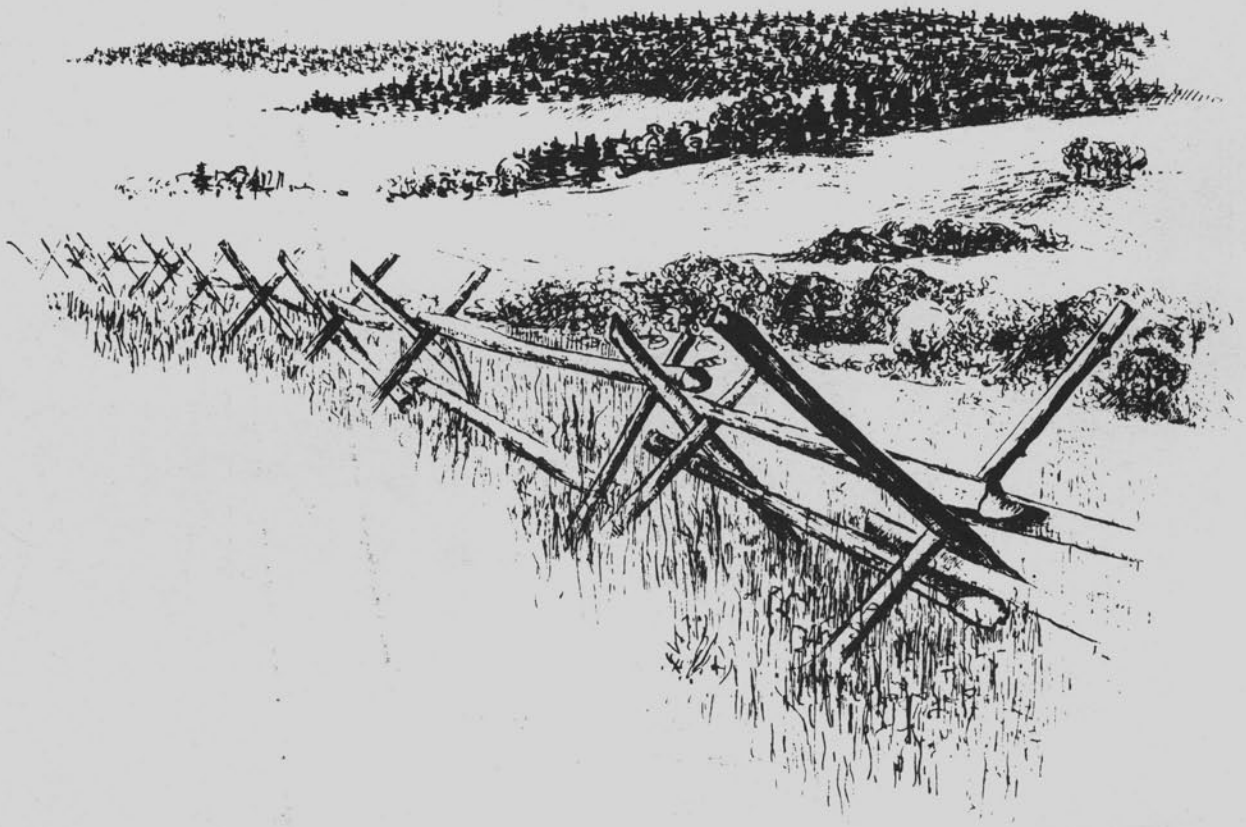
A Soil Resource and Land Use Survey of the

Alkali Lake Indian Reserve

L.A. Leskiw, L.Farstad and A.L. Bedwany
Edited by: Dr. R.E. Carlyle



1973

Report No. 276
Research Station,
Agriculture Canada,
6660 N.W. Marine Drive,
Vancouver 8, B.C.

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Acknowledgements

The authors express appreciation for assistance from the following people.

Mr. C. T. Johnson, Chief, (at the time of soil mapping) discussed soil utilization and granted permission to work on the Reserve.

Officials of the Department of Indian Affairs and Northern Development in Vancouver and Williams Lake, provided important background information and the names of local Indians to be contacted.

Mr. G. Cheesman, Agroclimatology Sector, British Columbia Land Inventory, supplied climatic data.

Ms. U. Bachinski drafted the figures. Mr. H. Reynolds helped with the field work. Soil analyses were done by Mr. L. Chan.

The aerial photographs were supplied by the Air Survey Division, Land Service, Victoria, British Columbia. The mosaic for the maps was prepared and printed by the Cartography Section, Soil Research Institute, Ottawa.

A SOIL RESOURCE AND LAND USE SURVEY OF THE ALKALI LAKE INDIAN RESERVE

Summary

This report presents the results of a survey of the soil resources of the Alkali Lake Indian Reserve. The survey revealed seven soils (Figure 3) grouped into six management areas (Figure 4). Suitable crops, irrigation requirements and fertilizer needs are indicated. Expected yields and special problems are noted.

