisler by having much stronger development of solonetzic features. A prominent solonetzic hardpan (Bnt) is characteristic of this soil. The Bnt is characterized by having hard roundtops when dry. Killam soils have higher concentrations of subsoil salinity than either Elnora or Heisler and have thinner topsoil layers (Ah horizons). Killam soils develop on lower to upper slope positions. They are often cultivated and are subject to moisture stress in dry years and to retention of excess moisture in wet years. Killam soil occurs as scattered patches in association with other less Solonetzic soils. Investigation of patches of poorer growth in otherwise vigorous crops will reveal the dense hardpan horizon (characteristic of this soil) at about 15 to 25 cm.

Daysland is classified as a Black Solod developed on till. It displays solonetzic development transitional between the strong solonetzic features of Killam series and the weak features of Heisler series. The solonetzic hardpan has been subjected to some breakdown and is less firm and dense, and is found at greater depth (20 to 40 cm) than in Killam soils. Crop growth on Daysland soils is as vigorous as on Elnora or Heisler soils. Only in dry years is there a noticeable reduction in growth on Daysland soils compared to Elnora or Heisler soils.

The principal map units in this area are dominated by Killam (KLM) and Daysland (DYD) soils or poorly drained Haight (HGT) or Foreman (FMN) soils. KLM4 is dominated by well-drained Solonetzic soils while KLM5 contains a greater proportion of poorly drained soils and is mapped in lower and more pitted landscapes. HGT and HGFM map units occupy poorly drained depressions and disrupted drainage channels. Most of these poorly drained units display significant surface salinity. Crop growth in dry years can be less successful in this area than in land unit 1A.

**Land system 2**

Land system 2 occupies the Daysland Plain in a zone running north-south through the center of the county. It is characterized by Black Chernozemic soils with weak to no solonetzic features developed on nearly level to undulating till landscapes. Elevations range from 663 m to 701 m and local relief from 1 to 5 m. Slopes average from 2 to 5 percent but may reach 9 percent. Topography is more accentuated and slopes longer and steeper than in land system 1.

The underlying bedrock sediments belong to the Bearpaw Formation and consist of marine shales, sandstones and ironstones. The overlying surficial sediments are moderately fine textured, slightly saline till. Depth to bedrock is deeper over most of the area than in land system 1. Drift thickness is estimated at 5 to 15 m, except over buried bedrock channels where it can exceed 75 m.

Surface and subsurface drainage are better-developed in this land system than in land system 1. Stream incision and the presence of better-developed integrated drainage networks reflect the existence of stonger surface gradients and less resistent surficial materials or underlying bedrock than in land system 1. The landscape still contains many small water bodies, most of which are seasonal and disappear or at least decrease in size over the summer season.

Local groundwater recharge occurs in the many closed depressions, but the depth to water table in this land system is greater than in land system 1. This appears related to greater thicknesses of surficial materials overlying bedrock and to stronger slope gradients and greater surface runoff than in land system 1. The presence of surface water in small closed depressions provides evidence that the water table still occurs above the 1 m depth during the spring. The water table occurs at 2 to 5 m over most upland landscapes in the area.

The area is within the thin Black soil zone and agroclimatic zone 2H. Soils have black topsoil horizons from 12 to 18 cm thick and are developed on medium-textured till. Most soils are well drained and belong to the Chernozemic order. Some of the Chernozemic soils possess weak solonetzic features but there are few strongly developed Solonetzic soils compared to land system 1. Poorly drained Gleysolic soils occupy the many small depressions and disrupted drainage channels. A large proportion of the Gleysolic soils in permanently wet depressions are slightly to strongly saline. Small, temporarily wet depressions are occupied by nonsaline Humic Luvic Gleysols.

Land system 2 is subdivided into two land units based on dominant soil characteristics and classification.

*Land unit 2A*

Land unit 2A is dominated by Chernozemic soils that exhibit no solonetzic development. Elnora is the principal series in this area.

Elnora is classified as an Orthic Black Chernozemic soil developed on nonsaline moderately fine textured till. Elnora soils are associated with better surface and internal drainage than Heisler series and with greater thickness of till sediments over bedrock. Elnora soils are well drained, have at least 10 cm of black topsoil and do not have any development of a subsurface solonetzic hardpan (Bnt). These soils permit deeper root penetration and provide a better moisture reserve during periods of drought than Heisler soils. Crop growth on Elnora soil is better than on adjacent Solonetzic soils.

A limited number of map units dominated by Elnora (EOR) or Haight (HGT) soils are defined for this area. These map units reflect changes in topography and drainage. EOR1 units are well drained and occupy higher landscape positions. EOR2 and EOR3 units contain significant poorly drained soils and are found on lower landscape positions with pitted topography and numerous water-filled depressions. EOR10 units have observable topsoil erosion, and Elnora-Rosebank (EORO) units contain a discontinuous veneer of sandy materials. Haight (HGT) and Haight-Foreman (HGFM) map units indicate very poor drainage and clayey soil conditions. Both groups of Gleysolic units may contain saline spots, but Haight-Foreman units are saline while pure Haight units are nonsaline.

*Land unit 2B*

Land unit 2B is similar to 2A except that it is dominated by soils with weak to strong solonetzic features rather than Chernozemic soils with no solonetzic development. The higher percentage of Solonetzic soils are related to a shallower depth to bedrock or water table in this area. Heisler and Killam are the principal series in this area with lesser amounts of the Elnora, Daysland, Haight and Foreman series present.

Heisler is classified as a Solonetzic Black Chernozemic developed on moderately fine textured till. It is well drained and has 10 to 20 cm of black topsoil. In dry years, subsoil salinity and the moderately strong solonetzic hardpan developed in the subsoil (Bnjt horizon) can restrict root penetration and limit moisture reserves available to growing crops. This results in a patchy or wavy pattern of crop growth in dry years.

The principal map units in this area are dominated by Heisler (HER) and Killam (KLM) soils or poorly drained Haight (HGT) or Foreman (FMN) soils. HER4 and KLM4 are dominated by well to imperfectly drained soils with weak and strong solonetzic features respectively. HER5 and KLM5 contain a greater proportion of poorly drained soils and are often mapped in lower and more pitted landscapes. HGT and HGFM map units occupy poorly drained depressions and disrupted drainage channels. Most of these poorly drained units display surface salinity. Crop growth in dry years can be less successful in this area than in land units 2A or 1A.

**Land system 3**

Land system 3 occupies a portion of the Daysland Plain associated with the Iron Creek drainage basin and the Wainwright buried valley channel. It is characterized by thin Black sandy soils, a better-developed drainage system than found in land systems 1 or 2 and by undulating to gently rolling or ridged topography. Elevations range from 648 m to 693 m and local relief averages 3 to 5 m but can reach 30 m. Slopes are longer and smoother than in either of land systems 1 or 2 but dominant slope gradients still range from about 3 to 5 percent. Steeper slopes occur adjacent to drainage channels and in a few areas of sand dunes and glacially formed ridges.

The principal bedrock sediments underlying this area belong to the Belly River Formation. Erosion of overlying formations, during development of the Wainwright buried valley channel, exposed these underlying nonmarine sandstone, siltstone and mudstone layers. The buried valley contains accumulations of coarse-textured glaciofluvial sediments (sands and gravels) overlain by moderately fine textured non to slightly saline till. Moderately coarse textured glaciofluvial materials (sandy loams to loamy sands) are the dominant surficial deposits south of the present day Iron Creek channel. These sandy sediments range in thickness from less than 1 m to over 20 m and overlie till. North of the Iron Creek channel, the dominant surficial material is moderately fine textured till with little or no overlying coarser materials. Erosion and infilling of the Wainwright bedrock channel is responsible for the great depth to bedrock over this area.

Drift thickness ranges from more than 90 m over the deepest portions of the buried channel to about 15 m in the upland till areas farthest from the channel.

Surface drainage is dominated by Iron Creek and its tributaries. Stream development and integrated drainage dissect the landscape and result in fewer small, unconnected temporary water bodies than in land systems 1 or 2. Most surface water is associated with flowing streams or with larger, more permanent ponds and lakes located along drainage channels.

Land system 3 is recognized for the high quality and quantity of ground water extracted from the Wainwright buried valley aquifer. The water table is close to the surface within drainage channels but is otherwise relatively deep. Discharge of highly calcareous groundwater occurs in a few locations along the south bank of Iron Creek. Development of Organic soils in two locations near Sedgewick provides evidence for a permanently high water table in these areas.

Land system 3 is defined as being within the thin Black soil zone and agroclimatic zone 2H. Soils have black topsoil horizons from 12 to 18 cm thick and are developed on moderately coarse textured glaciofluvial materials or medium-textured till. Wind erosion is a common problem for the sandier-textured soils, many of which are eroded and have topsoil horizons less than 10 cm thick. The sandy soils are well to rapidly drained and may be droughty during prolonged dry periods. They are classified as Chernozemic soils except for a few sandy Solonetzic soils in a ridged and fluted area east of Sedgwick. Soils developed on till in this area are classified as Solonetzic Black Chernozemic. Depressional areas and drainage channels are occupied by Gleysolic, Organic and some Regosolic soils. Some of the finer-textured fluvial soils in stream channel floors are strongly saline.

Land system 3 is subdivided into two land units based mainly on differences in soil texture and classification.

*Land unit 3A*

Land unit 3A is dominated by moderately coarse textured Chernozemic soils developed on glaciofluvial sandy loam to loamy sand overlying till. These soils show no evidence of solonetzic profile development. Irma, Rosebank, Red Willow and Elnora are the principal series in this area.

Irma is classified as an Orthic Black Chernozemic soil developed on moderately coarse textured glaciofluvial materials more than 1 m thick. Irma ranges in texture from sandy loam to loamy sand and is weakly to noncalcareous. Till often underlies this soil at depths of 1 to 5 m. Irma soils are susceptible to wind erosion and have a limited water-retention capacity in dry years.

Rosebank is classified as an Orthic Black Chernozemic soil. It is similar to Irma but develops on a thinner veneer of moderately coarse textured glaciofluvial materials less than 1 m thick overlying till. It is less droughty than Irma soil in the spring as infiltrating moisture is held up when it encounters the underlying till contact. However, once the sandy veneer dries out, root penetration into the underlying till and extraction of moisture from the till may be hampered by the marked change in texture between the overlying and underlying materials. Rosebank and Irma are equally susceptible to wind erosion.

Red Willow is classified as an Orthic Black Chernozemic soil. It is similar to Irma, but develops on better-sorted, coarser-textured, glaciofluvial loamy sands to sands. In some locations, this better sorting can be linked with post glacial eolian dune formation. In this area, Red Willow soils always occur on deep sandy deposits more than 3 m thick. Red Willow series is very susceptible to wind erosion.

The principal map units in land unit 3A are dominated by Irma (IRM), Rosebank (ROS), Red Willow (RED) and Elnora (EOR) series. Different map units reflect changes in the depth and texture of the overlying sandy materials and in the extent of poorly drained soils. Elnora-Rosebank (EORO) units are used for areas with thin, discontinuous sandy loam veneers less than 1 m thick over till. Irma-Rosebank (IRRO) units depict areas with thicker veneers to blankets of sandy loam material averaging over 1 m thick. Red Willow-Irma (REIR) units are used for the areas with the deepest and most highly sorted sandy parent materials. For all of these groupings, 1 unit contains less than 15 percent poorly drained soils and 2 units contain a higher proportion of poorly drained soils (15 to 30 percent). Depressions and drainage channels are occupied by sandy units (DSJ1, DSIR2), silty units (AV2) and saline clayey units (AV7), all of which are dominantly poorly drained. Very poorly drained organic units (ZOR) are mapped in two locations.

*Land unit 3B*

Land unit 3B is dominated by moderately fine textured Chernozemic soils developed on weakly to nonsaline till. Most soils show evidence of weak solonetzic profile development. Heisler and Elnora are the principal series in this area.

Heisler (HER) and Elnora (EOR) series are both thin Black Chernozemic soils with weak and no solonetzic features respectively (see descriptions given previously for land systems 1 and 2 for more detail). HER4 and EOR1 are both well-drained units with long smooth slopes and few wet depressions (<15 percent). HER5 and EOR2 units are similar but occur on slightly more pitted topography and contain a higher proportion of poorly drained depressional soils (15 to 30 percent). HGT3 unit is mapped in wet clayey depressions and drainage channels.

**Land system 4**

Land system 4 occupies the eastern portion of the Iron Creek drainage basin within the Neutral Upland physiographic district. It is characterized by sandy Black soils on dissected, undulating to moderately rolling or ridged topography with incised drainage channels, and better-developed surface drainage than in land systems 1 or 2. Elevations range from 617 m to 686 m and local relief averages 5 to 10 m but can reach 30 m. Slopes are long and smooth with gradients from 3 to 5 percent. A few ridged and duned areas have steep slopes with gradients up to 15 percent.

The area is underlain by nonmarine sandstone, siltstone and mudstone bedrock belonging to the Belly River Formation. The bedrock has been deeply eroded during formation of the Wainwright buried valley channel and its tributaries. The buried valley is infilled with thick deposits of sand and gravel, and there is little surface exposure of any till that may overlie the main buried channel deposits. The dominant surficial materials are coarse to moderately coarse textured glaciofluvial sands to sandy loams. These sandy sediments range from less than 1 to over 20 m thick with some thicknesses of up to 30 m. The sediments are deeper and better sorted in the eastern portion of the area around Hardisty. Some of the sandy ridges in this area are stabilized sand dunes. Depth to bedrock exceeds 20 m in this land system except along the bedrock controlled escarpments that, in places, define its borders. Drift thickness ranges up to 90 m in the deepest portions of the buried channel and is seldom less than 15 m.

Surface drainage is dominated by Iron Creek and its tributaries. Stream development and integrated drainage dissect the landscape and result in fewer small, unconnected temporary water bodies than in land systems 1, 2, 5 or 6. Most surface water is associated with flowing streams or with larger, more permanent ponds and lakes strung out along the bottoms of meltwater channels.

Land system 4, like land system 3, benefits from high quality groundwater extracted from the Wainwright buried valley aquifer. The water table is close to the surface within drainage channels, but is otherwise relatively deep. Low-lying meltwater channel bottoms are sites for local groundwater discharge. Water sampling and vegetation observations confirm that most of the groundwater discharge into these areas is relatively nonsaline.

Land system 4 is defined as an extension of land system 3. Soils have black topsoil horizons from 10 to 15 cm thick and are developed on coarse to moderately coarse textured glaciofluvial materials. Wind erosion is a common problem for the sandier-textured soils. Many of these have been eroded and have topsoil horizons less than 10 cm thick. The sandy soils are well to rapidly drained and may be droughty during prolonged dry periods. They are classsified into the Chernozemic order except for some very sandy Regosolic dune soils that possess weak profile development and thin to absent surface topsoil horizons (Ah). A few soils developed on till in this area are classified as Black Chernozemic with no solonetzic features. Depressional areas and drainage channels are occupied by Gleysolic and some Regosolic soils. Some of the finer-textured alluvial soils in stream channel floors are strongly saline.

Land system 4 is subdivided into two land units based mainly on differences in depth and degree of sorting of glaciofluvial deposits.

*Land unit 4A*

Land unit 4A is dominated by coarse to moderately coarse textured Chernozemic and Regosolic soils developed on thick deposits of glaciofluvial sand to sandy loam. These soils show no evidence of solonetzic profile development. Red Willow, Edgerton, Irma and Rosebank are the principal series in this area.

Red Willow (RED) is classified as an Orthic Black Chernozemic soil developed on coarse-textured glaciofluvial materials more than 1 m thick. Red Willow ranges in texture from loamy sand to sand and is weakly to noncalcareous. Till is seldom encountered in association with this soil. Red Willow series is very susceptible to wind erosion and has a very limited water-retention capacity in dry years.

Edgerton (ERT) is classified as an Orthic Regosol. It is similar to Wainwright but displays much weaker profile development related to recent erosion and reworking by wind. It forms on well-sorted, coarse-textured, glaciofluvial sands to loamy sands. In this area, Edgerton soils occur on deep sandy deposits more than 3 m thick. Edgerton series is highly susceptible to wind erosion and has a low moisture-holding capacity.

Irma (IRM) is classified as an Orthic Black Chernozemic soil developed on moderately coarse textured glaciofluvial materials more than 1 m thick. It is the Black equivalent of Metisko series. Irma ranges in texture from sandy loam to loamy sand and is weakly to noncalcareous. Till often underlies this soil at depths of 1 to 5 m. Irma series is susceptible to wind erosion and has a limited water-retention capacity in dry years.

Rosebank (ROS) is classified as an Orthic Black Chernozemic soil. It is the Black equivalent of Dolcy series. It is very similar to Irma but has developed on a thinner veneer of moderately coarse textured glaciofluvial materials less than 1 m thick overlying till. It is less droughty than Irma soil in the spring because infiltrating moisture is held up when it encounters the underlying till contact. However, once the sandy veneer dries out, root penetration into the underlying till and extraction of moisture from the till may be hampered by the marked change in texture between the overlying and underlying materials. Rosebank and Irma are equally susceptible to wind erosion.

The principal map units in land system 4A are dominated by the four series described above. Different map units reflect changes in the depth and texture of the overlying sandy materials and in the extent of poorly drained soils. Elnora-Rosebank (EORO) units are used for areas with thin, discontinuous sandy loam veneers less than 1 m thick over till and Irma-Rosebank (IRRO) units depict areas with thicker veneers to blankets of sandy loam material averaging over 1 m thick. Red Willow-Irma (REIR) and Red Willow-Edgerton (REER) units are used for areas with progressively deeper and more highly sorted sandy parent materials. For all of these groupings, 1 unit contains less than 15 percent poorly drained soils and 2 units contain a higher proportion of poorly drained soils (15 to 30 percent). Depressions and drainage channels are occupied by poorly drained silty alluvial units (AV2) and by some clayey saline units (HGFM1). A very poorly drained organic unit (ZOR) is mapped in one location.

*Land unit 4B*

Land unit 4B is similar to land unit 4A, except that it contains a wider variety of coarse-textured soils with a wider range of textures and modes of deposition. This area is dominated by moderately to very-coarse-textured Black Chernozemic soils developed on glaciofluvial materials ranging in texture from sandy loam to gravel and overlying till. The soils show no evidence of solonetzic profile development. Amity (AMT) and Kinsella (KNA) are the principal series in this area, in addition to the previously mentioned Rosebank (ROS), Irma (IRM), Red Willow (RED) and Elnora (EOR).

Amity (AMT) is classified as an Orthic Black Chernozemic soil developed on medium-textured fluvial or glaciolacustrine material less than 1 m thick overlying poorly sorted, coarse- to very-coarse-textured ice-contact sand and gravel. Amity has a loamy surface veneer up to 1 m thick overlying sand or gravel. This soil can be very stony and droughty.

Kinsella (KNA) is classified as an Orthic Black Chernozemic soil developed on poorly sorted, very-coarse-textured ice-contact sands and gravels. It is very stony and droughty.

A wide variety of map units occur in this small area. All units have in common some amount of coarser-textured parent material but the degree of sorting and depth of coarse material over till varies widely. Elnora-Rosebank units (EORO1) are mapped in well to rapidly drained areas having only a thin veneer of sandy loam to loamy sand overlying till. AMT1 unit is used for well to rapidly drained areas with a loamy surface veneer overlying sand or gravel. AMT2 areas are similar to AMT1 but contain a higher proportion of poorly drained soils. REIR1 units are mapped in well-drained areas with deeper, better-sorted sandy deposits than any of the above mentioned units. AV2 and AV7 units are mapped in poorly drained floodplains and stream channels.

**Land system 5**

Land system 5 occupies the southern portion of the Daysland Plain in a zone running east from Galahad through Battle Bend. It is characterized by Dark Brown Chernozemic soils with weak to no solonetzic features developed on very gently undulating to gently rolling till topography. Elevations range from 663 to 739 m and local relief from 2 to 5 m, with a maximum of 40 m along drainageways. Slopes average 2 to 5 percent but reach 9 percent on stronger topography. Topography is more accentuated, and slopes longer and steeper than in land systems 1 or 2.

The underlying bedrock sediments belong to the Bearpaw Formation and consist of marine shales, sandstones and ironstones. The overlying surficial sediments are moderately fine textured, slightly to nonsaline till. Depth to bedrock is deeper over most of the area than in land systems 1 or 2. Drift thickness is estimated to be 5 to 15 m except in the south adjacent to the Battle River valley where scouring has reduced the depth to bedrock to less than 1 m.

Surface and subsurface drainage is similar to land system 2 and is better developed than in land system 1. Stream incision and the presence of better-developed integrated drainage networks decrease the number of small undrained depressions relative to land systems 1 and 2. Solonetzic portions of the land system still contain many small seasonal water bodies, but overall this area has smoother topography and fewer depressions.

The depth to water table in this land system is greater than in land system 1. This is related to the elevation of the landscape over broad bedrock highs. Surface runoff and groundwater recharge remove water from the upland areas on the bedrock highs into lower-lying areas coinciding with locations of buried meltwater channels. The water table is therefore deeper than 3 to 5 m over most upland portions of this land system and is found at about 1 to 3 m in lower-lying areas. The presence of surface water in small closed depressions in lower-lying areas provides evidence that the water table in depressional areas still occurs above 1 m depth, at least during the spring.

The area is defined as occurring within the Dark Brown soil zone and agroclimatic zone 2A. It is the logical extension of land system 2 into the Dark Brown zone. Soils have dark brown topsoil horizons from 10 to 15 cm thick and are developed on medium-textured till. Most soils are well drained and belong to the Chernozemic order. Some of the Chernozemic soils in this land system possess weak solonetzic features. There are a few strongly developed Solonetzic soils. Poorly drained Gleysolic soils occupy depressions and disrupted drainage channels. A large proportion of the Gleysolic soils in permanently wet depressions are slightly to strongly saline. Small, temporarily wet depressions are occupied by nonsaline Humic Luvic Gleysols.

Land system 5 is subdivided into three land units based on soil characteristics and classification.

*Land unit 5A*

Land unit 5A is dominated by well-drained Dark Brown Chernozemic soils that exhibit no solonetzic development. Hughenden (HND) is the principal series in this area.

Hughenden is classified as an Orthic Dark Brown Chernozemic soil developed on moderately fine textured till. The till has few indications of salinity. Hughenden is the Dark Brown equivalent of Elnora series. Hughenden soils are associated with better surface and internal drainage than Flagstaff series and with greater depth to water table or thickness of till sediments over bedrock. Hughenden soils are well drained, have at least 10 cm of dark brown topsoil and do not have any significant development of a subsurface solonetzic hardpan (Bnt). These soils permit deeper root penetration and provide a better moisture reserve during periods of drought than Flagstaff (FST), Halkirk (HKR) or Brownfield (BFD) soils. Crop growth on Hughenden soil is better than on adjacent Solo- netzic soils.

A limited number of map units dominated by Hughenden (HND) soils are defined for this area. These map units reflect changes in topography and drainage. HND1 units are uniformly well drained and occupy higher landscape positions. HND2 and HND3 units contain significant poorly drained soils and are found in drainage channels or low-lying portions of the landscape with numerous water-filled depressions. HND4 units occur on steeper topography and have observable topsoil erosion. Hughenden-Dolcy units (HNDC1) contain a discontinuous veneer of sandy materials and HND6 units contain patches of coarse-textured ice-contact materials. Haight (HGT) map units indicate poor drainage and clayey soil conditions but are nonsaline in this area.

*Land unit 5B*

Land unit 5B is similar to 5A except that it is dominated by soils with more strongly developed solonetzic features rather than by Chernozemic soils with no solonetzic development. The higher percentage of Solonetzic soils is related to a shallower depth to water table in this portion of land system 5. Flagstaff (FST), Halkirk (HKR) and Brownfield (BFD) are the principal series in this area with lesser amounts of the Hughenden, Haight and Foreman series discussed previously.

Flagstaff is classified as a Solonetzic Dark Brown Chernozemic developed on moderately fine textured till. It is well drained and has at least 10 cm of dark brown topsoil, so is a good agricultural soil under most conditions. In dry years, however, subsoil salinity and the moderately strong solonetzic hardpan developed in the lower subsoil (Btnj horizon) can restrict root penetration and limit moisture reserves available to growing crops at critical periods. This results in a patchy or wavy crop pattern in dry years when moisture stress in these soils stunts crop growth.

Halkirk is classified as a Dark Brown Solodized Solonetz developed on the same moderately fine textured till as Hughenden and Flagstaff. It differs from these by having much stronger development of solonetzic features. A very prominent solonetzic hardpan is characteristic of this soil. This forms dense hard roundtops when dry and sticky gumbo when wet. Halkirk soils have much higher concentrations of subsoil salinity than either Hughenden or Flagstaff and have thinner topsoil layers (Ah horizons). Halkirk soils develop on lower to upper-slope positions. They are often cultivated, but are subject to severe moisture stress in dry years and to retention of excess moisture in wet years. Halkirk soils occur as scattered patches in association with other less Solonetzic soils. Investigation of patches of poorer growth in otherwise vigorous crops will often reveal the dense hardpan horizon at about 15 to 25 cm that is characteristic of this soil.

Brownfield is classified as a Dark Brown Solod developed on till. It displays solonetzic development transitional between the strong solonetzic features of Halkirk series and the weaker features of Flagstaff series. The solonetzic hardpan has been subjected to some breakdown and is less firm and dense and is found at greater depth in the soil (20 to 40 cm) than in Halkirk soils. Crop growth on Brownfield soils is often as vigorous as on Hughenden or Flagstaff soils. Only in very dry years is there a reduction in growth on Brownfield soils compared to Hughenden or Halkirk soils.

The principal map units in this area are dominated by Flagstaff (FST), Halkirk (HKR) and Brownfield (BFD) soils or poorly drained Haight (HGT) or Foreman (FMN) soils. FST7 and HKBF1 are dominated by well to imperfectly drained soils with weak and strong solonetzic features respectively. FST9 and HKBF2 contain a greater proportion of poorly drained soils and are mapped in lower and more pitted landscapes. Haight (HGT) and Haight-Foreman (HGFM) map units occupy the most poorly drained depressions and disrupted drainage channels. Most of these poorly drained units display significant surface salinity. Crop growth in dry years can be less successful in this area than in land systems 5A, 2A or 1A.

*Land unit 5C*

Land unit 5C differs from 5A and from most of the other land units described for the county. It is included in land system 5 because of similarities in climate, soil zone and bedrock type rather than similarities in soil characteristics. It is dominated by Dark Brown Chernozemic soils developed on shallow deposits of sand, till or lacustrine overlying weathered bedrock. The area was scoured by running water during the early stage of development of the Battle River, removing most of the surficial materials and leaving behind a variety of lag type deposits. These deposits vary in texture from clay loam through loam to sandy loam. All are less than 1 m thick above bedrock. Shallow and lithic variants of Flagstaff, Halkirk, Brownfield, Hughenden, Metisko, Dolcy, Oasis and Coronation series occur in this area. These various soils are described elsewhere in this report.

A wide variety of map units are used to describe this area. Detailed descriptions of the various map units are included in appendix B and are not repeated here. The common feature of all map units is the relatively shallow depth to bedrock. Soils range from Dark Brown Solonetz near Alliance to Dark Brown Chernozems near Battle Bend. Parent material textures range from silty clay (HGT1) to loamy sand (MEWW1). Most of the map units are well drained but shallow depth to bedrock and either light textures or solonetzic features can limit moisture storage and availability. Several of the map units have high surface stoniness.

**Land system 6**

Land system 6 coincides with the Neutral Upland physiographic district occupying the eastern quarter of the county. It is characterized by Black Chernozemic soils with no solonetzic features developed on till on gently to strongly sloping, rolling to hummocky topography. Numerous meltwater scour channels dissect the landscape and give rise to much of the topographic expression. Elevations range from 655 m to 792 m and local relief from 5 to 40 m. Slopes average from 5 to 9 percent but reach 30 percent on stronger topography. Topography is more accentuated and slopes longer and steeper than in all other county land systems except land system 7.

The underlying bedrock sediments belong to the Belly River Formation and consist of nonmarine sandstones, siltstones and mudstones. The overlying surficial sediments are moderately fine-textured, slightly to nonsaline till. Glacial scour channels create a varied bedrock topography with considerable relief. Depth to bedrock is greater than 2 m, except along steep scour channel escarpments. Drift thickness is estimated to be 5 to 15 m except in the hummocky terrain in the southeast where it exceeds 75 m.

Surface and subsurface drainage are better developed than in all other county land systems. The numerous meltwater scour channels promote stream incision and the development of integrated drainage networks. This decreases the number of small undrained depressions relative to other land systems.

The depth to water table in this land system is estimated to be greater than 3 to 10 m in upland areas and less than 1 m in scour channels. This is related to the elevation of the landscape over broad bedrock highs. Surface runoff and groundwater recharge remove water from the upland areas on the bedrock highs into lower-lying areas coinciding with locations of glacial meltwater channels.

The area occurs within the Black soil zone and agroclimatic zone 2H. Soils have black topsoil horizons (Ap) 10 to 15 cm thick and are developed on medium-textured till. Most soils are well drained and belong to the Chernozemic order. Very few of the Chernozemic soils in this land system display weak solonetzic features and there are no strongly developed Solonetzic soils. Poorly drained Gleysolic soils occupy depressions in the meltwater scour channels. Gleysolic soils in permanently wet depressions are slightly but not strongly saline.

Land system 6 is subdivided into three land units based on landform characteristics and thickness of till surficial sediments.

*Land unit 6A*

Land unit 6A is similar to 6B except that it is associated with gently to strongly sloping hummocky topography and surficial deposits of till up to 75 m thick. There are no scour channels and drainage is disrupted rather than integrated. There are many more small unconnected water-filled depressions than in land system 6B. Elnora (EOR) is the principal series in this area.

The principal map units in this area are dominated by Elnora (EOR) soils. EOR1 is a well-drained unit with less than 15 percent poorly drained soils. It is mapped in upland areas with longer smoother slopes than EOR2 units which contain more than 15 percent poorly drained soils and occur on more hummocky or pitted topography. EOR10 unit is similar to EOR1 but contains more eroded and thin profiles and occurs on steeper topography. EOR8 is the same as EOR10 but contains more than 15 percent poorly drained soils.

*Land unit 6B*

Land system 6B is dominated by well-drained Black Chernozemic soils with no solonetzic development that occur on broad very gently to gently sloping, rolling bedrock uplands. Elnora is the principal series in this area (for description see land system 1).

A number of map units dominated by Elnora (EOR) soils are defined for this area. These map units reflect changes in topography and drainage. EOR1 units are uniformly well drained and occupy higher landscape positions. EOR2 and EOR3 units contain poorly drained soils and are found in drainage channels or low-lying portions of the landscape with numerous water-filled depressions. EOR10 units occur on steeper topography and have observable topsoil erosion. Elnora-Rosebank units (EORO1) contain a discontinuous veneer of sandy materials, and EOR6 units contain patches of coarse-textured ice-contact materials. Haight (HGT) map units indicate poor drainage and clayey soil conditions but are nonsaline in this area.

*Land unit 6C*

Land unit 6C delineates areas dominated by deeply incised meltwater scour channels cut into Belly River bedrock and infilled with till. The land unit contains a mixture of well to imperfectly drained Black Chernozemics on channel escarpments and upper slopes and poorly drained Gleysols along the channel bottoms. Elnora (EOR), Haight (HGT) and Foreman (FMN) are the principal series in this area.

A variety of map units dominated by Elnora (EOR) and Haight (HGT) soils occur in this area. Steeply sloping valley sides are occupied by eroded EOR10 units and less steeply sloping upper slopes by well-drained EOR1 units. Extensive portions of channel bottoms are occupied by a mixture of well to poorly drained soils developed on slightly to moderately hummocky till. EOR2 units are dominantly well drained and contain 15 to 30 percent Gleysols. EOR3 units are less well drained and contain 30 to 50 percent Gleysols. Lower, more level, portions of channel bottoms are occupied by map units dominated by strongly saline Haight-Foreman (HGFM) or less saline Haight (HGT) units. Open water is found in a number of permanent lakes and ponds along meltwater channels.

**Land system 7**

Land system 7 coincides with the Viking Upland physiographic district occupying the north-eastern corner of the county. It is characterized by thin Black Chernozemic soils with no solonetzic features developed on till on gently to strongly sloping, hummocky to rolling topography. A few major glacial scour channels dissect the landscape and give rise to much of the topographic expression. Elevations range from 678 m to 739 m and local relief from 5 to 30 m. Slopes average from 9 to 15 percent, but reach 30 percent on stronger topography. Topography is more accentuated and slopes steeper than in all other county land systems.

The underlying bedrock sediments belong to the Belly River Formation and consist of nonmarine sandstones, siltstones and mudstones. The overlying surficial sediments are moderately fine textured, slightly to nonsaline till. Glacial scour channels create a varied bedrock topography with considerable relief. Depth to bedrock is seldom less than 15 m except along some steep scour channel escarpments. Drift thickness in areas of hummocky terrain is estimated to be 15 to 25 m, except along meltwater channel escarpments where it may be less than 2 m.

Surface and subsurface drainage is varied. Most of the area is dominated by hummocky topography and has disrupted surface drainage with numerous water-filled depressions. Several deep scour channels in the southeast portion of the land system drain into Iron Creek and produce a more integrated drainage with fewer unconnected depressions. Groundwater recharge takes place in the numerous closed depressions and there is little evidence of any groundwater discharge locally. The depth to water table in this land system is estimated to be 3 to 10 m in upland areas and less than 1 m in scour channels.

