A LANDSCAPE APPROACH TO LAND CLASSIFICATION AND EVALUATION FOR REGIONAL LAND USE PLANNING - SOUTHERN OKANAGAN VALLEY, BRITISH COLUMBIA

by

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ABSTRACT

This study is concerned with the problem of environmental data collection, interpretation and presentation for regional land use planning.

A landscape classification was carried out for the watershed of the southern Okakagan Valley by collecting and integrating data on surficial deposits, vegetation, soil and bedrock geology. Thirty nine land systems are described and mapped, and shown on a base map at a scale of 1:125,000. The land systems are relatively homogeneous landscape units, characterized by a particular landform (or patterns of landforms) with associated vegetation and soil.

Interpretive guidelines were developed for determining the suitability of the land systems for selected engineering (urban development), recreation and wildlife interpretations. The interpretive guidelines with the derived suitability ratings provide planning information for the region, show how the classification system can assist regional land use planning and form a framework for similar studies in other areas.

Methods of data presentation were used to facilitate the understanding and application of this information by planners, technical experts,scientists and the concerned public. Specifically this was accomplished through the use of an expanded legend, stereo-pair and colour photographs, and by having separate sections for referencing information.

The methods used in this study provide a rapid and relatively inexpensive framework for collecting, presenting and interpreting environmental baseline information. The information can be of valuable assistance to technical and non-technical people in the land use planning and decision making processes.

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Among material resources, the greatest, unquestionably, is the land. Study how a society uses its land, and you can come to pretty reliable conclusions as to what its future will be.
[Schumacher, 1973].

INTRODUCTION

Land use has become a major problem confronting society. Throughout the world there is increasing concern about how land resources are utilized. This concern is reflected through the unprecedented public criticism, protests, confrontations and litigations brought against planners, decision makers and users of our natural resources. Attitudes towards the environment are changing as greater emphasis is placed on the amenities of life, or liveability of a region, rather than material goods. The results of these changing attitudes will have profound effects not only on our political and economic institutions, but also on our concepts of individual freedom and equality of opportunity [Bolle, 1973]. There are numerous reasons for these changing attitudes.

The consequences of rapid population growth and of accelerating industrial and technological development have contributed in large part to these new perspectives. Environmental pollution, noise, urbanization, social stress, increased affluence, leisure time and mobility, have contributed to the general awareness that the environmental,

social, aesthetic and psychic costs of resource exploitation are increasingly outweighing the benefits [MacNeil, 1971]. Also contributing to these changing attitudes is the realization that our environment is an ecosystem, composed of connected and dependent parts. Society is realizing that they cannot remain isolated from environmental problems or catastrophes which occur in other parts of the world (e.g. oil spills, and accumulations of radio-active wastes). They are realizing that the present intensity and impacts of land use are placing a severe and unsustainable stress on our ecosystem -- a stress that threatens the existence of mankind.

New demands are being placed on our fixed land base. Greater and increasingly diverse benefits are expected from our land resources by a society which has changing values, but which maintains an increasing population growth with an accelerating, unregulated industrial and technological appetite. As the demands for land increase, the number, intensity, and complexity of land use conflicts also increase. Difficult decisions will have to be made in the future between resource development, environmental protection, and maintenance of environmental quality.

To arrive at agreeable solutions to the difficult choices we must make the planning process has to be improved. The increasing frequency of criticism, abuse, and confrontations that resource agencies and developers face is a clear indication of concern and unhappiness with the present system of evaluating our wants and needs [Bolle, 1973]. The next portion of the introduction attempts to provide a general understanding of the functioning of the planning process.

The Planning Process

This section discusses a simplified model of the planning process for resolving land use conflicts. An understanding of this process is important for two reasons. Firstly, to improve the methods of planning and decision making a general understanding of the processes involved is required. This includes an understanding of the processes that make up the system, how they function, their interactions, and their relative strengths and weaknesses, so that critical problem areas can be identified. Secondly, a understanding of the planning process will provide a better perspective for evaluating this project and will help to clarify the reasons for applying the methods used in data collection, analysis, and presentation.

Planning, as distinct from the planning process, is defined as an activity concerned with the systematic collection, analysis, organization and processing of technical information [Driver, 1970]. Planning can be thought of as an aid to better decision making. The planning process includes the activity of planning as well as a number of other activities. The planning process includes the following sequence of events: problem definition; planning (data collection, analysis and formulating alternative courses of action); decision making; plan implementation and re-evaluation of the problem.[1] The planning process is shown in Figure I.

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[1] Although the planning process is primarily a sequence of steps, it also has constant loop-backs (for re-evaluation of objectives, data needs, etc.). These are not discussed for purposes of simplicity.

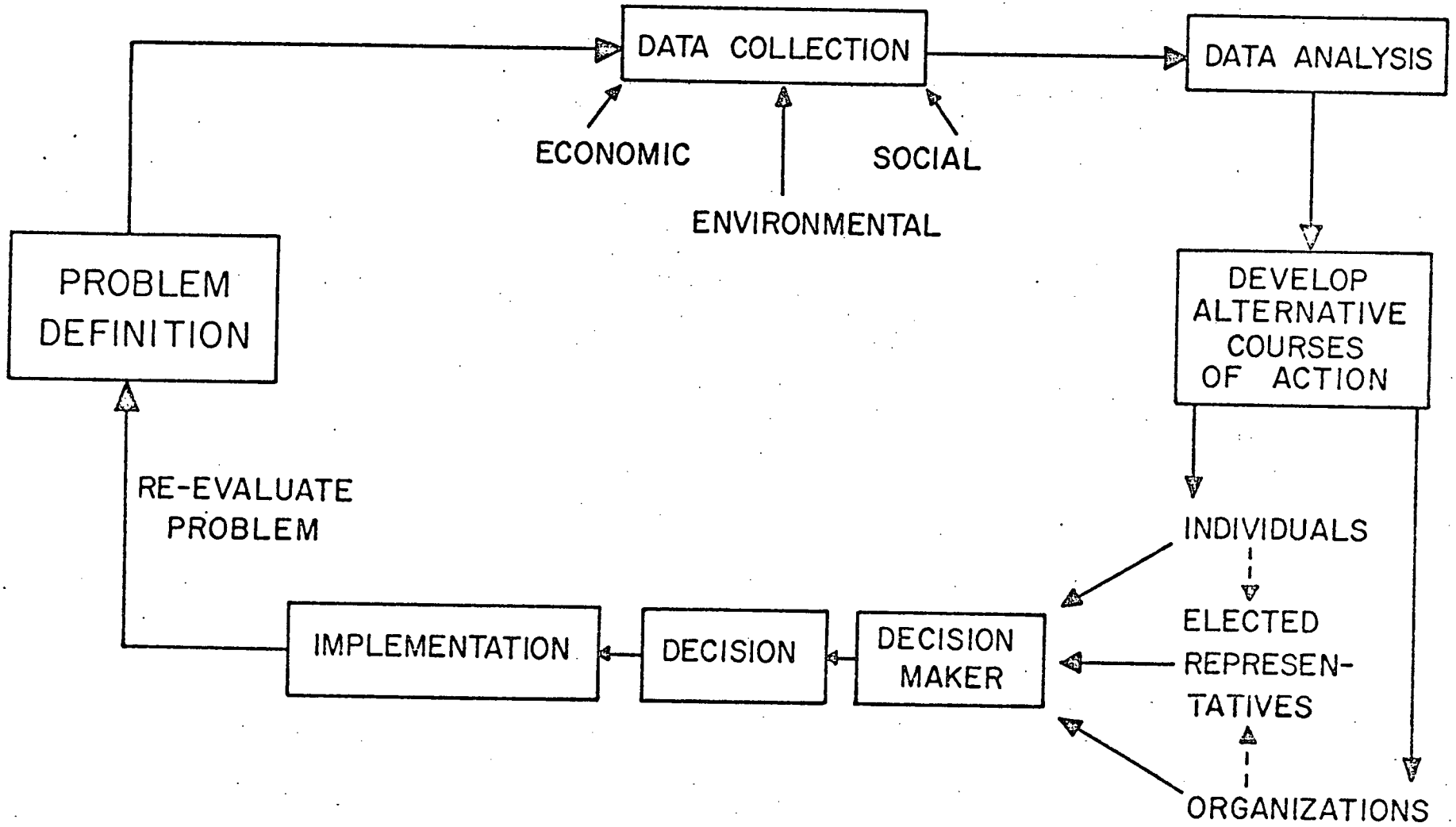

Figure 1 A simplified model of a possible planning process for resolving land use conflicts. (A number of "feed-back" loops and short circuits exist but have not been included for clarity).

The model of the planning process presented is simplified to show the sequence of processes that occur in this very complex system. In the real world these sequence of events may not always occur. Short cuts often develop in the system, most notably by postponing the data collection and analysis until after decisions have been made (e.g. Canadian environmental impact studies such as the James Bay project). As decision making becomes more difficult and better technical information and public input is required to arrive at agreeable solutions, the planning process will likely evolve increasingly towards the model presented.

Precise problem definition of the resource conflict is the starting point in the planning process. Once resource conflicts are clearly understood a framework is provided for data collection and analysis, and for rating the suitability of alternative courses of action. When the problem is not clearly understood (perhaps through a limited perspective of the nature of the conflicts), a satisfactory outcome to the planning process can not be accomplished.

Data collection provides the fuel for the planning process. The nature of the data collected and its presentation (type, amount, scale and quality), will affect the kinds of analysis that can be made and also the objectivity and quality of alternative courses of action that are proposed [Bross, 1965]. Data collection ultimately affects the quality or "rationality" of the decision making process.[2] Data requirements include environmental, economic and social.

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[2]For a discussion of rational decision making see Pressman, [1970].

Data analysis is the process of evaluation and refinement of information. Secondary and tertiary interpretations, such as capability, suitability and feasibility ratings may be made at this stage. To evaluate the analysis process it is important to consider how the analyses are made and who does the analysis. All analysts have their own value standards which almost invariably are reflected, to some extent, in the data collected and the alternatives selected [Fox, 1970]. If a bias is built into the analysis process, the range and quality of plans proposed and hence the choices presented to the decision maker, will also be biased.

Plans are developed to identify alternative courses of action, and their consequences, for consideration in the decision making process. The quality of the plans proposed depend in large part on the previous processes of problem definition, data collection and analysis. The quality of the plans proposed also depends upon the existing political, economic, social and environmental constraints that the planner has to deal with. It should be noted that the nature and quality of the alternatives provided and the manner in which they are provided, plays a significant part in determining what decisions will be made and how they will be implemented [Driver, 1970].

The decision making process consists of choosing between alternative plans or means for accomplishing an objective [Driver, 1970]. The decision maker is ideally trying to optimize public welfare by deciding on a course of action which confers the greatest mix of benefits to society.[3] However, there is no standard value system in society for

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[3]Optimization is used in the sense of Bolle [1973], as obtaining the best combination of benefits over time.

determining what the optimum mix of benefits will be [Pressman, 1970]. The decision maker must determine the optimum mix of benefits by weighing the value preferences received from individuals, organizations, and elected representatives. The decision maker should also be aware of certain principles that exist in a democratic society -- in particular, the principle that the individual or his elected representative, not a technical expert, should be the final judge of what is best for him [Fox, 1970]. To make good or "rational" decisions, the decision maker, elected representative, organizations and individuals depend upon planners presenting comprehensive, accurate, and unbiased alternative courses of action for consideration.

The implementation process is the one in which the plans decided upon are carried out. It is unlikely however, that the same plans will be interpreted and implemented similarly by different administration agencies. The way plans are implemented will depend upon the jurisdiction, organizational aims, and technical expertize of the administrative agency [Fox, 1973].

The last step in the planning process is to re-evaluate the problem or monitor the activities after the plans have been implemented. This is an important process for it will provide feedback to suggest plan adjustments that may be needed, and it will also help evaluate the success of the methods used in the planning process.

From this brief introduction to the planning process a number of points should be made. Firstly, the model presented of the planning process is greatly simplified for purposes of illustration. As different perceptions, prejudices and interests become involved in

the system the planning process becomes, as might be expected, enormously complicated. Secondly, the planning process consists of a sequence of dependent steps or processes. The quality of each process depends upon the way in which the previous processes were carried out (e.g. the decision making process depends on the alternatives presented to the decision maker, which in turn depends upon the data collected and analyzed). One weak step in the planning process can make the whole system appear inadequate.

It should be apparent that weak steps, or bottlenecks, do exist. A major bottleneck is data collection and analysis [Runge and Kusler, 1972]. The data required to make good informed choices is often lacking, incomplete, or not in a form that can be readily understood and used (e.g. many vegetation and soil survey reports). This is a very serious problem because the kind and quality of data collected ultimately determines the kind and quality of decisions that can be made [Bross, 1965]. This study will specifically address this important problem by presenting a method that can be used as an environmental framework for data collection and analysis in regional land use planning.

This study does not attempt to carry out the planning process, but only a part; namely information on the physical environment. The planning process is discussed so that the reader is aware that the study is cognizant of the process and that the study was conducted so that it could "fit-in" to the process directly, without reinterpretation.

Research Objectives

This study addresses the problem of environmental information, its collection, interpretation and presentation to aid in regional land use planning.

The research objectives are threefold:

Firstly, to make a land (biophysical) classification of the southern Okanagan Valley, by collecting and integrating data on vegetation, soil, surficial deposits and to a lesser extent bedrock geology. This integration is thought to be necessary to understand, conceptualize and apply ecological information in regional land use planning. The landscape units provide a framework for data analysis and for collection of further environmental information.

Secondly, to determine the general suitabilities of the landscape units for recreation, wildlife and urban development. This will show how the land classification can be a useful aid in regional planning, and also provide important planning information in the study area.

Thirdly, to attempt different methods of data presentation so that the data can be read, understood and used by planners, natural resource specialists and non-technical people. Emphasis is placed on making the data as clear and "useable" as possible, to promote more informed decision making.

P A R T I

Introduction

The information provided in this report is in two parts. Part I describes the area, the problems, provides general descriptions of the resources and illustrates the approach used in inventory and data presentation.

Part II provides the interpretive guidelines and suitability ratings developed for selected engineering (urban development), recreation and wildlife interpretations.

The thesis is designed so that inclusive sections can be referenced by the interested reader but the thesis forms an integrated whole.

Methods

Early in the summer of 1973 preliminary mapping of land systems was started for the watershed of the southern Okanagan Valley.[4] Mapping was done on aerial photographs at a scale of 1 mile = 1 inch.

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[4] Land systems are recurring patterns of landforms with associated vegetation and soils. For further information the reader should refer to Christian [1958].

The mapping procedure was similar to the guidelines developed for the Canadian Biophysical Land Classification [Lacate, 1969].

Land systems and boundaries were field checked at approximately 130 sites, of which sixty were selected for detailed habitat descriptions. At these sites (usually homogeneous units about 1/10 of an acre in size), detailed notes were made on the plant species present and their percent cover in the tree, shrub and herb layers. A soil pit was dug and the soil morphology described (materials, horizons, depths, textures and drainage). Other habitat features such as slope, elevation, aspect and history were noted and ground photographs were taken.

Fourteen benchmark soils were sampled for engineering interpretations. The soils were analyzed for particle size, liquid limit, plastic limit and the percent silt and clay by the soil laboratory of the Soils Branch, British Columbia Department of Agriculture, Kelowna, B.C.

In the fall and winter of 1973 final mapping and descriptions of the land systems were completed. A base map with an expanded legend was produced at a scale of 1:125,000. At this time, tables, maps and photographs were prepared (as in the following sections) and interpretive guidelines developed for recreation, wildlife and urban development (as in Part II).

Thirty nine land systems were established. They are relatively homogeneous landscape units usually characterized by a particular landform and one vegetation association and one soil association.[5]

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[5] On very complex landscapes (e.g. Louie and Roy land systems) scale limitations (see classification section) resulted in the inclusion of two or more landforms, vegetation or soil associations.

The plant nomenclature is after Hitchcock, et al. [1955, 1959, 1961, 1964 and 1969]. The soil classification follows, "The System of Soil Classification for Canada," 1970.

The detailed plot descriptions and soil analyses are available through the Soils Branch, British Columbia Department of Agriculture.

How to Use the Report

This report is designed for use by planners, scientists, natural resource managers and by the concerned public. The information presented provides baseline environmental information for regional land use planning and policy formation.

Numerous uses can be made of this report. Some are direct and relatively simple such as information about vegetation zones, surficial deposits and soils. Other uses are more indirect and require the user to interpret the basic information in light of his own needs. Examples of how the information can be used include planning for: recreation; wildlife; urban development; commercial, industrial and transportation developments; timber management; environmental impact studies; green belts; erosion prevention; and for predicting areas of land use conflicts.

Information Contained in the Report

Information is provided on surficial deposits, soils, vegetation, geology and climate. Interpretations for urban development, recreation and wildlife have also been developed.

The location and extent of the land systems are indicated on the base map (scale of 1:125,000). This map with its expanded legend, describes the elevation, surficial materials, vegetation, soils, topography and drainage of each land system. The map (with the expanded legend) is designed to provide readily available environmental information.

A general description of the study area (e.g. climate, history, vegetation) is given in the section entitled, "Description of the Study Area." The section "Land System Descriptions and Suitabilities for Urban Development, Recreation and Wildlife," provides more detailed information on each land system. Included are descriptions of the landforms, materials, soils and vegetation and suitability ratings for urban development, recreation and wildlife. Also included are ground and stereopair photographs (to provide information and to help conceptualize landscape units).

Information of a more technical nature is placed in Part II. In Part II are the criteria developed for determining suitability ratings with the derived suitability ratings in tabular form.

Classification

To avoid confusion in interpreting the map units the user should be aware of certain basic principles of classification systems.[6]

Classifications are contrivances developed by man. They are mental devices used to arrange things into man's idea of order -- not truths which can be discovered [Lavkulich, 1973]. It should be recognized that, "all classifications are purposive, whether or not this is realized by their creators" [Rowe, 1971].

Landscape units having similar properties of materials and associated vegetation and soil, were grouped into land systems. The land system is a taxonomic category based on defined properties. It is an abstraction of the landscape.

There are limitations of any map due to scale. Preliminary land system mapping was done on air photographs at a scale of 1 mile = 1 inch. At this scale the smallest unit which can be shown is about 40 acres and a line on the photograph equals approximately 150 feet on the ground. Therefore the base map (approximately 2 miles = 1 inch) cannot show units smaller than about 150 acres.

With these limitations of scale, it should be evident that map units are not 100 percent pure taxonomic units. Land systems will contain small inclusions of different kinds of soil, or materials, vegetation, etc. Inclusions of 10 percent or less of the area were not considered

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[6] An introduction to classification principles can be found in Cline, [1949].

to be significant at this level of survey.

Interpretations

Urban Development: Engineering interpretations were made to assist planning for urban development. They will facilitate planning activities involving the use or movement of soil materials such as in transportation corridor developments.

Suitability ratings show the general suitability of a land system for an engineering activity. Suitability ratings help predict the degree of limitation (expense) expected for a land system for a particular use. Ratings also help direct site-specific investigations. Overlays can be used to separate the activity or activities being considered.

Accompanying each suitability rating is the factor or factors considered limiting for that particular use (e.g. slope, drainage, etc.). In the appendices the limiting factor is discussed. These factors help the user predict the kinds of problems to expect when certain activities are planned within a land system.

As a result of the scale of mapping (see classification section) there may be large inclusions of materials with contrasting properties. The ratings should be used only to provide general suitabilities of an area for a particular use. They do not replace specific on-site engineering investigations.

Recreation: Recreation ratings are based on landscape features of surficial materials, soil, potential (climax) vegetation,

topography and climate. Other considerations important to recreational planning, such as recreation features, location, user demand and economics were not considered.

The suitability ratings are designed for regional planning. They indicate the general environmental suitability of an area for a particular recreation activity (and intensity of use). Suitability ratings help predict the degree of limitation (expense) expected for a land system for a particular use. They can be used to direct site-specific investigations.

The factor or factors considered limiting for a particular use are listed with the suitability ratings. They predict the kinds of problems which can be expected with use of the land system for an activity.

The criteria developed for determining the limitation ratings may provide a framework for recreational assessments in other areas. However, the criteria will likely require some modification if applied to different environments (as will the guidelines for engineering and wildlife).

Limitations of the information are due mainly to the scale of the survey (see classification section) and because of the omission of aesthetic, social and economic factors in the suitability ratings.

Wildlife: Selected wildlife interpretations are developed to assist regional planning. The study does not attempt to assess the total wildlife resource in the area.

Wildlife suitability ratings consider four habitat elements -- food (based on climax vegetation), cover, physiography and juxtaposition,

or interspersion of habitats. The habitat requirements of each species were determined largely through a literature review. Only limited local knowledged could be obtained.

The suitability ratings assess the degree of effort and expense required to make the land system (in its present condition) provide the habitat elements of each species. The ratings help identify key wildlife areas of high suitability. They can also be used to predict areas of potential resource conflicts.

The factor or factors considered to limit use for a particular species accompany the suitability ratings. These factors indicate the kinds of habitat improvements required by each species.

The impacts of development on wildlife can be assessed from this information. Knowing species habitat requirements should allow the planner to predict the effect that a land use practice will have on that species (e.g. logging, recreation developments, etc.).

When interpreting the information the user should be aware of limitations due to scale (see classification section) and due to the lack of local input in determining species habitat requirements. In addition, interpretations for cover and food were based on climax vegetation -- not seral vegetation which may presently exist.

Basic environmental habitat information is provided in this report. The user can develop different species suitability interpretations (birds, reptiles, bats, etc.) by determining specific species habitat requirements and assessing these requirements with the information provided herein.

Description of the Study Area

Location and Size

The study area is located in the southern interior of British Columbia (Figure II). It consists of the South Okanagan Watershed from Penticton to the International Boundary. It is situated between 49 degrees and 49 degrees 30'N, and between 119 degrees 10'E and 119 degrees 56'W.

The area is approximately 36 miles from north to south, and from 28 miles (at Penticton) to about 10 miles (at Osoyoos) in width. It covers approximately 400,000 acres.

Physiography and Drainage

The study area lies within two physiographic regions, the Interior Plateau mainly to the west of the Okanagan River, and the Columbia Highlands to the east [Douglas, 1970].

The Okanagan Valley consists of a north-south trench, joined by short tributary creeks with narrow valleys and steep gradients [Nasmith, 1962]. Above the valley bottom are steep slopes, bluffs and sloping terraces which give way to a rough plateau surface about 4,000 feet in elevation.

The average water level is about 1,121 feet for Okanagan Lake and 910 feet for Osoyoos Lake, with the valley bottom changing approximately 211 feet in elevation over 36 miles.

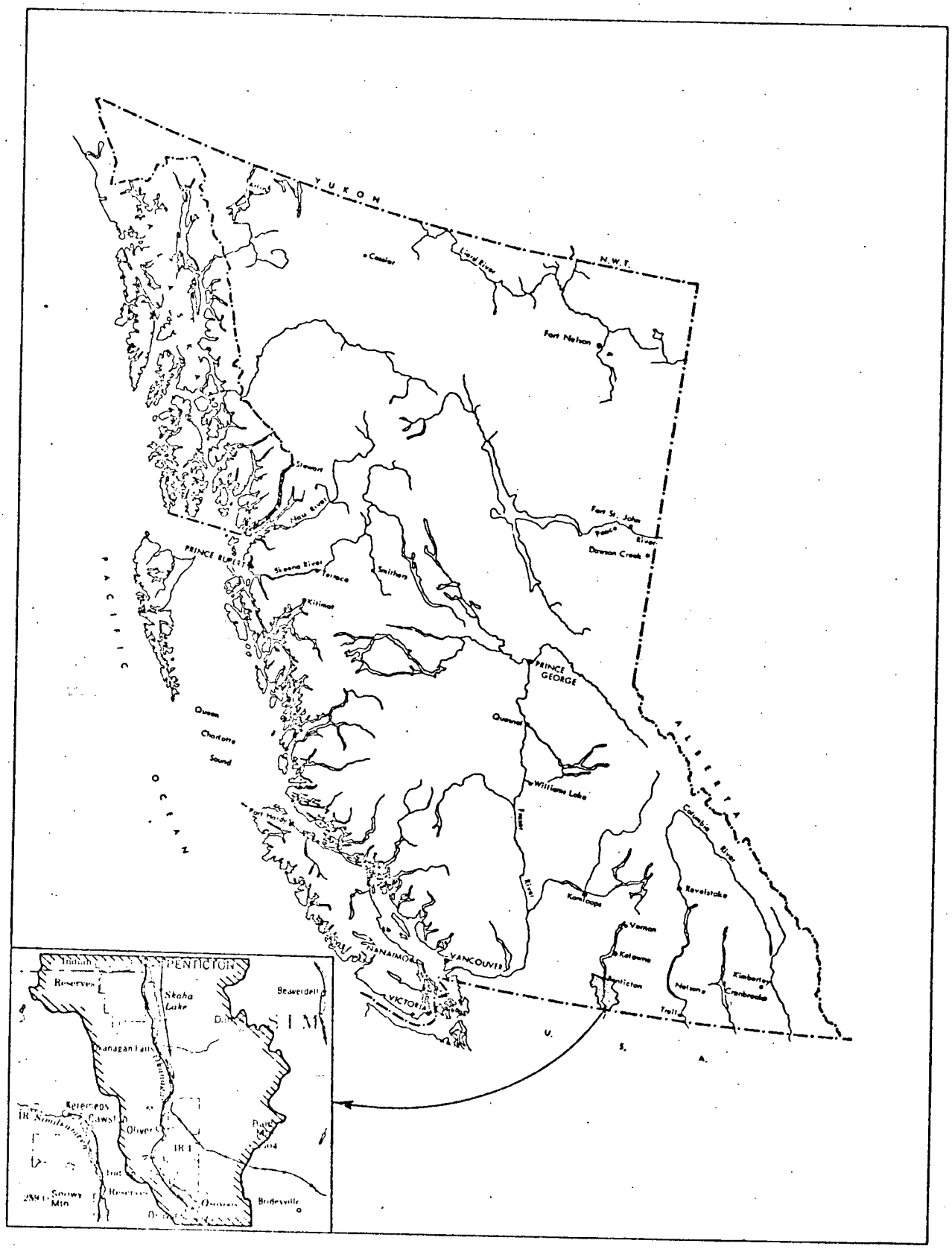

Figure 2 Location of the Study Area

Drainage in the Okanagan Valley is from north to south by the Okanagan River which flows from Okanagan Lake, through Skaha, Vaseux and Osoyoos Lakes into Washington. The major creeks are Penticton, Ellis and Shingle in the north, Shuttleworth, Vaseux, Wolfcub and Park Rill in the central region, and Testalinden and Inkaneep Creeks in the south.

The flow of Okanagan River is controlled by Okanagan Lake, Skaha Lake and S.O.L.I.D. dams as well as by a series of vertical drop structures (Okanagan Study Committee, Bulletin No. 1, 1972). Many of the upland creeks and lakes have been dammed to supply irrigation water.

Early Historical Development

Stuart and Montigny visited the Okanagan Valley in 1811 searching for a fur trading route to the interior of British Columbia. With the building of Fort Kamloops the Okanagan Valley became a main trading route until the establishment of the International Boundary in 1848.

In 1859 an influx of miners moved into the area when placer gold was discovered at Rock Creek and along the Similkameen River. A gold commissioner was established and in 1861 a Customs Office was located in Osoyoos.

The early 1860's saw the start of the ranching era with a large demand for horses, mules and cattle created by the gold miners. It is estimated that by 1892, there were 20,000 head of cattle in the Similkameen, Osoyoos and Boundary areas [Fraser, 1952].

In 1887 gold was discovered at Fairview near the present town of Oliver. By the 1890's Fairview was one of the largest towns in the inland Northwest [Sismey, 1968]. Major gold mines were also located to the east (Camp McKinney) and west (Nickel Plate) of the study area.

It was not until 1905 that intensive agriculture started. With the formation of the South Okanagan Land Company, storage dams and irrigation systems were constructed and orchards started in the Penticton area [Dawson, 1964]. In 1919 the Provincial Government purchased land from the South Okanagan Land Company for veterans of World War I.

Climate

The Okanagan Valley is largely protected from the eastward moving moist Pacific maritime air by the Coast and Cascade Mountains. This results in low precipitation, about 30 inches in the uplands and 12 inches in the valley bottom. Polar Continental (in winter) and Tropical Continental air is frequent, the latter resulting in the highest temperatures in the Province [Chapman, 1952].

There is a marked vertical zonation of climate where precipitation and runoff increase and the mean temperature and frost free period decrease with altitude (Table 1). This effect occurs to a lesser extent in the valley bottom, with the climate becoming progressively moister and cooler moving south to north [Chapman and Brown, 1966].

The highest and lowest temperatures recorded for Oliver are 111 and -23 degrees fahrenheit, and for Penticton 105 and -17 degrees

[British Columbia Department of Agriculture, 1970]. The annual precipitation falls in two peak periods, June, and November through January. As a result of the hot summers and low rainfall, a high water deficit exists [Chapman and Brown, 1966].

Topography and aspect greatly affect the local climate as is shown by the native vegetation [Tisdale, 1947]. Exposure modifies such factors as the amount and efficiency of precipitation, temperature, wind speed and direction, air drainage and duration of snow cover.

Surficial Deposits and Geology

Evidence indicates that the area has been glaciated four times [Armstrong et al., 1965]. The last, or Wisconsin glaciation, is thought to have moved as far south as the 48th parallel at its maximum extent and then started to retreat about 10,000 years ago [Nasmith, 1962].

As the ice moved through the valley it rounded off the surrounding hills and deposited a veneer of glacial till over the landscape. With the melting of the glacier extensive kames, outwash terraces, kettled outwash terraces, raised alluvial fans and deltas, and glacial lacustrine deposits were formed, particularly in the lowlands. Recent deposits (since glaciation), include alluvial fans, deltas, colluvium and the floodplain of the Okanagan River [Nasmith, 1962].

The unconsolidated materials transported by ice and water form the parent materials for most of the mineral soils in the South Okanagan [Kelley and Spilsbury, 1949].

TABLE 1

CLIMATIC DATA FOR SHUTTLEWORTH AND PENTICTON CREEKS, OKANAGAN VALLEY[1]

Station Name	Slope (0)	Aspect	Elevation (feet)	Frost Free Period 2 (days)	Growing Degree Days 2 (days)	Precipitation		Potential Evaporation[4] (inches)	Runoff (inches)
						May-Sept[2] (inches)	Annual[3] (inches)		
Vaseux	0	Valley Bottom	1112	163	4284	4.5	14.2	26.6	-12.4
Irrigation	2.5	S	2045	126	3242	5.1	16.5	23.0	-6.5
Dutton	25.0	N	3830	108	2179	6.2	24.6	20.4	4.2
Venner	4.0	NW	4735	54	1258	8.1	30.5	15.1	15.4
McLean-Clan	2.5	N	5050	40	611	9.3	32.9	12.0	20.9

[1]Climatic information was provided by Climate and Data Services, Environment and Land Use Committee Secretariat, Victoria, B.C.

[2]Estimates of 30 year normal values, based on long term data from Penticton airport.

[3]Annual precipitation was derived from regression equations presented by Canada-British Columbia Okanagan Basin Agreement, Preliminary Report No. 38, 1973.

[4]Potential evaporation was determined by Thornthwaite's method (Thornthwaite and Mather, 1957).

Palaeozoic gneisses and schists, Permo-Carboniferous quartzites, Middle and Upper Mesozoic granites, and Tertiary volcanics underlie the surficial deposits [Little, 1961; Douglas, 1970].

Vegetation

Vegetation in the Okanagan Valley has been described by Spilsbury and Tisdale [1944], Tisdale [1947], Tisdale and McLean [1957], Brayshaw [1965] and Brayshaw [1970]. Vegetation descriptions by McLean [1969] in the Similkameen Valley and Daubenmire [1952, 1968, 1970] in Washington and Idaho can also be applied to the study area.

The vegetation was organized into four broad zones which tend to occur sequentially in elevation. They are the: big sagebrush (*Artemisia tridentata*); Douglas fir (*Pseudotsuga menziesii*); Subalpine fir -- Engelmann spruce (*Abies lasiocarpa -- Picea engelmannii*); and alpine zones. These zones are areas of essentially uniform macroclimate where one plant community is climatically dominant (climatic climax), [Daubenmire, 1968 a]. The zones are characterized in forest regions by the dominant tree in the tree layer, and in the steppe region by the dominant shrub.

Secondary subdivisions of the vegetation were made on the basis of local soil or topographic influences which modify the macroclimate. These units are called habitat types [Daubenmire, 1968].[7]

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[7] A habitat type can be thought of as areas that support or potentially support the same climax vegetation.

Several phases or variations in habitat types are also recognized.

The vegetation zones and habitat types defined in this report are similar to those recognized by McLean [1969] and Daubenmire [1968, 1970]. One important exception is that because of the discontinuous nature of the ponderosa pine forest, it is treated as a subzone in the big sagebrush zone. A more comprehensive description of the vegetation will be completed by 1975 and made available through the Soils Branch of the British Columbia Department of Agriculture.

Big Sagebrush Zone: This zone occurs between 900 and 2,000 feet in elevation. It consists of the bunchgrass and ponderosa pine subzones:

(a) Bunchgrass subzone

This subzone is a treeless area of steppe vegetation characterized by big sagebrush with greasewood (*Purshia tridentata*) on outwash sands. The characteristic grass is bluebunch wheatgrass (*Agropyron spicatum*). The soils are Rego and Orthic Brown Chernozems.[8]

This subzone corresponds to Krajina's [1965] ponderosa pine-bunchgrass zone, bunchgrass subzone.

Three habitat types and one phase are recognized.

The big sagebrush-bluebunch wheatgrass habitat type is the climatic climax. It is characterized by big sagebrush and bluebunch wheatgrass. Other species include Sandberg's bluegrass (*Poa sandbergii*), phlox (*Phlox longifolia*), paintbrush (*Castilleja cervina*), yellow bell (*Fritillaria pudica*) and eriogonum species (*Eriogonum niveum*).

[8]The soil classification follows "The System of Soil Classification for Canada" 1970.

The big sagebrush -- speargrass (*Stipa comata*) habitat type occurs on shallow and coarse textured soils (edaphic climax). Floristically it is similar to the big sagebrush-bluebunch wheatgrass habitat type, but speargrass is the dominant grass. Sand dropseed (*Sporobolus cryptandrus*) and red three awn grass (*Aristida longiseta*) also occur.

The greasewood-speargrass habitat type occurs around Osoyoos Lake on coarse outwash sands and gravels (edaphic or zootic climax). Greasewood is the dominant shrub. Sand dropseed, red three awn and Sandberg's bluegrass are the dominant grasses.

A sumac (*Rhus glabra*) phase was identified. It occurs in seepage areas and at the base of slopes, probably indicating the presence of groundwater. Characteristic species are sumac, mock orange (*Philadelphus lewisii*), Saskatoon berry (*Amelanchier alnifolia*), wild cherry (*Prunus emarginata*) and on wetter sites hawthorn (*Crataegus* sp.) and wild rose (*Rosa* sp.).

(b) Ponderosa Pine Subzone

This subzone is transitional between the steppe and the Douglas fir forest. It is not continuously represented, but rather seems to obtain climax status on alluvial-colluvial fans and outwash sands and gravels. The soils are primarily Degraded Eutric Brunisols although some sites were classified as Brown Chernozems and Regosols.

The subzone is characterized by ponderosa pine with only the occasional Douglas fir present. Mature stands have an open canopy with a steppe-like herb cover.

Two habitat types and one phase are recognized.

The ponderosa pine -- Idaho fescue (*Festuca idahoensis*) habitat type is characterized by ponderosa pine, Idaho fescue and bluebunch wheatgrass. Other species include umbrella plant (*Eriogonum heracleoides*), Saskatoon berry, junegrass (*Koeleria cristata*), spring sunflower (*Balsamorhiza sagittata*), oyster plant (*Tragopogon dubius*), and lemonweed (*Lithospermum ruderale*).

The ponderosa pine-greasewood habitat type occurs on sandy outwash (edaphic climax), between Oliver and Kaleden. It is characterized by greasewood under a canopy of ponderosa pine. Other species include bluebunch wheatgrass, Sandberg's bluegrass, junegrass, sand dropseed, bitterroot (*Lewisia rediviva*), phlox, oyster plant and peacock species (*Dodecatheon pauciflorum*). At higher elevations (1,800 - 2,300 feet), Idaho fescue, larkspur (*Delphinium nuttallianum*), and penstemon (*Penstemon confertus*) occur.

The northern black cottonwood (*Populus trichocarpa*)--red-osier dogwood (*Cornus stolonifera*) phase occurs on the Okanagan River floodplain. While no mature stands were found it appears that the tree cover is dominated by northern black cottonwood, ponderosa pine, trembling aspen (*Populus tremuloides*) and water birch (*Betula occidentalis*). The shrub cover consists of wild rose (*Rosa nutkana*), red-osier dogwood, willow (*Salix* sp.), alder (*Alnus tenuifolia*), hawthorn, white clematis (*Clematis ligusticifolia*) and poison ivy (*Rhus radicans*). Carex (*Carex* spp.), northern bedstraw (*Galium boreale*), and osmorhiza (*Osmorhiza chilensis*) were found in the herb layer.

Douglas Fir Zone: This zone occurs from about 2,000 - 4,200 feet in elevation (but may extend above 5,500 feet on steep south facing slopes). It is an extensive forest zone lying between the lower big sagebrush and the subalpine fir-Engelmann spruce zones. The soils are primarily Degraded Eutric Brunisols but include Eutric Brunisols, Gray Luvisols and Dark Brown, Black and Dark Gray Chernozems.

Douglas fir is the climax tree with ponderosa pine, western larch (*Larix occidentalis*) and lodgepole pine (*Pinus contorta*) seral species invading after logging or fires. Two grassland habitat types are recognized as edaphic or topoedaphic climaxes on compact glacial till and steep south facing slopes.

This zone is similar to Krajina's [1965] interior Douglas fir zone.

Four major habitat types are recognized.

The Douglas fir-Idaho fescue habitat type occurs from about 2,000 to 2,500 feet in elevation. It is relatively open community characterized by Douglas fir and ponderosa pine. The shrub layer is not well developed but includes wild rose, mahonia and snow brush (*Ceanothus velutinus*). The characteristic grasses are bluebunch wheatgrass and Idaho fescue. Other species include june grass, hawk's beard (*Crepis atrabarba*), long plumed purple avens (*Geum triflorum*), wild strawberry (*Fragaria* spp.) and white hawkweed (*Hieracium albiflorum*).

The Douglas fir-pinegrass (*Calamagrostis rubescens*) habitat type forms the climatic climax from about 2,500 to 4,200 feet in elevation. It is characterized by a cover of Douglas fir and pinegrass.

