# SOIL INTERPRETATION FOR SELECTED COMPONENTS OF COMMUNITY DEVELOPMENT WITHIN THE NEW TOWN OF RAINBOW LAKE, ALBERTA

by: T.M. Macyk and M.D. Scheelar

March 1973

*Alberta Research Council*
*Open File Report 1973-5*

# *SOIL INTERPRETATIONS*

*for*

*SELECTED COMPONENTS OF COMMUNITY DEVELOPMENT*

*within*

*THE NEW TOWN OF RAINBOW LAKE, ALBERTA*

*by*

*T.M. Macyk and M.D. Scheelar*

*Soils Division*

*ALBERTA RESEARCH COUNCIL*

*March, 1973*

Alberta
RESEARCH COUNCIL

TABLE OF CONTENTS


INTRODUCTION . . . . . 1

CULTURAL AND PHYSICAL FEATURES OF THE AREA . . . 1

THE SOILS . . . . . .

I SOIL DEVELOPMENT . . . . . 3

II SOIL CLASSIFICATION AND MAPPING . . 3

III SOIL ASSOCIATIONS 5

Rainbow Soil Association . . . 5
Sousa Soil Association . . . 6
Zama Soil Association . . . 6
Mega Soil Association . . . 7
Haig Soil Association . . . 7
Basset Soil Association . . . 7
Bivouac Soil Association . . . 9
Vardie Soil Association . . . 9

SOIL SURVEY INTERPRETATIONS . . . . . 10

DISCUSSION OF CHEMICAL AND PHYSICAL ANALYSES . . . 15

ACKNOWLEDGMENTS . . . . . 19

REFERENCES . . . . . 19

APPENDIX - Chemical and Physical Analyses of Representative Profiles . . 20

- Glossary . . . . . 23

Figure 1 - A sketch of a soil profile showing major soil horizons and a brief outline of differences in properties. 4

Table 1 Soil suitability for selected uses. . . 14

## INTRODUCTION

This report describes a detailed soil survey and soil interpretation of approximately 2,720 acres in a selected area adjacent to the town of Rainbow Lake. Rainbow Lake is located 85 miles west of High Level, Alberta, in Township 109, Range 9, west of the 6th meridian. The survey, undertaken in the summer of 1971, was at the request of the Peace River Planning Commission to assist in planning community development.

The soil map, which accompanies this report and is printed at a scale of 650 feet to the inch, shows the location and extent of the soil areas. The soil legend included with the soil map indicates the classification of the soils. The cultural and physical features of the area have been described. A listing of limiting soil properties and a table of soil interpretations are included. The soil interpretations indicate the degrees of limitation (slight, moderate or severe) that each of the soils have for designated uses.

An appendix shows the chemical and physical properties of the soils and a glossary defines some of the more frequently used terms.

## CULTURAL AND PHYSICAL FEATURES OF THE AREA

The New Town of Rainbow Lake was established in the early 1960's. Today the economy of the town is based on the oil industry.

The land surface of the designated town area is characterized by gently

sloping and level areas and by a large number of depressional areas. There is a general regional slope from north to south.

The area is underlain by the Shaftesbury Formation of Cretaceous age (3). This bedrock formation consists mainly of dark gray shales of marine origin. The materials from which the majority of soils in the surveyed area have developed are deposits from glacial and postglacial times. Lacustro-till, till, recent alluvial, and organic materials were recognized in the area.

Lacustro-till deposits consist of fine textured stratified materials containing some stones. In the mapped area, lacustro-till comprises about 40 percent of the area.

Till is a heterogeneous material deposited directly from glacial ice. It is found in the northern portion and comprises about 30 per cent of the area surveyed.

The till is medium to fine textured and contains a large number of stones but it is not stratified.

Soils developed on alluvial materials are found along the floodplains and banks of the streams. They comprise about 10 per cent of the surficial deposits of the area. These materials vary in texture from sand to silty clay.

Organic deposits are of significant occurrence throughout the map area. These deposits have an accumulation of slightly to moderately decomposed organic material at the surface which is more than 24 inches thick. The very poorly drained organic deposits collectively account for about 10 per cent of the surficial deposits of the area.

# THE SOILS

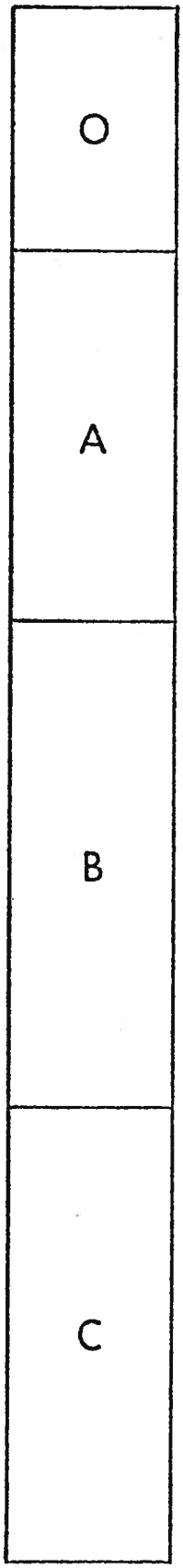
## I SOIL DEVELOPMENT

Soil is an organic or mineral layer (other than consolidated bedrock) thicker than four inches occurring naturally on the earth's surface. This layer has been subjected to the factors of soil development which include climate, vegetation, living organisms, topography, and the properties of its parent material. Over a period of time changes in its chemical and physical properties have taken place. These changes are reflected in the development of a sequence of horizons designated as A, B and C. These may or may not be overlain by an organic horizon. The recognition of the differences in the properties of each horizon permits the classification of the soils. A schematic diagram of a soil profile showing the major horizons and a brief description of horizon properties is shown in Figure 1.