The area defined occurs within the thin Black soil zone and agroclimatic zone 2H. Soils have thin black topsoil horizons from 10 to 15 cm thick and are developed on medium-textured till. Most soils are well drained and belong to the Chernozemic order. Very few of the Chernozemic soils in this land system display any solonetzic features. There are no strongly developed Solonetzic soils. Poorly drained Gleysolic soils occupy closed depressions and meltwater channel floors. Gleysolic soils in permanently wet depressions are not saline.

Land system 7 is subdivided into two land units based primarily on landform characteristics and thickness of till surficial sediments.

*Land unit 7A*

Land unit 7A is similar to 6A except that it is associated with thin Black soils on the Viking Upland rather than Black soils on the Neutral Upland. It is characterized by gently to strongly sloping hummocky topography and surficial deposits of till up to 25 m thick. There are no scour channels and drainage is disrupted rather than integrated. There are many more small unconnected water-filled depressions than in land system 7B. Elnora (EOR) is the principal series in this area.

The principal map units in this area are dominated by Elnora (EOR) soils. EOR1 is a well-drained unit with less than 15 percent poorly drained soils. It is mapped in upland areas with fewer depressions than EOR2 unit which contains more than 15 percent poorly drained soils and occurs on hummocky or pitted topography. EOR10 and EOR8 are similar to EOR1 and EOR2 respectively but contain more than 15 percent thin or eroded soils and occur on steeper hummocky topography.

*Land unit 7B*

Land unit 7B is dominated by well-drained thin Black Chernozemic soils with no solonetzic development that occur on broad very gently to gently sloping, rolling bedrock uplands dissected by deep glacial meltwater channels. Elnora is the principal series in this area (for description of Elnora see land system 2A).

A number of map units dominated by Elnora (EOR) soils are defined for this area. These map units reflect changes in topography and drainage. EOR1 units are uniformly well drained and occupy higher landscape positions with smoother, less pitted topography. EOR2 units contain significant poorly drained soils and are found in drainage channels or low-lying portions of the landscape with numerous water-filled depressions. EOR4 units occur on steeper topography and have observable topsoil erosion.

**Land system 8**

Land system 8 is used to describe the Battle River valley where it borders the south and east boundaries of the county. It is characterized by a variety of thin Black, Dark Brown and undifferentiated soils that develop either on steep river valley escarpments or very gently sloping to nearly level terraces and flood plains.

Elevations range from a high of 701 m at the top of the Battle River escarpment in the western corner of the county to a low of 632 m in the northeast where the Battle River exits the county. Local relief as great as 120 m occurs along the length of the valley. Escarpment slopes range from 16 to 60 percent. Slopes range from 3 to 9 percent on aprons and fans along the valley sides, to 1 to 2 percent on the floodplain.

Bedrock exposed along the length of the valley includes marine and nonmarine shales, sandstones, siltstones and mudstones. Several seams and beds of coal are exposed in outcrops of the Horseshoe Canyon Formation south of Forestburg. Depth to bedrock varies but is less than 1 m on the steepest portions of the escarpments. The surficial deposits on the Battle River floodplain, aprons and fans are loamy fluvial sediments. Other materials found in this unit include till, colluvium and sandy glaciofluvial.

Surface drainage into the valley is extremely rapid and precludes any subsurface infiltration. Subsurface seepage of groundwater occurs at the contact between the bedrock and the overlying sandy glaciofluvial sediments. This seepage produces flowing springs about a third of the way down the escarpment in several locations. The area is dominated by strongly to very strongly sloping inclined topography. Gully erosion has created numerous v-shaped, steep-sided ravines and gullies that extend back from the main valley for distances of 2 to 6 km. The water table depth along the valley floor is consistently less than 2 m. Along the escarpment it is more than 5 m, except in seepage and discharge locations.

The valley traverses both the thin Black and Dark Brown soil zones and agroclimatic zones 2H and 2A. There is little point in subdividing the land system on the basis of soil zone since most of the soils mapped in the valley are azonal. Soils on the steep slopes have thin to absent black to dark brown topsoil horizons from 5 to 15 cm and are developed on medium-textured till or a mixture of till and weathered bedrock. These soils are rapidly drained and belong to the Chernozemic or Regosolic orders. A large number of the soils formed in slopewash at the base of escarpments contain high concentrations of sodic materials and display strongly developed solonetzic features. Soils formed in alluvial and fluvial materials on the floodplain typically display no solonetzic features, but display multiple depositional layering and weak horizon development associated with Regosolic soils. Poorly drained Gleysolic soils are rare except within the active drainage channel.

Land system 8 is subdivided into two land units based primarily on landform characteristics and texture of the dominant surficial sediments.

*Land unit 8A*

Land system 8A describes the steep and narrow portion of the Battle River valley from where it enters the county in the west to where it turns north at about Tp 40 Rg 9 along the eastern side of the county. It is characterized by steeply sloping Chernozemic and Regosolic soils developed on till or a mixture of till and weathered bedrock. The valley bottom contains only a narrow floodplain occupied by medium-textured fluvial soils overlying coarser-textured glaciofluvial sandy loam to loamy sand. Upper portions of the escarpments develop in till sediments and are characterized by deep straight gully development and by longitudinal slumping. Slumping in the till produces a series of discrete steps with alternating steep slopes and narrow benches. Stepwise slumping stops at the contact with the underlying bedrock and is replaced by the development of steeply sloping bedrock exposures. Material eroded from the bedrock exposures and overlying till accumulates at the base of these bedrock cliffs in a series of narrow fans and aprons. This material is quite sodic and forms soils with strong Solonetzic features.

Undifferentiated Rough Broken (RB) units dominate this land system. RB1 unit describes areas of thin, well to rapidly drained Chernozemic soils developed on till or other medium-textured surficial materials. RB2 is used in steeply sloping areas with thin till cover and more than 10 percent bedrock exposures. RB4 units apply to well to rapidly drained soils formed in steep sided V-shaped gullies cut into till and other surficial materials. RB5 units describe areas of mixed till and bedrock characterized by stepwise slumping. Coronation-Oasis (CNOA2) unit is used to describe the alluvial floodplain soils characterized by loamy materials overlying coarser-textured sandy loams to loamy sands. Bigknife (BKF1) unit describes the sodic slopewash soils found at the base of some steep bedrock slopes.

*Land unit 8B*

Land unit 8B describes the broader and deeper eastern portion of the Battle River valley from where it turns north at about Tp 40 Rg 9 to where it exits the county in the northeast. It is characterized by a broader valley, up to 4 km wide, containing extensive deposits of coarse-textured parent materials ranging from sandy loams to gravels. Dark Brown Chernozemic and Regosolic soils developed on these glaciofluvial deposits dominate the land system. The escarpments bordering the valley are characterized by thin Dark Brown Chernozemic soils developed in (1 to 3 m thick) till.

Coarse-textured glaciofluvial soil units dominate this land system. Kinsella units (KNA1) are mapped in areas dominated by very-coarse-textured glaciofluvial gravels, while Metisko-Scollard (MESC1) units contain a mixture of coarse sand and gravel. Metisko-Wainwright (MEWW1) and Oasis-Metisko (OAME1) units identify areas dominated by sandy loam to loamy sand parent materials, but with increasingly extensive overlying loamy surface veneers. Metisko-Dolcy (MEDC1) units describe areas containing Dark Brown soils with a variable thickness veneer of sandy loam to loamy sand overlying till. Coronation-Oasis (CNOA2) unit is used for lower-lying floodplain areas containing a mixture of well and poorly drained soils formed on loamy alluvium overlying sandy loam to loamy sand parent materials.

# Part 3 - Interpretations for specific uses

## Capability for dryland (arable) agriculture

The Soil Capability for Agriculture (Canada Land Inventory, 1965) has been replaced with the Land Capability Classification for Arable Agriculture (Alberta Soils Advisory Committee, 1987). Ratings based on the new system are presented (table 9). The two systems are very similar in approach and final output, but differ somewhat in the interpretation of climate. Following is a brief description and comparison of the systems.

Both recognize seven classes which indicate increasing limitations for common arable crops:

Class 1 – no limitation
Class 2 – slight limitation
Class 3 – moderate limitation
Class 4 – severe limitation (marginal situation)
Class 5 – very severe limitation (annual cultivation using common practices not recommended)
Class 6 – extremely severe limitation
Class 7 – no capability for arable agriculture

Both recognize subclasses which indicate the kind of limitation. In the County of Flagstaff these are:

A – moisture limiting (climate)
D – undesirable structure, usually Solonetzic soils
E – erosion damage
H – heat limiting (climate)
M – lack of moisture-holding capacity
N – excessive salinity
P – excessive stoniness
R – shallow to bedrock
T – adverse topography
W – excessive wetness

The climate assessments differ in the County of Flagstaff in that the CLI (1965) rated all areas of greater than 90 frost-free days as class 1, whereas the Land Capability (1987) using growing degree days for the growing season, rates the County of Flagstaff as 2H – a slight limitation. The moisture component of both systems are similar with the Dark Brown soils rated as 2A – a slight limitation in each. Rating by the 1987 version allows for a separate assessment of each component with the final rating presented as a composite, or using the most limiting of the three. In this case, a single value is given based on the most limiting factor which in practice is very similar to the older CLI.

With specific reference to the County of Flagstaff, the following generalization can be made using the 1987 Land Capability System.

1. Most of the county is in agroclimatic zone 2H with the Dark Browns in the southeast in 2A. This indicates that the growing season is often not as long or as warm as might be desired. There is a slight limitation due to early frosts and an additional aridity limitation towards the south.
2. The east side of the county has some hilly land with topographic (T) limitations requiring special considerations for erosion management (4T, 5T). This area also has many sandy soils which are often droughty (3M, 4M, 5M), and which can present wind erosion problems. The lower ratings are reflected in the marked increase in pasture, mixed farms and numbers of cattle.
3. The west side of the county is dominated by Solonetzic soils with subsurface structure limitations (3D, 4D). Increased pasture is again associated with the marginal areas.
4. The central part of the county has few soil or topographic limitations and is mainly classes 2 and 3.
5. Most of the county had topography which results in many undrained depressions (sloughs). These are recognized by percentages of 4W, 5W or 6W, depending on the average degree of wetness.

## Suitability of soils for deep plowing

Deep plowing is shown to increase yields of crops on Solonetzic soils (Ballyntyne, 1983). This increase is attributed to the physical breakup of the Solonetzic hardpan.

The system for rating the suitability of soils for deep plowing (Wells, 1985) is based on two main assumptions:

1. that deep plowing of Solonetzic soils will give a greater yield increase than plowing non-Solonetzic soils;
2. other physical or chemical factors such as stoniness (p), slope (t), texture (x), drainage (w), depth to sodic bedrock (r) and percent of eroded pits (e) can also limit the feasibility of deep plowing.

Four classes are used to rate the degree to which soils are likely to be improved in terms of increased crop yields (Wells, 1985 and table 10). The classes are:

Suitable (S) – Deep plowing will give significant yield increases for dryland grain and oilseed crops. Areas rated suitable for deep plowing are dominantly (greater than 40 percent) Solonetzic with no or slight limitations.

Marginal (M) – Areas rated marginal are dominantly (greater than 40 percent) Solonetzic soils affected to some degree by one or more subclass limiting criteria or areas containing 20 to 40 percent Solonetzic soils with no or slight limitations.

Unsuitable (U) – Deep plowing will give reduced yields or may cause irreparable soil damage. Examples of areas unsuitable for deep plowing are complexes of poorly drained Solonetzic and Gleysolic soils where existing salinity problems will be aggravated and complexes of poorly to imperfectly drained Solonetzic soils on sandy or shallow to bedrock materials.

Not Solonetzic (N) – Areas containing minor amounts (less than 20 percent) of Solonetzic soils are rated as 'Not Solonetzic'. These areas are dominantly (greater than 80 percent) Chernozemic, Gleysolic and Regosolic.

**Table 9.** Capability ratings for dryland (arable) agriculture for the County of Flagstaff.

| Map unit | Agriculture rating | Map unit | Agriculture rating |
|---|---|---|---|
| AMIR1/3 | 2M:5/3M:5 | HKTL1/4 | 4DAT |
| AMT1/3 | 2M | HND1/3 | 3A-2A |
| AMT1/4 | 2MT | HND1/4 | 3AT |
| AMT2/4 | 3MT:7/4W:3 | HND2/3 | 3A:7/4W:3 |
| AV2 | 6I | HND2/4 | 3AT:7/5W:3 |
| AV7 | 5ID | HND3/3 | 3A:6/5W:4 |
| BEAM2/2 | 2A:6/4W:4 | HND4/4 | 3AT |
| BEL1/3 | 2A | HND4/5 | 4TA |
| BKF1/4 | 5ND | HND6/3 | 3M |
| CNN1/3 | 3A | HND6/4 | 3MT |
| CNOA2/2 | 3A:6/4W:4 | HND6/5 | 4TA |
| DC:L1/3 | 4MP | HNDC1/3 | 3M |
| DSIR2/3 | 5WN:7/3M:3 | HNDC1/4 | 3MT |
| DSJ1/3 | 5WN | HNDC2/3 | 3MT:6/4W:4 |
| DUG1/2 | 4DA | HN:L1/3 | 4AR |
| DUG2/2P | 4DA:7/5NW:3 | IRKN1/3 | 3M |
| EOR1/3 | 2A | IRRO1/3 | 3M |
| EOR1/4 | 2AT | IRRO1/4 | 3MT |
| EOR1/5 | 4TA | IRRO2/3 | 2M-3M:7/4W:3 |
| EOR2/3 | 2A:7/4W:3 | IRRO10/4 | 3MT |
| EOR2/4 | 2AT:7/4W:3 | KLM4/3 | 3D |
| EOR2/5 | 4TA:7/5W:3 | KLM5/3 | 3D:7/5WN:3 |
| EOR2/6 | 5TA:7/5W:3 | KLM6/3 | 4D |
| EOR3/3 | 2A:6/5W:4 | KLM7/3 | 4D:7/5WN:3 |
| EOR6/3 | 2A | KNA1/3 | 4M |
| EOR6/4 | 2AT | KNA1/4 | 4MT |
| EOR6/5 | 4TM | KNIR2/3-4 | 4MT |
| EOR8/4 | 3AT:7/5W:3 | KPBL1/2 | 2AD |
| EOR8/5 | 4TA:7/5W:3 | MEDC1/3 | 3M |
| EOR10/4 | 3AT | MESC1/3 | 4M |
| EOR10/5 | 4TA | MEWW1/3 | 4M |
| EOR10/6 | 5TA | MEWW1/4 | 4MT |
| EORO1/3 | 2M | OAME1/3 | 3M |
| EORO1/4 | 2MT | RB1 | 6T |
| EORO2/3 | 2M:7/4W:3 | RB2 | 7 |
| FMN1/2 | 5WN | RB4 | 6T |
| FST7/3 | 3A | RB5 | 6T |
| FST7/4 | 3AT | REER1/3 | 5M |
| FST9/3 | 3A:7/5WN:3 | REER1/4 | 5MT |
| HER4/3 | 2AD | REER1/5-6 | 5MT:6/6MT:4 |
| HER4/4 | 2AT | REIR1/3 | 3M |
| HER5/3 | 2AD:7/5WN:3 | REIR1/4 | 4MT |
| HER5/4 | 2AT:7/5WN:3 | REIR1/5 | 4TM |
| HGFM1/2 | 5WN | REIR1/6 | 5TM |
| HGT1/2 | 5W | REIR2/3 | 3M:7/4W:3 |
| HGT2/3 | 5W:6/3AT:4 | REIR2/4-5 | 4MT:7/5W:3 |
| HGT3/3 | 5W:6/3AT:4 | SUWE2/2 | 2D:7/4W:3 |
| HKBF1/3 | 4 or 3AD | TOA1/3 | 2A |
| HKBF2/3 | 4 or | ZDL | 7 |
| | 3AD:6/5WN:4 | ZOR | 7 |
| HKTL1/3 | 4DA | ZZZ | |

## Degradation of soils by water erosion

Soil erosion by water is a natural occurring process. Under natural vegetative cover, the risk of soil erosion in central Alberta is slight. However, because man has plowed the native sod and cleared land for crops the risk of soil erosion has greatly increased. The use of farming practices such as summerfallow, up-and-down

**Table 10.** Deep plow ratings for the County of Flagstaff.

| Map unit | Deep plow rating | Map unit | Deep plow rating |
|---|---|---|---|
| AMIR1/3 | N | HND1/3 | N |
| AMT1/3 | N | HND1/4 | N |
| AMT1/4 | N | HND2/3 | N |
| AMT2/4 | N | HND2/4 | N |
| AV2 | N | HND3/3 | N |
| AV7 | N | HND4/4 | N |
| BEAM2/2 | N | HND4/5 | N |
| BEL1/3 | N | HND6/3 | N |
| BKF1/4 | N | HND6/4 | N |
| CNN1/3 | N | HND6/5 | N |
| CNOA2/2 | N | HNDC1/3 | N |
| DC:L1/3 | N | HNDC1/4 | N |
| DSIR2/3 | N | HNDC2/3 | N |
| DSJ1/3 | N | HN:L1/3 | N |
| DUG1/2 | Uwx | IRKN1/3 | N |
| DUG2/2P | Uwp | IRRO1/3 | N |
| EOR1/3 | N | IRRO1/4 | N |
| EOR1/4 | N | IRRO2/3 | N |
| EOR1/5 | N | IRRO10/4 | N |
| EOR2/3 | N | KLM4/3 | Mc |
| EOR2/4 | N | KLM5/3 | Mwc |
| EOR2/5 | N | KLM6/3 | Mcr |
| EOR2/6 | N | KLM7/3 | Uwr |
| EOR3/3 | N | KNA1/3 | N |
| EOR6/3 | N | KNA1/4 | N |
| EOR6/4 | N | KNIR2/3-4 | N |
| EOR6/5 | N | KPBL1/2 | Mcz |
| EOR8/4 | N | MEDC1/3 | N |
| EOR8/5 | N | MESC1/3 | N |
| EOR10/4 | N | MEWW1/3 | N |
| EOR10/5 | N | MEWW1/4 | N |
| EOR10/6 | N | OAME1/3 | N |
| EORO1/3 | N | RB1 | N |
| EORO1/4 | N | RB2 | N |
| EORO2/3 | N | RB4 | N |
| FMN1/2 | Uwx | RB5 | N |
| FST7/3 | Mz | REER1/3 | N |
| FST7/4 | Mzt | REER1/4 | N |
| FST9/3 | Uwz | REER1/5 | N |
| HER4/3 | Mcz | REER1/6 | N |
| HER4/4 | Mcz | REIR1/3 | N |
| HER5/3 | Uwz | REIR1/4 | N |
| HER5/4 | Uwz | REIR1/5-6 | N |
| HGFM1/2 | Uw | REIR2/3 | N |
| HGT1/2 | N | REIR2/4-5 | N |
| HGT2/3 | N | SUWE2/2 | Mzx |
| HGT3/3 | N | TOA1/3 | N |
| HKBF1/3 | S | ZDL | N |
| HKBF2/3 | Mwt | ZOR | N |
| HKTL1/3 | S | ZZZ | N |
| HKTL1/4 | Mtr | | |

slope cultivation on long inclined slopes and excessive tillage have further increased the risk of soil erosion.

Soil erosion by water is a two-step process. The first step is detachment of small soil particles at the soil surface either by the impact of raindrops or by the shear force of running water.

1. The soil resistance to detachment depends on the chemical and physical condition of a particular soil. Well-aggregated, humus-rich and fine-textured soil will erode less rapidly, than a silty or fine sandy soil with low organic matter content. The second step is transportation of detached soil particles by water flowing over land.
2. This occurs, in Alberta, during spring snowmelt or very intensive rainstorms when the precipitation intensity exceeds infiltration.

The transportation step results in actual soil loss. Under Alberta conditions, water erosion results in redistribution of soil. Soil eroded from upper parts of the slope is deposited at the toe of the concave portion of the same slope.

Some visible signs of soil erosion by water can be observed in the county. They are:

a) rill formation after spring snowmelt or heavy rains,
b) accumulation of fresh topsoil deposits at the base of steeper slopes and
c) eroded knolls or the appearance of subsoil indicating the A horizon has been removed by erosion (this includes wind erosion and cultivation).

Soil erosion by water includes sheet, rill and gully erosion. Gully erosion is the most visible, sheet and rill erosion cause the highest amounts of soil redistribution. Sheet erosion is caused by the impact effect of raindrops on unprotected soil and/or the movement layer of shallow water across the soil surface, while rill and gully erosion results from the concentrated flow of runoff water.

The most widely used method of soil loss prediction is the Universal Soil Loss Equation (USLE) devised by Wischmeier and Smith (1965) and modified for Alberta climatic conditions by Tajek et. al., (1985).

The prediction of soil loss (A) is based on six major factors controlling the soil erosion from agricultural land:

- Average annual soil loss t/ha (A)=A=$R_T$KLSC
  $R_T$=Total precipitation factor (mj mm/ha/h) includes the combined erosivity of rain fall and spring runoff
- K=soil erosivity factor based on soil physical properties and pedogenetic development
- LS=slope length and slope steepness factor combines the effect of slope gradient and slope length
- C=cropping-management factor based on typical cropping and management practices as well as the seasonal distribution of precipitation erosivity

Values for individual factors, taken from the Water erosion potential of soil in Alberta (Tajek et. al., 1985) were used for assessment of erosion risk for the county. The $R_T$ 600 was used for the entire area. The K-factor for individual map units was assessed with respect to the dominant and codominant soil. Values of K ranged from low erosivity class 1 (0.011) for coarse-textured soils such as Redwillow (RED) or Wainwright (WWT) soil series, to class 4 for highly erodible Torlea (TLA) soil series. The LS-factor was assessed with respect to the average slope gradient and length of predominant landform associated with a particular map. Values for LS-factor ranged from a low of 0.2 for the near level landform to 5.0 for the slopes with a slope gradient larger than 15 percent. The C-factors for cereal crop, canola and alfalfa used in computation are based on typical management practice and the annual $R_T$ distribution in the region.

The soil loss for the dominant or codominant soil component of each map unit was computed for bare soil, cereal, canola and alfalfa. Computed potential annual soil loss values represent long-term average based on 25 years of climatic data. Soil loss values were ranked into 6 classes:

| Class | Category | Potential loss t/ha/yr |
|---|---|---|
| 1 | negligible | <6 |
| 2 | slight | 6-11 |
| 3 | moderate | 11-22 |
| 4 | severe | 22-33 |
| 5 | very severe | 33-35 |
| 6 | extreme | 55 |

A complete list of soil loss classes for bare soil, cereal and alfalfa, for all map units is given in table 11.

The erosion intensity could vary significantly from year to year, depending on the intensity of individual rainstorms or runoff from snowmelt as well as timing of individual rainstorms in relation to crop stage and density of plant cover. The highest soil loss occurs on soils that are not protected by vegetation, stubble or crop residue.

Vegetation offers protection against both rainsplash and runoff ranging from row for row crop or grain in early stages of development to excellent for well-established grass or alfalfa.

Results of predicted soil loss show a wide range in erosion potential (table 11). The controlling factors are the slope gradient on topography steeper than 15 percent, slope length and the soil erosivity on slopes with lesser gradient. Assuming bare soil (potential erosion), the highest soil losses were computed for soils that occur on slope classes 5 and 6. The lowest soil losses were obtained for soils that are found on slope class 2 or for coarse-textured soils (WWT) on slope class 3.

Some erosion will be associated with intensive large scale farming. Soil losses should be kept below 6t/ha/yr on deep Chernozemic soils and at minimum for other soils in order to sustain present productivity. Fields with high erosion potential (class 5 or 6 for bare soil) require special conservation practices such as conservation tillage or strip cropping. The worst areas should be used for hay production if erosion risk is to be minimized. The Rough Broken (RB) units should not be cultivated. Reduced cultivation, better stubble management or reduction in field length through contour strip cropping are required on fields rated as erosion class 2 or 3.

**Table 11.** Predicted soil erodibility for individual map units in the County of Flagstaff.

| Map unit | Bare soil | Cereal | Canola | Alfalfa |
|---|---|---|---|---|
| | 1 2 | 1 2 | 1 2 | 1 2 ** |
| AMIR1/3 | 2 1 | 1 1 | 1 1 | 1 1 |
| AMT1/3 | 2 | 1 | 1 | 1 |
| AMT1/4 | 3 | 1 | 2 | 1 |
| AMT2/4 | 3 | 1 | 2 | 1 |
| AV2 | 1 | 1 | 1 | 1 |
| AV7 | 1 | 1 | 1 | 1 |
| BEAM2/2 | 2 2 | 1 1 | 1 1 | 1 1 |
| BEL1/3 | 2 | 1 | 1 | 1 |
| BKF1/4 | 4 | 2 | 2 | 1 |
| CNN1/3 | 2 | 1 | 1 | 1 |
| CNOA2/2 | 1 1 | 1 1 | 1 1 | 1 1 |
| DC:L1/3 | 1 | 1 | 1 | 1 |
| DSIR2/3 | 1 1 | 1 1 | 1 1 | 1 1 |
| DSJ1/2 | 1 | 1 | 1 | 1 |
| DUG1/2 | 1 | 1 | 1 | 1 |
| DUG2/2p | 1 | 1 | 1 | 1 |
| EOR1/3 | 1 | 1 | 1 | 1 |
| EOR1/4 | 3 | 1 | 1 | 1 |
| EOR1/5 | 5 | 2 | 3 | 1 |
| EOR2/3 | 1 | 1 | 1 | 1 |
| EOR2/4 | 3 | 1 | 1 | 1 |
| EOR2/5 | 5 | 2 | 3 | 1 |
| EOR2/6 | 6 | 3 | 4 | 1 |
| EOR3/3 | 1 | 1 | 1 | 1 |
| EOR6/3 | 1 | 1 | 1 | 1 |
| EOR6/4 | 3 | 1 | 1 | 1 |
| EOR6/5 | 5 | 2 | 3 | 1 |
| EOR8/4 | 3 | 1 | 1 | 1 |
| EOR8/5 | 5 | 2 | 3 | 1 |
| EOR10/4 | 3 | 1 | 1 | 1 |
| EOR10/5 | 5 | 3 | 3 | 1 |
| EOR10/6 | 6 | 4 | 4 | 1 |
| EORO1/3 | 2 1 | 1 1 | 1 1 | 1 1 |
| EORO1/4 | 3 2 | 1 1 | 1 1 | 1 1 |
| EORO2/3 | 2 1 | 1 1 | 1 1 | 1 1 |
| FMN1/2 | 1 | 1 | 1 | 1 |
| FST7/3 | 2 | 1 | 1 | 1 |
| FST7/4 | 3 | 1 | 1 | 1 |
| FST9/3 | 2 | 1 | 1 | 1 |
| HER4/3 | 1 | 1 | 1 | 1 |
| HER4/4 | 3 | 1 | 1 | 1 |
| HER5/3 | 1 | 1 | 1 | 1 |
| HER5/4 | 3 | 1 | 1 | 1 |
| HGFM1/2 | 1 1 | 1 1 | 1 1 | 1 1 |
| HGT1/2 | 1 | 1 | 1 | 1 |
| HGT2/3 | 1 | 1 | 1 | 1 |
| HGT3/3 | 1 | 1 | 1 | 1 |
| HKBF1/3 | 2 2 | 1 1 | 1 1 | 1 1 |
| HKBF2/3 | 2 2 | 1 1 | 1 1 | 1 1 |
| HKTL1/3 | 2 2 | 1 1 | 1 1 | 1 1 |

**Table 11.** (continued)

| Map unit | Bare soil | Cereal | Canola | Alfalfa |
|---|---|---|---|---|
| HKTL1/4 | 5 5 | 2 2 | 3 3 | 1 1 |
| HND1/3 | 2 | 1 | 1 | 1 |
| HND1/4 | 3 | 1 | 1 | 1 |
| HND2/3 | 2 | 1 | 1 | 1 |
| HND2/4 | 3 | 1 | 1 | 1 |
| HND3/3 | 2 | 1 | 1 | 1 |
| HND4/4 | 3 | 1 | 2 | 1 |
| HND4/5 | 5 | 3 | 3 | 1 |
| HND6/3 | 2 | 1 | 1 | 1 |
| HND6/4 | 3 | 1 | 1 | 1 |
| HND6/5 | 5 | 3 | 3 | 1 |
| HNDC1/3 | 2 1 | 1 1 | 1 1 | 1 1 |
| HNDC1/4 | 4 4 | 2 1 | 2 2 | 1 1 |
| HNDC2/3 | 2 1 | 1 1 | 1 1 | 1 1 |
| HN:L1/2 | 1 | 1 | 1 | 1 |
| IRKN1/3 | 2 1 | 1 1 | 1 1 | 1 1 |
| IRRO1/3 | 1 1 | 1 1 | 1 1 | 1 1 |
| IRRO1/4 | 3 2 | 1 1 | 1 1 | 1 1 |
| IRRO2/3 | 1 1 | 1 1 | 1 1 | 1 1 |
| IRRO10/4 | 3 2 | 1 1 | 1 1 | 1 1 |
| KLM4/3 | 2 | 1 | 1 | 1 |
| KLM5/3 | 2 | 1 | 1 | 1 |
| KLM6/3 | 2 | 1 | 1 | 1 |
| KLM7/3 | 2 | 1 | 1 | 1 |
| KNA1/3 | 1 | 1 | 1 | 1 |
| KNA1/4 | 1 | 1 | 1 | 1 |
| KNIR2/3-4 | 1 2 | 1 1 | 1 1 | 1 1 |
| KPBL1/2 | 3 1 | 1 1 | 1 1 | 1 1 |
| MEDC1/3 | 1 1 | 1 1 | 1 1 | 1 1 |
| MESC1/3 | 1 1 | 1 1 | 1 1 | 1 1 |
| MEWW1/3 | 1 1 | 1 1 | 1 1 | 1 1 |
| MEWW1/4 | 3 2 | 1 1 | 1 1 | 1 1 |
| OAME1/3 | 1 1 | 1 1 | 1 1 | 1 1 |
| RB1 | 6 | | | 1 |
| RB2 | 6 | | | 1 |
| RB4 | 5 | | | 1 |
| RB5 | 4 | | | 1 |
| REER1/3 | 1 1 | 1 1 | 1 1 | 1 1 |
| REER1/4 | 1 2 | 2 1 | 1 1 | 1 1 |
| REER1/5-6 | 3 4 | 1 2 | 1 2 | 1 1 |
| REIR1/3 | 1 1 | 1 1 | 1 1 | 1 1 |
| REIR1/4 | 1 3 | 1 1 | 1 1 | 1 1 |
| REIR1/5 | 3 4 | 1 2 | 1 3 | 1 1 |
| REIR1/6 | 3 4 | 1 2 | 1 3 | 1 1 |
| REIR2/3 | 1 1 | 1 1 | 1 1 | 1 1 |
| REIR2/4-5 | 2 3 | 1 1 | 1 2 | 1 1 |
| SUWE2/2 | 2 1 | 1 1 | 1 1 | 1 1 |
| TOA1/3 | 1 | 1 | 1 | 1 |
| ZDL | | | | |
| ZOR | | | | |
| ZZZ | | | | |

NOTE: ** 1) dominant soil 2) codominant soil

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# Appendix A. Soil series descriptions and selected analytical data.

