Soils of the Langley-Vancouver Map Area

RAB Bulletin 18

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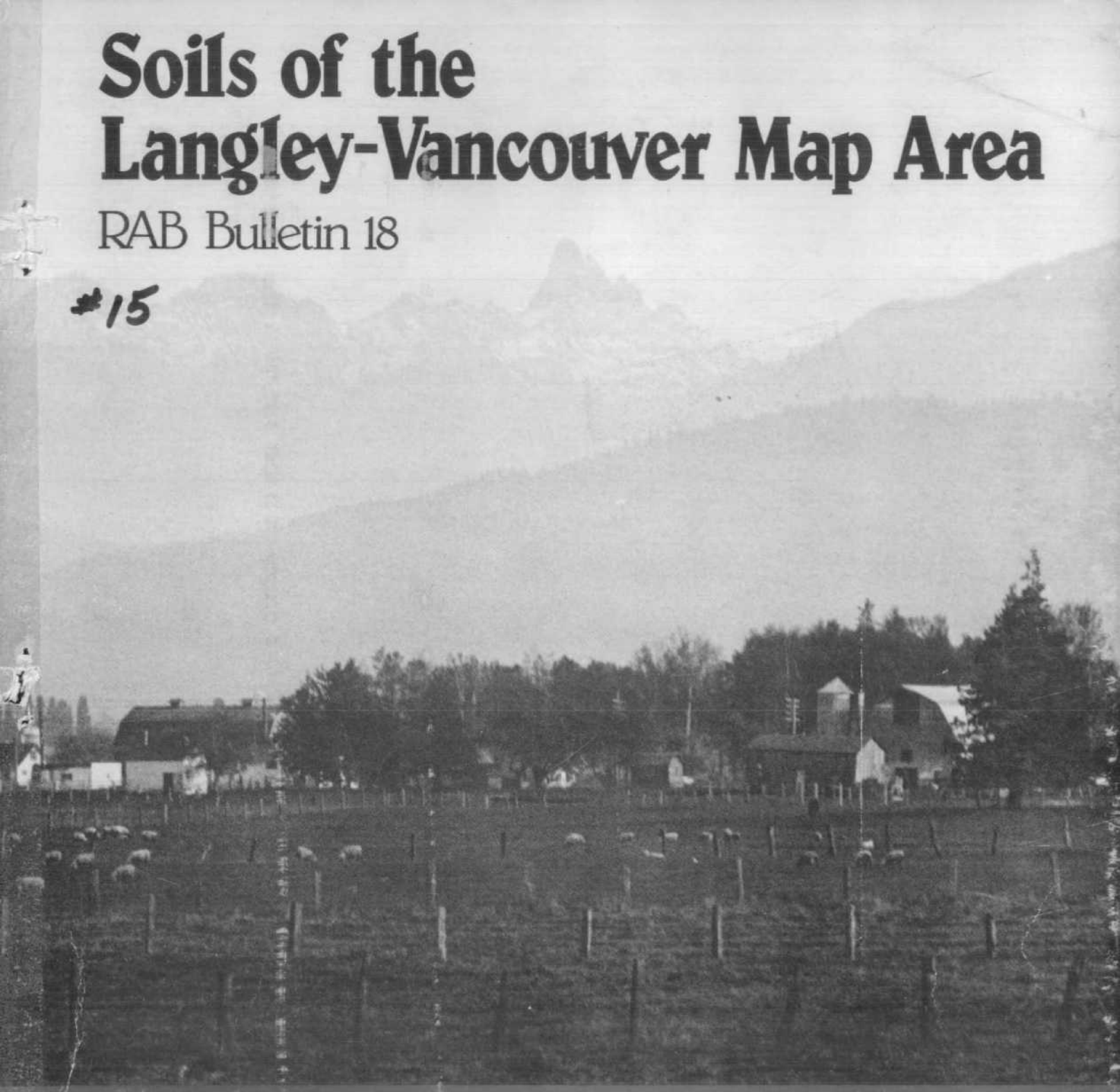

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SOILS OF THE LANGLEY-VANCOUVER MAP AREA

Report No. 15
British Columbia Soil Survey

VOLUME 5
Agriculture Soil Management Groups

by

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INTRODUCTION

The first soil survey of the Lower Fraser Valley was completed in the late 1930's (Kelly and Spillsbury, 1939). This valuable publication adequately served its users for many years but as agricultural and other land use problems became increasingly complex, the realization grew that a more detailed, larger-scale soil survey was required. To meet this need, a detailed resurvey of the Lower Fraser Valley was initiated in the late 1950's and field mapping was completed in the early 1970's. Included in the survey area as well were the adjacent Coast Mountains and the southern part of the Sunshine Coast. The original impetus for the resurvey was supplied by the Assessment Commissioner, British Columbia Department of Finance who requested assistance in developing uniform land assessments in the Lower Fraser Valley. His request for more detailed soil information was strongly supported by a variety of soil and land users.

As the survey progressed, preliminary reports and soil maps (scale 1:24 000) were prepared, generally on a municipal base. A total of eleven separate maps and ten reports were published. The current report, Soils of the the Langley-Vancouver Map Area, collates, summarizes and updates the soil information contained in most of the preliminary series as well as presenting new information not published previously.

Field mapping procedures and soil classification techniques changed over the period of years required for the soil survey. Users of the preliminary maps and reports probably have noticed differences in terminology and soil classification among them. The present report, as much as possible, updates the information contained in the preliminary series to current standards (The Canadian System of Soil Classification, 1978) and presents it in a uniform, consistent manner.

Soils of the Langley-Vancouver Map Area encompasses an area bounded on the west by the Strait of Georgia and on the east by 122°00' west longitude (a north-south line passing between Chilliwack and Sumas Canal). The southern boundary is the Canada - United States of America border (49th parallel) while 49°30' north latitude forms the northern boundary. Included are the western and central parts of the Lower Fraser Valley, the southern part of the Sunshine Coast and the southern edge of the Coast Mountains west of Chehalis Lake. Users will note that some areas, particularly those in the vicinity of metropolitan Vancouver, are not mapped or classified. These consist mainly of areas which were either already partially or completely urbanized (or industrialized) at the time of the field survey.

Soils of the Langley-Vancouver Map Area is being produced, published and distributed in six volumes. Volume 1 consists of soil map mosaics (1:25 000 scale) with legend, and covers the Lower Fraser Valley portion of the map area. Volume 2 contains soil maps (1:50 000 scale) with legend, that encompass the remainder of the map area, mainly the southern Sunshine Coast and Coast Mountains. Volume 3 describes, in detail, the soils mapped and classified in Volumes 1 and 2. It also generally discusses the environmental characteristics of the map area and contains a glossary and list of references. Volume 4 contains interpretations for specified engineering uses of the soils described in Volume 3 (and mapped in Volumes 1 and 2). It contains information regarding soil suitability (or limitations) for septic tank effluent disposal, basement construction and other urban-related land uses. Also included are some interpretations for forest management concerns as well as interpretations for recreational endeavours. Volume 5 (this publication) is agriculturally oriented and assembles the soils described in Volume 3 into agricultural soil management groups Each group generally consists of several individual soils which either require similar management, or are expected to respond in a similar manner to management inputs. A few groups contain only one unique soil. Also forming part of this publication are maps depicting the

distribution of the soil management groups in the map area. Updated and revised land capability for agriculture maps replacing the currently available provisional series were initially scheduled to be included in this Volume as well. These will now be produced as a separate series of maps. Volume 6 consists of the detailed, technical profile descriptions of the soils discussed in Volume 3 and also contains the results of chemical and physical analyses of the sampled soils (or individual soil horizons). Only a limited number of copies of Volume 6 are being produced, mainly for those persons who have day-to-day use for this detailed, specific data. Since this information is also stored in the British Columbia Soil Information System others can, as required, request the data (or portions of it) directly from the data file.

HOW TO USE THE SOIL MAPS AND REPORT

Long-term soil resource managers such as farmers usually know the characteristics and variations of the soils in their immediate locality. Unless a soil map and report are available, however, comparison with other soils in the area or region is impossible. Regional (and local) similarities and differences among soils are evident after a soil map has been made. Proven (or new) management techniques on a soil may then be transferred to the same or similar soils elsewhere with the least chance of failure.

To efficiently use this soil survey report, the following procedure is suggested:

1) Generally locate the area of concern on the "Index to Map Sheets" which immediately preceed the soil map mosaics in Volume 1 and soil maps in Volume 2. Note the number(s) of the map sheet(s) which cover the area under consideration. Generally, lands in the Lower Fraser Valley are covered in Volume 1 while areas on the Sunshine Coast or in the Coast Mountains are contained in Volume 2.
2) Turn to the appropriate map sheet(s) and locate in detail the area of concern. Lakes, creeks, and rivers and other natural features as well as cultural detail including main roads, railways, communities, and section numbers are shown to assist in location.
3) Note the soil map symbols in the map delineations (polygons) which encompass the area(s) under consideration.
4) Consult the soil legend for a description of the soil symbols. The topographic and stoniness classes are described here as is the soil parent material and drainage classification. Also given is the name(s) of the soil(s) identified by the symbol in the soil map polygon(s).
5) Locate the named soil in Volume 3. A detailed description of the soil is given here as well as its general suitability (or limitations) for a variety of uses.
6) Refer to Volumes 4 and 5 for specified use interpretations of the named soils. Volume 4 deals with engineering characteristics related mainly to urban and associated land uses, as well as interpretations dealing with some forest management concerns and recreational endeavors. Volume 5 assembles the named soils into agricultural soil managment groups. Accompanying maps showing the distribution of the groups in the map area are available on request from MAPS-BC*. These maps are at the same scale as the soil maps in Volumes 1 and 2.
7) Persons requiring the detailed, site specific, technical soil profile descriptions and associated physical and chemical analyses are referred to Volume 6 or, if this information is required only on an irregular basis, to the British Columbia Soil Information System.

Users of the soil maps and reports should note that soils are differentiated on the basis of characteristics to a depth of a meter or more. Even though several soils may have similar surfaces, their subsurface and subsoil character can vary widely. Users should also understand that each soil exhibits a range of properties and that boundaries between different soils are not necessarily well defined. The boundaries shown on the soil maps are the best estimate of where soil characteristics change sufficiently to warrant identification of another soil.

*MAPS-BC, Ministry of Environment, Parliament Buildings, Victoria, British Columbia, V8V 1X5.

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The positive editorial comments, encouragement and support provided by P. N. Sprout are specially acknowledged.

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CHAPTER ONE

AGRICULTURAL SOIL MANAGEMENT GROUPS IN THE LANGLEY - VANCOUVER MAP AREA

Agriculture is one of the main land users in the Langley-Vancouver map area and dominates on most of the lowlands and uplands of the Lower Fraser Valley. Soils with a variety of different characteristics occur and this, coupled with generally well-suited climatic conditions, affords the opportunity for the successful production of a wide range of forage, cereal, vegetable and fruit crops. In fact, the map area is considered as one of the agriculturally most diverse and productive regions in Canada.

The diversity of soils in the map area implies however, that the management of the individual soils is also diverse. A few, general management practices will not suffice for all soils. Management methods or prescriptions to maintain or improve productivity have to be developed for individual soils, or for groups of soils that have similar characteristics.

Each Agricultural Soil Management Group (there are 43 in total) is composed of one to several individual soils. The soils in each group have similar agriculturally important soil parameters. The soils in a group either require similar management, or are expected to respond similarily to management inputs. Additionally, several groups consist of soils which have either extremely limited agricultural uses or are considered non-arable from an agricultural standpoint.

The distribution of the agricultural management groups in the Langley - Vancouver map area are shown on a total of 23 - 1:25 000 scale and 4 - 1:50 000 scale maps. The key map in Figure 1 shows each map's location and number. One map, as an example, is located in the pocket on the inside back cover of this publication. The remainder are available on request from MAPS-BC, Ministry of Environment, Parliament Buildings, Victoria, British Columbia, V8V 1X5.

The soils and landtypes identified in Langley-Vancouver map area (i.e. on the soil map legends) have all been grouped into agricultural management groups. The management groups are generally named after a dominant soil which occurs in the group. For example, in the Fairfield Soil Management Group, the Fairfield soil is one of the main soils.

GUIDELINES FOR DETERMINING AGRICULTURAL SOIL MANAGEMENT GROUPS*

An Agricultural Soil Management Group consists of one or more soils that either require similar management or are expected to respond in a similar manner to management inputs. The soil parameters used in defining the management groups are those relatively permanent characteristics considered important for successful agricultural soil management and crop production. Most of the parameters are interrelated and cannot be definitively separated from each other; texture for example, has implications for soil water holding capacity while soil parent material (surficial geologic deposits) may influence salinity. The narrowness of class limits within each parameter are dependent on the detail of the data base available and on the level of management that can reasonably be expected to be applied.

* The definitions and limits of the soil parameters were developed in conjunction with R. Bertrand and C. Wood, British Columbia Ministry of Agriculture and Food, Surrey, British Columbia.

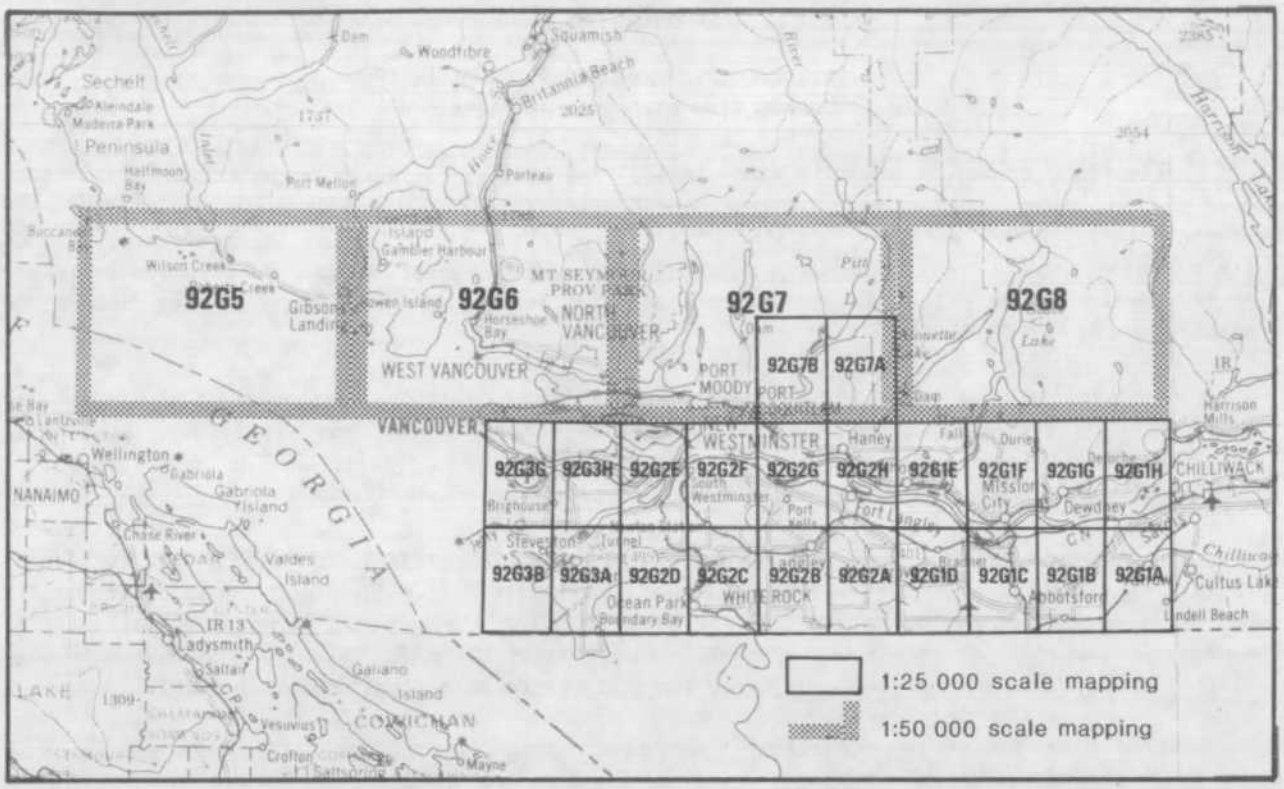

Figure 1. Key to Map Numbers and Scale of the Agricultural Soil Management Group maps for the Langley - Vancouver Map Area.

Eight soil parameters are considered in defining the agricultural management groups. They are 1) Soil Parent Material, 2) Soil Drainage, 3) Soil Texture, 4) Soil Salinity, 5) Subsoil Characteristics, 6) Soil Stoniness, 7) Available Water Storage Capacity, and 8) Organic Matter Content, Soil Reaction and Cation Exchange Capacity. Each is discussed more fully in the following sections.

Climate and topography are important characteristics which should also be evaluated when considering soils for agricultural uses. They, however, have not been included as specific parameters to be used in defining the agricultural soil management groups in this publication. Climatic conditions over most of the agricultural portions of the map area are relatively similar and it would only be repititious to include its description in most management groups. If the climatic conditions for a specific management group differs significantly from the norm, comment is made. The general climatic conditions for the Langley - Vancouver map area is given in Volume 3.

The inclusion of topographic (slope) classes as definitive parameters determining agricultural management groups would produce an unduly large number since the same soil, or group of soils, may occur under a variety of slope conditions. Instead, for each group depicted on the management group maps, the specific slope class (or classes), as determined from the soil map, is given.

Soil Parent Material (Surficial Geologic Deposits)

Soils develop from surficial geologic deposits and the character of the surficial deposits often have a direct effect on the properties of the soils developed. Glaciofluvial and marine lag deposits, for example, are generally coarse in texture and often stony while glaciomarine and marine deposits are mostly fine-textured, dense and slowly pervious. Soils developed from these deposits have characteristics similar to the original deposits. Several geologic deposits may have similar characteristics and soils developed on them may be similar also. Surficial geologic deposits (or groups of deposits) are a good primary stratification to generally define soils into preliminary management groups - further stratification can then be based on the characteristics of the soils within the preliminary groups based on soil parent material.

The preliminary management groups based on soil parent material are given in Table 2, pages 10 - 11 of Volume 3. The general characteristics of the indivdual parent materials are described as well.

Soil Drainage

Drainage is a soil parameter that has important management and cropping implications. The following soil drainage groupings are generally used in defining the agricultural management groups: **Well and rapidly drained** - excess water is not considered to be a management concern and artificial soil drainage is generally not required for good crop production; **Imperfectly drained** - periodic temporary high water tables occur and may be a management concern for some crops, particularly for those that are sensitive to these conditions; and **Poorly and very poorly drained** - artificial soil drainage is generally required for good maintenance and production of most crops as well as providing conditions suitable for timely cultivation, planting and harvesting.