The arable acreage of this Reserve is relatively small. At the present time only forage is grown. It is estimated that the arable land on the Reserve is capable of producing 450 - 500 tons/annum of good quality forage. Although the frost-free period is rather short, vegetables can be grown successfully in this region. These include Brussel sprouts, broccoli, cabbage, carrots, cauliflower and many others.

Irrigation is necessary for cultivated crops on this Reserve. Alkali Creek is a satisfactory source of water. Intensification of this practice requires a trained full-time irrigation technician. Alternatively, a practical knowledge of irrigation practices can be made a part of the agricultural manager's qualifications.

Three important considerations are involved in increasing the agricultural production. These are; (a) increased capital expenditures, (b) a manager with technical agricultural training, and (c) social and philosophical adjustments. The last item is not easily achieved and requires considerable time for change.

A stepwise plan for increasing crop production in the immediate future is as follows; (a) continue flood irrigation on Management Area B and establish a sprinkler irrigation system on Area C for forage production, (b) begin vegetable growing on Area C for home use, if this is successful expand into commercial production as expertise and markets are developed, (c) expand the sprinkler system to cover Area A. This area is characterized by very gravelly subsoil hence cultivation must be minimal restricting the use to forage crop production, and (d) start including the other tracts of land belonging to the Band into a general improvement plan.

Introduction

This report is one of several describing the soil resources of some of the Indian reserves in British Columbia. These surveys are done by the Soil Survey Section, Research Station, Canada Department of Agriculture, Vancouver, at the request of the Department of Indian Affairs and Northern Development.

The population of the Reserve is listed at 280.

At the present time the main agricultural use of the Reserve is production of forage on a 50 acre, flood irrigated field. A garden is grown to provide fresh vegetables for home use. This Reserve, like most others in the region, has a number of nearby tracts of land, usually hay meadows, which provide pasture or a limited forage supply.

The objectives of this report are as follows;

(a) to classify and assess the soil resources of Reserve No. 1,

(b) to group the soils into management areas including practical management suggestions for each area,

(c) to outline irrigation water and fertilizer requirements, and

(d) to suggest crops adaptable to the soils and climate and estimate possible yields.

To achieve the objectives, a general discussion was held with the Chief and some of the residents. Next, the soils were systematically mapped and samples were collected for chemical analyses. Finally, the soils were grouped into management areas and their distribution mapped.