## II SOIL CLASSIFICATION AND MAPPING

The soil legend shows the classification of the soils in the map area. The soils were mapped and classified according to the System of Soil Classification for Canada (2). Eight soil associations were mapped - two on lacustro-till, three on till, one on alluvial and two on organic parent materials. Because of soil variability the soil association, which often consists of two or more soil subgroups, was employed in mapping the area. The soil association is further subdivided into dominant and significant subgroup soil members. The dominant soil represents more than 60 per cent of the association while the significant soil member(s) represent less than 40

Figure 1. A sketch of a soil profile showing major soil horizons and a brief outline of differences in properties.




O - an organic horizon at the surface. May be further subdivided with respect to degree of decomposition. Characteristic of soil of Organic Order and peaty phase of Gleysolic soils. May be thin or absent in Gleysols.

A - a mineral horizon at or near the surface. It may be a dark colored organo-mineral horizon in which there is an accumulation of organic matter (Ah) or a light colored mineral horizon from which clay has been leached (Ae). May be dull in color due to gleying in soils of Gleysolic Order and in gleyed intergrades.

B - a mineral horizon below the A in which there is no appreciable amount of organic matter but which is affected by other soil processes. Absent in Rego Gleysols and Regosols. May be dull in color and mottled due to gleying as in Orthic Gleysols, Peaty Gleysols and gleyed intergrades.

C - a mineral horizon below the B horizon which is comparatively unaffected by the soil forming processes except for gleying and accumulation of salts and carbonates. It is calcareous in all soils of the map area. In soils of the Gleysolic Order dull colors and mottling are prominent.

per cent. Each mapping unit of a soil association contains unique terrain and soil characteristics.

The use of soil associations appeared suited to this study because the fine divisions included in the soil classification system could be recognized, although in many instances their intimate occurrence in the landscape precluded delineation on the soil map. This is not regarded, however, as a shortcoming of the mapping procedure since most of these inseparable units, although significant from a classification standpoint, are not sufficiently different with respect to soil properties to affect their use for urban development. A generalized description of the soil associations occurring in the mapped area is presented.

## III SOIL ASSOCIATIONS

### Rainbow Soil Association

The Rainbow soil association consists of well to imperfectly drained Gray Luvisols developed from weakly calcareous, fine textured lacustro-till. This material is often characterized by alternating lighter colored strata that consist of till-like material. These soils are typified by a thin leaf litter (L-H horizon) overlying a gray leached (Ae) horizon which is slightly acidic in reaction. The texture of the Ae horizon ranges from very fine sandy loam to silt loam and the average thickness of this horizon is about five inches. The subsoil (B horizon) is blocky in structure, slightly acidic to neutral in reaction, ranges in texture from silty clay loam to clay and is 15 to 30 inches thick. The parent material (C horizon) is weakly calcareous, mildly alkaline, stratified clay loam to clay.

Soils of mapping units 1 and 3 of the Rainbow association occur on slopes of 0 to 2 per cent whereas those of mapping unit 2 occur on slopes of 2 to 5 per cent. Due to periodic wetness in the soil solum, soils of mapping unit 3 commonly have duller colors than those of mapping units 1 and 2.

Sousa Soil Association

The Sousa soil association consists of poorly drained Gleysols developed from lacustro-till parent material.

The surface organic horizon of these soils varies in thickness from 2 to 15 inches. Soils having more than three inches of organo-mineral (Ah) horizon are classified as Humic Gleysols. Those soils not having an Ah horizon of three inches or more in depth are classified as Orthic Gleysols and Rego Gleysols. The massive to blocky structured, slightly acidic subsoil (B horizon) ranges in texture from silty clay loam to clay and is highly mottled.

The parent material (C horizon) is neutral to mildly alkaline in reaction and ranges in texture from clay loam to clay.

Soils of the Sousa association occur on slopes of 0 to 2 per cent.

Zama Soil Association

The Zama soil association consists of well to imperfectly drained Gray Luvisols developed from weakly calcareous medium to fine textured till.

These soils have a thin leaf litter (L-H horizon) overlying a gray leached (Ae) horizon which is slightly acid in reaction, ranges in texture from very fine sandy loam to silt loam and is usually about 5 inches thick. The blocky structured subsoil (B horizon) is strongly acidic in reaction,

ranges in texture from silty clay loam to clay loam and is usually 15 to 25 inches thick.

The mildly alkaline parent material (C horizon) is a weakly calcareous silty clay loam to clay loam.