Lodgepole pine, ponderosa pine and western larch are the principal seral trees. The shrub cover is well developed and contains kinnikinnick (*Arctostaphylos uva-ursi*), spirea (*Spiraea betulifolia*) and waxberry (*Symphoricarpos albus*). The herb cover is dominated by pinegrass with heart-leaf arnica (*Arnica cordifolia*), carex (*Carex concinnoides*), wild strawberry, showy aster (*Aster conspicuus*), and lupine (*Lupinus* sp.). Above 3,500 feet in elevation soopolallie (*Sheperdia canadensis*), false box (*Pachistima myrsinites*) and grouseberry (*Vaccinium scoparium*) may occur.

The threetip sagebrush (*Artemisia tripartita*) -- bluebunch wheatgrass habitat type is a topoedaphic climax between 2,000 and 3,000 feet in elevation. This steppe vegetation is transitional between the big sagebrush and Douglas fir zones. It is characterized by the presence of threetip sagebrush. Other species include big sagebrush, bluebunch wheatgrass, junegrass, umbrella plant and fleabane (*Erigeron filifolius*).

The Idaho fescue -- umbrella plant habitat type is a topoedaphic climax between about 3,000 and 5,200 feet in elevation. It is characterized by umbrella plant, Idaho fescue and bluebunch wheatgrass. Other species include lupine (*Lupinus sericeus*), erigeron (*Erigeron corymbosus*), sticky geranium (*Geranium viscosissimum*), arnica (*Arnica sororus*), phacelia (*Phacelia linearis*), and smooth agoseris (*Agoseris glauca*).

Subalpine Fir - Engelmann Spruce Zone: This zone is the highest forest zone in the study area. It lies between the lower Douglas fir and the upper alpine zones, between approximately 4,200 and

7,400 feet in elevation. The soils are primarily Degraded Dystric and Dystric Brunisols, but include Brunisolic Gray Luvisols, Mini Humo-Ferric Podzols, Alpine Dystric Brunisols and Black Chernozems.

This zone corresponds roughly with Krajina's [1965] Engelmann spruce - subalpine fir zone, in what he calls the Canadian Cordilleran subalpine forest region.

Four habitat types are recognized.

The subalpine fir - Engelmann spruce-pinegrass habitat type occurs on the lower and drier slopes of the zone, from about 4,200 to 5,500 feet in elevation. The seral species lodgepole pine and Douglas fir often dominate the stands with Engelmann spruce and to a lesser extent subalpine fir present as regeneration. Shrubs include grouseberry, false box, soopolallie, spirea, and mountain labrador tea (*Ledum glandulosum*). The herb layer is dominated by pinegrass and includes carex, heart-leaf arnica, lupine (*Lupinus latifolius*), wild strawberry, twin flower (*Linnaea borealis*) and pyrola (*Pyrola secunda*).

The subalpine fir-Engelmann spruce-grouseberry habitat type occurs at middle elevations in this zone, from about 5,500 to 6,600 feet in elevation (climatic climax). Subalpine fir and Engelmann spruce dominate the tree layer with lodgepole pine the most important seral tree. Characteristic shrubs include grouseberry, big whortleberry (*Vaccinium membranaceum*), black twinberry (*Lonicera involucrata*), red twinberry (*Lonicera utahensis*), labrador tea and white rhododendron (*Rhododendron albiflorum*). Grasses are poorly represented. Herbs include heart-leaf arnica, broad-leaf arnica (*Arnica latifolia*), alpine lupine (*Lupinus latifolius*), trailing rubus (*Rubus pedatus*), wood betony

(*Pedicularis bracteosa*), wild strawberry and pyrola. In seepage areas swamp gooseberry (*Ribes lacustre*), mountain valerian (*Valeriana sitchensis*), Indian hellebore (*Veratrum viride*), white marsh marigold (*Caltha leptosepala*), giant ragwort (*Senecio triangularis*), and globe flower (*Trollius laxus*) may occur.

The subalpine fir-Engelmann spruce-red heather (*Phyllodoce empetriformis*) habitat type occurs at the highest elevations in the zone from about 6,600 to 7,400 feet in elevation. This habitat type includes the krummholz formation where the tree cover is somewhat open and the trees are stunted. Common species include subalpine fir, Engelmann spruce, lodgepole pine, grouseberry, red heather and to a lesser extent yellow heather (*Phyllodoce glanduliflora*). The herb layer includes broad-leaf arnica, alpine lupine, mountain valerian and wood betony.

The high sagebrush (*Artemisia tridentata* ssp. *vaseyana*) -- pinegrass habitat type occurs on steep south aspects (topoedaphic climax) from about 5,100 to 6,100 feet in elevation. It is characterized by the presence of high sagebrush and pinegrass. Other species include june grass, Idaho fescue, lupine (*Lupinus* sp.), umbrella plant, wild strawberry, sulphur eriogonum (*Eriogonum umbellatum*) and long plumed purple avens.

Alpine Zone: This zone is generally found above 7,400 feet in elevation but may occur at lower elevations on exposed slopes. The zone lies above the krummholz vegetation in the subalpine fir -- Engelmann spruce zone. The soils are primarily Alpine Dystric Brunisols.

This zone corresponds with Krajina's [1965] alpine zone.

Trees are characteristically lacking although rare, windswept and very much dwarfed white-bark pine (*Pinus albicaulis*), lodgepole pine and Engelmann spruce were found. The shrub layer includes dwarf juniper (*Juniperus communis*), shrubby cinquefoil (*Potentilla fruiticosa*), red heather and dwarf willow (*Salix nivalis*). Other species include white pussytoes (*Antennaria alpina*), little flower penstemon (*Penstemon procerus*), potentilla (*Potentilla nivea*) and numerous sedges and rushes.

On dry exposed soils white dryas (*Dryas octopetale*), mountain sandworts (*Arenaria* spp.), and spring beauty (*Claytonia lanceolata*) increase. In moist sites arnica (*Arnica mollis*), ragwort species (*Senecio cymbalarioides*), buttercup (*Ranunculus glaberrimus*) and Indian paintbrush (*Castilleja rhexifolia*) increase.

Soils

Soils are natural dynamic bodies forming a continuum at the surface of the earth. Their properties result from the integrating effects of climate, parent material, biological activity and topography acting over a period of time.

The parent materials in the study area are largely those produced by glacial deposition. They include glacial till, glacial fluvial outwash, glaciolacustrine, colluvium, alluvial-colluvial fans and alluvial deposits.

The soils are generally coarse textured reflecting textures of both the parent materials and the underlying bedrocks. Most soils have a capping of up to 2 feet of mixed loess and ash [Lewis, 1971]. This gives the surface a sandy loam to loam texture and tends to mask soil morphology [Louie, 1972]. Soil drainage is dominantly rapid to moderately well, but includes significant areas of imperfect and poor drainage, such as the Okanagan River floodplain.

The soils were classified into the following groups. For further information on these groups the reader should refer to, "The System of Soil Classification for Canada," 1970.

Brown Chernozemic soils are low elevation grassland soils, usually below 2,000 feet. They are associated with big sagebrush-bluebunch wheatgrass vegetation (and to a lesser extent ponderosa pine), in a cool semi-arid climate. These soils are characterized by a light brown Ah horizon resulting from the accumulation and decomposition of grasses and forbs. Leaching is slight with the B and C horizons having a high base saturation. The two major subgroups found are the Orthic and Rego Browns.

Dark Brown Chernozemic soils are grassland soils primarily on south facing slopes. They occur at mid-elevations, usually associated with the Douglas fir forest. These soils are characterized by a dark brown Ah horizon resulting from the accumulation and decomposition of grasses and forbs. Leaching is slight with the B and C horizons having a high base saturation. The major subgroup is the Orthic Dark Brown.

Black Chernozemic soils are high elevation grassland soils usually on south facing slopes. They are developed on wetter and cooler

grassland regions associated with the subalpine fir-Engelmann spruce forest. These soils are characterized by a very dark gray to black Ah horizon, resulting from the accumulation and decomposition of grasses, forbs and shrubs. Leaching is not intense and the surface horizon is neutral to slightly acidic. The three major subgroups found are: Orthic Black, Rego Black and Lithic Black.

Eutric Brunisols are dry forest soils found under a cover of ponderosa pine or Douglas fir. They occur from lower to mid-elevations and are the dominant soils in the study area. These soils are characterized by a thin litter layer overlaying a neutral to slightly acid brownish B horizon. They have a weakly developed soil morphology indicating that the soils are in an early stage of development. The parent materials are generally coarse textured. The two main subgroups found are Degraded Eutric Brunisols and Orthic Eutric Brunisols.

Dystric Brunisols are forest soils forming under cool to cold climates at higher elevations. They are found under a cover of Engelmann spruce, subalpine fir and lodgepole pine, and also under alpine vegetation. These soils are characterized by a thin litter layer overlying a moderately acidic brownish B horizon. They are similar in appearance to podzols but fail to meet the podzolic requirements of organic matter and sesquioxide accumulation. Parent materials are generally acidic. The four main subgroups found are: Orthic Dystric, Degraded Dystric, Alpine Dystric and Lithic Dystric Brunisols.

Gray Luvisols are moist to moderately dry forest soils at mid to high elevations. They are not extensive in the area, being restricted to medium textured parent materials where there is enough

precipitation to cause leaching. The tree cover is Douglas fir or subalpine fir and Engelmann spruce. These soils are characterized by a surface litter layer, an eluviated horizon and an underlying illuvial horizon of clay accumulation. These soils are generally slightly to moderately acidic with a high base saturation. The two main subgroups are Orthic Gray and Brunisolic Gray Luvisols.

Podzolic soils are forest soils forming under cold climates at high elevations. They do not occur extensively in the area. The tree cover is subalpine fir, Engelmann spruce and lodgepole pine. These soils are characterized by a litter layer, a light coloured eluvial horizon, and an underlying reddish brown B horizon in which organic matter and sesquioxides accumulate. Parent materials are generally acidic or have had free lime leached out. The major subgroup found is the Mini Humo-Ferric Podzol.

Regosols are weakly developed soils which fail to meet the requirements of other groups. They may have a non-chernozemic Ah horizon and a litter layer. They occur on recently deposited materials such as alluvium and colluvium. The two main subgroups found are Orthic and Gleyed Regosols.

Humic Gleysols are poorly and very poorly drained soils saturated with water and under reducing conditions continuously or during some period of the year. These soils are characterized by an accumulation of organic matter (Ah horizon) over a gleyed, grayish mineral horizon which may be mottled.

Lithic subgroups have bedrock within twenty inches of the surface.

Land System Descriptions and General Suitabilities for Urban Development, Recreation and Wildlife

ALLENDALE LAND SYSTEM

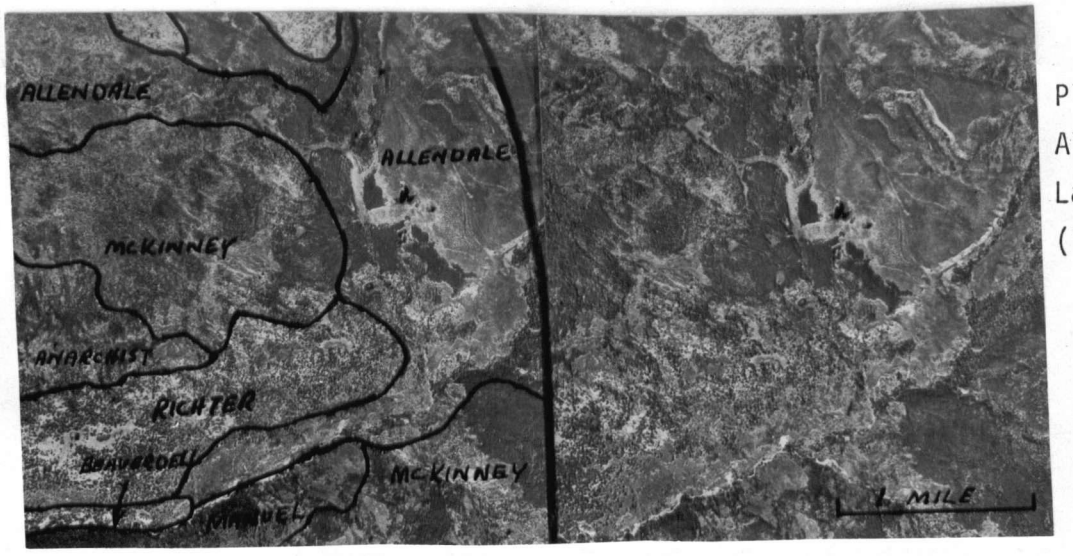

Plate 1
Allendale
Land System
(l.s.)

Landform and Materials. This land system consists of very gently to steeply sloping glacial fluvial outwash terraces or deltas. Surfaces may be pitted and contain old channel scars. The materials are usually deep deposits of well sorted sands and gravels over a variety of mostly acidic bedrocks. There are minor inclusions of shallow glacial fluvial outwash over glacial till and bedrock.[9]

Vegetation. The vegetation belongs to the subalpine fir -- Engelmann spruce zone. Lodgepole pine, and to a lesser extent subalpine fir and Engelmann spruce dominate the tree cover. Grouseberry and pinegrass dominate the shrub and herb cover respectively. The vegetation was

classified as the subalpine fir -- Engelmann spruce -- pinegrass habitat type.

Soils. The soils are dominantly Degraded Dystric Brunisols and Orthic Dystric Brunisols. Soils have a loamy sand, gravelly loamy sand or sandy loam texture and are well to rapidly drained.

Landscape Features. Elevations are approximately 4,200 to 6,000 feet. Slopes are usually between 3 and 15 percent. This land system is similar in topography and materials to Beaverdell l.s. (at lower elevations).

Plate 2 Allendale l.s.

Suitability for:

Engineering and Urban Development: Poor soil cohesion on sandy materials (resulting in erosion and duning) generally provides moderate to severe engineering limitations. The harsh climate will restrict residential use. An excellent source of sand and gravel.

Recreation: Generally unsuited for intensive recreation because of dense, uniform vegetation (which may also be a fire hazard), poor soil cohesion (dustiness and erosion) and a cold climate.

Wildlife: The suitability for spruce grouse is good and for blue grouse moderate.

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[9] Inclusions of 10 - 20 percent are called minor and 20 - 40 percent significant. Deep refers to materials greater than 5 feet in thickness, and shallow to materials less than 5 feet in thickness. Exposed bedrock refers to materials less than 20 inches in thickness over bedrock.

ANARCHIST LAND SYSTEM

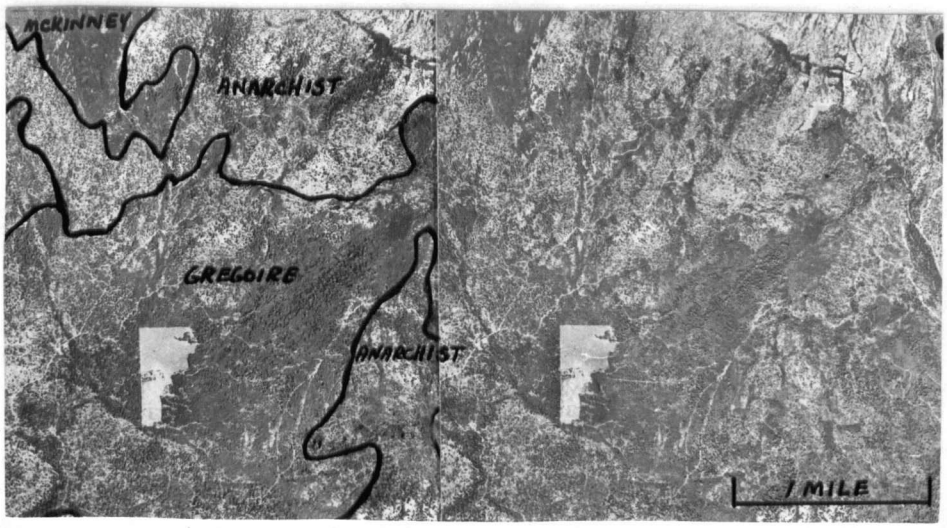

Plate 3
Anarchist
l.s.

Landform and Materials. The landform consists of a thin mantle of glacial till and colluvium over hilly to strongly rolling mountain slopes. The surface form is controlled by the underlying mostly acidic bedrock. The materials are dominantly shallow coarse textured till and colluvium over bedrock with significant inclusions of deep glacial till or colluvium, and exposed bedrock.

Vegetation. The vegetation belongs to the subalpine fir-Engelmann spruce zone. Englemann spruce, subalpine fir, Douglas fir and lodgepole pine provide the tree cover. The shrub cover is dominated by grouseberry and the herb cover by pinegrass. The vegetation was classified as the subalpine fir -- Engelmann spruce -- pinegrass habitat type.

Soils. The soils are dominantly Degraded Dystric Brunisols. There are significant inclusions of Lithic Dystric Brunisols and minor inclusions of Brunisolic Gray Luvisols. Soils have gravelly sandy loam to gravelly loamy sand textures and are rapidly to well drained.

Landscape Features. Elevations are approximately 4,200 to 5,500 feet. Slopes are usually between 20 and 60 percent. This land system is similar in topography and materials to Keogan l.s. (at lower elevations) and Culper l.s. (at higher elevations).

Suitability for.

Engineering and Urban Development: Steep slopes, shallow depths of materials over bedrock and a harsh climate provide severe limitations for use.

Recreation: Usually unsuited for intensive recreation due to steep slopes, shallow depths of material over bedrock, a cold climate and relatively dense vegetation.

Wildlife: The suitability for spruce grouse is generally good and for blue grouse moderate.

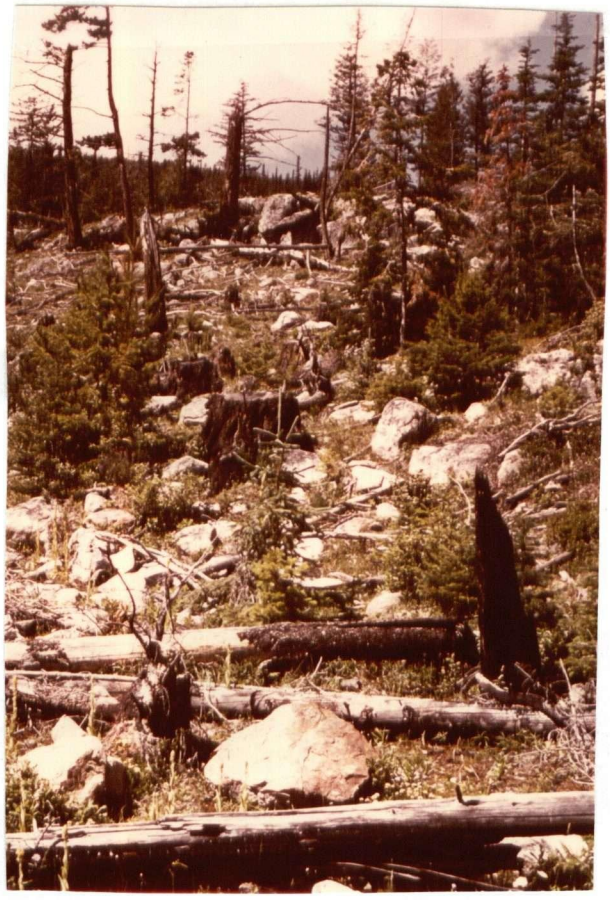

Plate 4
Anarchist l.s.

APEX LAND SYSTEM

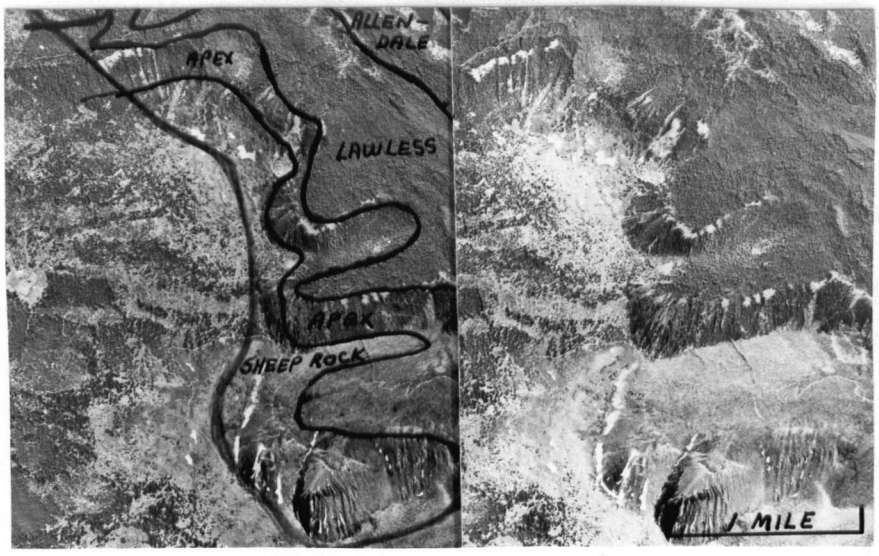

Plate 5
Apex l.s.

Landform and Materials. The landform consists of a mantle of extremely sloping colluvial materials over high elevation mountain slopes. The materials are dominately deep gravelly and stony colluvium over bedrock. There are significant inclusions of shallow colluvium over a variety of bedrocks.

Vegetation. The vegetation belongs to the subalpine fir -- Engelmann spruce zone. Subalpine fir, Engelmann spruce and lodgepole pine dominate the tree cover. White rhododendron, mountain labrador tea and grouseberry characterize the shrub layer. The vegetation was classified into the subalpine fir -- Engelmann spruce -- grouseberry habitat type.

Soils. The soils are dominately Mini Humo-Ferric Podzols with minor inclusions of Orthic Regosols. Soils have a gravelly to stony loamy sand texture and are rapidly drained.

Landscape Features. Elevations are approximately 5,500 to 6,500 feet. Slopes are usually greater than 60 percent. This land system is similar

in topography and materials to Manuel l.s. (at lower elevations).

Suitability for.

Engineering and Urban Development: Very steep slopes, unstable soil materials, shallow depths of material over bedrock and stoniness provide severe limitations for use.

Recreation: This land system is not suitable for intensive recreation because of very steep slopes and unstable soil materials. Viewing and skiing provide the main recreation features.

Wildlife: The habitat suitability for spruce and blue grouse is moderate.

Plate 6 Apex l.s. (south aspect)

BEAVERDELL LAND SYSTEM

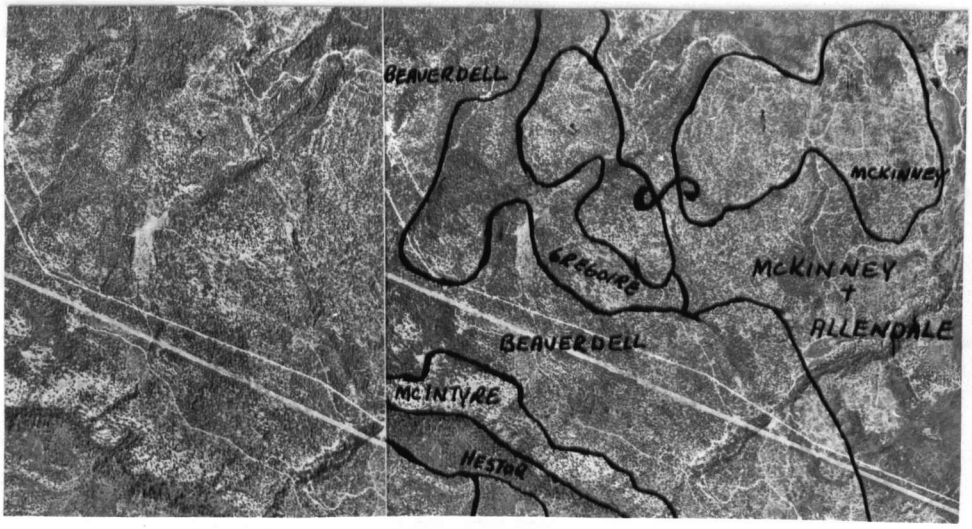

Plate 7
Beaverdell
l.s.

Landform and Materials. The landform consists of gently to steeply sloping glacial fluvial outwash terraces and deltas. Surfaces may be pitted or contain old channel scars. The materials are usually deep deposits of well sorted sands and gravels. There are minor inclusions of shallow glacial fluvial outwash over glacial till or over a variety of bedrocks.

Vegetation. The vegetation belongs to the Douglas fir zone. Lodgepole pine (particularly following fires), and Douglas fir characterize the tree layer. Kinnikinnick dominates the shrub layer and Idaho fescue and pinegrass dominate the herb layer. The vegetation was classified as the Douglas fir -- pinegrass habitat type with inclusions of the Douglas fir -- Idaho fescue habitat type at lower elevations.

Soils. The soils are dominantly Degraded Eutric Brunisols with significant inclusions of Orthic Eutric Brunisols. Soil textures range from gravelly and stony loamy sand, loamy sand to sandy loam. Soils are rapidly drained.

Landscape Features. Elevations are approximately 3,000 to 4,200 feet. Slopes are usually between 3 and 15 percent. This land system is similar in topography and materials to Allendale l.s. (at higher elevations).

Suitability for.

Engineering and Urban Development: Poor soil cohesion (on sands), and steep slopes provide generally moderate engineering limitations. There are few limitations for urban development. The land system provides a good source of sand and gravel.

Recreation: Generally moderately suitable for intensive recreation. Dense, usually unattractive vegetation, and poor soil cohesion (dustiness) are the main limitations.

Wildlife: The suitability for blue grouse is moderate. There are inclusions of moderately suitable habitats for mule deer winter range (at lower elevations), and for white-tailed deer, ruffed grouse and spruce grouse.

Plate 8
Bl-Beaverdell l.s.
Kn-Keogan l.s.

BLUFF LAND SYSTEM

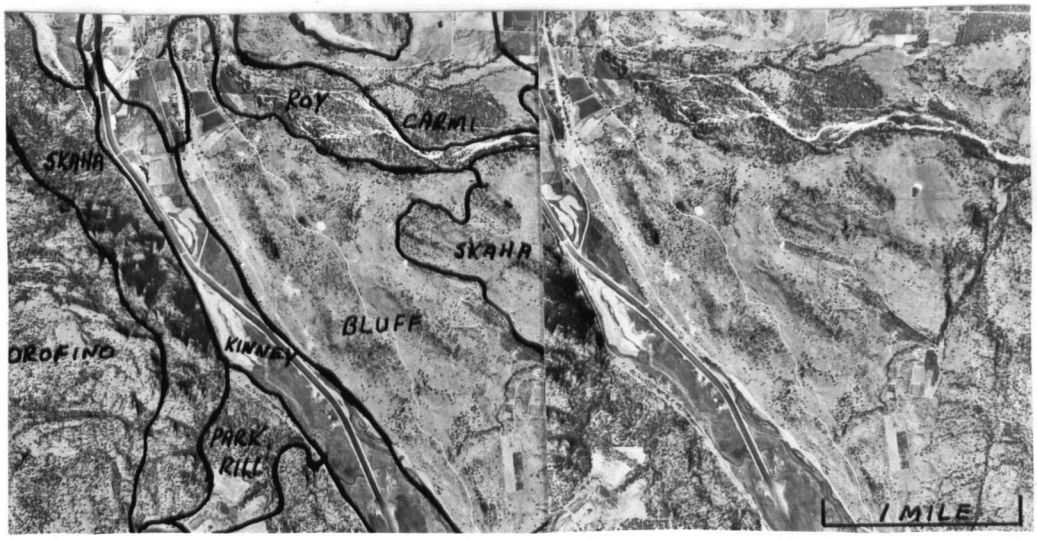

Plate 9
Bluff l.s.

Landform and Materials. The landform is moderately rolling to very hilly, kettled ice contact drift over glacial till. Materials are dominantly shallow to deep deposits of stratified sands and gravels overlying glacial till. There are significant inclusions of glacial till.

Vegetation. The vegetation belongs to the big sagebrush zone, ponderosa pine subzone. It is characterized by tree cover of ponderosa pine and a shrub cover of bitterbrush. Bluebunch wheatgrass dominates the herb cover. The vegetation was classified as the ponderosa pine -- bitterbrush habitat type.

Soils. The soils are dominantly Orthic Brown Chernozems. They have gravelly loamy sand and gravelly sandy loam textures and are well to rapidly drained.

Landscape Features. Elevations are approximately 1,000 to 1,500 feet. Slopes are variable, but are usually between 9 and 60 percent. This land system occurs around the north end of Vaseux Lake.

Suitability for.

Engineering and Urban Development: Steep slopes and stoniness provide moderate to severe engineering limitations. The suitability for urban development is usually poor but there are inclusions of moderately suitable areas. A fair source of sand and gravel.

Recreation: This land system is moderately suitable for intensive recreation. Steep slopes, stoniness and vegetation sensitivity to disturbance provide limitations.

Wildlife: The suitability for California bighorn sheep and mule deer winter and spring range is good. The habitat suitabliity for white-tailed deer is moderate.

Plate 10 Bf - Bluff l.s.
Sa - Skaha l.s.
The location of plate 10 is shown on plate 9.

CARMI LAND SYSTEM

See plates 54 and 58.

Landform and Materials. This land system is dominately a gently to steeply sloping glacial fluvial delta. To the west of Penticton are significant inclusions of glacial fluvial outwash terraces, kettled outwash and meltwater channels (plate 54). The materials are dominately well sorted sands over gravels but include deep sands, gravels and stones. There are minor inclusions of deltaic materials over silty glaciolacustrine deposits.

Vegetation. The vegetation belongs to the big sagebrush zone, ponderosa pine and bunchgrass subzones (depending on soil textures). There is a scattered ponderosa pine cover which is regenerating slowly. Bluebunch wheatgrass and Idaho fescue characterize the herb cover. The vegetation was classified as dominantly the ponderosa pine -- Idaho fescue habitat type.

Soils. The soils are dominantly Degraded Eutric Brunisols with tree cover and Orthic Brown Chernozems with grassland vegetation. There are significant inclusions of Orthic Dark Brown Chernozems at higher elevations. Soil textures range from sandy loam to gravelly sandy loam at the surface to loamy sand and sands, gravels and stones. Soils are rapidly drained.

Landscape Features. Elevations are approximately 1,100 to 1,800 feet. Slopes are usually between 3 and 15 percent. This land system is variable in materials. It occurs around Penticton.

Suitability for.

Engineering and Urban Development: Stoniness and poor soil cohesion (on sands) provide slight to severe engineering limitations. The land system is generally well suited for urban development, but intensive use of septic tank absorption fields should be restricted. A good source of gravel.

Recreation: Generally moderately suitable for intensive recreation. Stoniness, soil cohesion (particularly on sands), lack of tree cover and the sensitivity of vegetation to disturbance are the main limitations.

Wildlife: The habitat suitability for mule deer winter and spring range, and for white-tailed deer is moderate. There are inclusions of moderately suitable California bighorn sheep winter ranges.

Plate 11 Carmi l.s.

COLUMNS LAND SYSTEM

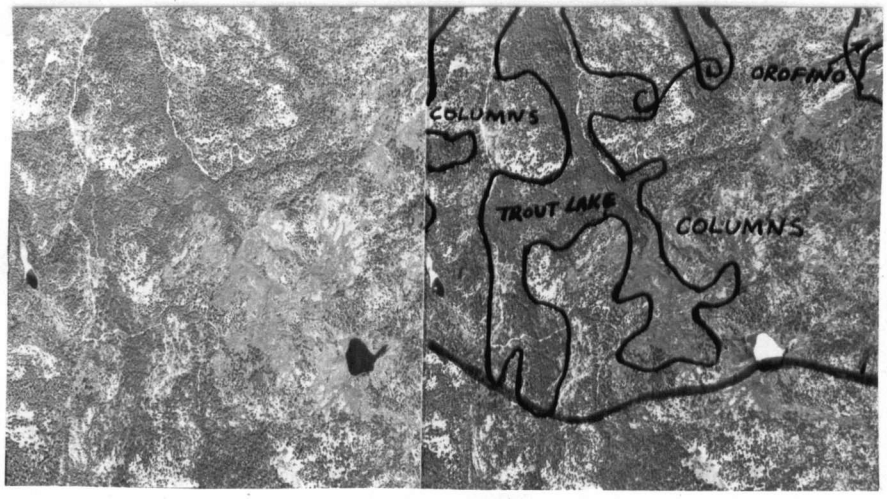

Plate 12
Columns l.s.

Landform and Materials. The landform consists of a shallow mantle of glacial till and colluvium on strongly rolling to very hilly volcanic and sedimentary bedrocks. The materials are dominantly shallow, medium textured glacial till and colluvium over bedrock. There are significant inclusions of exposed bedrock and minor inclusions of deep glacial till or colluvium.

Vegetation. The vegetation belongs to the subalpine fir -- Engelmann spruce zone. Subalpine fir, Engelmann spruce and lodgepole pine dominate the tree cover. Grouseberry and pinegrass dominate the shrub and herb layers respectively. The vegetation was classified as the subalpine fir -- Engelmann spruce -- pinegrass habitat type.

Soils. The soils are dominantly Orthic Dystric Brunisols. There are significant inclusions of Lithic Regosols and minor inclusions of Orthic Gray Luvisols. Soils have a gravelly loam to gravelly sandy loam texture and are well to rapidly drained.

Landscape Features. Elevations are between 4,200 and 5,500 feet. Slopes are usually between 15 and 60 percent. This land system is similar in materials and topography to Orofino l.s. (at lower elevations).

Suitability for.

Engineering and Urban Development: Very steep slopes and shallow depths of materials over bedrock provide severe limitations for use.

Recreation: Generally not suited for intensive recreation because of very steep slopes and shallow depths of material over bedrock.

Wildlife: The suitability for both blue and spruce grouse is moderate.

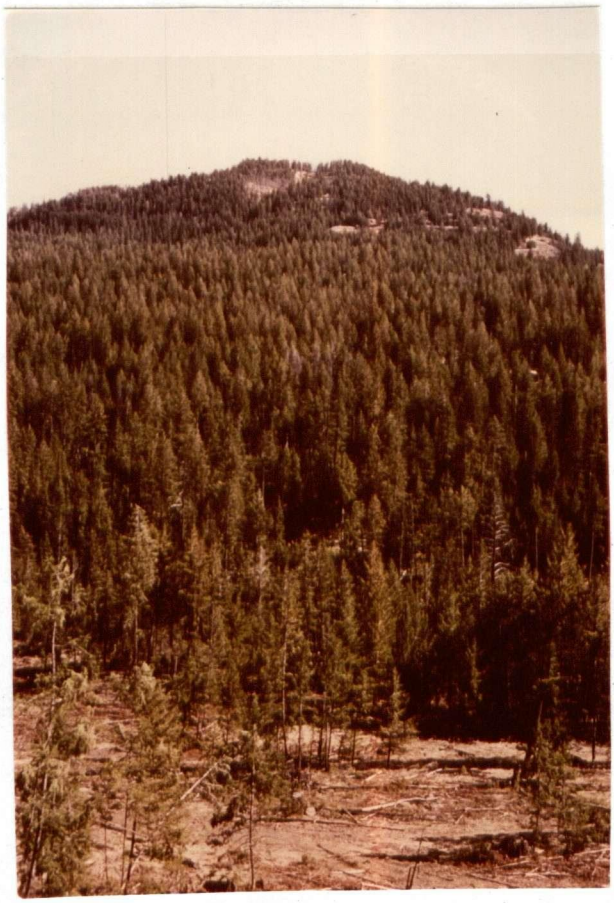

Plate 13 Cs - Columns l.s. Ma - Marron l.s.

CULPER LAND SYSTEM

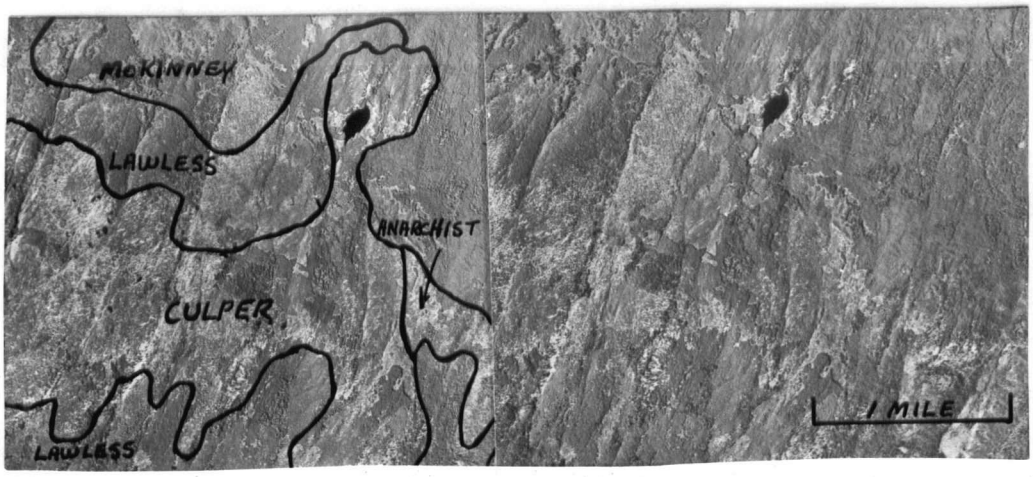

Plate 14
Culper l.s.

Landform and Materials. The landform consists of a shallow mantle of glacial till and colluvium over hilly to very hilly mountain slopes. The materials are dominately shallow, gravelly glacial till and colluvium over mostly acidic bedrock. There are significant inclusions of deep glacial till or colluvium and minor inclusions of exposed bedrock.

Vegetation. The vegetation belongs to the subalpine fir -- Engelmann spruce zone. The tree cover is relatively open consisting of lodgepole pine, Engelmann spruce and subalpine fir. The shrub layer is dominated by grouseberry and white rhododendron and the herb layer by alpine lupine, arnica species and wild strawberry. The vegetation was classified as the subalpine fir -- Engelmann spruce -- grouseberry habitat type.

Soils. The soils are dominately mini Humo-Ferric Podzols with significant inclusions of Lithic Humo-Ferric Podzols. Soils have gravelly sandy loam to gravelly loamy sand textures and are well to moderately well drained.

Landscape Features. Elevations are approximately 5,500 to 6,600 feet. Slopes are usually between 30 and 60 percent. This land system is similar in topography and materials to Anarchist l.s. (at lower elevations).

Suitability for.

Engineering and Urban Development: Steep slopes, shallow depths of materials over bedrock and a harsh climate provide severe limitations for use.

Recreation: Not suitable for intensive recreation due to steep slopes, shallow depths of materials over bedrock and a harsh climate. It is attractive for extensive use.

Wildlife: Culper land systems has moderate suitabilities for both blue and spruce grouse.

Plate 15
Culper l.s.

GREGOIRE LAND SYSTEM

Plate 16
Gregoire l.s.