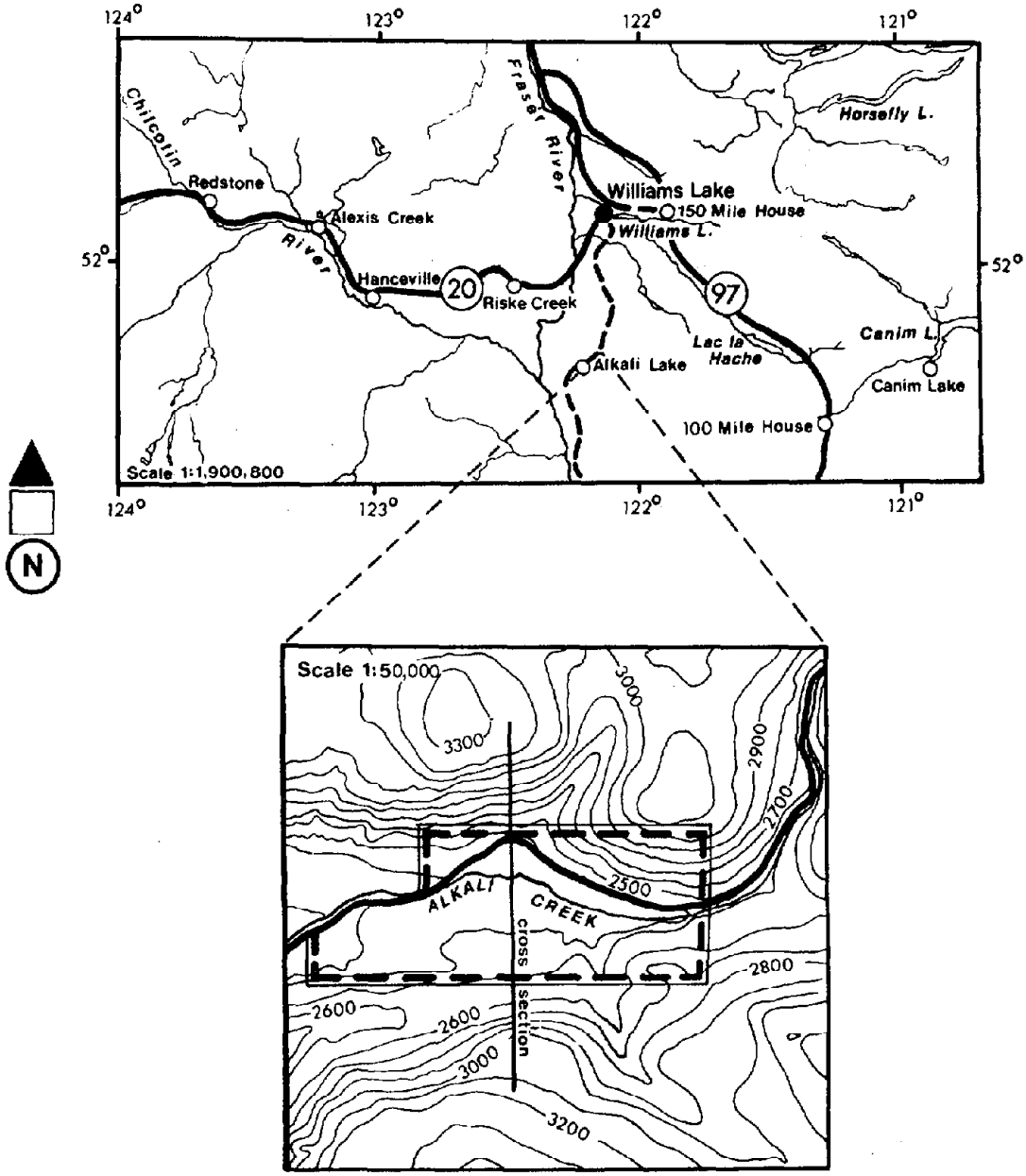


Figure 1. Location map of Alkali Lake Indian Reserve 1.

Highway

Reserve boundary

Contour Line

Contour Interval 100 ft.

Location and Extent

Alkali Lake Indian Reserve is located approximately 30 miles south of Williams Lake, British Columbia (Figure 1) in typical Cariboo Parkland.

The Reserve totals 600 acres[1] of which 190 acres are more or less suitable for agricultural development. Approximately 80 acres now are used to produce hay, utilizing flood irrigation.

The Reserve lies within National Topographical Sheet No. 93-0/16 East.

[1] Acreages are based on aerial photograph measurements.