**Brownfield (BFD)**
Classification: Dark Brown Solod (DB.SO)
Parent material: Weakly calcareous, moderately saline, clay loam till.
Drainage: Moderately well
Agroclimatic zone: 2A
Physiographic district: Daysland Plain

Selected characteristics of BFD

| | Topsoil (Ah/Ap) | Subsoil (Bnt) | Parent material (Ccas) |
|---|---|---|---|
| Depth (cm) | 0-11 | 25-58 | 58+ |
| Thickness (cm) | 10-15 | 20-40 | - |
| Texture | L | CL | CL |
| pH ($CaCl_2$) | 5.0 | 6.5 | 7.5 |
| Organic C % | 5 | 1 | - |
| CEC | 19 | 20 | - |
| $CaCO_3$ equivalent % | - | - | 3 |
| CA/NA | 30 | 5 | - |
| SAR | - | 7 | 11 |

**Coronation (CNN)**
Classification: Orthic Dark Brown Chernozemic (O.DB)
Parent material: Weakly calcareous, loam to silt loam glaciofluvial.
Drainage: Well
Agroclimatic zone: 2A
Physiographic district: Daysland Plain, Neutral Upland

Selected characteristics of CNN

| | Topsoil (Ah/Ap) | Subsoil (Bm) | Parent material (Cca/Ck) |
|---|---|---|---|
| Depth (cm) | 0-16 | 16-56 | 79+ (70-90) |
| Thickness (cm) | 10-20 | 20-40 | - |
| Texture | L | L | L-SCL |
| pH ($CaCl_2$) | 4.5 | 5.5 | 7.5 |
| Organic C % | 4 | 1 | - |
| CEC | 23 | 20 | - |
| $CaCO_3$ equivalent % | - | - | 2 |
| CA/NA | - | - | - |
| SAR | - | - | - |

**Cordel (COR)**
Classification: Humic Luvic Gleysol (HU.LG)
Parent material: Weakly calcareous, clay loam till
Drainage: Imperfect
Agroclimatic zone: 2H
Physiographic district: Daysland Plain

Selected characteristics of COR

| | Topsoil (Ah/Ap) | Subsoil (Btg) | Parent material (Ckg) |
|---|---|---|---|
| Depth (cm) | 0-12 | 28-48 | 100+ |
| Thickness (cm) | 10-15 | 15-30 | - |
| Texture | L | CL | CL |
| pH ($CaCl_2$) | 5.0 | 6.0 | 7.0 |
| Organic C % | 6 | 1 | - |
| CEC | 19 | 15 | 13 |
| $CaCO_3$ equivalent % | - | - | - |
| CA/NA | 25 | 35 | 35 |
| SAR | 1 | 2 | - |

**Daugh (DUG)**
Classification: Black Solonetz (BL.SZ)
Parent material: Moderately calcareous, weakly saline, silty clay glaciolacustrine.
Drainage: Imperfect
Agroclimatic zone: 2H
Physiographic district: Daysland Plain

Selected characteristics of DUG

| | Topsoil (Ah/Ap) | Subsoil (Bnt) | Parent material (Csk) |
|---|---|---|---|
| Depth (cm) | 0-10 | 10-35 | 50+ |
| Thickness (cm) | 5-15 | 10-30 | - |
| Texture | SiCL | SiCL | C |
| pH ($H_2O$) | 6.0 | 7.5 | 8.5 |
| Organic C % | 8 | 2 | - |
| CEC | 42 | 40 | - |
| $CaCO_3$ equivalent % | - | 3 | 10 |
| CA/NA | 15 | 5 | - |
| SAR | - | - | 8 |

## Appendix A. (continued)

### Daysland (DYD)
Classification: Black Solod (BL.SO)
Parent material: Weakly calcareous, weakly saline, clay loam till.
Drainage: Moderately well
Agroclimatic zone: 2H
Physiographic district: Daysland Plain

Selected characteristics of DYD

| | Topsoil (Ah/Ap) | Subsoil (Bnt) | Parent material (Ccasa) |
|---|---|---|---|
| Depth (cm) | 0-20 | 35-55 | 55+ |
| Thickness (cm) | 10-25 | 15-30 | - |
| Texture | L | CL | CL |
| pH ($CaCl_2$) | 5.5 | 7.5 | 8.0 |
| Organic C % | 3 | 1 | - |
| CEC | 23 | 22 | - |
| $CaCO_3$ equivalent % | - | - | 6 |
| CA/NA | 90 | 3 | - |
| SAR | - | 14 | 6 |

### Dolcy (DCY)
Classification: Orthic Dark Brown Chernozemic (O.DB)
Parent material: Sandy glaciofluvial veneer overlying weakly calcareous, clay loam till.
Drainage: Well
Agroclimatic zone: 2A
Physiographic district: Daysland Plain

Selected characteristics of DCY

| | Topsoil (Ah/Ap) | Subsoil (Bm) | Parent material (IICk) |
|---|---|---|---|
| Depth (cm) | 0-18 | 18-70 | 70+ |
| Thickness (cm) | 10-20 | 30-70 | - |
| Texture | SL | SL | L-CL |
| pH ($CaCl_2$) | 4.5 | 6.0 | 6.0 |
| Organic C % | 3 | 1 | - |
| CEC | 23 | 17 | 19 |
| $CaCO_3$ equivalent % | - | - | - |
| CA/NA | - | - | - |
| SAR | - | - | - |

### Edgerton (ERT)
Classification: Orthic Regosol (O.R)
Parent material: Sandy glaciofluvial
Drainage: Rapid
Agroclimatic zone: 2H
Physiographic district: Neutral Upland

Selected characteristics of ERT

| | Topsoil (Ah/Ap) | Parent material (C) |
|---|---|---|
| Depth (cm) | 0-2 | 2-275 |
| Thickness (cm) | 0-5 | - |
| Texture | S | S |
| pH ($H_2O$) | 5.5 | 6.0 |
| Organic C % | 1 | - |
| CEC | - | - |
| $CaCO_3$ equivalent % | - | - |
| CA/NA | - | - |
| SAR | - | - |

### Elnora (EOR)
Classification: Orthic Black Chernozemic (O.BL)
Parent material: Weakly calcareous, clay loam till
Drainage: Moderately well
Agroclimatic zone: 2H
Physiographic district: Daysland Plain, Viking Upland

Selected characteristics of EOR

| | Topsoil (Ah/Ap) | Subsoil (Bm) | Parent material (Cca/Ck) |
|---|---|---|---|
| Depth (cm) | 0-15 | 15-50 | 50+ |
| Thickness (cm) | 10-18 | 30-40 | - |
| Texture | L | L-CL | L-CL |
| pH ($H_2O$) | 7.0 | 7.0 | 7.5 |
| Organic C % | 5 | 1 | - |
| CEC | 25 | 20 | - |
| $CaCO_3$ equivalent % | - | - | 15 |
| CA/NA | 300 | 300 | - |
| SAR | | | - |

## Appendix A. *(continued)*

### Flagstaff (FST)
Classification: Solonetzic Dark Brown Chernozemic (SZ.DB)
Parent material: Weakly calcareous, weakly saline, clay loam till
Drainage: Moderately well
Agroclimatic zone: 2A
Physiographic district: Daysland Plain

Selected characteristics of FST

| | Topsoil (Ah/Ap) | Subsoil (Bnjt) | Parent material (Cca/Ck) |
|---|---|---|---|
| Depth (cm) | 0-15 | 25-60 | 60+ |
| Thickness (cm) | 10-18 | 25-50 | - |
| Texture | L | CL | CL |
| pH ($H_2O$) | 5.5 | 7.0 | 8.0 |
| Organic C % | 4 | 1 | - |
| CEC | 20 | 20 | - |
| $CaCO_3$ equivalent % | - | - | 5 |
| CA/NA | 40 | 30 | - |
| SAR | - | 5 | 4 |

### Foreman (FMN)
Classification: Solonetzic Humic Gleysol (SZ.HG)
Parent material: Weakly calcareous, weakly saline, clay loam till
Drainage: Poor
Agroclimatic zone: 2H
Physiographic district: Daysland Plain

Selected characteristics of FMN

| | Topsoil (Ah/Ap) | Subsoil (Bntg) | Parent material (Csakg) |
|---|---|---|---|
| Depth (cm) | 0-5 | 5-30 | 30+ |
| Thickness (cm) | 0-10 | 20-30 | - |
| Texture | L | CL | CL |
| pH ($CaCl_2$) | 6.0 | 7.0 | 8.0 |
| Organic C % | 4 | - | - |
| CEC | 25 | 23 | - |
| $CaCO_3$ equivalent % | - | - | 5 |
| CA/NA | - | 3 | - |
| SAR | - | 20 | 25 |

### Haight (HGT)
Classification: Orthic Humic Gleysol (O.HG)
Parent material: Weakly calcareous, clayey glacio-lacustrine
Drainage: Poor
Agroclimatic zone: 2H
Physiographic district: Daysland Plain

Selected characteristics of HGT

| | Topsoil (Ah/Ap) | Subsoil (Bg) | Parent material (Ckg) |
|---|---|---|---|
| Depth (cm) | 0-10 | 35-45 | 45-80 |
| Thickness (cm) | 10-20 | 10-30 | - |
| Texture | SiCL | SiC-C | SiC |
| pH ($H_2O$) | 7.0 | 7.5 | 7.5 |
| Organic C % | - | - | - |
| CEC | - | - | - |
| $CaCO_3$ equivalent % | - | - | 6 |
| CA/NA | - | - | - |
| SAR | - | - | - |

### Hairy Hill (HYL)
Classification: Saline Carbonated Orthic Humic Gleysol (saca O.HG)
Parent material: Moderately calcareous, moderately saline, clay loam till
Drainage: Poor to very poor
Agroclimatic zone: 2H
Physiographic district: Daysland Plain

Selected characteristics of HYL (ranges in brackets)

| | Topsoil (Ahks) | Subsoil (Bskg) | Parent material (Ccasg) |
|---|---|---|---|
| Depth (cm) | 0-18 | 18-46 | 46-69 |
| Thickness (cm) | 15-20 | 20-40 | - |
| Texture | L | L-CL | CL |
| pH ($H_2O$) | 8.0 | 8.5 | 8.5 |
| Organic C % | 3 | - | - |
| CEC | - | - | - |
| $CaCO_3$ equivalent % | 6 | 7 | 15 |
| CA/NA | - | - | - |
| SAR | - | - | - |

## Appendix A. (continued)

### Halkirk (HKR)
Classification: Dark Brown Solodized Solonetz (DB.SS)
Parent material: Weakly calcareous, moderately saline, clay loam till
Drainage: Moderately well
Agroclimatic zone: 2A
Physiographic district: Daysland Plain

Selected characteristics of HKR

| | Topsoil (Ah/Ap) | Subsoil (Bnt) | Parent material (Ccasa) |
|---|---|---|---|
| Depth (cm) | 0-13 | 19-37 | 37+ |
| Thickness (cm) | 10-17 | 15-25 | - |
| Texture | L | CL | CL |
| pH ($CaCl_2$) | 5.5 | 7.0 | 8.0 |
| Organic C % | 4 | 11 | - |
| CEC | 19 | 15 | - |
| $CaCO_3$ equivalent % | - | - | - |
| CA/NA | 15 | 2 | - |
| SAR | - | 20 | 20 |

### Heisler (HER)
Classification: Solonetzic Black Chernozemic (SZ.BL)
Parent material: Weakly calcareous, weakly saline, clay loam till
Drainage: Moderately well
Agroclimatic zone: 2H
Physiographic district: Daysland Plain

Selected characteristics of HER

| | Topsoil (Ah/Ap) | Subsoil (Bnjt) | Parent material (Cca/Ck) |
|---|---|---|---|
| Depth (cm) | 0-20 | 25-60 | 60+ |
| Thickness (cm) | 15-21 | 25-35 | - |
| Texture | L | CL | CL |
| pH ($H_2O$) | 6.0 | 6.5 | 7.5 |
| Organic C % | - | - | - |
| CEC | 34 | 24 | - |
| $CaCO_3$ equivalent % | - | - | 6 |
| CA/NA | 300 | 30 | - |
| SAR | - | | |

### Hughenden (HND)
Classification: Orthic Dark Brown Chernozemic (O.DB)
Parent material: Moderately calcareous, clay loam till
Drainage: Moderately well
Agroclimatic zone: 2A
Physiographic district: Daysland Plain, Neutral Upland

Selected characteristics of HND

| | Topsoil (Ah/Ap) | Subsoil (Bm) | Parent material (Cca/Ck) |
|---|---|---|---|
| Depth (cm) | 0-15 | 15-40 | 40+ |
| Thickness (cm) | 10-20 | 20-50 | - |
| Texture | L | L-CL | CL |
| pH ($CaCl_2$) | 5.5 | 6.5 | 7.5 |
| Organic C % | 3 | - | - |
| CEC | 21 | 19 | - |
| $CaCO_3$ equivalent % | - | - | 7 |
| CA/NA | - | - | - |
| SAR | - | - | - |

### Irma (IRM)
Classification: Orthic Black Chernozemic (O.BL)
Parent material: Sandy loam glaciofluvial
Drainage: Well
Agroclimatic zone: 2H
Physiographic district: Daysland Plain, Neutral Upland

Selected characteristics of IRM

| | Topsoil (Ah/Ap) | Subsoil (Bm) | Parent material (Cca/Ck) |
|---|---|---|---|
| Depth (cm) | 0-25 | 25-55 | 110+ |
| Thickness (cm) | 20-25 | 20-50 | - |
| Texture | SL | SL | SL-S |
| pH ($H_2O$) | 6.0 | 6.5 | 7.5 |
| Organic C % | - | - | - |
| CEC | 10 | 5 | - |
| $CaCO_3$ equivalent % | - | - | 5 |
| CA/NA | - | - | - |
| SAR | - | - | - |

## Appendix A. (continued)

### Killam (KLM)

Classification: Black Solodized Solonetz (BL.SS)
Parent material: Weakly calcareous, moderately saline, clay loam till
Drainage: Moderately well
Agroclimatic zone: 2H
Physiographic district: Daysland Plain

Selected characteristics of KLM

| | Topsoil (Ah/Ap) | Subsoil (Bnt) | Parent material (Ccasa) |
|---|---|---|---|
| Depth (cm) | 0-13 | 18-33 | 50+ |
| Thickness (cm) | 10-15 | 10-20 | - |
| Texture | L | CL | CL |
| pH ($H_2O$) | 6.0 | 7.5 | 8.0 |
| Organic C % | 5 | 1 | - |
| CEC | 25 | 22 | 16 |
| $CaCO_3$ equivalent % | - | - | 5 |
| CA/NA | 20 | 2 | 5 |
| SAR | - | 20 | 20 |

### Neutral (NUT)

Classification: Rego Dark Brown Chernozemic (R.DB)
Parent material: Moderately calcareous, clay loam till
Drainage: Well
Agroclimatic zone: 2A
Physiographic district: Daysland Plain, Neutral Upland

Selected characteristics of NUT

| | Topsoil (Ah/Ap) | Parent material (Cca/Ck) |
|---|---|---|
| Depth (cm) | 0-10 | 10+ |
| Thickness (cm) | 5-20 | - |
| Texture | L | CL |
| pH ($H_2O$) | 7.0 | 8.0 |
| Organic C % | 4 | - |
| CEC | 16 | - |
| $CaCO_3$ equivalent % | - | 9 |
| CA/NA | - | - |
| SAR | - | - |

### Metisko (MET)

Classification: Orthic Dark Brown Chernozemic (O.DB)
Parent material: Sandy loam glaciofluvial
Drainage: Well
Agroclimatic zone: 2A
Physiographic district: Daysland Plain, Neutral Upland

Selected characteristics of MET

| | Topsoil (Ah/Ap) | Subsoil (Bm) | Parent material (Cca/Ck) |
|---|---|---|---|
| Depth (cm) | 0-15 | 25-45 | 80+ |
| Thickness (cm) | 5-20 | 10-30 | - |
| Texture | SL | SL | SL |
| pH ($H_2O$) | 5.5 | 6.5 | 7.5 |
| Organic C % | 6 | - | - |
| CEC | 20 | 2 | 8 |
| $CaCO_3$ equivalent % | - | - | - |
| CA/NA | - | - | - |
| SAR | - | - | - |

### Oasis (OAS)

Classification: Orthic Dark Brown Chernozemic (O.DB)
Parent material: Weakly calcareous, loam to sandy loam glaciofluvial
Drainage: Well
Agroclimatic zone: 2A
Physiographic district: Daysland Plain, Neutral Upland

Selected characteristics of OAS

| | Topsoil (Ah/Ap) | Subsoil (Bm) | Parent material (Cca/Ck) |
|---|---|---|---|
| Depth (cm) | 0-15 | 15-30 | 30+ |
| Thickness (cm) | 10-20 | 10-20 | - |
| Texture | L | L | L |
| pH ($H_2O$) | 7.5 | 7.5 | 7.5 |
| Organic C % | 2 | - | - |
| CEC | 21 | 19 | - |
| $CaCO_3$ equivalent % | - | - | 10 |
| CA/NA | - | - | - |
| SAR | - | - | - |

## Appendix A. (continued)

**Red Willow (RED)**
Classification: Orthic Black Chernozemic (O.BL)
Parent material: Loamy sand to sandy glaciofluvial
Drainage: Well to rapid
Agroclimatic zone: 2H
Physiographic district: Daysland Plain

Selected characteristics of RED

| | Topsoil (Ah/Ap) | Subsoil (Bm) | Parent material (C) |
|---|---|---|---|
| Depth (cm) | 0-15 | 15-60 | 60+ |
| Thickness (cm) | 10-20 | 25-50 | - |
| Texture | LS | LS | LS-S |
| pH ($H_2O$) | 6.0 | 6.0 | 7.0 |
| Organic C % | 2 | - | - |
| CEC | 12 | 6 | - |
| $CaCO_3$ equivalent % | - | - | - |
| CA/NA | - | - | - |
| SAR | - | - | - |

**Torlea (TLA)**
Classification: Dark Brown Solodized Solonetz (DB.SS)
Parent material: Weakly calcareous, moderately saline, clay loam till veneer over weathered residual
Drainage: Moderately well
Agroclimatic zone: 2A
Physiographic district: Daysland Plain

Selected characteristics of TLA

| | Topsoil (Ah/Ap) | Subsoil (Bnt) | Parent material (Csak) |
|---|---|---|---|
| Depth (cm) | 0-11 | 11-28 | 28+ |
| Thickness (cm) | 10-15 | 15-35 | - |
| Texture | L-SL | L-CL | CL |
| pH ($CaCl_2$) | 5.0 | 7.0 | 8.0 |
| Organic C % | 4 | 1 | - |
| CEC | 20 | 32 | - |
| $CaCO_3$ equivalent % | - | - | 3 |
| CA/NA | 7 | 2 | - |
| SAR | - | 12 | 15 |

**Rosebank (ROS)**
Classification: Orthic Black Chernozemic (O.BL)
Parent material: Sandy glaciofluvial veneer over weakly calcareous, clay loam till
Drainage: Well
Agroclimatic zone: 2H
Physiographic district: Daysland Plain

Selected characteristics of ROS

| | Topsoil (Ah/Ap) | Subsoil (Bm) | Parent material (IICca) |
|---|---|---|---|
| Depth (cm) | 0-18 | 18-50 | 50+ |
| Thickness (cm) | 10-20 | 30-60 | - |
| Texture | SL | SL | CL |
| pH ($CaCl_2$) | 5.5 | 6.5 | 8.0 |
| Organic C % | 3 | - | - |
| CEC | 23 | 19 | - |
| $CaCO_3$ equivalent % | - | - | 8 |
| CA/NA | - | - | - |
| SAR | - | - | - |

**Thomas Lake (TOA)**
Classification: Orthic Black Chernozemic (O.BL)
Parent material: Weakly calcareous, clayey glacio-lacustrine
Drainage: Moderately well
Agroclimatic zone: 2H
Physiographic district: Viking Upland

Selected characteristics of TOA

| | Topsoil (Ah/Ap) | Subsoil (Bm) | Parent material (Cca/Ck) |
|---|---|---|---|
| Depth (cm) | 0-13 | 13-46 | 46+ |
| Thickness (cm) | - | - | - |
| Texture | SiC | C | SiC |
| pH ($H_2O$) | 5.5 | 6.0 | 7.5 |
| Organic C % | - | - | - |
| CEC | 38 | 45 | - |
| $CaCO_3$ equivalent % | - | - | 4 |
| CA/NA | - | - | - |
| SAR | - | - | - |

## **Appendix A.** (continued)

**Wainwright (WWT)**
Classification: Orthic Dark Brown Chernozemic (O.DB)
Parent material: Loamy sand glaciofluvial
Drainage: Well to rapid
Agroclimatic zone: 2A
Physiographic district: Daysland Plain, Neutral Upland

Selected characteristics of WWT

| | **Topsoil (Ah/Ap)** | **Subsoil (Bm)** | **Parent material (Cca/Ck)** |
|---|---|---|---|
| Depth (cm) | 0-13 | 13-71 | 110+ |
| Thickness (cm) | 10-20 | 40-80 | - |
| Texture | LS | LS | LS-S |
| pH ($H_2O$) | 7.0 | 7.0 | 8.0 |
| Organic C % | 1 | - | - |
| CEC | 7 | 6 | - |
| $CaCO_3$ equivalent % | - | - | 2 |
| CA/NA | - | - | - |
| SAR | - | - | - |

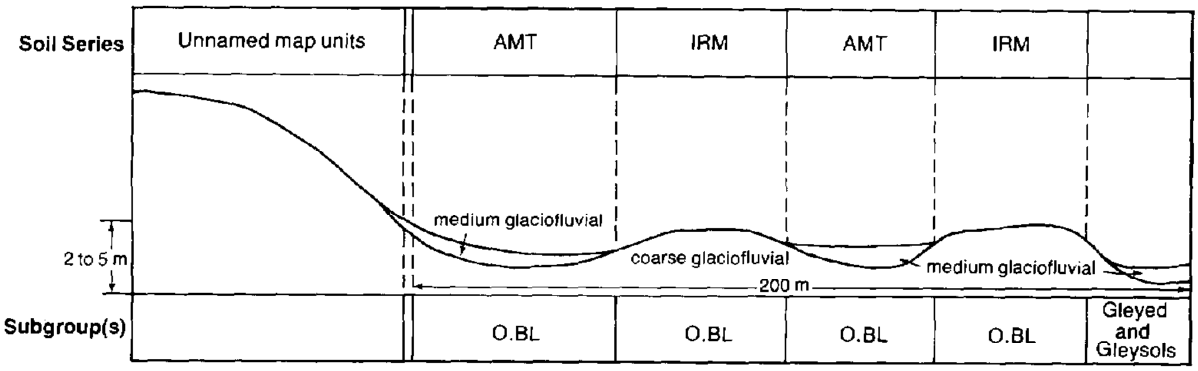
# Appendix B. Soil map unit descriptions

### AMIR1

This unit contains mainly (70 to 90 percent) Chernozemic soils developed on a discontinuous medium-textured, weakly calcareous, glaciolacustrine veneer overlying coarse-textured, weakly calcareous glaciofluvial deposits. Orthic Black Chernozemics developed on glaciolacustrine (AMT) and on glaciofluvial (IRM) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) are Gleyed Black Chernozemics (unnamed) and Gleysols. These minor soils are found on lower slopes and in depressional areas of the landscape.

One topographic phase of the AMIR1 soil unit is recognized.

AMIR1/3 is mapped on gently undulating landscapes along the Battle River floodplain where slopes are between 2 to 5 percent.




### AMT1

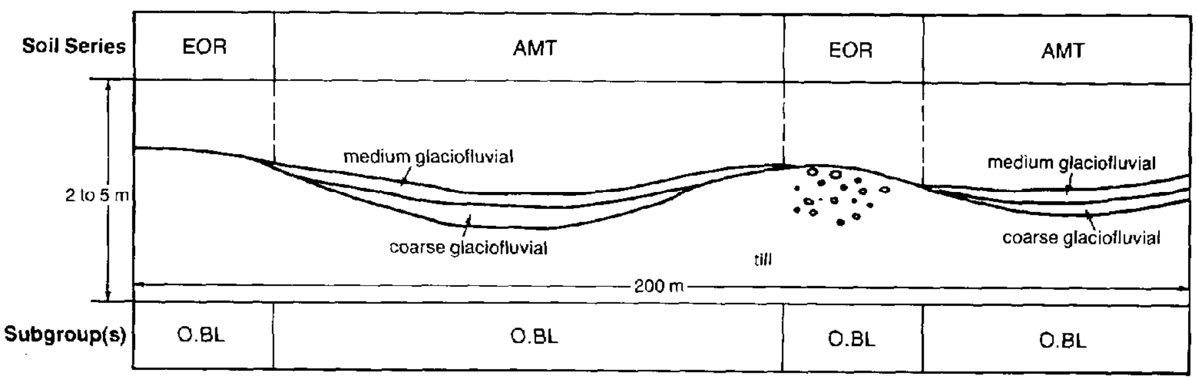
This unit contains mainly (70 to 90 percent) Chernozemic soils developed on a medium-textured, weakly calcareous glaciolacustrine veneer overlying coarse-textured, weakly calcareous glaciofluvial materials. Orthic Black Chernozemics (AMT) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) include Orthic Black Chernozemics developed on till (EOR) and glaciofluvial (IRM) materials. The minor soils are randomly distributed in the map unit.

AMT1 differs from AMT2 in that AMT1 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

Two topographic phases of the AMT1 soil units are recognized.

AMT1/3 is mapped on undulating landscapes where slopes are between 2 to 5 percent.

AMT1/4 is mapped on rolling to hummocky landscapes where slopes are between 6 to 9 percent.



## Appendix B. (continued)

### AMT2

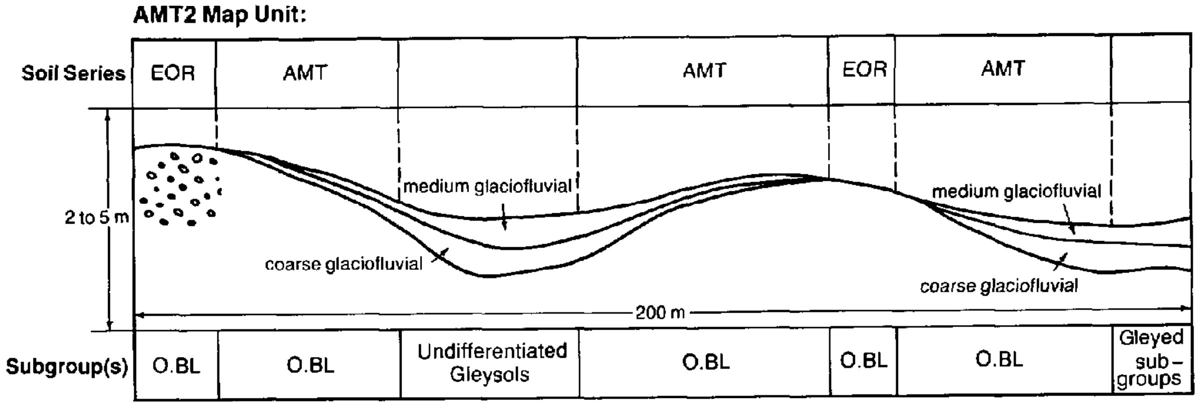
This unit contains mainly (50 to 80 percent) Chernozemic soils developed on a medium-textured, weakly calcareous glaciolacustrine veneer overlying coarse-textured, weakly calcareous glaciofluvial materials. Orthic Black Chernozemics (AMT) are the dominant soils in this unit. Soils present in significant amounts (15 to 30 percent) include Gleyed Black Chernozemics (unnamed) and Gleysols.The significant soils are found on lower slopes and depressional areas of the landscape.

AMT2 differs from AMT1 in that AMT2 contains a larger percentage (15 to 30 percent) of imperfectly and poorly drained soils.

One topographic phase of the AMT2 soil unit is recognized.

AMT2/4 is mapped on rolling to hummocky landscapes where slopes are between 6 to 9 percent.

**AMT2 Map Unit:**



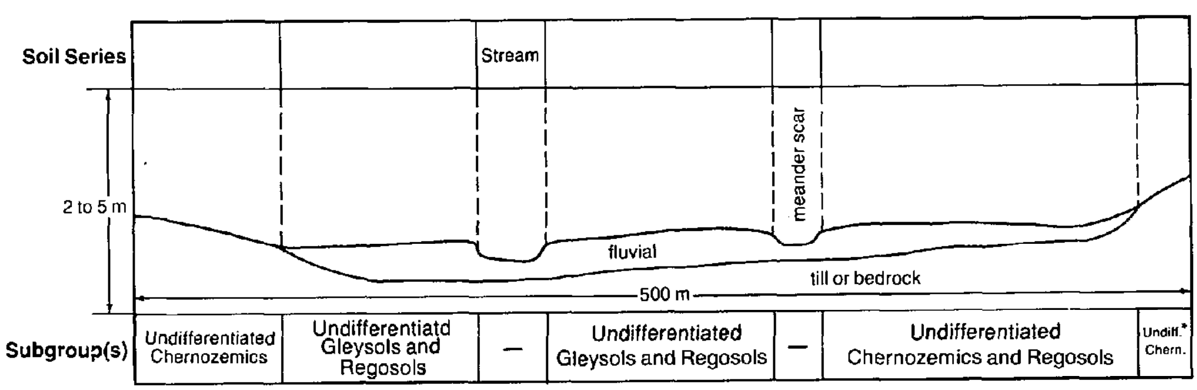

### AV2

This azonal unit contains codominant (30 to 60 percent) undifferentiated Chernozemic and Gleysolic soils developed on medium-textured, weakly calcareous fluvial materials. Soils present in minor amounts (less than 15 percent) are undifferentiated Regosolics. The minor soils are randomly distributed in the landscape.

AV2 differs from AV7 in that AV2 contains a larger percentage of Gleysolic soils (30 to 60 percent) and no Solonetzic soils.

One topographic phase of the AV2 soil unit is recognized.

AV2 is mapped on level to nearly level floodplains where slopes are between 0 to 2 percent.




*Undifferentiated Chernozemics

## Appendix B. (continued)

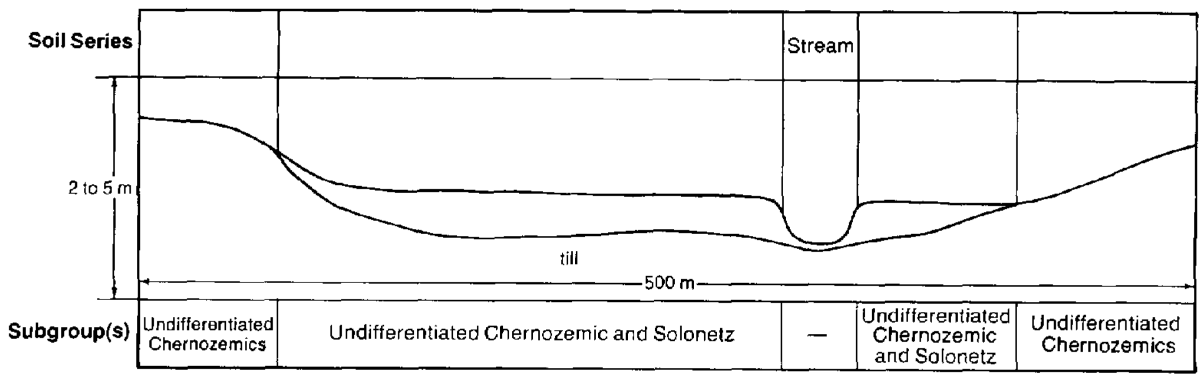
### AV7

This azonal unit contains codominant (30 to 60 percent) undifferentiated Chernozemic and Solonetzic soils developed on medium- to fine-textured, weakly calcareous, fluvial materials. Soils present in minor amounts (less than 15 percent) are undifferentiated Gleysolics. The minor soils are found in depressional areas of the landscape.

AV7 differs from AV2 in that AV7 contains a smaller percentage (less than 15 percent) of Gleysolic soils and contains a larger percentage (20 to 40 percent) of Solonetzic soils.

One topographic phase of the AV7 soil unit is recognized.

AV7 is mapped on level to nearly level floodplain landscapes where slopes are between 0 to 2 percent.

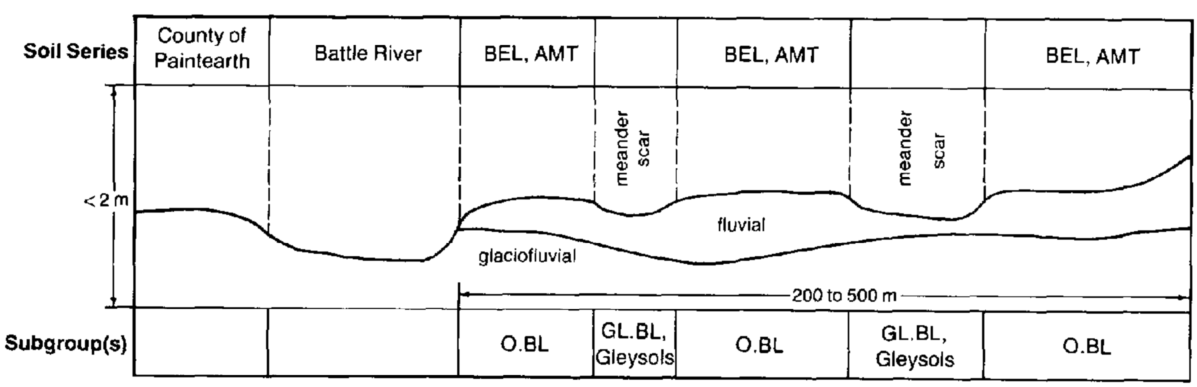



### BEAM2

This unit contains mainly (70 to 90 percent) Chernozemic soils developed on medium-textured, weakly calcareous fluvial veneer to blanket overlying coarse-textured, weakly calcareous glaciofluvial deposits. Orthic Black Chernozemics (BEL and AMT) are the dominant soils in the unit. Soils present in significant amounts (10 to 25 percent) include Gleyed Black Chernozemics (unnamed) and Gleysols. The significant soils are found on lower slopes and in depressional areas of the landscape.

One topographic phase of the BEAM2 soil unit is recognized.

BEAM2/2 is mapped on nearly level landscapes in the Battle River floodplain where slopes are between 0.5 to 2 percent.



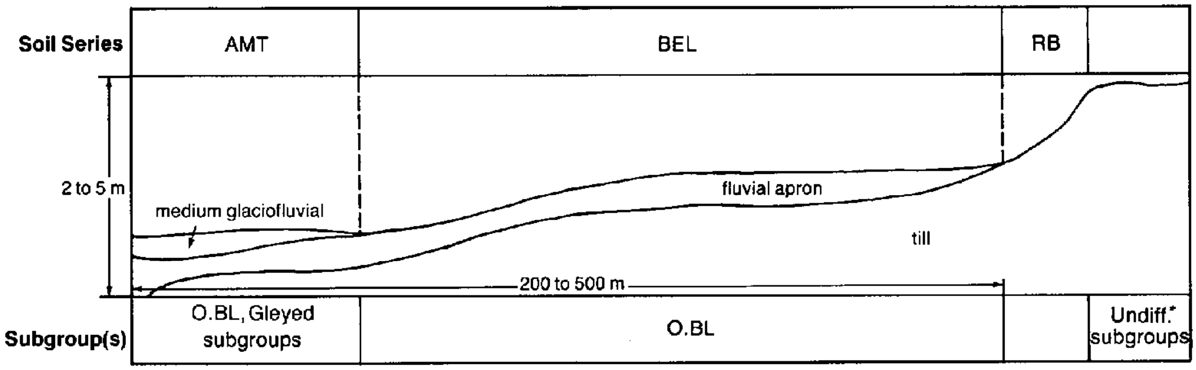
## Appendix B. (continued)

### BEL1

This unit contains mainly (80 to 90 percent) Chernozemic soils developed on medium-textured, weakly calcareous fluvial apron deposits. Orthic Black Chernozemics (BEL) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) include Orthic Black Chernozemics (AMT) and Gleyed subgroups (unnamed). Amity (AMT) soils are randomly distributed and Gleyed subgroups (unnamed) are found on lower slopes and in depressional areas of the landscape.