The stone content of these soils is variable throughout the area.

Soils of mapping unit 1 of the Zama association occur on slopes of from 0 to 2 per cent while those of mapping unit 2 occur on slopes of 2 to 5 per cent.

Mega Soil Association

The Mega soil association consists of Gleysolic soils developed from till. Like the soils of the Sousa association these soils are saturated during a major portion of the year.

The dominant soils of this association have more than three inches of an organo-mineral (Ah) horizon that is neutral in reaction and silt loam in texture. Soils of this association have a thin Ah horizon, less than three inches thick, and a prominent gleyed (Aeg) horizon. They are classified as Low Humic Eluviated Gleysols. Those soils of the Mega association having up to 16 inches of peat at the surface are classified as a peaty phase of the subgroup.

The subsoil (B horizon) is blocky in structure, neutral to mildly alkaline in reaction, and ranges in texture from loam to clay loam.

The parent material (C horizon) is mildly alkaline and also ranges in texture from loam to clay loam.

The soils of the Mega association occur on slopes of 0 to 2 per cent.

Haig Soil Association

The Haig soil association is comprised of well to imperfectly drained Brunisols and Luvisols consisting of sandy or gravelly materials 10 to 30 inches thick overlying till.

The surface horizon of these soils consists of a thin mat of leaf litter (L-H horizon) underlain by a gray medium to coarse textured leached (Ae) horizon. The horizon beneath the Ae (the Bm horizon) is generally brown in color and medium to coarse textured with weak structural development. Finer textured till occurs below this horizon and a thin gravelly layer may occur at the contact between the upper sandy material and the lower till material.

The till is weakly calcareous, mildly alkaline in reaction, and ranges in texture from silty clay loam to clay loam.

The soils of the Haig association occur on slopes ranging from 2 to 5 per cent.

Basset Soil Association

The Basset soil association consists dominantly of Gleysolic soils developed from recent alluvial parent material. These soils are saturated during a major portion of the year.

Those soils having more than three inches of an organo-mineral (Ah) horizon overlying layers of mineral material are classified as Rego Humic Gleysols. The soils classified as Gleyed Regosols include soils lacking distinct horizon development and are somewhat poorly drained. These soils are characterized by layers of mineral material with interlayers of organo-mineral material. The mineral matter has a wide range in texture, including sandy loams, silt loams, silty clay loams, and clay loams.

The soils of the Basset association occur adjacent to stream courses in the area.

Bivouac Soil Association

The Bivouac soil association includes Organic soils in which free water remains at or near the surface most of the year. They are comprised of dark brown to black fibrous peaty materials derived from the remains of sedges and grasses. The layers of peat are distinguished from one another by color and degree of decomposition. The thickness and occurrence of the different layers are highly variable over short distances.

These soils occur in level and depressional areas.

Vardie Soil Association

The Vardie soil association consists of Organic soils in which free water remains at or near the surface most of the year. These soils are composed of reddish brown to dark brown, coarse peaty materials consisting predominantly of mosses. The upper portion of the organic material is generally a mixture of fibrous feather mosses and sphagnum, while the lower portion consists of compact layers of moderately or well decomposed peat.

The thickness of the peat is quite variable and ranges from 24 to 60 or more inches in this area. There is evidence that some of these soils are frozen at shallow depths throughout the year.

Vardie soils occur in level and depressional areas where surface waters tend to accumulate.

## SOIL SURVEY INTERPRETATIONS

In the course of a soil survey, pedologists make many soil observations and descriptions in preparation for the compilation of the final soil map and report. The soil map is prepared by making soil delineations in combination with various terrain classes. To be useful this basic information must be interpreted for various uses.

Soil survey interpretations should be treated as evaluations of soil performance not as recommendations for the use of the soil. They can be useful in aiding site selection and evaluation which may assist the planner, engineer and developer in avoiding costly mistakes. However, the interpretive information is not intended to eliminate on-site investigations for specific uses. The information serves as a guide for evaluating sites and for planning more detailed investigations at minimum cost.

In the study area the soils will be required primarily for landscaping and as a construction material. The soils are rated in terms of the degree of limitation as follows:

1. Slight - soils with few known limitations for the use indicated.
2. Moderate - soils that have one or more properties limiting their use. Correcting these factors will increase costs.
3. Severe - soils that have one or more properties that seriously limit their use. The cost of development may be very high but using these soils without employing corrective measures could result in failure.

Table 1 describes the suitability of the soils in the Rainbow Lake area for selected uses, (see page 14).

LAWNS AND LANDSCAPING

The soils are rated for this use assuming they will be used for growing turf, shrubs and/or trees. Suitable soils are capable of supporting a turf that can withstand moderate traffic and control runoff without erosion. Soil properties considered in rating the soils for this use are surface texture as it relates to droughtiness and trafficability, depth to seasonal high water table, slope, and thickness and organic matter content of the surface material.