Other drainage characteristics which are considered include types of water tables (groundwater vs perched), soil perviouness, and source of seepage (if present). These all have implications for the type and extent of excess water control structures required. Also included under soil drainage is surface runoff which is a management consideration for erosion control and cropping patterns.

Soil Texture

Texture is the relative proportions of sand, silt and clay present in the soil, modified by the amount of coarse fragments (gravels, cobbles, stones) also present. It determines, at least in part, water and nutrient holding capacity, ease and timing of cultivation and other cropping and management considerations. In the context of the agricultural management groups, the mineral soils have been grouped into the following general classes: **Coarse-textured** - those soils which contain a high proportion of sand (sand, loamy sand, sandy loam, gravelly sand, gravelly loamy sand, gravelly sandy loam); **Medium-textured** - those soils which are high in silt content, or contain more or less equivalent amounts of sand, silt and clay (silt loam, loam, silt, silty clay loam, clay loam); and **Fine-textured** - those soils which are high in clay content (silty clay, clay, sandy clay, heavy clay). In some cases, the general groups are further subdivided (e.g. moderately coarse textured) if sufficient data is available.

The organic soils have been grouped into two classes according to the degree of decomposition of the organic material. These are: **a Well-to-moderately decomposed group** in which the subsurface consists mostly of humic or mesic material; and **a Poorly decomposed group** where the subsurface is dominantly fibric. The degree of decomposition of the surface layer is considered only as a secondary consideration since its' decomposition can usually be changed relatively rapidly by management practises.

Soil Salinity

Soil salinity refers to the presence of soluble salts in the soil and is an important consideration in cropping and management practises. It is usually measured as the electrical conductivity (E.C.) of a saturation extract expressed in millisiemens per centimeter (mS/cm). In the definition of the management groups both the depth to, and degree of salinity is considered. The three depth classes are: **Saline within 50 cm** of the surface; **Saline between 50 and 100 cm** of the surface; and **Non-saline within 100 cm** of the surface (E.C. less than 4 mS/cm). The three degrees of salinity are: **Weakly saline** - E.C. is between 4 and 8 mS/cm; **Moderately saline** - E.C. is between 8 and 15 mS/cm; **Strongly saline** - E.C. is higher than 15 mS/cm.

Subsoil Characteristics

Subsurface and subsoil characteristics have strong implications for cropping and soil management practises. They affect soil perviousness, water holding capacity, and rooting depth and distribution, among others. Soil characteristics considered include the presence of, and depth to, pedogenic horizons such as clay enriched (Bt) and cemented layers (duric, ortstein) and compact, massive soil parent materials.

Soil Stoniness

Stoniness (including cobbles, stones and boulders) has major implications for soil cropping and management. It affects choice of crops, cultivation methods and other management considerations (eg: the requirement for stone-picking). In the agricultural management groups the following levels of stoniness are considered: **No or very few stones** - stones are either not present or are only present in minor amounts and do not affect cropping or management practises (Stoniness classes S_{0-1}); **Moderately stony** - sufficient stones are present to hinder cultivation and/or limit the production (harvesting) of ground crops (Stoniness classes S_{2-3}); and **Severely stony** - stoniness is sufficiently severe to require stone-picking, on a more or less continuous basis for the maintenance of condition suitable for cultivation and harvesting (Stoniness classes S_{3-5}). In the context of the management groups both surface and subsurface (to about 50 cm depth) stoniness are considered.

Available Water Storage Capacity

Available water storage capacity refers to the soils' ability to provide moisture for plant growth and is mainly a function of soil texture, structure and depth. It is important in relation to the soils' capability to provide adequate moisture for crop requirements and also determines the need for irrigation, its frequency and application amount.

Four general values are used in defining the agricultural management groups and are generally inferred from the texture of the management groups. These are: **Low water storage capacity**

(<7.5 cm/m of soil) - soils whose textures are mainly of sand, gravelly sand, gravelly loamy sand, or loamy sand; **Moderate water storage capacity** (7.5-15 cm/m of soil) - soils whose textures are mainly sandy loam, fine sandy loam, gravelly sandy loam, fine loamy sand, or gravelly loam; **High water storage capacity** (15-22.5 cm/m of soil) - soils whose textures are mainly silt loam, loam, clay loam, silty clay loam, or clay; and **Very high water storage capacity** (>22.5 cm/m of soil) - soil composed mainly of humic, mesic or fibric organic material.

Organic Matter Content, Soil Reaction and Cation Exchange Capacity

Organic matter content, soil reaction (pH) and cation exchange capacity are important soil parameters to be considered for crop growth. Organic matter content is important for nutrient and water holding ability as well as soil tilth; exchange capacity is a measure of the nutrient holding ability of the soil while soil reaction indicates the pH (acidity or alkalinity) of the soil.

In the context of the agricultural management groups, organic matter levels of the surface layer (approximately upper 25 cm, excluding organic forest floor material) are grouped into: **Low** - less than 5% organic matter (<3% organic carbon); **Medium** - between 5 and 10% organic matter (3-6% organic carbon); **Moderately High** - 10-20% organic matter (6-11% organic carbon); **High** - 20-30% organic matter (11-17% organic carbon); and **Very High** - greater than 30% organic matter (>17% organic carbon).

Cation exchange capacities (excluding the organic forest floor material, where present) are generally grouped into: **Low** - less than 10 meq/100 g; **Moderate** - 10 to 20 meq/100 g; **High** - 20 to 30 meq/100 g; and **Very High** - greater than 30 meq/ 100 g.

Soil reaction (pH) is grouped into six classes, based on measurements taken in 1:1 or 1:5 H_2O. The groups are: **Extremely acid** - pH 4.5 or less; **Strongly acid** - pH 4.6 to 5.5; **Moderately acid** - pH 5.6 to 6.5; **Neutral** - pH 6.6 to 7.3; **Moderately alkaline** - pH 7.4 to 8.4; and **Strongly alkaline** - pH 8.5 or greater. The upper parts of almost all soils in the map area fall into one of the acidic classes.

Many crops require relatively specific soil conditions for adequate growth and production. The crops suited for production on the individual management groups are discussed in Bertrand and Wood, 1983.

CHAPTER TWO

DESCRIPTION OF THE AGRICULTURAL SOIL MANAGEMENT GROUPS

All the soils and land types occuring in the Langley - Vancouver map area have been grouped into 43 agricultural soil management groups. These groups are individually described in this chapter and their distribution is shown on the accompanying maps. The groupings were accomplished by manual means but the maps were produced using automated cartographic processes.

ABBOTSFORD SOIL MANAGEMENT GROUP

The agriculturally important Abbotsford Soil Management Group occupies about 12 600 ha on the uplands of the map area and most areas are currently developed for a variety of agricultural endeavors. The group dominates the landscape in the vicinities of Abbotsford and the Abbotsford Airport and is widespread in the southern part of Mission Municipality, near Hopington and in the Columbia Valley south of Cultus Lake. Smaller areas are scattered elsewhere east of approximately the Langley-Surrey municipal boundary. Abbotsford and Marble Hill are the dominant soils in the management group; Peardonville, Keystone, Laxton and Stave soils occupy lesser, though important areas as well. The management groups most commonly associated with the Abbotsford management group are Ryder and Columbia.

The soils in the Abbotsford management group have developed in silty eolian (windblown) material more than 20 cm but usually less than 100 cm thick, overlying mainly gravelly glaciofluvial deposits. In a few areas the underlay is sandy and consist mainly of dune deposits (Laxton soils).

Topographically the Abbotsford group is variable, ranging from nearly level or gently undulating (eg. near the Abbotsford Airport) to very steeply sloping and hilly; slope gradients range from less than 1% to well over 30%. Elevations generally range between about 10 m and 100 m asl but rise to 200 m in the Columbia Valley.

The reddish-brown soils in the Abbotsford management group are well to rapidly drained. The upper parts of the soil are moderately pervious while the subsoils are rapidly pervious. Available water storage capacities are moderate to high, depending on the thickness of the silty eolian capping. Surface runoff is slow in most areas, but increases to moderate where slopes are steep. Rooting depth and distribution is generally unrestricted in the silty eolian cap. The underlying gravelly material is variably restricting depending on the content of stones and cobbles.

The friable Abbotsford group soils are medium-textured in the surface and subsurface. Silt loam is usual with some variation to loam or fine sandy loam or occasionally, sandy loam where the coarse-textured underlay is close to the surface. The subsoil is usually gravelly or cobbly sand but ranges to sand in some areas. Most surfaces are stone-free; a few gravels and cobbles sometimes occur where the overlay is relatively shallow and have been incorporated from the subsoil by land clearing, stump removal or deep cultivation.

Soils of the Abbotsford group, in their natural state, are relatively leached and only moderately fertile. However, they have moderate to high nutrient holding ability and generally

respond well to fertilizer additions. Cation exchange capacity of the upper soil generally ranges between 15 to 25 meq/100 g. The fertility of presently cultivated areas varies depending on the management history. Organic matter content of the surface layer is low and generally less than 5%. Soil reaction is moderately to strongly acid and usually ranges between pH 5 and 6.

Management Considerations

1) Soils in the Abbotsford group are suited for most climatically adapted crops. Adverse topography in some areas is limiting for some crops, particularly those that require uniform maturity and specialized equipment that may be limited by steep slopes. Where the silty capping is shallow, production of ground crops may be limited by the gravelly and cobbly underlay.
2) Even though water holding capacity is moderate to high, irrigation is generally required during most summers for sustained growth of most crops, especially in those areas where the silty capping is relatively shallow.
3) The silty character of soils in the Abbotsford group makes them prone to water erosion and gullying. The susceptibility increases with steepness of slope and management practises that concentrate water discharge on slopes should be avoided. Row and similar crops should be planted along the contour to minimize waterflow and concentration. Moderately sloping areas should have trash cover or cover crops during the wet, winter months and very steep areas should be maintained in permanent grass or similar cover.
4) If land leveling is undertaken, the silty surface layer should be removed and stockpiled and the gravelly or sandy underlay leveled. The stockpiled material should then be redistributed after leveling is complete.
5) The low filtration ability of the coarse-textured subsoils may lead to groundwater contamination if large amounts of sewage effluent are discharged in relatively small areas, particularly where the silty capping is shallow. A similar caution applies for large additions of manure or fertilizer to the soil surface.
6) Addition of soil amendments (e.g. liming) to raise and maintain the pH at about 5.5 or 6 is beneficial for most crops. Organic matter content is relatively low and manuring (either barnyard or green) is beneficial to improve and maintain the tilth and nutrient holding ability of the surface layer. Fertilizer additions should be based on soil test and the requirements of the crops being grown.
7) Soils of the Abbotsford group provide good sites for farmsteads. They have high bearing capacity and are well drained. Most areas are relatively level as well.
8) The soils tend to warm rapidly in the spring providing opportunity for early planting. Their well drained character also affords cultivation during all growing season periods except during and shortly after rain.

Plate 1. Strawberries being irrigated on soils of the Abbotsford management group. Raspberries are growing in the background. The somewhat droughty Abbotsford group is commonly used for the production of small fruits.

Plate 2. Cultured Christmas trees are produced in parts of the map area. These are growing on soils of the Abbotsford management group near the Abbotsford Airport. The somewhat droughty nature of the soils constrains leader growth which assists in producing compact, dense foliage.

ALOUETTE SOIL MANAGEMENT GROUP

The Alouette Soil Management Group occupies about 6250 ha on the lowlands of the map area. It is one of the dominant management groups in the Pitt Meadows - Pitt Polder area and occupies smaller scattered locations elsewhere, mainly in Matsqui and the western part of Sumas valleys. Substantial areas are still undeveloped for agriculture; these are mainly in northern Pitt Polder and in the vicinity of Addington Point and Sturgeon Slough. The group consists of the Alouette, Sturgeon, Annis and Hallert soils. The most commonly associated managment groups are Lumbum, Vedder and Pitt.

The Alouette soil group has developed in medium-to-moderately fine textured fluvial flood-plain deposits which generally have between 15 and 40 cm of well to partially decomposed organic material on the surface. Included also are a few areas (Hallert soils) where the capping does not meet the criteria for organic deposits (greater than 30% organic matter). The organic matter content, however, approaches 30% and generally exceeds 20%. Hallert soils usually have several organic strata of varying thickness in the subsurface and subsoil as well.

Topographically, the Alouette group varies from nearly level or very gently sloping to gently undulating; slope gradients are generally less than 2%. The group typically occupies slightly depressional landscape positions in areas where adjacent soils are mineral to the surface or occurs in the transition between mineral soils and those that are organic. Elevations are generally less than 5 m asl.

Alouette management group soils are poorly to very poorly drained and moderately to slowly pervious. They have high to very high available water storage capacity and slow surface runoff. Groundwater tables are usually near, and often at, the soil surface during the winter and early spring. In areas where artificial drainage is installed the water tables recede over the growing season. In undeveloped areas, the water tables tend to remain high all year. Surface ponding of varying duration is common during periods of high rainfall.

The surface of Alouette group soils generally consists of black to dark grayish-brown, organic material usually containing small amounts of silt derived either from flood deposition or incorporated by cultivation from the subsurface. The surface is generally friable when moist but tends to develop hard granules when dry which are difficult to rewet. Under the organic surface layer, the mineral soil is to gray or brownish-gray, strongly gleyed, massive silt loam or silty clay loam or, occasionally, silty clay. Widely spaced vertical cracks develop as this material dries. With increasing depth, textures gradually become coarser and below depths of at least 50 cm, and more commonly, below 1 m, sand or loamy sand occurs. Root distribution and depth is restricted by the massive subsurface material and high water tables.

Alouette group soils have very high nutrient holding ability. Cation exchange capacity in the surface layer is generally greater than 60 meq/100 g. Organic matter content of the surface is also very high, usually in excess of 50%. Soil reaction in the organic surface layer is extremely to strongly acid and ranges between pH 4 and 5. In the subsurface and subsoil the reaction is slightly less acidic, varying from about pH 4.5 to 5.5.

Management Considerations

1) Poor drainage is the main agricultural limitation of Alouette group soils. Improved drainage to control both high water tables and surface ponding (and in some areas, flooding) is required to maintain most perennials, allow earlier cultivation and prevent flooding-out of annual crops. Some areas (northern Pitt Polder, Addington Point) require extensive reclamation by improved regional ditching, pumping and diking before intensive cropping can be undertaken. Underdrain spacings should be relatively close because of slowly to moderately pervious nature of the mineral subsurface and subsoil materials. Underdrains should be protected from clogging by the sandy material usually present in the lower subsoil.
2) Periodic subsoiling to loosen the massive subsoil, particularly where Annis soils occur, is beneficial for improving downward water movement, especially if underdrains are installed. Subsoiling also improves aeration and root distribution. Best results from subsoiling occur if the soils are relatively dry, usually the latter part of the summer.
3) Soil reaction is generally extremely acid and amendments (eg. liming materials) which improve and maintain the pH above at least 5.5 are beneficial for most crops.
4) Management which minimizes decomposition of the organic surfaces is generally beneficial. In many areas further decomposition will require that some of the silty to clayey underlying material be incorporated into the plow layer. This will result in lowered organic matter content, sticky consistence and cloddy surfaces. Restricting cultivation to the minimum required for the crop and avoiding excessively deep plowing are two methods which help to restrict organic decomposition and dilution.
5) The main locations of Alouette group soils occur in areas that have less than 50 mm of Climatic Moisture Deficit and this together with high available water storage capacities, suggests that in most years irrigation is not required on Alouette group soils. Occasionally however, extended climatically dry summer periods do occur when supplementary irrigation sustains continued good crop growth and production, particularly if the crops are shallow rooted.

Plate 3. Juncus sp. is a common invader of inadequately managed, poorly drained areas. In this instance the soils are part of the Alouette management group.

Plate 4. Drainage ditch installed in soils of the Alouette management group. The photo was taken looking east across the Pitt Polder area. Note the depth to the water table.

Plate 5. View across soils of the Alouette and Prest management groups in the undeveloped northern part of Pitt Polder area. Extensive dyking and water table control is required before these soils can be brought into intensive production.

BENSON SOIL MANAGEMENT GROUP

The Benson Soil Management Group, composed of only Benson soils, occupies a very small portion of the map area. It encompasses about 200 ha and occurs almost exclusively on the lowlands of Delta Municipality near Mud Bay. Management groups associated with the Benson group are generally Delta and Guichon.

The Benson group consists of moderately coarse to coarse textured, stone-free soils developed in deltaic deposits of the Fraser River. The group is slightly depressional to very gently undulating with slope gradients less than 2% and elevations are all less than 3 m asl.

The Benson management group is poorly to very poorly drained, rapidly to moderately pervious and has moderate to low water holding capacity and slow surface runoff. The water table is near the soil surface during the winter but gradually recedes during the summer. Droughty conditions frequently develop during the summer due to the low water holding capacity and sharply curtailed summer precipitation. Sea water from nearby sources readily seeps through the subsurface and subsoil causing the group to be moderately to strongly saline.

The texture of the black to very dark gray cultivated surface layer of the Benson group is usually sandy loam, varying sometimes to loam. Whitish salt crystals are frequently present when the soil is dry. Under the surface layer is gray to greenish-gray, massive, stratified loamy sand or sand (occasionally sandy loam) containing many yellowish, brownish or reddish mottles. Rooting is generally restricted to less than 60 cm depth by the strongly saline soil conditions and high water tables.

Benson group soils have high nutrient holding ability in the surface layer. Cation exchange capacity is in excess of 20 meq/100 g, due mainly to the medium to moderately high organic matter levels present. These are usually between 8 and 15%. Soil reaction in the upper soil is strongly acid with pH between 4.5 and 5.5. This gradually decreases to extremely acid (pH less than 4) in the subsoil. Electrical conductivity in the surface layer is generally well in excess of 4 mS/cm and, in the subsurface and subsoil, ranges from about 8 mS/cm to over 16 mS/cm.

Management Considerations

1) High water tables, especially during the winter months, severely limit Benson group soils for the production of perennial crops. Annual crops are less severely affected since water tables tend to recede sufficiently during the summer for relatively adequate saturation-free root zones to develop. Underdrains are required to control winter water tables as well as saline seepage. They require protection from clogging by the sandy subsoil materials.
2) Droughty conditions frequently develop during most growing seasons, due to low water holding capacity and usually low levels of precipitation. As well, the droughtiness conditions tends to enhance the adverse affects of the saline soil conditions on crop growth. Irrigation is required to provide adequate soil moisture. It also helps wash excess salts downward from the rooting zone, particularly if adequate drainage is installed.
3) The high salinity of Benson group soils, if not controlled, tends to limit crops to those that are tolerant of moderately to strongly saline conditions. Control, as mentioned

previously, includes artificial drainage and irrigation to remove as much of the excess salts as possible. With adequate control, most shallow-rooted crops tolerant of slight or moderate salinity should produce satisfactorily. Adequate fertilization, of course, is required as well.