One topographic phase of the BEL1 soil unit is recognized.

BEL1/3 is mapped on gently undulating to inclined landscapes where slopes are between 2 to 5 percent.



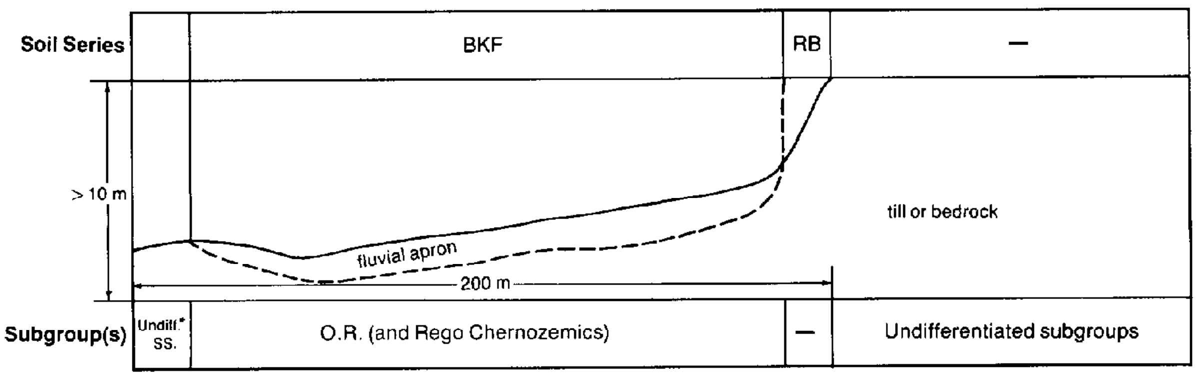

*Undifferentiated

### BKF1

This azonal unit contains mainly (60 to 90 percent) Regosolic soils developed on medium- to fine-textured, weakly saline, weakly calcareous, fluvial aprons and fans. Orthic Regosols (BKF) are the dominant soils in the unit. Soils present in minor amounts (less than 15 percent) are Rego Chernozemics (unnamed). The minor soils are randomly distributed in the unit.

One topographic phase of the BKF1 soil unit is recognized.

BKF1/4 is mapped on inclined landscapes where slopes are between 6 to 9 percent.




*Undifferentiated

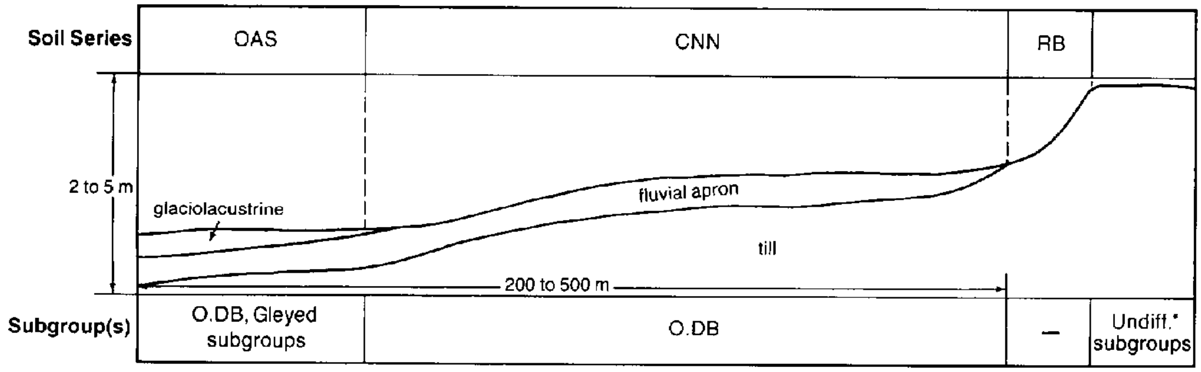
## Appendix B. (continued)

### CNN1

This unit contains mainly (80 to 90 percent) Chernozemic soils developed on medium-textured, weakly calcareous fluvial apron deposits. Orthic Dark Brown Chernozemics (CNN) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) include Orthic Dark Brown Chernozemics (OAS) and Gleyed subgroups (unnamed). Oasis (OAS) soils are randomly distributed and Gleyed subgroups (unnamed) are found on lower slopes and in depressional areas of the landscape.

One topographic phase of the CNN1 soil unit is recognized.

CNN1/3 is mapped on gently undulating to inclined landscapes where slopes are between 2 to 5 percent.



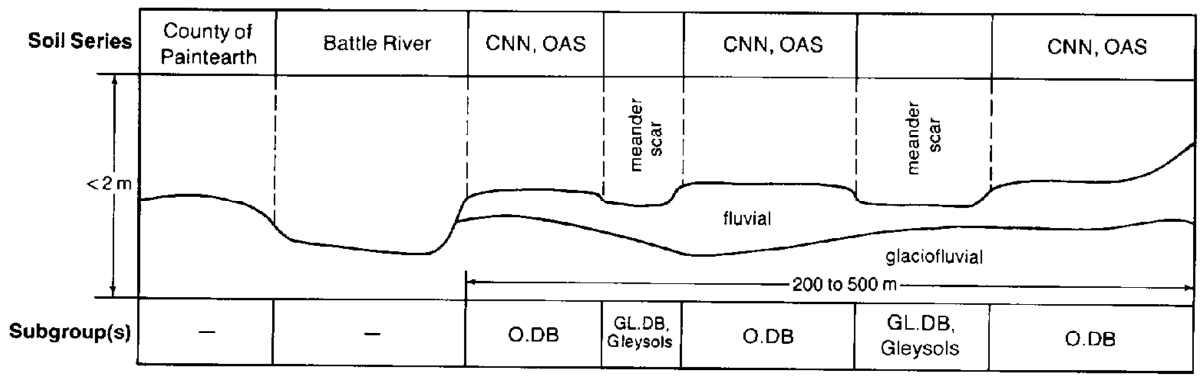

*Undifferentiated

### CNOA2

This unit contains mainly (70 to 90 percent) Chernozemic soils developed on medium-textured, weakly calcareous fluvial veneer to blanket overlying coarse-textured, weakly calcareous glaciofluvial deposits. Orthic Dark Brown Chernozemics (CNN and OAS) are the dominant soils in the unit. Soils present in significant amounts (10 to 25 percent) include Gleyed Dark Brown Chernozemics (unnamed) and Gleysols. The significant soils are found on lower slopes and in depressional areas of the landscape.

One topographic phase of the CNOA2 soil unit is recognized.

CNOA2/2 is mapped on nearly level landscapes in the Battle River floodplain where slopes are between 0.5 to 2 percent.



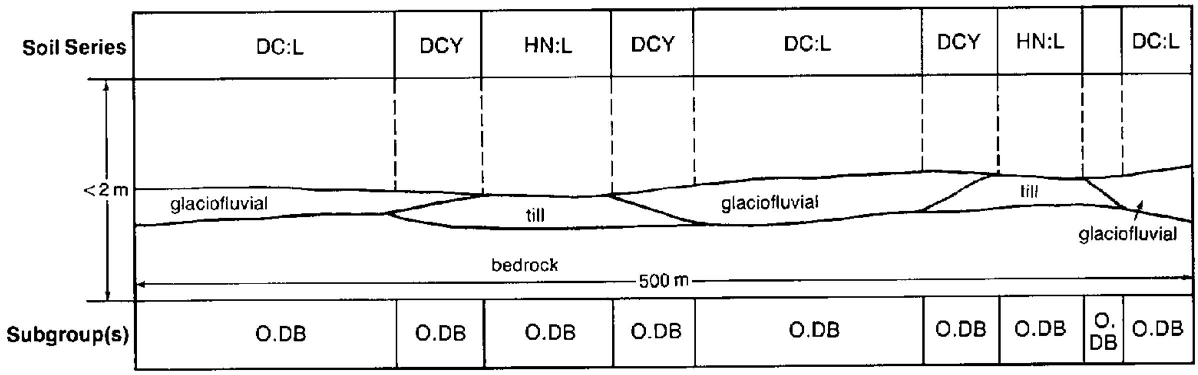
## **Appendix B.** (continued)

### DC:L1

This unit contains mainly (80 to 90 percent) Chernozemic soils developed on a coarse-textured, noncalcareous glaciofluvial veneer overlying bedrock. Orthic Dark Brown Chernozemics (DCY, lithic phase) are the dominant soils in the unit. Soils present in minor amounts (less than 15 percent) include Orthic Dark Brown Chernozemics (HND). The minor soils are randomly distributed in the landscape.

One topographic phase of the DC:L1 soil unit is recognized.

DC:L1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.



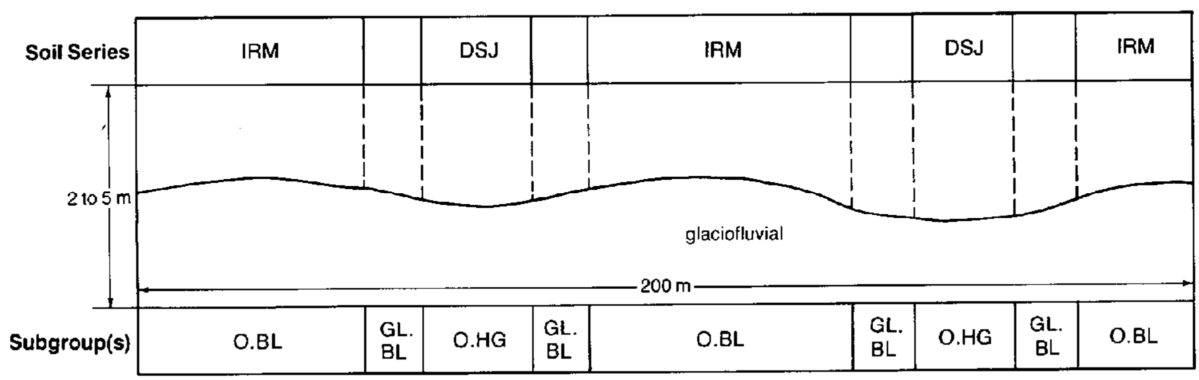

### DSIR2

This unit contains mainly (40 to 70 percent) Gleysolic soils developed on coarse-textured, moderately calcareous glaciofluvial materials. Orthic Humic Gleysols (DSJ) are the dominant soils in this unit. Soils present in significant amounts (20 to 50 percent) include Orthic Black Chernozemics (IRM) and Gleyed Black Chernozemics (unnamed). Irma (IRM) soils are found on mid to upper slopes of the landscape. Gleyed Black Chernozemics are found on lower slopes of the landscape.

DSIR2 differs from DSJ1 in that DSIR2 contains a larger amount (20 to 50 percent) of well-drained Orthic Black Chernozemic soils.

One topographic phase of the DSIR2 soil unit is recognized.

DSIR2/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.



## **Appendix B.** (continued)

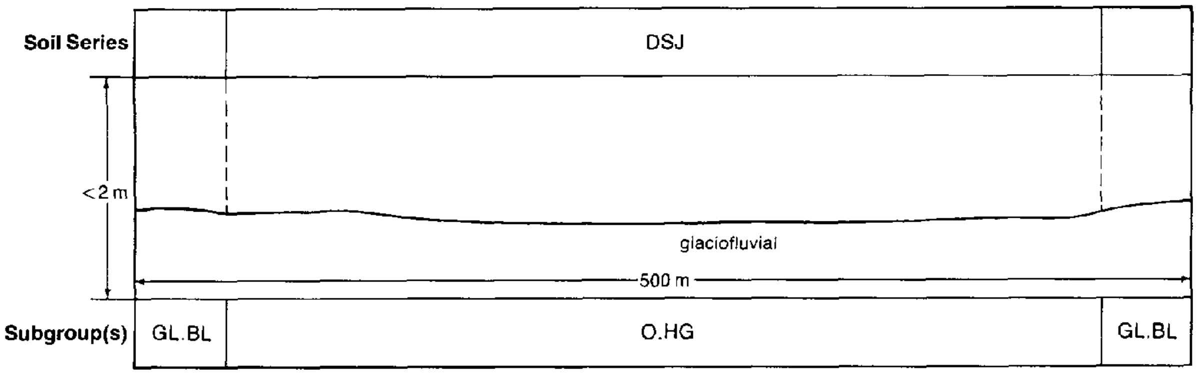
### DSJ1

This unit contains mainly (80 to 100 percent) Gleysolic soils developed on coarse-textured, moderately calcareous glaciofluvial materials. Orthic Humic Gleysols (DSJ) are the dominant soils in the unit. Soils present in minor amounts (less than 15 percent) include Gleyed Black Chernozemics (unnamed). The minor soils are found on upper slopes in the landscape.

DSJ1 differs from DSIR2 in that DSJ1 contains a larger percentage (80 to 100 percent) of Gleysols and a smaller percentage (less than 15 percent) of well-drained soils.

One topographic phase of the DSJ1 soil unit is recognized.

DSJ1/2 is mapped on nearly level landscapes where slopes are between 0.5 to 2 percent.



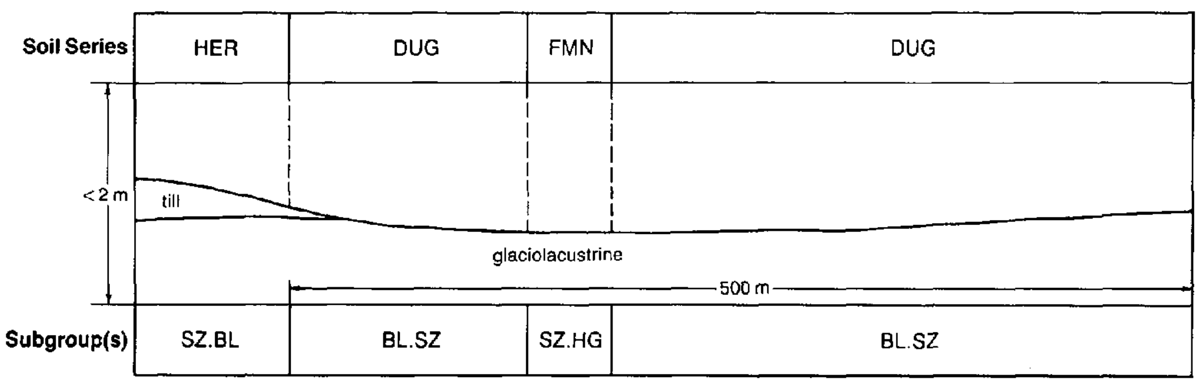

### DUG1

This unit contains mainly (70 to 100 percent) Solonetzic soils developed on fine-textured, moderately saline and sodic, weakly calcareous, glaciolacustrine materials. Black Solonetz (DUG) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) include Solonetzic Humic Gleysols (FMN). The minor soils are found on lower slopes and in depressional areas of the landscape.

DUG1 differs from DUG2 in that DUG1 contains a smaller percentage (less than 15 percent) of poorly drained soils.

One topographic phase of the DUG1 soil unit is recognized.

DUG1/2 is mapped on nearly level landscapes where slopes are between 0.5 to 2 percent.



## Appendix B. (continued)

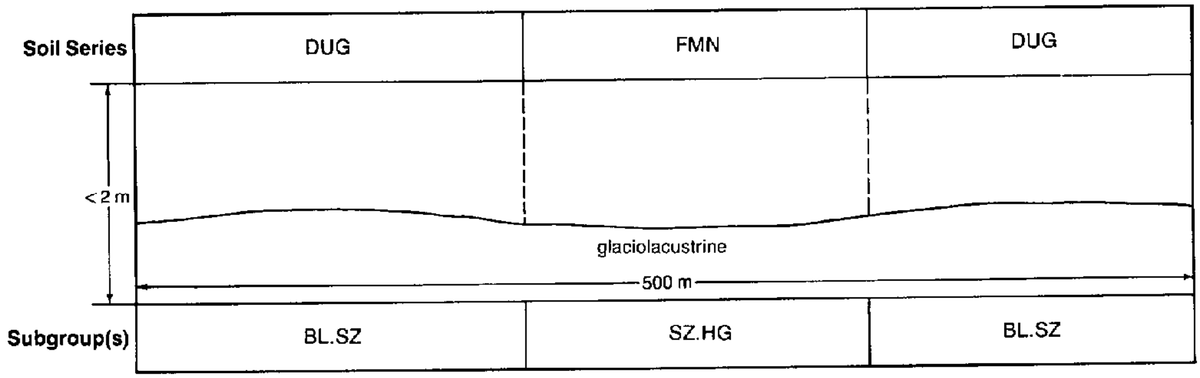
### DUG2

This unit contains mainly (60 to 90 percent) Solonetzic soils developed on fine-textured, moderately saline and sodic, moderately calcareous, moderately stony, glaciolacustrine materials. Black Solonetz (DUG) are the dominant soils in this unit. Soils present in significant amounts (15 to 30 percent) include Solonetzic Humic Gleysols (FMN). The significant soils are found on lower slopes and in depressional areas of the landscape.

DUG2 differs from DUG1 in that DUG2 contains a larger percentage (15 to 30 percent) of imperfectly and poorly drained soils.

One topographic phase of the DUG2 soil unit is recognized.

DUG2/2P is mapped on moderately stony, nearly level landscapes where slopes are between 0.5 to 2 percent.




### EOR1

This unit contains mainly (70 to 90 percent) Chernozemic soils developed on medium-textured, weakly calcareous till. Orthic Black Chernozemics (EOR) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) include Solonetzic Black Chernozemics (HER), Gleyed Black Chernozemics (unnamed) and Gleysols. The minor soils are found on lower slopes and in depressional areas of the landscape.

EOR1 differs from EOR2 in that EOR1 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

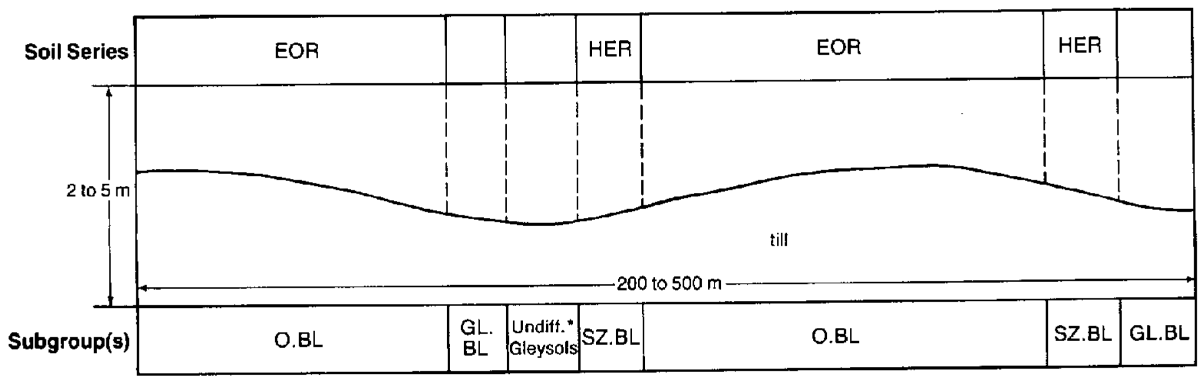
EOR1 differs from HER4 in that EOR1 contains a smaller percentage (less than 15 percent) of soils with solonetzic features.

Three topographic phases of the EOR1 soil unit are recognized.

EOR1/3 is mapped on undulating landscapes where slopes are between 2 to 5 percent.

EOR1/4 is mapped on hummocky and ridged landscapes where slopes are between 6 to 9 percent.

EOR1/5 is mapped on hummocky landscapes where slopes are between 10 to 15 percent.




*Undifferentiated

## Appendix B. (continued)

### EOR2

This unit contains mainly (60 to 80 percent) Chernozemic soils developed on medium-texured, weakly calcareous till. Orthic Black Chernozemics (EOR) are the dominant soils in this unit. Soils present in significant amounts (15 to 30 percent) include Gleyed Black Chernozemics (unnamed) and Gleysols. The significant soils are found on lower slope positions and in depressional areas of the landscape.

EOR2 differs from EOR1 in that EOR2 contains a larger percentage (15 to 30 percent) of imperfectly and poorly drained soils.

EOR2 differs from HER5 in that EOR2 contains a smaller percentage (less than 15 percent) of soils with solonetzic features.

EOR2 differs from EOR8 in that EOR2 contains a smaller percentage (less than 15 percent) of eroded soils.

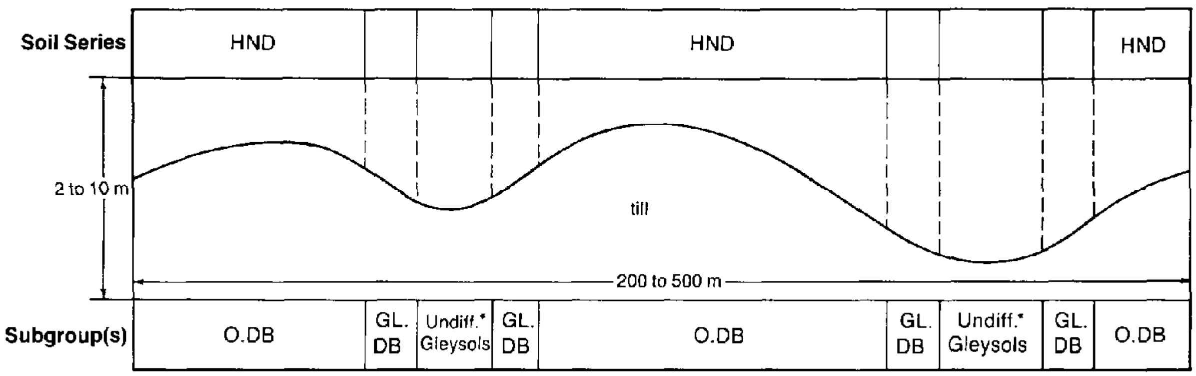
Four topographic phases of the EOR2 soil units are recognized.

EOR2/3 is mapped on undulating landscapes where slopes are between 2 to 5 percent.

EOR2/4 is mapped on hummocky and gently rolling landscapes where slopes are between 6 to 9 percent.

EOR2/5 is mapped on hummocky landscapes where slopes are between 10 to 15 percent.

EOR2/6 is mapped on hummocky landscapes where slopes are between 16 to 30 percent.




*Undifferentiated

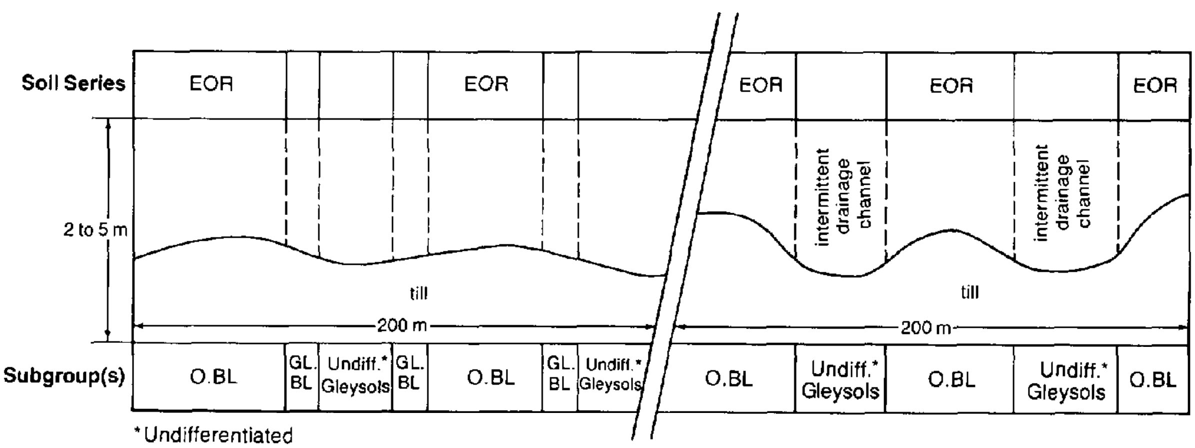
### EOR3

This unit contains mainly (40 to 60 percent) Chernozemic soils developed on medium-textured, weakly calcareous till. Orthic Black Chernozemics (EOR) are the dominant soils in this unit. Soils present in significant amounts (30 to 50 percent) include Gleyed Black Chernozemics (unnamed) and Gleysols. The significant soils are found on lower slopes and in depressional areas of the landscape.

EOR3 differs from EOR2 in that EOR3 contains a larger percentage (30 to 50 percent) of imperfectly and poorly drained soils.

One topographic phase of the EOR3 soil unit is recognized.

EOR3/3 is mapped on hummocky landscapes and in intermittant drainage channels where slopes are between 2 to 5 percent.




*Undifferentiated

## Appendix B. (continued)

### EOR6

This unit contains mainly (40 to 60 percent) Chernozemic soils developed on medium-textured, weakly calcareous till and lesser amounts (20 to 40 percent) of Chernozemic soils developed on stony and coarse-textured, weakly calcareous ice-contact and glaciofluvial materials. Orthic Black Chernozemics (EOR) are the dominant soils in this unit. Soils present in significant amounts (20 to 40 percent) are Orthic Black Chernozemics (AMT, ROS, IRM, KNA and RED). The significant soils are randomly distributed in the landscape.

EOR6 differs from EOR1 in that EOR6 contains a larger percentage (20 to 40 percent) of coarse-textured ice-contact and glaciofluvial materials.

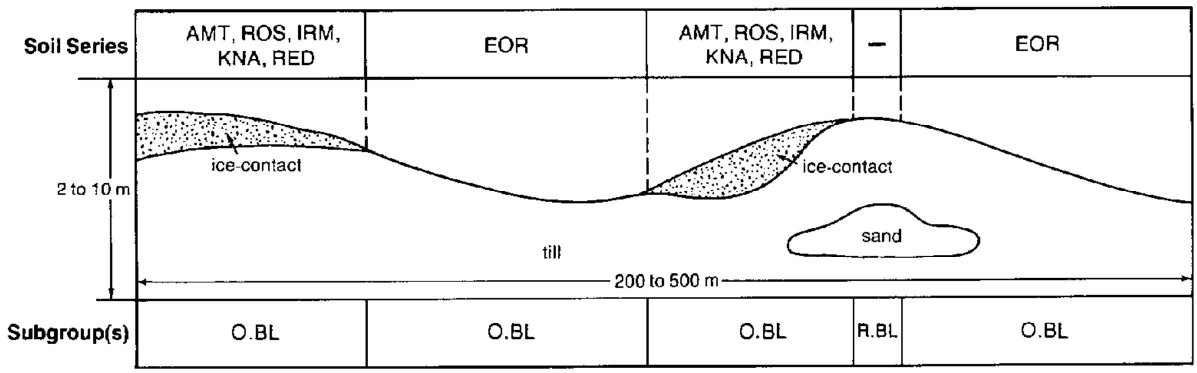
EOR6 differs from EOR2 in that EOR6 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils and contains a larger percentage (20 to 40 percent) of coarse-textured materials.

Three topographic phases of the EOR6 soil units are recognized.

EOR6/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

EOR6/4 is mapped on hummocky landscapes where slopes are between 6 to 9 percent.

EOR6/5 is mapped on hummocky landscapes where slopes are between 10 to 15 percent.




### EOR8

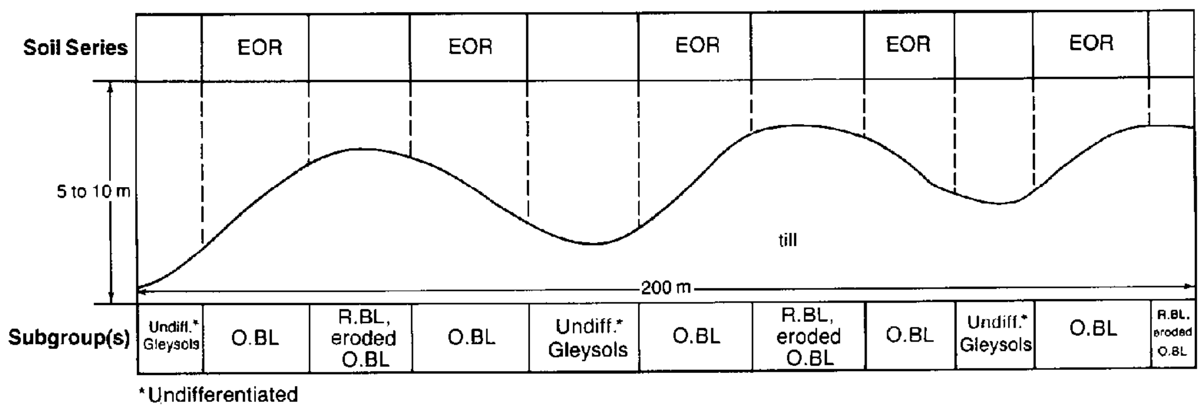
This unit contains mainly (60 to 80 percent) Chernozemic soils developed on medium-textured, weakly calcareous till. Orthic Black Chernozemics (EOR) are the dominant soils in this unit. Soils present in significant amounts (20 to 40 percent) include Rego Black Chernozemics (unnamed), eroded Black Chernozemics (unnamed), Gleyed Black Chernozemics (unnamed) and Gleysols. The Rego and eroded Black Chernozemics are found on upper slope and crest positions and the Gleyed Black Chernozemics and Gleysols are found on lower slopes and in depressional areas of the landscape.

EOR8 differs from EOR10 in that EOR8 contains a larger percentage (10 to 25 percent) of imperfectly and poorly drained soils.

Two topographic phases of the EOR8 soil units are recognized.

EOR8/4 is mapped on hummocky landscapes where slopes are between 6 to 9 percent.

EOR8/5 is mapped on hummocky landscapes where slopes are between 10 to 15 percent.



## **Appendix B.** (continued)

**EOR10**

This unit contains mainly (90 to 100 percent) Chernozemic soils developed on medium-textured, weakly calcareous till. Orthic Black Chernozemics (EOR) are the dominant soils in this unit. Soils present in significant amounts (10 to 25 percent) include Rego Black Chernozemics (unnamed) and eroded Black Chernozemics (unnamed) in which the A horizons have either been eroded off or been diluted by the B horizon. The significant soils are found on upper slope and crest positions of the landscape. Inclusions of coarser-textured soils may be present in areas with steeper topography.

EOR10 differs from EOR8 in that EOR10 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

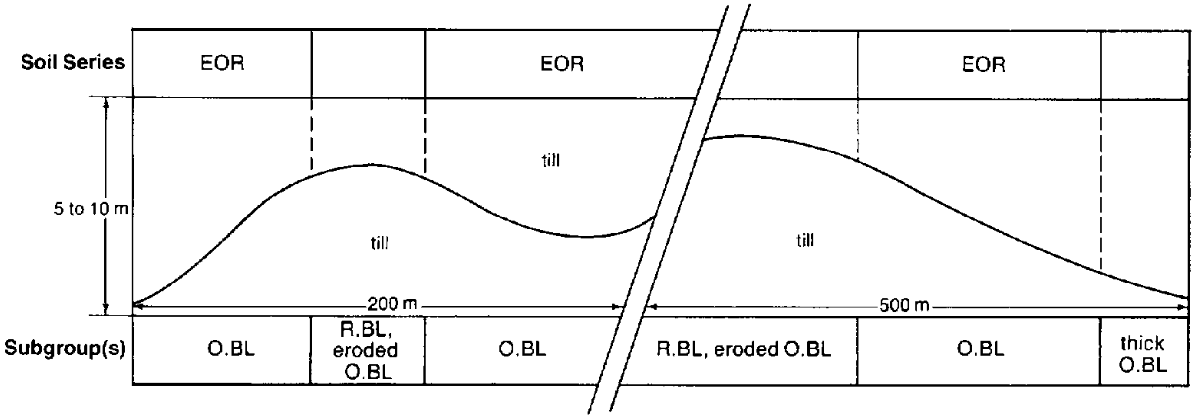
EOR10 differs from EOR1 in that EOR10 contains a larger percentage (10 to 25 percent) of eroded soils.

Three topographic phases of the EOR10 soil units are recognized.

EOR10/4 is mapped on hummocky and gently rolling landscapes where slopes are between 6 to 9 percent.

EOR10/5 is mapped on hummocky and strongly rolling landscapes where slopes are between 10 to 15 percent.

EOR10/6 is mapped on hummocky landscapes where slopes are between 16 to 30 percent.