Landform and Materials. This land system consists of a gently rolling to hilly till plain over mid elevation mountain slopes. The materials are dominately deep, coarse textured glacial till. There are significant inclusions of colluvium over glacial till on steeper slopes and shallow glacial till over a variety of mostly acidic bedrocks.

Vegetation. The vegetation belongs to the Douglas fir zone. Douglas fir dominates the tree cover. The shrub cover is dominated by kinnikinnick and the herb layer by pinegrass. The vegetation was classified as the Douglas fir -- pinegrass habitat type, with some Douglas fir -- Idaho fescue habitat type at lower elevations.

Soils. The soils are dominantly Degraded Eutric Brunisols. There are significant inclusions of Orthic Gray Luvisols on finer textured glacial tills. Soils have gravelly sandy loam and sandy loam textures and are well to moderately well drained.

Landscape Features. Elevations are approximately 3,000 to 4,200 feet. Slopes are usually from 9 to 30 percent. This land system is similar in topography and materials to McKinney l.s. (at higher elevations).

Suitability for.

Engineering and Urban Development: Stoniness and steep slopes provide moderate to severe engineering limitations. The suitability for residential development is usually moderate.

Recreation: The suitability for intensive recreation is usually moderate. Stoniness, steep slopes and vegetation attractiveness are limitations.

Wildlife: The suitability for blue grouse is good and for ruffed and spruce grouse moderate. The suitability for mule deer winter range is moderate and there are inclusions (at lower elevations) of moderately suitable California bighorn sheep and white-tailed deer ranges.

Plate 17
Gregoire l.s.

HESTOR LAND SYSTEM

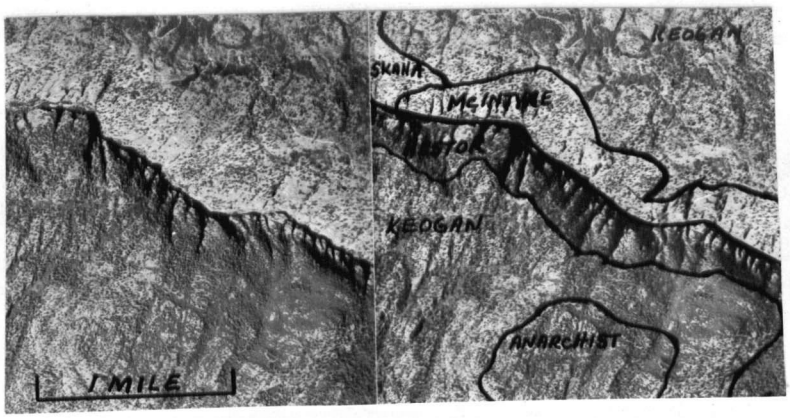

Plate 18
Hestor l.s.
(also see
plate 40)

Landform and Materials. The landform is a deep mantle of colluvium over very steeply to extremely sloping north facing valley walls. The materials are dominantly deep gravelly and stony colluvium. There are significant inclusions of shallow colluvium over bedrock and minor inclusions of ice contact deposits and exposed, mostly acidic bedrock.

Vegetation. The vegetation belongs to the Douglas fir zone. Douglas fir and ponderosa pine (at lower elevations) dominate the tree cover. The herb cover is dominated by pinegrass. The vegetation was classified as the Douglas fir -- pinegrass habitat type with Douglas fir -- Idaho fescue habitat type at lower elevations.

Soils. The soils are dominantly Orthic Eutric Brunisols. There are significant inclusions of Orthic Regosols and minor inclusions of Lithic Eutric Brunisols. Soils usually have a gravelly to stony loamy sand texture and are rapidly drained.

Landscape Features. Elevations are approximately 1,800 to 4,000 feet. Slopes are usually greater than 60 percent. This land system is similar in topography and materials to McIntyre l.s. (on south aspects).

Suitability for.

Engineering and Urban Development: Very steep slopes, unstable soil materials and shallow depths of materials over bedrock provide severe limitations for use.

Recreation: Very steep slopes and unstable soil materials make this land system unsuited for intensive recreation.

Wildlife: The suitability for California bighorn sheep and mule deer winter range is moderate to poor. The suitability for blue grouse is good.

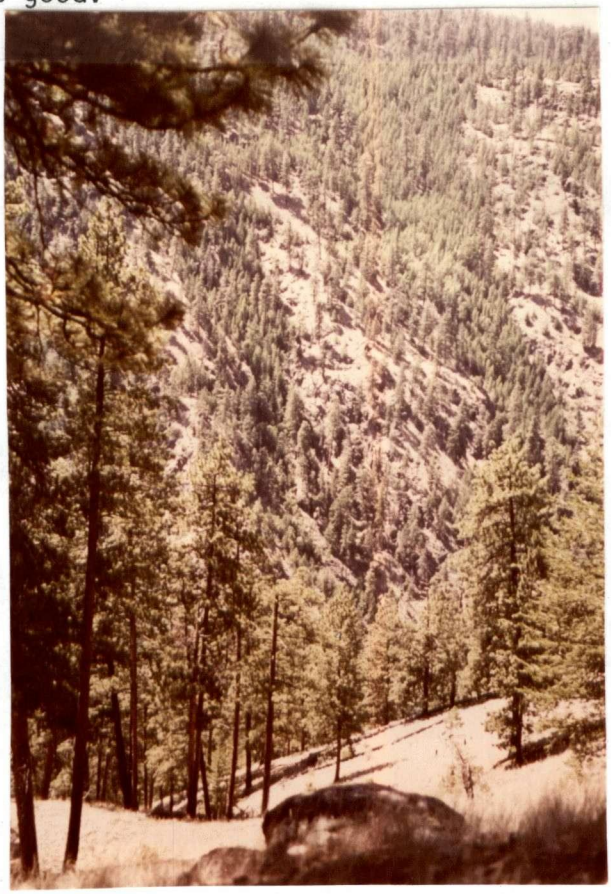

Plate 19
Hr - Hestor l.s.
Me - McIntyre l.s.
The location of plate 19 is shown on plate 18.

INKANEEP LAND SYSTEM

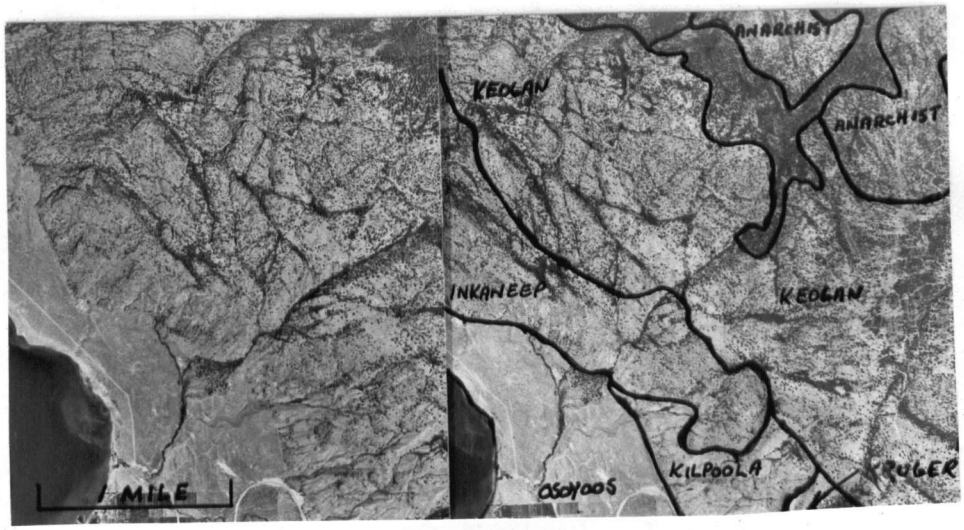

Plate 20
Inkaneep l.s.

Landform and Materials. A thin mantle of glacial till and colluvium overlays very steeply and extremely sloping valley walls. The materials are dominantly shallow, coarse textured glacial till and colluvium over bedrock, and exposed bedrock. There are minor inclusions of deep glacial till and colluvium over mostly acidic bedrock.

Vegetation. The vegetation belongs to the big sagebrush zone, bunchgrass subzone. There is a mixed big sagebrush and ponderosa pine cover with some bitterbrush. Bluebunch wheatgrass is the dominant herb. Gullies contain wild rose, sumac, red-osier dogwood and willow. The vegetation is generally similar to the big sagebrush -- speargrass habitat type.

Soils. The soils are dominantly Orthic Brown Chernozems with significant inclusions of Lithic Brown Chernozems. Soils have gravelly loamy sand and gravelly sandy loam textures and are rapidly to well drained.

Landscape Features. Elevations are approximately 1,000 to 2,100 feet. Slopes are usually greater than 30 percent and often greater than 60 percent. This land system is similar in materials and topography to Skaha l.s.

Suitability for.

Engineering and Urban Development: The steep, rugged topography, shallow depths of materials over bedrock and the large amount of exposed bedrock provides severe limitations for use.

Recreation: This land system is unsuited for intensive recreation because of very steep slopes, shallow depths of materials over bedrock and the vegetation sensitivity to disturbance. Indian paintings are a recreation feature.

Wildlife: The suitability for California bighorn sheep and mule deer winter and spring range is generally good. The suitability for white-tailed deer is moderate.

Plate 21

Ip - Inkaneep l.s.

Os - Osoyoos l.s.

Ky - Kinney l.s.

KEOGAN LAND SYSTEM

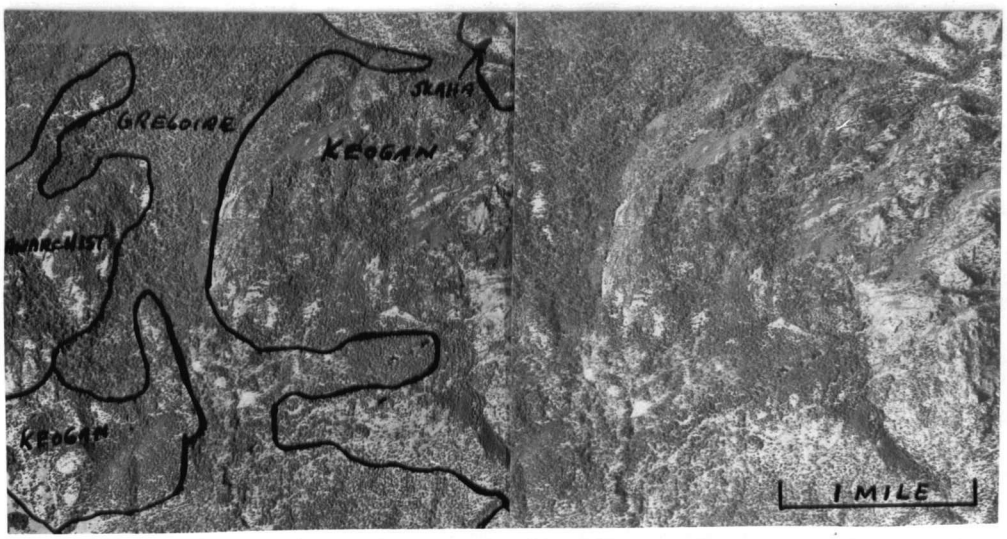

Plate 22

Keogan l.s.

Landform and Materials. A thin mantle of glacial till and colluvium overlays steeply to extremely sloping valley walls. The materials are dominately shallow,coarse textured glacial till and colluvium over usually acidic bedrocks. There are significant inclusions of exposed bedrock and minor inclusions of deep glacial till and colluvium.

Vegetation. The vegetation belongs to the Douglas fir zone. Douglas fir and ponderosa pine dominate the tree cover. The herb cover is dominated by pinegrass and Idaho fescue. The vegetation was classified as the Douglas fir -- pinegrass habitat type, with some Douglas fir -- Idaho fescue habitat type below about 3,000 feet in elevation.

Soils. The soils are dominantly Degraded Eutric Brunisols with minor inclusions of Orthic Gray Luvisols and Lithic Eutric Brunisols. Soils have gravelly sandy loam and gravelly loamy sand textures and are well to rapidly drained.

Landscape Features. Elevations are approximately 2,100 to 4,200 feet. Slopes are usually greater than 20 percent. This land system is similar in materials and topography to Anarchist l.s. (at higher elevations) and Skaha l.s. (at lower elevations).

Suitability for.

Engineering and Urban Development: Steep slopes and shallow depths of materials over bedrock provide severe limitations for use. Few areas are suitable for intensive residential development.

Recreation: Generally unsuited for intensive recreation because of steep slopes and shallow depths of materials over bedrock.

Wildlife: The suitability for California bighorn sheep and mule deer winter and spring range is moderate. The suitability for white-tailed deer, blue grouse and ruffed grouse is also moderate.

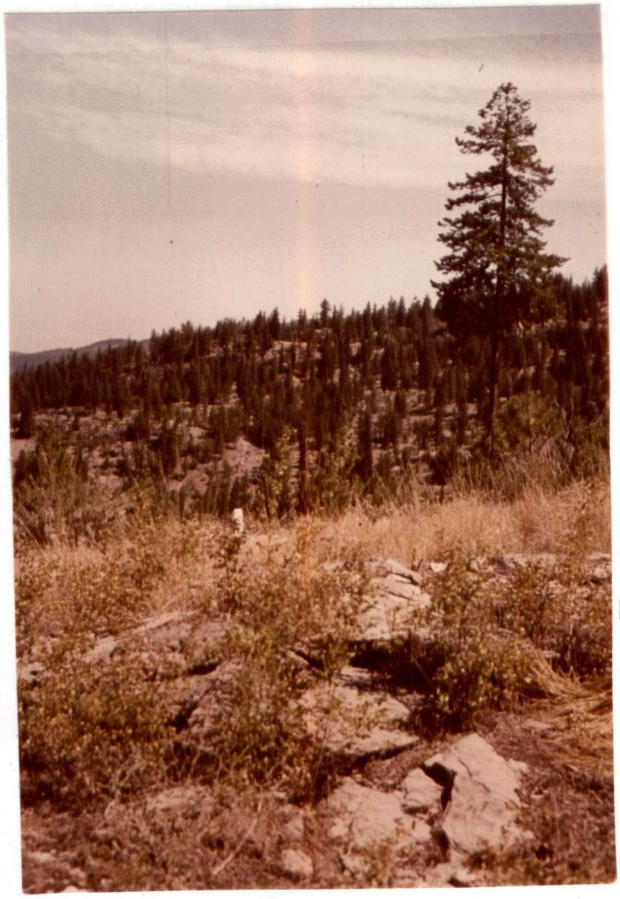

Plate 23

Keogan l.s.

KILPOOLA LAND SYSTEM

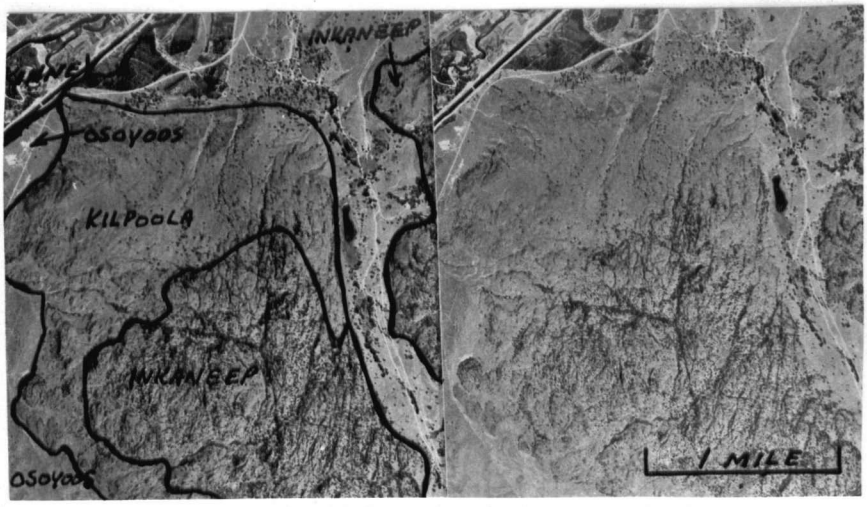

Plate 24
Kilpoola
l.s.

Landform and Materials. The landform consists of a mantle of moderately rolling to very hilly glacial till over bedrock. The materials are dominately deep, gravelly glacial till with inclusions of up to 50 percent shallow glacial till over bedrock. There are minor inclusions of a variety of exposed bedrocks.

Vegetation. The vegetation belongs to the big sagebrush zone, bunchgrass subzone. Big sagebrush dominates the shrub cover and bluebunch wheatgrass the herb cover. The vegetation was classified into the big sagebrush -- bluebunch wheatgrass habitat type.

Soils. The soils are dominantly Orthic Brown Chernozems with minor inclusions of Lithic Brown Chernozems. Soils have gravelly sandy loam and gravelly loamy sand textures and are well drained.

Landscape Features. Elevations are approximately 1,000 to 2,100 feet. Slopes are usually between 15 and 60 percent. This land system occurs in the southern part of the study area around (Mt. Kobau and Richter Pass).

Suitability for.

Engineering and Urban Development: Stoniness, steep slopes and shallow depths of materials provide moderate to severe engineering limitations. There are small areas having moderate to slight limitations for urban development.

Recreation: Intensive recreation is limited by steep slopes, shallow depths of materials, a lack of tree cover and vegetation sensitivity to disturbance. Hiking and horseback riding are generally moderately suitable, but surface stability is a limitation.

Wildlife: For the species considered the wildlife suitability is generally poor due to limited available food and cover.

Plate 25 Ka - Kilpoola l.s. Kr - Kruger l.s.

KINNEY LAND SYSTEM

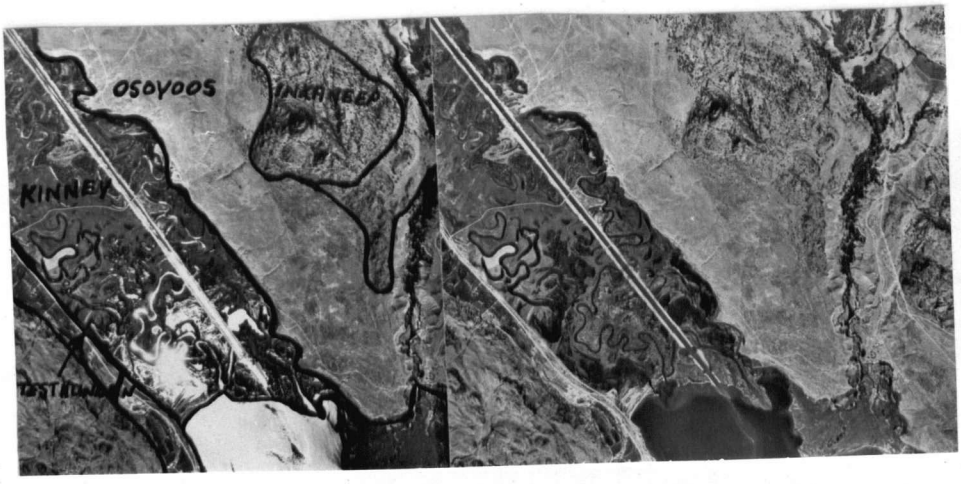

Plate 26

Kinney l.s.

Landform and Materials. The landform consists of alluvial floodplain deposits along the Okanagan River (now a controlled channel). The materials are dominantly deep, coarse textured alluvial sands with finer textured materials in the backswamp areas. There are minor inclusions of fan deposits.

Vegetation. The vegetation belongs to the big sagebrush zone, ponderosa pine subzone. The tree cover is dominated by northern black cottonwood and water birch. The shrub and herb covers are dominated by water birch, wild rose, wild raspberry, poison ivy and rushes and sedges. The vegetation was classified into the northern black cottonwood -- red-osier dogwood phase.

Soils. The soils are dominantly Rego Humic Gleysols with significant inclusions of Gleyed Regosols. Soils usually have a capping of about 2 feet of silt or clay loam over coarse textured sands. Deeper deposits of silt and clay loams are found in the backswamp areas. Soils are poorly and imperfectly drained.

Landscape Features. Elevations are approximately 900 to 1,100 feet. Slopes are generally less than 5 percent. This land system occurs along the Okanagan River channel. Flooding is a result of high water tables (plate 21).

Suitability for.

Engineering and Urban Development: Flooding, high water tables and poor soil permeabilities provide severe limitations for use (plate 51). Urban development should not normally be considered on this land system.

Recreation: Intensive recreation is severely limited by flooding, soil wetness, and surface soil textures (plate 51). The proximity to water bodies and other recreation features make it attractive for less intensive use.

Wildlife: Kinney land system has a good suitability for white-tailed deer and ruffed grouse.

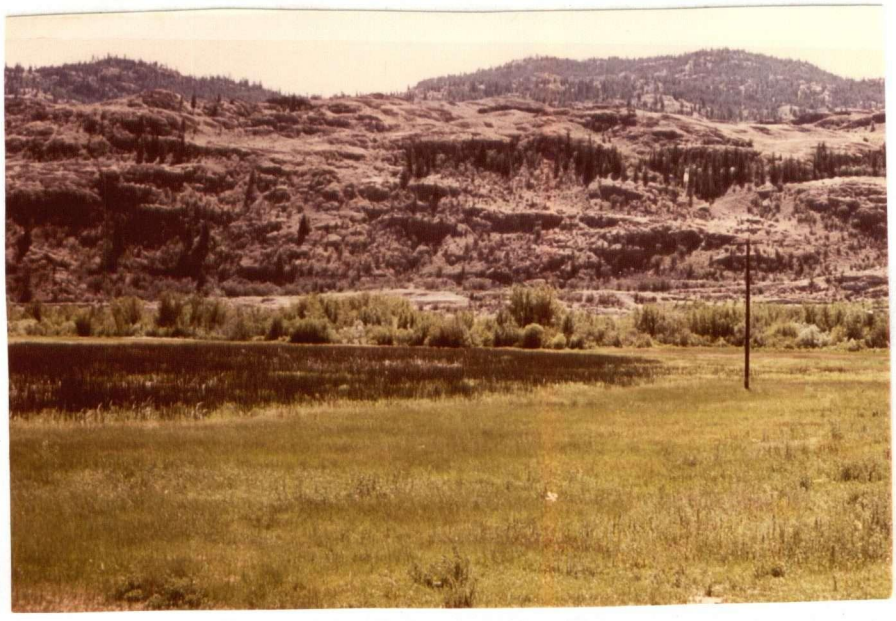

Plate 27
Ky - Kinney l.s.
Ka - Kilpoola l.s.

KOBAU LAND SYSTEM

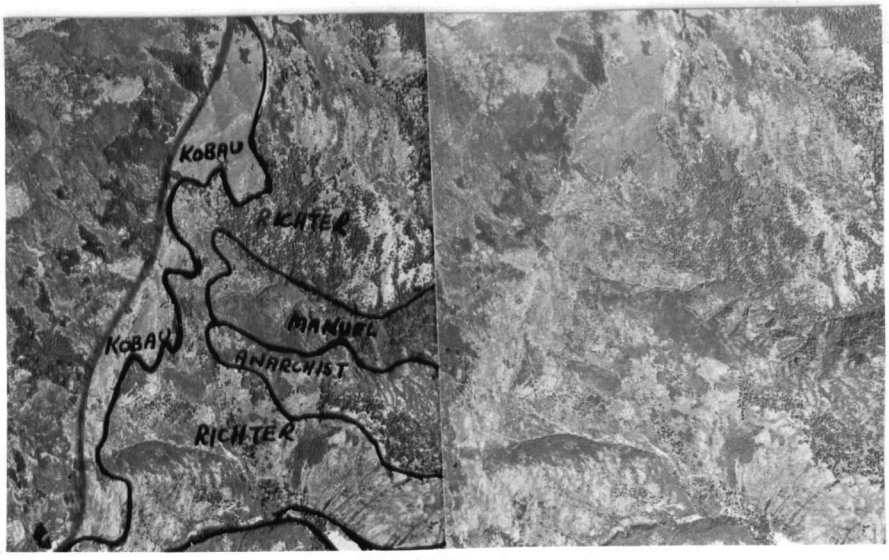

Plate 28
Kobau l.s.

Landform and Materials. The landform consists of a gently rolling to very hilly mantle of glacial till over steep, high elevation mountain slopes. The materials are dominantly shallow, coarse textured glacial till and colluvium over bedrock. There are significant inclusions of deep glacial till and minor inclusions of exposed bedrock.

Vegetation. The vegetation is high elevation grassland in the sub-alpine fir -- Engelmann spruce zone. High sagebrush and umbrella plant dominate the shrub layer and pinegrass the herb layer. The vegetation was classified as the high sagebrush -- pinegrass habitat type.

Soils. The soils are dominantly Orthic Black Chernozems. There are significant inclusions of Rego Black Chernozems and minor inclusions of Lithic Black Chernozems. Soils have generally gravelly sandy loam textures and are well to moderately well drained.

Landscape Features. Elevations are approximately 5,300 to 6,200 feet. Slopes are usually between 15 and 60 percent. This land system occurs in the Mt. Kobau area.

Suitability for.

Engineering and Urban Development: Steep slopes, shallow depths of materials over bedrock and potential frost action provide severe engineering limitations. The harsh climate, location and physical limitations preclude residential development.

Recreation: This land system is moderately suited for hiking, picnic areas and horseback riding. Vegetation diversity and viewing features are major attractions.

Wildlife: The habitat suitability for blue grouse is moderate.

Plate 29 Kobau l.s.

KRUGER LAND SYSTEM

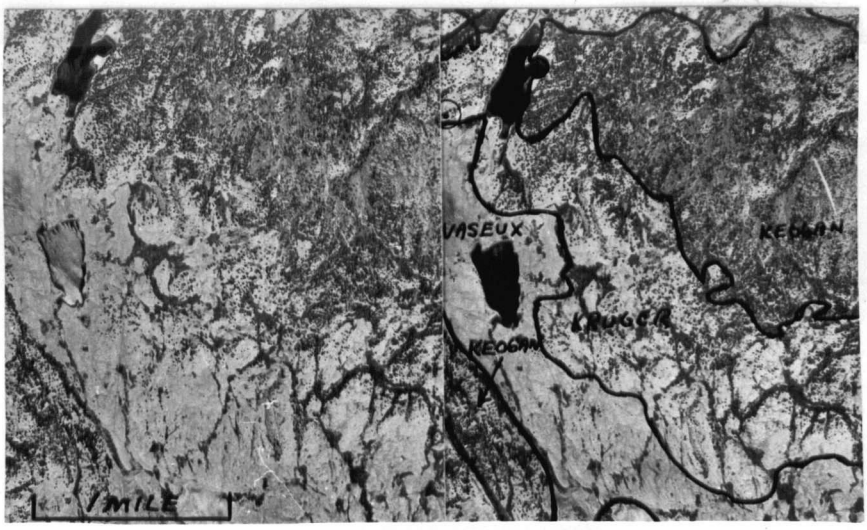

Plate 30

Kruger l.s.

Landform and Materials. The landform consists of a moderately rolling to very hilly mantle of glacial till over bedrock. The materials are dominantly shallow, coarse textured glacial till and colluvium over a variety of bedrocks. There are significant inclusions of deep glacial till and colluvium and exposed bedrock.

Vegetation. The vegetation is grassland in the Douglas fir zone. Only scattered ponderosa pine and Douglas fir occur (usually associated with rock outcrops and seepage areas). Threetip sagebrush and big sagebrush dominate the shrub layer and bluebunch wheatgrass and Idaho fescue the herb cover. The vegetation was classified as the threetip sagebrush -- bluebunch wheatgrass habitat type.

Soils. The soils are dominantly Orthic Dark Brown Chernozems. There are significant inclusions of Lithic Dark Brown Chermozems with minor

inclusions of Orthic Dark Gray Chernozems (associated with aspen cover in seepage areas). Soils are well to rapidly drained.

Landscape Features. Elevations are approximately 2,100 to 4,500 feet. Slopes are usually between 15 and 60 percent. This land system occurs in the southern portion of the study area.

Suitability for.

Engineering and Urban Development: Very steep slopes and shallow depths of materials over bedrock provide severe engineering limitations.

Recreation: Kruger land system is severely limited for intensive recreation by steep slopes, shallow depths of materials over bedrock, stoniness and a lack of tree cover.

Wildlife: The suitability for white-tailed deer and for California bighorn sheep and mule deer winter range is moderate.

Plate 31

Kruger l.s.
The location of plate 31 is shown on plate 30.

LAWLESS LAND SYSTEM

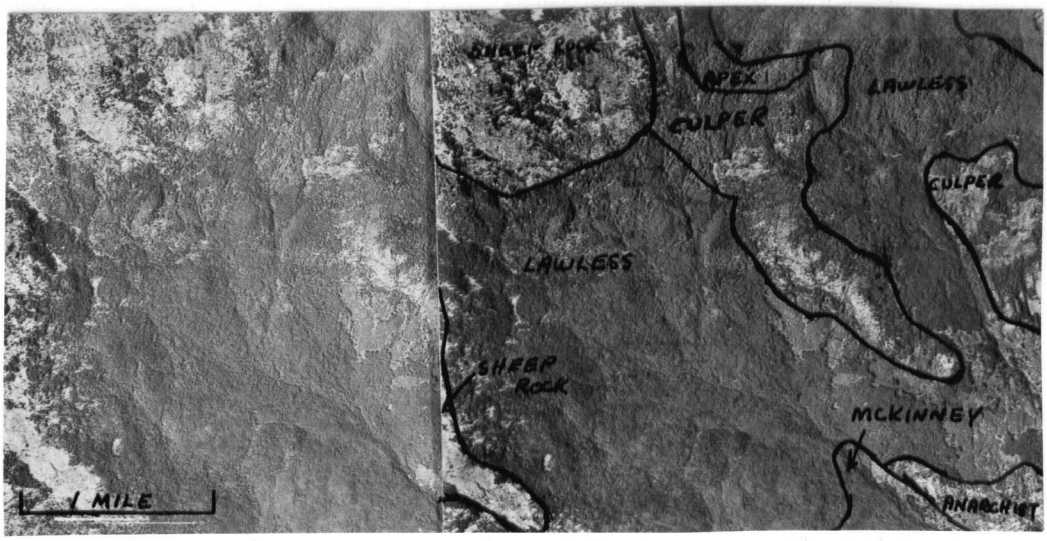

Plate 32

Lawless l.s.

Landform and Materials. The landform consists of moderately rolling to hilly deposits of deep glacial till over mountain slopes. The materials are dominantly deep, coarse textured glacial till or colluvium over glacial till. There are minor inclusions of shallow glacial till and colluvium over a variety of bedrocks.

Vegetation. The vegetation belongs to the subalpine fir -- Engelmann spruce zone. Subalpine fir, Engelmann spruce and lodgepole pine dominate the tree cover with grouseberry, white rhododendron and mountain labrador tea dominating the shrub cover. The vegetation was classified as the subalpine fir -- Engelmann spruce -- grouseberry habitat type.

Soils. The soils are dominantly mini Humo-Ferric Podzols. There are minor inclusions of Brunisolic Gray Luvisols. Soils have gravelly sandy loam and gravelly loamy sand textures and are well to moderately well drained.

Landscape Features. Elevations are approximately 5,500 to 6,600 feet. Slopes are usually between 15 and 60 percent. This land system is similar in materials and topography to McKinney l.s. (at lower elevations).

Suitability for.

Engineering and Urban Development: Stoniness and steep slopes usually provide moderate to severe engineering limitations. The harsh climate will restrict residential developments.

Recreation: Generally severe restrictions for intensive recreation because of a cold climate, dense vegetation, stoniness and steep slopes.

Wildlife: The suitability for spruce grouse is good to moderate. There are inclusions of moderately suitable areas for blue grouse.

Plate 33

Ls - Lawless l.s.
Ax - Apex l.s.
Ae - Allendale l.s.

LOUIE LAND SYSTEM

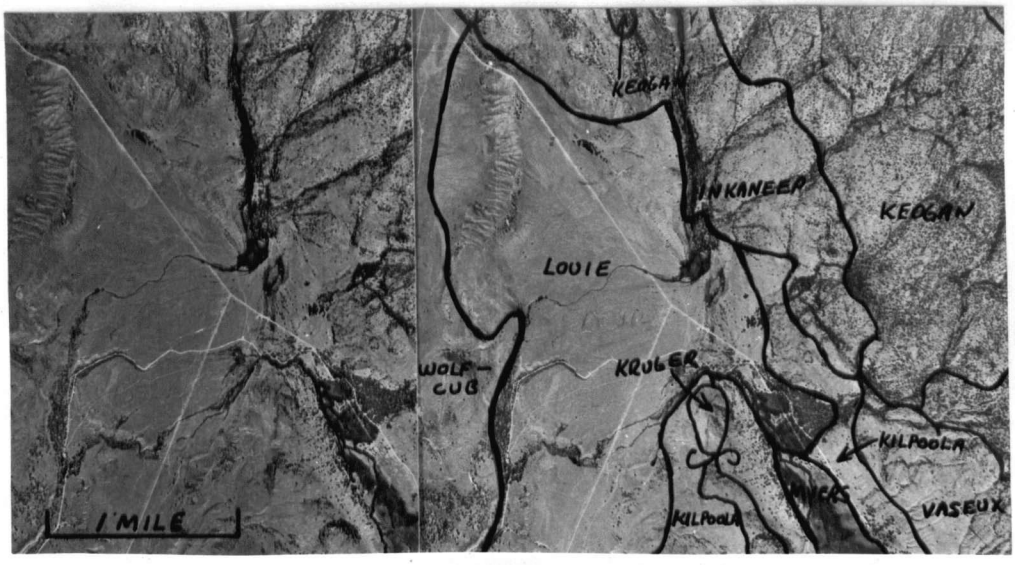

Plate 34

Louie l.s.

Landform and Materials. The landform is dominantly a gently sloping glacial fluvial delta but includes a large morainal ridge along the western boundary. The materials are dominantly coarse textured deltaic deposits with minor inclusions of shallow glacial fluvial outwash over glacial till and bedrock, and alluvial-colluvial fans.

Vegetation. The vegetation belongs to the big sagebrush zone, bunchgrass subzone. It is characterized by big sagebrush and bluebunch wheatgrass with ponderosa pine on deep sands. The vegetation is variable as a result of the different materials and land use activities.

Soils. The soils are dominantly Orthic Brown Chernozems. Dark Brown Chernozems were found at higher elevations and Degraded Eutric Brunisols under a cover of ponderosa pine. Soil textures are variable, from very stony and gravelly to deep coarse sands. Soils are rapidly drained.

Landscape Features. Elevations are approximately 1,200 to 1,600 feet. Slopes are usually between 2 and 15 percent. This land system is a mixture of different materials but is dominantly stony and gravelly deltaic deposits.

Suitability for.

Engineering and Urban Development: Stoniness and steep slopes provide moderate to severe limitations. The suitability for urban development is generally moderate. Septic tanks have a severe limitation due to the potential for ground water pollution. An excellent source of gravel and sand.

Recreation: Generally severe restrictions for intensive recreation because of stoniness, surface soil textures (dustiness on sands), lack of tree cover and vegetation sensitivity to disturbance. Hiking and horseback riding are moderately suitable.

Wildlife: The suitability for California bighorn sheep and mule deer winter and spring range is good to moderate. White-tailed deer have a moderate suitability.

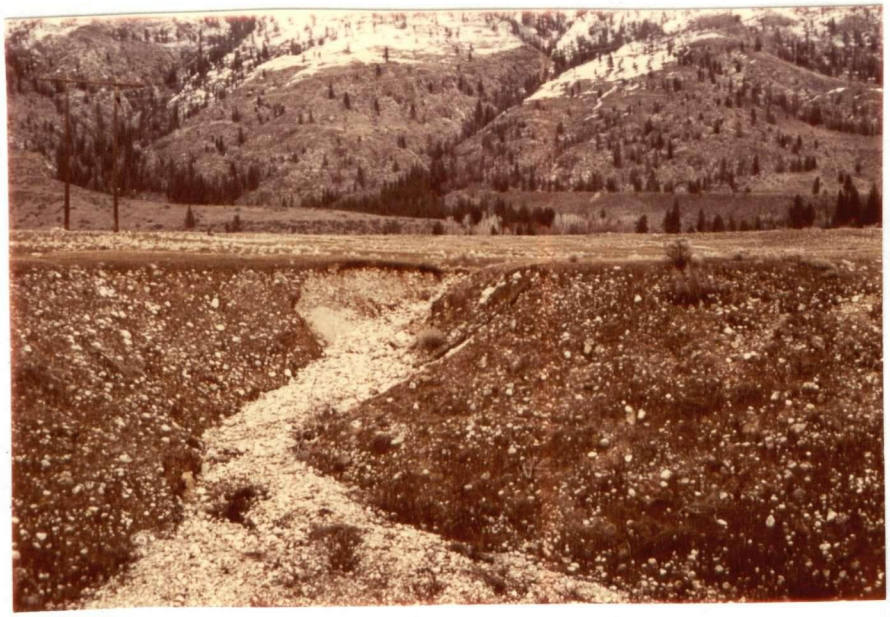

Plate 35
Le - Louie l.s.
lp - Inkaneep l.s.
The location of plate 35 is shown on plate 34.

MANUEL LAND SYSTEM

See plates 28 and 56.

Landform and Materials. The landform is an extremely sloping mantle of colluvial materials on north aspects of steep valley walls. The materials are dominantly deep gravelly to stony colluvium. There are significant inclusions of shallow colluvium over bedrock and minor inclusions of a variety of exposed bedrocks.

Vegetation. The vegetation belongs to the subalpine fir -- Engelmann spruce zone. Subalpine fir and Engelmann spruce dominate the tree cover, grouseberry the shrub cover and pinegrass the herb cover. The vegetation was classified into the subalpine fir -- Engelmann spruce -- pinegrass habitat type.

Soils. The soils are dominantly Orthic Dystric Brunisols and Degraded Dystric Brunisols. There are minor inclusions of Orthic Regosols. Soils usually have a gravelly or stony loamy sand texture and are rapidly drained.

Landscape Features. Elevations are approximately 4,000 to 5,500 feet. Slopes are usually greater than 60 percent. This land system is similar in topography and materials to Hestor l.s. (at lower elevations) and Richter l.s. (on south aspects).

Suitability for.

Engineering and Urban Development: Very steep slopes, unstable soil materials and shallow depths of materials over bedrock provide severe limitations for use.

Recreation: Manuel land system is generally unsuited for intensive (and extensive) recreation because of very steep slopes, unstable soil materials, a cold climate and dense vegetation.

Wildlife: The suitability for spruce grouse is good and for blue grouse moderate.

Plate 36 Manuel l.s.