4) The relatively coarse textures and rapid perviousness, together with adequate drainage, provides conditions which make the soils trafficable shortly after rainfall or irrigation. This is beneficial for crops that require cultivation, fertilization, harvesting, etc., at specific periods during the growing season.

5) Corrosion of underground installations (e.g. water lines), if not adequately protected, is likely because of the strongly saline and extremely acid and sulphurous soil conditions.

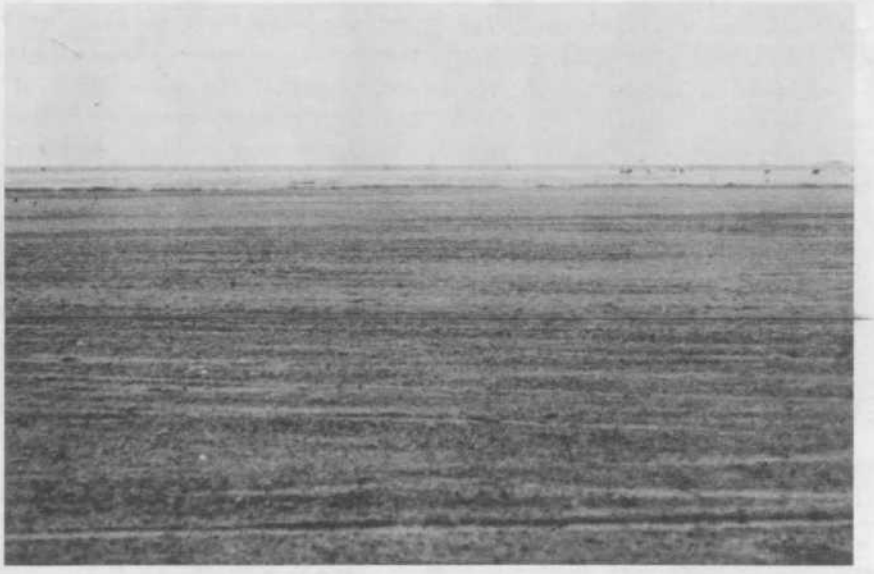

Plate 6. Newly planted turf on the Benson soil management group. Germination and crop growth in the darker areas is severely curtailed by high salinity.

BERRY SOIL MANAGEMENT GRUOP

The Berry Soil Management Group is limited to about 1300 ha in the map area and occurs mainly in the Langley Valley and north of Mission. Berry and Tunbridge soils comprise the management group with Berry soils substantially dominant in areal distribution. The Whatcom and Cloverdale management groups are often closely associated with the Berry group: north of Mission the Calkins group is closely associated.

The Berry soil group has mostly developed in clayey to silty, raised marine sediments (Berry soils). Soils developed from silty glaciolacustrine materials that occur in a small area north of Mission are also included (Tunbridge soils).

The topography of the management group is generally gently undulating to gently rolling with gradients less than 10%. Small areas along gullies and escarpments are steeply sloping. In the areas where it occurs, the Berry group tends to occupy intermediate landscape positions between the lower lying, poorly drained Cloverdale or Calkins groups and the higher, well to moderately well drained Whatcom group. Elevations range from about 15 to 75 m asl.

The imperfectly drained soils of the Berry group are moderately pervious in the surface and subsurface layers but become slowly pervious in the dense, compact subsoil below about 70 cm. Perched water tables develop above the slowly pervious subsoil during periods of heavy rain and lateral, downslope seepage develops. These brownish soils usually contain reddish mottles within 25 to 50 cm of the surface indicative of periodic reducing conditions. A dense layer enriched with illuvial clay is present at depths between 60 and 80 cm and this, coupled with the periodic, perched water tables, tends to limit rooting to depths less than 70 cm.

The Berry soil group is medium-textured in the surface and subsurface. Textures are mostly silt loam with some variation to silty clay loam. The subsoils are more variable with silty clay or clay the usual textures where the soils have developed from marine sediments and silt loam or silty clay loam where the materials are of glaciolacustrine origin. The surfaces are friable but subject to structure deterioration and compaction if cultivated or traversed when wet.

The Berry soil group has high to very high nutrient holding ability. Cation exchange capacity of the surface layer varies from about 30 to 45 meq/100 g. Organic matter content in the surface layer is moderate and generally falls between 5 and 10%. Soil reaction is usually moderately acid (between pH 5.6 and 6.5) in the upper part and gradually increases to near neutral in the subsoil. A few areas where Tunbridge soils occur may be strongly acid in the upper part.

Management Considerations

1) Soils in the Berry group are suited for a moderately wide range of crops. Perennial crops and others susceptible to root damage may be limited by perched high water tables unless artificial drainage is installed. Artificial drainage will not only provide water table control, it will also lessen seepage into adjacent, lower lying areas (usually Cloverdale or Calkins management groups) and increase rooting depth and distribution.
2) The Berry group is often closely intermingled with soils of other groups which require different management practises. This may cause variable crop maturity and problems in determining field boundaries and cropping and management practises.

3) Even though the soils have high water holding capacity, the availability of irrigation is good insurance against periodic, low rainfall growing seasons which sometimes occur. This is especially true if high-value, shallow rooted crops are being grown.
4) Management practises which at least maintain the present organic matter levels in the surface layer are important for the preservation of tilth.
5) Structure deterioration and compaction occurs when Berry group soils are cultivated, traversed or pastured by livestock when wet. This should be taken into account when management options are being developed. Occasional subsoiling to loosen the subsurface layers is beneficial for maintaining perviousness, aeration and rooting depth and distribution.

BLUNDELL SOIL MANAGEMENT GROUP

The Blundell Soil Management Group, composed only of Blundell soils, occurs in the Fraser River delta portion of the map area. It occupies about 750 ha and is most common in eastern Richmond Municipality and the northern Delta Municipality. The most commonly associated management groups are Delta and Alouette. Essentially all areas of Blundell group soils are currently developed for a variety of agricultural uses.

Blundell group soils have developed in medium-textured Fraser River deltaic deposits which are capped by between 15 and 40 cm of well to partially decomposed organic material. Sandy materials are usually present at depths of about 1 m and, on some of the smaller islands, may be somewhat shallower.

Level to very gently undulating with slopes less than 2% is the usual topography of the management group. The group is commonly slightly depressional in relation to adjacent soils (the Delta management group usually) and elevations all lie below 3 m asl.

The Blundell group is poorly to very poorly drained, moderately pervious and has slow surface runoff and high to very high available water storage capacity. The water table is either at or near the soil surface for most of the winter (except where artificially drained) but tends to recede somewhat during the growing season. Surface ponding is common during heavy rains. Below depths of about 75 cm, the soils are weakly to moderately saline and high levels of sulphur compounds become prominent.

The black to very dark brown surface layer of the Blundell group consists of friable, well-decomposed (humic) organic material usually containing slight to moderate amounts of admixed silty material. Under the organic surface is gray or grayish-brown, massive silt loam which grades to sandier material below 50 cm or more. A few, widely spaced vertical cracks and reddish to brownish mottles are usually present and below about 75 cm, hard, brownish tubules around old root channels also occur. Rooting is generally restricted to depths of 50 cm or less by high water tables and the massive nature of the subsoil.

Blundell group soils have very high nutrient holding ability in the surface layer and cation exchange capacities are generally well in excess of 50 meq/100 g. Organic matter content is also very high and usually varies between about 40 and 75%. Soil reaction is extremely acid throughout and ranges from about pH 4.5 or 5 in the upper part to less than 3.5 in the lower subsoil. Electrical conductivity below about 75 cm generally ranges between 4 and 8 mS/cm.

The Blundell management group is generally similar to the Alouette group except that the Alouette group is not saline in the subsoil.

Management Considerations

1) Poor drainage is the main agricultural limitation of Blundell group soils and is particularly restrictive for overwintering perennials and other crops that require either early spring planting or late fall harvesting. Artificial drainage sufficient to control high water tables and surface ponding will allow overwintering of most perennials, improve trafficability of the land and prevent flooding-out of crops during the growing season. Underdrains should be protected from clogging by the fine sandy material usually present in the lower subsoil.

2) Occasional subsoiling to loosen the massive subsoil is beneficial for improving downward water movement, especially if underdrains are installed. Subsoiling also helps to improve aeration and root distribution. Maximum disruption occurs when the soils are relatively dry, usually during the latter part of the growing season.
3) Subsoil salinity is usually sufficiently deep to have little effect on shallow rooted crops; deeper rooted crops may be adversely affected. Underdrains help in reducing the salinity, especially if irrigation is also available to wash out the salts. Irrigation also helps maintain good crop production during extended climatically dry summer periods, especially if crops are shallow rooted.
4) Soil amendments (e.g. liming) which increase and maintain soil reaction above at least 5.5 are beneficial for most crops.
5) Management which minimizes further decomposition of the friable organic surface is generally beneficial. In many areas further decomposition will require that some of the silty underlay be incorporated into the cultivated layer. This will likely result in decreased nutrient holding ability, sticky and slippery consistence and cloddy surfaces. Restricting cultivation to the minimum required for the crop and avoiding excessively deep cultivation are two methods which help restrict organic matter decomposition and dilution.
6) Subsoil material from ditches and other excavations spread over the adjacent land is likely to cause depressed crop growth due to the extremely acid and moderately saline nature of the material.
7) Underground installations such as foundations and pipes, if not adequately protected, are likely to suffer severe corrosion from the saline, sulphurous extremely acid soil conditions.

Plate 7. Severe crop damage due to surface water accumulation is common in many areas if adequate drainage is not provided. (M. G. Driehuyzen photo)

BOSE SOIL MANAGEMENT GROUP

The Bose Soil Management Group, composed of Bose, Langdale and Porpoise soils, occupies large areas on the uplands of the western part of the map area. It occupies about 18 050 ha in total, mostly on the uplands of Langley, Surrey and Delta municipalities and on the Sunshine Coast between Gibsons and Sechelt. Management groups occuring in close association with the Bose group commonly include Heron, Sunshine, Lehman, Whatcom and Capilano. Large areas of Bose group soils are still undeveloped for agricultural uses, mainly because of rather severe management limitations which have to be overcome.

Bose group soils have developed from moderately to very stony and gravelly littoral, glaciofluvial and slopewash deposits, usually between 50 and 150 cm thick, which overlie compact glacial till or glaciomarine deposits. A few small areas developed from glacial till are also included (Porpoise soils).

Topography of the group is variable and generally ranges from gently sloping or undulating to steeply sloping and strongly rolling; gradients are mostly between 5 and 30% with a few areas as steep as 50%. Most areas lie at elevations below 200 m although the Langdale soils sometimes range to about 750 m asl.

Bose management group soils are moderately well to well drained. They are rapidly to moderately pervious in upper, gravelly part but become slowly pervious in the compact subsoil. Available water storage capacity and is low to moderate and surface runoff is slow to moderate. Temporary perched water tables develop above the compact subsoil during periods of heavy, prolonged precipitation and lateral seepage develops along its surface during these periods.

Textures of the friable, reddish-brown surface layer of Bose group soils are generally moderately to very cobbly and stony, gravelly sandy loam or gravelly loamy sand, varying sometimes to sandy loam or loamy sand. These grade to loose or friable gravelly sand, gravelly loamy sand or gravel in the subsurface and upper subsoil. Weakly cemented patches are commonly present and stones and cobbles often occupy up to about 25% of the soil volume. The subsoil consists of compact sandy loam glacial till or clayey glaciomarine sediments. Rooting depth and distribution is moderately restricted by the coarse subsurface and subsoil textures and compact, dense lower subsoil.

Bose group soils have low to moderate nutrient holding capacity. Cation exchange capacity is generally less than 15 meq/100 g in the surface soil layer and decreases to less than 10 meq/100 g in the subsurface and subsoil. Soil reaction is strongly acid in the surface, usually ranging between pH 4.5 and 5. This increases slightly to about pH 5 or 5.5 in the subsoil. Organic matter content is low, generally less than 5% in the surface layer.

Management Considerations

1) Soils in the Bose management group are moderately to severely limited for agricultural cropping. They are coarse-textured and droughty. Irrigation is generally required for good, substantial crop production, particularly during the latter parts of the growing season. Low water storage capacities suggest that irrigation intervals be short. The amount of water added per application should be closely controlled since excessive amounts will cause perched water tables and seepage above the compact subsoil.

2) Moderate to intensive stone-picking is generally required on Bose group soils. Some areas are sufficiently stony that permanent pasture is probably the best agricultural land use. Root crops are generally unsuited because of the stony and gravelly nature of these soils.
3) In some areas Bose group soils are severely limited by adverse topography. Areas should be evaluated individually in regard to their topographic suitability for the crops considered, machinery limitations and erodibility.
4) Because of generally low nutrient holding ability, split applications of fertilizer are probably best, particularly if large amounts are required by the crops being grown. Strongly acid conditions suggest that liming to increase pH values is generally required for most crops.
5) Barnyard manure, green manure crops or other management practises which increase organic matter content are beneficial. Increased organic matter contents will improve nutrient and water holding ability and improve tilth.

BUNTZEN SOIL MANAGEMENT GROUP

The Buntzen Soil Management Group occupies substantial parts of the uplands and lower mountain slopes of the map area, particularly north of the Fraser River and west from the Hatzic Valley. The group, totalling about 16 750 ha, consists of Buntzen, Steelhead and Surrey soils. Bose and Sunshine management groups are sometimes associated with the Buntzen group. Generally however, the associated soils are unsuited for agricultural uses because of excessive stoniness, shallowness to bedrock or steep slopes. Only small areas of Buntzen group soils are developed for agriculture at the present time due, at least in part, to relatively severe limitations these soils have for agricultural cultivation and cropping.

Buntzen group soils have developed from moderately coarse and occasionally medium-textured glacial till which usually has silty eolian material either on or incorporated into the upper 20 to 40 cm. A continuous, strongly cemented layer is present at depths between 75 and 100 cm.

Topographically, the group varies from moderately sloping to hilly with most gradients between 5 and 30%; locally some slopes may be as steep as 50%. Elevations range from about 20 to over 500 m asl; most agriculturally suited areas however, lie below 200 m asl.

Soils in the Buntzen soil management group are mostly moderately well and sometimes imperfectly drained. They are moderately to rapidly pervious in the upper part but this decreases abruptly to slow in the compact, cemented subsoil. Lateral seepage is common along the surface of the cemented zone during and after heavy rain and during snowmelt. On lower slopes and in slightly drepressional areas temporary perched water tables usually develop (Steelhead soils). The group has moderate water holding capacity and slow to moderate surface runoff.

The friable, reddish-brown surface layer of Buntzen group soils varies from loam to gravelly sandy loam and contains common to many cobbles and stones. The subsurface is similar in texture but usually is somewhat higher in gravel, cobble and stone content, while the strongly cemented subsoil is gravelly sandy loam and extremely firm. Rooting is limited to the depth of soil above the cemented layer and root mats are common on its' surface. In lower slope and depressional landscape positions the temporary, perched water tables also moderately limit rooting depth.

Buntzen group soils have moderate to high nutrient holding ability in the upper soil where cation exchange capacities vary between about 25 and 50 meq/100 g. Organic matter content is moderate and varies from approximately 5 to 12%. Soil reaction is strongly acid in the upper part (pH values are usually between 4.5 and 5.5) and gradually increases to between pH 5 and 6 in the lower subsurface and subsoil.

Management Considerations

1) Most areas of Buntzen group soils are moderately to severely limited for agricultural cultivation and cropping. Adverse topography is one of the main limitations and many of the steeper, higher elevation areas are probably best left in a forested state. More gently sloping areas can be satisfactorily developed but cropping will likely be restricted to those crops which do not require uniform maturity or equipment which is not limited by moderate slopes. Management practises (e.g. cover crops, contour cultivation, etc.) which guard against erosion are also required, particularly on the more steeply sloping areas.

2) Stoniness is also a usual limitation of Buntzen group soils. Moderate to intensive stone picking is generally required to prepare good seedbeds and provide conditions suitable for efficient cultivation.
3) Rooting depth is somewhat restricted by the subsoil cementation, particularly if deep rooted crops are produced. Subsoiling is unlikely to be effective since the cemented zone may be as thick as 50 cm and the underlying soil parent material (glacial till) is only slightly less compact than the cemented zone.
4) Lower slope and depressional areas are likely to require installation of interception drainage or similar structures to control temporary perched water tables and seepage, especially if perennial or other crops susceptible to these conditions are being produced.
5) Liming or other amendments to increase soil reaction to at least pH 5.5 or 6 is required for good production of most crops.
6) Moderate available water storage capacities suggest that irrigation is generally beneficial for good sustained crop growth, particularly during the latter parts of the growing season and if crops are shallow rooted. The location of most areas of Buntzen group soils usually receive somewhat more precipitation than areas in the valley proper and moisture deficiencies are less likely to be severe and prolonged.

CAPILANO SOIL MANAGEMENT GROUP

The Capilano Soil Management Group occurs on the uplands and lower mountain slopes of the map area. It is prevalent between Gibsons and Sechelt on the Sunshine Coast, in the vicinity of the Alouette Valley south of Alouette Lake, in the Norrish and Statlu creek valleys and near Steelhead. Smaller areas also occur on the uplands of Delta and Surrey municipalities. It occupies about 11 700 ha in total and is composed of Capilano, Roach and Haney soils. The most commonly associated management groups are Bose and Buntzen. Only small areas of the group are currently developed for agricultural uses due, at least in part, to relatively severe limitations.

The Capilano group has developed in deep, coarse-textured (gravelly), cobbly and stony glaciofluvial, deltaic and marine lag deposits. Strongly to moderately cemented layers are usually present at depths below about 50 to 75 cm.

Topography of the group is variable. Moderately to strongly sloping or gently to strongly rolling with gradients between 10 and 30% are most common although areas with slopes as low as 5% or as steep as 50% also occur. Elevations generally range between 30 and 200 m asl although some areas in the Statlu and Norrish valleys range to near 500 m.

Soils in the Capilano group are mostly well to rapidly drained. A few moderately well drained inclusions also occur (Roach soils). These soils are rapidly pervious and have low water holding capacity and slow surface runoff. In some lower slope or depressional locations, very temporary perched water tables and lateral seepage develop during periods of heavy rain or during snowmelt.