Soils with moderate limitations for this use are those of the Rainbow, Zama, and Haig associations. These soils have a surface layer (L-H horizon) of organic material consisting mainly of leaves and needles. This layer, however, is thin (usually less than two inches) and quickly disappears when the surface is disturbed. The layer or horizon below (Ae) is low in organic matter content and has a platy structure. When wet, the Ae horizon behaves like a heavy paste but becomes very firm and crusted when dry. As a result, grass growth may be somewhat inhibited and the soil surface may be easily compacted.

These soils will benefit from the addition of humic materials and fertilizers when used for landscaping purposes.

Areas characterized by soils of the Sousa, Mega and Basset associations are poorly drained and vegetative rooting problems are likely to occur because of wetness.

The Bivouac and Vardie soils are very poorly drained and are severely limited by a permanent high water table.

## SEWAGE DISPOSAL

Successful operation of a septic tank disposal field depends upon the soils' ability to absorb and filter the effluent passing through the field. At the same time the soil should be relatively impermeable so that seepage will not contaminate groundwater supplies. Soil properties considered in rating soils for this use are the depth to a seasonally high water table and the texture of the soil as it relates to absorption and groundwater contamination.

Soils with moderate limitations for this use are soils of the Rainbow, Zama and Haig associations. These soils are limited by fine textured subsoils which have a low permeability.

Soils of the Sousa, Mega and Basset associations have severe limitations for this use because of a seasonally high water table. Severe limitations also occur with the Vardie and Bivouac associations because of their permanent high water table.

## HOMESITE LOCATIONS WITH BASEMENTS

These ratings are for homesites or buildings of three stories or less, with basements averaging at least five feet below ground level. Properties considered in rating soils for this use are depth to a seasonal or permanent high water table, degree of slope, and shrink-swell potential. The shrink-swell potential is an indication of the volume change to be expected in the soil with changes in moisture content.

The soils with a moderate limitation for this use, resulting from a moderate shrink-swell potential, include the soils of the Zama, Haig and Rainbow associations.

The soils with severe limitations because of a relatively high seasonal water table and a moderate shrink-swell potential include those of the Sousa, Mega and Basset associations. Soils of the Vardie and Bivouac associations have severe limitations resulting from a permanent high water table.

STREET AND ROAD LOCATIONS

The soils are rated for the use of locating streets and roads in subdivisions rather than major highways. It is assumed that the streets and roads would be hard surfaced. Properties considered in rating soils for this use are depth to a seasonal or permanent high water table and degree of slope.

The soils with the highest potential for this use include the soils of the Zama and Haig associations and mapping units 1 and 2 of the Rainbow association.

Soils with moderate limitations because of a relatively high seasonal water table include those of mapping unit 3 of the Rainbow association.

Soils with severe limitations because of a high seasonal water table include soils of the Sousa, Mega and Basset associations. Soils of the Vardie and Bivouac associations have severe limitations resulting from a permanent high water table.

Table 1. Soil Suitability for Selected Uses

| Soil Association | Mapping Units | Soil Suitability For: Lawns | Sewage Disposal | Homesites w/Basements | Street and Road Location |
|---|---|---|---|---|---|
| Rainbow | Rbw 1 | M3,4,6 | M5 | M6 | S |
| | Rbw 2 | M3,4 | M5 | M6 | S |
| | RBW 3 | M1,3,4,6 | M1,5 | M1,6 | M1 |
| Sousa | Ssa 1 | V1 | V1 | V1,6 | V1 |
| | Ssa 2 | V1 | V1 | V1,6 | V1 |
| Zama | Zm 1 | M3,4 | M5 | M6 | S |
| | Zm 2 | M3,4 | M5 | M6 | S |
| Mega | Mg 1 | V1 | V1 | V1,6 | V1 |
| Haig | Hag 1 | M2,3,4 | M5 | M6 | S |
| Basset | Bst 1 | V1 | V1 | V1,6 | V1 |
| Bovouac | Bvc 1 | V1 | V1 | V1 | V1 |
| Vardie | Vrd 1 | V1 | V1 | V1 | V1 |

Limitations

1) Shallow depth to seasonal high water table
2) Droughtiness
3) Trafficability (soil surface easily altered)
4) Lack of organic matter and low fertility
5) Low permeability
6) High shrink-swell potential

Degree of Limitation

S - Slight
M - Moderate
V - Severe

## DISCUSSION OF CHEMICAL AND PHYSICAL ANALYSES

Chemical and physical analytical data pertaining to some of the soils occurring in the Rainbow Lake townsite are presented in the appendix. Some comments on the significance of the data are given in the following discussion.

### CHEMICAL ANALYSES

Nitrogen is an important plant nutrient and the amount present in different soils varies considerably. The decomposed organic matter in the organo-mineral (Ah) horizon is the main source of nitrogen in a soil. Consequently soils having an Ah horizon are usually more fertile than those not having this horizon.

Soil reaction is expressed in terms of the pH scale. Soils with pH 7 are neutral. Values below 7 indicate a degree of acidity while those above 7 indicate a degree of alkalinity. The lowest pH values occur in the Ae and B horizons of the Brunisolic and Luvisolic soils. The Gleysolic soils are not generally as acidic as the Luvisolic soils because of bases contained in the groundwater. The C horizons of most of the soils in the map area are neutral to mildly alkaline in reaction.