MARRON LAND SYSTEM

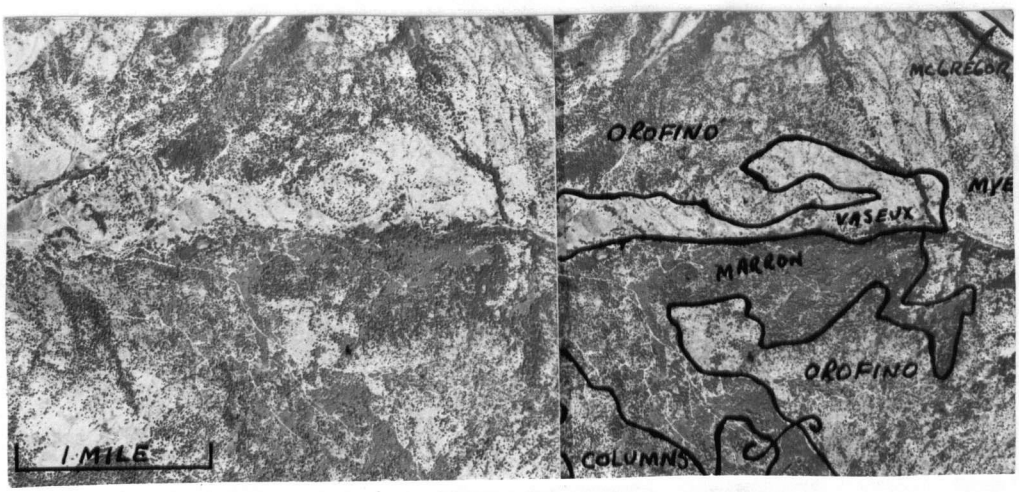

Plate 37

Marron l.s. (also see plate 48)

Landform and Materials. The landform consists of a mantle of moderately to extremely sloping glacial till over bedrock. The materials are dominantly deep, moderately textured glacial till. There are significant inclusions of shallow glacial till and colluvium over bedrock, and deep colluvium.

Vegetation. The vegetation belongs to the Douglas fir zone. The tree layer is dominated by Douglas fir with ponderosa pine at lower elevations. The herb layer is dominated by pinegrass with wild strawberry, heart-leaf arnica and lupine. The vegetation was classified as the Douglas fir -- pinegrass habitat type.

Soils. Soils were not well sampled due to general inaccessability. They are thought to be dominantly Orthic Gray Luvisols. They have a gravelly loam to loam texture and are well drained.

Landscape Features: Elevations are approximately 2,200 to 4,200 feet. Slopes are usually between 9 and 60 percent. This land system is similar in materials and topography to Trout Lake l.s. (at higher elevations).

Suitability for.

Engineering and Urban Development: Steep slopes and shallow depths of materials over bedrock provide moderate to severe engineering limitations. The suitability for urban development is poor.

Recreation: Generally unsuited for intensive recreation because of steep slopes and shallow depths of materials over bedrock. There are minor inclusions having a moderate suitability.

Wildlife: The habitat suitability for blue grouse is moderate to good, and for winter mule deer range moderate.

Plate 38

Ma - Marron l.s.
Oo - Orofino l.s.
Tn - Twin Lakes l.s.

McGREGOR LAND SYSTEM

See plate 71.

Landform and Materials. The landform consists of a thin mantle of glacial till and colluvium over strongly rolling to very hilly tilted sedimentary and volcanic bedrocks. The materials are dominantly coarse textured, shallow glacial till and colluvium over bedrock. There are significant inclusions of exposed bedrock and minor inclusions of deep colluvium and glacial till.

Vegetation. The vegetation is grassland in the Douglas fir zone. The shrub cover is dominated by threetip sagebrush and big sagebrush. Bluebunch wheatgrass and Idaho fescue dominate the herb cover. The vegetation was classified into the threetip sagebrush -- bluebunch wheatgrass habitat type.

Soils. The soils are dominantly Orthic Dark Brown Chernozems with significant inclusions of Orthic Regosols. Soils have gravelly loamy sand and gravelly sandy loam textures and are rapidly drained.

Landscape Features. Elevations are approximately 2,000 to 3,000 feet. Slopes are usually between 15 and 60 percent. This land system occurs around White Lake.

Suitability for.

Engineering and Urban Development: Steep slopes and shallow depths of materials over bedrock provide severe limitations for use.

Recreation: McGregor land system is not suitable for intensive recreation because of steep slopes, shallow depths of material over bedrock, vegetation sensitivity to disturbance and a lack of tree cover.

Wildlife: The suitability for mule deer winter and spring range is moderate.

Plate 39 Mg - McGregor l.s. Wl - White Lake l.s.
Oo - Orofino l.s.

McINTYRE LAND SYSTEM

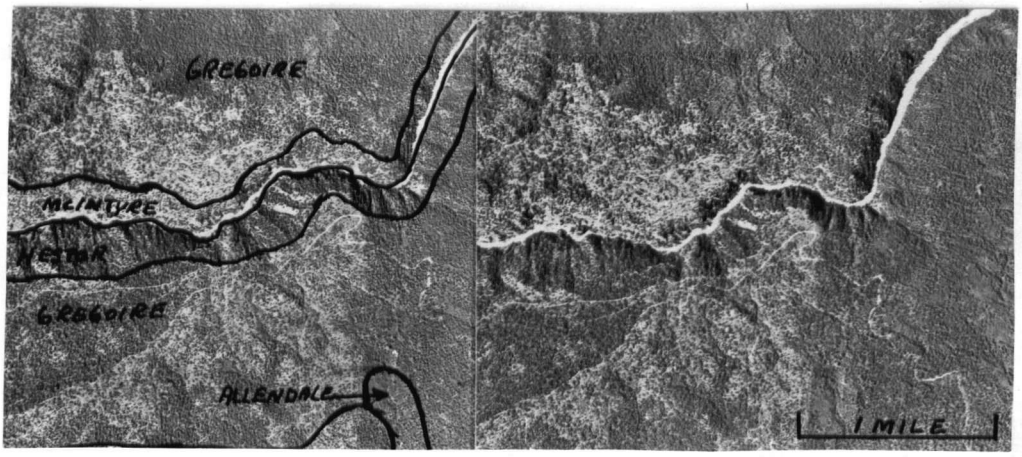

Plate 40

McIntyre l.s.

Landform and Materials. The landform consists of very steeply to extremely sloping colluvial deposits along south aspects of valley walls. The materials are dominantly deep gravelly and stony colluvium. There are significant inclusions of shallow colluvium over a variety of bedrocks, and minor inclusions of ice contact deposits and exposed bedrock.

Vegetation. The vegetation belongs to the Douglas fir zone. The tree cover is dominantly ponderosa pine with Douglas fir, and the herb cover bluebunch wheatgrass and Idaho fescue. The vegetation was classified into the Douglas fir -- Idaho fescue habitat type with some Douglas fir -- pinegrass habitat type at higher elevations.

Soils. The soils are dominantly weakly developed Orthic Eutric Brunisols and minor inclusions of Lithic Eutric Brunisols. Soils have gravelly loamy sand and gravelly sand textures and are rapidly drained.

Landscape Features. Elevations are approximately 2,000 to 4,200 feet. Slopes are usually greater than 60 percent. This land system is similar in topography and materials to Hestor l.s. (on north aspects).

Suitability for.

Engineering and Urban Development: Very steep slopes, unstable soil materials, shallow depths of materials over bedrock and stoniness provide severe engineering limitations.

Recreation: Unsuitable for intensive recreation because of very steep slopes, unstable soil materials, surface soil textures (erosion) and the vegetation sensitivity to disturbance.

Wildlife: The habitat suitability for California bighorn sheep and mule deer winter and spring range is good to moderate. The suitability for white-tailed deer and bluegrouse is also moderate.

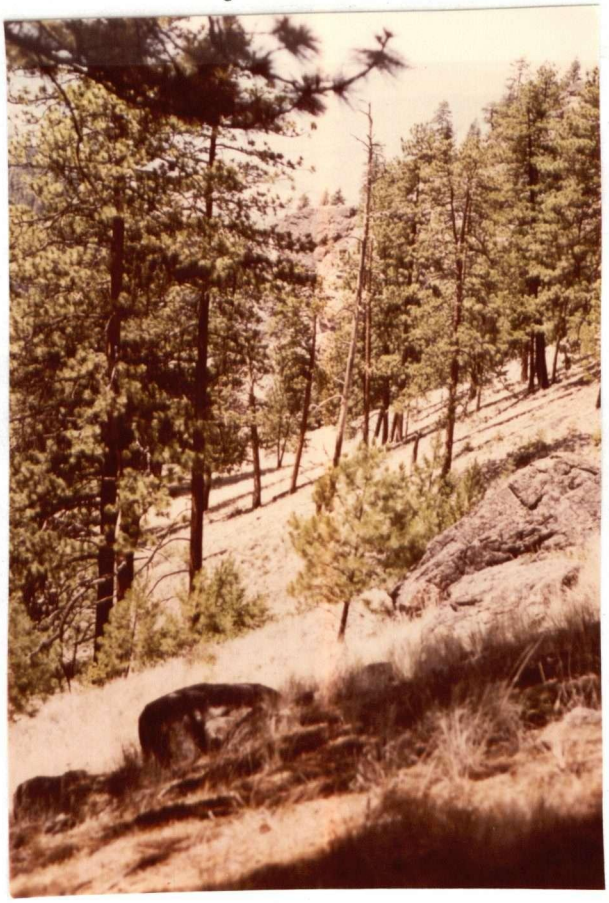

Plate 41

McIntyre l.s.

McKINNEY LAND SYSTEM

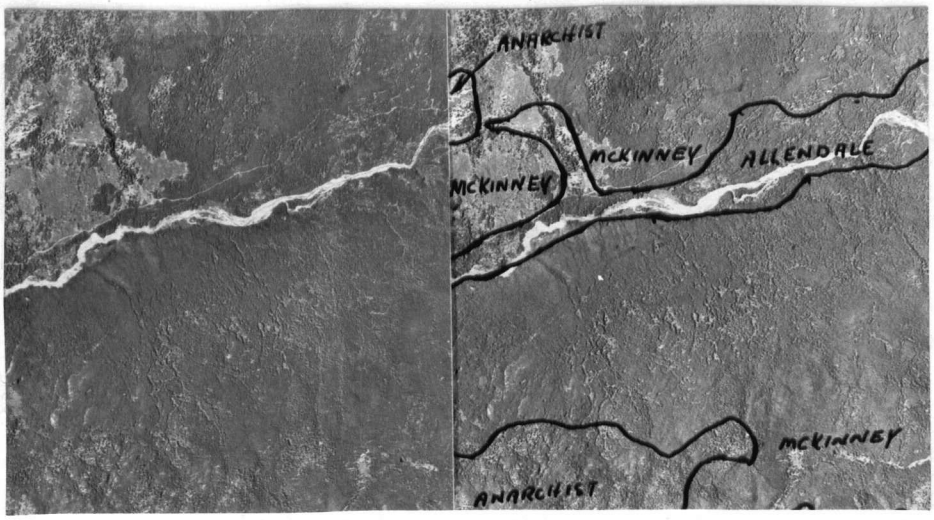

Plate 42

McKinney l.s.

Landform and Materials. The landform consists of a deep mantle of gently rolling to hilly glacial till over mountain slopes. The materials are dominantly deep, coarse textured glacial till with colluvium over glacial till on steeper slopes. There are minor inclusions of shallow glacial till and colluvium over mostly acidic bedrock.

Vegetation. The vegetation belongs to the subalpine fir -- Engelmann spruce zone. The tree cover is dominated by subalpine fir, Engelmann spruce and lodgepole pine. Grouseberry and pinegrass dominate the shrub and herb cover. The vegetation was classified into the subalpine fir -- Engelmann spruce -- pinegrass habitat type.

Soils. The soils are dominantly weakly developed Brunisolic Gray Luvisols and Degraded Dystric Brunisols. Soils usually have a gravelly sandy loam texture and are well to moderately well drained.

Landscape Features. Elevations are approximately 4,200 to 5,500 feet. Slopes are generally between 9 and 45 percent. This land system is similar in topography and materials to Gregoire l.s. (at lower elevations) and Lawless l.s. (at higher elevations).

Suitability for.

Engineering and Urban Development: Stoniness and steep slopes provide moderate to severe engineering limitations. This land system is unsuited for residential development due to the harsh climate.

Recreation: Generally moderate to severe limitations due to a cold climate, dense vegetation, stoniness and steep slopes.

Wildlife: The suitability for spruce grouse is good and for blue grouse moderate.

Plate 43

McKinney l.s.

MUNSON LAND SYSTEM

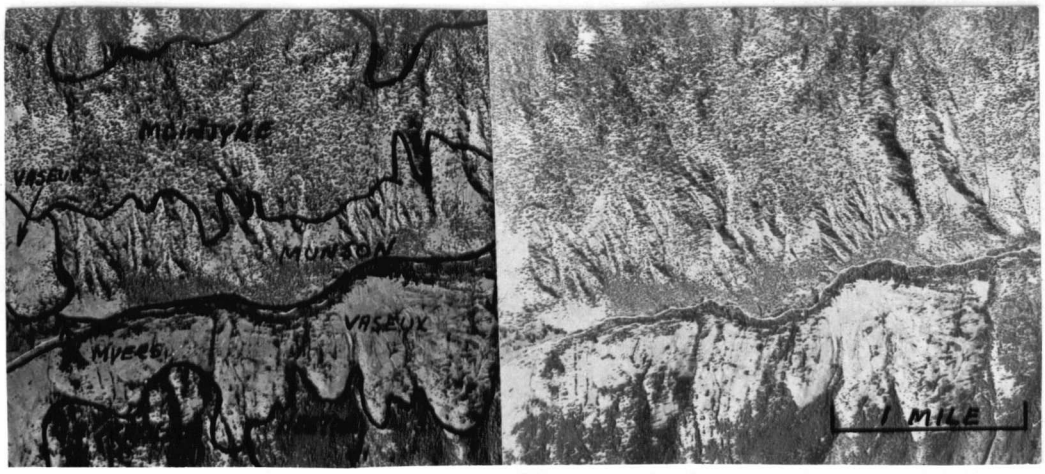

Plate 44

Munson l.s.

Landform and Materials. The landform consists of a deep mantle of very steeply to extremely sloping glacial till and colluvium over valley walls. The materials are dominantly deep, coarse textured glacial till and colluvium with minor inclusions of ice contact deposits.

Vegetation. The vegetation is transitional between the Douglas fir and big sagebrush zones. The tree cover consists of scattered ponderosa pine and Douglas fir. Bluebunch wheatgrass and Idaho fescue are the dominant herbs. The vegetation is similar to the Douglas fir -- Idaho fescue habitat type.

Soils. The soils are dominantly Orthic Dark Brown Chernozems with Degraded Eutric Brunisols under tree cover. Soils have gravelly sandy loam textures and are well drained.

Landscape Features. Elevations are approximately 1,300 to 2,000 feet. Slopes are usually between 30 and 60 percent. This land system only occurs around Penticton and Shingle Creek.

Suitability for.

Engineering and Urban Development: Very steep slopes and stoniness provide severe engineering limitations.

Recreation: Munson land system is unsuitable for intensive recreation because of very steep slopes and stoniness.

Wildlife: The habitat suitability for white-tailed deer, blue grouse and for California bighorn sheep and mule deer winter and spring range is moderate.

Plate 45 Mn - Munson l.s. Pn - Penticton l.s.

MYERS LAND SYSTEM

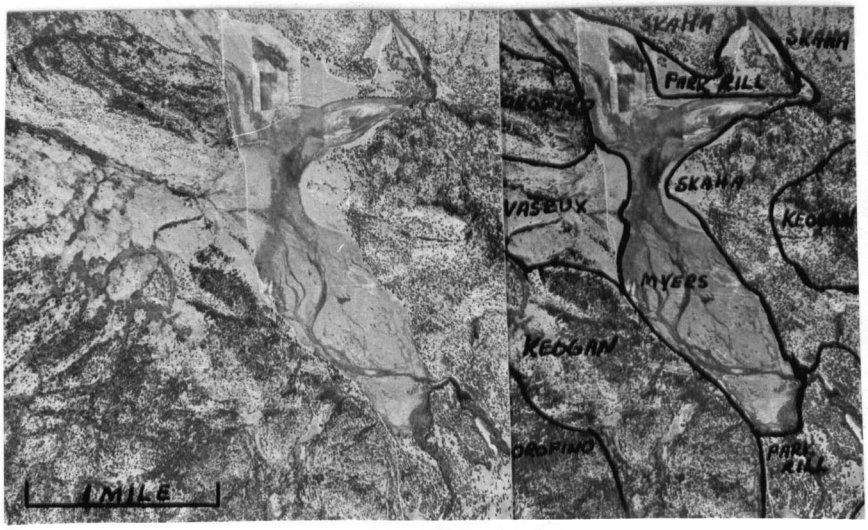

Plate 46
Myers l.s.

Landform and Materials. The landform consists of very gently to gently sloping recent alluvial fans, deltas and stream channels. These deposits are thought to overlay glacial fluvial outwash. The materials are dominantly moderately fine textured alluvium with minor inclusions of alluvial -- colluvial fan deposits.

Vegetation. The vegetation is transitional between the big sagebrush zone, ponderosa pine subzone and the lower Douglas fir zone. Ponderosa pine and water birch dominate the tree cover with wild rose, red-osier dogwood, hawthorn and water birch dominating the shrub cover. The vegetation is similar to the northern black cottonwood -- red-osier dogwood phase.

Soils. The soils are dominantly Gleyed Humic Gleysols. Soils have a silty loam to fine sandy loam texture and are usually poorly drained.

Landscape Features. Elevations are approximately 1,500 to 2,000 feet. Slopes are usually between 1 and 3 percent. This land system is well developed near Myers Flat.

Suitability for.

Engineering and Urban Development: High seasonal water tables, poor soil drainage and potential frost action provide severe engineering limitations. Urban development should not be considered.

Recreation: Intensive recreation is severely limited by soil wetness and surface soil textures (muddiness and dustiness).

Wildlife: The suitability for white-tailed deer, ruffed grouse, blue grouse and mule deer is generally moderate.

Plate 47 My - Myers l.s. Kn - Keogan l.s.

OROFINO LAND SYSTEM

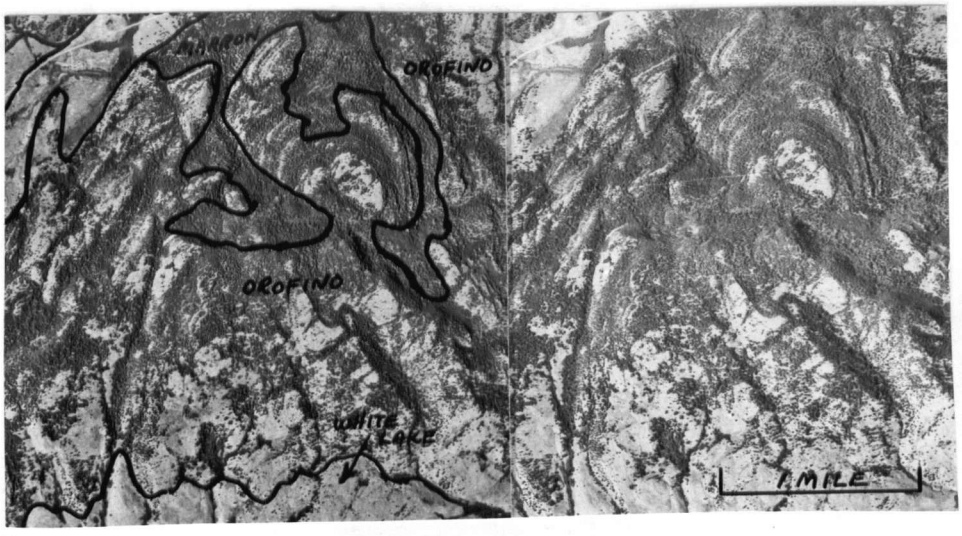

Plate 48

Orofino l.s.

Landform and Materials. The landform is a shallow mantle of strongly rolling to very hilly glacial till over bedrock. The physiography is controlled by the underlying volcanic bedrocks. The materials are dominantly shallow, coarse textured glacial till and colluvium. There are significant inclusions of exposed bedrock and minor inclusions of deep glacial till and colluvium.

Vegetation. The vegetation belongs to the Douglas fir zone. Douglas fir is the dominant tree and Idaho fescue and pinegrass the dominant herbs. The vegetation is usually the Douglas fir -- pinegrass habitat type.

Soils. The soils are dominantly Degraded Eutric Brunisols. There are significant inclusions of Lithic Regosols and minor inclusions of Orthic Gray Luvisols. Soils have a gravelly sandy loam to gravelly loam texture and are well and rapidly drained.

Landscape Features. Elevations are approximately 2,100 to 4,200 feet. Slopes are variable but are usually greater than 25 percent. This land system is similar in materials and topography to Columns l.s. (at higher elevations).

Suitability for.

Engineering and Urban Development: Very steep slopes and shallow depths of materials over bedrock provide severe engineering limitations.

Recreation: Very steep slopes and shallow depths of materials over bedrock make this land system unsuitable for intensive recreation.

Wildlife: Orofino land system has a moderate suitability for mule deer winter range. These are inclusions of moderately suitable areas for white-tailed deer, ruffed grouse and blue grouse.

Plate 49 Oo - Orofino l.s. Vx - Vaseux l.s.

OSOYOOS LAND SYSTEM

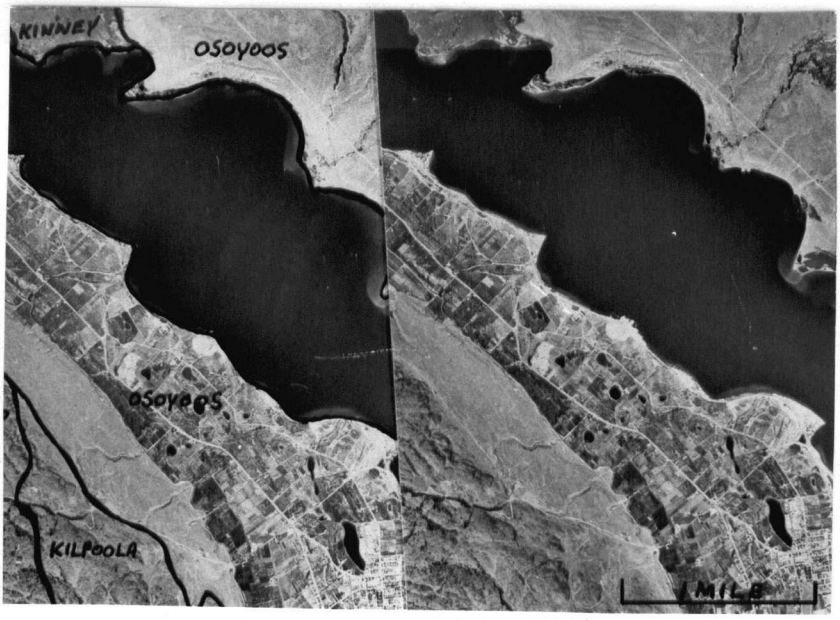

Plate 50
Osoyoos l.s.

Landform and Materials. This land system consists of gently sloping to gently rolling and hilly glacial fluvial outwash terraces. The terraces tend to be kettled to the west of Osoyoos Lake. They are underlaim by silty glaciolacustrine deposits. The materials are dominantly sandy glacial fluvial outwash. There are minor inclusions of alluvial -- colluvial fans and shallow glacial fluvial outwash over silty glaciolacustrine deposits.

Vegetation. The vegetation belongs to the big sagebrush zone, bunchgrass subzone. Bitterbrush and to a lesser extent big sagebrush dominate the shrub cover. The herb cover is dominated by speargrass. The vegetation was classified into the greasewood -- speargrass habitat type.

Soils. The soils are dominantly Orthic Brown Chernozems. There are significant inclusions of Orthic Regosols and minor inclusions of Rego

Brown Chernozems. The soils are mostly deep coarse sands over gravel with gravelly loamy sand, loamy sand and sandy loam textures. Soils are rapidly drained.

Landscape Features. Elevations are approximately 900 to 1,200 feet. Slopes are usually between 3 and 15 percent. This land system is similar in materials and topography to Wolfcub l.s.

Suitability for.

Engineering and Urban Development: The high potential for erosion and duning of sands provides slight to severe engineering limitations (plate 20). There are no major limitations for urban development but intensive use of septic tanks may lead to ground water pollution. A good source of sand.

Recreation: Generally unsuited for intensive recreation because of surface soil textures (dustiness and soil erosion), vegetation sensitivity to disturbance and lack of tree cover. Areas adjacent to Osoyoos Lake often have good to moderate suitabilities but flooding is a problem.

Wildlife: The suitability for California bighorn sheep and mule deer winter and early spring range is moderate.

Plate 51 (Note the campsite under water)

Os - Osoyoos l.s.

Ky - Kinney l.s.

Ip - Inkaneep l.s.

(see plate 21).

PARK RILL LAND SYSTEM

Plate 52

Park Rill l.s.

Landform and Materials. The landform is a gently sloping to moderately rolling glacial fluvial delta. There are small inclusions of glacial fluvial outwash terraces. The materials are dominantly deep, coarse textured sands and sands over gravel. There are minor inclusions of shallow glacial fluvial materials over bedrock and glacial till.

Vegetation. The vegetation belongs to the big sagebrush zone, ponderosa pine subzone. Ponderosa pine forms the tree cover. Bitterbrush dominates the shrub cover and bluebunch wheatgrass the herb cover. The vegetation was classified into the ponderosa pine -- bitterbrush habitat type.

Soils. The soils are dominantly Degraded Eutric Brunisols. There are significant inclusions of Orthic Brown Chernozems and minor inclusions of Rego Brown Chernozems. The soils have gravelly loamy sand and sandy loam textures and are rapidly drained.

Landscape Features. Elevations are approximately 1,000 to 1,500 feet. Slopes are usually between 2 and 15 percent. This land system is similar to Carmi and Louie l.s.'s, but is dominantly deep sands.

Suitability for.

Engineering and Urban Development: Potential erosion and duning of sands, and steep slopes provide slight to moderate engineering limitations (plate 52). There are few limitations for residential use but intensive use of septic tanks may lead to ground water pollution. A good source of sand.

Recreation: Generally poorly suited for intensive recreation because of surface soil textures (dustiness and erosion) and the vegetation sensitivity to disturbance.

Wildlife: The habitat suitability for winter and early spring range for California bighorn sheep and mule deer is moderate.

Plate 53 Pr - Park Rill l.s. Ip - Inkaneep l.s. The location of plate 53 is shown on plate 52.

PENTICTON LAND SYSTEM

Plate 54

Penticton l.s.

Landform and Materials. The landform consists of gently rolling to extremely sloping glaciolacustrine deposits. The materials are often highly dissected with vertical gully walls. The materials are dominantly deep glaciolacustrine silts and very fine sands with minor inclusions of shallow deposits over a variety of bedrocks.

Vegetation. The vegetation belongs to the big sagebrush zone, bunchgrass subzone. Big sagebrush dominates the shrub cover and bluebunch wheatgrass the herb cover. The vegetation was classified into the big sagebrush -- bluebunch wheatgrass habitat type.

Soils. The soils are dominantly Orthic Brown Chernozems. There are significant inclusions of Rego Brown Chernozems and minor inclusions of Orthic Regosols. Soil textures are dominantly silt loam with inclusions of fine sandy loam. The soils are well to moderately well drained.

Landscape Features. Elevations are approximately 1,100 to 1,400 feet. Slopes are usually between 5 and 20 percent (except for gully walls). This land system occurs around Skaha Lake and Penticton.

Suitability for.

Engineering and Urban Development: There is a high potential for mass soil movement (Plates 75 and 76). Steep slopes, shrink -- swell potentials and potential frost action further restrict use. Urban development should be restricted.

Recreation: Usually severe limitations for intensive recreation because of the soil erosion hazard, soil textures (dustiness), steep slopes, lack of tree cover and vegetation sensitivity to disturbance. There are inclusions having moderate suitabilities for selected activities (e.g. picnic areas).

Wildlife: The suitability for white-tailed deer is moderate, and for California bighorn sheep and mule deer winter and spring range moderate to poor.

Plate 55

Pn - Penticton l.s.

Ry - Roy l.s.

Ky - Kinney l.s.

RICHTER LAND SYSTEM

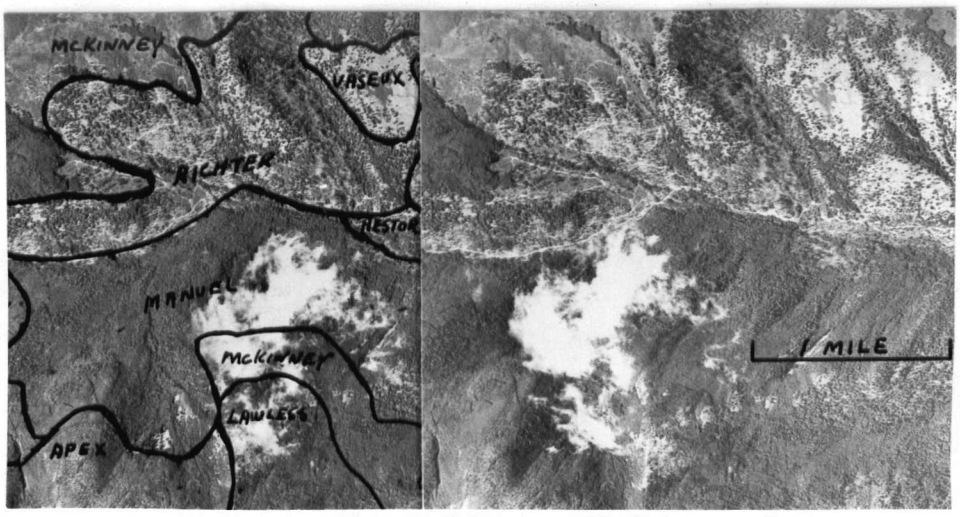

Plate 56

Richter l.s.

Landform and Materials. The landform consists of very steeply to extremely sloping colluvium on south aspects of high elevation valley walls. The materials are dominantly deep stony and gravelly colluvium. There are significant inclusions of shallow colluvium over bedrock and minor inclusions of a variety of exposed bedrocks.

Vegetation. The vegetation belongs to the subalpine fir -- Engelmann spruce zone. The tree cover is characterized by lodgepole pine, Douglas fir, Engelmann spruce and subalpine fir. Pinegrass is the dominant herb. The vegetation was classified into the subalpine fir -- Engelmann spruce -- pinegrass habitat type.

Soils. The soils are dominantly Degraded Eutric Brunisols. There are significant inclusions of Orthic Regosols and at higher elevations Orthic Dystric Brunisols. The soils have a gravelly to stony loamy sand texture and are rapidly drained.

Landscape Features. Elevations are approximately 4,200 to 5,500 feet. Slopes are usually greater than 60 percent. This land system is similar in topography and materials to Manuel l.s. (on north aspects).

Suitability for.

Engineering and Urban Development: Very steep slopes, unstable soil materials, shallow depths of materials over bedrock and stoniness provide severe limitations for use.

Recreation: Unsuitable for intensive recreation because of very steep slopes and unstable soil materials.

Wildlife: The suitability for blue grouse is moderate with inclusions of moderately suitable areas for spruce grouse.

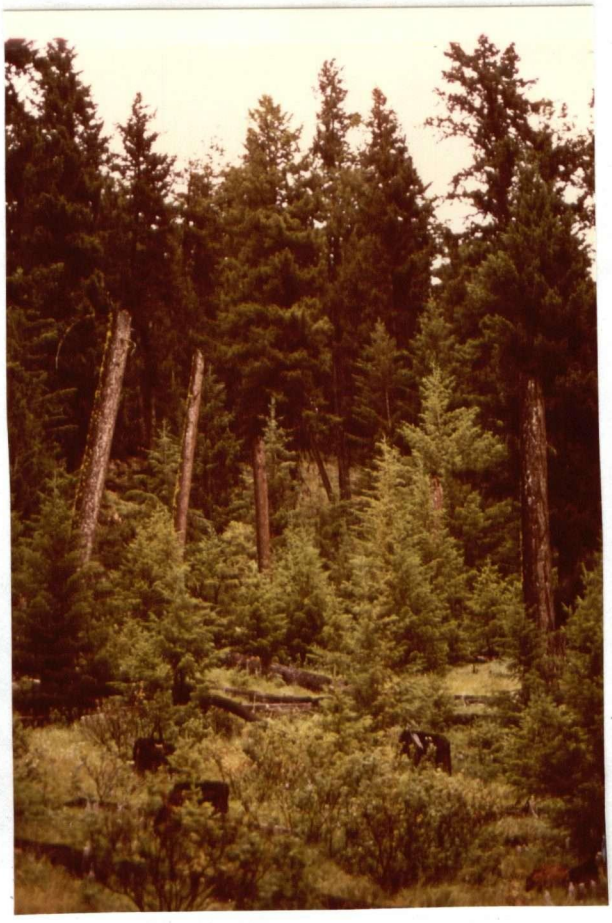

Plate 57

Richter l.s.

The location of plate 57 is shown on plate 56.

ROY LAND SYSTEM

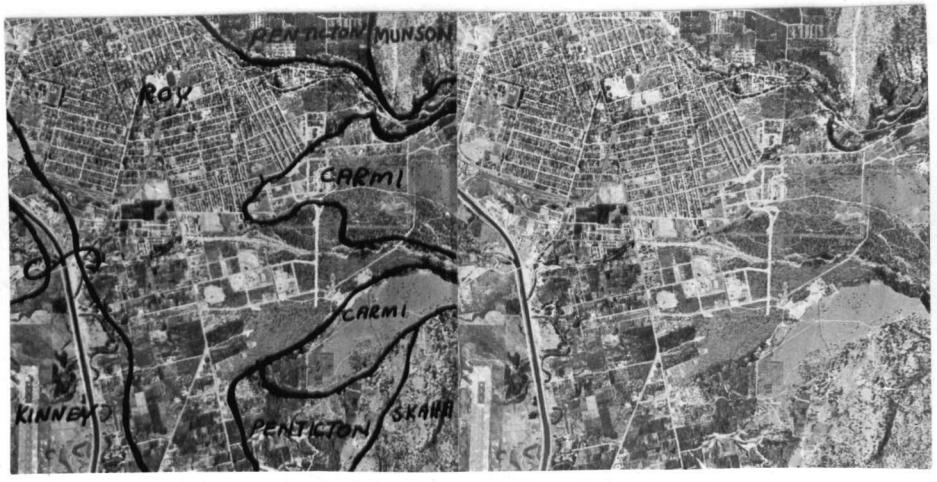

Plate 58

Roy l.s.

Landform and Materials. The landform consists of very gently to gently sloping alluvial fans and deltas. The materials are dominantly coarse textured sandy to stony alluvial fans and deltas with minor inclusions of alluvial floodplain deposits.

Vegetation. The vegetation belongs to the big sagebrush zone, ponderosa pine subzone. The vegetation is dominated by northern black cottonwood, ponderosa pine, Saskatoon berry, wild rose, sumac and poison ivy. The vegetation is similar to the northern black cottonwood -- red-osier dogwood phase.

Soils. The soils are variable, usually Orthic Regosols and Gleyed Regosols on lower parts of fans. There are minor inclusions of Rego Humic Gleysols. On upper parts of the fans, soils have a gravelly to stony sand and loamy sand texture and are well to rapidly drained. On lower parts they have a capping of loam or sandy loam over sands and gravels and are imperfectly to poorly drained.

Landscape Features. Elevations are approximately 1,100 to 1,400 feet. Slopes are usually between 2 and 5 percent. This land system is similar in materials to Testalinden l.s.

Suitability for.

Engineering and Urban Development: Stoniness and poor soil drainage provide generally moderate to severe engineering limitations. The suitability for urban development is generally moderate. Septic tank use should be restricted due to the high potential for ground water pollution

Recreation: Usually a good to moderate suitability for intensive recreation. Stoniness, surface soil textures and wetness are the main limitations.

Wildlife: Present land use makes the suitability of white-tailed deer, ruffed grouse and for winter range of mule deer poor to moderate.

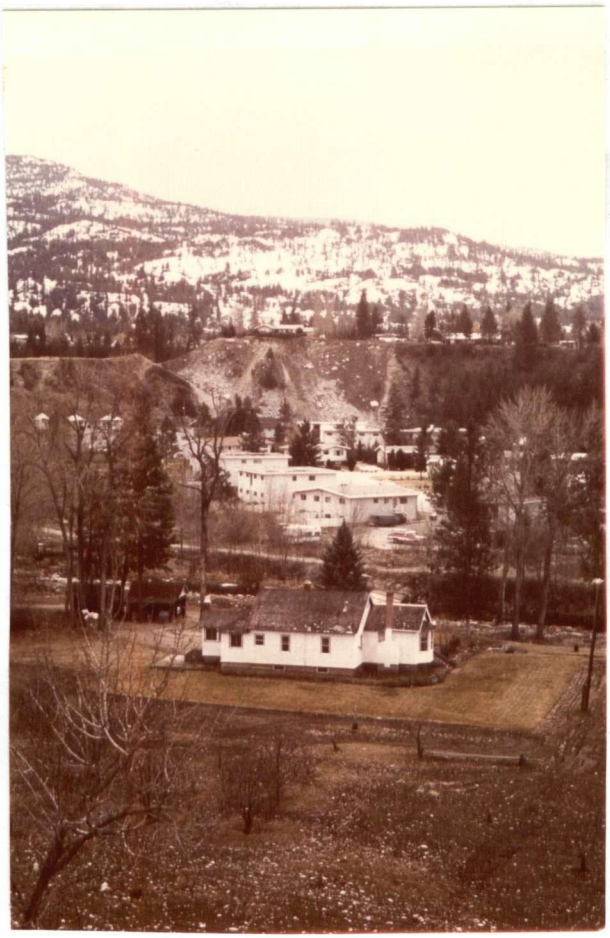

Plate 59

Ry - Roy l.s.

Ci - Carmi l.s.

Sa - Skaha l.s.

The location of plate 59 is shown on plate 58.

SHEEP ROCK LAND SYSTEM

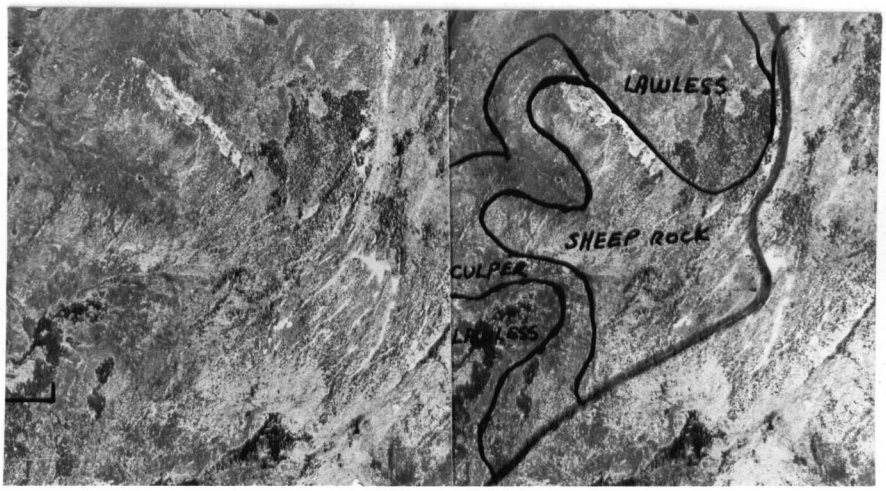

Plate 60

Sheep Rock l.s.