The texture of the reddish-brown surface layer of Capilano group soils is mostly very stony and cobbly gravelly loamy sand, occasionally varying to gravelly sandy loam. The subsurface and subsoil are generally very stony gravelly sand or very gravelly sand and are usually strongly cemented at depths beginning between 50 and 75 cm of the surface. Rooting depth is restricted by subsoil cementation to depths less than 75 cm and distribution is strongly curtailed by the stony and gravelly nature of the soil material.

Capilano group soils have low to moderate nutrient holding ability. Cation exchange capacity of the upper soil is generally less than 20 meq/100 g and decreases with increasing depth. Organic matter content in the surface mineral layer is also low to moderate and ranges from about 4 to 8%. Soil reaction is strongly acid in the upper part with pH usually between 4.5 and 5.5: this gradually increases to near pH 6 in the lower subsoil.

Management Considerations

1) Capilano group soils are generally moderately to severely impaired for agricultural uses by adverse topography which limits the choice and kind of machinery able to be employed. Areas with slopes greater than about 20% are probably best left in an undeveloped state.
2) Stoniness is usually also a severe limitation of Capilano soils and substantial stone picking is generally required to produce conditions for efficient cultivation and prevent severe wear-and-tear on implements. Some areas are sufficiently stony to preclude agricultural development.
3) Low water holding capacities and resulting droughtiness during the growing season require that supplemental irrigation be available for maintaining adequate crop growth.

4) Low nutrient holding ability suggests that most fertilizer additions be applied as split applications over the growing season. Liming or other soil amendments which increases soil reaction to at least pH 5.5 or 6 is beneficial for the good growth of most crops.
5) During landclearing care must be taken to minimize exposure of the subsurface and subsoil materials. Exposure of these materials at the surface will only enhance the already coarse-textured, severely stony nature of these soils and further lower the organic matter content with resultant decreases in nutrient and water holding capacities.
6) Additions of barnyard and/or green manure is highly beneficial to increase the organic matter content of the upper soil. Increases will improve the tilth of the soils and improve nutrient and water holding ability.

CARVOLTH SOIL MANAGEMENT GROUP

The Carvolth Soil Management Group, consisting of Carvolth and Ross soils, occupies small scattered areas on the uplands of the map area. It occupies about 1050 ha in total and is most common in Surrey, Langley and Matsqui municipalities. Cloverdale, Whatcom and Sardis management groups are often closely associated with the Carvolth group.

Carvolth group soils have developed in stone-free, medium to moderately fine textured fluvial deposits of streams which flow across or are incised in the upland areas. The deposits usually occur as narrow floodplains or low terraces along the stream margins and consist mainly of material originally eroded from upstream sources. Topography varies from nearly level to gently undulating with slope gradients generally less than 5%. Elevations range between about 10 and 100 m asl.

The soils in the Carvolth management group are poorly to very poorly drained. They are slowly to moderately pervious, have high water holding capacity and slow to moderate suface runoff. The poorly drained conditions are the result of lateral seepage and flooding from adjacent streams and seepage and runoff from higher adjacent areas. During periods of high rainfall, water levels in the streams rise and flooding for varying periods is common.

The friable, dark grayish brown to dark gray surface layer of Carvolth group soils is usually silty clay loam or silt loam in texture. The gray subsurface and upper subsoil are generally massive, firm, silty clay loam or silty clay and contain common reddish and brownish mottles. The lower subsoil in Carvolth soils is similar while in Ross soils sandy and/or gravelly strata sometimes occur. Rooting is generally restricted to the upper 50 cm by the high water tables and dense, massive nature of the subsoil.

Carvolth group soils have very high nutrient holding ability with cation exchange capacities generally between 30 and 40 meq/100 g in the surface layer and between 20 and 30 meq/100 g in the subsurface. Soil reaction is generally strongly acid in the surface and ranges between pH 4.5 and 5.5; this gradually increases to pH 6 or 6.5 in the subsoil. Organic matter content is medium to moderately high in the surface layer and usually varies between about 7 and 15%.

Management Considerations

1) The main agricultural limitation of Carvolth group soils are poor drainage and the potential for flooding during high rainfall periods. Underdrains to control water tables are generally required and dyking or some other stream control is usually needed to prevent stream overflow and flooding. Interception ditches to control seepage and runoff from adjacent areas should also be considered.
2) Carvolth group soils usually occur as long, narrow, discontinuous strips along stream margins which often makes them difficult to manage individually. Access to the soils in some areas is difficult because of their incised landscape locations.
3) Occasional subsoiling is generally beneficial to loosen the dense subsoil and improve rooting depth and distribution, aeration and water movement, particularly if adequate drainage has been installed.
4) During the rainy winter period especially, when danger of flooding is greatest, Carvolth group soils are susceptible to surface water erosion. Cover crops or other adequate surface protection are beneficial to minimize this potential resource loss.

CLOVERDALE SOIL MANAGEMENT GROUP

The Cloverdale Soil Management Group occupies about 5950 ha on the uplands of the map area. It mostly occurs in the Hazelmere Valley, near Cloverdale, in the Langley Valley around Milner, north and east of Haney and southeast of Murrayville. Cloverdale and Albion are the dominant soils in the management group; Langley soils, even though they have some surface characteristics which differ from the previous two soils, are included because of their limited areal extent. The most common associated management groups are Whatcom and Berry. Most areas of Cloverdale management group soils are currently developed for agricultural uses, mainly forage crops and pasture.

The Cloverdale group has developed in clayey, glaciomarine and raised marine sediments. The topography generally varies from nearly level or gently undulating to gently sloping; slope gradients are less than 5%. The management group usually occupies the lower landscape positions in the areas where it occurs; the associated Whatcom and Berry groups usually lie somewhat higher. Elevations range from about 15 to 75 m asl.

Soils in the Cloverdale management group are slowly pervious and poorly to moderately poorly drained. In undrained areas perched water tables are usually present during the winter months and other prolonged rainy periods. Temporary surface ponding is also common during these periods due to slow permeability. The soils have high water holding capacity and slow to moderate surface runoff. Surfaces vary from dark gray to black while subsoils are gray (gleyed) and contain variable amounts of reddish and brownish mottles. A dense layer enriched with illuvial clay is usually present at about 50 cm depth and this, coupled with high watertables, generally limits rooting to about 40 to 50 cm.

The stone-free soils in the Cloverdale group are fine or moderately fine in texture. Surface layers are generally clay loam or silty clay loam and grade to silty clay, clay or clay loam in the subsurface and subsoil. The surfaces are subject to structure deterioration and puddling if cultivated when wet; conversely, dry cultivation tends to produce hard, cloddy structures. Langley soils are generally somewhat less susceptible to structure problems due to higher organic matter contents.

The Cloverdale soil group has high to very high nutrient holding ability. Cation exchange capacity in the surface layer is usually well in excess of 30 meq/100 g. Organic matter content in the surface layer is medium to moderately high and varies from about 8 to 15% except in the Langley soils where it is high and usually ranges between 20 to 30%. Surface soil reaction is somewhat variable, depending on past management history but usually is moderately to strongly acid with pH values between 5 and 5.8. These gradually increase to neutral or moderately alkaline in the lower subsoil (between pH 6.5 and 7.8).

Management Considerations

1) With good and careful management, the Cloverdale group is suitable for a moderately wide range of crops. The main management concerns center around water control, high clay content and dense subsoils.
2) Artificial drainage to control the water tables as well as removing periodic surface ponding is one of the important management requirements of Cloverdale soils. Close drain spacings are required because of the dense, slowly pervious nature of the soils.

3) Subsoiling is beneficial to loosen subsurface and subsoil layers and improve aeration, water movement and rooting depth and distribution. The best results are usually achieved when the soils are relatively dry.
4) Cultivation when wet produces compaction, puddling and structure destruction. Cultivation when dry, on the other hand, tends to produce surfaces of hard clods. To produce a good seedbed, therefore, requires cultivation when the soils are moist and within a narrow range of moisture content.
5) Cloverdale soils have high to very high moisture holding capacity. The high clay content and relatively shallow rooting of most crops in these soils however, tends to produce droughty conditions and decreased productivity during the latter parts of some growing seasons. Irrigation as required guards against these problems and should be considered, particularly if shallow rooted, high value crops are being produced.
6) Power requirements for cultivation are high on Cloverdale group soils. Traction is severely limited when the soils are wet.
7) Soils in the Cloverdale group are relatively unsuited for farmsteads and similar construction. The slowly pervious soils limit septic tank effluent fields and water disposal from yards, animal feeding and similar areas. The relatively low bearing strength of the soils may require that special foundations be provided for silos and other heavy structures.

Plate 8. Decreased traction, severe structure deterioration and compaction all result from accessing land when it is wet. (M. G. Driehuyzen photo)

COGHLAN SOIL MANAGEMENT GROUP

The Coghlan Soil Management Group occupies small, scattered locations on the map area uplands. About 450 ha occur, mainly in the vicinities of Hopington, Steelhead, near the Abbotsford airport and south of Langley. Coghlan soils dominate in the management group while Errock soils occupy a few, lesser important areas. Columbia, Lehman, Defehr and Capilano management groups are often closely associated with the Coghlan group.

Coghlan management group soils have developed in coarse-textured, gravelly and stony glaciofluvial deposits which, in some areas, have small amounts of silty eolian material mixed into the surface (Coghlan soils). The soils are strongly cemented in the subsurface and sometimes, in the subsoil.

Topographically, the group varies from nearly level to gently undulating with slopes less than 5%. Usually the group occupies slightly depressional landscape positions when compared to adjacent, better drained soils. Most areas lie at elevations between 30 and 50 m asl but occasionally range substantially higher in small areas in the mountain valleys.

Coghlan group soils are imperfectly drained. They are rapidly pervious and have slow surface runoff and low to moderate water holding capacity. They are subject to seepage, and sometimes runoff, from adjacent higher areas and fluctuating, perched water tables develop during periods of high precipitation.

The brownish, moderately to excessively stony surface layer of Coghlan group soils is usually gravelly sandy loam or gravelly loamy sand in texture, varying in a few locations to loam or sandy loam where the silty eolian capping is deeper than usual. The subsurface and subsoil are gravelly sand or sandy gravel containing high proportions of cobbles and stones. A strongly cemented to indurated zone, about 40 to 50 cm thick begins approximately 25 to 30 cm below the soil surface. Rooting is generally restricted to about 30 to 40 cm depth by the subsoil cementation and coarse, stoney subsoil textures.

Coghlan group soils have low to moderate nutrient holding capacity. Cation exchange capacity is usually less than 15 meq/100 g in the surface layer and decreases with increasing depth. Reaction is the upper soil is strongly acid and ranges from about pH 4.8 to 5.3. This gradually increases to moderately acid in the subsoil. Organic matter content is moderate in the upper 25 cm and usually ranges between 5 and 10%.

Management Considerations

1) Low water holding capacity and stoniness are the main agricultural limitations of Coghlan group soils. Irrigation, particularly during the latter parts of most growing seasons, is generally required for sustained crop growth and production. The irrigation interval is relatively short due to low water holding capacity of the soils.
2) Coghlan group soils generally require stone picking to improve cultivation efficiency and decrease wear-and-tear on machinery. Some areas of Coghlan group soils are excessively stony, particularly the Errock soils, and are probably best used as permanent pasture or left in an undeveloped state. Root crops are generally unsuited for Coghlan group soils.

3) The strongly cemented subsurface requires disruption by subsoiling to improve rooting depth and distribution. Subsoiling should precede stone-picking since the previous operation is likely to raise to the surface variable amounts of stones and cobbles.
4) Water control is required if crops susceptible to periodic high water tables are considered. The control is particularly important for the overwintering of perennials.
5) Liming or other soil amendments which raise soil reaction to at least pH 5.5 or 6 are beneficial for most crops. Split fertilizer applications are suggested due to the relatively low nutrient holding ability of the soils, particularly if large amounts of fertilizer are to be added.

COLUMBIA SOIL MANAGEMENT GROUP

The Columbia Soil Management Group, composed only of Columbia soils, occupies about 5700 ha on the uplands of the map area. The largest areas of the management group are in the Columbia Valley south of Cultus Lake, in the vicinities of Hopington and Peardonville, in Glen Valley and south of Langley. Abbotsford, Lehman, Defehr and Lynden are the management groups most often closely associated with the Columbia group.

The Columbia management group has developed in deep, gravelly, coarse-textured glaciofluvial deposits, usually with a thin (less than 20 cm), silty, eolian layer mixed into the surface. Common to many stones and cobbles occur in both the surface and subsoil. Level to gently undulating or gently sloping with gradients up to 5% is the usual topography although scattered areas with slopes to 20% also occur. Elevations mostly lie between 30 and 100 m asl but range to 200 m in the Columbia Valley.

The reddish-brown Columbia soils are well to rapidly drained. They are rapidly pervious and have slow surface runoff. They have low to moderate water holding capacity and are droughty during most summers.

Textures of the friable surface layer are mostly gravelly sandy loam or sandy loam with occasional variation to loam or gravelly loamy sand. These grade to gravelly sand, sandy gravel or, occasionally, coarse sand in the subsurface and subsoil. No significant rooting restrictions other than those imposed by the gravelly and stony subsurface textures, are present to depths of 100 cm or more.

Columbia group soils have moderate to low nutrient holding ability. Cation exchange capacities of the surface layer are usually less than 20 meq/100 g. Soil reaction in the surface is strongly to moderately acid (between about pH 5.2 and 5.8) and decreases to moderately acid in the subsoil. Organic matter content in the surface layer is generally low and averages around 4 to 5%.

Management Considerations

1) The main agricultural limitation of Columbia group soils is low water holding capacity which causes droughty conditions during most summers. Irrigation is generally required for good crop production, particularly during the latter parts of the growing season. Irrigation interval should be relatively short due to the low water holding ability, and individual applications should be relatively small. Excessive applications will drain downward out of the root zone and will be of little benefit to the crops grown.
2) Surface stoniness is a hinderance in most areas and stone picking should be considered to improve cultivation efficiency and limit wear-and-tear on machinery. The shallow depth to the gravelly and stony subsurface limits or precludes production of root crops in many areas.
3) Because of the relatively low nutrient holding capacity of the Columbia soil group, split applications of fertilizer should be considered, particularly if crops requiring high applications are being produced. Nutrient and water holding ability will increase if manuring and other management practises to increase organic matter content are implemented.

CRESCENT SOIL MANAGEMENT GROUP

The Crescent Soil Management Group, composed of the Crescent and Kitter soils, occupies about 3450 ha in the Fraser River delta portion of the map area. The group is common in the southern part of Richmond Municipality, on Westham and Crescent islands, and near Mud Bay. The most commonly associated management group is Delta.

The Crescent group of soils has developed in medium-textured deltaic deposits, mostly originating from the Fraser River. At depths below about 100 cm the Crescent group becomes saline and compounds high in sulphur appear.

The topography of the group is gently undulating or undulating with gradients less than 5% and usually, less than 2%. The Crescent group occupies the highest landscape positions in the areas where it occurs. The adjacent, slightly lower lying areas are usually occupied by the Delta management group. Elevations are all less than 3 m asl.

The Crescent soil group consists of moderately pervious, moderately poorly or sometimes, imperfectly drained soils which have high waterholding capacity. High water tables and saturated conditions are usual during the winter but presently installed ditches, underdrains and pumping are usually sufficient in most areas to provide a moderate saturation-free rooting zone for most crops during the growing season.

The group consists of stone-free, medium-textured soils whose surfaces are friable to firm silt loam or occasionally, silty clay loam. Similar textures generally carry downward to about 100 cm where they change to sand or loamy sand. Surface layers are generally dark grayish brown while the subsurface and subsoil is grayish-brown to dark gray and contains common to abundant reddish and brownish mottles. Rooting depth and distribution is moderately restricted by relatively dense, periodically staturated subsurface and subsoil layers.

Crescent group soils have high to moderate nutrient holding ability. Their cation exchange capacity is usually between 15 and 30 meq/g. Organic matter content in the surface, cultivated layer is medium to low and usually ranges between 4 and 10%. The reaction of this layer is somewhat variable depending on management history, but mostly is between pH 5 and 6.5. With increasing depth the reaction decreases until at about 100 cm it usually is below pH 4.3. Conversely, electrical conductivity usually increases to in excess of 4 mS/cm below about 100 cm.

Management Considerations

1) The agriculturally important Crescent soil group is suited for most climatically adapted annual crops which are not strongly susceptible to periodic saturated soil conditions. Perennial crops are limited to those which can withstand the relatively high water table conditions during the winter months. Artificial water control during the growing season is sufficient for most crops. Improved control during the rainy winter months will widen the range of possible crops and increase their overwintering ability.
2) Periodic subsoiling is beneficial and improves aeration, water movement and rooting depth and distribution. The best results occur if the soils are relatively dry when the subsoiling is undertaken.

3) Management practices which increase and maintain organic matter contents in the surface layer, especially where it is currently low, will improve surface soil structure, friability and nutrient holding ability. Cover crops and the maintenance of surface trash over the winter months will help protect the soil surface from sealing due to raindrop impact and improve water infiltration.
4) The subsoil salinity (beginning at about 100 cm) is generally sufficiently deep to have little or no adverse impact on other than the most deeply rooted crops. Soil amendments which maintain surface pH at least between 5.5 or 6.0 is beneficial for most crops.
5) Distribution of subsoil material from ditch excavation or cleaning on the land surface may be detrimental for many crops because of the extremely acid reaction and often saline character of the material.
6) The availability of irrigation, even though soil water holding capacities are high, is beneficial to protect against extended, climatically dry periods that often occur in the delta area. This is especially true if high value, shallow rooted crops are being produced.
7) Concrete, metal pipes, and similar installations located in the subsoil, if not adequately protected, are likely to be subject to severe corrosion by the saline, sulphurous and acidic soil conditions.

Plate 9. The Crescent soil management group is suitable for a wide range of crops. Here cucumbers are being grown on the group in the southern part of Richmond Municipality.

Plate 10. Canning peas and bush beans are common crops in parts of the map area. These are being grown on soils of the Crescent and Delta management groups on Westham Island.

DELTA SOIL MANAGEMENT GROUP

The agriculturally important Delta Soil Management Group occupies about 6300 ha in the Fraser delta portion of the map area. It is common in Delta and Richmond municipalities and in the Serpentine - Nicomekl valley of Surrey Municipality near Mud Bay. Delta and Westham are the dominant soils in the management group with lesser areas occupied by the Deas, Embree, Mathews, Nicomekl and Sandel soils. The Crescent, Lumbum, Spetifore and Ladner management groups are usually closely associated with the Delta group.