**EORO1**

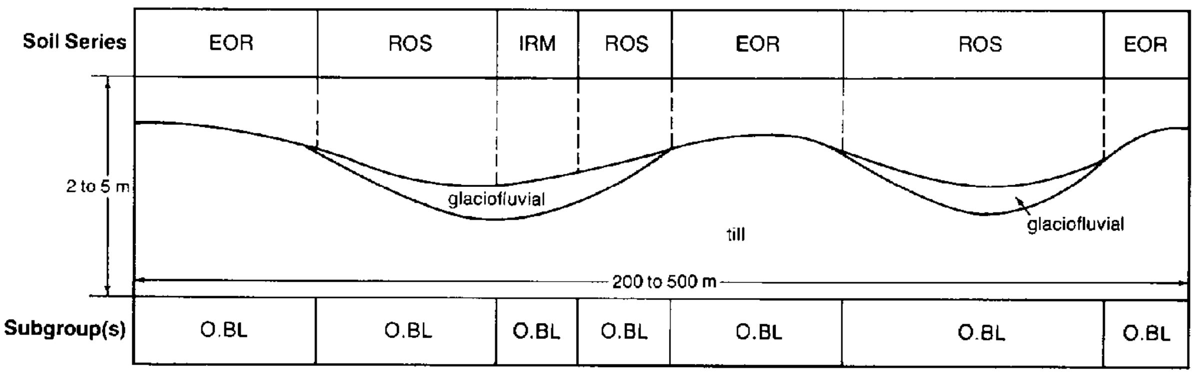
This unit contains mainly (80 to 100 percent) Chernozemic soils developed on discontinuous coarse-textured, noncalcareous glaciofluvial materials overlying medium-textured, weakly calcareous till. Orthic Black Chernozemics developed on till (EOR) and on glaciofluvial (ROS) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) include Orthic Black Chernozemics developed on glaciofluvial (IRM). The minor soils are randomly distributed in the landscape.

EORO1 differs from EORO2 in that EORO1 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

Two topographic phases of the EORO1 soil units are recognized.

EORO1/3 is mapped on gently undulating landscapes where slopes are between 2 and 5 percent.

EORO1/4 is mapped on hummocky landscapes where slopes are between 6 to 9 percent.



## Appendix B. (continued)

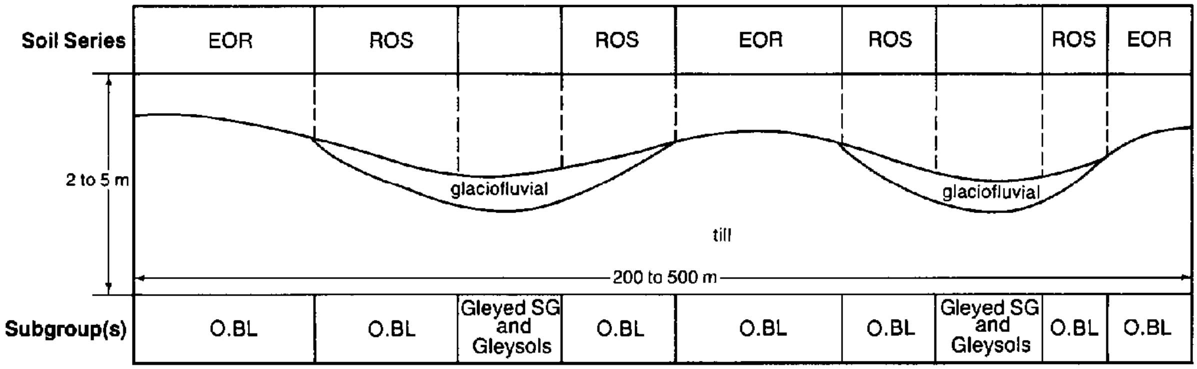
### EORO2

This unit contains mainly (60 to 80 percent) Chernozemic soils developed on discontinuous coarse-textured, noncalcareous glaciofluvial materials overlying medium-textured, weakly calcareous till. Orthic Black Chernozemics developed on till (EOR) and on glaciofluvial (ROS) are the dominant soils in this unit. Soils present in significant amounts (15 to 30 percent) include Orthic Black Chernozemics (IRM), Gleyed Black Chernozemics (unnamed) and Gleysols. Irma (IRM) soils are found on upper slope and crest positions. Gleyed Chernozemics and Gleysols are found on lower slope and depressional areas of the landscape.

EORO2 differs from EORO1 in that EORO2 contains a larger percentage (15 to 30 percent) of imperfectly and poorly drained soils.

One topographic phase of the EORO2 soil unit is recognized.

EORO2/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.



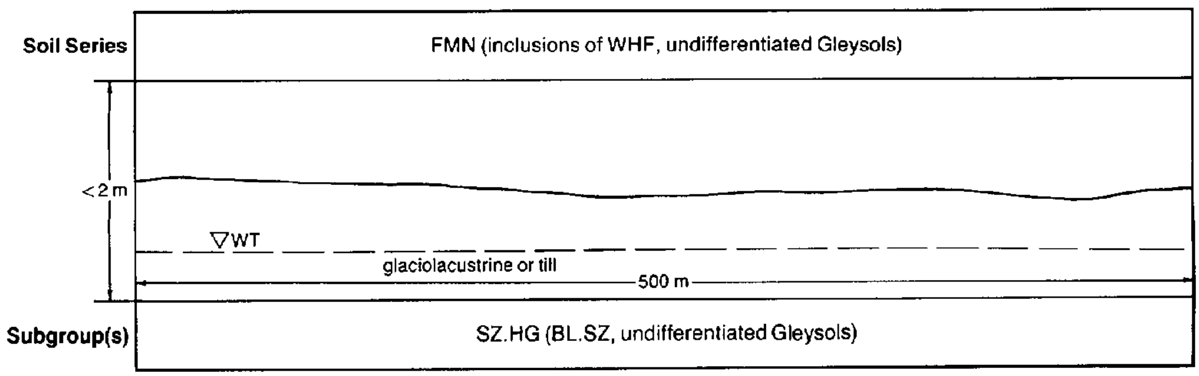

### FMN1

This unit contains mainly (80 to 100 percent) Gleysolic soils developed on medium- to fine-textured, moderately saline and sodic, weakly calcareous glaciolacustrine or till materials. Solonetzic Humic Gleysols (FMN) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) include Gleysols and Black Solonetz (DUG). The minor soils are randomly distributed in the landscape.

FMN1 differs from HGFM1 in that FMN1 contains a smaller percentage (less than 15 percent) of Orthic Humic Gleysols (HGT, HYL).

One topographic phase of the FMN1 soil unit is recognized.

FMN1/2 is mapped on nearly level to depressional landscapes where slopes are between 0 to 2 percent.



## **Appendix B.** (continued)

### FST7

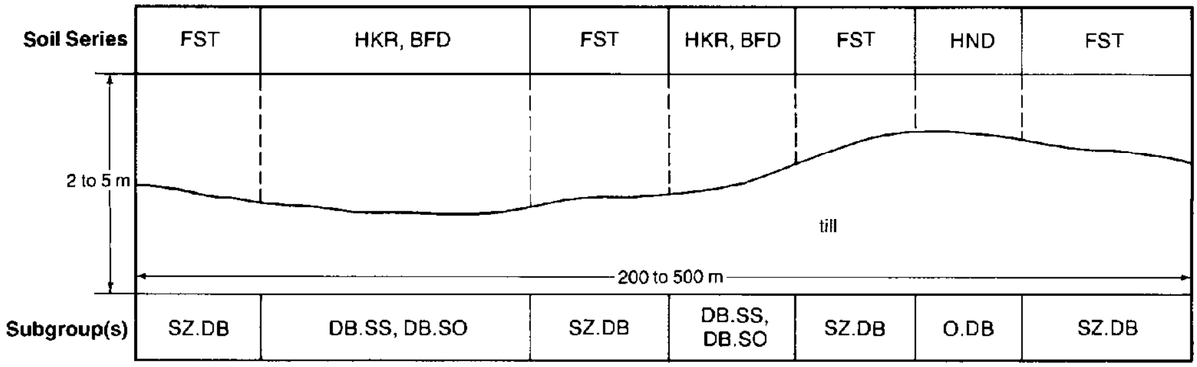
This unit contains mainly (50 to 80 percent) Chernozemic soils developed on medium-textured, weakly calcareous till. Solonetzic Dark Brown Chernozemics (FST) and Orthic Dark Brown Chernozemics (HND) are the dominant soils in this unit. Soils present in significant amounts (20 to 40 percent) include Dark Brown Solods (BFD) and Dark Brown Solodized Solonetz (HKR). The significant soils are found on mid and lower slopes of the landscape.

FST7 differs from FST9 in that FST7 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

Two topographic phases of the FST7 soil units are recognized.

FST7/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

FST7/4 is mapped on gently rolling to hummocky landscapes where slopes are between 6 to 9 percent.



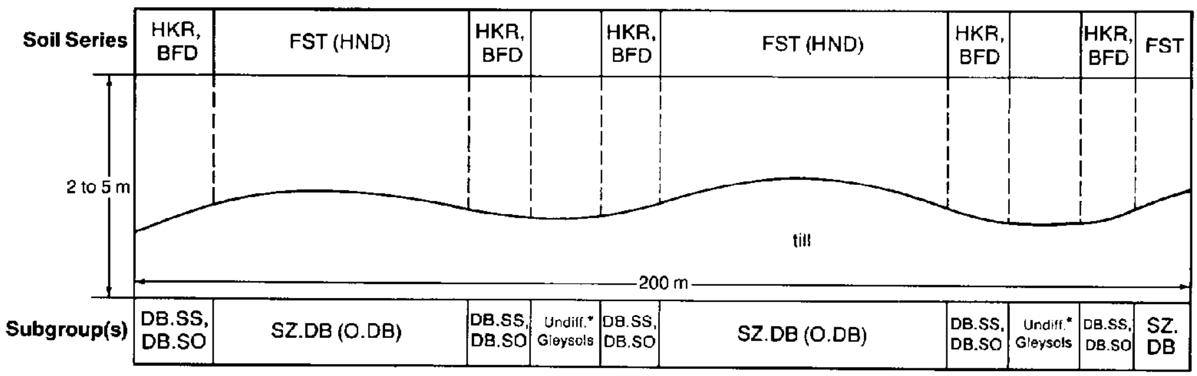

### FST9

This unit contains mainly (40 to 70 percent) Chernozemic soils developed on medium-textured, weakly calcareous till. Solonetzic Dark Brown Chernozemics (FST) and Orthic Dark Brown Chernozemics (HND) are the dominant soils in this unit. Soils present in significant amounts (20 to 40 percent) include Dark Brown Solods (BFD), Dark Brown Solodized Solonetz (HKR) and Gleysols. Halkirk (HKR) and Brownfield (BFD) soils are found on mid and lower slopes of the landscape. Gleysols are found in depressional areas of the landscape.

FST9 differs from FST7 in that FST9 contains a larger percentage (15 to 30 percent) of imperfectly and poorly drained soils.

One topographic phase of the FST9 soil unit is recognized.

FST9/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.




*Undifferentiated

## Appendix B. (continued)

### HER4

This unit contains mainly (50 to 80 percent) Chernozemic soils developed on medium-textured, weakly calcareous till. Solonetzic Black Chernozemics (HER) and Orthic Black Chernozemics (EOR) are the dominant soils in this unit. Soils present in significant amounts (15 to 30 percent) include Black Solodized Solonetz (KLM) and Black Solods (DYD). The significant soils are found on mid and lower slopes of the landscape.

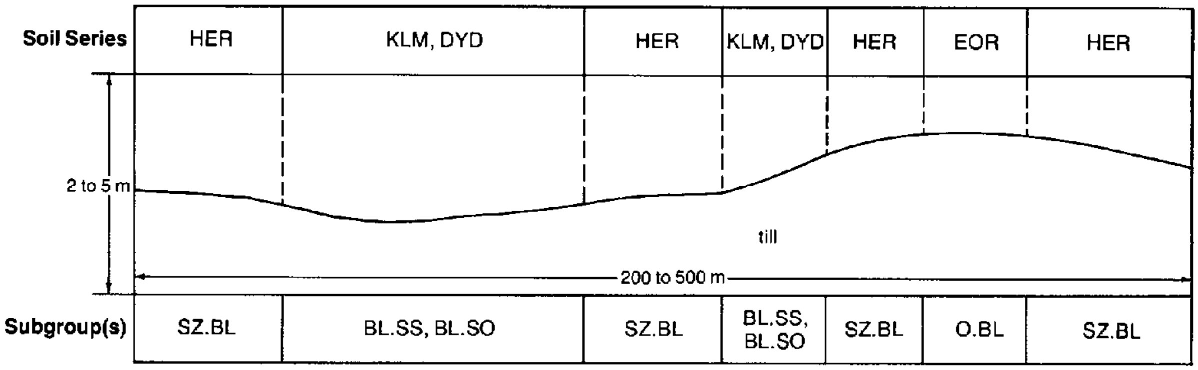
HER4 differs from HER5 in that HER4 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

HER4 differs from EOR1 in that HER4 contains a larger percentage (15 to 30 percent) of Solonetzic soils.

Two topographic phases of the HER4 soil units are recognized.

HER4/3 is mapped on gently undulating and hummocky landscapes where slopes are between 2 to 5 percent.

HER4/4 is mapped on hummocky landscapes where slopes are between 6 to 9 percent.




### HER5

This unit contains mainly (40 to 70 percent) Chernozemic soils developed on medium-textured, weakly calcareous till. Solonetzic Black Chernozemics (HER) and Orthic Black Chernozemics (EOR) are the dominant soils in this unit. Soils present in significant amounts (15 to 30 percent) include Black Solodized Solonetz (KLM), Black Solods (DYD) and Gleysols. Solonetzic soils are found on mid and lower slopes in the landscape. Gleysols are found in depressional areas of the landscape.

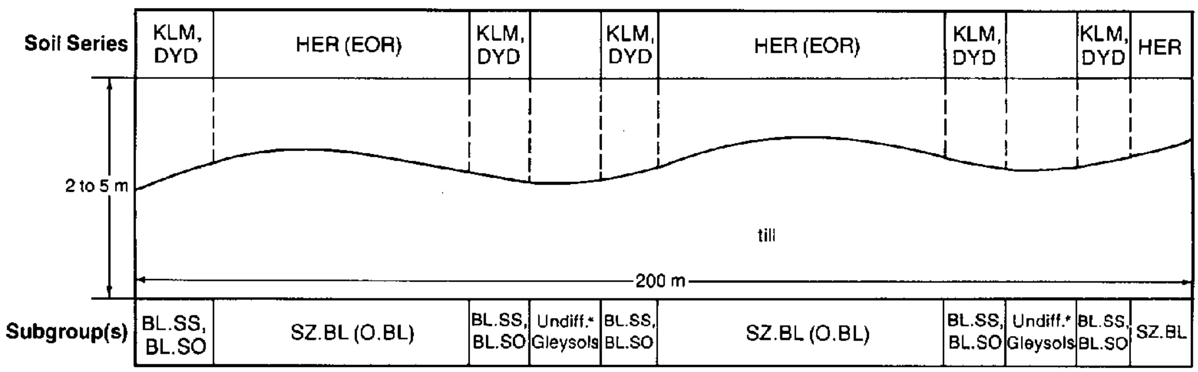
HER5 differs from HER4 in that HER5 contains a larger percentage (15 to 30 percent) of imperfectly and poorly drained soils.

HER5 differs from EOR2 in that HER5 contains a larger percentage (15 to 30 percent) of Solonetzic soils.

Two topographic phases of the HER5 soil units are recognized.

HER5/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

HER5/4 is mapped on gently rolling landscapes where slopes are between 6 to 9 percent.




*Undifferentiated

## Appendix B. (continued)

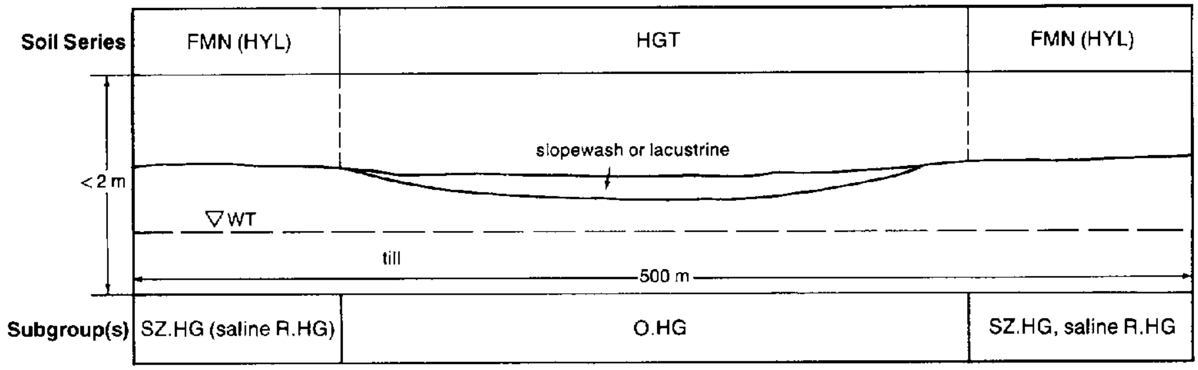
### HGFM1

This azonal unit contains mainly (80 to 100 percent) Gleysolic soils developed on medium- to fine-textured, weakly saline and sodic, weakly calcareous glaciolacustrine materials. Orthic Humic Gleysols (HGT) and Solonetzic Humic Gleysols (FMN) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) are saline Rego Humic Gleysols (HYL). These minor soils are randomly distributed in the landscape.

HGFM1 differs from HGT1, HGT2 and HGT3 in that HGFM1 contains a larger percentage (30 to 50 percent) of Solonetzic Humic Gleysols (FMN).

One topographic phase of the HGFM1 soil unit is recognized.

HGFM1/2 is mapped on nearly level landscapes where slopes are between 0.5 to 2 percent.




### HGT1

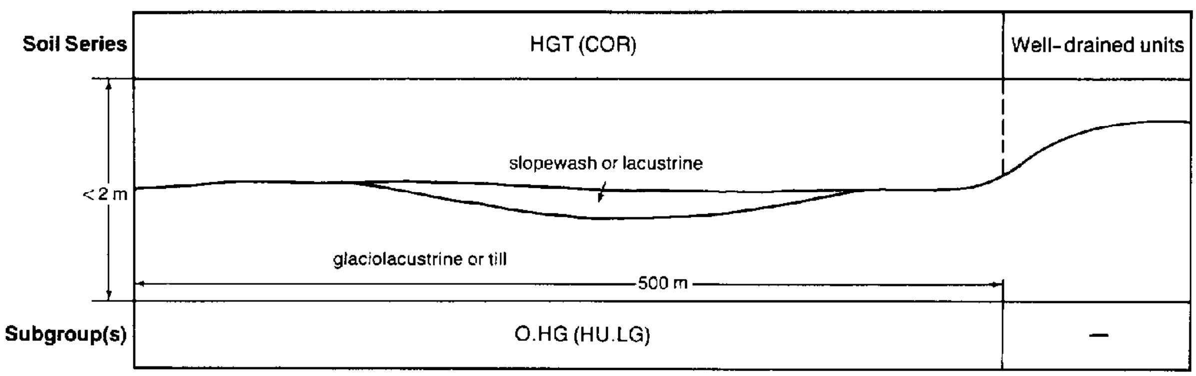
This azonal unit contains mainly (80 to 100 percent) Gleysolic soils developed on medium- to fine-textured, weakly calcareous glaciolacustrine materials. Orthic Humic Gleysols (HGT) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) include Humic Luvic Gleysols (COR) and Rego Humic Gleysols (unnamed). These soils are randomly distributed in the landscape.

HGT1 differs from HGFM1 in that HGT1 contains a smaller percentage (less than 15 percent) of Solonetzic Humic Gleysols (FMN).

HGT1 differs from HGT2 and HGT3 in that HGT1 contains a smaller percentage (less than 15 percent) of Chernozemic soils.

One topographic phase of the HGT1 soil unit is recognized.

HGT1/2 is mapped on nearly level landscapes where slopes are between 0.5 to 2 percent.



## Appendix B. (continued)

### HGT2

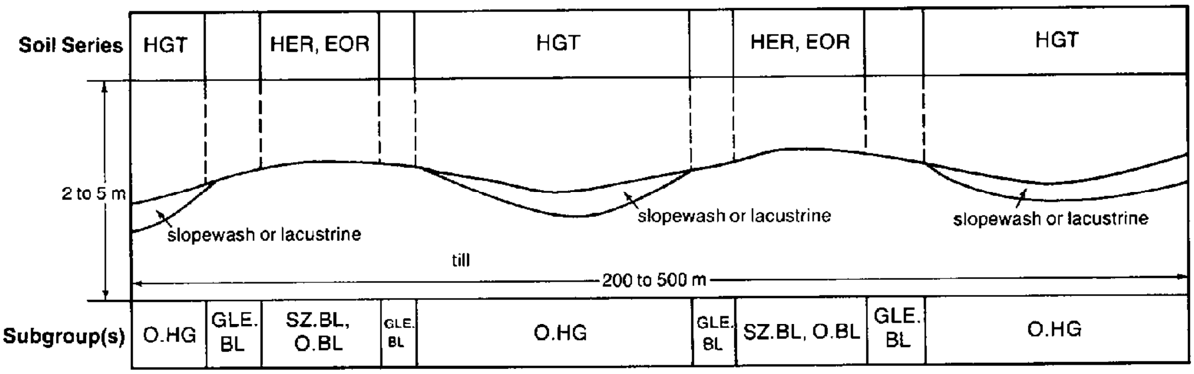
This azonal unit contains mainly (40 to 80 percent) Gleysolic soils developed on medium- to fine-textured, weakly calcareous glaciolacustrine materials. Orthic Humic Gleysols (HGT) are the dominant soils in this unit. Soils present in significant amounts (15 to 30 percent) include Gleyed Eluviated Black Chernozemics (PIB), Orthic Black Chernozemics (EOR) and Solonetzic Black Chernozemics (HER). These soils occupy lower to crest positions in the landscape. Open water is present in minor amounts (less than 15 percent) in this unit.

HGT2 differs from HGFM1 and HGT1 in that HGT2 contains a larger percentage (20 to 50 percent) of well-drained Chernozemic soils.

HGT2 differs from HGT3 in that HGT3 units occupy small intermittent drainage channels.

One topographic phase of the HGT2 soil unit is recognized.

HGT2/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.




### HGT3

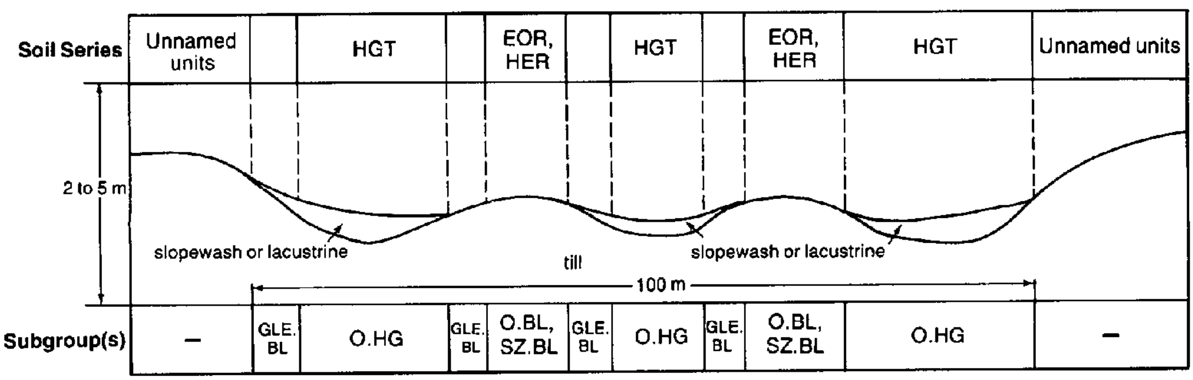
This azonal unit contains mainly (40 to 80 percent) Gleysolic soils developed on medium- to fine-textured, weakly calcareous glaciolacustrine materials. Orthic Humic Gleysols (HGT) are the dominant soils in this unit. Soils present in significant amounts (20 to 50 percent) include Gleyed Eluviated Black Chernozemics (PIB), Orthic Black Chernozemics (EOR) and Solonetzic Black Chernozemics (HER). These soils occupy lower to crest positions in the landscape. Open water is present in minor amounts (less than 15 percent) in this unit.

HGT3 differs from HGT1 and HGFM1 in that HGT3 contains a larger percentage (20 to 50 percent) of well-drained Chernozemic soils.

HGT3 differs from HGT2 in that HGT3 units occupy intermittent drainage channels.

One topographic phase of the HGT3 soil unit is recognized.

HGT3/3 is mapped on small drainage channels where slopes are between 2 to 5 percent.



## Appendix B. (continued)

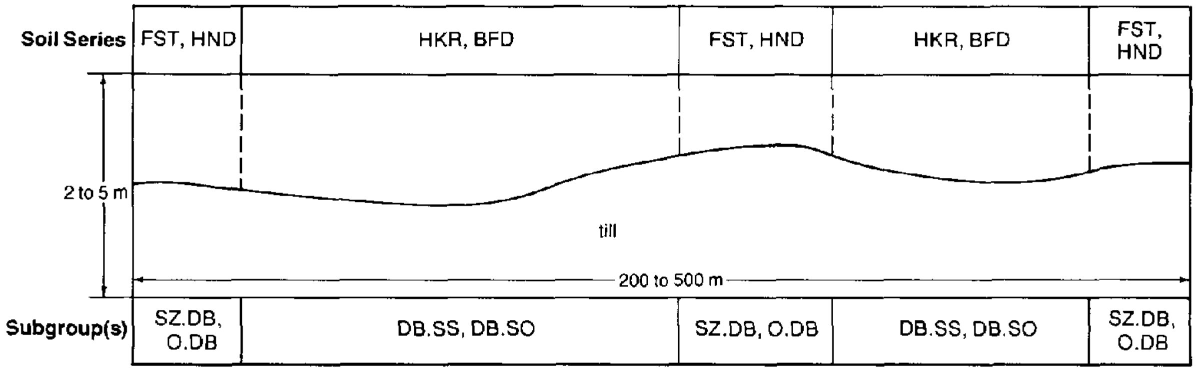
### HKBF1

This unit contains mainly (40 to 70 percent) Solonetzic soils developed on medium-textured, moderately saline and sodic, weakly calcareous till. Dark Brown Solodized Solonetz (HKR) and Dark Brown Solods (BFD) are the dominant soils in this unit. Soils present in significant amounts (20 to 50 percent) include Solonetzic Dark Brown Chernozemics (HER) and Orthic Dark Brown Chernozemics (HND). These soils occupy upper and crest positions in the landscape.

HKBF1 differs from HKBF2 in that HKBF1 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

One topographic phase of the HKBF1 soil unit is recognized.

HKBF1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.




### HKBF2

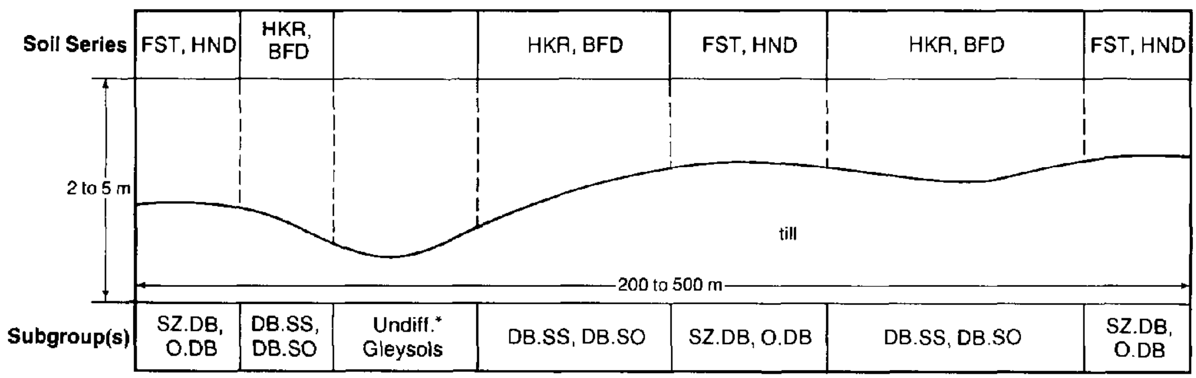
This unit contains mainly (40 to 70 percent) Solonetzic soils developed on medium-textured, moderately saline and sodic, weakly calcareous till. Dark Brown Solodized Solonetz (HKR) and Dark Brown Solods (BFD) are the dominant soils in this unit. Soils present in significant amounts (20 to 40 percent) are Orthic Dark Brown Chernozemics (HND) and Solonetzic Dark Brown Chernozemics (FST). These soils are found on upper and crest positions in the landscape. Soils also present in significant amounts (15 to 30 percent) are Gleysols.

These soils are found in depressional areas of the landscape.

HKBF2 differs from HKBF1 in that HKBF2 contains a larger percentage (15 to 30 percent) of imperfectly and poorly drained soils.

One topographic phase of the HKBF2 soil unit is recognized.

HKBF2/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.




*Undifferentiated

## Appendix B. (continued)

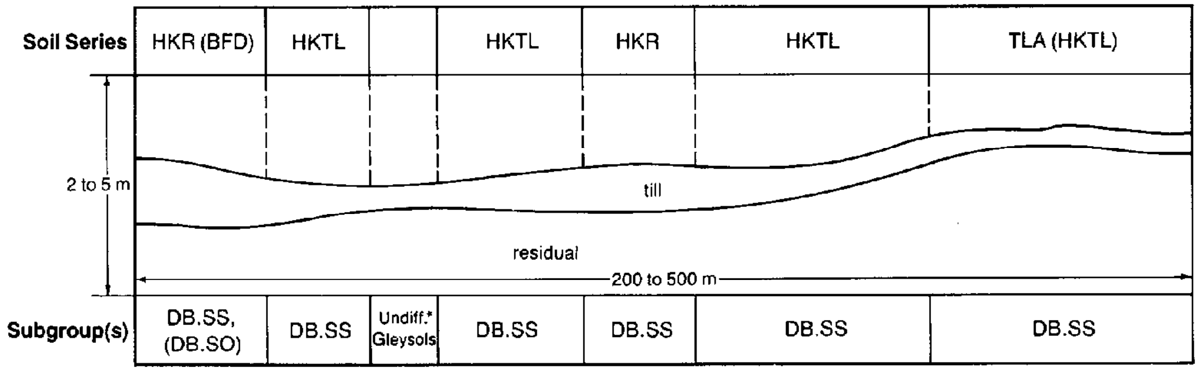
### HKTL1

This unit contains mainly (40 to 70 percent) Solonetzic soils developed on a medium-textured, moderately saline and sodic, weakly calcareous till veneer overlying weathered residual bedrock. Dark Brown Solodized Solonetz developed on till (HKR) and on weathered residual (TLA) are the dominant soils in this unit. Soils present in significant amounts (20 to 40 percent) include Dark Brown Solods (BFD), Solonetzic Dark Brown Chernozemics (FST) and Orthic Dark Brown Chernozemics (HND). These soils are randomly distributed in the landscape.

Two topographic phases of the HKTL1 soil units are recognized.

HKTL1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

HKTL1/4 is mapped on gently rolling landscapes where slopes are between 6 to 9 percent.




*Undifferentiated

### HND1

This unit contains mainly (70 to 90 percent) Chernozemics developed on medium-textured, moderately calcareous till. Orthic Dark Brown Chernozemics (HND) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) include Gleyed Dark Brown Chernozemics (unnamed) and Rego Dark Brown Chernozemics (NUT). The significant soils are found on lower slopes and crests of the landscape, respectively.

HND1 differs from HND2 and HND3 in that HND1 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

HND1 differs from HND4 in that HND1 contains a smaller percentage (less than 15 percent) of eroded soils.

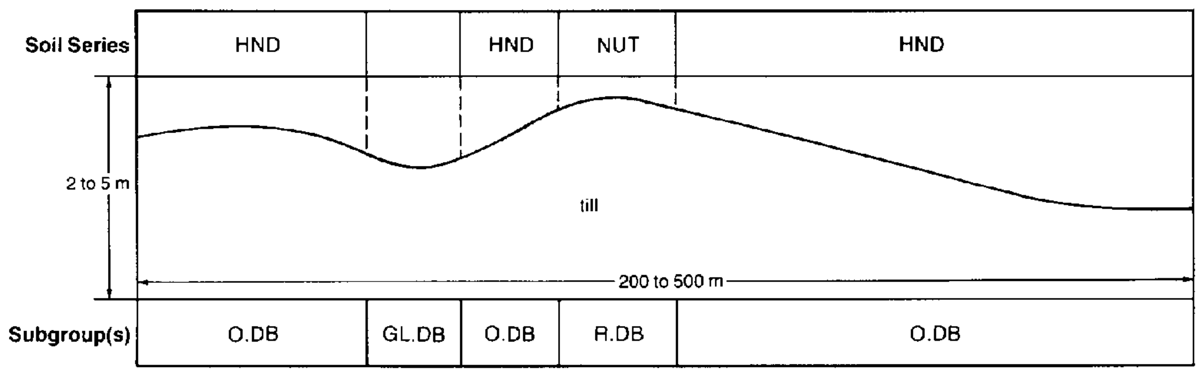
HND1 differs from HND6 in that HND1 contains a smaller percentage (less than 15 percent) of coarse-textured soils.

HND1 differs from HND8 in that HND1 contains a smaller percentage (less than 15 percent) of eroded soils and imperfectly and poorly drained soils.

Two topographic phases of the HND1 soil units are recognized.

HND1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

HND1/4 is mapped on hummocky and ridged landscapes where slopes are between 6 to 9 percent.