Landform and Materials. The landform consists of a thin mantle of steeply to extremely sloping glacial till and colluvium over high elevation mountain peaks. The materials are dominantly shallow, coarse textured glacial till and colluvium over bedrock. There are significant inclusions of a variety of exposed bedrocks, and deep glacial till and colluvium.

Vegetation. The vegetation is transitional between the subalpine fir -- Engelmann spruce zone and the alpine zone. Lodgepole pine, Engelmann spruce and subalpine fir are present but stunted and widely spaced. The shrub layer is dominated by red and yellow heather. The vegetation is dominantly the subalpine fir -- Engelmann spruce -- red heather habitat type with some alpine vegetation.

Soils. The soils are dominantly Alpine Dystric Brunisols with significant inclusions of Lithic Dystric Brunisols. Soils have a gravelly loamy sand to gravelly sand texture and are well to rapidly drained.

Landscape Features. Elevations are approximately 6,600 to 7,500 feet. Slopes are usually between 20 and 60 percent. This land system is well developed on Brent, Apex and Baldy mountains.

Suitability for.

Engineering and Urban Development: Steep slopes, shallow depths of materials over bedrock, stoniness, potential frost action and the harsh climate provide severe limitations. Engineering activities should be avoided because of the fragile environment.

Recreation: Unsuitable for intensive recreation because of steep slopes, shallow depths of materials over bedrock, a harsh climate and a sensitive environment to disturbance. It is attractive for extensive use.

Wildlife: The suitability for white-tailed ptarmigan is moderate to good. There are inclusions having a moderate suitability for blue grouse.

Plate 61

Sheep Rock l.s.

SKAHA LAND SYSTEM

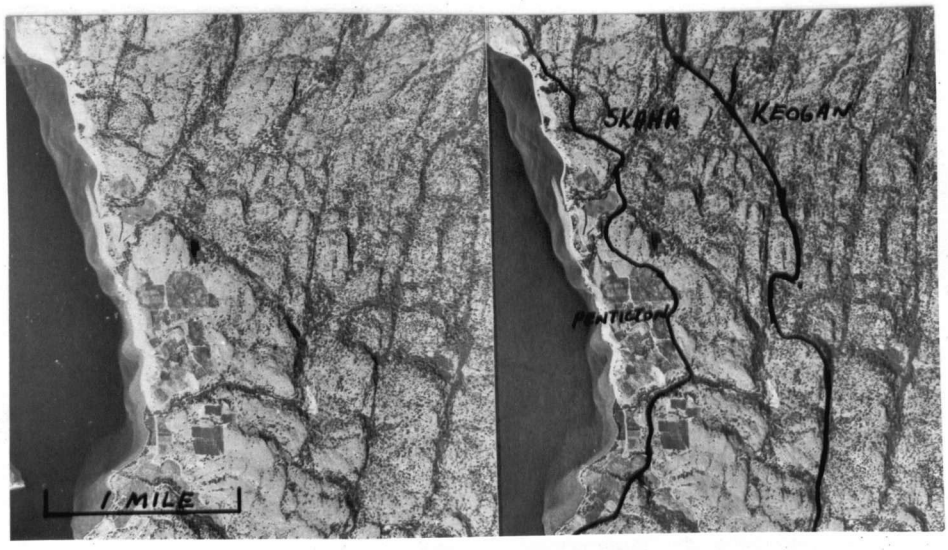

Plate 62

Skaha l.s.

Landform and Materials. The landform consists of a thin mantle of glacial till and colluvium overlying hilly and very hilly valley walls. The materials are dominantly shallow glacial till and colluvium over bedrock. There are significant inclusions of a variety of exposed bedrocks, and minor inclusions of deep glacial till and colluvium.

Vegetation. The vegetation belongs to the big sagebrush zone, ponderosa pine subzone. There is a scattered cover of ponderosa pine and Douglas fir (in gullies). Bluebunch wheatgrass dominates the herb cover. In the gullies are found Saskatoon berry, red-osier dogwood and willow. The vegetation is similar to the ponderosa pine -- Idaho fescue habitat type.

Soils. The soils are dominantly Degraded Eutric Brunisols. There are significant inclusions of Lithic Eutric Brunisols and Orthic Brown Chernozems. Soils have gravelly sandy loam and gravelly loamy sand textures and are rapidly to moderately well drained.

Landscape Features. Elevations are approximately 1,000 to 2,100 feet. Slopes are usually greater than 30 percent. This land system is similar in topography and materials to Inkaneep l.s. (in the south).

Suitability for.

Engineering and Urban Development: The very steep, rugged topography and shallow depths of material over bedrock provide severe engineering limitations.

Recreation: Unsuitable for intensive recreation because of very steep slopes, shallow depths of materials over bedrock and sensitive vegetation to disturbance.

Wildlife: The suitability for white-tailed deer, ruffed grouse and blue grouse is moderate, and for California bighorn sheep and mule deer winter range good and moderate.

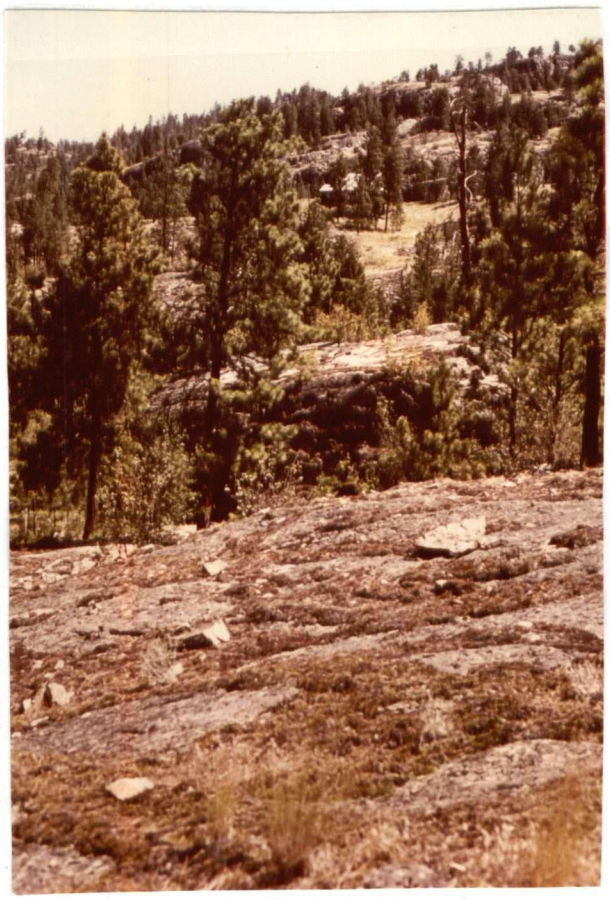

Plate 63

Skaha l.s.

TESTALINDEN LAND SYSTEM

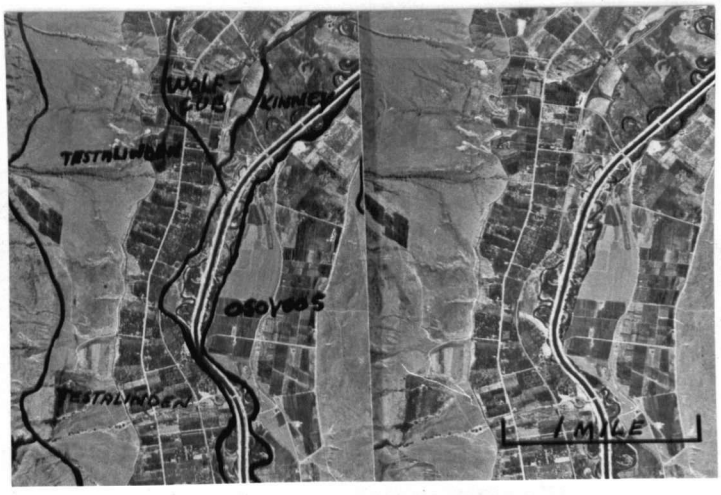

Plate 64

Testalinden l.s.

Landform and Materials. The landform consists of gently to steeply sloping alluvial -- colluvial fans and raised alluvial fans and deltas. The materials are dominantly coarse textured alluvial -- colluvial fan and deltaic deposits with minor inclusions of sandy and gravelly glacial fluvial outwash.

Vegetation. The vegetation belongs to the big sagebrush zone, bunchgrass subzone. There is only a scattered ponderosa pine tree cover. Big sagebrush and bitterbrush dominate the shrub cover, and bluebunch wheatgrass the herb cover. The vegetation was classified as the big sagebrush -- bluebunch wheatgrass habitat type with inclusions of the ponderosa pine -- bitterbrush habitat type (e.g. Vaseux Creek).

Soils. The soils are dominantly Orthic Dark Brown Chernozems, with Orthic Brown Chernozems on finer textured materials. There are minor inclusions of Gleyed Regosols on lower parts of fans. Soil textures are

variable, from gravelly and stony sand and loamy sands to sandy loams at lower parts of fans. Soils are generally rapid to well drained.

Landscape Features. Elevations are approximately 1,000 to 1,700 feet. Slopes are usually between 5 and 30 percent. This land system is similar in topography and materials to Roy l.s. (to the north).

Suitability for.

Engineering and Urban Development: Stoniness, soil drainage and steep slopes provide moderate to severe engineering limitations. Generally the suitability for residential development is moderate. Intensive use of septic tanks will likely lead to ground water pollution.

Recreation: There are severe to moderate limitations for intensive recreation because of stoniness, surface soil textures, steep slopes and soil wetness and a general lack of tree cover.

Wildlife: The suitability for California bighorn sheep and mule deer winter and spring range is moderate.

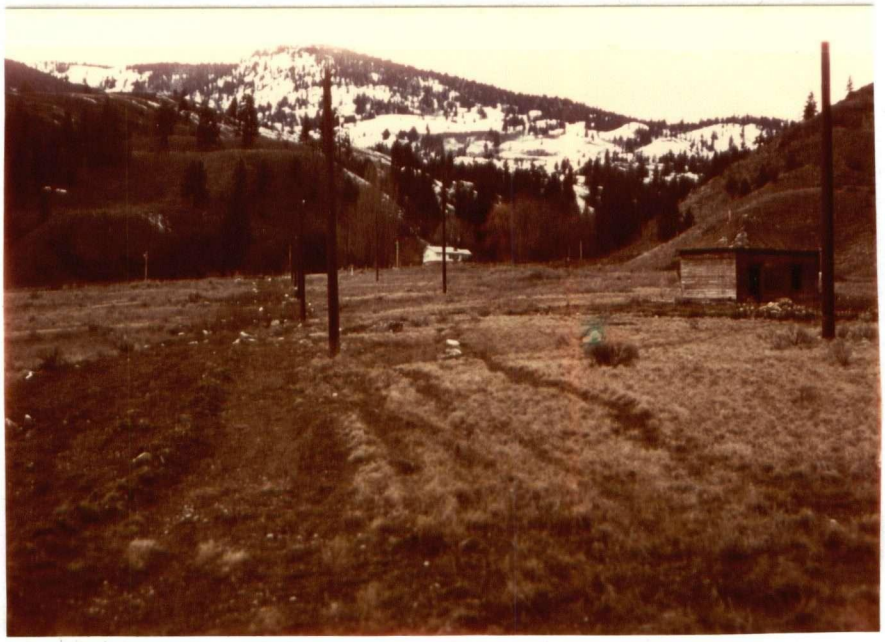

Plate 65

Te - Testalinden l.s.

Ka - Kilpoola l.s.

TROUT LAKE LAND SYSTEM

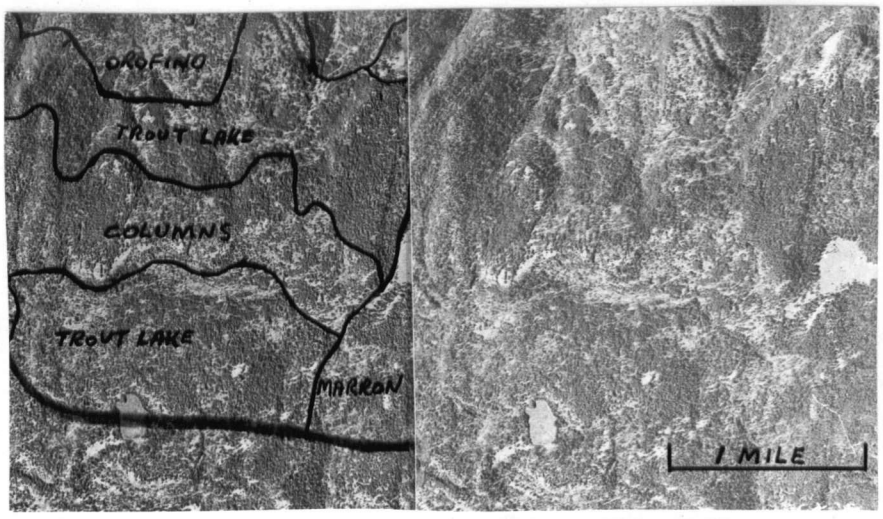

Plate 66

Trout Lake l.s.

Landform and Materials. The landform consists of a mantle of undulating to very steeply sloping glacial till over bedrock. The physiography is controlled by the underlying volcanic bedrock. The materials are dominantly deep, moderately coarse textured glacial till and colluvium. There are significant inclusions of shallow glacial till and colluvium over bedrock.

Vegetation. The vegetation belongs to the subalpine fir -- Engelmann spruce zone. The tree cover is dominated by subalpine fir and Engelmann spruce. Grouseberry dominates the shrub cover and pinegrass the herb cover. The vegetation was classified as the subalpine fir -- Engelmann spruce -- pinegrass habitat type.

Soils. The soils were not well sampled due to general inaccessability. They are thought to be dominantly Brunisolic Gray Luvisols with significant

inclusions of Orthic Gray Luvisols. They have loam to gravelly sandy loam textures and are well to moderately well drained.

Landscape Features. Elevations are approximately 4,200 to 5,500 feet. Slopes are usually between 5 and 45 percent. This land system is similar in topography and materials to Marron l.s. (at lower elevations).

Suitability for.

Engineering and Urban Development: Steep slopes, potential frost action and shallow depths of materials provide moderate engineering limitations. The harsh climate and location will likely preclude residential development.

Recreation: Trout Lake land system is generally severely limited for intensive recreation because of steep slopes, stoniness and dense vegetation. There are inclusions of moderately suitable areas, usually on gentle slopes and deep soils.

Wildlife: The suitability for spruce grouse is good and for blue grouse moderate.

TWIN LAKES LAND SYSTEM

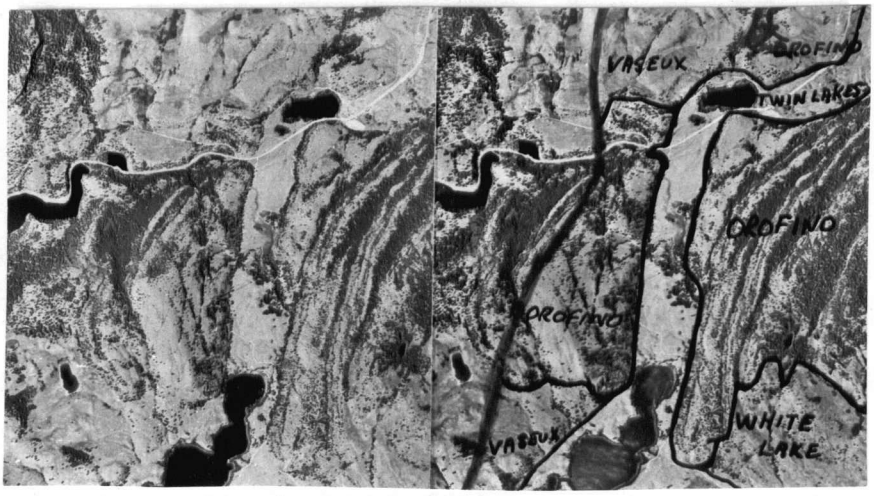

Plate 67

Twin Lakes l.s.

Landform and Materials. The landform consists of gently sloping to extremely sloping glacial fluvial outwash terraces and kettled outwash. The materials are dominantly sandy and gravelly glacial fluvial outwash. There are minor inclusions of ice contact deposits, ponded silts, alluvial and colluvial fans and shallow glacial fluvial outwash over glacial till.

Vegetation. The vegetation consists of mixed grassland and forest in the Douglas fir zone. The tree cover (usually on deep sands) is dominated by ponderosa pine and Douglas fir. Threetip sagebrush dominates the shrub cover and bluebunch wheatgrass and Idaho fescue the herb cover. The vegetation was classified as the threetip sagebrush -- bluebunch wheatgrass and the Douglas fir -- Idaho fescue habitat types.

Soils. The soils are dominantly Orthic Dark Brown Chernozems with significant inclusions of Degraded Eutric Brunisols. Soils have sandy

loam, gravelly sandy loam, gravelly loamy sand and silt loam textures. They are rapidly to well drained.

Landscape Features. Elevations are approximately 2,000 to 3,000 feet. Slopes are highly variable from nearly level to over 60 percent. This land system occurs around Twin Lakes and in the Marron Valley.

Suitability for.

Engineering and Urban Development: There is a large variability in topography and materials. Steep slopes, stoniness and soil textures provide slight to severe limitations for urban development. The use of septic tanks near water bodies should be restricted.

Recreation: The suitability is variable, but there are large areas having few to moderate limitations.

Wildlife: The suitability for white-tailed deer is moderate, and for mule deer winter and spring range generally moderate.

Plate 68

Tn - Twin Lakes l.s.

Oo - Orofino l.s.

VASEUX LAND SYSTEM

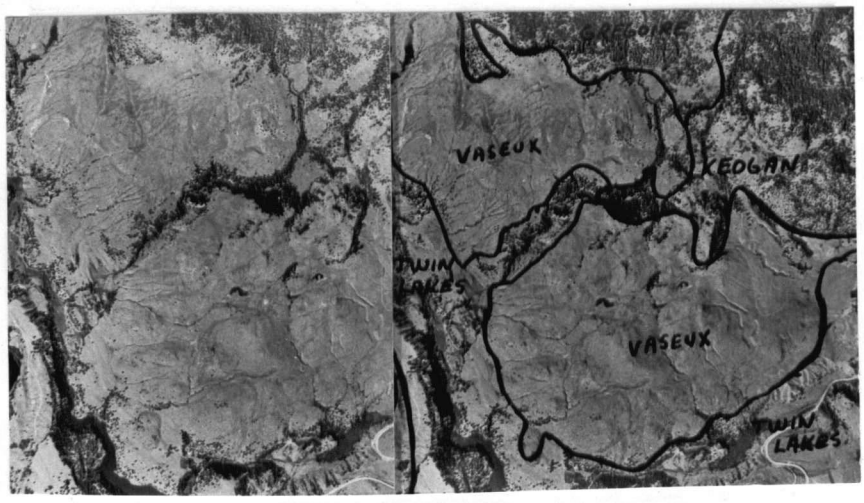

Plate 69

Vaseux l.s.

Landform and Materials. The landform consists of a mantle of glacial till over steeply to extremely sloping south facing valley walls. The materials are dominantly deep, coarse textured glacial till, and colluvium over till. There are significant inclusions of shallow glacial till and colluvium over bedrock, and minor inclusions of a variety of exposed bedrocks.

Vegetation. The vegetation is grassland in the Douglas fir zone. It is dominated by threetip sagebrush (at lower elevations), umbrella plant and by big sagebrush. Idaho fescue and bluebunch wheatgrass dominate the herb cover. The vegetation belongs to the Idaho fescue -- umbrella plant habitat type.

Soils. The soils are dominantly Orthic Dark Brown Chernozems with significant inclusions of Rego Dark Brown Chernozems. Soils usually have a gravelly sandy loam texture and are well drained.

Landscape Features. Elevations are approximately 2,000 to over 5,000 feet. Slopes are usually between 15 and 60 percent. This land system occurs throughout the area on steep south facing slopes with deep glacial till.

Suitability for.

Engineering and Urban Development: Steep and very steep slopes, stoniness and shallow depths of materials over bedrock provide severe to moderate engineering limitations. Vaseux land system is poorly suited for urban development.

Recreation: Generally unsuitable for intensive recreation because of steep slopes, shallow depths of materials over bedrock and a lack of tree cover.

Wildlife: The habitat suitability for white-tailed deer, and for California bighorn sheep and mule deer winter and spring range is moderate to good.

Plate 70

Vx - Vaseux l.s.

Oo - Orofino l.s.

WHITE LAKE LAND SYSTEM

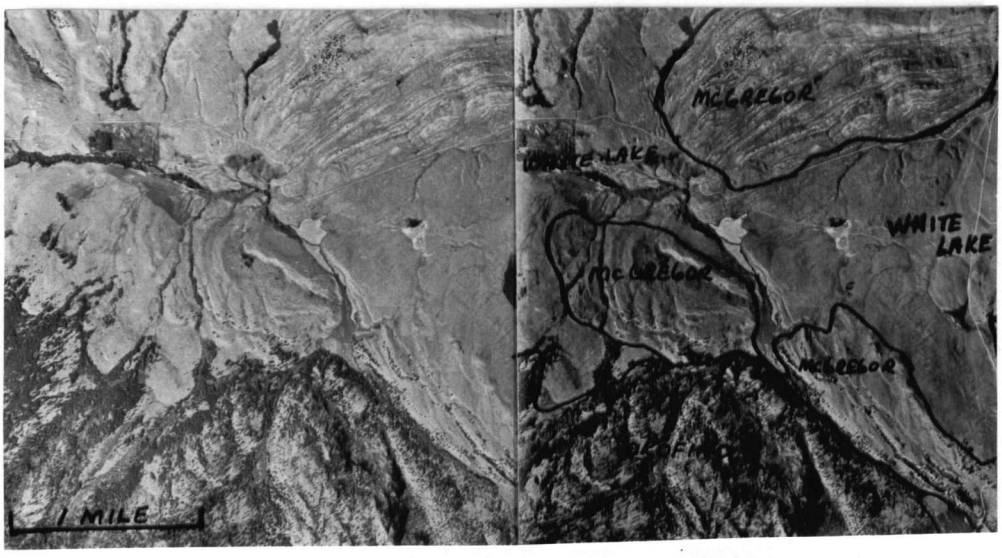

Plate 71

White Lake l.s.

Landform and Materials. The landform consists of a shallow mantle of glacial till and colluvium over strongly to very steeply sloping valley walls. The materials are dominantly shallow, coarse textured glacial till and colluvium over volcanic and sedimentary bedrocks. There are minor inclusions of deep glacial till and colluvium, and glacial fluvial outwash.

Vegetation. The vegetation is grassland in the Douglas fir zone. The shrub layer is dominated by threetip sagebrush and big sagebrush, and the herb cover by bluebunch wheatgrass and Idaho fescue. The vegetation is dominantly the threetip sagebrush -- bluebunch wheatgrass habitat type, with Idaho fescue -- umbrella plant habitat type at higher elevations.

Soils. The soils are dominantly Orthic Dark Brown Chernozems with significant inclusions of Rego Dark Brown Chernozems. Soils have gravelly

sandy loam and gravelly loamy sand textures and are well drained.

Landscape Features. Elevations are approximately 2,000 to 4,500 feet. Slopes are usually between 15 and 45%. This land system occurs around White Lake.

Suitability for.

Engineering and Urban Development. Steep and very steep slopes, shallow depths of materials over bedrock and stoniness provide severe and moderate engineering limitations. The suitability for urban development is generally severe except for the inclusions of glacial fluvial outwash and gently sloping glacial till.

Recreation: Intensive recreation is generally unsuitable because of steep slopes, shallow depths of materials over bedrock and a lack of tree cover. The glacial fluvial outwash materials have a moderate suitability.

Wildlife: The habitat suitability for mule deer winter and spring range and for white-tailed deer and ruffed grouse is moderate to good.

Plate 72

Wl - White Lake l.s.

Oo - Orofino l.s.

The location of plate 72 is shown on plate 71.

WOLFCUB LAND SYSTEM

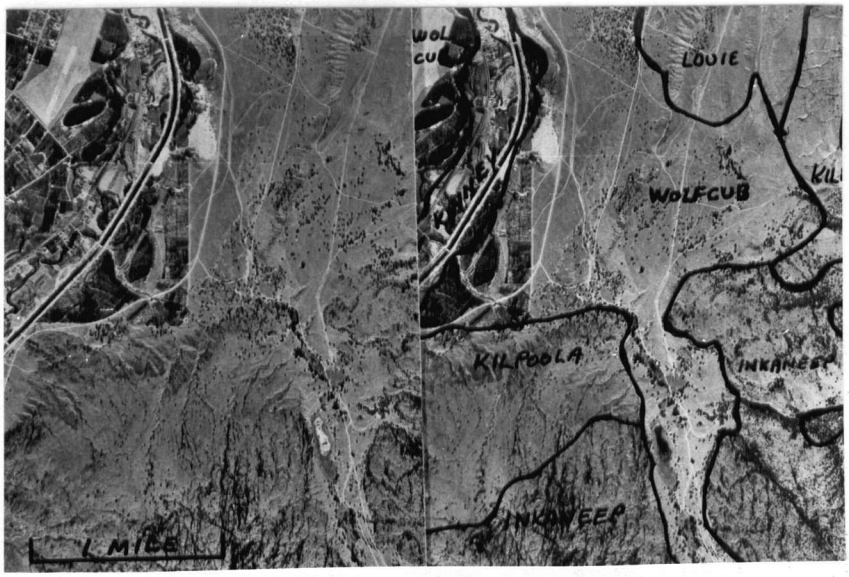

Plate 73

Wolfcub l.s.

Landform and Materials. The landform consists of undulating to strongly rolling glacial fluvial outwash. The outwash is both terraced and kettled and is probably underlain by glaciolacustrine deposits. The materials are dominantly sandy and gravelly glacial fluvial outwash with minor inclusions of alluvial -- colluvial fan deposits.

Vegetation. The vegetation belongs to the big sagebrush zone, ponderosa pine subzone. Ponderosa pine and bitterbrush dominate the tree and shrub-cover respectively. The herb cover is dominated by bluebunch wheatgrass and speargrass.

Soils. The soils are dominantly Orthic Brown Chernozems. There are significant inclusions of Orthic Regosols and minor inclusions of Rego Brown Chernozems. Soil textures vary from sandy loam and gravelly sandy loam to loamy sand and gravelly loamy sand. Soils are rapidly drained.

Landscape Features. Elevations are approximately 1,000 to 1,400 feet. Slopes are usually between 2 and 15 percent. This land system is similar in topography and materials to Osoyoos l.s.

Suitability for.

Engineering and Urban Development: Erosion and duning of sands provide generally moderate to severe engineering limitations. There are generally no major limitations for urban development but the use of septic tanks may lead to ground water pollution. A good source of sand and gravel.

Recreation: Generally severe and moderate limitations for intensive recreation because of surface soil textures (dustiness and erosion), vegetation sensitivity to disturbance and a sparse tree cover.

Wildlife: The suitability for California bighorn sheep and mule deer winter and spring range is moderate.

Plate 74

Wolfcub l.s.

PART II

Introduction

Part I describes the study area, the problems, provides general descriptions of the resources and illustrates the approach used in inventory and data presentation. This section discusses the interpretive guidelines and suitability ratings developed for selected engineering (urban development), recreation and wildlife interpretations.

Interpretive Guidelines and Suitability Ratings for Engineering

Selected engineering interpretations were developed to aid in planning residential developments in the Southern Okanagan Valley. The engineering interpretations discussed include: surface erosion and mass soil movement potentials; limitations for septic tank absorption fields; shallow excavations; dwellings without basements and area type sanitary landfills. General suitabilities as sources of road fill, sand and gravel and topsoil material are also included.

Criteria are established, and ratings made, for the degree of limitation or suitability each land system has for a specific engineering activity. Table II shows the general suitability rating or the limitation rating (with limiting factors) given to each engineering activity.

Three suitability classes are used. They are defined as follows:

None to slight limitation -- a rating of none to slight limitation (good suitability) indicates that if there are limitations they will be generally easy to overcome without special planning or management procedures.

Moderate limitation -- a rating of moderate limitation (moderate suitability) indicates restrictions which generally can be overcome with good planning or management, at a moderate to moderately high expense.

Severe limitation -- a rating of severe limitation (poor suitability) indicates that even with very good planning and management the restrictions will be difficult and expensive to overcome. Areas having severe limitations generally require special and costly procedures to make the land suitable for a specified purpose.

The interpretations provide a useful guide to people such as farmers, contractors, land developers, engineers and planners, regarding the degree and types of restrictions and environmental hazards that can be expected from different engineering uses on each land system. However, to maximize the usefulness of this information the user should become familiar with the section "How to Use the Report."

It is emphasized that because the mapping was done at a reconnaisance level (a scale of 1 mile = 1 inch) inclusions of dissimilar units are to be expected and there may be large variations in soil and other properties within the same land system. The interpretations are not intended to and should *not* be used to replace specific, onsite engineering investigations.

The main source used for establishing limitation ratings was the publication by the Soil Conservation Service, 1971. Other references are provided in the text where appropriate.

Surface Erosion Potential[10]

Soil erosion is the detachment and subsequent transport of soil particles by wind or flowing water. Criteria considered in determining surface erosion potentials include: the potential water infiltration and transmission properties of soils; surface soil stability; slope; and soil compactability.

Surface soil erosion potential is an important consideration in the Okanagan Valley. The dry climate, steep dissected topography and shallow surficial deposits over bedrock make the soils very susceptible to surface erosion when disturbed. Surface soil erosion will decrease site productivity, affect the quality of the fishery and water resources and is aesthetically unattractive.

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[10]The guidelines used are modified from work done by the author and G. Utzig (Graduate Student, Department of Soil Science) on soil erosion in the Chilliwack Valley for Planning 521, U.B.C.

Water Infiltration and Transmission: Water infiltration and transmission properties of soils are important considerations in estimating the potential for surface erosion. Hydrologic soil groups were used to estimate the ability of water to move into and through a soil, and hence the runoff potential [Soil Conservation Service, 1971]. Deep, rapidly drained sands and gravels with high infiltration rates have few restrictions for use. Soils having very slow infiltration rates due to a high clay content, clay pans, high water tables, or shallow depths to an impermeable layer, have severe restrictions for use.

Soil Surface Stability: Soil surface stability is the relative resistance of soil particles to detachment and transport. Surface stability is determined by inherent soil properties such as texture and structure (water stable aggregates), topography and by the protective vegetative cover. Soil surface stability was interpreted largely from soil texture, assuming some vegetation disturbance. Well graded gravels and moderately fine textured loams, because of their coarseness and potential for structure formation respectively, were generally considered to have few limitations. Both coarse textured sands and loamy sands (which lack cohesive properties) and fine textured silts and clays (which lose cohesion on saturation and are susceptible to frost deformation) are considered to have a higher degree of limitation.

Soil Compaction: Soil compaction (the breaking down of soil structure and decreasing soil pores) decreases the infiltration rates of water into soils. Consequently surface runoff and erosion increase. Compaction can be caused by rainfall on bare soil or by trampling the soil surface by foot or machinery. The degree to which a soil is susceptible to compaction depends upon soil texture, structure and the moisture content at the time of disturbance. Very wet or very dry soils are generally more easily compacted [Swanston and Dyrness, 1973]. Coarse textured gravels, sands and sandy loams generally provide few limitations, while moderately fine textured loams and silts have an increased limitation.

Slope: Slope is one of the most important determinants of surface erosion potential. With undisturbed vegetation most soils will be porous enough to have little surface runoff, even on steep slopes. However, with soil compaction the infiltration capacity is decreased and the drainage pattern interrupted. As a result, steeper slopes have an increased surface erosion potential. Slopes less than 5 percent are thought to have generally few slope limitations while slopes greater than 30 percent generally have a greater degree of limitation.

Table II shows the degree of limitation of each land system for potential surface erosion.

Mass Soil Movement Potential[11]

Mass soil movement is movement of soil material by the force of gravity. Criteria considered in determining mass soil movement potentials include: slope; shear strength; depth to impermeable layer; bedrock type; and potential frost action. A special erosion feature in the study area, the Penticton silts, are discussed.

Mass soil movement potential ratings can be used as a guide for planning land use activities and identifying environmental hazards throughout the study area (e.g. buildings, roads, pipelines, timber harvesting and recreation developments). Where care is not taken to prevent losses of soil material, erosion will result in lower site productivity, damage to roads, houses and other improvements, deteriorate the quality of the fishery and water resources, and affect public safety.

The potential for mass movement depends upon the balance between gravitational stress and sliding resistance. Gravitational stress is the downslope force acting on the soil. It is controlled by the weight of the soil mass and the gradient of the sliding surface. Sliding resistance refers to the sum of forces counteracting gravitational stress -- i.e. soil cohesion, and frictional resistance between soil particles, between the soil mass and the sliding surface

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[11] The guidelines used are modified from work done by the author and G. Utzig (Graduate Student, Department of Soil Science) on soil erosion in the Chilliwack Valley, for Planning 521, U.B.C.

and by external support (i.e. tree roots). Frictional resistance is dependent upon the nature of the soil particles and on the moisture content of the soil. (Saturated soils have reduced frictional resistance due to their tendency to "float" with high water pressure in soil pores and because cohesion is reduced with high soil water content).

Slope: The angle of slope plays a major role in determining soil stability. Steep slopes combined with high soil moisture content are common to most mass movements of soil on forest land [Swanston and Dyrness, 1973]. As the angle of slope increases, the gravitational stress on the soil mass increases. At the same time the frictional resistance between the soil mass and the sliding surface decreases giving the soil a higher potential for mass wasting. Slopes less than 30 percent generally have few slope limitations for use while slopes greater than 60 percent have a greater degree of limitation.

Shear Strength: Shear strength is the resistance of a soil to movement. It measures the components of frictional resistance and strength due to cohesion. Relative shear strengths are estimated from soil textural groupings based on measurements of saturated soils [Canada Department of Agriculture, 1958]. Coarse textured gravels, sands, loamy sands and sandy loams have high saturated shear strengths. Fine textured silts and clays have low shear strengths. The latter provide greater limitations at high moisture contents.

Depth to Impermeable Layer: Soils shallow to bedrock or with an impermeable layer become saturated more quickly than deeper soils. When saturated these soils tend to "float" above the sliding surface owing to the pressure of water in the pores [Swanston, 1970]. This decrease in the soils effective weight lessens the frictional resistance of the soil body and increases the potential for mass wasting. Soils greater than 5 feet in thickness generally have few (thickness) limitations. Soils less than 3 feet in thickness have a greater potential for saturation and therefore a higher degree of limitation.

Bedrock Type: Bedrock has both a direct and indirect influence on the potential stability of an area. Bedrock directly affects soil stability by offering zones of weakness which can act as failure mechanisms (e.g. joint or bedding planes parallel to the slope). Large areas of exposed bedrock may increase stability by acting as a stable block (i.e. by breaking up the soil continuum and providing external support to the soil). The indirect influence exerted by bedrock is through soil properties as well as by providing an impermeable layer. Some soil properties which reflect the bedrock from which they were derived include weatherability, texture and drainage.

Coarse textured acidic bedrocks such as granites and gneiss, which are very hard and resistant to weathering even when exposed, are thought to contribute little to mass wasting potential. Units containing greater than 50 percent exposed bedrock were also considered to have few limitations due to external support. Finer textured and basic bedrocks, which generally weather more easily, and highly

jointed bedrock or bedrock with bedding planes parallel to the slope are considered to have a higher limitation.

Frost Action: When soils are exposed through vegetation disturbance the potential for surficial frost action is greatly increased. Frost action results from the formation of ice lenses at the soil surface. Ice lenses result from a slowly moving freezing front which is supplied with moisture from the soil. With the formation of ice lenses soil particles are loosened and are then susceptible to erosion by wind, water or gravity. Fine textured loams and silts are rated as having a severe limitation for frost action, due to their capability to deliver water for ice lense formation. Coarse textured sands and gravels generally have few limitations.

Special Erosion: A critical erosion problem occurs in the Penticton land system (Plates 75 and 76). This land system includes what are known as the Penticton silts, a glaciolacustrine deposit which occurs around the southern end of Okanagan Lake to Skaha Lake. The silts are highly erodable materials characterized by steep sided gullies and frequent sinkholes [Wright and Kelly, 1959]. Erosion appears to be the result of two processes: boring of water into the silts when it continually strikes the same point (resulting in tunneling and the consequent sinkholes as material falls into the tunnel); and soil saturation, producing a sudden collapse of the silt structure (causing steep gully walls), [Wright and Kelly, 1959].

Plate 75 Penticton land system. Note the attempts to cover the sinkhole forming at the head of the gully.

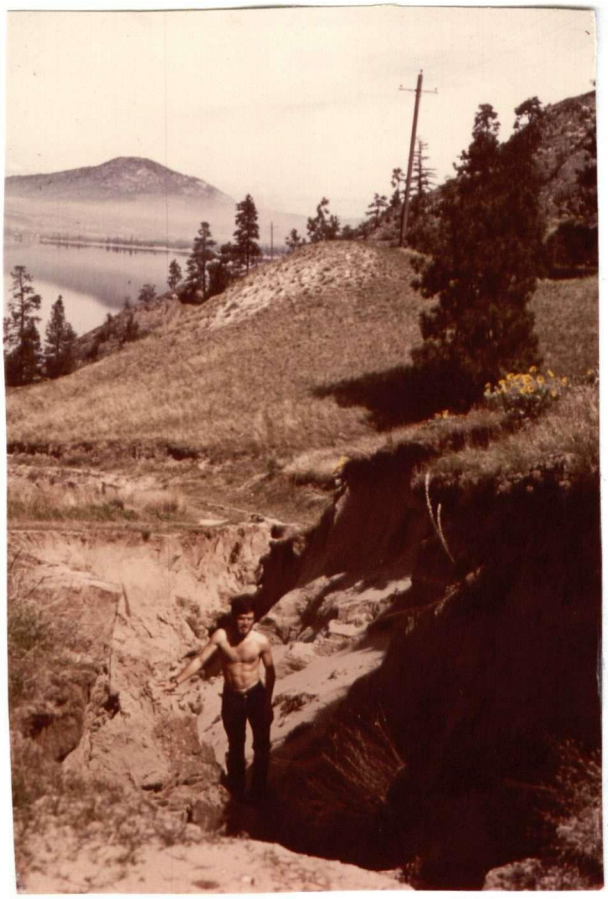

Plate 76 Penticton land system. This photograph shows soil erosion of lacustrine fine sands along a power line access road.