The Delta soil group has developed in medium-textured deltaic deposits, mostly originating from the Fraser River. Saline conditions generally occur at depths between 60 and 100 cm. Compounds high in sulphur content are present at these depths as well.

The topography of the management group is gently undulating or undulating with slope gradients less than 5%; most are less than 2%. The Delta group occupies the lower slopes and shallow depressions in the landscape. The higher areas are occupied by the Crescent group while lower lying areas are usually part of the Spetifore or Lumbum groups. Elevations all lie less than 3 m asl.

The Delta management group consists of moderately to slowly pervious, poorly drained soils with high waterholding capacity. High water tables and saturated soil conditions are usual during the winter months and early part of the growing season. Surface ponding is common in the depressional areas after heavy prolonged rain. The high water tables generally recede sufficiently over the growing season (due mainly to existing artificial drainage) to provide a moderate saturation-free surface layer suitable for many shallow-rooted annual crops.

The soils in the Delta management group are medium-textured and stone-free. Surfaces usually consist of friable to firm silt loam, varying sometimes to silty clay loam or occasionally, to loam. Textures similar to the surface carry into the subsurface and subsoil to depths of at least 50 cm and usually to about 100 cm where they change, often abruptly, to medium or fine sand or loamy sand. One or more moderately to well decomposed organic strata are sometimes present in the subsoil (Embree soils) but generally total less than 30 cm in thickness. The surface of Delta group soils varies from very dark gray to black in color; this is underlain by gray (strongly gleyed), mainly massive material which often cracks vertically on drying and contains variable amounts of reddish and brownish mottles. At depths around 75 cm the mottles often become yellow or brownish-yellow and usually coincide with the beginning of the saline subsoil high in sulphur compounds. More or less vertical tubules with hard, reddish or brownish walls formed around old root channels are commonly present as well. Rooting is usually restricted to depths of less than 60 cm by the relatively dense subsoil and high water tables.

Delta group soils have high to very high nutrient holding ability. Cation exchange capacities are generally well in excess of 20 meq/100 g. Organic matter content in the cultivated surface layer is relatively high, ranging from about 12% to 25% (except in the Westham soils where it generally lies between 5 and 10%). Surface soil reaction is variable, depending on management history but generally lies between pH 4.5 and 6.0. It then gradually decreases with increasing depth until at about 75 cm, it generally is less than pH 4.5 and often, less than pH 4. Conversely, electrical conductivity gradually increases to greater than 4 mS/cm at depths between 50 and 100 cm.

Management Considerations

1) Most annual crops not strongly susceptible to periodic saturated soil conditions currently grow reasonably well on Delta group soils due mainly to existing drainage systems. Improved drainage, particularly over the wet winter months will improve overwintering of most perennials as well as allowing earlier cultivation in the spring. The relatively slow perviousness of the soils requires that underdrains have close spacings. Drainage tends also to help flush excess salts from the lower soil layers.
2) Periodic subsoiling is beneficial for improving aeration, water infiltration and root distribution and depth. For maximum soil disruption the subsoiling should occur when the soils are relatively dry. In some areas plow pans (dense, compact layers immediately below the cultivated zone) have developed due to continuous cultivation to the same depth. Subsoiling disrupts the pan and cultivation to variable depth tends to limit its reformation.
3) Cover crops and surface trash over the winter months assists in protecting the soil surface from sealing due to raindrop impact and resulting lowered water infiltration. Surface ponding of water is also reduced. Management practises which increase organic matter in the Westham soils will improve surface structure and nutrient holding ability.
4) Subsoil salinity generally adversely affects only deep rooted crops. Management which prevents rising of the salts by capillary action is beneficial. Underdrains to flush salts form the subsoil, together with irrigation to wash salts downward and prevent capillary rise of salty water should maintain a generally salt-free zone.
5) Soil amendments which increase and maintain pH of the surface soil layer at least between 5.5 and 6.0 is beneficial for most crops.
6) Distribution on the land surface of subsoil material from ditch excavation or cleaning may be detrimental for many crops because of the extremely acid reaction when the material dries as well as its usually saline character.
7) Even though waterholding capacities are high, availability of irrigation is good protection against extended, climatically dry periods that sometimes occur, especially if high-value, shallow rooted crops are being grown.
8) Concrete, metal pipes, and similar installations in the subsoil, if not adequately protected, are likely to suffer severe corrosion due to saline, acidic and sulphurous soil conditions.

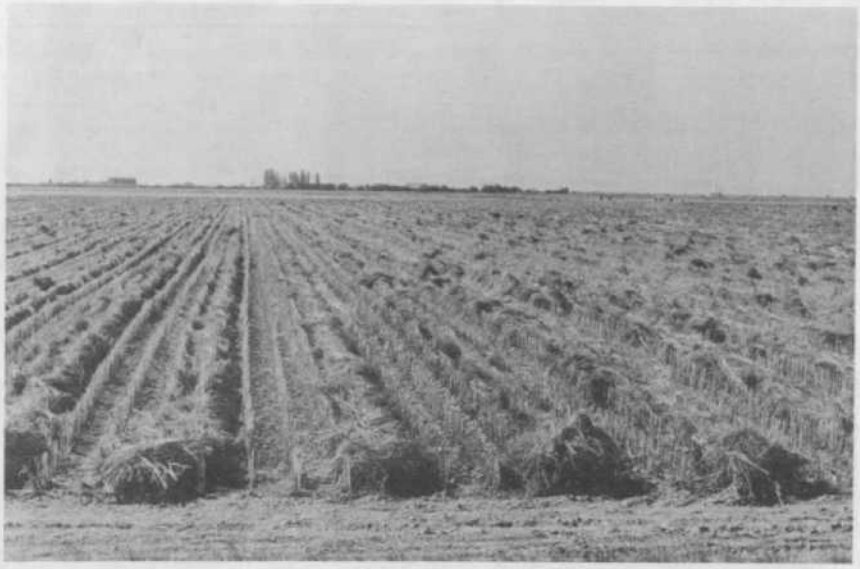

Plate 11. Swathed sugar beets on Westham Island being harvested for seed. This crop is usually grown on soils of the Crescent and Delta management groups.

Plate 12. Surface ponding of water in the Delta area. High amounts of precipitation, particularly during the winter, coupled with high water tables and relatively low soil perviousness causes water to accumulate on the surface for varying lengths of time. (M. G. Driehuyzen photo)

ELPHINGSTONE SOIL MANAGEMENT GROUP

The Elphingstone soil management group, composed only of Elphingstone soils, occupies a few small areas scattered in the mountainous portions of the map area. The largest area occurs in the vicinity of Mount Elphingstone, northwest of Sechelt. In total, the management group covers about 60 ha. Adjacent areas generally consist of the Non-agricultural soil management group.

The Elphingstone management group has developed in partially decomposed organic deposits between 60 and 140 cm thick. The organic material is mainly derived from sedge, reeds and grasses while the underlying deposits are generally glacial till or, occasionally, alluvium. Topography varies from depressional to gently rolling and runoff and seepage accumulation are usual. Elevations range between 300 and 1200 m asl.

Drainage of the Elphingstone soil group is very poor. The soils are generally saturated for most of the year and surface water accumulation is common. Rooting of the water tolerant, native reeds, sedges, grasses and forbs is mainly restricted to depths of less than 70 cm.

The Elphingstone group generally has a relatively undecomposed surface layer about 20 cm thick consisting mainly of reed, sedge and grass remains. This is underlain by about 70 cm of partially decomposed material that grades to a well humified zone about 10 cm thick immendiately above the mineral contact. The mineral underlay is usually gravelly sandy loam in texture.

Nutrient holding capacity of the Elphingstone management group is very high. Cation exchange capacity is well in excess of 40 meq/100 g. Soil reaction is extremely acid in the surface and grades to strongly acid at depth.

Management Considerations

1) The scattered, small sized, poorly accessible nature of the Elphingstone management group, together with its' high elevation locations, severely limits use for agricultural purposes. Snowpacks are high and often remain into the growing season.
2) Potentially, the management group could be reclaimed through drainage and water control to provide conditions suitable for forage production. Costs are likely to be very high, however.
3) In the native condition, the group provides potential for limited grazing although competition from wildlife uses are likely.

FAIRFIELD SOIL MANAGEMENT GROUP

The agriculturally important Fairfield Soil Management Group occupies about 10 050 ha in the map area and is common in the northern part of Matsqui Valley, in Sumas Valley, on Nicomen Island and the western part of Chilliwack Municipality. It also occupies smaller areas in Pitt Meadows, Hatzic Valley and other scattered locations along the Fraser River. Included in the management group are Fairfield, Bates, Dewdney, Bonson, Grigg, Fadden, Henderson and Vye soils. The Monroe and Page management groups are commonly closely associated with the Fairfield group.

This large group of soils has developed in Fraser River floodplain deposits and overbank deposits of smaller streams and rivers which flow across the lowland. The topography of the group typically ranges from gently undulating to gently rolling. Slopes are generally less than 10% and usually between 1 and 5%. The Fairfield group typically occupies the shallower depressions and lower ridges of the undulating landscape. Elevations all lie less than 15 m asl.

The Fairfield management group is composed of imperfectly drained, moderately pervious soils. Very temporary surface water ponding sometimes occurs during prolonged, high rainfall periods where the landscape position is slightly depressional. Fluctuating ground water tables are typical of this group and prominent, reddish or brownish mottles are usual in subsurface and subsoil layers. Moderate to slight rooting restrictions are usually present at about 50 cm depth due to the presence of a moderately developed clay accumulation layer. The fluctuating water table is also an impediment to some deeper rooted crops, particularly perennials and those very susceptible to periodic "wet-feet".

The Fairfield group consists of stone-free, friable, medium-textured soils. Surface and subsurface textures are mostly silt loam, varying occassionally to fine sandy loam or silty clay loam. At depths of 50 cm or more, these textures grade to loamy sand, sand or sandy loam. Sometimes the sandy underlay occurs within 30 cm of the surface (Dewdney soils and shallow varient of Bates soils).

The Fairfield group of soils have high to very high nutrient holding ability. Cation exchange capacity in the upper soil is usually between 20 and 40 meq/100 g. Organic matter content of the surface layer is usually moderately high (between 10 and 20%) except in the Fairfield soils where it is medium (between 5 and 10%). Soil reaction in the upper layers is strongly to moderately acid (between about pH 5 and 6) and gradually increases to between pH 5.5 and 6.5 in the subsoil.

Management Considerations

1) Soils in the Fairfield management group are probably among the most productive in the map area and are suited for almost all climatically adapted crops. For crops which are very susceptible to period "wet-feet", artificial control of the fluctuating water table may be required, particularly during the rainy winter period.
2) The undulating topography may in some areas be a hindrance to uniform crop maturity. If land levelling is undertaken, the silty topsoil should be stockpiled, then redistributed over the levelled, sandy subsoil.
3) High water storage capacity, coupled with some capillary moisture provided by the fluctuating water table generally supplies adequate moisture for most crops during the growing season. During drier than normal years however, supplemental irrigation is beneficial.

4) Compaction and structure deterioration with accompanying decrease in water infiltration is likely to occur when soils of the Fairfield management group are cultivated or traversed when wet. Equipment traction is also severely decreased during this periods.

Plate 13. Dairying and associated pasture and forage production is an important agricultural enterprise in the map area, particularly in the lowland areas. Grass-clover mixes and silage corn are the main crops. The most common managment groups used for these purposes are Monroe, Fairfield, Page, Vedder, Pitt and Alouette.

GREVELL SOIL MANAGEMENT GROUP

The Grevell Soil Management Group occupies about 1700 ha on the lowlands of the map area. It occurs mainly on islands in the Fraser River and near the river's edge as well as near Mud Bay in the Delta area. Included in the management group are Grevell, Tsawwassen, Neptune and Seabird soils. Commonly associated management groups are Monroe, Fairfield, Delta and Gulchon.

Soils in the Grevell group have developed in coarse-textured (sandy), stone-free Fraser River floodplain deposits and, to a lesser extent, marine beach deposits. Very gently undulating to gently rolling is the usual topography and slope gradients are less than 8%. The Grevell group generally occupies the crests, upper slopes and shallow depressions in the undulating landscapes. Elevations range from less than 3 to about 12 m asl.

Grevell group soils are rapidly to moderately pervious, mostly well to moderately well drained (the limited acreage of Seabird soils are imperfectly drained) and have slow surface runoff. Water holding capacity is low to moderate. During extended periods of heavy precipitation or when water levels in the Fraser River are high, temporary water tables develop in the lower subsoil. Flooding of areas outside the dykes is likely during the freshet period of the Fraser River, particularly if levels are higher than usual. No significant limitations to rooting are apparent to depths of a meter or more.

The texture of the grayish to brownish surface layer of Grevell group soils is usually loamy sand, varying occasionally to sandy loam or sand. Subsurface and subsoil textures are mostly sand, containing sometimes a few gravel sized fragments and thin, finer-textured strata.

Grevell management group soils have low to moderate nutrient holding ability and cation exchange capacities are generally less than 15 meq/100 g. Organic matter content in the surface layer is also low, usually less than 4%. Soil reaction in the surface varies from moderately acid to neutral (pH is between 5.6 and 7) and remains relatively constant with increasing depth.

Management Considerations

1) Low water holding capacity which leads to droughty conditions during the growing season is the main agricultural limitation of the Grevell management group. Irrigation is generally required for good crop growth and where it is available most crops can be satisfactorily produced. Irrigation intervals are relatively short and large additions of water at any one application is wasteful because of low water holding capacity. The excess merely drains downward out of the root zone.
2) The danger of flooding during the Fraser River freshet is also a limitation for those areas lying outside the dykes. Early season, rapidly maturing crops which are harvested before the freshet season or rapidly maturing crops which can be planted after the freshet retreats may be options. Access to the Grevell areas is difficult for those that are located on islands in the Fraser River.
3) Management practises (such as applications of barnyard manure or green manure crops) which increase and maintain organic matter levels in the soil surface are very beneficial. Nutrient and water holding ability will both be increased.
4) The low nutrient holding ability suggests several smaller fertilizer applications over the growing season may be more beneficial then one or two large applications. The

amounts and kind of fertilizer should, of course, be determined by soil test and crops being grown.

5) Grevell group soils tend to dry rather quickly after water additions. Therefore, they may be better suited for crops that require cultivation, harvesting, etc. at critical periods than heavier textured soils which are sometimes limited by poor trafficability.

6) Where protected by dykes, the Grevell management group probably provides the best locations for farmsteads and similar construction on the floodplain area. The Grevell group generally occupies the highest and best drained landscape locations.

GROUSE SOIL MANAGEMENT GROUP

The Grouse soil management group occurs at the higher elevations in the mountainous, northern portion of the map area. It consists of Grouse and Hollyburn soils and occupies about 9 300 ha in the alpine and alpine-forested transition areas. The Non-agricultural soil management group is consistently associated with the Grouse group.

The Grouse soil group has developed in colluvial and/or glacial till deposits which usually are less than 100 cm thick over bedrock. The topography is generally moderately rolling to hilly with slopes between 10 and 30%. Elevations are mostly well in excess of 1000 m asl. Vegetation generally consists of open stands of coniferous forest interspread with shrubs, grasses, sedges and heather. At the highest elevations trees are usually absent.

Well or moderately well drained is the usual drainage of the Grouse group although imperfectly drained areas also occur. The soils are rapidly pervious, have low water holding capacity and moderate to slow surface runoff. Winter snowpacks are deep. They persist well into the spring and begin to reaccumulate in early fall.

Stony, moderately coarse to coarse-textures typify the Grouse management group. Gravelly sandy loam or gravelly loamy sand is usual. A turfy organic matter enriched surface layer is present in some areas; in others the surface consists of a thin layer of organic material underlain by a grayish leached zone up to 10 cm thick. Soil reactions are strongly acid.

Management Considerations

1) The Grouse management group is unsuited for arable agricultural uses because of harsh, alpine climate, adverse topography and shallow, stony soils.
2) Some areas of the management group potentially have the ability of providing limited natural grazing. This use is however, effectively precluded at the present time by poor access. Should grazing use become possible, careful management will be required to prevent damage to the relatively fragile, slow to recover vegetation.

GUICHON SOIL MANAGEMENT GROUP

The Guichon Soil Management Group, consisting of Guichon and Seaview soils, occurs only on the Fraser River delta in the vicinity of Boundary Bay where it occupies about 450 ha. The Grevell, Ladner, Delta and Benson managment groups are sometimes closely associated with the Guichon group.

Soils in the Guichon management group have developed in mainly medium and sometimes moderately fine textured deltaic deposits, usually 40 to 70 cm thick, which overlie sandy material. The subsurface and subsoil layers, and sometimes the surface, are moderately to strongly saline.

Topography is nearly level to very gently undulating with slope gradients less than 2%. The group often occupies slightly depressional landscape positions in relation to adjacent soil groups. Elevations all lie less than 3 m asl.

Soils in the Guichon group are poorly to very poorly drained, moderately pervious and have moderate to high water holding capacity and slow surface runoff. The water table is near or at the soil surface during the winter but recedes slightly during the summer. Surface ponding is common during and after heavy rains, due in part to their slightly depressional landscape position. The coarse-textured subsoil allows saline seepage to enter the soils from Boundary Bay. Some areas of the managment group (mainly the Seaview soils) are only partly protected by dykes and are susceptible to sea-water flooding during high tides and severe storms. The subsurface and subsoil of the group are moderately to strongly saline; the salinity frequently extends into the surface as well.

The black to dark grayish-brown surface of Guichon group soils is friable and silt loam or silty clay loam in texture. Under this is gray or olive gray, hard (when dry), similarily textured material for about 20 to 40 cm. Vertical cracking on drying and common, yellowish-red to reddish-brown mottles are usual. Underlying the silty material is loamy sand or sand, sometimes containing a few gravels as well as silty lenses and fragments of sea shells. Ditch faces and other exposures frequently exhibit precipitated salts below about 20 cm depth. Rooting is generally restricted to the upper 50 cm of soil because of saline soil conditions and high water tables.

Nutrient holding ability of Guichon group soils is high. Cation exchange capacity of the surface layer is about 25 to 30 meq/100 g. Organic matter content in the surface is medium to moderately high, and ranges between about 8 and 20%. Soil reaction is extremely to strongly acid in the surface and generally ranges between pH 3.9 and 5.5. It gradually increases to moderately acid or neutral in the lower subsoil. Electrical conductivity in the subsurface and subsoil is usually between 8 and 15 mS/cm. Conductivity in the surface approaches 15 mS/cm in undeveloped areas; in most cultivated areas, however, it is substantially less due to improvements through management.