The calcium carbonate ($CaCO_3$) equivalent gives an indication of the carbonate content of the parent material of the soils. The analyses indicate that the parent material is primarily weakly calcareous to moderately calcareous.

The electrical conductivity analysis provides a measure of the salt content of a soil. This determination is important because saline soils pose a number of problems with regard to urban development. One of the major

concerns is with the potential corrosion of concrete structures and underground conduit because of subsoil salinity. The low values in the table, however, indicate that subsoil salinity is not a problem in this regard in the Rainbow Lake area.

PHYSICAL ANALYSES

The physical analyses presented in the appendix are based on data obtained by mechanical analyses and by tests to determine liquid limit and plastic limit (Atterberg Limits). These properties are of special interest to engineers because they affect the construction and maintenance of highways, pipelines, building foundations, water storage facilities, sewage-disposal systems, and drainage systems.

To aid in the evaluation of the soils for engineering purposes, soil samples from six locations were analyzed according to procedures outlined in the ASTM Book of Standards, Part 11 (1). Particle size analyses were done by the pipette method (5).

The tests for liquid limit and plastic limit measure the effects of water on the consistence of soil material. As the moisture content of an expandable clay soil increases from a dry state, the material changes from a semisolid to a plastic. As the moisture content is further increased, the material changes from a plastic to a liquid. The plastic limit is the moisture content at which the soil passes from a semisolid to a plastic. The liquid limit is the moisture content at which the soil passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. This parameter indicates the range of moisture content within which a soil material is in a plastic condition.

There are two systems for classifying soil materials in general use among engineers (4). One system is that approved by the American Association of State Highway Officials and referred to as the AASHO Classification System. The other is the Unified Soil Classification System.

In the AASHO System, soil material is classified into seven groups. These groups range from A-1, consisting of gravelly soils of high bearing capacity, to A-7, consisting of clay soils having low strength when wet. Within each group the relative engineering value of the soil material is indicated by an index number. The indexes range from 0 for the best material to 20 for the poorest. The index number is shown in parentheses following the soil group symbol. Increasing values of the index within each basic soil group reflect the reduction of the load-carrying capacity of subgrades and the combined effect of increasing liquid limits and plasticity indexes and decreasing percentages of coarse material. The AASHO classification is based on results obtained from particle size analyses, liquid limit, plastic limit, calculated plasticity index and the calculated group index numbers.

In the Unified Soil Classification System the soils are identified according to their textures and plasticity and are grouped according to their performance as engineering construction materials. This system recognizes eight classes of coarse grained soils, six classes of fine grained soils, and highly organic soils. Coarse grained soils are those that have 50 per cent or less of material passing the No. 200 sieve; fine grained soils are those having more than 50 per cent material passing the No. 200 sieve. The letters G, S, C, M, and O stand for gravel, sand, clay, silt, and organic material respectively; the the letters W, P, L, and H refer to well graded, poorly graded, low liquid limit, and high liquid limit, respectively. The

designation CL, for example, shows silts mixed with clays whereas SC shows sands with an appreciable amount of fines. Also recognized in the Unified System are organic silts (OL), organic clays (OH), and peat or other highly organic soils (PT).

The textural classification of the soils according to the United States Department of Agriculture system (USDA) is also listed in the table of physical analyses.

## ACKNOWLEDGMENTS

The authors acknowledge the assistance received from many members of the Soils Division of the Research Council of Alberta. Special recognition is given to Mr. Z. Widtman who drafted the map and to the laboratory staff for soil analyses.

## REFERENCES

1. Amer. Soc. for Testing and Materials. 1970. Annual Book of ASTM Standards, Part 11. 1916 - Race St., Philadelphia, Pa. 19103. 982 pp.

2. Canada Department of Agriculture. 1970. System of Soil Classification for Canada, Can. Dept. of Agric., Queen's Printer, Ottawa. 249 pp.

3. Geological Map of Alberta. 1972. Research Council of Alberta Map No. 65.

4. Portland Cement Association. 1962. PCA Primer. 33 West Grand Ave., Chicago, Ill. 60610.

5. Toogood, J. A. and T. W. Peters. 1953. Comparison of methods of mechanical analysis of soils. Can. J. Agric. Sci. 33:159-171.

# APPENDIX

CHEMICAL ANALYSIS OF REPRESENTATIVE PROFILES:

| Mapping Unit | Subgroup | Horizon | Depth in. | pH | % N | % $CaCO_3$ | Elect.Cond. mmhos/cm. |
|---|---|---|---|---|---|---|---|
| Rbw 1 | Solodic Gray Luvisol | Ae | 0-5 | 6.0 | 0.1 | - | - |
| | | Bt | 5-16 | 6.7 | 0.1 | - | - |
| | | BC | 16-27 | 6.8 | - | - | - |
| | | Ck1 | 27-50 | 7.5 | - | 1.9 | 0.5 |
| | | Ck2 | 50+ | 7.5 | - | 3.0 | 1.0 |
| Rbw 2 | Solodic Gray Luvisol | Ae | 0-4 | 5.8 | 0.1 | - | - |
| | | AB | 4-9 | 4.9 | 0.1 | - | - |
| | | Bt | 9-22 | 5.0 | 0.1 | - | - |
| | | BC | 22-26 | 6.6 | - | - | - |
| | | Cca | 26-32 | 7.7 | - | 6.5 | 0.7 |
| | | Ck | 32-60 | 7.5 | - | 2.5 | 0.3 |
| | | IICk | 60+ | 7.5 | - | 2.5 | 0.4 |
| Ssa 1 | Peaty Orthic Humic Gleysol | F-H | 12-0 | 6.4 | - | - | - |
| | | Ah | 0-3 | 6.1 | 1.4 | - | - |
| | | Bg | 3-10 | 6.3 | 0.1 | - | - |
| | | Cg1 | 10-26 | 6.3 | - | - | - |
| | | Ckg1 | 26-40 | 7.1 | - | 1.4 | - |
| | | Ckg2 | 40+ | 7.0 | - | 1.4 | 0.5 |
| Ssa 2 | Orthic Gleysol | F | 0-5 | 6.1 | - | - | - |
| | | H | 5-8 | 6.2 | - | - | - |
| | | Bg | 8-15 | 6.4 | 0.2 | - | - |
| | | Cg1 | 15-22 | 6.6 | - | - | - |
| | | Cg2 | 22-38 | 5.8 | - | - | - |
| | | Cg3 | 38-50 | 6.6 | - | - | - |
| Zm 1 | Orthic Gray Luvisol | L-H | 2-0 | - | 0.04 | - | - |
| | | Ae | 0-6 | 5.3 | 0.04 | - | - |
| | | Bt | 6-22 | 4.7 | 0.01 | - | - |
| | | BC1 | 22-33 | 4.6 | - | - | - |
| | | BC2 | 33-42 | 5.9 | - | - | - |
| | | Ck1 | 42-52 | 7.2 | - | 2.5 | 0.4 |
| | | Ck2 | 52+ | 7.3 | - | 1.7 | 0.3 |
| Mg 1 | Peaty Humic Gleysol | F | 10-0 | 6.8 | - | - | - |
| | | Ah | 0-6 | 6.8 | 1.46 | - | - |
| | | Bg | 6-20 | 6.9 | - | - | - |
| | | Ckg | 20+ | 7.4 | - | 6.8 | - |

| Mapping Unit | Subgroup | Horizon | Depth in. | pH | % N | $CaCO_3$ | Elect.Cond. mmhos/cm. |
|---|---|---|---|---|---|---|---|
| Hag 1 | Degraded Eutric Brunisol | Ae | 0-5 | 5.4 | 0.1 | - | - |
| | | Bm | 5-15 | 5.1 | - | - | - |
| | | IIBt | 15-25 | 4.8 | - | - | - |
| | | IIBC | 25-43 | 5.0 | - | - | - |
| | | IICk | 43+ | 7.4 | - | 4.4 | 0.3 |
| Bst 1 | Rego Humic Gleysol | Ah | 0-8 | 5.9 | 0.5 | - | - |
| | | Cg1 | 8-27 | 5.6 | - | - | - |
| | | Cg2 | 27-50 | 5.8 | - | - | - |
| | | Cg3 | 50+ | 6.1 | - | - | 0.2 |