Land use activities planned for this land system should include measures to protect the vegetation cover and prevent excess soil moisture or runoff which will greatly accelerate natural erosion processes. General erosion hazard ratings are available for these silt deposits [Runka, 1971].

Table II shows the degree of limitation for each land system due to potential mass soil movement.

Septic Tank Absorption Fields

A septic tank absorption field is a sewage disposal system which distributes effluent through subsurface tiles into the soil. The effluent is purified, under suitable soil conditions, by processes of absorption, filtration and micro-biological decomposition. Criteria considered in determining the degree of limitation of the land systems for septic tank absorption fields include: soil permeability; depth to water table; flooding; depth to impermeable layer; slope; stoniness; and phosphorus fixation.

Soil suitability for septic tank use is an important consideration for two reasons. Firstly, septic tanks will probably continue to be used in rural areas having a small population. They are presently the most economical means of domestic sewage disposal. Secondly, septic tanks, particularly near lakes and streams,are a significant source of phosphorus to the main valley lakes. They contribute to the general water quality problem in the Okanagan Valley [Consultative Board, 1973].

To maintain good water quality standards new septic tanks must be located on suitable soils and constructed to standards that prevent ground water pollution.[12]

Soil Permeability: Soil permeability is the ease with which gases, liquids or plant roots penetrate a mass or layer of soil. Slowly permeable to impermeable soils, having slow soil absorption of sewage effluent, will be severely limited for septic tank use. Soils having rapid to moderately rapid permeabilities generally provide few limitations for effluent absorption. Important exceptions are coarse textured sands, gravels, stones and fractured bedrock where very rapid permeabilities can contribute to ground water pollution. Soil permeabilities and their limitations for septic tank absorption fields were interpreted from criteria in Bouma et al. [1972], and Canada Department of Agriculture [1958].

Flooding: Flooding and seasonal high water tables interfere with the filtration and absorption processes of sewage effluent. Soils with a seasonal water table within 4 feet of the surface, or areas subject to flooding, generally should not be considered for use of septic tanks owing to potential ground water pollution.

Depth to Impermeable Layer: Shallow soils over an impermeable layer (e.g. bedrock) afford difficult construction and

[12]The Consultative Board of the Canada-British Columbia Water Basin Agreement recommend, "That all new septic tank installations be constructed to standards that ensure 80 percent phosphorus removal where soil conditions are such that special measures are required to control nutrients from this source."

maintenance problems for septic tank use. Soils with an impermeable layer within 5 feet of the soil surface were considered to have a severe limitation.

Slope: Steep slopes increase construction costs and maintenance problems for septic tank filter fields. Lateral seepage of effluent can become a particularly difficult problem on steeper slopes. Slopes greater than 15 percent were considered to have a severe limitation.

Stoniness: Stony soils are generally unsuited for septic tank use. They impose high construction costs and also have a high potential for ground water pollution (i.e. poor filtration and absorption of effluent due to large pores, small total surface area, low cation exchange capacity, etc.).

Phosphorus Fixation: Phosphorus fixation is the process whereby soluble phosphorus is made insoluble by chemical or biological attraction to the soil particles. Factors considered in estimating the relative limitations soils have for phosphorus fixation were: soil pH; organic matter content; the presence of calcium carbonate, iron, aluminum and manganese; and the proximity of the soil to a water source. In general a soil pH between 6 and 7 is considered to have the greatest limitation for phosphorus fixation [Buckman and Brady, 1972]. An increasing content of calcium carbonate at higher pH's and iron, aluminum and manganese at lower pH's, results in an increase in phosphorus fixation.

Table II shows the degree of limitation of each land system for septic tank absorption fields.

Shallow Excavations

Shallow excavations refer to excavating or trenching the soil to a depth of about 5 feet. Criteria considered in determining the degree of limitation of land systems for shallow excavations include: soil drainage; seasonal water table; flooding; soil texture; depth to bedrock; stoniness; degree of compaction; and slope.

The interpretations developed provide a general guide to the degree of limitation expected when excavating soils in the different land systems. When planning land uses such as cemeteries, utility lines and pipelines, additional information should be collected (e.g. shrink-swell potentials and corrosivity).

The guidelines used in determining limitation rating are discussed briefly. Those wishing more detail should consult the Soil Conservation Service [1971].

Drainage, Water Table, Flooding: Soils having poor drainage, a high seasonal water table (less than 30" from the surface) or subject to flooding, were considered to have a severe limitation.

Texture: Organic soils and loose, uncompacted sands and gravels which have little resistance to sloughing were considered to have a severe limitation.

Stoniness, Depth to Bedrock: Very stony and shallow soils (less than 40 inches over bedrock) are difficult to excavate. They are considered to have a severe limitation.

Compaction: Very compact tills (basal tills) which are difficult to excavate, were considered to have a severe limitation.

Slope: Steep slopes not only make the use of excavation equipment difficult but also increase soil instability and erosion. Slopes greater than 15 percent were considered to have a severe limitation.

Table II shows the degree of limitation of each land system for shallow excavations.

Dwelling Without Basements

The degree of limitation of land systems for dwellings without basements is based on soil requirements for construction of single family dwellings or similar structures. The interpretations do not apply to buildings with a foundation load in excess of three stories. In determining the degree of limitation of land systems for dwellings without basements consideration was given to soil factors affecting: foundation support (bearing capacity and settlement under load); ease of excavation; and the installation of utility lines.

Foundation Support: Foundation support depends on soil features such as density, wetness, flooding, plasticity, texture, shrink-swell potentials, bearing capacity and settlement under load. With the exception of flooding and wetness, these factors were not considered to be severely limiting in the area due to the coarse textures of the soils. Soil wetness and flooding are severely limiting along the Okanagan River and along main valley lakes (e.g. Osoyoos Lake).

Ease of Excavation: Factors affecting the ease of excavation include: soil wetness; slope; depth to bedrock; and stoniness. Soils having poor drainage, a seasonal water table within 20 inches of the surface, slopes greater than 15 percent, or which are very stony, were considered to have a severe limitation.

Utility Lines: Soils less than twenty inches in thickness over bedrock were considered to be severely limiting for the installation of utility lines.

Table II shows the degree of limitation of each land system for dwellings without basements.

Area Type Sanitary Landfill

Area type sanitary landfill refers to waste disposal by depositing successive layers of refuse over soil material. Criteria considered in determining the degree of limitation of land systems for area type sanitary landfill include: soil permeability; drainage;

depth to seasonal water table; flooding; texture; thickness of material; stoniness; and slope.

The interpretations that have been made are based primarily on the top 5 feet of soil. For this reason and because of the potential for pollution of ground water supplies due to leachates, onsite geologic investigations are required.

Permeability, Drainage, Depth to Water Table, Flooding: Soil permeability, drainage, depth to seasonal water table and flooding are of primary concern because they affect potential contamination of ground water. Soils having very rapid permeabilities, poor drainage, a seasonal water table within 5 feet of the surface, or soils subject to flooding, were considered to have a severe limitation.

Texture, Thickness of Material, Stoniness, Slope: Soil properties of texture, thickness of material, stoniness and slope were considered because they affect soil workability.

Table II shows the degree of limitation of each land system for area type sanitary landfill.

Road Fill

The general suitability of soil materials in each land system to provide a source of road fill material is discussed. Suitability ratings are based on characteristics of the top 5 feet of soil. They reflect how well a soil should perform after it is placed in a shallow

road embankment (generally less than 6 feet high). The ratings are applicable only to local and secondary roads, not freeways.

Criteria considered in determining the suitability of land systems for road fill material include: soil texture; shrink-swell potential; susceptibility to frost action; drainage; stoniness; depth to bedrock; and slope.

Texture, Shrink-Swell Potential, Frost: Soil texture, shrink-swell potential and susceptibility to frost action are factors which affect soil performance when placed in road embankments. Due to the coarse textures of the soils in the study area (except for the silt loams and silty clay loams of the Penticton land system) these factors were not considered to be severely limiting.

Depth to Bedrock, Drainage, Flooding, Stoniness, Slope: Depth to bedrock, drainage, flooding, stoniness and slope, primarily concern the ease with which soil material can be removed. Soils that are shallow to bedrock (less than 5 feet), poorly drained, subject to flooding, very stony, or have slopes greater than 15 percent were considered to have a poor suitability.

Table II shows the suitability of each land system as a source of road fill material.

Sand and Gravel

The general suitability of soils in each land system to provide a potential source of sand and gravel for different types of construc-

tion work is discussed. Ratings are based on the probability that soils contain sizeable quantities of sand or gravel. Sand and gravel were grouped together because of their variability in composition throughout the study area.

To qualify as a good or fair probable source the deposit must be at least 3 feet thick (although not entirely in the upper 5 feet of soil). Deep sands and gravels, either well or poorly graded, were considered to have a good suitability.

Poorly suited sources include soils having moderately fine textures and soils that are dominantly shallow to bedrock. Unsuited sources include soils having fine textures and coarse textured colluvial deposits which would be highly erodable if disturbed.

Table II shows the suitability of each land system as a source of sand and gravel.

Topsoil

The general suitability of soils in each land system to provide a quality source of topsoil for re-establishment or maintenance of vegetation is discussed. Suitability ratings are based on a topsoil depth of 8 inches. As a result of the shallow profile development of soils in the study area the term topsoil usually includes the surface soil (A horizon) and some of the subsoil (B horizon).

In making suitability ratings consideration was given to the ease of excavation, the degree of expected damage resulting from topsoil removal, and to some biological and chemical properties of soils.

Ease of Excavation: The ease of excavation is affected by slope, texture, wetness, and thickness of the soil material. Soils with slopes greater than 15 percent, coarse textures (gravels or sands), poorly drained, and soils shallow to bedrock, were considered to be poorly suited.

Expected Damage: Where removal of topsoil is expected to cause severe damage by resulting in revegetation or erosion problems, the land systems were rated as being poorly suited. The dry climate which characterizes lower elevations in the study area, results in slow soil formation and slow revegetation following disturbances. Hence many lower elevation sites will have a high potential for damage with topsoil removal.

Chemical and Biological Properties: Chemical and biological properties of soil affect the quality of topsoil. The amount of organic matter, soluble salts, and soil pH were considered for topsoil quality.

Table II shows the suitability of each land system as a source of topsoil.

TABLE II

Suitability Ratings and Limiting Factors for Selected Engineering Activities

Land System and Map Symbol	Unified Soil Classification System	Degree and Kinds of Limitations For:						Suitability as a Source of:		
		Surface Erosion Potential	Mass Soil Movement Potential	Septic Tank Absorption Fields (Intensive Use)	Shallow Excavations	Dwellings Without Basements	Area Type Sanitary Landfill	Road Fill	Sand and Gravel	Topsoil
Allendale Ae	SW and GW	Severe: surface stability; moderate to slight on gravels	Slight . .	Moderate: permeability	Severe: texture	Slight . .	Severe: permeability	Good	Good	Poor
Anarchist At	SM and GM	Severe: water transmission; slope	Moderate and severe: slope; depth to impermeable	Severe: slope; shallow to bedrock	Severe: slope; shallow to bedrock	Severe: slope	Severe: slope; thickness of material	Poor	Poor	Poor
Apex Ax	SM, SW and GW	Severe: slope	Severe: slope	Severe: slope; stoniness shallow to bedrock	Severe: slope; shallow to bedrock; stoniness	Severe: slope	Severe: slope	Poor	Unsuited	Poor
Beaverdell Bl	SW and GW	Moderate: surface stability; severe with coarse sands to surface	Slight . .	Moderate: permeability	Severe: texture	Slight. .	Moderate: permeability; stoniness	Good	Good	Poor
Bluff Bf	SM	Moderate and severe: surface stability; slope; water infiltration and transmission	Moderate: slope; slight on slopes less than 30%	Severe: slope; underlying till may form impervious barrier; slopes less than 8% moderate	Severe and moderate: slope; stoniness	Severe: slope	Moderate and severe: slope; stoniness	Good to Poor	Fair	Poor
Carmi Ci	GP and SP	Slight: with coarse sands to surface severe	Slight . .	Moderate: permeability; severe on gravelly and stony materials and steeper slopes	Severe: texture; stoniness	Slight to moderate: stoniness slopes greater than 8% moderate to severe	Severe and moderate: permeability stoniness	Good	Good	Poor
Columns Cs	SM	Severe: water transmission; slope	Severe and moderate: slope; depth to impermeable; bedrock type	Severe: slope; shallow to bedrock; exposed bedrock	Severe: slope; shallow to bedrock	Severe: slope; depth to bedrock	Severe: slope; thickness of material	Poor	Poor	Poor
Culper Cr	SM and GM	Severe: water transmission; slope	Moderate: slope; depth to impermeable; slopes greater than 60% severe	Severe: slope; shallow to bedrock; exposed bedrock	Severe: slope; shallow to bedrock	Severe: slope; depth to bedrock	Severe: slope; thickness of material	Poor	Poor	Poor

Table II (continued)

Land System and Map Symbol	Unified Soil Classification System	Degree and Kinds of Limitations For: Surface Erosion Potential	Mass Soil Movement Potential	Septic Tank Absorption Fields (Intensive Use)	Shallow Excavations	Dwellings Without Basements	Area Type Sanitary Landfill	Suitability as a Source of: Road Fill	Sand and Gravel	Topsoil
Grenoire Gc	SW-SM	Moderate: surface stability; water transmission; slopes greater than 30% severe	Slight.. slopes greater than 30% moderate	Severe: slopes; moderate on slopes less than 15%	Severe and moderate: slope; stoniness	Moderate and severe: slope	Moderate and severe: slope; stoniness	Fair	Poor	Poor
Hestor Hr	SW and GW	Severe: slope	Severe: slope	Severe: slope; stoniness; shallow to bedrock	Severe: slope; shallow to bedrock; stoniness	Severe: slope	Severe: slope	Poor	Unsuited	Poor
Inkaneep Ip	SM and GM	Severe: water transmission; slope	Severe and moderate: slope; depth to impermeable	Severe: slope; shallow to bedrock; exposed bedrock	Severe: slope; shallow to bedrock	Severe: slope; depth to bedrock	Severe: slope; thickness of materials	Poor	Poor	Poor
Keogan Kn	SM	Severe: water transmission; slope	Moderate: slope; depth to impermeable; slopes greater than 60% severe	Severe: slope; shallow to bedrock; exposed bedrock	Severe: slope; shallow to bedrock	Severe: slope; depth to bedrock	Severe: slope; thickness of materials	Poor	Poor	Poor
Kilpoola Ka	SM and GM	Moderate and severe: water transmission; slope	Moderate and slight: slope; depth to impermeable	Severe: slope; shallow to bedrock	Severe and moderate: slope; shallow to bedrock; stoniness	Severe: slope; slopes less than 15% moderate	Moderate and severe: stoniness; slope; thickness of material	Fair	Poor	Poor
Kinney Ky	ML	Severe and moderate: water transmission; compactability; surface stability	Moderate: potential frost action	Severe: flooding; water table; permeability	Severe: drainage; water table; flooding	Severe: drainage; water table; flooding	Severe: water table; drainage; flooding	Poor	Unsuited	Poor
Kobau Ku	SM	Severe and moderate: water transmission; slope	Moderate: slope; depth to impermeable; frost action	Severe: slope; shallow to bedrock	Severe: slope; shallow to bedrock	Severe: slope; depth to bedrock; frost action	Severe: slope; thickness of material	Poor	Poor	Fair
Kruger Kr	SW-SM	Severe: water transmission; slope	Moderate: slope; depth to impermeable	Severe: slope; shallow to bedrock	Severe: slope; shallow to bedrock	Severe: slope	Severe: slope; thickness of material	Poor	Poor	Poor
Lawless La	SM	Moderate: water transmission; slope; slopes greater than 30% severe	Moderate: (variable) slope;	Severe: slope; slopes less than 15% moderate	Severe and moderate: slope; stoniness	Severe: slope; slopes less than 15% moderate	Severe and moderate: slope; stoniness	Fair	Poor	Poor

Table II (continued)

Land System and Map Symbol	Unified Soil Classif-ication System	Degree and Kinds of Limitations For: Surface Erosion Potential	Mass Soil Movement Potential	Septic Tank Absorption Fields (Intensive Use)	Shallow Excavations	Dwellings Without Basements	Area Type Sanitary Landfill	Suitability as a Source of: Road Fill	Sand and Gravel	Topsoil
Louie Le	GP and SP	Slight: deep coarse sands and slopes greater than 30% severe	Slight: slopes greater than 30% moderate	Severe: stoniness; on deep sands moderate	Severe: texture; stoniness	Moderate: (variabld stoniness slope	Severe and moderate: permeability; stoniness	Good	Good	Poor
Manuel Ml	SM and GM	Severe: slope	Severe: slope	Severe: slope; shallow to bedrock; stoniness	Severe: slope; shallow to bedrock; stoniness	Severe: slope	Severe: slope	Poor	Unsuited	Poor
Marron Ma	SM	Severe and moderate: slope; water trans-mission	Moderate and severe: slope; shear strength; bedrock type	Severe and moderate: slope; depth to bedrock	Severe and moderate: slope; shallow to bedrock	Severe and moderate; slope; shrink-swell	Severe and moderate: slope; thickness of material	Fair	Unsuited	Poor
McGregor Mg	SW-SM	Severe: slope; water trans-mission	Moderate: slope; depth to imper-meable	Severe: slope; shallow to bedrock; exposed bedrock	Severe: slope; shallow to bedrock	Severe: slope; depth to bedrock	Severe: slope; thickness of material	Poor	Poor	Poor
McIntyre Mc	SW-SM and GW	Severe: slope; surface stability	Severe and moderate: slope	Severe: slope; shallow to bedrock; stoniness	Severe: slope; shallow to bedrock; stoniness	Severe: slope	Severe: slope	Poor	Unsuited	Poor
McKinney My	SW-SM and SM	Moderate: water trans-mission; slope; slopes greater than 30% severe	Moderate and slight: slope	Severe: slope; slopes less than 15% moderate	Severe and moderate: slope; stoniness	Severe and moderate: slope; stonin-ess	Severe and moderate: slope; stoniness	Fair and Poor	Poor	Poor
Munson Mn	SM and GM	Severe: slope	Moderate: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Poor	Poor	Poor
Myers Mm	ML and SM	Severe: water trans-mission; surface stability; compac-tability	Moderate: front action	Severe: water table; permea-bility	Severe: drainage; water table	Severe: water table; frost action	Severe: seasonal water table; drainage	Poor	Unsuited	Poor
Orofino Oo	SM	Severe: water trans-mission; slope	Severe and moderate: slope; depth to imper-meable; bedrock type	Severe: slope; shallow to bedrock; exposed bedrock	Severe: slope; shallow to bedrock	Severe: slope; depth to bedrock	Severe: slope; thickness of material	Poor	Poor	Poor

Table II (continued)

Land System and Map Symbol	Unified Soil Classification System	Degree and Kinds of Limitations For: Surface Erosion Potential	Mass Soil Movement Potential	Septic Tank Absorption Fields (Intensive Use)	Shallow Excavations	Dwellings Without Basements	Area Type Sanitary Landfill	Suitability as a Source of: Road Fill	Sand and Gravel	Topsoil
Osoyoos Os	SW and SM	Severe: surface stability	Slight . .	Moderate and severe: permeability; phosphorus fixation; slope	Severe: texture	Slight . .	Moderate and severe: permeability	Good	Good	Poor
Park Hill Pr	SW and SM	Severe: surface stability	Slight . .	Moderate: permeability; phosphorus fixation	Severe: texture	Slight . .	Moderate: permeability	Good	Good	Poor
Penticton Pn	ML	Severe: surface stability; compactability	Severe: shear strength; frost action; sink holes	Moderate: permeability; slopes greater than 15% severe	Slight: slopes greater than 15% severe	Moderate: shrink-swell potential; frost action; slopes greater than 15% severe	Slight: slopes greater than 8% moderate to severe	Poor	Unsuited	Good and Fair
Richter Rr	GW, SW and SM	Severe: slope	Severe: slope	Severe: slope; shallow to bedrock; stoniness	Severe: slope; shallow to bedrock; stoniness	Severe: slope	Severe: slope	Poor	Unsuited	Poor
Roy Ry	GW, GM, SM and ML	Slight to severe: water transmission; compactability	Slight . .	Severe: stoniness; water table; permeability; phosphorus fixation	Severe: texture; drainage; water table	Moderate: drainage; stoniness	Severe: permeability; stoniness; drainage	Good and Fair	Good to Poor	Poor
Sheep Rock Sr	GP and GM	Severe: water transmission; slope	Moderate and severe: slope; depth to impermeable; frost action	Severe: slope; stoniness; shallow to bedrock; exposed bedrock	Severe: slope; shallow to bedrock	Severe: slope	Severe: slope; thickness of materials	Poor	Poor	Poor
Skaha Sa	SM	Severe: water transmission; slope	Moderate and severe: slope; depth to impermeable	Severe: slope; shallow to bedrock; exposed bedrock	Severe: slope; shallow to bedrock	Severe: slope; depth to bedrock	Severe: slope; thickness of material	Poor	Poor	Poor
Testalinden Te	GW and GM	Slight and moderate: slope; surface stability	Slight . .	Severe: stoniness; slope; water table; permeability; phosphorus fixation	Severe: texture; drainage; water table	Moderate and severe: stoniness slope; drainage	Severe: permeability; drainage; stoniness	Good	Fair	Poor

Table II (continued)

Land System and Map Symbol	Unified Soil Classification System	Degree and Kinds of Limitations For:						Suitability as a Source of:		
		Surface Erosion Potential	Mass Soil Movement Potential	Septic Tank Absorption Fields (Intensive Use)	Shallow Excavations	Dwellings Without Basements	Area Type Sanitary Landfill	Road Fill	Sand and Gravel	Topsoil
Trout Lake Tl	ML	Moderate: water transmission; slope; slopes greater than 30% severe	Moderate and severe: slope; shear strength; bedrock type; frost action	Moderate and severe: slope; permeability; shallow to bedrock	Moderate and severe: slope; shallow to bedrock; stoniness	Severe and moderate: slope; shrink-swell potential; frost action	Severe and moderate: slope; stoniness	Fair	Not Suited	Poor
Twin Lakes Tn	SP, GP, and SM	Slight to severe: slope; surface stability	Slight to severe: slope	Moderate: permeability; phosphorus fixation; slope	Severe: texture; slope	Slight to severe: slope; stoniness	Moderate to severe: slope; permeability	Good and Fair	Good	Fair and Poor
Vaseux Vx	GM, SW-SM, and SM	Severe and moderate: slope; water transmission	Moderate: slope	Severe: slope; shallow to bedrock	Severe: slope	Severe: slope	Severe: slope	Poor and Fair	Poor	Poor
White Lake Wl	GM, SW-SM, and SM	Severe and moderate: slope; water transmission; surface stability	Moderate and slight: slope; depth to impermeable	Severe: slope; shallow to bedrock; moderate on outwash	Severe and moderate: slope; shallow to bedrock; texture	Severe and moderate: slope; stoniness	Severe and moderate: slope; thickness of materials; permeability	Poor to Good	Fair	Poor
Wolfcub Wb	SW, GW and SM	Severe: surface stability	Slight . .	Moderate and severe: permeability; phosphorus fixation	Severe: texture	Slight . .	Moderate and severe: permeability	Good	Good	Poor

Interpretive Guidelines and Suitability Ratings for Recreation

Selected recreation interpretations are developed for land systems in the Southern Okanagan Valley. The recreation uses considered are: campgrounds; picnic areas; play areas; horseback riding; and paths and trails. Canada Land Inventory capability ratings for recreation are also discussed.[13]

Recreation is a major component of the lifestyle and economy of the Southern Okanagan Valley. The number of tourists who annually visit the Okanagan region is around 700,000, and is expected to increase to between 1.8 and 2.3 million within the next 50 years [Consultative Board, 1973]. The Southern Okanagan at present, "captures the largest share of the tourist trade . . . and perhaps experiences the biggest problems associated with over-use of municipal facilities during the summer months," [O'Riordan, 1973].

To satisfy present and future demands for recreational opportunities and to obtain a base for recreation planning, a land assessment of recreational potentials should be undertaken.[14] This assessment is required to make full use of, and to be compatable with, environmental conditions. It should indicate how the natural environment is a major factor in development, maintenance, and improvement of

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[13]The ratings were interpreted from the Land Capability for Recreation map, Environment and Land Use Committee Secretariat, 1968.

[14]An inventory of natural attractions or recreational features should also be undertaken to complement studies on physical and biological limitations for recreation use.

recreational facilities. Without this type of assessment the total cost of construction and maintenance of facilities will be higher, potential environmental hazards may not be avoided (e.g. mass soil erosion, flooding, etc.), and full use will not be made of the environmental attributes. Environmental deterioration will also increase as a result of the use of unsuited sites for activities which are not physically compatible.

In this section an attempt is made to assess the degree of limitation or suitability of each land system for selected recreational activities.[15] This provides a foundation on which to build recreational plans [Densmore and Dahlstrand, 1965]. Criteria are established, and ratings made, for the degree of limitation or suitability each land system has for a recreation activity. Table III shows the general suitability or limitation ratings(with the limiting factors),given for each recreation activity.

Three suitability classes are used. They are defined as follows:

None to slight limitations -- a rating of none to slight (good suitability)indicates that if there are limitations they will be generally easy to overcome without special planning or management procedures.

Moderate limitation -- a rating of moderate (moderate suitability) indicates that the limitations identified can generally be overcome with good planning, design or management at a moderate to moderately high cost.

[15]Water based recreation has been studied for the Canada-British Columbia Okanagan Basin Agreement [Collins, 1973].

Severe limitation -- a rating of severe (poor suitability) indicates that even with good planning and management the limitations will be difficult to overcome. Areas with severe limitations generally are unsuitable, or require special and costly procedures to make them suitable for a specified recreation use.

The criteria used for establishing suitability ratings have been developed from a number of sources. They include: Hawes and Brière, 1974; Brocke, 1970; Cressman and Hoffman, 1968; Montgomery and Edminster, 1966; and Wisconsin Bureau of Recreation, 1968. Specific references are also provided in the text where appropriate.

Campgrounds

The criteria established for determining the suitability of land systems for campgrounds are discussed. The criteria were developed for intensive use (i.e. at least 30 units) with improvements such as camping pads, picnic tables, water and sewage facilities and access roads.

In determining suitability ratings consideration was given to: wetness; flooding; permeability; slope; surface soil texture; coarse fragment content; stoniness; depth to bedrock; and vegetation.

Wetness: Wet soils are usually restricted in their length and season of use. They are unattractive due to muddiness and because of soil compaction and erosion problems. They will also limit the use of wells and on-site sewage disposal due to the potential for surface and ground water pollution.

Soil wetness was inferred from soil drainage properties. Rapidly to moderately well drained soils (which are not wet for long periods of the year) have few limitations.[16] Poorly drained and very poorly drained soils (which have water at or near the surface for a large part of the year) have greater limitations.

Flooding: Flooding severely limits the suitability of an area for campground use. Permanent structures such as buildings, tables, roads, and camp pads are damaged by flooding. The use of wells and on-site sewage disposal is also limited due to potential ground and surface water pollution.

Areas subject to frequent flooding (inferred from soil morphology and vegetation) were considered to be severely limited for campground use.

Permeability: Permeability is the ability of soil to transmit water and air. Soils with a high clay content have slow permeabilities often resulting in wet and sticky soils for prolonged

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[16]For an explanation of these terms see, "The System of Soil Classification for Canada," 1970.

periods. Sands and gravels have rapid permeabilities which provide few wetness limitations.

Slope: The angle of slope is a major limiting factor for campgrounds. As the angle of slope increases the costs for construction and maintenance of campsites also increases. Soil erosion problems associated with use will also be greater on steeper slopes (e.g. paths and trails).

Slopes less than 9 percent generally provide few slope limitations, while slopes greater than 15 percent were considered to be severely limiting.

Surface Soil Texture: Surface soil texture can be used to infer properties of soil permeability and cohesion. Permeability, the ability of liquids and gases to move through the soil, is directly related to soil texture. Cohesion, or the ability of soil to stick together, is the primary factor affecting surface stability. Soils high in clay have slow permeabilities, resulting in wet and sticky soils. On the other hand sandy soils are highly permeable, but lack cohesion when dry, making them very erodable and dusty. Gravels which are permeable, and loams which are permeable with good cohesive properties, generally provide few textural limitations. Sands, clays and silty clays, have a greater degree of limitation.

Coarse Fragment Content: As the coarse fragment content increases (i.e. fragments between 3 mm and 10 inches in size) the costs for site preparation and installation of camping facilities also increase. In addition a high coarse fragment content makes the maintenance of paths and trails more difficult because fine particles necessary to bind fragments are lacking.

A coarse fragment content less than 15 percent generally provides few limitations for use. Soils with more than a 50 percent coarse fragment content have significant limitations.

Stoniness: Stoniness refers to the relative proportion of stones over 10 inches in diameter in or on the soil. As the content of stones increase the costs for site preparation and installation of facilities also increase. In addition, stony soils are generally inconvenient to the user.

Soils that were exceedingly or excessively stony were considered to have a severe limitation for use.[17]

Depth to Bedrock: Soils that are shallow to bedrock (less than 5 feet) require greater site preparation for intensive campsite use. Soil drainage may be a problem, particularly if on-site sewage disposal is considered. Establishment and maintenance

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[17]For the explanation of these terms see, "The System of Soil Classification for Canada," 1970.

of vegetation is also generally more difficult due to decreased water holding capacity of the soil.

Vegetation Considerations: A review of the literature provides little information about criteria that might be used to evaluate the different types of vegetation in the study area for recreational activities. Although it is difficult to make generalizations owing to the lack of basic studies, three vegetative factors were considered. These were: the relative resistance of vegetation to disturbance; the ability to recover following disturbances; and general attractiveness.

(a) Resistance of vegetation to disturbance. Ground cover vegetation helps not only to maintain the aesthetic attractiveness of an area but it also plays a significant role in preventing soil erosion and dust problems. Ground cover provides the most important methods of erosion prevention and control [Stevens, 1966].

To prevent soil trampling and erosion a large percentage of tall shrubs and grasses is desirable. Tall shrubs, which are both difficult to trample and restrict wandering, tend to be relatively tolerant to recreational pressures. Shrubs with a low stature are more susceptible to trampling and breakage. A thick cover of perennial grasses (e.g. pinegrass *Calamagrostis rubescens* and Idaho fescue *Festuca idahoensis*) also protects the soil surface from disturbance.

(b) Ability to recover from disturbances. Some vegetation associations are extremely slow to recover from disturbances caused by recreational activities. These associations are usually either in very dry [Beardsley and Wagar, 1971] or cold climates. The big sagebrush (*Artemisia tridentata*), ponderosa pine and alpine zones generally have slow to very slow recovery rates following disturbances [McLean and Tisdale, 1972; Willard and Marr, 1971]. The Douglas fir and subalpine fir zones generally have moderate to good rates of recovery.

(c) Attractiveness. The considerations used in assessing the attractiveness of vegetation for recreational activities were: the presence of tree cover; density of vegetation; and the variety of species present.

Tree cover is an important requirement for many activities (e.g. camping and picnic sites). It provides both shade and a sense of "privacy."

Density of vegetation also affects the general attractiveness of an area for use. Very dense vegetation (e.g. stagnant Lodgepole pine *Pinus contorta* stands) tend to restrict movement, the potential for viewing and the amount and variety of ground cover.

Areas having a large variety of species are more attractive for aesthetic appreciation and nature studies. Another important consideration is the period of flowering.

For example, areas having a large variety of species which flower over a short time period (alpine and upper timberline regions) are particularly attractive for viewing (but are extremely sensitive to disturbance).

Table III shows the degree of limitation of each land system for campground use.

Picnic Areas

The criteria established for determining the suitability of land systems for picnic areas are discussed. The criteria were developed for relatively intensive picnic use (i.e. at least 30 units) with improvements such as access roads, parking lots, tables and sewage facilities.

In determining suitability ratings consideration was given to: slope; flooding; surface soil texture; coarse fragment content; wetness; compactability; and vegetation. With the exception of compactability and vegetation, the criteria used to assess suitabilities for picnic areas have virtually the same limitations as those used to assess campgrounds.[18] Those wishing more detailed information on the criteria should consult the appropriate heading in the campground section.

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[18]However for less intensive use, areas subject to flooding are often adaptable for picnic areas during the summer months.

Soil Compaction: When soils are compacted there is a breakdown of soil structure and a decrease in soil porosity.[19] As a consequence infiltration rates of soils are decreased, thereby increasing the potential for surface runoff and erosion.

To estimate soil compactibility, soil texture was used. Coarse textured gravels, sands and sandy loams, with their relatively large sized particles, provide few limitations. Moderately fine textured loams and silts, which have large amounts of fine and coarse particles, have greater limitations.

Vegetation Considerations: Picnic areas will probably be concentrated along water bodies (i.e. lakes, rivers and streams).

The riparian vegetation found along these water bodies is luxuriant compared to the typical plant associations occurring in the area. In general, riparian vegetation has a high rate of growth and well developed layers (i.e. trees, shrubs and herbs). As a result of both the high growth rate and the vegetation composition (especially the shrubs), these sites are comparatively resistant to disturbance. Following disturbance by recreational activities these sites should be able to recover relatively well, providing severe soil erosion did not occur.

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[19]Soil compaction is discussed more fully under "Surface Soil Erosion," in the section "Interpretive Guidelines and Suitability Ratings for Engineering."

Consideration should be given to attractiveness of the vegetation. In particular, tree cover is desirable to provide shade. The density of vegetation should also be considered. Very dense vegetation (e.g. some Engelmann spruce *Picea engelmannii* stands) will be generally unattractive for use if movement in the area is restricted (and can be unattractive because they provide shelter for insects such as mosquitoes).

Table III shows the degree of limitation of each land system for picnic areas.

Playing Fields

Criteria were established for determining the suitability of land systems for playing fields. The criteria are based on the assumptions that the sites are at least two acres in size and will be used for organized activities such as playgrounds and athletic fields. Special consideration was given to the valley bottoms, for playing fields will probably be associated with either large campgrounds or urban areas.

Playing fields are subject to heavy foot traffic. They require level surfaces which are well drained and free from any obstructions (such as stones). The surface soil texture should provide a firm surface. The soil should also be able to support the growth of grasses.

In determining suitability ratings consideration was given to: surface soil texture; permeability; wetness; flooding; depth to

bedrock; stoniness; slope and the ability of soil to sustain a vegetative cover. Except for slope and vegetation,the criteria used to assess suitabilities for playing fields are virtually the same as those used to assess campgrounds. Those wishing more information should refer to the appropriate heading in the campground section.

Slope: Perhaps the most limiting factor for playing fields is slope. Slopes less than 2 percent generally provide few limitations for use. Slopes greater than 9 percent are severely limiting.

Vegetation Considerations: Vegetation growth is usually required on all areas not surfaced. Consideration was given to the soil conditions which will affect the establishment or maintenance of grasses -- specifically, soluble salt content, pH, and organic matter in the soil.

Table III shows the degree of limitation of each land system for playing fields.

Horseback Riding

Criteria were established for determining the suitability of land systems for horseback riding. The criteria are designed for use of areas as they occur in nature, i.e. without major cuts and fills for trail construction. Two assumptions were made: firstly, that natural vegetative cover is present; and secondly that the trail design fits the landscape (to minimize environmental impacts).

Horseback riding is particularly hard on soil and vegetation. The hoofs of horses compact the soil and break down its structure. They also dig up the soil surface, especially when galloping. This destroys the ground vegetation cover and loosens the surface soil, making it highly susceptible to water and wind erosion.

In determining suitability ratings consideration was given to: the surface soil erosion potential; drainage; slope; stoniness; and vegetation.

Surface Erosion Potential: The surface erosion potential ratings (engineering section) were used to determine the general trafficability of each land system. Consideration was given to the potential water infiltration and transmission properties of soils, surface soil stability, slope, and soil compactability.

In general, soils on gentle slopes with a sandy loam to loam texture were considered to have the most suitable characteristics for horseback riding.

Drainage: Soil compaction and erosion is potentially more serious on poorly drained soils. Soil having poor and very poor drainage were considered to be severely limited for use in horseback riding if site deterioration is to be avoided.[20]

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[20]For an explanation of the terms see, "The System of Soil Classification for Canada," 1970.

Slope: Slopes should be generally less than 15 percent for horseback riding [Southeastern Wisconsin Regional Planning Commission Land Use - Transportation Study, 1966]. However, trails for horseback riding, as with hiking trails, can be designed to follow contours and other landscape features. For this reason slopes less than 30 percent were generally considered to provide few limitations for use. Slopes greater than 60 percent were considered to be severely limiting.

Stoniness: Stony and very stony soils increase the costs for trail construction and maintenance. In addition, these soils are generally inconvenient for horseback riding. The guidelines used for stoniness follow those developed in the section on campgrounds.

Vegetation Considerations: Consideration should be given to the density of vegetation, its sensitivity to disturbance and ability to recover from disturbances.

Dense vegetation (as is common in subalpine fir, [*Abies lasiocarpa*] and Engelmann spruce forests) requires a larger effort (expense) to clear a trail wide and high enough for horseback riding. Dense vegetative is also less desirable because it tends to restrict viewing.

Due to the high potential for soil erosion by horseback riding, the relative resistance of vegetation to disturbance and its ability to recover following disturbances should be considered. Alpine, dry sagebrush and ponderosa pine regions have a high potential to sustain

severe vegetation damage due to horseback riding (particularly on sand and loamy sand soils).

Table III shows the degree of limitation of each land system for horseback riding.

Paths and Trails

Criteria were established for determining the suitability of land systems for paths and trails. The criteria are designed for areas to be used as they occur in nature. Two assumptions were made. Firstly, that natural vegetation cover is present. Secondly, that the trail design fits the landscape. This means that on steeper slopes different trail designs are required to minimize environmental impacts (e.g. make trails narrower, use switch backs, etc.).

Selection of suitable sites or routes for paths and trails is dependent on many factors, both physical and biological. In planning trails, "the location is the most important feature in a park trail. If it is made interesting by running through scenic areas and by points of interests, the trail will be popular even though its construction is poor. Conversely, a well constructed trail is unsatisfactory if it does not give the hiker a feeling of being close to nature," [British Columbia Provincial Parks Branch, 1972].

In determining suitability ratings, consideration was given to: surface soil texture; permeability; wetness; flooding; slope; coarse fragment content; aspect; and vegetation. Except for slope, aspect and vegetation, the criteria used to assess suitabilities for

paths and trails are virtually the same as those used for campgrounds. For more detail the user should consult the appropriate heading in the campground section.