Management Considerations

1) High water tables and surface ponding, during the winter months especially, severely limit Guichon group soils for perennial crops. Lower precipitation during the summer months allows water tables to retreat somewhat and allows annual crops which are not

highly susceptible to periodic wet conditions to be produced. Artificial drainage to control high water tables (and dyking in some areas to control flooding) is required. Improved drainage helps in controlling the saline conditions. Underdrains require protection from "washing-in" and clogging by the subsoil sandy materials.

2) Salinity in the subsurface and subsoil layers, and frequently in the surface limits crop growth. Crops susceptible to high salt levels are usually not suited unless the salt content can be controlled. Irrigation, coupled with underdrains help wash excess salts downward and out of the system. Winter precipitation acts in a similar manner if underdrains are installed.
3) Occasional subsoiling (of the Gulchon soils particularly) will improve aeration, water movement and root distribution. Subsoiling should be undertaken during the drier part of the year.
4) The strongly acid reaction of the surface layer is detrimental for most crops and soil amendments which raise the pH to at least 5.5 or 6.0 is beneficial for most crops.
5) Material excavated or cleaned from ditches and spread over the adjacent land is detrimental because of its strongly saline characteristics.
6) Corrosion of underground installations, if not adequately protected, is likely because of strongly saline conditions.

HARRISON SOIL MANAGEMENT GROUP

The Harrison Soil Management Group is composed of Harrison, Isar and Chehalis soils and occupies about 3400 ha scattered through the map area. It is most common in areas north of the Fraser River and usually occurs in the vicinity where streams issuing from the mountains discharge onto the uplands and lowlands. Most areas are still undeveloped, mainly because of the groups' moderate to severe limitations for agricultural uses. The Shalish management group is often associated with the Harrison group.

The Harrison group has developed in gravelly, coarse-textured, usually moderately to severely stony and cobbly, alluvial fan deposits. A few non-stony areas occur on the aprons of some fans and, in the eastern part of the map area, small amounts of silty eolian material is mixed into the upper part of the fan deposits.

Topography varies from gently to steeply sloping with gradients between 5 and 30%; most areas however, are moderately sloping with slopes between about 5 and 20%. The more subdued slopes are usually on fan aprons while the steep areas are most commonly associated with the fan apexes. Elevations range from about 10 to 175 m above sea level.

Soils in the Harrison group are generally well to rapidly drained although a few locations on some fan aprons are moderately well drained due to temporary, fluctuating water tables in the subsoil when the water levels in adjacent streams are high. The soils are rapidly pervious and have low water holding capacity and slow surface runoff. Some areas, particularly those composed of Isar soils, are susceptible to flooding and stream channel shifting during high runoff periods.

The surface textures of Harrison group soils are somewhat variable. They range from sand to loam but dominantly are gravelly sandy loam or gravelly loamy sand. Subsurface and subsoil textures are gravelly sand or sandy gravel. Moderate to high contents of cobbles and stones are generally present.

Harrison group soils have low to moderate nutrient holding capacity. Cation exchange capacities are generally less than 15 meq/100 g. Organic matter content is also low, generally less than 5%. Soil reaction is moderately to strongly acid in the upper soil and ranges in the vicinity of pH 5.5. The reaction increases slightly in the subsoil to between pH 5.5 and 6.

Management Considerations

1) Stoniness is usually a moderately to severely limiting feature of Harrison group soils and picking is generally required to produce a surface layer suitable for efficient cultivation and crop production. In most areas subsurface and subsoil stoniness precludes production of groundcrops. Deep cultivation is detrimental since it will bring further stones and cobbles to the surface.
2) Low water holding capacities require that irrigation be available over the growing season. Irrigation interval is short and large individual applications is wasteful of water. Amounts in excess of water holding capacity will be lost through downward drainage out of the root zone.
3) Adverse topography sometimes may be limiting for some crops and machinery. This should be assessed on a site specific basis.

4) During land clearing, care is required to prevent exposing the subsurface stony and gravelly material. Exposure of this material will even further increase the requirement for stone picking and lower water holding and nutrient holding ability.
5) Low nutrient holding capacities suggest fertilizers be applied as split-applications over the growing season. Increasing organic matter content of the surface layer will help improve both water and nutrient holding ability as well as tilth.
6) Some areas, particularly those composed of Isar soils, are susceptible to stream overflow and channel shifting during periods of excessive runoff. This limitation should be assessed when determining if areas are suitable for development.

HERON SOIL MANAGEMENT GROUP

The Heron Soil Management Group, composed of Heron and Livingstone soils, occupies about 2550 ha in the uplands of the map area, mainly in Surrey, Langley and Matsqui municipalities. Commonly associated management groups are Sunshine, Murrayville, Cloverdale, Summer and Scat.

Heron group soils have developed in stone-free, moderately coarse to coarse-textured (sandy) littoral and glaciofluvial deposits, usually between 50 and 150 cm deep, overlying moderately fine and fine-textured glaciomarine and marine deposits. Topographically the group varies from very gently sloping or slightly depressional to gently sloping and undulating. Slope gradients are less than 5%. Elevations range from about 15 to 100 m asl.

Heron group soils vary from poorly or moderately poorly to imperfectly drained. They are rapidly to moderately pervious in the upper sandy material but become slowly pervious in the clayey subsoil. Water holding capacity (in the upper, sandy part) is moderate to low and surface runoff is slow. Perched water tables develop above the dense, clayey subsoil during rainy periods, particularly during the winter months, and surface ponding in depressional locations develops during these periods as well. During the summer months the water tables tend to dissipate and droughtly conditions develop during extended, precipitation free periods.

The black to very dark gray surface layer of Heron group soils consists of friable sandy loam, loam or fine sandy loam. Under this is brownish to grayish loamy sand or sand which varies in consistence from mostly loose to hard where discontinuous, moderately cemented lenses and patches are present. Common to many, reddish or yellowish mottles are also present. At depths between 50 and 150 cm dense, gray clay, clay loam or silty clay loam occurs. Rooting tends to be restricted to the upper 50 to 75 cm by high water tables and dense, clayey subsoils.

Heron management group soils have moderate to high nutrient holding capacity in the surface layer where the cation exchange capacity varies from about 15 to 30 meq/100 g. This decreases to low in the subsurface sandy material. Organic matter content in the surface is medium to moderately high and usually ranges from about 8 to 15% but may be as low as 5% in a few areas. Surface soil reactions are somewhat variable depending on past management practises but generally are strongly to moderately acid and range between pH 4.5 and 6. The reaction increases to between pH 5.5 and 6.5 in the subsurface sand and increases further in the underlying clay to about pH 6 or 7.

Management Considerations

1) High water tables and poor drainage, especially during the winter months, limit Heron group soils for perennial crops and delay early spring cultivation and planting. Annual crops are generally less affected since water tables tend to recede and dissipate over the growing season although periodically they rise for short periods during and shortly after heavy summer rains. Underdrains to control the high winter water tables are required to improve overwintering of perennial crops and improve trafficability.
2) Droughty conditions develop during the latter parts of most growing seasons and irrigation is beneficial to maintain good growth and production, particularly if shallow rooted, high value crops are being produced.

3) The friable, rapidly pervious sandy character of the surface layer is attractive for crops that require periodic cultivation during the growing season, particularly if underdrains are present. The discontinuous, moderate subsurface cementation (present mainly in Livingstone soils) can generally be adequately disrupted by occasional subsoiling.
4) Liming or other soil amendments which raise soil reaction to at least between pH 5.5 or 6.0 is beneficial for most crops.
5) Deep cultivation (i.e. deeper than about 20 cm) should be avoided. Mixing the sandy subsurface into the cultivated layer lowers nutrient and water holding capacity and dilutes the organic matter present. Management which maintains the organic water content in the surface (eg. green manure crops, barnyard manure additions) should be practised.

LADNER SOIL MANAGEMENT GROUP

The Ladner soil management group occupies about 1700 ha in the Fraser River delta portion of the map area. This areally restricted but important soil group occurs mostly in central Delta Municipality with small areas in Richmond Municipality. Ladner is the only soil in the management group. Frequently associated management groups are Delta and Spetifore.

The Ladner soil group has developed in moderately fine textured, mixed marine and non-marine deltaic deposits which usually become sandier at depths of 1 m or more. The underlying sandy material is usually saline and contains substantial amounts of compounds high in sulphur.

Topographically the group varies from nearly level to gently undulating with slopes less than 2% and tends to occupy the higher landscape positions in the areas where it occurs. The associated Delta and Spetifore groups usually lie slightly lower or occupy slight depressions in the Ladner group. Elevations all lie less than 3 m asl.

The Ladner group consists of moderately to slowly pervious, moderately poorly to poorly drained soils which have high water holding capacity and slow surface runoff. High water tables are usual during the winter and surface ponding is common during and after heavy rains. The water tables generally recede during the growing season due in part, to installed artificial drainage which provides a moderate, water-free rooting zone suitable for many annual crops.

The Ladner soil management group consists of stone-free, moderately fine textured soils. The surface layer is generally firm, silty clay loam or clay loam while the subsurface, enriched with illuvial clay, is very firm, strongly structured silty clay. The subsoil is massive silty clay loam or silt loam changing at depths below about 100 cm to sandier, generally saline material. The surface (cultivated) layer is dark gray while the underlying materials are gray (gleyed) and contain many reddish mottles. At about 80 cm depth the mottles become yellowish and hard tubules around old root channels begin to appear. Rooting depth is usually restricted to the upper 60 cm by the dense clayey subsurface layer and high water table.

Ladner group soils have very high to high nutrient holding ability. Cation exchange capacities are usually in excess of 30 meq/100 g. Organic matter in the cultivated surface layer is moderately high, usually between 12 and 20%. Soil reaction in the surface layer is variable depending on past management history but usually is moderately to strongly acid (pH ranges from about 5 to 6). This gradually decreases to less than pH 4.0 at about 100 cm depth. Electrical conductivity begins to exceed 4 mS/cm at about 100 cm.

Management Considerations

1) Most annual crops not strongly susceptible to periodic saturated soil conditions currently do reasonably well on Ladner group soils, due mainly to existing drainage systems. Improved drainage, particularly systems which provide better winter drainage and remove ponded surface water will help maintain perennials and allow earlier spring cultivation. The relatively slow perviousness of the soils requires underdrains with close spacings.
2) The relatively fine surface textures require that cultivation be carried out in a narrow range of soil moisture content. If worked when wet, undue compaction with resulting decreased water infiltration and root distribution is likely. If cultivated when dry, a hard, cloddy surface is probable in which a good seedbed is difficult to establish.

3) Periodic subsoiling is required to rupture the subsurface clayey layer thereby improving downward water movement, aeration and root distribution and depth. For maximum disruption the subsoiling should occur when the soils are relatively dry.
4) The clayey nature of the soils requires high power requirements for cultivation. When wet, the soils become very sticky and slippery resulting in severe traction losses.
5) Cover crops and surface trash over the winter months provides protection from raindrop splash and surface sealing which usually results in lowered water infiltration and increased surface ponding.
6) Soil admendments (eg. liming) which increase and maintain the soil reaction of the surface layer at least near pH 6 is beneficial for most crops.
7) Distribution of subsoil material from ditch excavation and cleaning on the land surface may be detrimental for many crops due to the extremely acid reaction when the material dries as well as its usually saline character.
8) Even though waterholding capacities are high, availability of irrigation is good protection against extended, climatically dry periods that sometimes occur during the summer growing season, especially if high-value, shallow rooted crops are being grown.
9) Underground concrete and metal installations, if not adequately protected are likely to be subjected to severe corrosion by the saline, highly acidic subsoils. Septic tank effluent disposal fields are likely to function poorly because of the slowly pervious soils and high water tables.

Plate 14. Most of the medium and heavier textured soils in the map area benefit from occasional subsoiling. It assists in improving water movement, aeration and root distribution and depth. Best results are usually achieved if the operation is conducted when the soils are relatively dry. (M. G. Driehuyzen photo)

LEHMAN SOIL MANAGEMENT GROUP

The Lehman Soil Management Group, composed of Lehman, Elk, Boosey and Calkins soils, occurs in small, scattered areas on the uplands and, less commonly, on the lowlands of the map area. It occupies about 1700 ha in total. Commonly associated management groups include Columbia, Bose, Harrison, Coghlan and Murrayville.

The Lehman management group has mainly developed in gravelly, coarse-textured glaciofluvial and alluvial fan deposits and, in a few areas, raised littoral deposits. Silty eolian material, up to about 30 cm thick, is usually present, either overlying or mixed with the coarser-textured material. In a few areas (Boosey and Calkins soils), compact glacial till occurs at depths of between about 50 and 150 cm.

Topographically, the group varies from nearly level or slightly depressional to gently sloping or undulating. Slope gradients are less than 8%. Elevations generally range from 10 to 100 m asl.

Lehman management group soils are poorly drained, rapidly to moderately pervious and have low to moderate surface runoff. Water holding capacity is moderate to low. They are usually subject to runoff accumulation and seepage from higher, adjacent lands, and perched water tables develop. In some areas (Elk soils) seepage, and sometimes overflow, from associated streams contributes to the poorly drained conditions. High water tables are most prevalent during the rainy winter season. They tend to disappear during the drier summer period, often resulting in droughty conditions during the latter parts of the growing season.

The black to dark grayish brown surface of Lehman group soils consists of friable silt loam or loam varying sometimes to gravelly sandy loam. Moderate amounts of cobbles and stones are usually present. The subsurface and subsoil generally consists of coarse gravelly sand or gravelly loamy sand; stone and cobble content is moderate to high. Rooting depth is generally restricted to about 50 cm due to periodically high water tables and coarse subsoil textures.

Lehman group soils have high to very high nutrient holding ability in the surface layer where cation exchange capacities vary from about 25 to 40 meq/100 g but this changes to low in the coarse-textured subsoil. Organic matter content in the surface layer usually is moderately high to high and varies between about 10 and 20%. Soil reaction in the surface is strongly to moderately acid and usually ranges between about pH 4.5 and 5.5; it gradually increases to between about pH 5 and 6 in the subsoil.

Management Considerations

1) Poor drainage and high water tables, especially during the winter months, limit Lehman group soils for perennial crops and delay early spring cultivation and planting. Annual crops are generally less affected because water tables tend to recede over the course of the growing season although periodically they rise for short periods during and shortly after heavy summer rains. Artificial drainage is required for water control. In some areas interception drains to accumulate runoff and seepage from adjacent higher areas is sufficient while in other areas underdrains are probably more practical. Dyking along some streams is also required to control overbank flooding.

2) Droughty conditions sometimes develop during the latter parts of growing seasons, after water tables recede. Supplemental irrigation is beneficial to maintain good crop production especially for shallow rooted crops.
3) Stone and cobble content in the surface layer in some areas is sufficient to interfere with cultivation and stone picking may be required. Deep cultivation is discouraged because of the likelihood of raising stones and cobbles from the subsurface layer. Problems producing root crops should be anticipated on Lehman group soils because of the gravelly, stony and cobbly subsurface character.
4) For most crops, soil amendments (e.g. liming) to increase soil reaction in the surface layer to at least pH 5.5 or 6.0 is beneficial.
5) Lehman management group soils usually occur as small, irregularly shaped areas interspersed among management groups of differing requirements. This may cause problems in determing field boundaries and overall management practises.

LUMBUM SOIL MANAGEMENT GROUP

The Lumbum Soil Management Group occupies about 12 700 ha in the map area. It mostly occurs on the lowlands, notably in Delta and Richmond municipalities, in the Big Bend area of Burnaby, in Glen and Matsqui valleys and in the Pitt Meadows - Pitt Polder - Coquitlam areas. Smaller areas occur on the uplands, scattered from the Sunshine Coast to Abbotsford. Lumbum, Lulu, Richmond, Gibson and Judson are the dominant soils in the management group; others of lesser area are Banford, Goudy, Annacis and Widgeon. Commonly associated management groups are Trigg, Delta, Alouette, Vinod and Vedder.

The soils in the Lumbum Soil Management Group have developed in organic deposits that are at least 40 cm but usually less than 2 m thick and consist mostly of mixed sedge, reed, and moss remains. The underlying mineral sediments, on the lowlands, are mainly fluvial and deltaic deposits of the Fraser River. The underlying material on the uplands is mostly either glaciomarine deposits or glacial till.

The topography of the management group varies from slightly depressional or nearly level to gently undulating; slope gradients are less than 2%. Elevations generally are less than 5 m asl on the lowlands and range to about 75 m on the uplands.

The Lumbum management group is very poorly to poorly drained. The organic material is usually moderately pervious while the mineral underlay is generally slowly pervious. Waterholding capacities are very high. Water tables are at or near the soil surface for much of the year, particularly in those areas where artificial drainage has not been installed. The high water tables are the result of depressional or lowlying landscape positions with accompanying high groundwater conditions, substantial runoff accumulation from adjacent or nearby uplands and in some areas, seepage and overflow from adjacent water courses.

The Lumbum management group consists of partially to well-decomposed organic soils. The surface layer in presently cultivated areas is generally well decomposed. In undeveloped areas the surface is usually partially decomposed, sometimes with a thin, undecomposed layer on the surface. The underlying mineral material varies in texture from silt loam to silty clay. In the deltaic areas the underlay is usually saline; occasionally the lower part of the organic material in saline as well (Goudy soils). Observations since the soil survey was completed indicate that many organic areas contain a significant component of sedimentary peat and sometimes, diatomaceous earth, particularly near the contact with the underlying mineral material. This type of organic material has especially high shrinkage when dried and is hydrophobic (difficult to rewet). These characteristics may present special management problems.

The Lumbum soil management group has very high nutrient holding ability. Cation exchange capacities are generally well in excess of 50 meq/100 g and often exceed 100 meq/100 g. Under natural conditions, however, the group is relatively infertile due to the undecomposed or only partially decomposed nature of the surface layer and extemely acid soil reaction. The extremely acid upper soil (under natural conditions) generally ranges from about pH 3.5 to 4.5. This increases slightly to between pH 4 and 5 in the subsoil organic material and upper part of the mineral underlay. Organic matter content is at least 30% and commonly is near 100%.