## Appendix B. (continued)

### HND2

This unit contains mainly (60 to 80 percent) Chernozemic soils developed on medium-textured, moderately calcareous till. Orthic Dark Brown Chernozemics (HND) are the dominant soils in this unit. Soils present in significant amounts (15 to 30 percent) include Gleyed Dark Brown Chernozemics (unnamed) and Gleysols. The significant soils are found on lower slopes and in depressional areas of the landscape.

HND2 differs from HND1 in that HND2 contains a larger percentage (15 to 30 percent) of imperfectly and poorly drained soils.

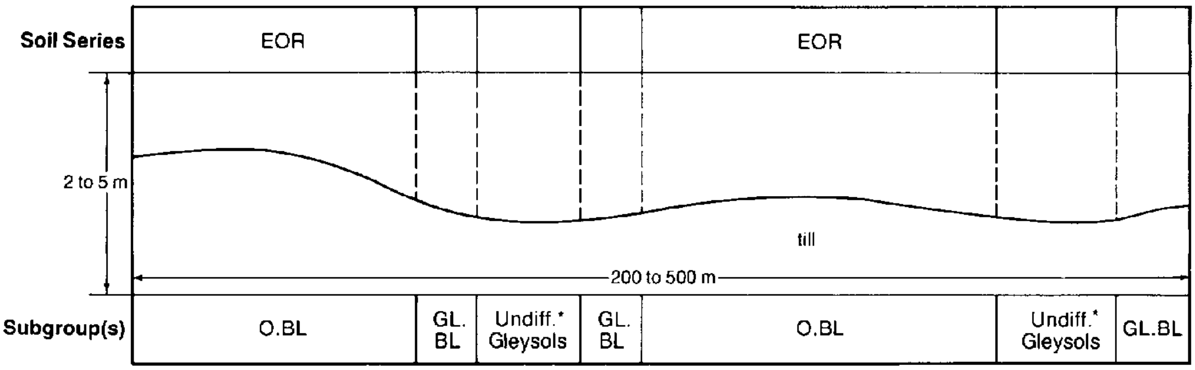
HND2 differs from HND3 in that HND3 units are mapped in intermittent drainage channels and contains a larger percentage (30 to 50 percent) of imperfectly and poorly drained soils.

HND2 differs from HND8 in that HND2 contains a smaller percentage (less than 15 percent) of eroded soils.

Two topographic phases of the HND2 soil units are recognized.

HND2/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

HND2/4 is mapped on hummocky landscapes where slopes are between 6 to 9 percent.




*Undifferentiated

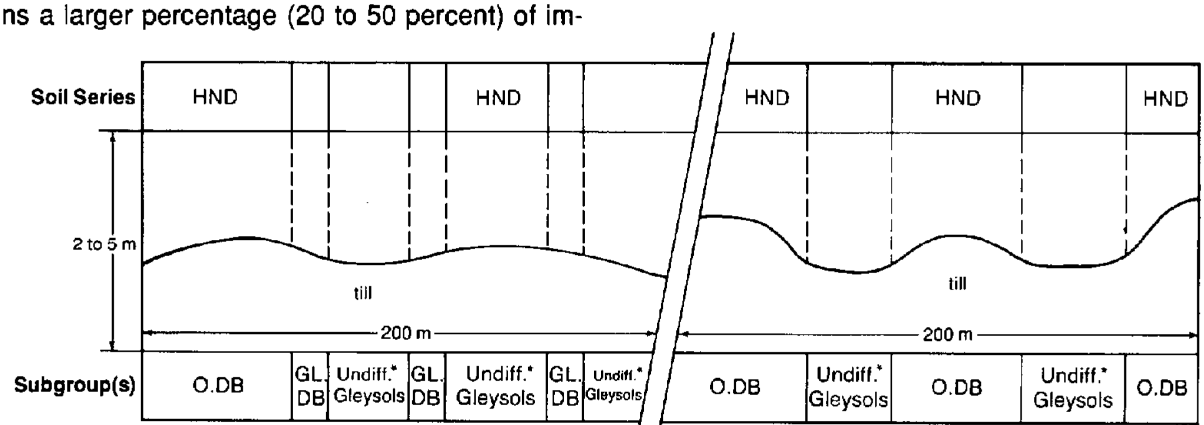
### HND3

This unit contains mainly (40 to 60 percent) Chernozemic soils developed on medium-textured, moderately calcareous till. Orthic Dark Brown Chernozemics (HND) are the dominant soils in this unit. Soils present in significant amounts (20 to 50 percent) include Gleyed Dark Brown Chernozemics (unnamed) and Gleysols. These soils are found on lower slopes and in depressional areas of the landscape.

HND3 differs from HND2 and HND8 in that HND3 contains a larger percentage (20 to 50 percent) of imperfectly and poorly drained soils and is mapped in intermittent drainage channels.

One topographic phase of the HND3 soil unit is recognized.

HND3/3 is mapped on gently undulating landscapes and in intermittent drainage channels where slopes are between 2 to 5 percent.




*Undifferentiated

## Appendix B. (continued)

### HND4

This unit contains mainly (50 to 80 percent) Chernozemic soils developed on medium-textured, moderately calcareous till. Orthic Dark Brown Chernozemics (HND) are the dominant soils in this unit. Soils present in significant amounts (20 to 40 percent) include Calcareous Dark Brown Chernozemics (NUT) and eroded Orthic Dark Brown Chernozemics (unnamed). These soils are found on upper and crest positions in the landscape.

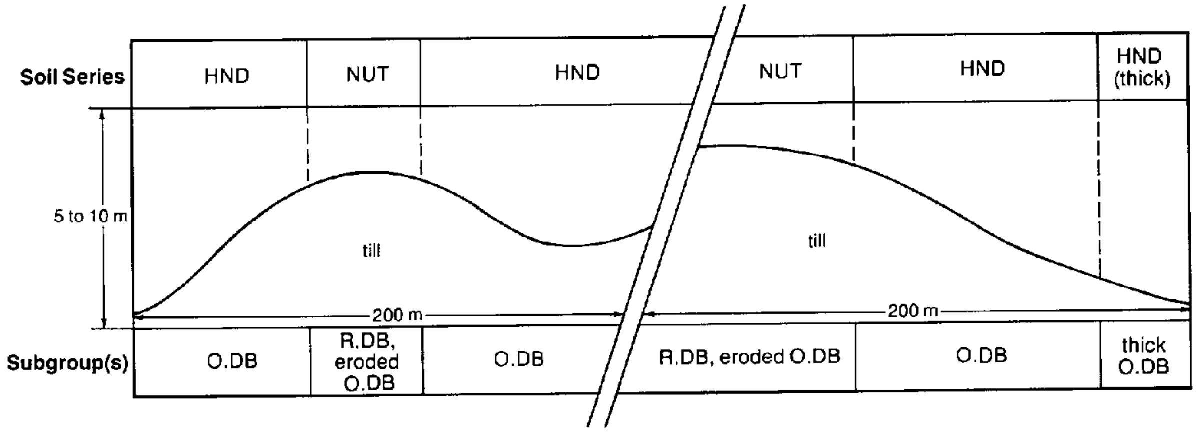
HND4 differs from HND1 in that HND4 contains a larger percentage (20 to 40 percent) of eroded soils.

HND4 differs from HND8 in that HND4 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

Two topographic phases of the HND4 soil units are recognized.

HND4/4 is mapped on hummocky or inclined landscapes where slopes are between 6 to 9 percent.

HND4/5 is mapped on hummocky or inclined landscapes where slopes are between 10 to 15 percent.




### HND6

This unit contains mainly (70 to 100 percent) Chernozemic soils developed on medium-textured, moderately calcareous till and coarse-textured, weakly calcareous, ice-contact materials. Orthic Dark Brown Chernozemics (HND) are the dominant soils in this unit. Soils present in significant amounts (15 to 50 percent) include Orthic Dark Brown Chernozemics developed on glaciofluvial materials (OAS, DCY, MET, WWT, SCD). The significant soils are randomly distributed in the landscape.

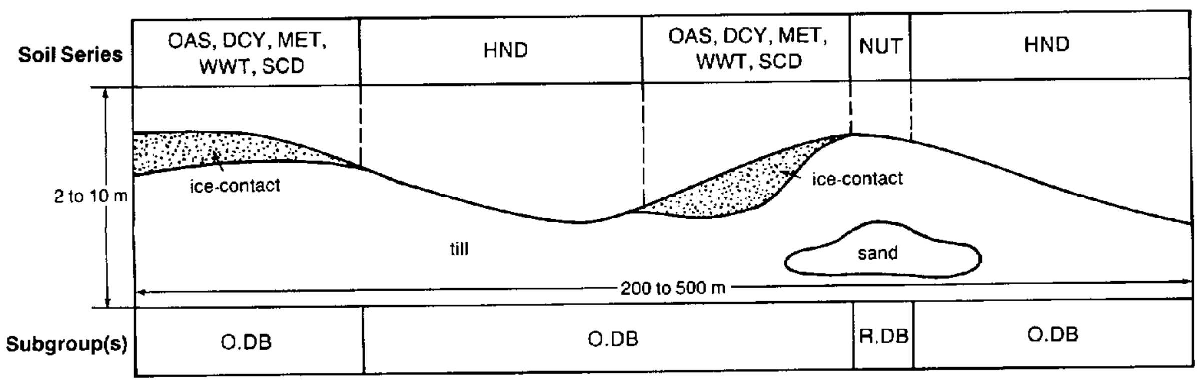
HND6 differs from HND1 in that HND6 contains a larger percentage (15 to 50 percent) of coarse-textured soils.

Three topographic phases of the HND6 map units are recognized.

HND6/3 is mapped on hummocky landscapes where slopes are between 2 to 5 percent.

HND6/4 is mapped on hummocky landscapes where slopes are between 6 to 9 percent.

HND6/5 is mapped on hummocky landscapes where slopes are between 10 to 15 percent.



## Appendix B. (continued)

### HNDC1

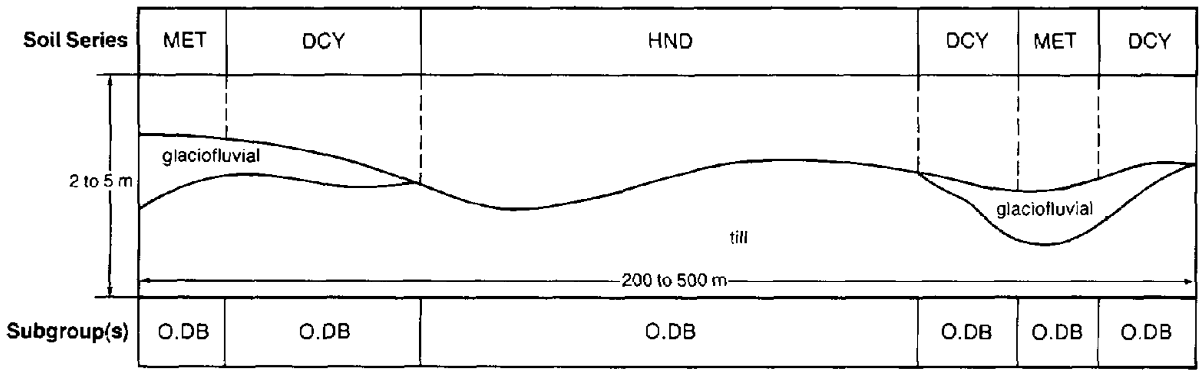
This unit contains mainly (70 to 100 percent) Chernozemic soils developed on discontinuous, coarse-textured, noncalcareous glaciofluvial materials overlying medium-textured, weakly calcareous till. Orthic Dark Brown Chernozemics developed on till (HND) and on glaciofluvial veneer overlying till (DCY) are the dominant soils in these units. Soils present in significant amounts (20 to 40 percent) are Orthic Dark Brown Chernozemics (MET). Metisko (MET) soils are randomly distributed in the landscape.

HNDC1 differs from HNDC2 in that HNDC1 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

Two topographic phases of the HNDC1 soil units are recognized.

HNDC1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

HNDC1/4 is mapped on gently undulating landscapes where slopes are between 6 to 9 percent.



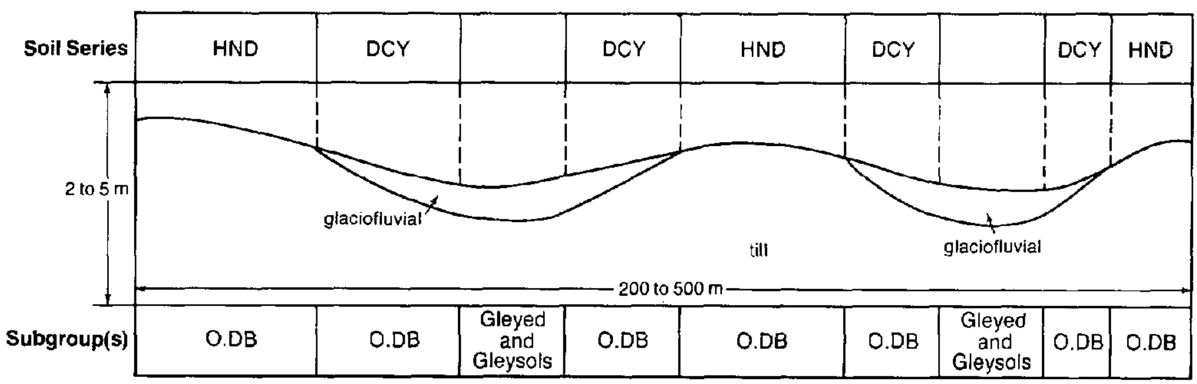

### HNDC2

This unit contains mainly (60 to 80 percent) Chernozemic soils developed on discontinuous, coarse-textured, noncalcareous glaciofluvial materials overlying medium-textured, weakly calcareous till. Orthic Dark Brown Chernozemics developed on till (HND) and on glaciofluvial veneer overlying till (DCY) are the dominant soils in this unit. Soils present in significant amounts (15 to 30 percent) are Orthic Dark Brown Chernozemics (MET) and Gleysols. Metisko (MET) soils are randomly distributed in the landscape. Gleysols are found in depressional areas of the landscape.

HNDC2 differs from HNDC1 in that HNDC2 contains a larger percentage (15 to 30 percent) of imperfectly and poorly drained soils.

One topographic phase of the HNDC2 soil unit is recognized.

HNDC2/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.



## Appendix B. (continued)

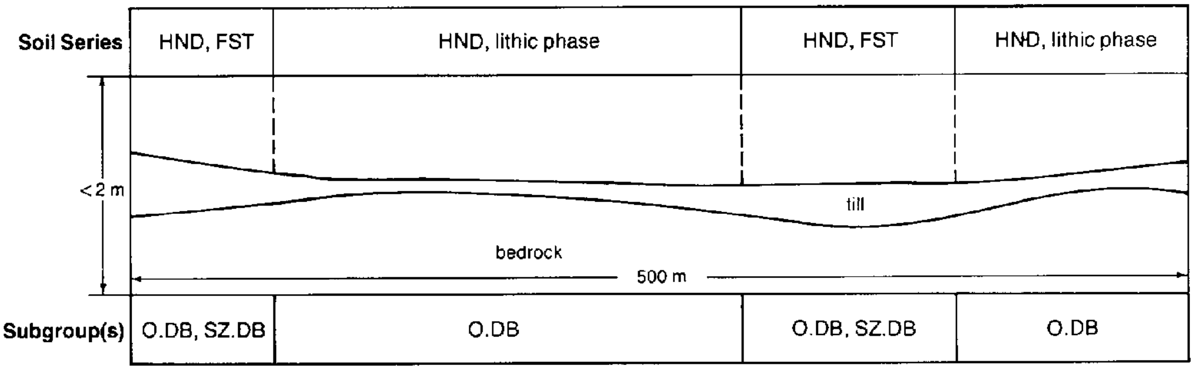
### HN:L1

This unit contains mainly (80 to 100 percent) Chernozemic soils developed on a medium-textured, weakly calcareous till veneer overlying bedrock. Orthic Dark Brown Chernozemics (HND, lithic phase) are the dominant soils in this unit. Soils present in significant amounts (15 to 30 percent) include Orthic Dark Brown Chernozemics (HND) and Solonetzic Dark Brown Chernozemics (FST). The significant soils are randomly distributed in the landscape.

HN:L1 differs from HND1 in that HN:L1 contains dominant amounts (50 to 70 percent) of soils developed on thin (50 to 100 cm) till veneer overlying bedrock.

One topographic phase of the HN:L1 soil unit is recognized.

HN:L1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

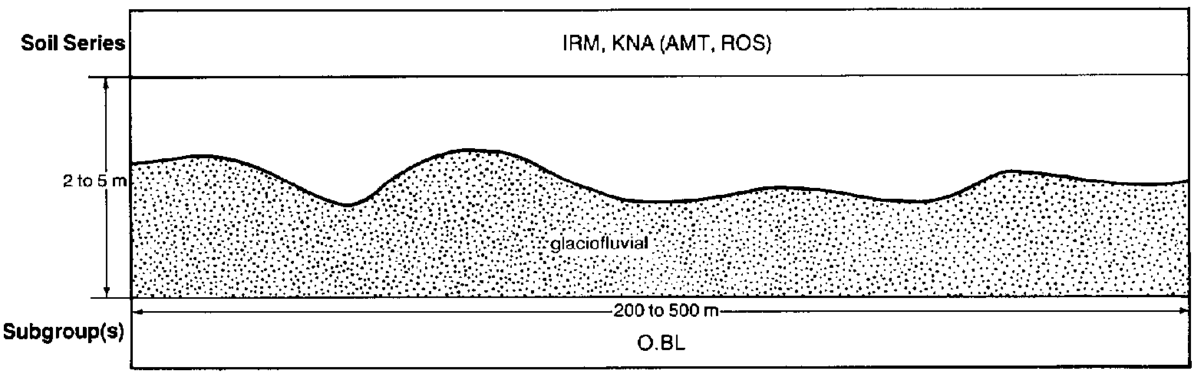



### IRKN1

This unit contains mainly (70 to 90 percent) Chernozemic soils developed on coarse and gravelly coarse textured, weakly calcareous glaciofluvial materials. Orthic Black Chernozemics developed on sandy loam glaciofluvial (IRM) and on gravelly glaciofluvial (KNA) are the dominant soils in this unit. Soils present in significant amounts (20 to 40 percent) include Orthic Black Chernozemics (AMT, ROS). The significant soils are randomly distributed in the landscape.

One topographic phase of the IRKN1 soil unit is recognized.

IRKN1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.



## Appendix B. (continued)

### IRRO1

This unit contains mainly (70 to 100 percent) Chernozemic soils developed on coarse-textured, noncalcareous glaciofluvial materials overlying medium-textured, weakly calcareous till. Orthic Black Chernozemics developed on glaciofluvial blanket (IRM) and on glaciofluvial veneer overlying till (ROS) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) are Orthic Black Chernozemics (IRM). The minor soils are randomly distributed in the landscape.

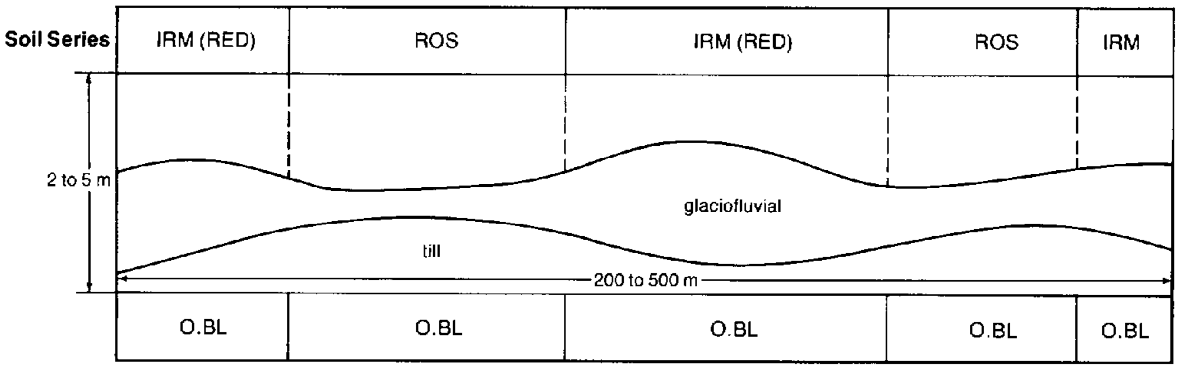
IRRO1 differs from IRRO2 in that IRRO1 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

IRRO1 differs from IRRO10 in that IRRO1 contains a smaller percentage (less than 15 percent) of eroded profiles.

Two topographic phases of the IRRO1 soil units are recognized.

IRRO1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

IRRO1/4 is mapped on hummocky or inclined landscapes where slopes are between 6 to 9 percent.



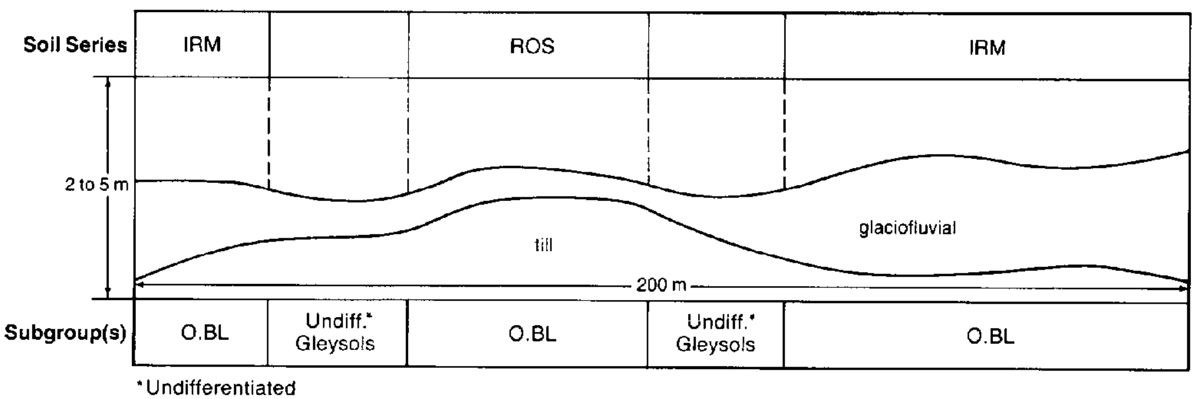

### IRRO2

This unit contains mainly (60 to 80 percent) Chernozemic soils developed on coarse-textured, noncalcareous glaciofluvial materials overlying medium-textured, weakly calcareous till. Orthic Black Chernozemics developed on glaciofluvial blanket (IRM) and on glaciofluvial veneer overlying till (ROS) are the dominant soils in this unit. Soils present in significant amounts (15 to 30 percent) are Gleysols. The significant soils are found in depressional areas of the landscape.

IRRO2 differs from IRRO1 in that IRRO2 contains a larger percentage (15 to 30 percent) of imperfectly and poorly drained soils.

One topographic phase of the IRRO2 soil unit is recognized.

IRRO2/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.



## Appendix B. (continued)

**IRRO10**

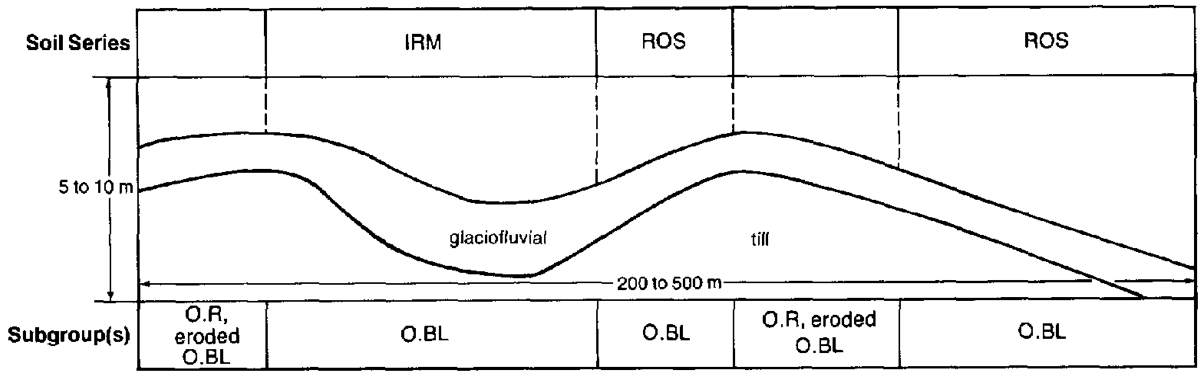
This unit contains mainly (70 to 90 percent) Chernozemic soils developed on coarse-textured, noncalcareous glaciofluvial materials overlying medium-textured, weakly calcareous till. Orthic Black Chernozemics developed on glaciofluvial (IRM) and on glaciofluvial veneer overlying till (ROS) are the dominant soils in this unit. Soils present in significant amounts (20 to 40 percent) are Orthic Regosols (unnamed) and eroded Black Chernozemics (unnamed). The significant soils are found on upper slope and crest positions of the landscape.

IRRO10 differs from IRRO1 in that IRRO10 contains a larger percentage (20 to 40 percent) of eroded and Regosolic soils.

IRRO10 differs from IRRO2 in that IRRO10 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

One topographic phase of the IRRO10 soil unit is recognized.

IRRO10/4 is mapped on hummocky or inclined landscapes where slopes are between 6 to 9 percent.




**KLM4**

This unit contains mainly (40 to 80 percent) Solonetzic soils developed on medium-textured, moderately saline and sodic, weakly calcareous till. Black Solodized Solonetz (KLM) and Black Solods (DYD) are the dominant soils in this unit. Soils present in significant amounts (20 to 50 percent) are Solonetzic Black Chernozemics (HER) and Orthic Black Chernozemics (EOR). These soils are randomly distributed in the landscape.

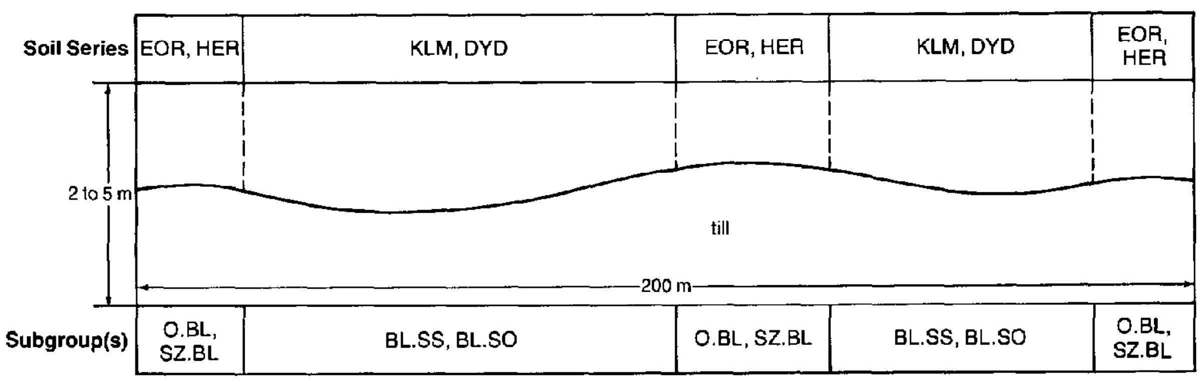
KLM4 differs from KLM5 in that KLM4 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

KLM4 differs from KLM6 in that KLM6 units are developed on thin till deposits overlying weathered residual materials.

KLM4 differs from KLM7 in that KLM7 units are developed on thin till deposits overlying weathered residual materials and contain a larger percentage (15 to 30 percent) of imperfectly and poorly drained soils.

One topographic phase of the KLM4 soil unit is recognized.

KLM4/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.



## Appendix B. (continued)

### KLM5

This unit contains mainly (40 to 80 percent) Solonetzic soils developed on medium-textured, moderately saline and sodic, weakly calcareous till. Black Solodized Solonetz (KLM) and Black Solods (DYD) are the dominant soils in this unit. Soils present in significant amounts (10 to 40 percent) include Solonetzic Black Chernozemics (HER), Orthic Black Chernozemics (EOR) and Gleysols. Gleysols are found in depressional areas of the landscape. Black Chernozemics are randomly distributed in the landscape.

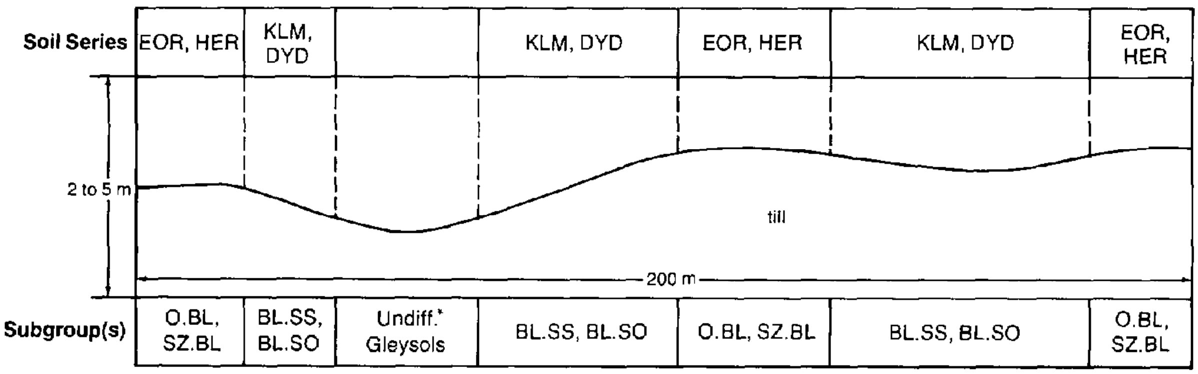
KLM5 differs from KLM4 in that KLM5 contains a larger percentage (10 to 40 percent) of imperfectly and poorly drained soils.

KLM5 differs from KLM6 in that KLM6 units are developed on thin till deposits overlying weathered residual materials and contain a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

KLM5 differs from KLM7 in that KLM7 units are developed on thin till deposits overlying weathered residual materials.

One topographic phase of the KLM5 soil unit is recognized.

KLM5/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.




*Undifferentiated

### KLM6

This unit contains mainly (50 to 80 percent) Solonetzic soils developed on a medium-textured, moderately saline and sodic, weakly calcareous till veneer overlying moderately saline and sodic weathered residual materials. Black Solodized Solonetz developed on till (KLM), Black Solodized Solonetz developed on weathered residual (SHS), and Black Solods (DYD) are the dominant soils in this unit. Soils present in significant amounts (20 to 40 percent) are Solonetzic Black Chernozemics (HER) and Orthic Black Chernozemics (EOR). The significant soils are randomly distributed in the landscape.

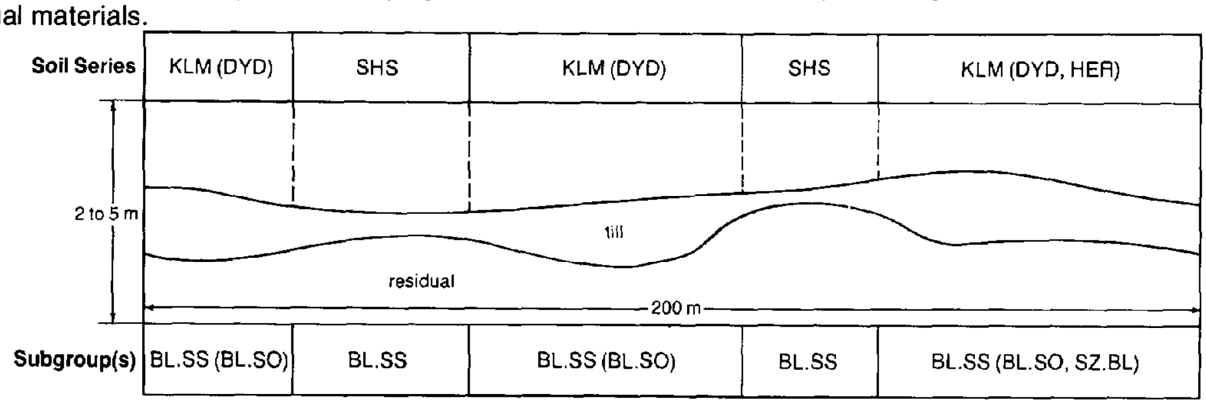
KLM6 differs from KLM4 in that KLM6 units are developed on thin till deposits overlying weathered residual materials.

KLM6 differs from KLM5 in that KLM6 units are developed on thin till deposits overlying weathered residual material and contain a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

KLM6 differs from KLM7 in that KLM6 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

One topographic phase of the KLM6 soil unit is recognized.

KLM6/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent. There is one ridge of KLM6 with slopes of 6 to 9 percent that is found in township 41, range 12.



## Appendix B. (continued)

### KLM7

This unit contains mainly (40 to 80 percent) Solonetzic soils developed on medium-textured, moderately saline and sodic, weakly calcareous till veneer overlying moderately saline and sodic, weathered residual materials. Black Solodized Solonetz developed on till (KLM), Black Solodized Solonetz developed on weathered residual (SHS), and Black Solods (DYD) are the dominant soils in this unit. Soils present in significant amounts (10 to 40 percent) include Solonetzic Black Chernozemics (HER) and Gleysols. Heisler (HER) soils are found on upper slope and crest positions of the landscape. Gleysols are found in depressional areas of the landscape.