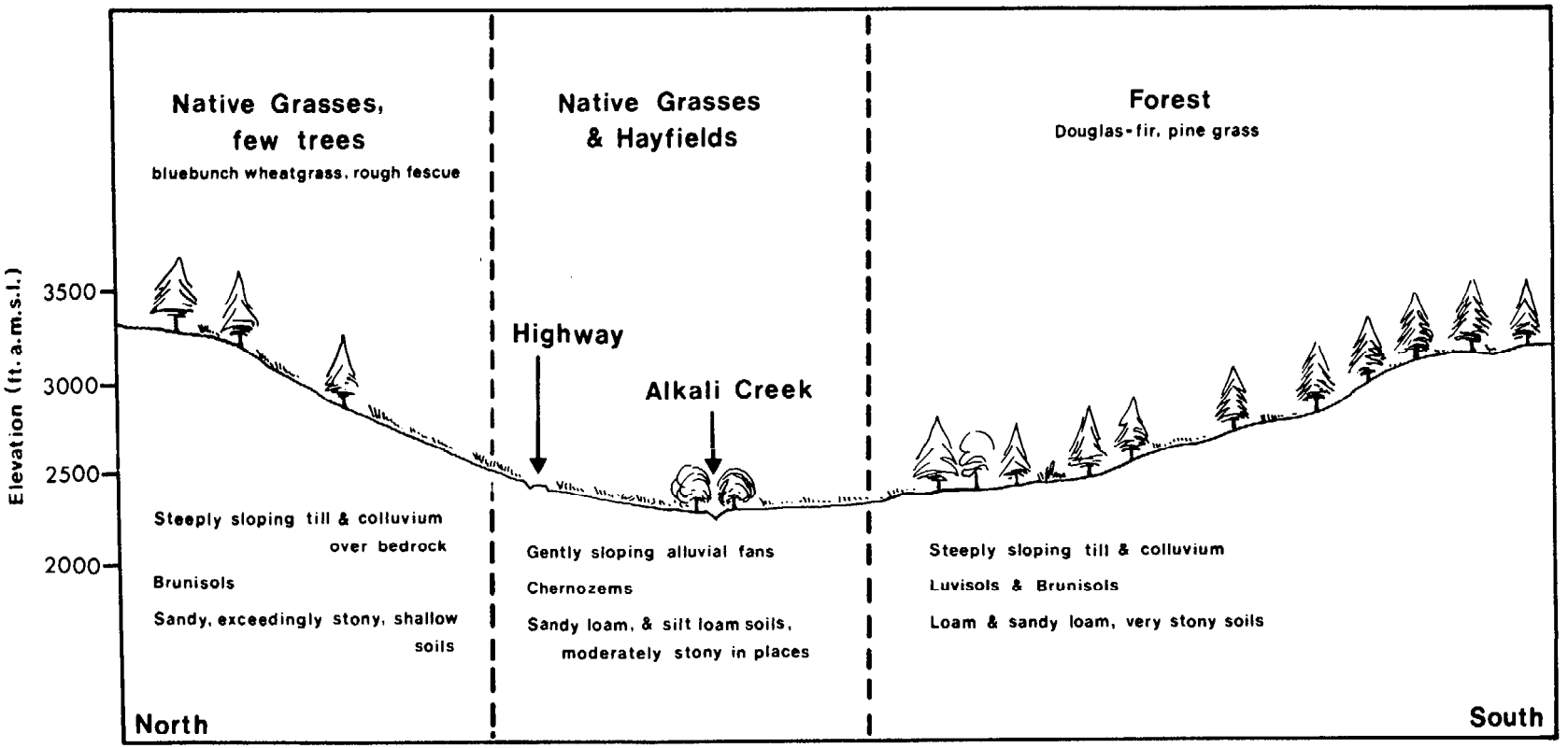


Figure 2. Idealized cross section of Alkali Lake Indian Reserve 1 indicating vegetation, landforms, soils, soil texture, and stoniness.

Nature of the Landscape

The Reserve occurs within a large tributary valley of the Fraser River through which Alkali Creek flows. The valley bottom is at an elevation of about 2300 feet and the slopes extend to about 3000 feet.

A cross-section (Figure 2) outlines the general topography, landforms, soils and vegetation.

Alluvial fans along the Creek form the most important agricultural part of the Reserve. A flat area of sandy, gravelly soil located southwest of the village is also suitable for irrigation.

The north-facing slopes on the southern part of the reserve are forested. This tract has a low forest capability rating but is valuable as a source of wood, fencing materials, and limited lumber supply. The remainder of the Reserve is undulating parkland suitable for grazing.

Climate

Annual precipitation -	14.5 inches
May through September precipitation -	7.5 inches
Annual snowfall -	50 - 60 inches
Frost-free period -	70 days
Growing degree days above 42° F -	2200°

The climate is characterized by cold winters and hot summers. The valleys in particular reach relatively high temperatures during the summer period. As indicated, rainfall is sparse particularly during the crop growing period. The climate is rated as semi-arid even though snowfall can be plentiful in the winter.

The lack of rainfall and high summer daytime temperature of the valley precludes economical crop production unless irrigation water is available.

Vegetation

The native vegetation is light forest (Douglas-fir and lodgepole pine) with grasses forming ground cover. This also prevails on the non-arable parts of the Reserve. Low-lying areas along streams grow various sedges, rushes, willows and coarse grasses.

If water is available a wide range of crops can be grown, particularly in the valleys. These include cereals (oats and barley), forages (alfalfa, red, alsike, sweet clover, brome and timothy grasses), and cool-loving vegetables (cabbage, cauliflower, potatoes, etc.). Emphasis is placed on a combination of timothy and clovers. Poor harvesting weather sometimes causes problems with the cereals.

Cultivation Practices

For the present, the size of arable acreage dictates that cultivation be as simple as possible. An area of only 190 acres largely devoted to forage production cannot justify by itself a large outlay for machinery. Unless machinery is available from other Reserves, "Custom" cultivation may be the most economical provided it is available.

The main operations are disc plowing, seeding, fertilizing, swathing and baling. It is doubtful if cereal growing except as forage could be justified. Vegetables can be grown for home use and commercially only if a reliable market is available.

Irrigation

Alkali Creek is the source of irrigation water. Following is an analysis of the water done in 1971.

Conductance	-	mmhos/cm	0.630
pH	-		7.95
Ca^{++}	-	p.p.m.	40
Mg^{++}	-	p.p.m.	68
Na^{++}	-	p.p.m.	18
K^{+}	-	p.p.m.	6
CO_3	-	p.p.m.	0
HCO_3	-	p.p.m.	450
Cl^{-}	-	p.p.m.	0
SO_4	-	p.p.m.	8

According to the above data, Alkali Creek water can be rated as "Good" or Class 2 (2). With continued applications over an extended period of time, this water carries enough mineral elements to cause salt problems. Thus, periodically, excess water should be applied to wash out accumulated salts.

The supply of water is considered adequate for the management areas recommended for irrigation.

In this report, water in the soil is expressed as inches of water per foot of soil. The total amount of water available to plants is known as the Available Water Storage Capacity (AWSC). Technically, it is the difference in soil moisture content between Field Capacity and Permanent Wilting Point.

Water is not uniformly available to plants over the entire range of the AWSC. For example, the first 35 percent of the range may be readily available to a given crop and then become increasingly difficult to take from the soil over the remaining 65 percent of the range. For this report it is assumed that 50 percent of the AWSC is readily available to plants. Evapotranspiration requirement for a forage crop is considered to be 0.20 inches per day for the growing season. The recommended irrigation requirement for each management area includes a limited contribution from precipitation but excludes application losses. If irrigation efficiency is 50 percent, application rates, in terms of irrigation system design, must be doubled (1).