Slope: The angle of slope considered suitable for intensive use of paths and trails is 15 percent or less. However, because paths and trails are narrow and can be designed to follow contours, slopes less than 30 percent were generally considered to provide few limitations for use. Slopes greater than 70 percent were considered to be severely limiting (but you can still cross these areas on the contour).

Aspect: Aspect, or exposure to the sun, is an important consideration in trail location. South and west facing slopes are generally drier, warmer, have more open vegetative cover and a better viewing opportunity than north and easterly aspects. In general, southerly aspects will be important for use at mid and high elevations because of their warmer temperatures and longer season of use.

Vegetation: Probably the most important consideration for vegetation is its attractiveness. Trails should be located so as to traverse a wide variety of plant communities. Variety in vegetation cover will make the trail more attractive than a trail located in essentially homogeneous vegetation.

The relative resistance to and ability to recover from disturbances should also be considered. Intensive trail use in alpine and dry sagebrush areas creates a potential for severe vegetation

damage which may require a long period of time to recover to its previous condition.

Table III shows the degree of limitation of each land system for paths and trails.

TABLE III

Suitability Ratings and Limiting Factors for Selected Recreation Activities

Land System and Map Symbol	Degree and Kind of Limitations For: Campgrounds (Intensive use)	Picnic Areas (Intensive use)	Playing Fields	Horseback Riding	Paths and Trails	C.L.I. Recreation Ratings and Other Comments
Allendale Ae	Severe and moderate: surface soil texture; vegetation attractiveness	Severe and moderate: surface soil texture; vegetation attractiveness	Severe: surface soil texture; slope	Severe: surface erosion potential; vegetation density	Severe and moderate: surface soil texture; vegetation attractiveness	C.L.I. class 6; topographic patterns and vegetation features
Anarchist At	Severe: slope; depth to bedrock	Severe: slope	Severe: slope; depth to bedrock	Severe: surface erosion potential; slope	Moderate: slope; vegetation attractiveness	C.L.I. classes 6 and 5; topographic patterns and vegetation features
Apex Ax	Severe: slope	Severe: slope	Severe: slope	Severe: surface erosion potential; slope	Severe: slope; aspect; vegetation attractiveness	C.L.I. class dominantly 6; inclusion of 2 and 3; vegetation, viewing, topographic patterns and skiing features
Beaverdell Bl	Moderate and severe: surface soil texture; vegetation attractiveness	Moderate and severe: surface soil texture; vegetation attractiveness	Severe and moderate: surface soil texture; slope	Moderate and severe: surface erosion potential; vegetation density; and susceptibility to disturbance	Moderate and severe: surface soil texture; vegetation attractiveness	C.L.I. class dominantly 5; topographic patterns, vegetation and some upland wildlife features
Bluff Bf	Severe and moderate: slope; stoniness; coarse fragment content	Moderate and severe: slope; stoniness	Severe: slope; stoniness	Moderate to severe: surface erosion potential; stoniness; vegetation sensitivity to disturbance	Slight	C.L.I. classes 3, 4,5; upland wildlife, topographic patterns, vegetation, viewing, wetland wildlife, cultural landscape patterns and organized camping
Carmi Ci	Moderate and severe: surface soil texture; slope; coarse fragment content; vegetation attractiveness	Moderate and severe: vegetation attractiveness; surface soil texture; stoniness; slope; vegetation sensitivity	Severe and moderate: surface soil texture; slope; stoniness	Moderate and severe: surface erosion potential; vegetation sensitivity to, and ability to recover from disturbances	Moderate and severe: surface soil texture; stoniness; vegetation sensitivity to and ability to recover from disturbances	C.L.I. class 5; topographic and cultural landscape patterns, historic sites, landforms and small surface water features
Columns Cs	Severe: slope; depth to bedrock	Severe: slope	Severe: slope; depth to bedrock	Severe: surface erosion potential; vegetation density; slope	Moderate: slope; vegetation attractiveness	C.L.I. class 5; topographic patterns and vegetation features
Culper Cr	Severe: slope; depth to bedrock	Severe: slope	Severe: slope; depth to bedrock	Severe: surface erosion potential; slope	Moderate: slope; vegetation attractiveness	C.L.I. class 6; dominantly topographic patterns and vegetation features

Table III (continued)

Land System and Map Symbol	Degree and Kind of Limitations For: Campgrounds (Intensive use)	Picnic Areas (Intensive use)	Playing Fields	Horseback Riding	Paths and Trails	C.L.I. Recreation Ratings and Other Comments
Gregoire Ge	Moderate and severe: slope; coarse fragment content; (minor inclusions of slight limitations)	Moderate and severe: slope; vegetation attractiveness; (minor inclusions of slight limitations)	Severe: slope; stoniness	Moderate: surface erosion potential; vegetation density	Slight	C.L.I. class dominantly 5; topographic patterns and vegetation features
Hestor Hr	Severe: slope	Severe: slope	Severe: slope	Severe: surface erosion potential; slope	Severe: slope	C.L.I. class 5; topographic patterns and vegetation features
Inkaneep Ip	Severe: slope; depth to bedrock; sensitivity of vegetation to, and ability to recover from disturbances	Severe: slope	Severe: slope; depth to bedrock	Severe: surface erosion potential; slope; vegetation sensitivity to, and ability to recover from disturbances	Severe: slope; vegetation sensitivity to, and ability to recover from disturbances	C.L.I. class dominantly 4; inclusions of 3 and 5; topographic patterns, vegetation and viewing features
Keogan Kn	Severe: slope; depth to bedrock	Severe: slope	Severe: slope; depth to bedrock	Severe: surface erosion potential; slope; vegetation sensitivity to disturbance	Severe and moderate: slope	C.L.I. class dominantly 5; inclusion of 3, upland wildlife, topographic patterns, vegetation and viewing features
Kilpoola Ka	Severe: slope; vegetation attractiveness (lack of tree cover); depth to bedrock	Severe and moderate: slope; vegetation attractiveness and sensitivity to disturbance	Severe: slope; depth to bedrock; stoniness	Moderate and severe: surface erosion potential; vegetation sensitivity to and ability to recover from disturbance	Moderate: vegetation sensitivity to, and ability to recover from disturbances	C.L.I. class dominantly 4; topographic patterns, vegetation and viewing features
Kinney Ky	Severe and moderate: wetness; flooding; surface soil texture	Severe and moderate: wetness; flooding; surface soil texture	Severe and moderate: wetness; flooding; surface soil texture; permeability	Severe and moderate: surface erosion potential; drainage; vegetation density	Moderate and severe: wetness; flooding; surface soil texture	C.L.I. classes 4, 3,2, and 5; wetland wildlife, cultural landscape patterns, organized camping, angling and historic features
Kobau Ku	Severe: slope; depth to bedrock; vegetation attractiveness	Moderate and severe: slope	Severe: slope; depth to bedrock	Moderate and severe: surface erosion potential; slope	Slight and moderate: slope	C.L.I. classes 4 and 5; vegetation, topographic patterns, viewing and special man made features
Kruger Kr	Severe: slope; depth to bedrock	Severe: slope	Severe: slope; depth to bedrock; stoniness	Severe: surface erosion potential; slope; vegetation sensitivity to disturbance	Severe and moderate: slope; coarse fragment content	C.L.I. class 4; topographic patterns, vegetation and viewing features
Lawless Ls	Severe: slope; vegetation attractiveness (density of vegetation)	Severe and moderate: slope; vegetation attractiveness	Severe: slope; stoniness	Severe: vegetation density; surface erosion potential	Moderate: vegetation attractiveness; slope	C.L.I. class dominantly 6; topographic patterns and vegetation features; inclusions of 3, with viewing and skiing features

Table III (continued)

Land System and Map Symbol	Degree and Kind of Limitations For: Campgrounds (Intensive use)	Picnic Areas (Intensive use)	Playing Fields	Horseback Riding	Paths and Trails	C.L.I. Recreation Ratings and Other Comments
Louie Le	Severe: surface soil texture; stoniness; vegetation sensitivity and general lack of tree cover	Severe: surface soil textures; stoniness; vegetation sensitivity and general lack of tree cover	Severe and moderate: surface soil texture; slope; stoniness	Moderate and severe: vegetation sensitivity to, and ability to recover from disturbances; surface erosion potential; stoniness	Moderate and severe: stoniness; surface soil texture; vegetation sensitivity	C.L.I. classes 3 and 4; vegetation, topographic patterns, viewing and wildlife features
Manuel Ml	Severe: slope	Severe: slope	Severe: slope	Severe: surface erosion potential; slope	Severe: slope; aspect	C.L.I. classes 5 and 6; vegetation, topographic pattern features
Marron Ma	Severe and moderate: slope; depth to bedrock	Severe and moderate: slope	Severe: slope; depth to bedrock	Severe and moderate: surface erosion potential	Moderate and slight: slope	C.L.I. class dominantly 5; vegetation and topographic pattern features
McGregor Mg	Severe: slope; depth to bedrock	Severe: slope	Severe: slope; depth to bedrock	Severe: surface erosion potential; slope	Severe: slope; stoniness; vegetation sensitivity to disturbance	C.L.I. class 4; viewing, vegetation and rock formation features
McIntyre Mc	Severe: slope	Severe: slope	Severe: slope	Severe: surface erosion potential; slope	Severe and moderate: slope; surface soil texture	C.L.I. classes 5 and 6; viewing, landforms, small surface waters, vegetation and topographic pattern features
McKinney My	Severe and moderate: vegetation attractiveness; slope; coarse fragment content	Moderate and severe: slope; vegetation attractiveness	Severe: slope; stoniness	Severe and moderate: vegetation density; surface erosion potential	Moderate and slight: vegetation attractiveness; slope; coarse fragment content	C.L.I. classes 6 and 5; vegetation and topographic pattern features
Munson Mn	Severe: slope	Severe: slope	Severe: slope	Severe: surface erosion potential; slope	Severe and moderate: slope	C.L.I. class dominantly 5; topographic patterns, vegetation and viewing features
Myers Ms	Severe and moderate: wetness; surface soil texture	Severe and moderate: surface soil texture; wetness; compactability	Severe and moderate: wetness; surface soil texture	Severe: surface erosion potential; drainage	Severe and moderate: wetness; surface soil texture	C.L.I. class 4; topographic patterns, vegetation, viewing and historical features
Orofino Oo	Severe: slope; depth to bedrock	Severe: slope	Severe: slope; depth to bedrock	Severe: surface erosion potential; slope	Severe and moderate: slope; stoniness	C.L.I. class dominantly 5; topographic patterns, vegetation and viewing features

Table III (continued)

Land System and Map Symbol	Degree and Kind of Limitations For: Campgrounds (Intensive use)	Picnic Areas (Intensive use)	Playing Fields	Horseback Riding	Paths and Trails	C.L.I. Recreation Ratings and Other Comments
Osoyoos Os	Severe: surface soil textures; vegetation attractiveness (lack of tree covers); vegetation sensitivity to and ability to recover from disturbances	Severe: surface soil textures; vegetation attractiveness, and sensitivity to, and ability to recover from disturbances	Severe: surface soil textures; slope	Severe: surface erosion potential; vegetation sensitivity to, and ability to recover from disturbances	Severe: surface soil textures; vegetation sensitivity to, and ability to recover from disturbances	C.L.I. classes 4, 3 and 2; angling, beach, organized camping, vegetation, viewing, topographic patterns, cultural landscape patterns, and historical features
Park Rill Pr	Severe: surface soil texture; vegetation sensitivity to disturbances	Severe and moderate: surface soil texture; vegetation attractiveness and sensitivity to disturbances	Severe and moderate: surface soil texture	Severe: surface erosion potential; vegetation sensitivity to, and ability to recover from disturbances	Severe and moderate: surface soil texture; vegetation sensitivity to and ability to recover from disturbances	C.L.I. classes 4 and 5; topographic patterns, vegetation and viewing features
Penticton Pn	Severe: vegetation attractiveness (lack of tree cover) and sensitivity to disturbance; surface soil texture	Severe and moderate: compactability; surface soil texture; vegetation attractiveness, and sensitivity to disturbances	Severe to slight: slope; surface soil texture; (moderate to slight on fine sandy loams)	Severe: surface erosion potential; vegetation sensitivity to, and ability to recover from disturbances	Moderate: surface soil textures; slope; vegetation sensitivity to disturbances	C.L.I. classes 5, 3 and 4; cultural landscape patterns, topographic patterns, historical, viewing and beach features
Richter Rr	Severe: slope	Severe: slope	Severe: slope	Severe: surface erosion potential; slope	Severe and moderate: slope; surface soil texture; coarse fragment content	C.L.I. classes 5 and 6; topographic patterns and vegetation features
Roy Ry	Slight to severe: (highly variable) stoniness; wetness; surface soil texture	Slight to severe: (highly variable) stoniness; surface soil texture; wetness	Moderate and severe: surface soil texture; stoniness; wetness	Moderate and severe: surface erosion potential; drainage; stoniness	Moderate and slight: stoniness; surface soil texture; wetness	C.L.I. class dominantly 5; cultural landscape patterns, topographical patterns and historical features
Sheep Rock Sr	Severe: slope; depth to bedrock; sensitivity of vegetation to, and ability to recover from disturbances	Moderate and severe: slope; vegetation sensitivity to, and an ability to recover from disturbances	Severe: slope; depth to bedrock	Severe: surface erosion potential; vegetation sensitivity to, and ability to recover from disturbances	Severe and moderate: vegetation sensitivity to, and ability to recover from disturbances; slope; coarse fragment content	C.L.I. classes 5, 2 and 6; viewing, topographic patterns, vegetation and skiing features
Skaha Sa	Severe: slope; depth to bedrock	Severe: slope	Severe: slope	Severe: surface erosion potential; slope; vegetation sensitivity to, and ability to recover from disturbances	Severe: slope; vegetation sensitivity to, and ability to recover from disturbances	C.L.I. classes 5, 4 and 3; topographic patterns, viewing, vegetation and wildlife features

Table III (continued)

Land System and Map Symbol	Degree and Kind of Limitations For: Campgrounds (Intensive use)	Picnic Areas (Intensive use)	Playing Fields	Horseback Riding	Paths and Trails	C.L.I. Recreation Ratings and Other Comments
Testalinden Te	Severe and moderate: stoniness; coarse fragment content; surface soil texture; slope; vegetation attractiveness	Severe and moderate: stoniness; surface soil texture; slope; vegetation attractiveness	Severe and moderate: surface soil texture; stoniness; slope; wetness	Moderate and severe: wetness; stoniness; surface erosion potential; vegetation sensitivity to disturbances	Moderate and slight: stoniness; surface soil texture; wetness	C.L.I. class 4; cultural landscape patterns, viewing and organized camping features
Trout Lake Te	Severe and moderate: slope; vegetation attractiveness	Severe and moderate: slope; vegetation attractiveness	Severe: slope; stoniness	Severe and moderate: vegetation density; surface erosion potential	Moderate: vegetation attractiveness; slope	C.L.I. class 5; topographic patterns and vegetation features
Twin Lakes Tn	Moderate and severe: slope; surface soil texture; coarse fragment content; vegetation attractiveness and sensitivity	Slight to severe: (variable land system) slope; surface soil texture; vegetation sensitivity to disturbances	Severe to slight: (variable land system) slope; surface soil texture; stoniness	Moderate and severe: surface erosion potential; slope; vegetation sensitivity to disturbances	Slight to severe: (variable land system) surface soil texture; slope; coarse fragment content	C.L.I. classes 5 and 4; vegetation, topographic patterns, rock formations, small surface waters and historical site features
Vaseux Vx	Severe: slope; vegetation attractiveness (lack of tree cover)	Severe and moderate: slope; vegetation attractiveness	Severe: slope; depth to bedrock	Severe to moderate: surface erosion potential	Moderate and slight: slope; coarse fragment content	C.L.I. classes 5, 4 and 6; vegetation, topographic patterns, viewing, rock formation and historical factors
White Lake Wl	Severe: vegetation attractiveness (lack of tree cover); slope	Severe and moderate: slope; vegetation attractiveness	Severe and moderate: slope; depth to bedrock; stoniness	Moderate and severe: surface erosion potential; slope	Moderate and slight: slope; coarse fragment content	C.L.I. classes 4, 5 and 3; vegetation, topographic patterns, rock formations, small surface waters, historical sites and man-made features
Wolfcub Wb	Severe and moderate: surface soil textures; vegetation sensitivity to, and ability to recover from disturbances	Moderate and severe: surface soil texture; vegetation sensitivity to and ability to recover from disturbances	Severe and moderate: surface soil texture; slope	Severe: surface erosion potential; vegetation sensitivity to, and ability to recover from disturbances	Severe and moderate: surface soil texture; vegetation sensitivity to and ability to recover from disturbances	C.L.I. class dominantly 4; topographic patterns, vegetation, cultural landscape patterns, and viewing features

1. C.L.I. recreation ratings were interpreted from the Land Capability for Recreation map for Penticton 82E, (1968).

Interpretive Guidelines and Suitability Ratings for Wildlife

Preservation of wildlife is important in the Southern Okanagan Valley. Variations in topography and climate, from semi-arid valley bottoms to alpine peaks, have provided habitats suitable for a wide variety of wildlife species [Brooks, 1973]. The local fauna is both diverse and unique, with several species being rare or absent in other parts of British Columbia; such as California bighorn sheep, several reptiles, horned toads and scorpions.

Changing land use activities threaten the destruction of some critical habitats -- particularly the lower elevation winter feeding areas [Spalding and Bone, 1969]. To maintain the abundance and diversity of wildlife in the Southern Okanagan Valley more detailed information on specific habitat requirements of threated species must be acquired. If these habitat requirements cannot be maintained the capacity of the land for wildlife production will be diminished.

The most critical wildlife habitats in the Southern Okanagan Valley occur at low elevations. Lower elevation slopes and valley bottoms provide important winter and spring ranges. Cold temperatures and deep snow during the winter in upland areas, make access to, and maintenance of winter ranges critical for the survival of species such as California bighorn sheep and mule deer. Spring ranges, also limited in extent, provide for rapid recovery of animals following winter in preparation for reproduction and lactation.

An attempt was made to develop and apply a technique for providing baseline wildlife information for regional land use planning.

Information on the habitat requirements of selected wildlife species was collected, interpreted and presented in manner to facilitate it consideration in the planning process. It is emphasized that information on specific habitat requirements is based on limited local knowledge. Because habitat requirements for most species can vary considerably at the local level [Luckhurst, 1974], the user should be aware that this information does not replace more detailed wildlife investigations.

Seven wildlife species were selected for study: California bighorn sheep; mule deer; white-tailed deer; blue grouse; ruffed grouse; spruce grouse [Franklin's grouse]; and white-tailed ptarmigan. For each species base line habitat information on food, cover physiography and juxtapostion of habitat elements (or habitat interspersion) was collected. Suitability ratings were then made for the relative ability of each land system (in their present condition) to provide these habitat requirements.

The suitability ratings are defined as the capacity of the land system in its present condition to respond to management techniques (including consideration of the degree of effort or expense) for a specific kind and intensity of use. The degree of effort is, "the relative amount of time and energy required to provide optimum habitat . . . through habitat manipulation, for each wildlife species considered," [Thomasson, 1973]. Three suitability ratings were used:

> Good suitability -- a good suitability rating means that the land system in its present condition has a high capacity to provide the necessary habitat for the species. Little or no habitat manipulation is required.

Moderate suitability -- a moderate suitability rating means that the land system does not, in its present condition, provide the necessary habitat for the species. A moderate to moderately high effort and expense is required to improve the habitat.

Poor suitability -- a poor suitability rating means that the land system is generally unsuited to meet the habitat needs of the species. The land may require a major effort and expense to improve the habitat; the land system may be virtually lost for wildlife use (e.g. industrial or urban developments); or, due to the physical and biological makeup of the land system it is unsuitable for use.

California Bighorn Sheep

This section attempts to identify land systems that might provide suitable California bighorn sheep winter and early spring ranges, as shown in Table IV. It was assumed that abundant summer range is available for California bighorn sheep and its protection is not as critical as winter range.

On the east side of Skaha and Vaseux Lakes is a small herd of California bighorn sheep (*Ovis canadensis californiana*) numbering around 300 animals [Spalding and Bone, 1969]. This herd is well known to many local residents and tourists who hunt, study, photograph and observe these animals.

For several months during the winter this herd congregates on lower slopes which are both warmer and essentially free of snow. These lower elevation slopes make up the California bighorn sheep winter range and are critical to the survival of the herd [Spalding and Bone, 1969].

Plate 77

This photo of California bighorn sheep was taken near Vaseux Lake in December, 1972.

The behaviour of sheep is based on tradition and they do not normally pioneer into vacated habitats [Geist, 1971]. However, they might have the potential to expand with intensive management (for example by transplanting individuals into a new environment). The suitability ratings are based on the assumption that land systems which are not presently used by sheep, but which provide the necessary habitat requirements, may be used in the future with intensive management.

Food: The winter and early spring range consists of open ponderosa pine (*Pinus ponderosa*) and grassland areas (with small amounts of Douglas fir [*Pseudotsuga menziesii*] at higher elevations). They feed primarily on the 'hard' perennial grasses such as bluebunch wheatgrass (*Agropyron spicatum*) and Idaho fescue (*Festuca idahoensis*) but also on forbs and browse [Morrison, 1972].[21] Annuals such as cheatgrass (*Bromus tectorum*) are often green in late winter and early spring and are grazed.

Shrubs found on the range include Saskatoon berry (*Amelanchier alnifolia*), big sagebrush (*Artemisia tridentata*), bitterbrush (*Purshia tridentata*), squaw currant (*Ribes cereum*), Oregon grape (*Berberis aquifolium*), sumac (*Rhus glabra*), and wild rose (*Rosa* spp.) [Spalding and Bone, 1969]. Pasture sage (*Artemisia frigida*) is important where it occurs [Demarchii and Mitchell, 1973].

Grass species include Sandberg's bluegrass (*Poa sandbergii*), bluebunch wheatgrass, cheatgrass, speargrass (*Stipa comata*) and Idaho fescue (*Festuca idahoensis*).

Cover: Forest cover is important where it is dense and forms an effective barrier to movement, or where it reduces the growth of important grasses and forbs.

Winter cover consists of ponderosa pine and some Douglas fir at higher elevations [Spalding and Bone, 1969]. In the early spring the animals move to open grasslands.

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[21] Morrison found in the Ashnola River drainage that 91 percent of the spring diet was grass.

Physiography: California bighorn sheep prefer a rocky landscape within easy access [Capp, 1968]. In the winter they congregate on lower elevation grasslands and south facing, exposed, snow-free ridges where snow depth is less than 1 foot.

Since sheep feed very close to the ground searching for high quality forbs and grass shoots, crusting (particularly where it 'locks' pasturage close to the ground surface) is detrimental. An extremely heterogeneous microtopography helps to reduce crusting.

Juxtaposition: Bighorn sheep require a nearby escape terrain. This is usually within several hundred yards of a feeding area [Oldemeyer *et al.*, 1971]. The type of escape terrain required is a rocky inaccessible area to sheep's predators, not covered by heavy timber.

Mule Deer

This section is concerned with identifying land systems that provide suitable habitats for mule deer winter and early spring ranges, as shown in Table IV.

The Southern Okanagan Valley provides a natural range for mule deer (*Odocoileus hemionus hemionus*). Mule deer are important to the area as they are a major huntable and viewing species. They also respond well to management and are generally compatable with other land use activities.

Mule deer occur at high elevations during the summer [Scheffler, 1972; Spalding, 1968]. With snowfall accumulation in late autumn, mule deer move down to lower slopes for winter feeding [Spalding, 1968]. These lower elevation slopes, which have generally warmer temperatures and less snow, are important for survival of mule deer.

Food: Mule deer eat primarily browse species throughout the year [Morrison, 1972]. The shrubs waxberry (*Symphoricarpos albus*), kinnikinnick (*Arctostaphylos uva-ursi*), Saskatoon berry, snowbrush (*Ceanothus velutinus*), soopolallie (*Sheperdia canadensis*), squaw currant, sumac, mock orange (*Philadelphus lewisii*), willow (*Salix* spp.), and red-osier dogwood (*Cornus stolonifera*) are important food sources [Spalding, 1968]. Aspen (*Populus tremuloides*), bitterbrush, big sagebrush, and western choke cherry (*Prunus virginiana*) may be used locally.

Douglas fir is an important winter food, particularly where shrubs are not abundant and during periods of deep snow.

During early spring greenup, grasses are used as a source of food. Bluebunch wheatgrass, Idaho fescue and cheatgrass are important species [Hudson, 1974]. Sandberg's bluegrass may also be grazed heavily [McLean, 1974].

Cover: The preferred winter cover is a mixture of trees (ponderosa pine, Douglas fir) with a variety of shrubs adjacent to forest openings. Tree cover provides an escape habitat, protection from the climate (e.g. wind) and provides food in times of heavy snowfall. In early spring open grasslands are preferred but tree cover is important during the day.

Physiography: Snow depth and cold temperatures appear to be important in determining the location of mule deer winter ranges [Capp, 1968; Spalding, 1968]. Mule deer migrate to lower elevation grasslands and forested areas in winter, particularly with heavy snowfalls. In spring greenup they may move to even lower slopes and open grassland areas.

Juxtaposition: Juxtaposition is important primarily as it affects heterogeneity of vegetation -- a desirable characteristic for mule deer.

Human disturbance and dogs constitute a major problem [King, 1974]. However, mule deer may tolerate some human activity such as livestock and logging. They respond to patch logging of about 100 acres or less or where they can obtain cover within about 100 yards.

White-Tailed Deer

This portion of the study is concerned with identifying the land systems suitable for use by white-tailed deer, as shown in Table IV. It is based on the assumption that there is little significant elevational migration for most animals.

White-tailed deer (*Odocoileus virginianus*) is a significant wildlife species in the Southern Okanagan Valley. They recently spread into the valley from the Boundary region and appear to be increasing in numbers as a result of human activity [Spalding, 1968].

White-tailed deer are more adaptable to human activity than are mule deer. This gives them a competitive advantage. Compared

to mule deer they are difficult to hunt because of their skittishness; they respond better to human activity (e.g. farming) being more secretive animals; and they have a significant reproductive advantage, with a large percentage of young does breeding a year earlier and adults producing twins more often [Krämer, n.d.].

White-tailed deer are animals of the valley bottoms and lower slopes [Spalding, 1968]. They do not migrate to the extent of mule deer but rather remain in and around valley thickets, floodplains and farmland. In the winter they prefer slopes having less snowfall and warmer temperatures.

Food: White-tailed deer feed in seepage areas such as thickets along creeks and floodplains. They are less dependent on Douglas fir for food than are mule deer.

They feed primarily on browse. Important species include western choke cherry, red-osier dogwood, Saskatoon berry, trembling aspen, kinnikinnick, Oregon grape (*Berberis aquifolium*), wild rose (*Rosa* spp.) and waxberry. Bitterbrush may be locally important (although it does not readily show signs of being grazed). In addition, forage crops such as alfalfa are used as a food source.

Cover: White-tailed deer prefer dense, low elevation thicket vegetation (i.e. trembling aspen, water birch [*Betula occidentalis*], hawthorn [*Crataegus* spp.], etc.). In summer some animals migrate to higher elevations but a sizeable population stays in the valleys around thickets and agricultural areas.

Physiography: The general physiographic requirements are riparian vegetation along water courses at lower elevations. The landscape is usually flatter and less varied than that used by mule deer or California bighorn sheep. In the winter white-tailed deer move to warmer slopes with less snow cover.

Juxtaposition: White-tailed deer respond well to changes in land use. They are generally adaptable and tolerant of human activity as long as large areas of food and cover are not removed.

Clearing of the Okanagan River floodplain may have a limiting effect on the population as year round food and cover will be lost.

Ruffed Grouse

This portion of the study is concerned with identifying land systems that provide suitable habitats for ruffed grouse, as shown in Table IV.

Ruffed grouse (*Bonasa umbellus*) generally occur at lower elevations, often along stream bottoms. They have habitat requirements similar to those of white-tailed deer.

Food: Ruffed grouse tend to rely on vegetative growth of deciduous trees and shrubs [Mussehl *et al.*, 1971]. They are associated with species such as willows, alder (*Alnus* spp.) and aspen [Weeden, 1967]. Aspen appears to be the preferred species.

In winter, twig tips and buds are eaten and also fruits of species such as Saskatoon berry and western choke cherry.

Cover: Ruffed grouse prefer a heterogeneous cover of deciduous species. They respond well to habitat disturbances by fire, flooding, land clearing, frost action and other activities which create a heterogeneous plant cover.

They do not tolerate heavy snow crusting,such as with open aspen cover [Gullion and Marshall, 1968].

Physiography: The important physiographic consideration is the effect on vegetation -- both species diversity and abundance, and also landscape susceptability to disturbance (e.g. flooding).

Ruffed grouse occur mainly at lower elevations among deciduous vegetation. There is no major migration pattern [Mussehl *et al.*, 1971]. They are hardy enough to withstand cold winters.

Juxtaposition: Ruffed grouse prefer wetter vegetation than what normally occurs throughout the area (e.g. aspen) for food and cover.

Blue Grouse

This section is concerned with identifying land systems that provide suitable habitats for blue grouse, as shown in Table IV.

Blue grouse (*Dendragapus obsurus*) occur in the coniferous forests of the Southern Okanagan Valley. They are a migratory species without a clear pattern of movement [Zwickel *et al.*, 1968]. In the winter they rely on a heavy Douglas fir or Subalpine fir -- Engelmann spruce cover. In the summer they migrate both vertically and laterally seeking open cuts and clearings, etc. for breeding and raising their young.

Food: Conifer needles make up 80 percent or more of the winter diet. Summer food is variable due to the wide elevational range of the species. It includes green plants, berries, seeds and insects (e.g. wild rose, blueberry [*Vaccinium* spp.] and kinnikinnick).

King [1973] concluded that food *per se* is not important in determining the distribution of blue grouse.

Cover: Blue grouse stay in dense Douglas fir and subalpine fir -- Engelmann spruce forests in winter and early spring. They spend most of their time in trees for both food and shelter. They prefer a mature forest stand with some vegetation heterogeneity for food.

In the summer, they seek open areas and forest fringes for raising their young. They require some cover (not heavily grazed sites) to protect the young from ground and aerial predators [Zwickel, 1972].

Physiography: Physiographic requirements are reflected in vegetation.

Juxtaposition: Forest ecotones improve productivity, particularly a Douglas fir -- deciduous ecotone. However, juxtaposition is generally of lesser importance because blue grouse migrate over large areas. Some birds have been found to migrate as far as 10 miles [Zwickel *et al.*, 1968].

Spruce Grouse

This section is concerned with identifying land systems that provide suitable habitats for spruce grouse as shown in Table IV. The habitats required by Franklin grouse are essentially the same as those of spruce grouse.

Spruce grouse (*Canachites canadensis*), [Mussehl *et al.*, 1971] occur in the subalpine fir -- Engelmann spruce forests of the Southern Okanagan Valley. They are essentially a wilderness species, preferring mature subalpine forests. Their habitat requirements are somewhat similar to blue grouse except that they are more adapted to Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*) and lodgepole pine (*Pinus contorta*) than to Douglas fir. Migration is not a major consideration with spruce grouse.

Food: Winter food is dominantly spruce needles [Weeden, 1967]. Needles of lodgepole pine also provide a significant food source.

Summer food consists of leaves and berries. Important species include grouseberry (*Vaccinium scoparium*), kinnikinnick, alder and bunchberry (*Cornus canadensis*), [Weeden, 1967]. Mountain labrador tea (*Ledum glandulosum*) may also be an important species.

Cover: Spruce grouse depend on tree cover throughout the year. They prefer a dense tree cover of Engelmann spruce for both escape and winter roosting.

Physiography: Physiography is important in its affect on vegetation.

Juxtaposition: Spruce grouse prefer a mature spruce forest. However, extensive stands of pure spruce do not seem to be attractive [Weeden, 1967]. Forest harvesting activities will probably not benefit spruce grouse due to the removal of food and cover.

White-Tailed Ptarmigan

This section is concerned with identifying land systems that provide suitable habitats for white-tailed ptarmigan as shown in Table IV.

White-tailed ptarmigan (*Lagopus leucurus*) are adapted to the alpine and upper treeline regions [Weeden, 1967].

Food: Snow conditions in winter (October to May) restrict feeding primarily to shrubs. Winter food consists of buds, twigs and catkins of shrubs, particularly dwarf birch (*Betula glandulosa*), [Weeden, 1967]. Other food species include blueberries (*Vaccinium* spp.), willows (*Salix* spp.), the seed heads of sedges (*Carex* spp.) and leaves of dryas (*Dryas octopetala*).

Summer food for white-tailed ptarmigan includes new plant growth and insects. Buds and catkins of dwarf birch and willow are particularly important, and also blueberry flowers and fruits, moss capsules, pedicularis and dryas leaves and caterpillars.

Cover: Summer cover is minimal. Open rocky areas are preferred. In winter white-tailed ptarmigan move lower to the fringes of timberline [Weeden, 1967]. Some females migrate to shrubby openings in the subalpine forest.

Physiography: Alpine areas in general are the physiographic requirement. Within the alpine white-tailed ptarmigan prefer open areas with snow, precipitous slopes, rocky areas, rocky ledges, valleys and glacial cirques [Chrest, 1971].

Juxtaposition: Juxtaposition does not appear to be particularly important, possibly due to the diverse nature of the alpine and/or the fact that white-tailed ptarmigans habitat requirements are poorly understood [Luckhurst, 1974].

Openings in the subalpine forest apparently provide important winter habitats for female ptarmigan [Weeden, 1967]. Ski developments and associated activities in the alpine and timberline areas will likely have an adverse effect on the species.