## APPENDIX

### PHYSICAL ANALYSES OF REPRESENTATIVE PROFILES

| apping Unit | Subgroup | Horizon | Depth (inches) | Mechanical Analysis % Sand | % Silt | % Clay | USDA Text. | Sieve Analysis % Pass # 40 | % Pass # 200 | VFS | Atterberg Limits Liquid Limit | Plastic Limit | Plasti-city Index | Activity PI/C | Unified Soil Class. | AASHO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ainbow 2 | Solodic Gray Luvisol | Ae | 0-4 | 38 | 47 | 15 | L | | | | | | | | | |
| | | AB | 4-9 | 26 | 42 | 32 | CL | | | | | | | | | |
| | | Bt | 9-22 | 29 | 35 | 36 | CL | | | | | | | | | |
| | | BC | 22-26 | 23 | 43 | 34 | CL | | | | | | | | | |
| | | Cca | 26-32 | 31 | 41 | 28 | L | 95 | 74 | 21 | 36 | 21 | 15 | 0.5 | CL | A-6 (10) |
| | | Ck | 32-60 | 20 | 40 | 40 | C | 96 | 80 | 16 | 38 | 22 | 16 | 0.4 | CL | A-6 (11) |
| | | IICk | 60+ | 22 | 40 | 38 | CL | 96 | 77 | 19 | 9 | NP | NP | - | CL | A-4 (8) |
| ousa 1 | Peaty Orthic Humic Gleysol | F-H | 12-0 | - | - | - | | | | | | | | | | |
| | | Ah | 0-3 | 40 | 45 | 15 | L | | | | | | | | | |
| | | Bg | 3-10 | 24 | 36 | 40 | C | | | | | | | | | |
| | | Cg1 | 10-26 | 18 | 39 | 43 | C | 96 | 82 | 14 | 44 | 24 | 20 | 0.5 | CL | A-7-6 (12) |
| | | Ckg1 | 26-40 | 20 | 37 | 43 | C | 95 | 81 | 14 | 39 | 23 | 16 | 0.4 | CL | A-6 (10) |
| | | Ckg2 | 40+ | 19 | 39 | 42 | C | 94 | 79 | 15 | 40 | 22 | 18 | 0.4 | CL | A-6 (11) |
| ousa 2 | Orthic Gleysol | F | 0-5 | - | - | - | | | | | | | | | | |
| | | H | 5-8 | - | - | - | | | | | | | | | | |
| | | Bg | 8-15 | 13 | 53 | 34 | SiCL | | | | | | | | | |
| | | Cg1 | 15-22 | 22 | 39 | 39 | CL | 95 | 77 | 18 | 44 | 23 | 21 | 0.5 | CL | A-7-6 (13) |
| | | Cg2 | 22-38 | 54 | 27 | 19 | SCL | 86 | 44 | 42 | 30 | 19 | 11 | 0.5 | SC | A-6 (2) |
| | | Cg3 | 38-50 | 49 | 17 | 34 | SCL | 87 | 42 | 45 | 27 | 15 | 12 | 0.3 | SC | A-6 (2) |
| ama 1 | Orthic Gray Luvisol | Ae | 0-6 | 24 | 58 | 18 | SiL | | | | | | | | | |
| | | Bt | 6-22 | 17 | 41 | 42 | SiC | | | | | | | | | |
| | | BC1 | 22-33 | 18 | 45 | 37 | SiCL | | | | | | | | | |
| | | BC2 | 33-42 | 18 | 47 | 35 | SiCL | | | | | | | | | |
| | | Ck1 | 42-52 | 19 | 46 | 35 | SiCL | 96 | 77 | 19 | 35 | 21 | 14 | 0.4 | CL | A-6 (9) |
| | | Ck2 | 52+ | 19 | 47 | 34 | SiCL | 95 | 75 | 20 | 34 | 21 | 13 | 0.4 | CL | A-6 (8) |
| lega 1 | Peaty Humic Gleysol | F | 10-0 | - | - | - | | | | | | | | | | |
| | | Ah | 0-6 | - | - | - | | | | | | | | | | |
| | | Bg | 6-20 | 40 | 39 | 21 | L | | | | | | | | | |
| | | Ckg | 20+ | 41 | 39 | 20 | L | 99 | 72 | 27 | 22 | 15 | 7 | 0.4 | CL | A-4 (9) |
| asset 1 | Rego Humic Gleysol | Ah | 0-8 | 23 | 48 | 29 | CL | | | | | | | | | |
| | | Cg1 | 8-27 | 17 | 51 | 32 | SiCL | 100 | 79 | 2[illegible] | 50 | 35 | 15 | 0.5 | CL | A-7-5 (12) |
| | | Cg2 | 27-50 | 55 | 24 | 21 | SCL | 94 | 45 | 49 | 22 | 15 | 7 | 0.3 | SC | A-4 (2) |
| | | Cg3 | 50+ | 62 | 20 | 18 | SL | 98 | 41 | 57 | 20 | NP | NP | - | SMd | A-4 (1) |

# APPENDIX

Acolian material - material deposited by wind.

Alluvial material - material deposited by water.

Association, Soil - a group of soils geographically associated in a characteristic repeating pattern in the landscape.

Calcareous material - material containing free carbonates which effervesces visibly when treated with dilute hydrochloric acid.

Cation - an ion carrying a positive charge of electricity. The common soil cations are calcium, magnesium, potassium, sodium and hydrogen.

Eluviation - the removal of soil material in suspension or in solution from a layer or layers of a soil.

Field capacity - the amount of moisture held in a soil after the free water has been drained away into drier soil material below.

Gleying - a reduction process that takes place in soils that are saturated with water for long periods of time.

Horizon - a layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil-forming processes.

Illuviation - the process of deposition of soil material from an upper to a lower horizon in the soil profile.

Intergrade - a soil that possesses moderately well-developed distinguishing characteristics of two or more soil Orders.

Lacustrine materials - material deposited in lake water and later exposed by a lowering of the water or uplift of the land.

Liquid limit - 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.

Peat - unconsolidated soil material consisting largely of undecomposed to partially decomposed organic matter accumulated under conditions of excessive moisture.

Ped - a unit of soil structure such as a prism, block or granule formed by natural processes (in contrast to a clod which is formed artifically).

Pedology - those aspects of soil science involving the constitution, distribution, genesis and classification of soils.

Permeability - the ease with which gases, liquids or plant roots penetrate or pass through a bulk mass of soil or a layer of soil.

pH - a notation used to designate the relative acidity or alkalinity of soils and other materials. A pH of 7.0 indicates neutrality, high values indicate alkalinity, lower values acidity.

Plastic limit - water content at which a soil will just begin to crumble when rolled into a thread approximately 3 mm. in diameter.

Plasticity index - the numerical difference between the liquid and plastic limits.