When the AWSC has not been measured for a certain soil, it is possible to estimate it from soil textures and the depths of the layers making up the plant root zone.

Soil Management Areas

Soils of this Reserve could be grouped in many ways, depending on present and probable use. The present and probable future use of these lands is not intensive. The soils, therefore, have been grouped geographically for broad planning and land use purposes. These groups, called soil management areas, are shown on a map (Figure 4) at the back of this report. In preparing these groupings the kinds of soil, parent material, topography, and climate are considered. Each area consists of a single soil or a group of soils which, in a general way, lend themselves to similar systems of management or rotation and have the same potential ability to respond and produce the desired crop. However, within each management area some soils may be included that are markedly different. These are incorporated because the acreage is small or because they occur in small, isolated individual areas, making separate management impracticable.

In this report, each of the six soil management areas is shown on the map by capital letters (Figure 4). The data used in discussing water requirements, fertilizer rates and crop yields are based on local experience, regional records and soil characteristics.

Management Area A (60 acres)

Management Area A occurs on the sandy and gravelly flats southwest of the village. The soils are characterized by a sandy loam or silt loam surface, slightly stony, overlying a very gravelly subsoil. This finer textured surface layer is generally less than 10 inches deep.

Chemical analyses (Table 1) indicate that these soils are free of salinity and acidity problems. With irrigation the soils require fertilizers containing nitrogen, phosphorus, and potassium for optimum crop yields. For grass-legume mixtures, 50 lb./acre N, 50 lb./acre P_2O_5, and 100 lb./acre K_2O should be applied. For grasses alone, an additional 200 lb. of N are recommended. These amounts should be split, one half being applied in the spring and the remainder added after the first cutting.

Soil cultivation should be shallow. The number of operations must be minimal, otherwise the very gravelly subsoil may be brought to the surface making the soil less suitable for crop growth.

It is recommended that Area A be used for forage production using combinations of grasses and clovers. Oats and barley may be grown as cover crops.

Area A is well suited for a sprinkler irrigation system as far as soils and topography are concerned. The soils are permeable and drainage is good. The available water storage capacity is estimated to be 3 inches within the top 3 feet of soil. Since about half of this is readily available for plant use, the soil should be irrigated when 1.5 inches of water are used by the crop. Assuming that evapotranspiration may amount to 0.20 inches of water per day during peak consumption, and considering some contribution by rainfall, the soil should be irrigated every 9 days at which time 1.5 inches of water is required. Over-irrigating, particularly following fertilization, must be avoided to prevent the loss of plant nutrients. Otherwise, valuable nutrients may be leached down and lost.

With fertilization, irrigation, and two cuttings per season, a yield of 5-6 tons/acre/year can be expected.

Management Area B (50 acres)

Management Area B, on the south side of Alkali Creek occurs on gently sloping fine sandy loam and silt loam. The soils are moderately well drained, moderately fertile, and calcareous. This Area is flood irrigated and used for hay production.

Under the present flooding system, fertilization should increase yields considerably. For optimum productivity, a more uniform and controlled application of water is required. This could be achieved by installing a sprinkler system but the cost and production relationship require study.

The available water storage capacity of the soils is estimated to be 2 inches per foot. Only half of this is readily available for plants, therefore, assuming a 3 foot rooting depth, 3 inches of water should be applied about every 18 days. If a shorter irrigation interval is desired, apply 2 inches every 12 days.

As already mentioned, these soils are calcareous, so a fairly large application of phosphorus fertilizer is necessary. Fifty lb./acre N, 80 lb./acre P_2O_5, and 100 lb. of K_2O should be applied annually for grass-legume mixtures. An additional 100 lb./acre N added is needed for grasses alone. The fertilizers should be applied in spring and midsummer (after the first cutting). Forage yields of 4 tons/acre/year can be expected.

Management Area C (80 acres)

This Area is characterized by well drained, slightly stony, gravelly sandy loam soils occurring on the gently to moderately sloping alluvial fans to the north of Alkali Creek.

The topsoil is dark gray, friable, and moderately fertile. When dry the subsoil is fairly compact. A calcareous layer usually occurs at a depth of 25 to 30 inches. Chemical analyses (Table 1) indicate that these soils would respond favourably to fertilization. About 50 lb./acre N, 50 lb./acre P_2O_5, and 125 lb./acre K_2O are recommended for grass-legume mixtures with an additional 200 lb./acre N for grasses alone.

The available water storage capacity of these soils is approximately 3.5 inches in the top 3 feet. Since about half of this water is readily available for crops, 1.75 inches of water should be applied every 12 days. A sprinkler irrigation system is recommended for this Area. The surface is too sloping and the soils too permeable to permit uniform water distribution by flood irrigation.

The soils are generally suitable for cultivation so that forage, cereal and vegetable crops may be grown. Vegetable production would be marginal and cereal production is limited to oats and barley. Everything considered, the Area is best suited to forage production. Yields of 5 tons per acre per annum might be expected.