TABLE IV

Stability Ratings and Limiting Factors for Selected Wildlife Species

Land System and Map Symbol	Suitability and Kinds of Limitations For: California Bighorn - Sheep 2	Mule deer 2	White-tailed Deer	Ruffed Grouse 2	Blue Grouse	Spruce Grouse	White-tailed Ptarmigan	Canada Land Inventory Capability Class: Ungulates	Waterfowl
Allendale Ae	Poor: physiography; food; cover; juxtaposition	Poor: physiography; food; cover; juxtaposition	Poor: physiography; food; cover	Poor: food; cover; physiography	Moderate: food; cover	Good moderate: food; cover	Poor: food; cover; physiogrraphy	4	7 (minor inclusions of 5 and 6)
Anarchist At	Poor: physiography; food; cover	Poor: physiography; food; cover	Poor: physiography; food; cover	Poor: food; cover; physiography; juxtaposition	Moderate: food; cover	Good and moderate: food; cover	Poor: food; cover; physiography	4	7
Apex Ax	Poor: physiography; food; cover; juxtaposition	Poor: physiography; food; cover	Poor: physiography; food; cover	Poor: food; cover; physiography; juxtaposition	Moderate to poor: food; physiography	Moderate: food	Poor: food; cover; physiography	6 , 4	7
Beaverdell Bl	Poor: food; cover; physiography; juxtaposition	Poor and moderate: physiography; food	Poor and moderate: physiography; food; cover	Poor and moderate: food; cover	Moderate: food; cover	Poor and moderate: food; cover	Poor: food; cover; physiography	4	7 (minor inclusions of 5 and 4)
Bluff Bf	Good and moderate: juxtaposition; physiography	Good and moderate: food	Moderate and good: cover; food	Poor: cover; food	Poor and moderate: food; cover	Poor: food, cover; physiography	Poor: food; cover; physiography	1w, 3w	7
Carmi Ci	Poor and moderate: physiography; juxtaposition; land use activities	Moderate and poor: cover; food; land use activities	Moderate and poor: cover; food; land use activities	Poor: food; cover	Poor: food; cover; physiography	Poor: food; cover; physiography	Poor: food; cover; physiography	3w, 4	7
Columns Cs	Poor: food; cover; physiography; juxtaposition	Poor: physiography; food; cover	Poor: physiography; food; cover	Poor: food; cover; physiography; juxtaposition	Moderate: food; cover	Moderate and good: cover; food	Poor: food; cover; physiography	4	7
Culper Cr	Poor: food; cover; physiography; juxtaposition	Poor: food; cover; physiography	Poor: physiography; food; cover	Poor: food; cover; physiography; juxtaposition	Moderate: cover	Moderate poor: cover	Poor to moderate: cover; physiography	4	7

Table IV (continued)

Land System and Map Symbol	Suitability and Kinds of Limitations For: California Bighorn Sheep 2	2 Mule deer	White-tailed Deer	2 Ruffed Grouse	Blue Grouse	Spruce Grouse	White-tailed Ptarmigan	Canada Land Inventory Capability Class: Ungulates	Waterfowl
Gregoire Ge	Poor and moderate: food; physiography; cover; juxtaposition	Moderate and poor: food; physiography	Poor and moderate: physiography; food; cover; juxtaposition	Moderate: food; cover	Good...	Moderate and poor: food; cover	Poor: food; cover; physiography	4, 3w	7 (minor inclusions of 5)
Hestor Hr	Moderate to poor: physiography; cover; food	Moderate and poor: physiography; food	Poor: physiography; food; cover	Poor and moderate: food; cover	Good and moderate: cover; food	Poor: food; cover	Poor: food; cover; physiography	3w, 4, 3	7
Inkaneep Ip	Good and moderate: food	Good to poor: food; cover	Moderate to poor: physiography; food; cover; juxtaposition	Poor and moderate: food; cover	Poor and moderate: food; cover	Poor: food; cover; physiography	Poor: food; cover; physiography	3w, 1w, 4	7
Keogan Kn	Moderate: (inclusions of good and poor) food; physiography	Moderate and good: food; cover; physiography	Moderate and good: physiography; food	Moderate: food; cover	Moderate: food; cover	Poor: food; cover; physiography	Poor: food; cover; physiography	3w, 2w, 3 - 4	7 (minor inclusions of 3, 4 and 5)
Kilpoola Ka	Poor: physiography; juxtaposition	Poor and moderate: cover; food; juxtaposition	Poor and moderate: cover; food	Poor and moderate: food; cover	Poor and moderate: food; cover	Poor: food; cover; physiography	Poor: food; cover; physiography	3 w, 4	7 (inclusions of 2 and 3)
Kinney Ky	Poor: food; physiography; cover	Poor: food; cover	Good....	Good....	Poor: food; cover; physiography	Poor: food; cover; physiography	Poor: food; cover; physiography	3	2, 3 and 7
Kobau Ku	Poor: food; physiography	Poor: physiography	Poor: physiography; food; cover; juxtaposition	Poor: food; cover; physiography; juxtaposition	Moderate: cover; food	Poor: cover; food	Poor: food; cover; physiography	4	7
Kruger Kr	Moderate and poor: physiography; food	Moderate: physiography; food	Moderate and poor: food; physiography	Poor: food; cover	Poor and moderate: food; cover	Poor: food; cover; physiography	Poor: food; cover; physiography	3w, 4	7 (inclusions of 2 and 4)
Lawless Ls	Poor: physiography; food; cover; juxtaposition	Poor: physiography; food; cover; juxtaposition	Poor: physiography; food; cover; juxtaposition	Poor: food; cover; physiography; juxtaposition	Poor and moderate: food; cover	Good and moderate: juxtaposition; cover	Poor: food; cover; physiography	4	7

Table IV (continued)

Land System and Map Symbol	Suitability and Kinds of Limitations For: California Bighorn Sheep [2]	Mule deer [2]	White-tailed Deer	Ruffed Grouse [2]	Blue Grouse	Spruce Grouse	White-tailed Ptarmigan	Canada Land Inventory Capability Class: Ungulates	Waterfowl
Louie Le	Good and moderate: food; physiography	Good to moderate: food; cover	Moderate poor: physiography; food; cover	Poor: food; cover	Poor: cover; food	Poor: food; cover; physiography	Poor: food; cover; physiography	1w-3w, 3, 4	7
Manuel Ml	Poor: physiography; food; cover; juxtaposition	Poor: physiography; food; cover; juxtaposition	Poor: physiography; food; cover	Poor: physiography; food; cover	Moderate: food	Good and moderate: food; cover	Poor: food; cover; physiography	4	7
Marron Ma	Poor: food; cover; physiography	Moderate and poor: food; physiography	Poor and moderate: food; cover; physiography	Poor and moderate: food; cover	Moderate and good: food; cover	Poor: food; cover; physiography	Poor: food; cover; physiography	4, 3w	7
McGregor Mg	Poor and moderate: physiography	Moderate: food; cover	Poor: food; cover; physiography	Poor: food; cover; juxtaposition	Poor: food; cover; physiography	Poor: food; cover; physiography	Poor: food; cover; physiography	3w, 4	7
McIntyre Mc	Good and moderate: food; physiography	Good and moderate: food	Moderate: food; cover; physiography	Poor: food; cover	Moderate: cover; physiography; food	Poor: food; cover; physiography	Poor: food; cover; physiography	3w-1w	7
McKinney My	Poor: physiography; food; cover; juxtaposition	Poor: physiography; food; cover; juxtaposition	Poor: physiography; food; cover; juxtaposition	Poor: food; cover; physiography; juxtaposition	Moderate to poor: food; cover	Good and moderate: juxtaposition; cover	Poor: food; cover; physiography	4	7
Munson Mn	Moderate and poor: physiography; food	Moderate and good: food; cover	Moderate: food; cover; physiography	Poor: food; cover	Moderate: food; cover	Poor: food: cover; physiography	Poor: food; cover; physiography	3w, 3-4	7
Myers Ms	Poor: food; cover; physiography; juxtaposition	Moderate and poor: cover; food	Moderate: food; cover	Moderate and good: food; cover	Moderate: food; cover	Poor: food; cover; physiography	Poor: food; cover; physiography	3w, 4	7, 5

Table IV (continued)

Land System and Map Symbol	Suitability and Kinds of Limitations For: California Bighorn Sheep 2	Mule deer 2	White-tailed Deer	Ruffed Grouse 2	Blue Grouse	Spruce Grouse	White-tailed Ptarmigan	Canada Land Inventory Capability Class: Ungulates	Waterfowl
Orofino Oo	Poor and moderate: food; physiography; cover	Moderate and poor: food; physiography	Poor and moderate: food; cover; physiography	Poor and moderate: food; cover	Poor and moderate: food; cover	Poor: food; cover; physiography	Poor: food; cover; physiography	4, 3w	7 (minor inclusions of 4)
Osoyoos Os	Moderate and poor: food; physiography; land use activities	Moderate: cover; food	Poor and moderate: food; cover; physiography	Poor: food; cover	Poor: food; cover	Poor: food; cover; physiography	Poor: food; cover; physiography	3w, 3, 4	7 (inclusions of 3)
Park Rill Pr	Moderate: food; physiography; land use activities	Moderate: cover; food	Poor and moderate: food; cover; physiography	Poor: food; cover	Poor: food; cover;	Poor: food; cover; physiography	Poor: food; cover; physiography	3w, 4	7
Penticton Pn	Moderate and poor: (inclusions of good) physiography; land use activities	Moderate and poor: land use activities; cover; food	Moderate: food; cover	Poor: food; cover	Poor: food; cover	Poor: food; cover; physiography	Poor: food; cover; physiography	3w-2w, 3, 4	7
Richter Rr	Poor: food; cover; physiography; juxtaposition	Poor and moderate: physiography	Poor: physiography; food; cover	Poor: food; cover; physiography	Moderate: food; cover	Poor and moderate: cover; food	Poor: food; cover; physiography	4	7
Roy Ry	Poor: land use activities; physiography; juxtaposition	Poor and moderate: land use activities	Poor and moderate: cover; food	Poor and moderate: land use activities	Poor: food; cover	Poor: food; cover; physiography	Poor: food; cover; physiography	3, 3w	7
Sheep Rock Sr	Poor: food; cover; physiography; juxtaposition	Poor: physiography	Poor: physiography; food; cover; juxtaposition	Poor: food; cover; physiography; juxtaposition	Poor to moderate: food; cover; physiography	Poor: cover; food	Moderate good: physiography; cover	6, 4	7
Skaha Sa	Good and moderate: food	Good and moderate: food	Moderate and good: cover; food; physiography	Moderate and poor: food; cover	Moderate: food; cover	Poor: food; cover; physiography	Poor: food; cover; physiography	3w-1w, 4	7 (inclusions of 2, 3 and 4)

Table IV (continued)

Land System and Map Symbol	Suitability and Kinds of Limitations For: California Bighorn Sheep [2]	Mule deer [2]	White-tailed Deer	Ruffed Grouse [2]	Blue Grouse	Spruce Grouse	White-tailed Ptarmigan	Canada Land Inventory Capability Class: Ungulates	Waterfowl
Testalinden Te	Moderate: juxta-position; physio-graphy; land use activ-ities	Moderate and poor: land use act-ivities; cover; food	Poor and moderate: food; cover	Poor and moderate: food; cover; land use activ-ities	Poor: cover; food	Poor: food; cover; physio-graphy	Poor: food; cover; physio-graphy	3, 3w, 4	7
Trout Lake Tl	Poor: physio-graphy; food; cover; juxta-position	Poor: physio-graphy; juxta-position; food	Poor: physio-graphy; food; cover; juxta-position	Poor: food; cover; physio-graphy; juxta-position	Moderate: food; cover; juxta-position	Good and moder-ate: cover; juxta-position	Poor: food; cover; physio-graphy	4	7 (minor inclusion of 4)
Twin Lakes Tn	Poor: physio-graphy; cover; juxta-position	Moderate and poor: food; cover; physio-graphy	Moderate and poor: food; cover; physio-graphy	Poor and moder-ate: food; cover	Poor and moder-ate: food; cover	Poor: food; cover; physio-graphy	Poor: food; cover; physio-graphy	3w, 4	7 (inclus-ions of 3 and 5)
Vaseux Vx	Moderate and good: physio-graphy; food; juxta-position	Good and moder-ate: cover; physio-graphy	Moderate and good: cover; physio-graphy; food; juxta-position	Poor and moder-ate: food; cover; physio-graphy	Poor: food; cover; physio-graphy	Poor: food; cover; physio-graphy	Poor: food; cover; physio-graphy	3w-1w, 3, 4	7
White Lake Wl	Poor and moderate: physio-graphy; food; juxta-position	Good and moder-ate: cover; physio-graphy	Moderate and good: cover; physio-graphy; food; juxta-position	Moderate and poor: food; cover; physio-graphy	Poor: food; cover; physio-graphy	Poor: food; cover; physio-graphy	Poor: food; cover; physio-graphy	3w, 4	7 (inclus-ions of 3 and 5)
Wolfcub Wb	Moderate and poor: food; physio-graphy; land use activ-ities	Moderate: cover; food	Poor and moder-ate: cover; food; physio-graphy	Poor: food; cover	Poor: food; cover	Poor: food; cover; physio-graphy	Poor: food; cover; physio-graphy	3, 3w, 4	7 (inclus-ions of 2, 3 and 5)

1. The suitability ratings are based on limited local knowledge of the habitat requirements of each species.

2. When land use activities are identified as a limiting factor a significant portion of the land system has been lost for this wildlife use, usually due to cultivation or residential developments.

DISCUSSION

Land systems integrate the physical and biological aspects of the environment (i.e. climate, bedrock geology, surficial deposits, soil and vegetation). They can be used to facilitate the understanding and use of environmental information in land use planning and serve as a framework for future and more site specific studies.

The landscape approach was applied to environmental data collection to fit into the planning process directly, without re-interpretation.

Stereo-pair and colour ground photographs were used to aid the user or reader in conceptualizing the landscape units. This is especially important for the non-technical user and for making decisions in planning without benefit of field observations.

Interpretive guidelines were developed and applied at a broad level (1:125,000) for recreation, urban development and wildlife. For specific objectives further studies must be conducted, but the framework and general guidelines are provided.

The interpretations have limitations due to scale and due to the lack of socio-economic considerations. The interpretations do, however, provide a comprehensive environmental overview sufficient for regional land use planning.

The interpretations were based largely on literature references. Modifications were made to fit the environmental conditions examined in the field and the specific research objectives of land use planning at the regional level.

This study differs from many studies carried out in British Columbia in that suitability ratings were developed and applied. Thus, the present level of resource development was incorporated into the interpretations.

Although complex interpretations were made at the reconnaissance level, relatively few parameters required detailed analysis. What was required were mainly landscape features such as surficial deposits, slope, vegetation, drainage and physical analysis of soils. Chemical soil analysis is of lesser importance except for indications of soluble salts, pH and general levels of organic matter. More detailed analysis should be obtained for site specific planning or development, and for taxonomic classification of soils.

Vegetation is important in regional and local land use planning. Present cover is not necessarily the most important consideration because it is ephemeral. What is required is a description of more stable vegetation (such as habitat types), which yield basic environmental information for long term planning. For management of wildlife, and to a limited extent recreation, additional information on present cover should be collected.

It is estimated that a similar study could be applied to an area of the same size for approximately $30,000. This works out to a cost of about 7 cents an acre. If an experienced person were assigned the task, the costs would be decreased.

In conclusion the following points can be made:

1. A landscape classification at the level of land systems appears to be satisfactory for regional land use planning.

2. A "holistic" environmental approach is more applicably to regional planning than single resource studies.

3. The inventory approach used provides an environmental framework for future studies and for studies undertaken in greater detail.

4. This "holistic" environmental approach provides a base for broad interpretations for many resource fields (e.g. urban development, recreation, wildlife, forestry, etc.).

5. Due to the complexity of the terrain, these broad level interpretations do not negate the need for on-site investigations.

6. Expanded legends and photographs are useful methods of data presentation.

7. Presentation of information in sections allows for ready referencing of information by the reader.

8. The approach used in this study can be applied to other areas with slight modifications.

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LAND SYSTEMS OF THE SOUTH OKANAGAN

PENTICTON

Scale 1:125,000 Échelle

Miles 1 0 2 4 6 8 10 Miles
Kilometres 2 1 0 2 4 6 8 10 12 14 Kilomètres

82 E/SW

LEGEND

Map Symbol	Land System	Elevation[1] (feet)	Materials[2]	Vegetation[3]	Soils[4]	Comments[4]
Ae	ALLENDALE	4,200-5,500+	Glacial fluvial outwash; minor inclusions of shallow glacial fluvial outwash over glacial till or bedrock; occurs over a variety of bedrocks	Subalpine fir zone: Subalpine fir, Engelmann spruce, Lodgepole pine (particularly after fires), Grouseberry and Pinegrass	Dominant Degraded Dystric Brunisols; significant inclusions of Orthic Dystric Brunisols	Very gently sloping to steeply sloping topography; slopes mostly 3 to 15%; gravelly or stony loamy sand to sandy loam textures, mostly deep coarse sands or sands over gravel; rapidly to well drained; similar to Beaverdell in topography and materials but found at higher elevations
At	ANARCHIST	4,200-5,500	Shallow glacial till and colluvium over bedrock; significant inclusions of deep glacial till or colluvium, also exposed bedrock; occurs over a variety of bedrocks	Subalpine fir zone: Subalpine fir, Engelmann spruce, some Douglas fir, Grouseberry and Pinegrass	Dominant Degraded Dystric Brunisols; significant inclusions of Lithic Dystric Brunisols; minor inclusions of Brunisolic Gray Luvisols	Hilly to strongly rolling topography; slopes mostly 20 to 60%; gravelly sandy loam to gravelly loamy sand textures; well to rapidly drained; mapped with McKinney which occurs on deep glacial till and colluvium; similar in materials and topography to Keogan, but found at higher elevations
Ax	APEX	5,500-6,600	Deep colluvium; significant inclusions of shallow colluvium over bedrock; occurs over a variety of bedrocks	Subalpine fir zone: Subalpine fir, Engelmann spruce, Lodgepole pine, Grouseberry, White rhododendron and Mountain labrador tea, few grasses	Dominant Mini Humo-Ferric Podzols; minor inclusions of Orthic Regosols	Extremely sloping topography; slopes mostly greater than 60%; gravelly to stony colluvium; rapidly drained; similar in topography and materials to Manuel but found at higher elevations; mapped with Lawless, but occurs on steeper slopes with mostly deep colluvial materials
Bl	BEAVERDELL	3,000-4,200	Glacial fluvial outwash; minor inclusions of shallow glacial fluvial outwash over glacial till or bedrock; occurs over a variety of bedrocks	Douglas fir zone: Douglas fir, Lodgepole pine (particularly after fires at higher elevations), Kinnikinnick, Heart leaf arnica, Idaho fescue and Pinegrass	Dominant Degraded Eutric Brunisols; significant inclusions of Orthic Eutric Brunisols	Gently to steeply sloping topography; slopes mostly 3 to 15%; gravelly or stony loamy sand to sandy loam textures, mostly deep coarse sands or sands over gravel; rapidly drained; similar to Allendale in topography and materials, but found at lower elevations
Bf	BLUFF	1,000-1,500	Kettled glacial moraine; shallow to deep deposits of glacial fluvial sands and gravels over glacial till; significant inclusions of kame terraces; occurs over a variety of bedrocks	Big sagebrush zone: Ponderosa pine, Bitterbrush, Bluebunch wheatgrass and Phlox	Dominant Orthic Brown Chernozems	Moderately rolling to very hilly topography; slopes mostly 9 to 60%; gravelly loamy sand to gravelly sandy loam textures; well drained; occurs around Vaseux Lake
Ci	CARMI	1,100-1,800	Glacial fluvial delta; significant inclusions of glacial fluvial outwash terraces; minor inclusions of deltaic material over silty lacustrine deposits	Big sagebrush zone: Ponderosa pine, Bluebunch wheatgrass and Idaho fescue	Dominant Degraded Eutric Brunisols and Orthic Brown Chernozems; significant inclusions of Orthic Dark Brown Chernozems	Gently to steeply sloping topography but very steeply to extremely sloping or very hilly where kettled; slopes mostly 3 to 15%; deep coarse loamy sands, coarse sands, to sands over gravel, gravelly and very stony textures; rapidly drained; much of area has had Ponderosa pine removed, and regeneration is very slow, particularly on gravels and stones; similar to Louie, but mainly Degraded Eutric Brunisol and Orthic Dark Brown Chernozem soils
Cs	COLUMNS	4,200-5,500	Shallow glacial till and colluvium over bedrock; significant inclusions of exposed bedrock; minor inclusions of deep glacial till or colluvium; occurs mainly on volcanic bedrock	Subalpine fir zone: Subalpine fir, Engelmann spruce, Grouseberry and Pinegrass	Dominant Orthic Dystric Brunisols; significant Lithic Regosols; minor inclusions of Orthic Gray Luvisols	Strongly rolling to very hilly topography; slopes mostly 15 to 60%; gravelly loam to gravelly sandy loam textures; well to rapidly drained; mapped with Trout Lake but occurs on shallow glacial till and colluvium over bedrock; similar in materials and topography to Orofino, but occurs at higher elevations
Cr	CULPER	5,500-6,600	Shallow glacial till and colluvium over bedrock; significant inclusions of deep glacial till or colluvium; minor inclusions of exposed bedrock; occurs on a variety of bedrocks	Subalpine fir zone: Subalpine fir, Engelmann spruce, Grouseberry, White rhododendron, Mountain labrador tea, few grasses	Dominant Mini Humo-Ferric Podzol; significant inclusions of Lithic Humo-Ferric Podzols	Hilly to very hilly topography; slopes mostly 30 to 60%; gravelly sandy loam to gravelly loamy sand textures; well to moderately well drained; similar in topography and materials to Anarchist, but occurs higher in elevation; mapped with Lawless which is deep glacial till and colluvium
Ge	GREGOIRE	3,000-4,200	Deep glacial till; significant inclusions of colluvium over glacial till where steeper; minor inclusions of shallow glacial till over bedrock; occurs over a variety of bedrocks	Douglas fir zone: Douglas fir, some Western larch and Lodgepole pine above 3,500 feet in elevation, Pinegrass, Kinnikinnick, Heart leaf arnica and Wild strawberry	Dominant Degraded Eutric Brunisols; significant inclusions of Orthic Gray Luvisols on finer textured tills	Gently rolling to hilly topography; slopes mostly 9 to 30%; gravelly sandy loam to sandy loam textures; well to moderately well drained; mapped with Keogan which is shallow glacial till over bedrock; similar to McKinney but occurs lower in elevation
Hr	HESTOR	1,800-4,000	Deep colluvium; significant inclusions of shallow colluvium over bedrock; minor inclusions of exposed bedrock; occurs over a variety of bedrocks	Douglas fir zone: Douglas fir, some Ponderosa pine at lower elevations, Pinegrass, Lupines, Wild strawberry and Heart leaf arnica	Dominant Orthic Eutric Brunisols; significant inclusions of Orthic Regosols; minor inclusions of Lithic Eutric Brunisols	Very steeply to extremely sloping topography; slopes mostly greater than 60%; gravelly to stony colluvium; rapidly drained; similar to McIntyre but mapped on north aspects; usually occurs along north aspects of steep valley walls
Ip	INKANEEP	1,000-2,100	Shallow glacial till and colluvium over bedrock; significant inclusions of exposed bedrock; minor inclusions of deep glacial till or colluvium; occurs over a variety of bedrocks	Big sagebrush zone: mixed Big sagebrush and Ponderosa pine, Bluebunch wheatgrass, and Bitterbrush	Dominant Orthic Brown Chernozems; significant inclusions of Lithic Brown Chernozems	From steeply to extremely sloping, and hilly to very hilly topography; slopes usually greater than 30%; gravelly sandy loam to gravelly loamy sand textures; rapidly to moderately well drained; mapped with Kilpoola which has deep deposits of glacial till; differs from Skaha by the presence of Bitterbrush and Big sagebrush, and by having dominantly Orthic Brown Chernozem soils
Kn	KEOGAN	2,100-4,200	Shallow glacial till and colluvium over bedrock; significant inclusions of exposed bedrock; minor inclusions of deep glacial till or colluvium; occurs over a variety of bedrocks	Douglas fir zone: Ponderosa pine, Douglas fir and Idaho fescue at lower elevations; Douglas fir, Pinegrass, Heart leaf arnica, Lupine and Wild strawberry at higher elevations	Dominant Degraded Eutric Brunisols; minor inclusions of Orthic Gray Luvisols, also Lithic Eutric Brunisols	From steeply sloping to extremely sloping, and strongly rolling to very hilly topography; slopes mostly greater than 20%; gravelly sandy loam texture; well to rapidly drained; mapped with Gregoire which is deep glacial till; similar in materials and topography to Skaha which occurs at lower elevations, and Anarchist which occurs at higher elevations
Ka	KILPOOLA	1,000-2,100	Dominantly deep glacial till, but up to 50% inclusions of shallow glacial till over bedrock; minor inclusions of exposed bedrock; occurs over a variety of bedrocks	Big sagebrush zone: Big sagebrush, Bluebunch wheatgrass and Phlox	Dominant Orthic Brown Chernozems; minor inclusions of Lithic Brown Chernozems	Moderately rolling to very hilly topography; slopes mostly 15 to 60%; gravelly sandy loam texture; well drained; mapped with Inkaneep which is shallow glacial till and colluvium over bedrock
Ky	KINNEY	900-1,100	Deep sandy alluvial floodplain deposits; finer materials in backswamp areas; minor inclusions of beach ridges and fan materials particularly near Penticton	Big sagebrush zone: Northern black cottonwood, Water birch, Wild rose, Willow, Scouring rush, Wild raspberry, and Poison ivy	Dominant Rego Humic Gleysols; significant inclusions of Gleyed Regosols	Very gently sloping to undulating topography; slopes less than 5%; about 2 feet of silt or clay loam over coarse textured sands, deeper loam capping in backswamp areas; poorly to imperfectly drained; occurs along Okanagan River which is now a controlled channel; flooding is by high water table
Ku	KOBAU	5,300-6,200	Shallow glacial till and colluvium over bedrock; significant inclusions of deep glacial till; minor inclusions of exposed bedrock; occurs over a variety of bedrocks	Subalpine fir zone: High sagebrush, Pinegrass, Idaho fescue, Bluebunch wheatgrass, and Eriogonum species	Dominant Orthic Black Chernozems; significant inclusions of Rego Black Chernozems; minor inclusions of Lithic Black Chernozems	Gently rolling to very hilly topography; slopes mostly between 15 to 60 ; gravelly sandy loam texture; well to moderately well drained; occurs as grassland in the Subalpine fir zone around Mt. Kobau
Kr	KRUGER	2,100-4,500	Shallow glacial till and colluvium over bedrock; significant inclusions of deep glacial till and colluvium; minor inclusions of exposed bedrock; occurs over a variety of bedrocks	Douglas fir zone: Threetip sagebrush, Big sagebrush, Bluebunch wheatgrass, and Idaho fescue; widely scattered Ponderosa pine and Douglas fir	Dominant Orthic Dark Brown Chernozems; significant inclusions of Lithic Dark Brown Chernozems; minor inclusions of Orthic Dark Gray Chernozems	Moderately rolling to very hilly topography; slopes mostly 15 to 60%; gravelly sandy loam to gravelly loamy sand textures; well to rapidly drained; occurs as grassland in the Douglas fir zone around Mt. Kobau, often on south aspects; mapped with Keogan, but has more deep glacial till and colluvium and fewer trees; similar to Vaseux but has less deep glacial till and colluvium
Ls	LAWLESS	5,500-6,600	Deep glacial till with colluvium over glacial till on steeper slopes; minor inclusions of shallow glacial till or colluvium over bedrock; occurs over a variety of bedrocks	Subalpine fir zone: Subalpine fir, Engelmann spruce, Grouseberry, White rhododendron and Mountain labrador tea, few grasses	Dominant Mini Humo-Ferric Podzols; minor inclusion of Brunisolic Gray Luvisols at lower elevations	Moderately rolling to hilly topography; slopes mostly 15 to 60%; gravelly sandy loam to gravelly loamy sand textures; well to moderately well drained; mapped with Culper which has shallower deposits of glacial till and colluvium over bedrock; similar to McKinney but occurs at higher elevations
Le	LOUIE	1,200-1,600	Glacial fluvial delta; significant inclusions of alluvial and colluvial material; minor inclusions of shallow glacial fluvial outwash over glacial till and bedrock; occurs over a variety of bedrocks	Big sagebrush zone: Big sagebrush, Bluebunch wheatgrass, some Ponderosa pine on deep sands	Dominant Orthic Brown Chernozems; minor inclusions of Orthic Dark Brown Chernozems, and Degraded Eutric Brunisols with tree cover	Gently to very steeply sloping topography; slopes mostly 2 to 15%; stony to gravelly with some sands over gravels and deep coarse sands; rapidly drained; the unit is a mixture of different materials but is dominated by stony and gravelly deltaic deposits; similar to Carmi, but lacks kettle holes, has more inclusions and mostly Brown Chernozem soils
Ml	MANUEL	4,000-5,500	Deep colluvium; significant inclusions of shallow colluvium over bedrock; minor inclusions of exposed bedrock; occurs over a variety of bedrocks	Subalpine fir zone: Subalpine fir, Engelmann spruce, Grouseberry, and Pinegrass	Dominant Orthic Dystric Brunisols to Degraded Dystric Brunisols; minor inclusions of Orthic Regosols	Extremely sloping topography; slopes mostly greater than 60%; gravelly to stony colluvium; rapidly drained; mapped with McKinney, but occurs on steeper slopes with mostly deep colluvial materials; similar to Richter in topography and materials, but occurs on northerly aspects
Ma	MARRON	2,200-4,200	Deep glacial till; significant inclusions of deep colluvium, also shallow glacial till or colluvium over bedrock; occurs mainly on volcanic bedrock	Douglas fir zone: Douglas fir, Pinegrass, Wild strawberry, Heart leaf arnica, and Lupine	Dominant Orthic Gray Luvisols	Moderately to extremely sloping topography; slopes mostly 9 to 60%; gravelly loam to loam textures; well drained; mapped with Orofino but occurs on deeper soils; similar to Trout Lake in topography and materials, but occurs at lower elevations
Mg	McGREGOR	2,000-3,000	Shallow glacial till and colluvium over bedrock; significant inclusions of exposed bedrock; minor inclusions of deep colluvium or glacial till; occurs on vertically tilted volcanics	Douglas fir zone: Threetip sagebrush, Big sagebrush, Bluebunch wheatgrass and Idaho fescue	Dominant Orthic Dark Brown Chernozems; significant inclusions of Orthic Regosols	Strongly rolling to very hilly topography; slopes mostly 15 to 60%; gravelly loamy sands to gravelly sandy loam textures; well to rapidly drained; occurs as grassland in the Douglas fir zone around White Lake; mapped with White Lake but occurs on vertically tilted volcanics with generally shallower soils
Me	McINTYRE	2,000-4,200	Deep colluvium; significant inclusions of shallow colluvium over bedrock; minor inclusions of kame terraces and exposed bedrock; occurs over a variety of bedrocks	Douglas fir zone: open forest of Ponderosa pine and Douglas fir and Bluebunch wheatgrass; at higher elevations Douglas fir, Ponderosa pine, Idaho fescue and some Pinegrass	Dominant weakly developed Orthic Eutric Brunisols; significant inclusions of Orthic Regosols; minor inclusion of Lithic Eutric Brunisols	Very steeply to extremely sloping topography; slopes mostly greater than 60%; gravelly to stony colluvium; rapidly drained; similar to Hestor but occurs on south aspects; usually occurs along south aspects of steep valley walls
My	McKINNEY	4,200-5,500	Deep glacial till with colluvium over glacial till on steeper slopes; minor inclusions of shallow glacial till or colluvium over bedrock; occurs over a variety of bedrocks	Subalpine fir zone: Subalpine fir, Engelmann spruce, Grouseberry and Pinegrass	Dominant Brunisolic Gray Luvisols; significant inclusions of Degraded Dystric Brunisols	Gently rolling to hilly topography; slopes mostly 9 to 45%; gravelly sandy loam textures; well to moderately well drained; mapped with Anarchist which has shallow deposits of glacial till; similar to Gregoire but occurs higher in elevation
Mn	MUNSON	1,300-2,000	Deep glacial till with colluvium over glacial till on steeper slopes; minor inclusions of kame deposits; occurs over a variety of bedrocks	Douglas fir zone: lower elevation of Douglas fir zone with scattered Ponderosa pine, Douglas fir, Bluebunch wheatgrass and Idaho fescue	Dominant Orthic Dark Brown Chernozems, grading to Degraded Eutric Brunisols with tree cover	Very steeply to extremely sloping topography; slopes mostly 30 to 60%; gravelly sandy loam textures; well drained; occurs around Penticton and Shingle Creek
Ms	MYERS	1,500-2,000	Recent alluvium; minor inclusions of alluvial-colluvial fan deposits	Big sagebrush to lower Douglas fir zone: Ponderosa pine, Water birch, Wild rose, Red osier dogwood, and Hawthorn species	Dominant Gleyed Humic Gleysols	Very gently to gently sloping topography; slopes mostly 1 to 3%; silty loam to fine sandy loam textures; poorly to imperfectly drained; best developed near Myers Flat
Oo	OROFINO	2,100-4,200	Shallow glacial till and colluvium over bedrock; significant inclusions of exposed bedrock; minor inclusions of deep glacial till or colluvium; occurs mainly on volcanic bedrock	Douglas fir zone: Douglas fir; Idaho fescue, Pinegrass, Wild strawberry, Lupine, and Heart leaf arnica	Dominant Degraded Eutric Brunisols; significant inclusions of Lithic Regosols; minor inclusions of Orthic Gray Luvisols	Strongly rolling to very hilly topography; slopes mostly greater than 25%; gravelly sandy loam to gravelly loam textures; well to rapidly drained; mapped with Marron, but has shallow soils; similar in materials and topography to Columns but occurs at lower elevations
Os	OSOYOOS	900-1,200	Glacial fluvial outwash; significant inclusions of kettled terraces particularly on the west side of Osoyoos Lake; minor inclusions of alluvial-colluvial fan deposits, also shallow outwash over silty lacustrine deposits which appear to underlie the outwash at depth	Big sagebrush zone: Bitterbrush, Big sagebrush, Phlox and Bluebunch wheatgrass	Dominant Orthic Brown Chernozems; significant inclusions of Orthic Regosols; minor inclusions of Rego Brown Chernozems	Gently sloping to gently rolling and hilly topography; slopes mostly 3 to 15%; gravelly loamy sand, loamy sand to sandy loam textures, mostly deep sands over gravel; rapidly drained; similar to Wolfcub but lacks Ponderosa pine; significant inclusion of sand dunes along the east side of Osoyoos Lake, particularly on overgrazed sites; includes the area known as "Osoyoos Arid"
Pr	PARK RILL	1,000-1,500	Glacial fluvial delta; minor inclusions of shallow glacial fluvial material over bedrock or glacial till; occurs over a variety of bedrocks	Big sagebrush zone: Ponderosa pine, Bitterbrush, and Bluebunch wheatgrass	Dominant Degraded Eutric Brunisols; Significant inclusions of Orthic Brown Chernozem; minor inclusions of Rego Brown Chernozems	Gently sloping to moderately rolling topography; slopes mostly 2 to 15%; gravelly loamy sand to sandy loam textures; mostly deep coarse sands and sands over gravel; rapidly drained; some duning of sands; finer textured than Carmi and Louie with more uniform topography
Pn	PENTICTON	1,100-1,400	Deep glacial lacustrine silts and very fine sands; minor inclusion of deep loess, also shallow silts and very fine sands over a variety of bedrocks	Big sagebrush zone: Big sagebrush and Bluebunch wheatgrass	Dominant Orthic Brown Chernozems; significant inclusions of Rego Brown Chernozems; minor inclusions of Orthic Regosols	Dissected topography, particularly around Skaha Lake, from gently rolling to extremely sloping; slopes mostly 5 to 20%; silt loam to fine sandy loam textures; well to moderately well drained; occurs mostly around Penticton
Rr	RICHTER	4,200-5,500+	Deep colluvium; significant inclusions of shallow colluvium over bedrock; minor inclusions of exposed bedrock; occurs over a variety of bedrocks	Subalpine fir zone: open forest of Douglas fir, Engelmann spruce, Subalpine fir and Pinegrass	Dominant Degraded Eutric Brunisols; significant inclusions of Orthic Regosols, also Orthic Dystric Brunisols at higher elevations	Very steeply to extremely sloping topography; slopes mostly over 60%; gravelly to stony colluvium; rapidly drained; mapped with McKinney which occurs on deep glacial till and colluvium over glacial till; similar to Manuel in topography and materials, but occurs on southerly aspects
Ry	ROY	1,100-1,400	Alluvial fans; minor inclusions of alluvial floodplain deposits	Big sagebrush zone: Ponderosa pine, Sumac, Bluebunch wheatgrass and Saskatoon berry on well drained sites; Northern black cottonwood, Wild rose, Red osier dogwood and Hawthorn on poorly drained sites	Orthic Regosols on upper parts of fans, Gley Regosols on lower fans; minor inclusions of Rego Humic Gleysols	Very gently to gently sloping topography; slopes mostly 2 to 5%; gravelly to stony sand and loamy sand in upper part of fans, and a capping of loam or sandy loam over sands and gravels on lower part of fans; well to rapidly drained on upper part of fans; imperfectly to poorly drained on lower part of fans; occurs around Penticton; similar to Testalinden but soils dominantly Orthic Regosols and Gleyed Regosols
Sr	SHEEP ROCK	6,600-7,500+	Shallow glacial till and colluvium over bedrock; significant inclusions of deep glacial till and colluvium, also exposed bedrock; occurs over a variety of bedrocks	Krummholz and Alpine zone: widely spaced and stunted Lodgepole pine, Engelmann spruce, Subalpine fir and Whitebark pine, Red and Yellow heather, and Alpine lupine	Dominant Alpine Dystric Brunisols; significant inclusions of Lithic Dystric Brunisols	Steeply to extremely sloping topography; slopes mostly 20 to 60%; gravelly loamy sand to gravelly sand textures; well to rapidly drained; this unit occurs in the alpine-forest border and is the highest unit mapped; it is similar in materials and topography to Culper, but occurs at higher elevations
Sa	SKAHA	1,000-2,100	Shallow glacial till and colluvium over bedrock; significant inclusions of exposed bedrock; minor inclusions of deep glacial till or colluvium; occurs over a variety of bedrocks	Big sagebrush zone: Ponderosa pine, Douglas fir, and Bluebunch wheatgrass	Dominant Degraded Eutric Brunisols; significant inclusions of Lithic Eutric Brunisols and Orthic Brown Chernozems	Hilly to very hilly topography; slopes mostly greater than 30%; gravelly sandy loam to gravelly loamy sand textures; rapidly to moderately well drained; similar to Inkaneep but occurs further north with greater tree cover, and Degraded Eutric Brunisol soils; similar in topography and materials to Keogan which is found higher in elevation
Te	TESTALINDEN	1,000-1,700	Alluvial-colluvial fan deposits; minor inclusion of sandy glacial fluvial outwash	Big sagebrush zone: Ponderosa pine, Big sagebrush, Bitterbrush, and Bluebunch wheatgrass	Dominant Orthic Dark Brown Chernozems; minor inclusions of Gleyed Regosols on lower parts of fans	Gently to steeply sloping topography; slopes mostly 5 to 30%; gravelly to stony with finer materials on lower parts of fans; rapidly to well drained with some poorly drained soil adjacent to floodplain; similar to Roy, but soils dominantly Orthic Dark Brown Chernozems rather than Regosols or Gleysols
Tl	TROUT LAKE	4,200-5,500	Deep glacial till; significant inclusions of deep colluvium, also shallow glacial till or colluvium over bedrock; occurs mainly on volcanic bedrock	Subalpine fir zone: Subalpine fir, Engelmann spruce, Grouseberry and Pinegrass	Dominant Brunisolic Gray Luvisols; significant inclusions of Orthic Gray Luvisols	Undulating to very steeply sloping topography; slopes mostly 5 to 45%; loam to gravelly sandy loam textures; well to moderately well drained; mapped with Columns but occurs on deeper soils; similar to Marron in topography and materials, but occurs at higher elevations
Tn	TWIN LAKES	2,000-3,000	Glacial fluvial outwash; minor inclusions of kame materials, ponded silts, alluvial and colluvial fans, and shallow outwash over glacial till	Douglas fir zone: Ponderosa pine, Douglas fir, Threetip sagebrush, Bluebunch wheatgrass and Idaho fescue	Dominant Orthic Dark Brown Chernozems; significant inclusions of Degraded Eutric Brunisols	Gently sloping to extremely sloping topography, particularly around kettle holes and sides of terraces; slopes highly variable from 2 to greater than 60%; sandy loam, gravelly sandy loam to gravelly loamy sand textures; rapidly to well drained; differs from Beaverdell by being mixed forest and grassland, and by having Dark Brown Chernozem soils
Vx	VASEUX	2,000-5,000+	Deep glacial till and colluvium over till; significant inclusions of glacial till and colluvium over bedrock; minor inclusions of exposed bedrock; occurs over a variety of bedrocks	Douglas fir zone: Threetip sagebrush, Bluebunch wheatgrass, Idaho fescue, and Eriogonum species	Dominant Orthic Dark Brown Chernozems; significant inclusions of Rego Dark Brown Chernozems	Steeply to extremely sloping topography; slopes mostly 15 to 60%; gravelly sandy loam textures; well drained; occurs mostly on steep south aspects as grassland in the Douglas fir zone; similar to Kruger but contains mostly deep glacial till and colluvium over glacial till
Wl	WHITE LAKE	2,000-4,500	Shallow glacial till and colluvium over bedrock; minor inclusions of deep glacial till, colluvium, and glacial fluvial outwash; occurs mainly on volcanic bedrock	Douglas fir zone: Threetip sagebrush, Big sagebrush, Bluebunch wheatgrass, Idaho fescue, and Eriogonum species	Dominant Orthic Dark Brown Chernozems; significant inclusions of Rego Brown Chernozems	Strongly to very steeply sloping topography except for inclusions of gently sloping glacial fluvial outwash; slopes mostly 15 to 45%; gravelly sandy loam textures; well drained; occurs around White Lake as grassland in the Douglas fir zone; similar to Kruger except occurs on volcanic bedrock and also has a minor inclusion of glacial fluvial outwash; similar to Vaseux, but has shallower materials
Wb	WOLFCUB	1,000-1,400	Glacial fluvial outwash; minor inclusions of alluvial and colluvial fan deposits	Big sagebrush zone: Ponderosa pine, Bitterbrush, Phlox and Bluebunch wheatgrass	Dominant Orthic Brown Chernozems; significant inclusions of Orthic Regosols; minor inclusions of Rego Brown Chernozems	Undulating to strongly rolling topography; slopes mostly 2 to 15%; gravelly loamy sand, loamy sand to sandy loam textures, mostly deep sands over gravel; rapidly drained; similar to Osoyoos, but supports the growth of Ponderosa pine

[1] This is the common elevation range for the land system. Changes in aspect, soil moisture, and materials may result in variations of + or - 300 feet.

[2] See appendix of thesis for an explanation of materials; inclusion of 20 to 40% are called significant, and 10 to 20% minor; deep refers to a material greater than 5 feet in thickness, and shallow to materials less than 5 feet in thickness.

[3] See the thesis for an explanation of the vegetation zones and for the scientific names of the plant species.

[4] See "The System of Soil Classification for Canada", 1970.