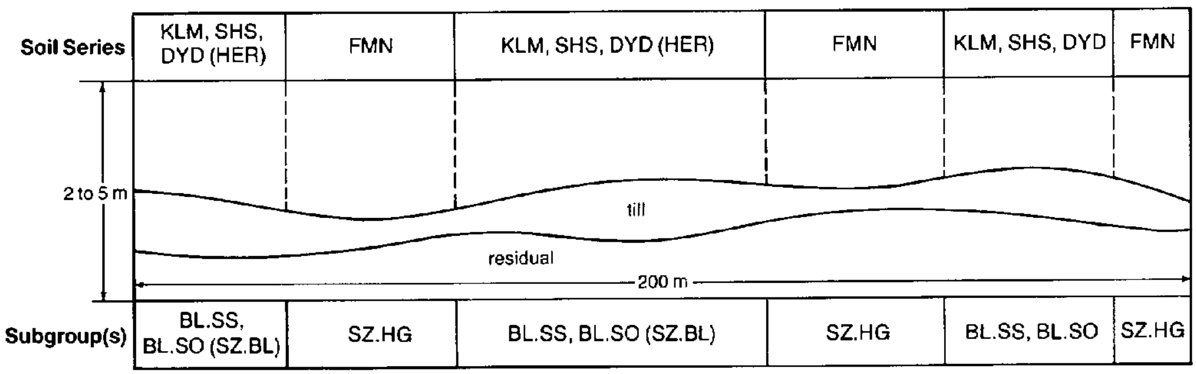
KLM7 differs from KLM4 in that KLM7 units are developed on thin till deposits and contain a larger percentage (10 to 40 percent) of imperfectly and poorly drained soils.

KLM7 differs from KLM5 in that KLM7 units are developed on thin till deposits.

KLM7 differs from KLM6 in that KLM7 contains a larger percentage (10 to 40 percent) of imperfectly and poorly drained soils.

One topographic phase of the KLM7 soil unit is recognized.

KLM7/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.



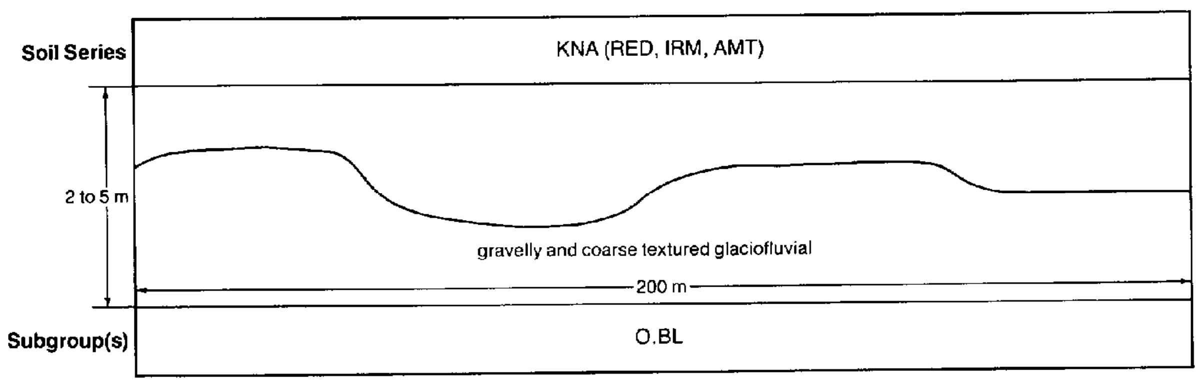

### KNA1

This unit contains mainly (70 to 90 percent) Chernozemic soils developed on gravelly, medium- to coarse-textured, weakly calcareous glaciofluvial materials. Orthic Black Chernozemics (KNA) are the dominant soils in this unit. Soils present in significant amounts (20 to 40 percent) include Orthic Black Chernozemics developed on coarse glaciofluvial (RED, IRM, AMT). The significant soils are randomly distributed in the landscape.

Two topographic phases of the KNA1 soil units are recognized.

KNA1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

KNA1/4 is mapped on gently rolling and ridged landscapes where slopes are between 6 to 9 percent.



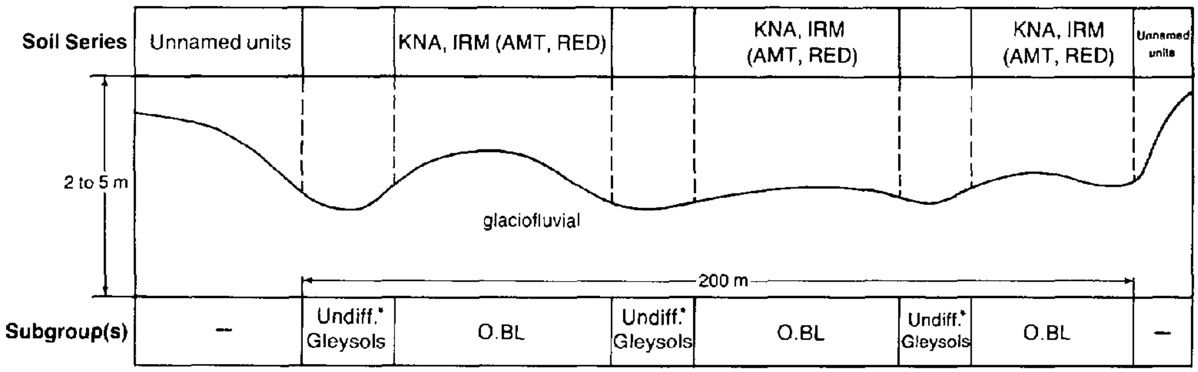
## Appendix B. (continued)

### KNIR2

This unit contains mainly (60 to 90 percent) Chernozemic soils developed on gravelly coarse textured and coarse-textured, weakly calcareous glaciofluvial materials. Orthic Black Chernozemics developed on gravelly glaciofluvial (KNA) and on sandy glaciofluvial (IRM) are the dominant soils in this unit. Soils present in significant amounts (20 to 50 percent) include Orthic Black Chernozemics (AMT, RED, ROS) and Gleysols. The significant Chernozemic soils are randomly distributed in the landscape. The Gleysols are found in depressional areas of the landscape.

One topographic phase of the KNIR2 soil unit is recognized.

KNIR2/3-4 is mapped on gently undulating to hummocky landscapes where slopes are between 2 to 9 percent.



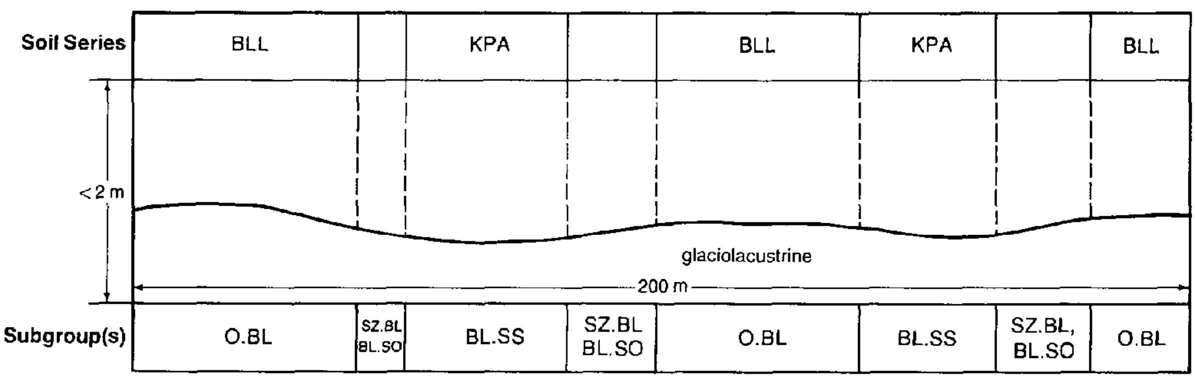

*Undifferentiated

### KPBL1

This unit contains mainly (30 to 60 percent) Chernozemic and Solonetzic soils developed on medium-textured, weakly saline and sodic, weakly calcareous glaciolacustrine materials. Black (KPA) and Orthic Black Chernozemics (BLL) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) include Solonetzic Black Chernozemics (unnamed) and Black Solodized Solonetz (unnamed). The minor soils are found at random in the map unit.

One topographic phase of the KPBL1 soil unit is recognized.

KPBL1/2 is mapped on nearly level landscapes where slopes are between 0.5 to 2 percent.



# Appendix B. (continued)

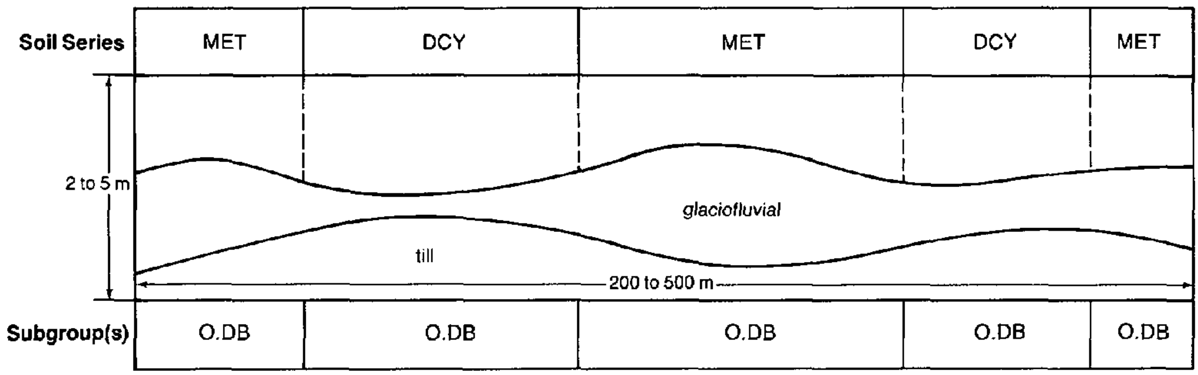
## MEDC1

This unit contains mainly (60 to 90 percent) Chernozemic soils developed on coarse-textured, weakly calcareous glaciofluvial materials overlying medium-textured, weakly calcareous till. Orthic Dark Brown Chernozemics developed on glaciofluvial blanket (MET) and on glaciofluvial veneer overlying till (DCY) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) in this unit are Orthic Dark Brown Chernozemics (HND). The significant soils are randomly distributed in the landscape.

MEDC1 differs from MEDC2 in that MEDC1 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

One topographic phase of the MEDC1 soil unit is recognized.

MEDC1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

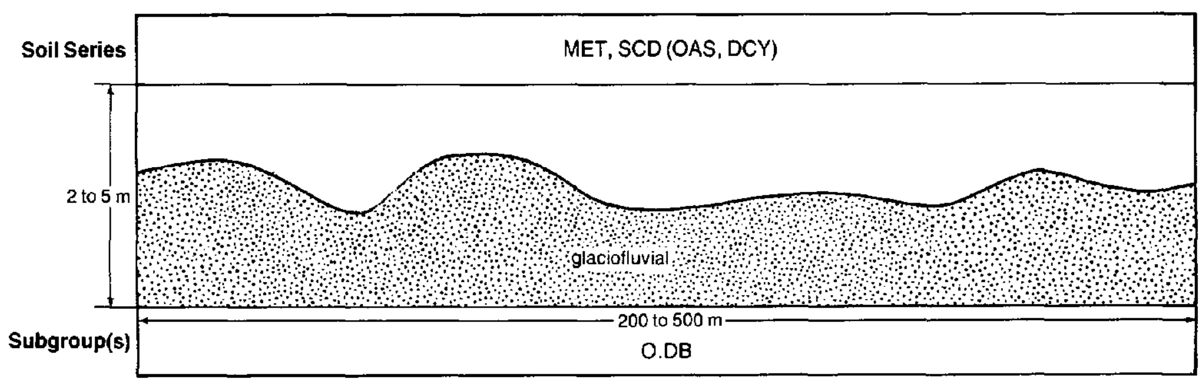



## MESC1

This unit contains mainly (70 to 90 percent) Chernozemic soils developed on coarse- and gravelly coarse-textured, weakly calcareous glaciofluvial materials. Orthic Dark Brown Chernozemics developed on sandy loam glaciofluvial (MET) and on gravelly glaciofluvial (SCD) are the dominant soils in this unit. Soils present in significant amounts (20 to 40 percent) include Orthic Dark Brown Chernozemics (OAS, DCY). The significant soils are randomly distributed in the landscape.

One topographic phase of the MESC1 soil unit is recognized.

MESC1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.



# Appendix B. (continued)

## MEWW1

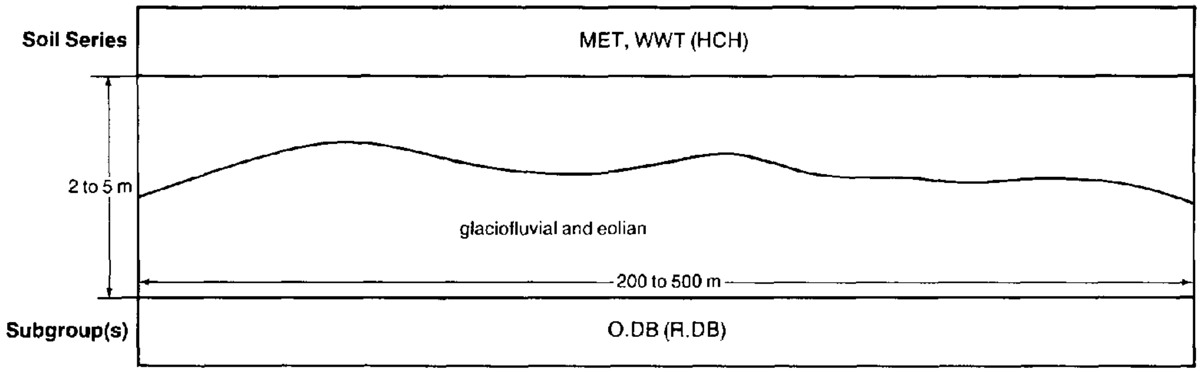
This unit contains mainly (70 to 90 percent) Chernozemic soils developed on coarse-textured, weakly calcareous glaciofluvial and eolian materials. Orthic Dark Brown Chernozemics developed on sandy loam glaciofluvial (MET) and on loamy sand glaciofluvial (WWT) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) are Rego Dark Brown Chernozemics (HCH) and imperfectly and poorly drained soils (unnamed). Rego Dark Brown Chernozemics are found on upper slope and crest positions, imperfectly and poorly drained soils are found on lower slopes and in depressional areas of the landscape.

MEWW1 differs from MEWW2 in that MEWW1 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

Two topographic phases of the MEWW1 soil units are recognized.

MEWW1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

MEWW1/4 is mapped on gently rolling and hummocky landscapes where slopes are between 6 to 9 percent.

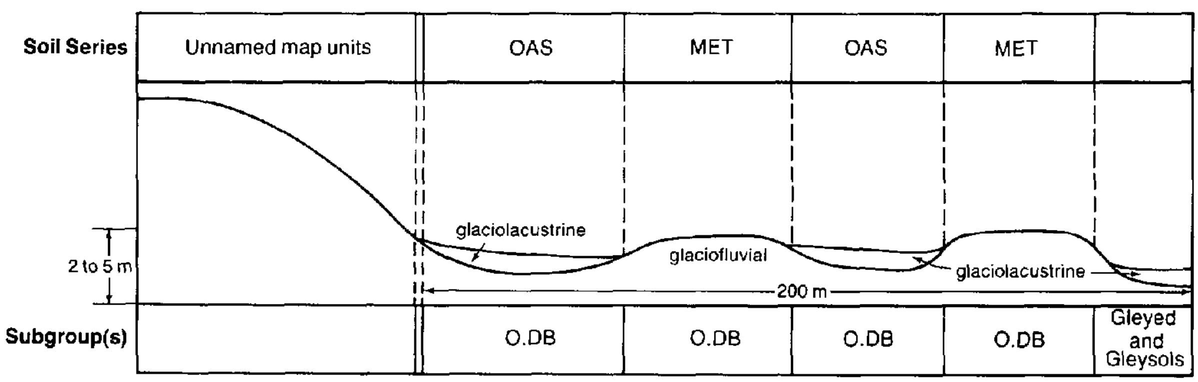



## OAME1

This unit contains mainly (70 to 90 percent) Chernozemic soils developed on a discontinuous medium-textured, weakly calcareous, glaciolacustrine veneer overlying coarse-textured, weakly calcareous glaciofluvial deposits. Orthic Dark Brown Chernozemics developed on glaciolacustrine (OAS) are the dominant soils in this unit. Soils present in significant amounts (15 to 40 percent) are Orthic Dark Brown Chermozemics developed on glaciofluvial (MET). The significant soils are randomly distributed in the landscape. Soils present in minor amounts (less than 15 percent) are Gleyed Dark Brown Chernozemics (unnamed) and Gleysols. These minor soils are found on lower slopes and in depressional areas of the landscape.

One topographic phase of the OAME1 soil unit is recognized.

OAME1/3 is mapped on gently undulating landscapes along the Battle River floodplain where slopes are between 2 to 5 percent.



## Appendix B. (continued)

### RB1

This azonal unit contains mainly (50 to 80 percent) Chernozemic soils developed on medium-textured, weakly calcareous till. Undifferentiated mixtures of Orthic and Rego, Dark Brown and Black Chernozemic soils (unnamed) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) are Orthic Regosols (unnamed). Exposures of bedrock comprise less than 10 percent of the unit.

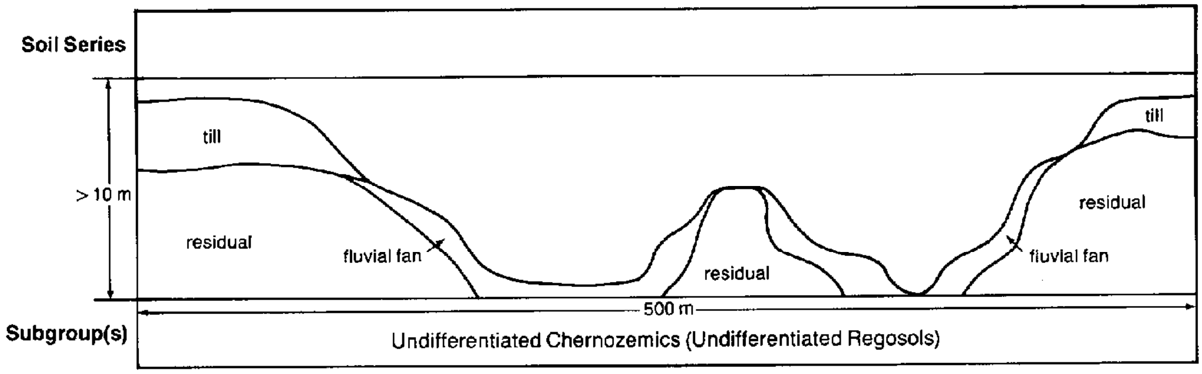
RB1 differs from RB2 in that RB1 contains a smaller percentage (less than 10 percent) of areas with exposed bedrock.

RB1 differs from RB4 in that RB4 units occupy steep sided, V-shaped coulees and drains. RB1 units are mapped on inclined landscapes adjacent to rivers and creeks.

RB1 differs from RB5 in that RB5 units are found on landscapes affected by slope failure and slumping.

One RB1 soil unit is recognized.

RB1 is mapped on steep inclined landscapes along rivers and creeks where slopes are between 10 to 70 percent.




### RB2

This azonal unit contains mainly (40 to 60 percent) Chernozemic and Regosolic soils developed on medium-textured, weakly calcareous till and residual material. Undifferentiated mixtures of Orthic and Rego, Dark Brown and Black Chernozemic soils (unnamed) and Orthic Regosols (unnamed) are the codominant soils in this unit. Soils present in minor amounts (less than 15 percent) are Orthic Regosols developed on fluvial aprons (BKF). The minor soils are found on toe-slope positions of the landscape. Exposures of bedrock comprise 10 to 50 percent of this unit.

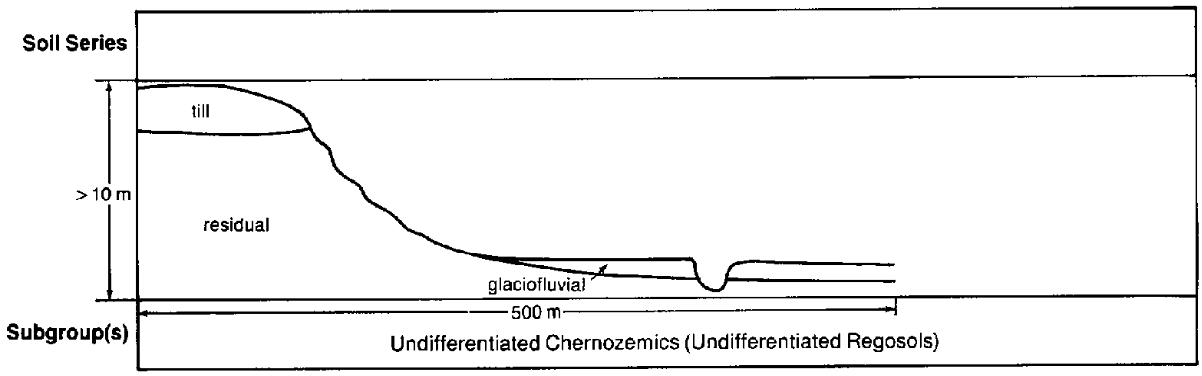
RB2 differs from RB1 in that RB2 contains a larger percentage (10 to 50 percent) of areas with exposed bedrock.

RB2 differs from RB4 in that RB4 units occupy steep-sided V-shaped coulees and drains. RB2 units are mapped on inclined landscapes adjacent to rivers and creeks.

RB2 differs from RB5 in that RB5 units are found on landscapes affected by slope failure and slumping.

One RB2 soil unit is recognized.

RB2 is mapped on steep inclined landscapes along rivers and creeks where slopes are between 10 to 70 percent.



## Appendix B. (continued)

### RB4

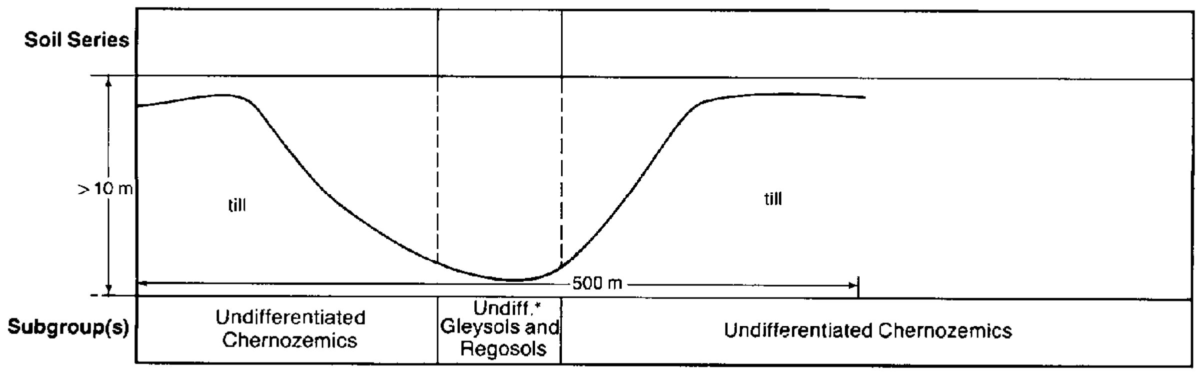
This azonal unit contains mainly (40 to 70 percent) Chernozemic soils developed on medium-textured, weakly calcareous till. Undifferentiated mixtures of Orthic Dark Brown and Orthic Black Chernozemics (unnamed) are the dominant soils in this unit. Soils present in significant amounts (15 to 30 percent) include undifferentiated Gleysols (unnamed) and undifferentiated Regosols (unnamed). The significant Regosols are randomly distributed in the landscape. The significant Gleysols are found in depressional areas of the landscape. This unit occupies steep-sided modern drainage channels.

RB4 differs from RB1 and RB2 in that RB4 units occupy steep-sided, V-shaped coulees and drains. RB1 and RB2 units occupy only the steep sides of the drainage channels, not the wetter areas of the drain.

RB4 differs from RB5 in that RB5 units are found on landscapes affected by slope failure and slumping.

One RB4 soil unit is recognized.

RB4 is mapped on steep-sided, V-shaped coulees and drains where slopes are between 0 to 50 percent.




*Undifferentiated

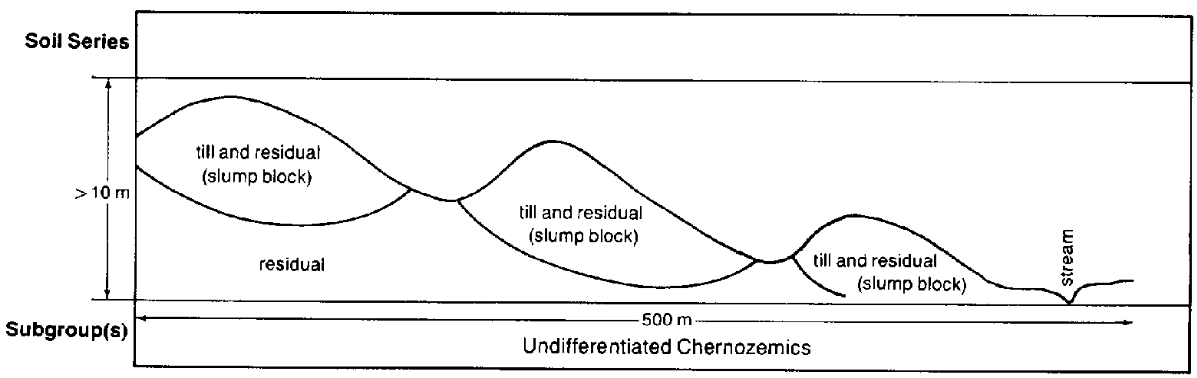
### RB5

This azonal unit contains mainly (50 to 80 percent) Chernozemic soils developed on medium-textured, weakly calcareous till and variable-textured, weakly calcareous residual materials. Undifferentiated Orthic and Rego Dark Brown and Black Chernozemics are the dominant soils in this unit. This unit occurs along the Battle River where the banks have been affected by slope failure and slumping.

RB5 differs from RB1, RB2 and RB4 in that RB5 units are found along the Battle River where the banks have been affected by slope failure and slumping.

One RB5 soil unit is recognized.

RB5 is mapped on hummocky and inclined, slumped landscapes along the Battle River where slopes are between 5 to 30 percent.



## **Appendix B.** (continued)

**REER1**

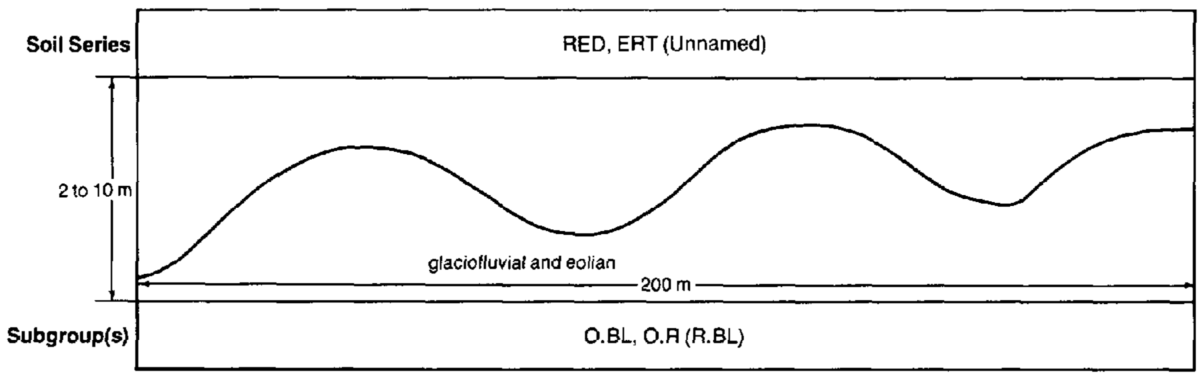
These units contain mainly (30 to 60 percent) Chernozemic and Regosolic soils developed on coarse-textured, noncalcareous glaciofluvial and eolian materials. Orthic Black Chernozemics (RED) and Orthic Regosols (ERT) are the codominant soils in this unit. Soils present in significant amounts (20 to 40 percent) include Rego Black Chernozemics (unnamed). The significant soils are randomly distributed in the landscape.

Three topographic phases of the REER1 soil units are recognized.

REER1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

REER1/4 is mapped on hummocky landscapes where slopes are between 6 to 9 percent.

REER1/5-6 is mapped on hummocky landscapes where slopes are between 10 to 30 percent.




**REIR1**

This unit contains mainly (70 to 90 percent) Chernozemic soils developed on coarse-textured, weakly calcareous glaciofluvial materials. Orthic Black Chernozemics developed on loamy sand glaciofluvial (RED) and on sandy loam glaciofluvial (IRM) are the dominant soils in these units. Soils present in significant amounts (15 to 30 percent) include Orthic Black Chernozemics developed on thin glaciofluvial overlying till (ROS). The significant soils are randomly distributed in the landscape.

REIR1 differs from REIR2 in that REIR1 contains a smaller percentage (less than 15 percent) of imperfectly and poorly drained soils.

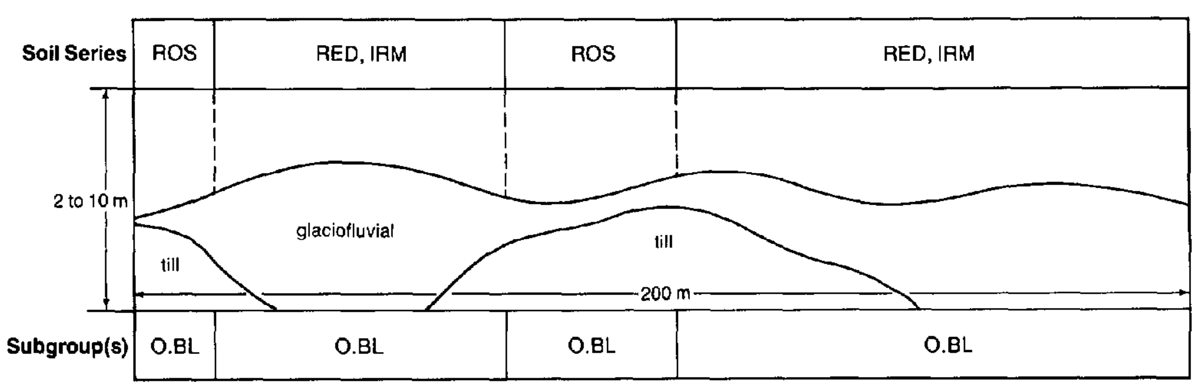
Four topographic phases of the REIR1 soil units are recognized.

REIR1/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

REIR1/4 is mapped on hummocky landscapes where slopes are between 6 to 9 percent.

REIR1/5 is mapped on hummocky landscapes where slopes are between 10 to 15 percent.

REIR1/6 is mapped on hummocky landscapes where slopes are between 16 to 30 percent.



## Appendix B. (continued)

### REIR2

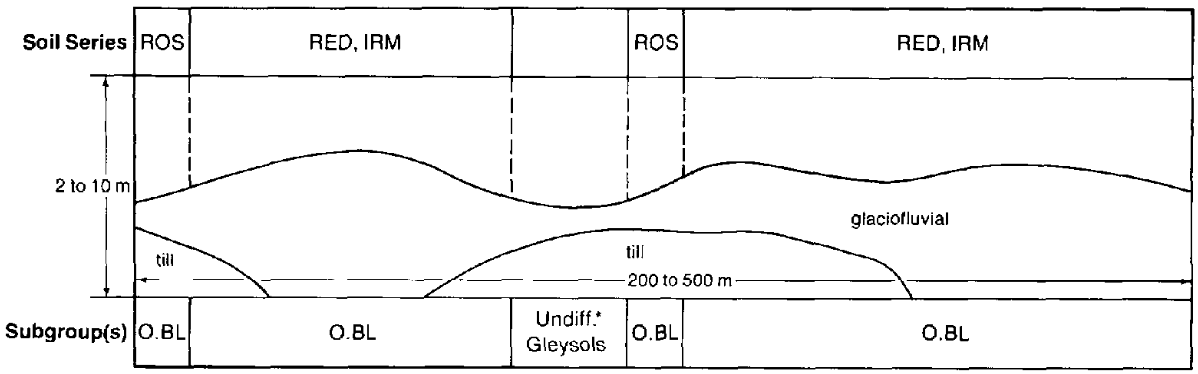
This unit contains mainly (60 to 80 percent) Chernozemic soils developed on coarse-textured, weakly calcareous glaciofluvial materials. Orthic Black Chernozemics developed on loamy sand glaciofluvial (RED) and on sandy loam glaciofluvial (IRM) are the dominant soils in this unit. Soils present in significant amounts (15 to 30 percent) include Orthic Black Chernozemics developed on thin glaciofluvial overlying till (ROS) and Gleysols. Rosebank (ROS) soils are randomly distributed in the landscape. Gleysols are found in depressional areas of the landscape.

REIR2 differs from REIR1 in that REIR2 contains a larger percentage (15 to 30 percent) of imperfectly and poorly drained soils.

Two topographic phases of the REIR2 soil units are recognized.

REIR2/3 is mapped on gently undulating landscapes where slopes are between 2 to 5 percent.

REIR2/4-5 is mapped on gently rolling to hummocky landscapes where slopes are between 6 to 15 percent.