Management Area D (200 acres)

Management Area D includes the very steeply sloping valley walls characterized by native grass vegetation. The steepness of the slopes precludes the use of farm machinery so improvements are impracticable. The Area should be used for pasture but over-grazing must be avoided to prevent serious erosion.

Management Area E (200 acres)

Area E occurs on the steeply sloping forested region in the south-eastern part of the reserve. As in Area D, the topography is too rugged for arable agriculture. Although the Area is forested, the potential for logging is limited by the relatively small acreage and poor forest growth. The area may be used for grazing but the carrying capacity is low.

Management Area F (15 acres)

This Area includes the banks and deposits along Alkali Creek. Willows are the dominant vegetation.

There is little or no potential for agricultural development in this Area. The vegetation should not be disturbed because it helps to reduce silting of the stream which may result from erosion of the stream banks and erosion of the adjacent fields.

Table 1. Alkali Lake Indian Reserve: Selected chemical analyses of topsoils of three management areas.

Management Area	pH ($CaCl_2$)	Organic matter %	N %	S %	K me/100g.	P ppm
A	7.00	3.15	0.210	0.018	0.78	42
A	7.33	3.93	0.218	0.017	1.08	54
B	7.93	9.41	0.474	0.081	0.92	7
C	7.62	3.85	0.220	0.026	0.93	81
C	7.00	4.00	0.212	0.023	0.61	59

Note:

Analyses procedures are those commonly used in the laboratory of the Soil Survey Section, Research Station, Canada Department of Agriculture, Vancouver.

Each sample is a composite of four subsamples.

References

1. British Columbia Irrigation Guide. Published by British Columbia Department of Agriculture, Victoria, British Columbia.

2. Suitability for irrigation of water from lakes and streams in the southern interior of British Columbia, Canada Department of Agriculture, Publication 1179, 1963.

3. The system of soil classification for Canada. Canada Department of Agriculture, Queen's Printer, Ottawa, Ontario, 1970.

Glossary

alkaline soil - Any soil that has a pH greater than 7.0. See also - reaction, soil.

alluvial fan - A fan-shaped deposit of alluvium laid down by a stream where it emerges from an upland into a less steeply sloping terrain.

alluvium - Material such as clay, silt, sand, and gravel deposited by modern rivers and streams.

available water storage capacity - The range in soil water between field capacity and permanent wilting point. Units: percentage of oven dry weight of soil, inches of water per foot of soil or per effective rooting depth.

calcareous soil - Soil containing sufficient calcium carbonate, often with magnesium carbonate, to effervesce visibly when treated with cold 0.1N hydrochloric acid.

colluvium - A heterogeneous mixture of material that as a result of gravitational action has moved down a slope and settled at its base.

drainage soil - Classes used on Soil Map are as follows:

1) Rapidly drained - The soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.
2) Well drained - The soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year.
3) Moderately well drained - The soil moisture in excess of field capacity remains for a small but significant period of the year.
4) Imperfectly drained - The soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year.
5) Poorly drained - The 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.

dunes - Wind-built ridges and hills of sand formed in the same manner as snowdrifts.

evapotranspiration - Water transpired by plants, built into plant tissue, and evaporated from the soil surface.

field capacity - Soil water content retained by the soil following an irrigation or heavy rain, after downward movement of water has materially decreased. It is the upper limit of soil water available for plant use.

flood irrigation - Application of water by flooding to soil for the purpose of supplying the moisture essential for plant growth.

frost-free period - Average number of days between last spring frost and first fall frost, based on 32°F.

glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melted ice.

growing degree days (also, degree-days, above 42°F) - The number of degrees above 42 accumulated for all days during the growing season. This expresses the length and warmth of the growing season in a single figure.

growing season - The dates in spring and fall corresponding to a mean temperature of 42°F are used as the start and end of the growing season.

irrigation interval - The number of days between the start of an irrigation at any one spot and the start of the next irrigation at the same spot.

lacustrine deposit - Material deposited in lake water and later exposed either by lowering the water level or by uplifting of the land. These sediments range in texture from sands to clays.

leaching - The process of removing soluble material from the soil by passage of water through the soil.

outwash - Sediments washed out by flowing water beyond the glacier and laid down as stratified drift in thin forest beds. The particle size may vary from boulders to silt.

permanent wilting point - The water content of the soil when plants growing in it are wilted to the point where they will not recover when placed in the dark for 12 hours in an atmosphere of 100% relative humidity. It occurs at about 15 bars of soil moisture tension.

permeability, soil (1) - The ease with which gases, liquids or plant roots penetrate or pass through a bulk mass of soil or a layer of soil. In the absence of precise measurements, soils may be placed into relative permeability classes through studies of structure, texture, porosity and cracking in the soil profile in relation to local use experience. The relative classes presented in this report are estimated and are as follows:

	Possible rates in inches per hour
Slow	less than 0.20
Moderate	0.20 to 5.00
Rapid	over 5.00

pH - 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.

reaction, soil - The degree of acidity or alkalinity of a soil, usually expressed as a pH value. Descriptive terms, commonly associated with certain ranges in pH (H_2O) are: Moderately acid, 5.6-6.0; slightly acid, 6.1-6.5; neutral, 6.6-7.3; slightly alkaline, 7.4-7.8; moderately alkaline, 7.9-8.4.

root zone - That part of the soil occupied by plant roots.

saline soil - A nonalkali soil that contains enough soluble salts 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.

soil - (i) The unconsolidated material on the immediate surface of the earth that serves as a natural medium for the growth of land plants.
(ii) The naturally occurring unconsolidated material on the surface of the earth that has been influenced by parent material, climate, macro- and microorganisms, and topography, all acting over a period of time to produce soil that may differ from the material from which it was derived in many physical, chemical, mineralogical, biological, and morphological properties.

soil classification - The systematic arrangement of soils into groups or categories 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.

soil horizon - A layer of soil, approximately parallel to the soil surface, with distinct characteristics produced by soil forming processes.

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

soil series - This is the basic unit of soil classification, and consists of soils that are essentially alike in all major profile characteristics except the texture of the surface.

sprinkler irrigation system - For design purposes, this includes all equipment required to apply water to the design area from the source of water supplying the system to the revolving sprinklers, nozzles or perforated pipe.

stocking rate - The number of acres needed to graze a 1000-pound cow for one month (AUM). They are determined by calculating the amount of available forage, allowing for a 45 percent carryover to avoid damage to the range. About 660 pounds of available forage is needed per AUM.

stoniness - The classes of stoniness are defined as follows:
1) Slightly stony land- There are some stones, but they offer only slight to no hindrance to cultivation.
2) Moderately stony land - There are enough stones to cause some interference with cultivation.
3) Very stony land - There are enough stones to constitute a serious handicap to cultivation and some clearing is required.
4) Exceedingly stony land - There are enough stones to prevent cultivation until considerable clearing is done.
5) Excessively stony land - This land is too stony to permit any cultivation (boulder or stone pavement).

texture, soil - The percentages of sand (S), silt (Si), and clay (C) in a soil determine its texture. Size groups from 2 mm to 0.05 mm in diameter are called sand, those from 0.05 to 0.002 mm are called silt, and those less than 0.002 mm in diameter are called clay.

From: Toogood, J. A.—A Simplified Textural Classification Diagram. Can. J. Soil 38: 54-55. 1958

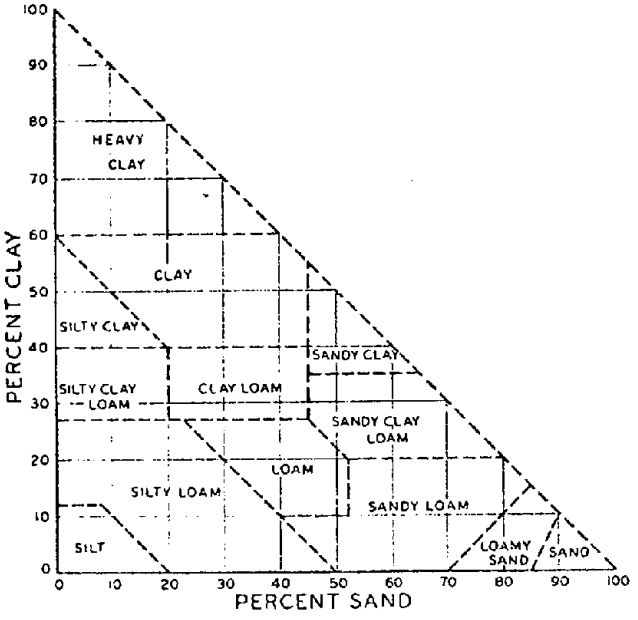


Chart showing proportions of soil separates.

topography - definition of classes used on Soil Map (Fig. 3):

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

topsoil - The layer of soil moved in cultivation.

wilting point - See permanent wilting point.