Management Considerations

1) Under good management, soils in the Lumbum management group are suited for a relatively wide range of crops, particularly annuals and those that are not strongly susceptible to periodic wetness and relatively low pH.
2) Poor drainage and high water tables are the main limitations for agricultural uses of Lumbum management group soils and their control are required before good use can be made of these soils. Water control systems that provide progressive lowering of the water tables over the growing season as required by the crop are best. Overdraining leads to accelerated decomposition and subsidence of the organic materials and subsequent lowering of the landscape.
3) Newly developed areas are relatively infertile. Substantial liming, fertilization and cultivation are required for a few years to develop a seedbed suitable for the range of crops possible.
4) Plow pans tend to develop if these soils are continuously cultivated to the same depth. Variable depths of cultivation and occasional subsoiling (when the soils are relatively dry) help to alleviate this problem and assist in root distribution and water penetration.
5) Finely divided, exposed surfaces are susceptible to wind and water erosion. The light weight of the organic material makes it easy to move by wind and washing or floating away by moving water. Cover crops and surface trash help protect against erosion.
6) The Lumbum management group soils have low bearing capacity and specialized equipment with high flotation tires is usually required.
7) Undue decomposition and subsidence of the organic material should be guarded against. Subsidence lowers the land surface, causes increased drainage problems, and in areas where the organic material is shallow, it will increasingly bring the silty or clayey mineral subsoil into the rooting zone. This is especially important in the Delta and Serpentine-Nicomeki areas where the mineral underlay is usually saline. It will also increasingly incorporate the underlying sedimentary peat into the plow layer making it difficult to rewet after drying and cause high shrinkage which may disrupt crop roots.
8) Lumbum soil management group soils have very high water holding capacity. For high value, shallow rooted crops, however, irrigation is good insurance agains lengthy rain-free periods during the growing season.

Plate 15. Pumping drainage waters from field to municipal ditches near Cloverdale. The soils are part of the Lumbum group and are commonly used for a variety of annual vegetable crops. Note the underground drains discharging into the ditch. The change from dark to light tones along the ditch wall coincides with the contact between the organic and underlying mineral materials. (M. G. Driehuyzen photo)

Plate 16. Celery harvest near Cloverdale. The soils mainly belong to the Lumbum soil management group although the Vinod group is also present on the grayish area in the cultivation to the left center of the photo. (R. C. Wood photo)

Plate 17. Lettuce and cabbage growing on soils of the Lumbum management group. The slightly raised undulation near the middle of the field consists of Vinod management group soils.

Plate 18. Carrots are a common crop near Cloverdale on soils of the Lumbum management group. They are usually grown in raised beds which assists in improving drainage and increasing soil temperature.

MISCELLANEOUS LAND TYPE MANAGEMENT GROUP

The Miscellaneous Land Type group consists of areas classified as gravel pits, recent alluvium, tidal flats and man-made (anthropogenic) areas. It includes areas lying outside the dykes in the delta area, sand and gravel bars in the Fraser River and areas covered by hog fuel and other fill materials. At the time of the soil survey, about 5850 ha were classified in this group. The actual area occupied by this group at the present time may be somewhat different since some gravel pits have likely been enlarged and many of the sand and gravel bars in the Fraser River have changed size and shape.

Management Considerations

1) The Miscellaneous Land Type group is generally unsuited for agricultural uses due to a variety of limitations. The tidal flats are very poorly drained, subject to tidal flooding and extremely saline. Substantial dyking and drainage would be required to reclaim them for agricultural uses. Gravel pits generally have excessive slopes and stony, very coarse-textured soils. Substantial landscape modification is required to provide topography suitable for agricultural uses and top soil additions would likely be needed. The areas of recent alluvium are subject to periodic flooding and erosion and also usually have stony, very coarse-textured soils. The anthropogenic areas have received additions of materials unsuitable for crop production. Reclamation of these areas would likely require substantial modification of the materials, or its removal.

MONROE SOIL MANAGEMENT GROUP

The Monroe Soil Management Group is common in the northern part of Matsqui Valley, on Nicomen Island and in the northern part of Chilliwack Municipality. Smaller areas occur in Sumas Valley, the southern part of Hatzic Valley as well as other scattered locations near the Fraser River. In total, the group occupies about 3400 ha. Included in the group are Monroe, Matsqui and Lickman soils. Commonly associated management groups are the Fairfield and Page groups.

This group of agriculturally important soils have developed in Fraser River floodplain deposits and in overbank deposits of smaller streams and rivers which flow across the lowlands. The group lies at elevations below 15 m asl and occupies the higher landscape positions in the areas where it occurs. Topographically, the landscapes range from gently undulating to gently rolling; slopes are generally less than 10% and usually between 2 and 6%.

The Monroe management group consists of moderately pervious, well to moderately well drained soils. Water holding capacity is moderate to high. No significant rooting restrictions occur to depths of a meter or more.

Texturally, the group consists of stone-free, friable, medium-textured soils whose surfaces are usually silt loam, varying sometimes to very fine sandy loam or silty clay loam. Similar textures usually carry downwards for 50 cm or more than grade to sand or loamy sand. Sometimes the sandy textures start at about 25 cm depth as in Matsqui soils and in the shallow variant of Lickman soils.

The soils of the Monroe group are moderately fertile and have moderate to high nutrient holding ability. Cation exchange capacities vary from about 15 to 50 meq/100 g. Organic matter content in the surface layer is medium (between 5 and 10%). Soil reaction varies somewhat with management history but usually is moderately acid (between pH 5.5 and 6) in the surface layer and gradually increases to between pH 6 and 6.5 in the subsoil.

Management Considerations

1) The Monroe soil management group is generally suited for all climatically adapted crops. Supplemental irrigation is beneficial during the latter parts of most growing seasons for the maintenance of good crop production, especially in those areas where the underlying sand is relatively close to the surface.
2) If land leveling is undertaken as an aid, for example, to more uniform crop maturity, the silty topsoil should be stockpiled, then redistributed over the levelled sandy subsoil. The sandy material is otherwise likely to be exposed at the surface, lowering the water holding capacity and increasing the possibility of droughty conditions.
3) Periodic organic matter additions, either through manure applications or green manure crops, are required to maintain, and in some cases improve, the organic matter content of the surface layer.
4) A few, small areas of the Monroe management group lie outside the presently dyked areas. These are susceptible to flooding during higher than normal freshet levels on the Fraser River.

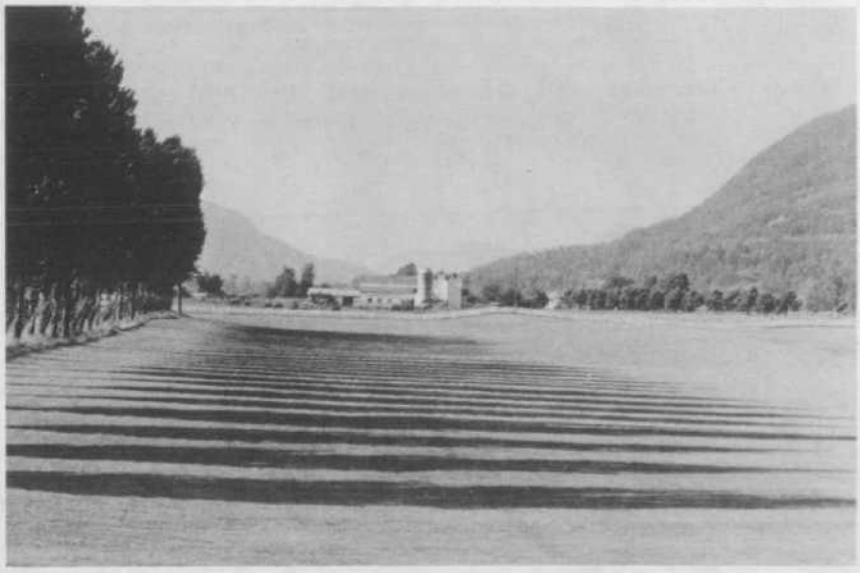

Plate 19. Turf being produced on soils of the Monroe and Fairfield management groups. The Monroe group usually occupies the higher landscape positions while the Fairfield group occupies the intervening swales. Continued maintenance of a friable, organic matter enriched surface layer is critical for sustained, good production on these soils.

MURRAYVILLE SOIL MANAGEMENT GROUP

The Murrayville Soil Management Group, composed of Murrayville, Fellows and Defehr soils, occupies about 3750 ha on the uplands of the map area, mainly in the vicinity of Haney, in the Langley Valley and near Coquitlam Lake. Commonly associated management groups include, among others, Whatcom, Heron, Sunshine, and Lehman.

Murrayville management group soils have developed in moderately coarse to coarse textured (sandy) littoral, glaciofluvial and glaciolacustrine deposits usually more than 75 cm thick which overlie clayey marine or glaciomarine sediments or, sometimes, contain root and water restricting lenses which act in a manner similar to the clayey materials. A few gravels are sometimes present in the lower parts of the sandy overlay.

The most common topography of the management group is very gently sloping or undulating to moderately rolling with slope gradients less than 15%. Areas with hilly topography and slopes to 50% also occur. Elevations of the present agriculturally developed areas generally range between 15 and 100 m asl. The group, however, ranges in a few locations in the mountains valleys upwards to about 300 m asl (e.g. Fellows soils in the Statlu Creek Valley east of Chehalis Lake).

The brownish to reddish soils of the Murrayville group are imperfectly to moderately well-drained and moderately to rapidly pervious in the surface and subsurface. Perviousness decreases to slow in the subsoil. Water holding capacity is moderate to low and surface runoff is usually slow, increasing to moderate where slopes are steep. During extended periods of heavy precipitation, during the winter especially, fluctuating, perched water tables develop above the slowly pervious subsoils and lateral seepage sometimes develops. The water tables retreat and dissipate during the growing season and droughty conditions frequently develop.

The friable surface layer of the Murayville management group is sandy loam, fine sandy loam or loam in texture. This usually grades to 40 cm or more of friable to loose sand, loamy sand or loamy fine sand containing common reddish or brownish mottles and occasionally, a few gravelly strata. The underlying fine-textured layer, where present is usually compact clay or silty clay. In areas where the clayey subsoil is absent, compact, moderately cemented sand occurs at equivalent depth. Rooting depth and distribution for most crops is generally unimpeded to depths of at least 50 to 75 cm. Rooting by perennials susceptible to periodic high water tables in the winter is likely restricted to depths that are somewhat shallower.

Nutrient holding ability of Murrayville soils is usually moderate to high. The cation exchange capacity generally ranges between 15 and 30 meq/100 g in the surface layer. Organic matter content of the surface layer is somewhat variable but usually ranges between about 5 and 12%. Soil reaction generally varies between pH 5 and 6 in the surface layer although in Fellows soils it may sometimes be as low as pH 4.5. The reaction gradually increases to about pH 5.5 or 6 in the subsurface and upper subsoil and to about pH 7 or so in the clayey underlay.

Management Considerations

1) Moderate to low water holding capacities generally produce droughty conditions during the growing season and irrigation is required for good production of most crops, especially during the latter parts of the growing season. Care is required in application to prevent perched water tables from developing above the slowly pervious subsoil.

2) Periodically high water tables during the winter months restrict overwintering of susceptible perennial crops and underdrains may be required if these types of crops are being considered. Water control will also provide improved conditions for earlier spring cultivation and planting.
3) The friable, sandy surface of the Murrayville management group makes seedbeds easy to prepare for most crops and the general absence of root restrictions to 50 cm or more provides conditions suitable for most root crops.
4) The friable, sandy nature of the upper soil, coupled with low perviousness in the subsoil, makes Murrayville soils susceptible to water erosion and gullying. The likelihood of erosion increases with steepness of slope and in areas where slopes exceed about 5 to 10%, contour cultivation and planting should be considered. Also, management practises which concentrate water discharge on slopes should be avoided and cover crops to protect the soil surface during the winter should be planted. Areas which have slopes in excess of 15 to 20% are likely best in permanent pasture or forage cover.
5) Amendments (e.g. liming) that increase soils reaction of the surface layer to at least between pH 5.5 and 6 are beneficial for good crop growth.

NON-AGRICULTURAL SOIL MANAGEMENT GROUP

The Non-agricultural Soil Management Group is composed of numerous soils in the map area which are unsuited for agricultural purposes. The soils generally consist of those occuring in the mountainous, northern portion and together occupy about 163 000 ha. Burwell, Cannell, Eunice, Golden Ears, Poignant, Sayres, Strachan, Whonnock, Blaney, Cascade, Dennett, Devil, Hoover, Kenworthy, Marlon, Palisade, Paton, Lions, and Rogers soils and Ice, Talus and Rock Outcrop land types comprise the group.

This large group of soils has dominantly developed in moderately coarse to coarse-textured colluvium which is usually very stony, or in moderately coarse textured, stony glacial till. Many areas are shallow to bedrock.

Topographically, the group is very to extremely steep with gradients generally well in excess of 20%. Elevations range from sea level to about 1500 m.

The soils are well to imperfectly drained and in areas where glacial till forms the soil parent material, seepage along the surface of compact, cemented subsoil layers is common. The soils are forested and strongly weathered and leached; soil reaction in the upper parts are generally extremely acid while subsoils are usually strongly acid.

Management Considerations

1) Very steep topography, stony, coarse and moderately coarse soil textures, frequent shallowness to bedrock, and at the higher elevations, harsh climate preclude the use of the management group for agricultural purposes.

Plate 20. A typical example of lands included in the Non-Agricultural Soil Management Group.

PAGE SOIL MANAGEMENT GROUP

The Page Soil Management Group occurs mainly in Sumas and Matsqui valleys, in eastern Chilliwack Municipality and on Nicomen Island. Smaller areas are scattered elsewhere on the lowlands as well. In total, it occupies about 6350 ha. Included in the management group are Arnold, Blackburn, Buckerfield, Hjorth, Hopedale, McElvee, Sim, Niven and Page soils. Commonly associated management groups are the Monroe, Fairfield and Vedder groups.

This group of agriculturally important soils has mainly developed in fluvial floodplain and overbank deposits of the Fraser River and other smaller streams and rivers which flow across the lowlands. Included also are some soils developed in mixed lacustrine and fluvial deposits as well as a few that consist of organic material in the lower subsoil.

The topography is typically gently undulating or undulating with slopes less than 5%. Where associated with the Monroe or Fairfield management groups, the Page group occupies depressional and other lower lying positions in the undulating to rolling landscapes. Elevations lie below 15 m asl.

Soils of the Page management group are moderately to slowly pervious and poorly drained. Ground water tables are near the surface for much of the year, particularly during periods of heavy, prolonged rainfall and when the rivers and streams are high with runoff. Temporary surface ponding is common due to runoff accumulation from adjacent higher land and relatively low permeability. Subsurface and subsoil layers are strongly gleyed (gray) with variable amounts of reddish or brownish mottles. Rooting is severely impeded below depths of 40 to 50 cm by the high water tables as well as relatively dense, often moderately clay-enriched subsurface soil layers. Overwintering perennials and other crops susceptible to "wet-feet" are particularly restricted.

Stone-free, medium and occasionally, moderately fine textures are typical of the Page management group. Surfaces are generally friable, silt loam or silty clay loam. Subsurface and upper subsoil textures are usually similar to those of the surface but may grade to sand, loamy sand or sandy loam at depths of 50 cm or more. Sometimes the sandy material occurs within 30 cm of the surface (Hopedale soils and shallow variants of Page and Hjorth soils). Small areas have moderately to slightly decomposed, mainly sedge-derived organic material in the lower subsoil (Niven soils).

Page management group soils have high to very high nutrient holding ability. The cation exchange capacity is generally between 20 and 45 meq/100 g. Organic matter content of the surface layer is usually medium (between 5 and 10%) but occasionally increases to about 20%. Soil reaction of the upper soil ranges from moderately to strongly acid (between about pH 5 and 6) and increases slightly in the subsoil to between pH 5.6 or 6.5.

Management Considerations

1) Poor drainage is the main agricultural limitation of soils in the Page managment group. Artificial drainage (subsurface and/or ditches) is generally required for the group to achieve its agricultural potential. Depressional landscape positions and often intimate intermixing with soils of better drained management groups sometimes provides problems in locating drainage outlets and designing the drainage system. Tile lines should be

protected from "washing-in" and clogging by the subsoil sandy material. Watertables usually rise near the Fraser River during the freshet period and should be considered when making cropping and other management decisions.

2) Occasional subsoiling should be considered to improve water infiltration and permeability as well as improving root distribution.
3) Wet conditions (where adequate drainge is not present) generally delays spring cultivation and planting. Harvesting (particularly of late maturing crops) is also frequently made difficult by wet field conditions.
4) The Page soil management group is susceptible to compaction and structure deterioration if cultivated or traversed when wet. Equipment traction is also severly reduced during wet periods.
5) Irrigation is usually not required to achieve good crop growth on Page group soils. However, if high-value crops are being grown, particularly those that are shallow-rooted, availability of supplemental irrigation is good insurance against the periodic, low rainfall conditions that sometimes occur during the summer.

PITT SOIL MANAGEMENT GROUP

The Pitt Soil Management Group only occurs in the lowland areas of Pitt Meadows, Pitt Polder, Coquitlam and Maple Ridge. In total it occupies about 2400 ha. Included in the management group are Pitt, Hammond and Neaves soils. The main associated management group is Alouette with Fairfield and Page groups abutting along the southern margins.

The Pitt management group has developed in fluvial floodplain and overbank deposits of mainly the Alouette, Coquitlam and Pitt rivers mixed with some sediment from the Fraser River as well as other smaller streams which traverse the lowlands. The source of much of the sediment, at least in the sandy subsoils, appears to be in the granitic Coast Mountains.

The usual topography of the management group varies from nearly level or slightly depressional to gently undulating. Slope gradients are generally below 5%. Where associated with the Alouette group the Pitt group either occupies the slightly higher areas in the landscape (which consist mainly of the Pitt soils). If Hammond and Neaves soils dominate, their landscape positions are similar to the Alouette group. Elevations are all below 5 m asl.

Soils in the Pitt group are poorly drained and moderately to slowly pervious. Groundwater tables are near the surface for substantial parts of the year, particularly during periods of heavy, prolonged rainfall and when the rivers and streams are high with runoff. In level or depressional locations temporary surface ponding during these periods is common. Water holding capacity is high. Surfaces vary from grayish-brown to black while subsurface and subsoils are gray to olive gray (strongly gleyed) and contain variable amounts of reddish or brownish mottles. Rooting is generally severely impeded below about 50 cm by high water tables and massive, dense subsoils. Overwintering perennials and other crops susceptible to "wet-feet" are particularly restricted.

Stone-free, medium and, occasionally, moderately fine textures are typical of the Pitt management group. Surfaces are generally friable silt loam or silty clay loam. Subsurface and upper subsoil textures are usually similar to the surface, then often grade to sandier material at depths of 50 cm or more.