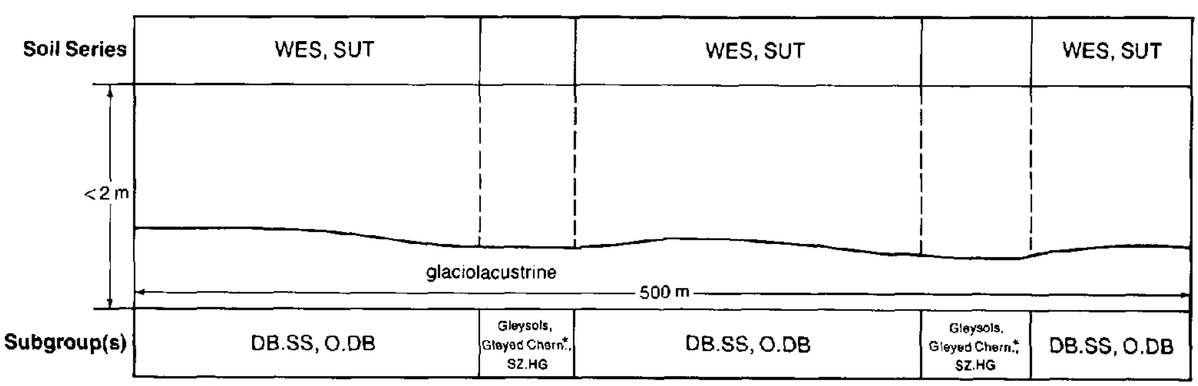

*Undifferentiated

### SUWE2

This unit contains mainly (30 to 60 percent) Chernozemic and Solonetzic soils developed on fine-textured, weakly saline and sodic, weakly calcareous, glaciolacustrine materials. Orthic Dark Brown Chernozemic (SUT) and Dark Brown Solodized Solonetz (WES) are the dominant soils in the unit. Soils present in significant amounts (15 to 30 percent) include Gleysols, Gleyed Chernozemics (unnamed) and Solonetzic Humic Gleysols (FMN). The significant soils are found on lower slopes and in depressional areas of the landscape.

One topographic phase of the SUWE2 soil unit is recognized.

SUWE2/2 is mapped on nearly level landscapes where slopes are between 0.5 to 2 percent.




*Chernozemics

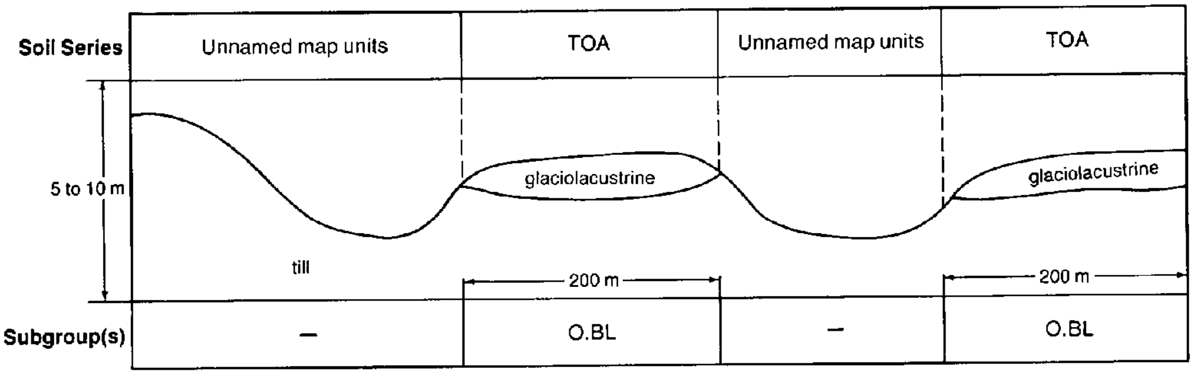
## Appendix B. (continued)

### TOA1

This unit contains mainly (70 to 90 percent) glaciolacustrine veneer overlying medium-textured, weakly calcareous till. Orthic Black Chernozemics (TOA) are the dominant soils in this unit. Soils present in minor amounts (less than 15 percent) include Orthic Black Chernozemics developed on till (EOR). The minor soils are randomly distributed in the landscape. Thomas Lake units are found on glaciolacustrine plateaus in till areas.

One topographic phase of the TOA1 soil unit is recognized.

TOA1/3 is mapped on gently undulating glaciolacustrine plateaus in till areas where slopes are between 2 to 5 percent.




### ZDL

This azonal unit contains lands disturbed by surface coal mining. The unit contains dominantly (70 to 90 percent) reconstructed Regosolic soils on fine- to medium-textured, weakly calcareous, moderately saline till and weathered resudual materials. Soils present in significant amounts (15 to 30 percent) are reconstructed Gleysolics. The significant soils are found in depressional areas of the landscape.

One ZDL soil unit is recognized.

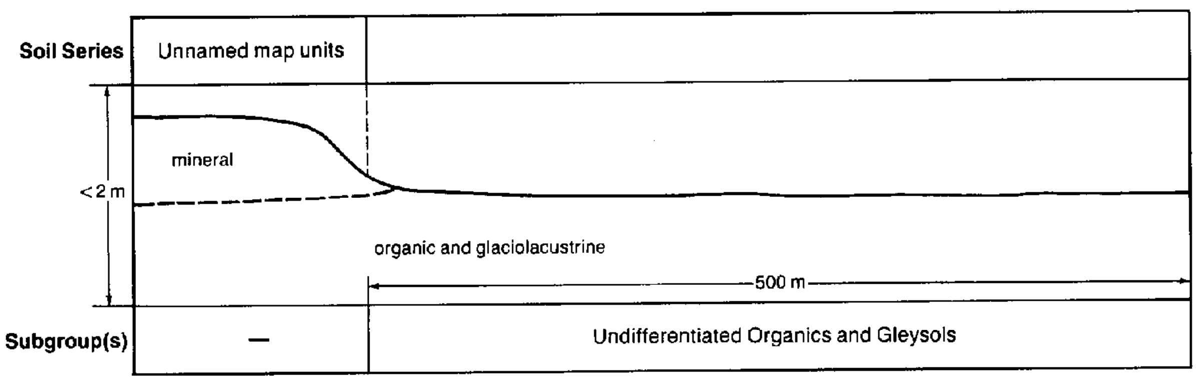
ZDL is mapped on lands disturbed by surface coal mining where slopes are between 2 to 5 percent.

### ZOR

This azonal unit contains mainly (70 to 90 percent) Organic soils developed on moderately calcareous sedge peat. Undifferentiated Organic soils are dominant in this unit. Water and undifferentiated Gleysols occur in significant amounts (15 to 30 percent).

One ZOR soil unit is recognized.

ZOR is mapped on level sedge fens where slopes are between 0 to 0.5 percent.



# Appendix C. Glossary of terms.

## Definition of terms

### Summary of Canadian System of Soil Classification (1978)

*Mineral horizons and layers*

Mineral horizons contain 17 percent or less organic C (about 30 percent organic matter) by weight.

A – This is a mineral horizon formed at or near the surface in the zone of leaching or eluviation of materials in solution or suspension, or of maximum in situ accumulation of organic matter or both.

B – This is a mineral horizon characterized by enrichment in organic matter, sesquioxides, or clay; or by the development of soil structure; or by a change of color denoting hydrolysis, reduction or oxidation.

C – This is a mineral horizon comparatively unaffected by the pedogenic processes operative in A and B, (C), except the process of gleying (Cg), and the accumulation of calcium and magnesium carbonates (Cca) and more soluble salts (Cs, Csa).

*Organic horizons*

Organic horizons are found in Organic soils and commonly at the surface of mineral soils. They may occur at any depth beneath the surface in buried soils or overlying geologic deposits. They contain more than 17 percent organic C (approximately 30 percent organic matter) by weight. Two groups of these horizons are recognized, the O horizons and the L, F and H horizons.

O – This is an organic horizon developed mainly from mosses, rushes and woody materials.

L – This is an organic horizon that is characterised by an accumulation of organic matter derived mainly from leaves, twigs and woody materials in which the original structures are easily discernible.

F – This is an organic horizon that is characterized by an accumulation of partly decomposed organic matter derived mainly from leaves, twigs and woody materials.

H – This is an organic horizon that is characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible.

*Lower case suffixes*

ca – A horizon of secondary carbonate enrichment in which the concentration of lime exceeds that in the unenriched parent material.

e – A horizon characterized by the eluviation of clay, Fe, Al or organic matter alone or in combination.

g – A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction.

h – A horizon enriched with organic matter.

j – This is used as a modifier of suffixes e, f, g, n and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies.

k – Denotes the presence of carbonate as indicated by visible effervescence when dilute HC1 is added.

m – A horizon slightly altered by hydrolysis, oxidation or solution or all three to give a change in color or structure or both.

n – A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less.

p – A horizon disturbed by man's activities such as cultivation, logging and habitation.

s – A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by depressed crop growth or by the presence of salt-tolerant plants.

sa – A horizon with secondary enrichment of salts more soluble than Ca and Mg carbonates; the concentration of salts exceeds that in the unenriched parent material.

t – An illuvial horizon enriched with silicate clay.

*Topography*

There are 10 slope classes, and each one is defined in terms of percent and degrees.

| Class | Slope (%) | Approximate degrees | Terminology |
|---|---|---|---|
| 1 | 0 to 0.5 | 0 | Level |
| 2 | 0.5 to 2.0 | 0.3 - 1.1 | Nearly level |
| 3 | 2 to 5 | 1.1 - 3 | Very gentle slopes |
| 4 | 5 - 9 | 3 - 5 | Gentle slopes |
| 5 | 9 - 15 | 5 - 8.5 | Moderate slopes |
| 6 | 15 - 30 | 8.5 - 16.5 | Strong slopes |
| 7 | 30 - 45 | 16.5 - 24 | Very strong slopes |
| 8 | 45 - 70 | 24 - 35 | Extreme slopes |
| 9 | 70 - 100 | 35 - 45 | Steep slopes |
| 10 | 100 | 45 | Very steep slopes |

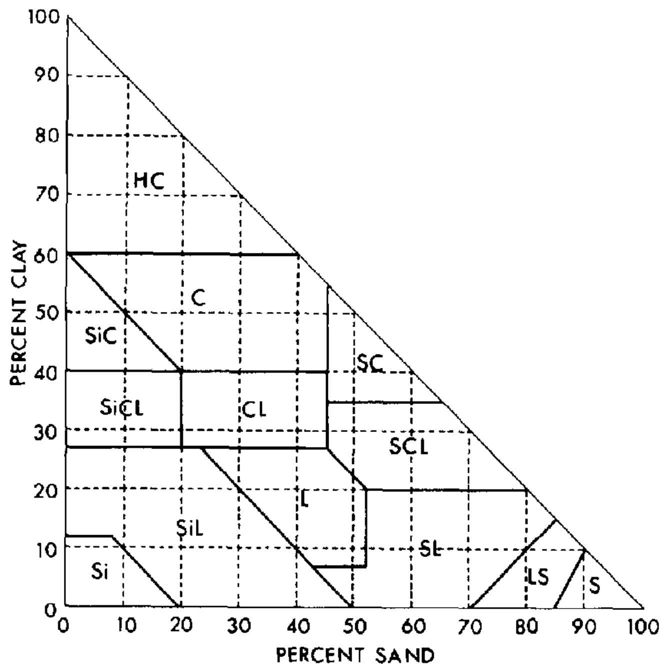
Throughout this report, descriptive terms are used repeatedly to describe features of significance within the map area. The following are definitions of some of these descriptive terms.

*Soil texture*

Soil separates (particle size) on which textural classes are based

| Separates | Diameter in millimeters |
|---|---|
| Very Coarse Sand (V.C.S.) | 2.0 - 1.0 |
| Coarse Sand (C.S.) | 1.0 - 0.5 |
| Medium Sand (M.S.) Sand (S.) | 0.5 - 0.25 |
| Fine Sand (F.S.) | 0.25 - 0.10 |
| Very Fine Sand (V.F.S.) | 0.10 - 0.05 |
| Silt (Si.) | 0.05 - 0.002 |
| Clay (C.) | less than 0.002 |
| Fine Clay (F.C.) | less than 0.0002 |

## Appendix C. (continued)




*Proportions of soils separates in various soil textural classes*

From: Toogood, J.A. (1958): A simplified textural classification diagram; Canadian Journal of Soil Science, vol. 38, p. 54-55.

Sands are further divided according to the prevalence of differently sized sand fractions. Medium and coarse sands may contain over 25 percent coarse sand but not over 50 percent fine sands. Fine and very fine sands must contain over 50 percent of the res- pective fine sand fractions.

The Soil textural classes are grouped according to the Canada Soil Survey Committee of Canada as follows:

(a) coarse textured sands, loamy sands

(b) moderately coarse textured sandy loam, fine sandy loam

(c) medium textured very fine sandy loam, loam, silt loam, silt

(d) moderately fine textured sandy clay loam, clay loam, silty clay loam (e) fine textured sandy clay, silty clay, clay (40 to 60 percent)

(f) very fine textured heavy clay (more than 60 percent clay)

The particle-size classes for family groupings are as follows:

**Fragmental.** Stones, cobbles and gravel, with too little fine earth to fill interstices larger than 1 mm.

**Sandy-skeletal.** Particles coarser than 2 mm occupy 35 percent or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the sandy particle-size class.

**Loamy-skeletal.** Particles 2 mm to 25 cm occupy 35 percent or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the loamy particle-size class.

**Clayey-skeletal.** Particles 2 mm to 25 cm occupy 35 percent or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the clayey particle-size class.

**Sandy.** The texture of the fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures; particles 2 mm to 25 cm occupy less than 35 percent by volume.

**Loamy.** The texture of the fine earth includes loamy very fine sand, very fine sand and finer textures with less than 35 percent clay; particles 2 mm to 25 cm occupy less than 35 percent by volume.

*Coarse-loamy.* A loamy particle size that has 15 percent or more by weight of fine sand (0.25 to 0.1 mm) or coarser particles, including fragments up to 7.5 cm and less than 18 percent clay in the fine earth fraction.

*Fine-loamy.* A loamy particle size that has 15 percent or more by weight of fine sand (0.25 to 0.1 mm) or coarser particles, including fragments up to 7.5 cm and has 18 to 35 percent clay in the fine earth fraction.

*Coarse-silty.* A loamy particle size that has less than 15 percent of fine sand (0.25 to 0.1 mm) or coarse particles, including fragments up to 7.5 cm and has less than 18 percent clay in the fine earth fraction.

*Fine-silty.* A loamy particle size that has less than 15 percent of fine sand (0.25 to 0.1 mm) or coarser particles, including fragments up to 7.5 cm and has 18 to 35 percent clay in the fine earth fraction.

**Clayey.** The fine earth contains 35 percent or more clay by weight and particles 2 mm to 25 cm occupy less than 35 percent by volume.

*Fine-clayey.* A clayey particle size that has 35 to 60 percent clay in the fine earth fraction.

*Very-fine-clayey.* A clayey particle size that has 60 percent or more clay in the fine earth fraction.

### Soil structure and consistence

Soil structure refers to the aggregation of the primary soil particles into compound particles, or clusters of primary particles, which are separated from adjoining aggregates by surfaces of weakness. The aggregates differ in grade of development (degree of distinctness) and this distinctness is classed as: weak, moderate and strong. The aggregates vary in size and are classed as: very fine, fine, medium, coarse, and very coarse. They also vary in kind; that is, in the character of their faces and edges. The kinds mentioned in this report are: single grain-loose, incoherent mass of individual par-

## Appendix C. (continued)

ticles as in sands; blocky-faces rectangular and flattened, vertices sharply angular; subangular blocky-faces subrectangular, vertices mostly oblique or subrounded; columnar-vertical edges near top of columns are not sharp (columns may be flat-topped, round-topped or irregular); granular-spheroidal, characterized by rounded vertices; platy-horizontal planes more or less developed.

Soil consistence comprises the attributes of soil materials that are expressed by the degree and kind of cohesion and adhesion or by the resistance to deformation and rupture. Consistence reflects the strength and nature of the forces of attraction within a soil mass. The terms used in describing soils in this report are: loose-noncoherent; friable (specifies friable when moist) – a soil material crushes easily under gently to moderate pressure between thumb and forefinger, and coheres when pressed together; firm (specifies firm when moist) – soil material crushes under moderate pressure between thumb and forefinger but resistance is distinctly noticeable; hard (specifies hard when dry) – moderately resistant to pressure, can be broken in the hands without difficulty but rarely breakable between thumb and forefinger; compact-term denotes a combination of firm consistence and a close packing or arrangement of particles; plastic (specifies plastic when wet) – soil material can be formed into wires by rolling between the thumb and forefinger and moderate pressure is required for deformation of the soil mass.

### Soil moisture classes

Soil moisture classes are defined according to: (1) actual moisture content in excess of field-moisture capacity, and (2) the extent of the period during which such excess water is present in the plant root zone. The classes are:

(a) rapidly drained soil-moisture content seldom ex ceeds field capacity in any horizon except immediately after water additions;

(b) well-drained soil-moisture content does not normally exceed field capacity in any horizon, except possibly the C, for a significant part of the year;

(c) moderately well-drained soil-moisture in excess of field capacity remains for a small but significant period of the year;

(d) imperfectly drained soil-moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year;

(e) poorly drained soil-moisture in excess of field capacity remains in all horizons for a large part of the year;

(f) very poorly drained free-water remains at or within 30 cm of the surface most of the year.

Special reference to surface drainage may be designated in terms of runoff and described as high, medium, low or ponded. Similarly, specific reference to the characteristics of horizons within the profile may be designated in terms of permeability or percolation and described as rapid, moderate, slow, very slow and none.

### Calcareous classes

The Canada Soil Survey Committee (1978) has set the following nomenclature and limits for calcareous grades:

(a) weakly calcareous: 1 to 5 percent calcium carbonate equivalent

(b) moderately calcareous: 6 to 15 percent calcium carbonate equivalent

(c) strongly calcareous: 16 to 25 percent calcium carbonate equivalent

(d) very strongly calcareous: 26 to 40 percent calcium carbonate equivalent

(e) extremely calcareous: greater than 40 percent calcium carbonate equivalent

### Reaction classes

The reaction classes and terminology adopted by the Canada Soil Survey Committee (1978) are:

| Class | pH($H_20$) |
|---|---|
| (a) Extremely acid | less than 4.5 |
| (b) Very strongly acid | 4.6 to 5.0 |
| (c) Strongly acid | 5.1 to 5.5 |
| (d) Medium acid | 5.6 to 6.0 |
| (e) Slightly acid | 6.1 to 6.5 |
| (f) Neutral | 6.6 to 7.3 |
| (g) Mildly alkaline | 7.4 to 7.8 |
| (h) Moderately alkaline | 7.9 to 8.4 |
| (i) Strongly alkaline | 8.5 to 9.0 |
| (j) Very strongly alkaline | 9.0 |

### Horizon boundaries

The lower boundary of each horizon is described by indicating its distinctness and form as suggested in the USDA Soil Survey Manual (United States Department of Agriculture, 1951). The classes of distinctness are:

| | |
|---|---|
| (a) abrupt | less than 2.5 cm wide |
| (b) clear | 2.5 to 6 cm wide |
| (c) gradual | 6 to 12.5 cm wide |
| (d) diffuse | more than 12.5 cm wide |

The categories for form are:

| | |
|---|---|
| (a) smooth | nearly a plane |
| (b) wavy | pockets are wider than deep |
| (c) irregular | pockets are deeper than wide |
| (d) broken | parts of the horizon are unconnected with other parts |

## Appendix C. (continued)

### Roots

The terminology for describing roots is that adopted by the Canada Soil Survey Committee (1978). In this system both the abundance and diameter of roots are described. The classes of abundance are:

| Abundance | Number per unit area surface |
|---|---|
| (a) very few | less than 1 |
| (b) few | 1 to 3 |
| (c) plentiful | 4 to 14 |
| (d) abundant | more than 14 |

The diameter categories are:

| | |
|---|---|
| (a) micro | less than 0.075 mm |
| (b) very fine | 0.075 to 1 mm |
| (c) fine | 1 to 2 mm |
| (d) medium | 2 to 5 mm |
| (e) coarse | more than 5 mm |

# Glossary

This is included to define terms commonly used in soil science: it is not a comprehensive soil glossary.

**acid soil** – A soil having a pH of less than 7.0.

**aggregate** – A group of soil particles cohering so as to behave mechanically as a unit.

**alkaline soil** – A soil having a pH greater than 7.0.

**alluvium** – A general term for all deposits of modern rivers and streams.

**available nutrient** – That portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants. ("Available" should not be confused with "exchangeable.")

**bedrock** – The solid rock underlying soils and the regolith or exposed at the surface.

**bog** – Permanently wet land with low bearing strength.

**bulk density, soil** – The mass of dry soil per unit bulk volume.

**calcareous soil** – Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with cold 0.1N hydrochloric acid.

**capability class (soil)** – The class indicates the general suitability of the soils for agricultural use. It is a grouping of subclasses that have the same relative degree of limitation or hazard. The limitation or hazard becomes progressively greater from Class 1 to Class 7.

**capability subclass (soil)** – This is a grouping of soils with similar kinds of limitations and hazards. It provides information on the kind of conservation problem or limitation. The class and subclass together provide the user with information about the degree and kind of limitation for broad land use planning and for the assessment of conservation needs.

**category** – Any one of the ranks of the system of soil classification in which soils are grouped on the basis of their characteristics.

**cation exchange** – The interchange between a cation in solution and another cation on the surface of any surface-active material such as clay colloids or organic colloids.

**cation-exchange capacity** – The sum total of exchangeable cations that a soil can absorb. Sometimes called "total-exchange capacity," "base-exchange capacity," or "cation-adsorption capacity." Expressed in milliequivalents per 100 grams of soil.

**classification, soil** – The systematic arrangement of soils into categories and classes on the basis of their characteristics. Broad groupings are made on the basis of general characteristics and subdivisions on the basis of more detailed differences in specific properties.

**clay** – As a particle-size term; a size fraction .002 mm equivalent diameter.

**clayey** – Containing large amounts of clay or having properties similar to those of clay.

**coarse fragments** – Rock or mineral particles 2.0 mm in diameter.

**coarse texture** – The texture exhibited by sands, loamy sands, and sandy loams except very fine sandy loam. A soil containing large quantities of these textural classes.

**consistency** – (i) The resistance of a material to deformation or rupture (ii) the degree of cohesion or adhesion of the soil mass.

**crust** – A surface layer on cultivated soils, ranging in thickness from a few millimeters to as much as 3 cm, that is much more compact, hard and brittle when dry than the material immediately beneath it.

**degradation** – The changing of a soil to a more highly leached and more highly weathered condition, usually accompanied by morphological changes such as the development of an eluviated, light colored Ae horizon.

**deposit** – Material left in a new position by a natural transporting agent such as water, wind, ice, or gravity, or by the activity of man.

**eluvial horizon** – A soil horizon that has been formed by the process of eluviation. See illuvial horizon.

**eolian deposit** – Wind deposit; includes both loess and dune sand.

**erosion** – The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep.

**fertility, soil** – The status of a soil with respect to the amount and availability to plants of elements necessary for plant growth.

## Appendix C. (continued)

**fertilizer** – Any organic or inorganic material of natural or synthetic origin that is added to a soil to supply certain elements essential to the growth of plants.

**fertilizer requirements** – The quantity of certain plant nutrient elements needed, in addition to the amount supplied by the soil, to increase plant growth to a designated optimum.

**fine texture** – Consisting of or containing large quantities of the fine fractions, particularly silt and clay.

**floodplain** – The land bordering a stream, built up of sediments from overflow of the stream and subject to inundation when the stream is at flood stage.

**fluvial deposits** – All sediments, past and present, deposited by flowing water, including glaciofluvial deposits. Wave-worked deposits and deposits resulting from sheet erosion and mass wasting are not included.

**friable** – A consistency term pertaining to the ease of crumbling of soils.

**frost action** – Freezing and thawing of moisture in materials and the resultant effects on these materials and on structures of which they are a part or with which they are in contact.

**glacial drift** – Embraces all rock material transported by glacier ice, glacial meltwater and rafted by icebergs. This term includes till, stratified drift and scattered rock fragments.

**glaciofluvial deposits** – Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers and kame terraces.

**glaciolacustrine deposit** – Material deposited in lake water and later exposed either by lowering the water level or by uplift of the land. These sediments range in texture from sands to clays.

**gravelly** – Containing appreciable or significant amounts of gravel.

**green manure** – Plant material incorporated with the soil while green, for improving the soil.

**ground moraine** – Generally an unsorted mixture of rocks, boulders, sand, silt and clay deposited by glacial ice. The predominant material is till, though stratified drift is present in places. The till is thought to have accumulated largely by lodgment beneath the ice but also partly by being let down from the upper surface of the ice through the ablation process. Ground moraine is most commonly in the form of undulating plains with gently sloping swells, sags and enclosed depressions.

**groundwater** – That portion of the total precipitation that at any particular time is either passing through or standing in the soil and the underlying strata and is free to move under the influence of gravity.

**illuvial horizon** – A soil layer or horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. The layer of accumulation.

**illuviation** – The process of deposition of soil material removed from one horizon to another in the soil; usually from an upper to a lower horizon in the soil profile. Illuviated substances include silicate clay, iron and aluminum hydrous oxides or organic matter.

**immature soil** – A soil with indistinct or only slightly developed horizons.

**infiltration** – The downward entry of water into the soil.

**landscape** – All the natural features such as fields, hills, forests, water, etc., that distinguish one part of the earth's surface from another part. Usually that portion of land or territory that the eye can comprehend in a single view, including all its natural characteristics.

**leaching** – The removal of materials in solution from the soil.

**liquid limit** – (upper plastic limit) – (i) The water content corresponding to an arbitrary limit between the liquid and plastic states of consistency of a soil. (ii) The water content at which a pat of soil, cut by a groove of standard dimensions, will flow together for a distance of 12 mm under the impact of 25 blows in a standard liquid limit apparatus.

**marsh** – Periodically wet or continually flooded areas with the surface not deeply submerged. Covered dominantly by sedges, cattails, rushes or other hydrophytic plants. Subclass includes freshwater and salt-water marshes.

**mature soil** – A soil with well-developed soil horizons produced by the natural processes of soil formation.

**medium texture** – Intermediate between fine-textured and coarse-textured (soils). (It includes the following textural classes: very fine sandy loam, loam, silt loam and silt).

**mineral soil** – A soil consisting predominantly of, and having its properties determined predominantly by, mineral matter. It contains percent organic matter except for an organic surface layer that may be up to 30 cm thick, if consolidated, or 45 cm if unconsolidated.

**mottles** – Spots or blotches of different color or shades of color interspersed with the dominant color resulting from reducing conditions.

**Munsell color system** – A color designation system that specifies the relative degree of the three simple variables of color: hue, value, and chroma. For example: 10YR 6/4 is a color (of soil) with a hue + 10YR, value 6, and chroma 4. These notations can

## Appendix C. (continued)

be translated into several different systems of color names as desired.

**neutral soil** – A soil in which the surface layer, at least to normal plow depth, is neither acid nor alkaline in reaction.

**organic soil** – A soil that has developed dominantly from organic deposits. The majority of Organic soils are saturated for most of the year, unless artificially drained, but some of them are not usually saturated for more than a few days. They contain 17 percent or more organic carbon and:

1) if the surface layer consists of fibric organic material and the bulk density is less than 0.1 (with or without a mesic or humic Op less than 15 cm thick), the organic material must extend to a depth of at least 60 cm; or
2) if the surface layer consists of organic material with a bulk density of 0.1 or more, the organic material must extend to a depth of at least 40 cm; or
3) if a lithic contact occurs at a depth shallower than stated in 1) or 2) above, the organic material must extend to a depth of at least 60 cm.

**outwash** – Sediments 'washed out' by flowing water in front of the glacier and laid down in beds as stratified drift. Particle size may range from boulders to silt.

**parent material** – The unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of a soil is developed by pedogenic processes.

**particle size** – The effective diameter of a particle measured by sedimentation, sieving or micrometric methods.

**particle size distribution** – The amounts of the various soil separates in a soil sample, usually expressed as weight percentages.

**peat** – Unconsolidated soil material consisting largely of undecomposed, or only slightly decomposed, or- ganic matter.

**ped** – A unit of soil structure such as a prism, block or granule, formed by natural processes (in contrast with a clod, which is formed artificially).

**pedology** – Those aspects of soil science involving the constitution, distribution, genesis and classification of soils.

**percolation, soil water** – The downward movement of water through soil. Especially the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of the order of 1.0 or less.

**pH, soil** – the negative logarithm of the hydrogen-ion activity of a soil. The degree of acidity or alkalinity of a soil as determined by means of a glass, quinhydrone or other suitable electrode or indicator at a specified moisture content or soil-water ratio and expressed in terms of the pH scale.

**phase, soil** – A subdivision of a soil type or other unit of classification having characteristics that affect the use and management of the soil but which do not vary sufficiently to differentiate it as a separate type. A variation in a property or characteristic such as degree of slope, degree of erosion and content of stones.

**physical properties (of soils)** – Those characteristics, processes or reactions of a soil which are caused by physical forces and which can be described by, or expressed in, physical terms or equations. Sometimes confused with and difficult to separate from chemical properties; hence, the terms 'physical-chemical' or 'physiochemical' (not used in this report).

**plastic limit** – (i) The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of a soil. (ii) Water content at which a soil will just begin to crumble when rolled into a thread approximately 3 mm in diameter.

**platy** – Consisting of soil aggregates that are developed predominately along the horizontal axes; laminated; flaky.

**pore space** – Total space not occupied by soil particles in a bulk volume of soil.

**productivity, soil** – The capacity of a soil, in its normal environment, for producing a specified plant or sequence of plants under a specified system of management. The "specified" limitations are necessary since no soil can produce all crops with equal success nor can a single system of management produce the same effect on all soils. Productivity emphasizes the capacity of soil to produce crops and should be expressed in terms of yields.

**profile, soil** – A vertical section of the soil through all its horizons and extending into the parent material.

**reaction, soil** – The degree of acidity or alkalinity of a soil, usually expressed as a pH value.

**saline soil** – A nonalkali soil containing soluble salts in such quantities as to interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 mmhos/cm, the exchangeable-sodium percentage is less than 15, and the pH is usually less than 8.5.

**sand** – A soil particle between 0.05 and 2.0 mm in diameter.

**silt** – A soil particle between 0.05 and 0.002 mm in diameter.

**soil** – (i) The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. (ii) The unconsolidated mineral matter on the surface of the earth that has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and

## Appendix C. (continued)

temperature effects), macro- and microorganisms and topography, all acting over a period of time and producing a product-soil that differs from the material from which it is derived in many physical, chemical, biological and morphological properties and characteristics.

**soil conservation** – (i) Protection of the soil against physical loss by erosion or against chemical deterioration; that is, excessive loss of fertility by either natural or artificial means. (ii) A combination of all management and land-use methods that safeguard the soil against depletion or deterioration by natural or by man-induced factors.

**soil genesis** – The mode of origin of the soil with special reference to the processes or soil-forming factors responsible for the development of the solum or true soil, from the unconsolidated parent material.

**soil management** – The sum total of all tillage operations, cropping practices, fertilizer, lime and other treatments conducted on or applied to a soil for the production of plants.

**soil map** – A map showing the distribution of soil mapping units in relation to the prominent physical and cultural features of the earth's surface.

**soil moisture** – Water contained in the soil.

**soil morphology** – (i) The physical constitution, particularly the structural properties, of a soil profile as exhibited by the kinds, thickness and arrangement of the horizons in the profile and by the textures, structure, consistency and porosity of each horizon. (ii) The structural characteristics of the soil or any of its parts.

**soil organic matter** – The organic fraction of the soil; includes plant and animal residues at various stages of decomposition, cells and tissues of soil organisms and substances synthesized by the soil population. Usually determined on soils which have been sieved to pass a 2.0 mm sieve.

**soil separates** – Mineral particles, <2.0 mm in equivalent diameter, ranging between specified size limits.

**soil structure** – The combination or arrangement of primary soil particles into secondary particles, units or peds. These secondary units may be, but usually are not, arranged in the profile in such a manner as to give a distinctive characteristic pattern. The secondary units are characterized and classified on the basis of size, shape and degree of distinctness into classes, types and grades, respectively.

**soil survey** – The systematic examination, description, classification and mapping of soils in an area. Soil surveys are classified according to the kind and intensity of field examination.

**soil texture** – The relative proportions of the various soil separates in a soil. The textural classes may be modified by the addition of suitable adjectives when coarse fragments are present in substantial amounts, for example, 'stony silt loam,' or 'silt loam, stony phase.'

**solum (plural sola)** – The upper horizons of a soil in which the parent material has been modified and within which most plant roots are confined. It consists usually of A and B horizons.

**stones** – Rock fragments 25 cm in diameter if rounded and 38 cm along the greater axis if flat.

**stony** – Containing sufficient stones to interfere with or to prevent tillage.

**surface soil** – The uppermost part of the soil, ordinarily moved in tillage or its equivalent in uncultivated soils and ranging in depth from 8 or 10 cm to 20 or 25 cm. Frequently designated as the 'plow layer,' the 'Ap layer,' or the 'Ap horizon.'

**till** – (i) Unstratified glacial drift deposited directly by the ice and consisting of clay, sand, gravel and boulders intermingled in any proportion. (ii) To plow and prepare for seeding; to seed or cultivate the soil.

**tilth** – The physical condition of soil as related to its ease of tillage, fitness as a seedbed and its impedance to seeding emergence and root penetration.

**very coarse texture** – Consisting of sands and loamy sands.

**very fine texture** – Consisting of very fine clay particles (more than 60 percent clay.

**water logged** - Saturated with water.

**weathering** - The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.