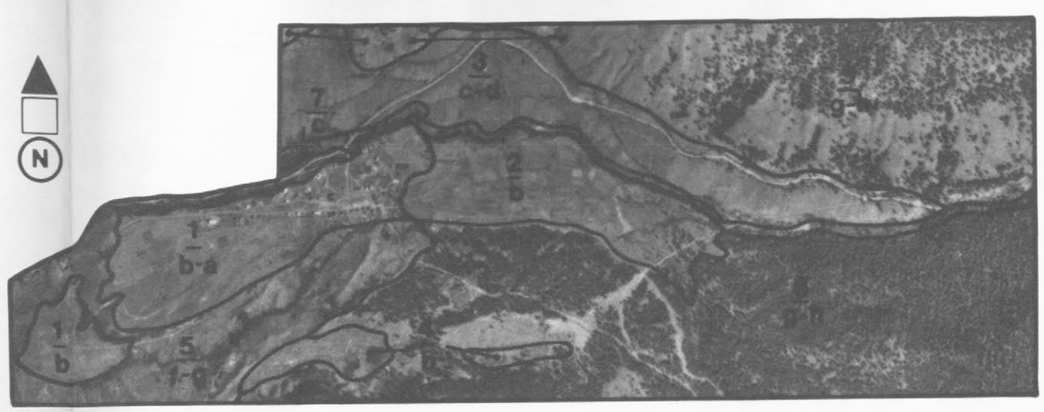
Figure 3
Soil Map

Alkali Lake Indian Reserve 1

0 — 1 mile

Mapping & Compilation by Soils Section, C.D.A., Vancouver
Aerial Photography by B.C. Government 1966
Mosaic & Reproduction by Soil Research Institute,
Cartography Section, Ottawa

Convention: 1/b — 1 = SOIL UNIT; b = TOPOGRAPHIC CLASS (as defined in glossary)



LEGEND

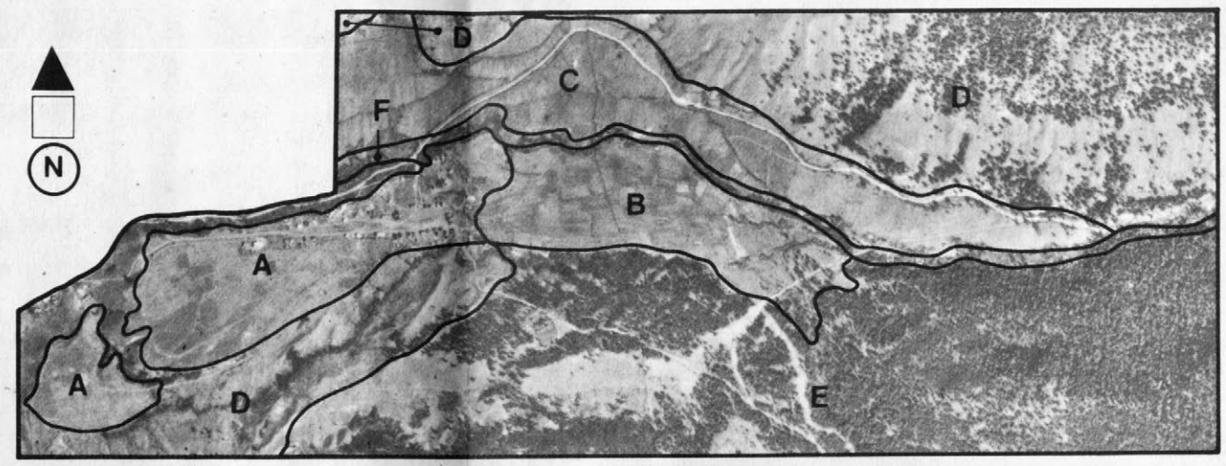
Soil Unit	Geologic Material and Topographic Expression	Soil Classification, (3)	Soil Drainage	Permeability	Stoniness	Vegetatio
1	Sandy loam capping over gravelly outwash; nearly level to gently undulating terraces	Orthic Dark Brown Chernozem	Rapidly drained	Rapid	Slightly stony	Grasses
2	Calcareous fine sandy loam, silt loam alluvium; gently sloping	Carbonated Dark Gray Chernozem	Moderately well drained	Moderate	Slightly stony	Forage cr
3	Gravelly sandy loam, sandy loam alluvium; moderately and gently sloping fans	Orthic Dark Gray Chernozem	Well drained	Moderate	Moderately stony	Forage cr cultivate
4	Calcareous sandy loam, silt loam alluvium; wet depressions	Carbonated Gleyed Regosol	Imperfectly and poorly drained	Moderate	Slightly stony	Grasses, sedges
5	Loam, sandy loam till and colluvium; steeply sloping and strongly rolling. Bedrock shallow and exposed in many places	Orthic Dark Gray Chernozem Orthic Eutric Brunisol	Well and rapidly drained	Moderate	Very stony	Grasses, Douglas-f
6	Loam, sandy loam, clay loam till and colluvium; very steeply sloping	Orthic Gray Luvisol Degraded Eutric Brunisol	Well drained	Moderate	Very stony	Douglas-f
7	Loam, gravelly sandy loam deposits along Alkali Creek	Gleyed Orthic Regosol	Well to poorly drained	Moderate	Moderately stony	Willows

Figure 4

Management Area Map

Alkali Lake Indian Reserve 1

0 — 1 mile

Mapping & Compilation by Soils Section, C.D.A., Vancouver
Aerial Photography by B.C. Government 1966
Mosaic & Reproduction by Soil Research Institute,
Cartography Section, Ottawa

For discussion of management areas refer to report