Profile - a vertical section of the soil throughout all its horizons and extending into the parent material.

Saline material - material whose saturated extract has an electrical conductivity greater than 4 mmhos/cm. The grades of salinity are: weakly saline - 4 to 8 mmhos/cm., moderately saline - 8 to 15 mmhos/cm., and strongly saline - over 15 mmhos/cm.

Soil moisture classes - defined in terms of (a) actual moisture in excess of field capacity and (b) the extent of the period during which excess water is present in the plant root zone.

(1) Rapidly drained - soil moisture content seldom exceeds field capacity except immediately after water additions.

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

(3) Moderately well drained - soil moisture in excess of field capacity remains for a small but significant part of the year.

(4) Imperfectly drained - soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods of the year.

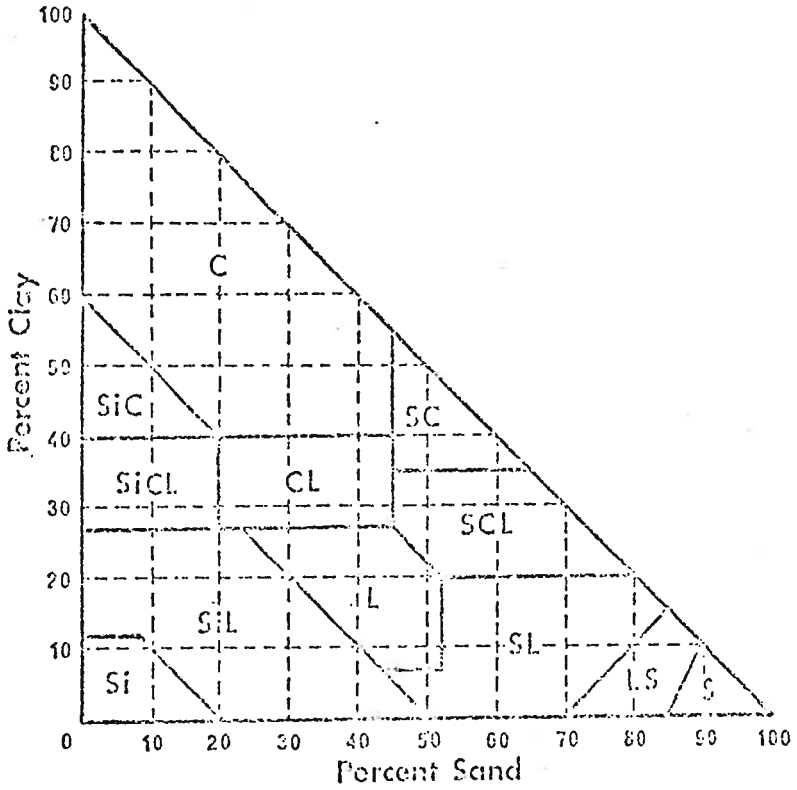
(5) Poorly drained - soil moisture in excess of field capacity remains in all horizons for a large part of the year.

(6) Very poorly drained - free water remains at or within 12 inches of the surface most of the year.

Texture - the composition of the soil on the basis of the per cent of the different soil separates. The soil separates or particle sizes on which textural classes are based are:

| Separates | Diam. in mm.* |
|---|---|
| Gravel (G) | more than 2.0 |
| Very coarse sand (VCS) | 2.0 - 1.0 |
| Coarse sand (CS) | 1.0 - 0.5 |
| Medium sand (MS) | 0.5 - 0.25 |
| Fine sand (FS) | 0.25 - 0.10 |
| Very fine sand (VFS) | 0.10 - 0.05 |
| Silt (Si) | 0.05 - 0.002 |
| Clay (C) | less than 0.002 |
| Fine clay (FC) | less than 0.0002 |

* USDA Classification




The various textures are grouped as follows: coarse textured - sands (S) and loamy sands (LS); moderately coarse textured - sandy loams (SL) and fine sandy loams (FSL); medium textured - loams (L), very fine sandy loams (VFSL), silt loams (SiL), and silts (Si); moderately fine textured - sandy clay loam (SCL), clay loam (CL), and silty clay loams (SiCL); fine textured - sandy clays (SC), clays (C), and silty clays (SiC); very fine textured - heavy clays (HC).

Topographic classes and symbols -

| Simple Topography Single Slopes (regular surface) | | Complex Topography Multiple Slopes (irregular surface) | Slope (%) |
|---|---|---|---|
| A | depressional to level | a nearly level | 0 to 0.5 |
| B | very gently sloping | b gently undulating | 0.5+ to 2 |
| C | gently sloping | c undulating | 2+ to 5 |
| D | moderately sloping | d gently rolling | 5+ to 9 |
| E | strongly sloping | e moderately rolling | 9+ to 15 |
| F | steeply sloping | f strongly rolling | 15+ to 30 |
| G | very steeply sloping | g hilly | 30+ to 60 |
| H | extremely sloping | h very hilly | over 60 |

Water holding capacity - the ability of a soil to hold water.

Water table - the upper limit of that part of the soil that is wholly saturated with water.