Pitt management group soils have high to very high nutrient holding ability. The cation exchange capacity in the upper soil is usually between 25 and 50 meq/100 g. Organic matter content in the surface layer is somewhat variable but usually falls between 15 and 30%. Soil reaction in the upper part is strongly acid, usually ranging between pH 4.5 and 5 and increases to moderately acid (between pH 5.5 and 6.5) in the lower subsoil. The Pitt soil management group is similar to the Page management group except that the organic matter content in the surface is generally higher (15 to 30% vs 5 to 10%) and the surface soil reaction is more acidic (pH 4.5 to 5 vs pH 5 to 6).

Management Considerations

1) Poor drainage is the main agricultural limitation of soils in the Pitt management group. Comprehensive artificial drainage (subsurface and/or ditches) is required for the group to achieve its agricultural potential. Subsurface drains should be protected from "washing-in" and clogging by sandy subsoil material. Because of its location, the Pitt

management group generally receives more precipitation than is usual for most other agricultural lands in the Lower Fraser Valley and emphasis on improved drainage is perhaps even more critical.

2) Occasional subsoiling should be considered to improve permeability and root distribution. The best results are likely to occur when the subsoiling is undertaken during the driest part of the year. Maximum disruption of the subsurface and subsoil occurs when the soils are relatively dry.
3) Where adequate drainage is not present, wet conditions generally delay spring cultivation and planting. Harvesting (particularly of late maturing crops) is also frequently difficult due to wet field conditions.
4) Pitt management group soils are susceptible to compaction and structure deterioration if traversed or cultivated when wet. This leads to lowered infiltration and increased surface ponding of water and aggravates already poorly drained conditions. Equipment traction is also severely reduced during wet periods.
5) The soil reaction (pH) of the surface layer is generally lower than most crops require for good growth. Appropriate soil amendments (eg. liming) to increase and maintain the pH at least near 5.5 is suggested.
6) Irrigation is usually not required on Pitt group soils. However, if high-value crops are being produced, particularly those that are shallow-rooted, the availability of supplemental irrigation is good insurance against the occasional very low rainfall conditions that sometimes occur during the summer months.

PREST SOIL MANAGEMENT GROUP

The Prest Soil Management Group, composed of Prest and Addington soils, occupies scattered, small locations on the map area lowlands. In total it occupies about 1650 ha and is most prevalent in the Pitt Polder and Addington Point areas, on Nicomen Island and in Matsqui Valley. Management groups commonly associated with the Prest group on the Fraser River floodplain are the Page and Fairfield groups while the Pitt Polder area, the Alouette and Lumbum groups are most commonly associated.

Prest management group soils have developed in medium to moderately fine textured fluvial deposits of the Fraser and Pitt rivers. An organic capping less than 40 cm thick is sometimes present on the soil surface. Subsoil sand is frequently present at depths between 50 and 100 cm.

Topographically, the Prest group is depressional in landscape postion and occupies old meander channels and other similar low-lying landscape locations. Elevations are generally below 10 m asl.

Prest group soils are very poorly drained. They are moderately to slowly pervious and have high water holding capacity. Water tables are near the surface throughout the year and surface ponding is common for long periods. Their low-lying position makes them susceptible to runoff accumulation from adjacent higher areas (particularly during the rainy winter months) and in some areas they act as surface waterways for these waters. Subsurface seepage during the freshet period on the Fraser and Pitt Rivers frequently accumulates in the Prest soil areas as well.

Prest soils commonly have a thin, turfy, organic surface layer, particularly in areas that have been undeveloped. The mineral soil consists of 50 cm or more of massive, grey to bluish-gray (strongly gleyed) silt loam or silty clay loam, sometimes varying to loam and containing thin, sandy lenses.

Nutrient holding capacity of Prest group soils is high to moderate. The cation exchange capacity of the upper soil is usually well in excess of 15 meq/ 100 g. Soil reaction is somewhat variable, depending on whether an organic capping is present and whether the location is on the Fraser floodplain proper or in the Pitt Valley. The organic cappings are usually strongly acid with pH values between 4.5 and 5. In the Pitt Valley, the mineral soil pH values are similar to the organic values while those in the main valley are usually moderately acid. Organic matter contents are also variable, ranging from in excess of 30% where orgainc cappings are present to less than 5% in areas which have no organic capping and have been subjected to recent mineral deposition.

Management Considerations

1) Poor drainage, including both permanently high watertables and surface ponding, is the main agricultural restriction on Prest group soils. To overcome this limitation is difficult in many cases because of depressional locations with poor drainage outlets, runoff from surrounding areas, subsurface seepage and watertables above soil level during the freshet period. If watertable control cannot be economically achieved, the best use for Prest soil areas is probably reed canary grass or similar cover which can tolerate the usually wet conditions.

2) The Prest group often occurs as long, narrow, sinuous depressions which makes their management difficult from the point of determining field boundaries and cultivation.
3) Prest soils areas have in some areas been developed for water storage and used for irrigation and similar uses.

RYDER SOIL MANAGEMENT GROUP

The Ryder Soil Management Group occupies about 14 450 ha on the uplands and lower mountain slopes in the eastern part of the map area. It is common in the vicinities of Abbotsford, Mount Lehman and Mission and dominates on parts of Sumas and Vedder mountains. Ryder and Lonzo creek soils are the only soils in the management group. The most commonly associated management groups are the Abbotsford and Non-agricultural groups with the Whatcom group important in some areas. North of the Fraser River the Ryder group occasionally grades into the Buntzen group.

The soils in the Ryder management group have developed in silty eolian (windblown) material generally more than 20 cm but less than 100 cm thick, and overlies glacial till. Topographically the group is variable, ranging from undulating or gently rolling with slope gradients around 5% to strongly rolling or hilly with gradients to 50%. The steeper slopes are usually occur on the lower mountain slopes. Elevations range from about 20 to 200 m asl.

The reddish-brown soils of the Ryder management group are well to moderately well drained. The upper part of the soil is moderately pervious; this usually decreases to moderately to slowly pervious in the compact subsoil. Waterholding capacities vary from moderate to high depending on the thickness of the eolian overlay. Temporary perched water tables often develop above the glacial till subsoil during heavy, prolonged rain and lateral downslope seepage develops. Rooting depth and distribution is generally unrestricted in the silty, eolian capping but root penetration into the dense, compact glacial till subsoil is severely curtailed and thin, discontinuous root mats are often present on its' surface.

Ryder group soils are friable and medium-textured in the surface and subsurface. Silt loam is the usual texture with some variation to loam or fine sandy loam in some areas. The subsoil glacial till is generally compact, sandy loam or gravelly sandy loam. Most surfaces are stone-free. A few stones and gravels occur where the silty overlay is thin and have been incorporated by land clearing, uprooting trees or, perhaps, deep cultivation. Ryder and Abbotsford soil groups are similar in surface and subsurface characteristics; the main differences occur in the character of the subsoil.

Soils of the Ryder management group, in their natural state, are relatively leached and only moderately fertile. They, however, have moderate to high nutrient holding ability and therefore respond well to fertilizer addition. Cation exchange capacity of the upper soil is usually between about 20 and 30 meq/100 g. Organic matter content in the surface layer is medium and varies between 5 and 8% while soil reaction mostly falls between pH 5.5 and 6 in both the surface and subsurface layers.

Management Considerations

1) Soils in the Ryder group are suited for most climatically suited crops. In many areas however, adverse topography severely limits the range of crops possible. Particularly limited are those that require relatively uniform topography for even maturation or need specialized equipment that may be limited by steep slopes. In areas where the silty suface capping is relatively shallow, production of potatoes and other root crops may be limited by the compact underlying glacial till.
2) Even though the waterholding capacity is relatively high, irrigation is generally beneficial for good production of most crops, especially where the silty overlay is shallow or

If the crops are shallow-rooted. Excessive irrigation should be avoided since temporary perched water tables and seepage may develop above the compact subsoil.

3) The silty character of the Ryder soil group makes them prone to water erosion. The susceptibility increases with steepness of slope. Management that concentrates water discharge on slopes should be avoided. Row and similar crops should be planted across the slope to minimize waterflow and concentration. Waterways should be permanently grassed and contain water barriers. Moderately sloping areas should have trash cover or cover crops, especially during the rainy winter months and steep areas should be maintained in permanent grass or forest cover.
4) Periodic perched water tables and seepage during the rainy winter months may be detrimental to some perennial crops. Installation of interception drains across the slope will tend to lower the water table and control seepage as well as reducing the amount of water entering adjacent depressions.
5) During land levelling, the silty surface layer should be removed and stockpiled and the subsoil redistributed. The stockpiled material should be evenly respread after levelling is complete.
6) Management practises which maintain organic matter contents (eg. manuring) are beneficial for maintaining the tilth and nutrient holding ability of the surface layer. Fertilizer additions should be based on soil test and the requirements of the crops grown.

Plate 21. Gully erosion after heavy, prolonged rain on soils of the Ryder management group. The floor of the shallow channel in the foreground is glacial till which underlies the silty, eolian surface. (M. G. Driehuyzen photo)

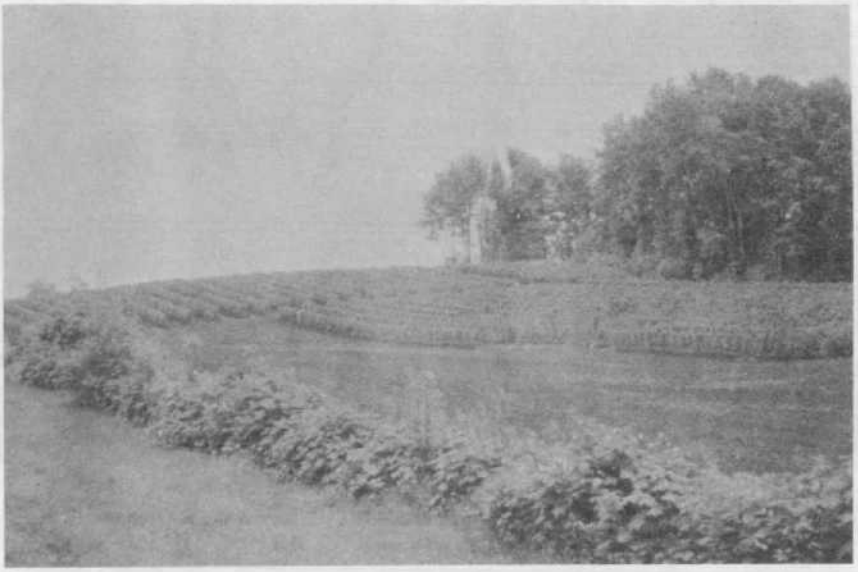

Plate 22. Raspberries planted across the slope on soils of the Ryder management group to help prevent water erosion. (R. C. Wood photo)

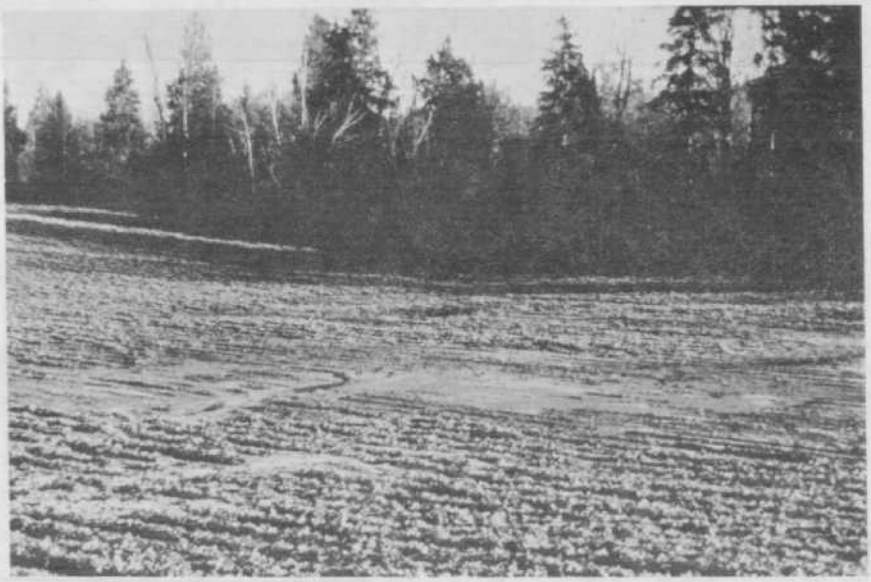

Plate 23. Eroded sediment accumulating at the base of a slope. Not only does erosion cause damage to crops upslope, it also frequently buries them in the area of deposition. (M. G. Driehuyzen photo)

SARDIS SOIL MANAGEMENT GROUP

The Sardis Soil Management Group, composed of Sardis and Eastcap soils, occupies about 3150 ha in the map area. It is prevalent east of Yarrow, along the Alouette River north of Haney and along the margins of rivers and streams in the mountainous, northern part of the map area. Most areas are relatively undeveloped, due mainly to the rather severe limitations these soils have for agricultural uses. The Carvolth, Monroe and Fairfield management groups are commonly associated with the Sardis group.

Soils in the Sardis group have developed in coarse-textured (gravelly), variably stony fluvial deposits which occur as floodplains, islands and low terraces along the margins of streams flowing over the uplands and lowlands and issuing from the mountains. Topography varies from nearly level to undulating; slope gradients are generally less than 5%. Elevations range from about 10 to 300 m above sea level.

Sardis group soils vary from moderately well to imperfectly drained. They are rapidly pervious and have low water holding capacity and slow to moderate surface runoff. Water tables generally fluctuate with the water levels in the adjacent streams and rivers. Flooding in undyked areas is common during periods of heavy rain or rapid snowmelt.

Textures of the surface layer of Sardis group soils are somewhat variable and range from gravelly sand to sandy loam; most common textures, however, are gravelly loamy sand and gravelly sandy loam. Subsurface and subsoil textures range from gravelly sand to gravel. Common to many cobbles and stones are usually present in the surface and become numerous in the subsurface and subsoil. Rooting depth is usually restricted to the upper 50 cm by the stony, coarse-textured subsoils and periodic high water tables.

Nutrient holding capacity of Sardis group soils is low to moderate Cation exchange capacities are generally less than 15 meq/100 g. Organic matter content is also low, usually less than 4%. Soil reactions are generally strongly to moderately acid and range from about pH 5 to 6.

Management Considerations

1) Danger of flooding in undyked areas is a severe agricultural limitation of Sardis group soils. Dyking or other water control is required to protect most Sardis group soils, particularly those in areas located adjacent to streams and rivers subject to high flows during snowmelt and periods of high rainfall.
2) Periodically high water tables may be limiting for some crops, particularly those that are overwintering. Control of the water table may be difficult in some areas due to coarse subsoil textures which allow rapid seepage from the adjacent streams and rivers, particularly during periods of high water.
3) Conversely, low water holding capacity leads to droughty conditions during most growing seasons after the freshet period is past and water tables have retreated. Irrigation is generally required to maintain good crop growth during the season.
4) Stoniness is a severe restriction in many areas and picking is usually required to produce an adequate cultivatable surface layer and seedbed. Root crops are generally not suited because of the high proportion of coarse fragments present.

5) Low nutrient holding capacity and organic matter content suggest that fertilizers be applied as split applications. Applications in excess of the soils' retention capacity will be leached and lost for crop use. Management practises such as manuring which increase organic matter content are very beneficial to improve nutrient and water holding ability.

SCAT MANAGEMENT GROUP

The Scat Soil Management Group occupies about 1950 ha in the map area. It occurs as many small areas scattered on mainly the Surrey-Langley-Matsqui uplands, east of Haney and in the vicinity of Mission. Scat is the only soil in the group. The Whatcom soil group is usually associated with the Scat group as are, sometimes, the Lumbum and Albion groups.

The Scat group consists of soils developed in moderately fine textured glaciomarine deposits which may be capped by silty eolian deposits up to about 50 cm thick. The thicker cappings are more prevalent in the eastern parts of the map area. The topography is generally nearly level, depressional or gently undulating with most gradients less than 5%. The landscape position is usually depressional in relation to the adjacent soils and soil groups. Elevations range from about 10 to 150 m asl.

The soils in the Scat group are slowly pervious, poorly drained and have slow surface runoff. Seepage and runoff accumulates in Scat soil areas resulting in perched water tables above the slowly permeable subsoil and surface ponding is common during prolonged rainy periods. Well defined natural drainageways are often not present and the soil group often exists as scattered, small, disconnected wet areas in the landscape. Surfaces vary from dark gray to black while the subsurface and subsoil is gray (gleyed) and contains variable amounts of reddish to brownish mottles. The dense, compact, slowly pervious subsoil begins at about 50 cm and together with the poorly drained conditions, limits rooting to shallow depths.

The Scat soil group is usually stone-free and medium-textured in the surface and subsurface layers. Textures vary from silt loam to silty clay loam. Subsoils are somewhat heavier and usually range from compact, dense clay loam to silty clay. Surface layers are usually friable.

The Scat soil group has high to very high nutrient holding ability with cation exchange capacities mostly between 30 and 50 meq/100 g in the surface layer. Organic matter content is moderately high in the surface layer and ranges between about 10 and 20%. Soil reaction is generally strongly acid in the surface and ranges between pH 4.5 and 5.5, then gradually increases to between pH 5.5 and 6.5 in the lower subsoil.

Management considerations

1) Poor drainage is the main agricultural limitation of Scat group soils. High water tables and surface ponding restrict most perennials over the winter months and spring cultivating and planting is substantially delayed in most years. Crop damage during the growing season is also likely after heavy prolonged rain. Artificial drainage is required. In some areas open ditches may be satisfactory while underdrains may be required in others. Which system is best depends on crops grown, the size of the area being drained and the availability of outlets. In some cases the small scattered depressional nature of Scat group soils makes drainage system design difficult and expensive to install. Extensive excavation through higher lying, well drained soils may be required.
2) Subsoiling (in conjunction with drainage) is beneficial to improve water movement, aeration and rooting depth and distribution, especially where the dense subsoil is near the surface.
3) Soil amendments to raise and maintain soil reaction at least between pH 5.5 and 6.5 in the surface layer is beneficial for most crops.

4) Cultivation and pasturing when the soils are wet causes structure deterioration and compaction, therefore it should be avoided.
5) Scat soil areas are unsuited for farmsteads and similar construction. Septic tank effluent fields function poorly in these poorly drained, slowly pervious soils and the wet conditions which include surface ponding are likely to cause access and trafficability problems.

Plate 24. Trampling by livestock not only severely damages the crop, it also causes soil compaction and structure deterioration. (R. C. Wood photo)

SHALISH SOIL MANAGEMENT GROUP

The Shalish Soil Management Group, dominantly composed of Shalish soils and to a lesser extent, Dean, Cheam and Seymour soils, occupies about 9050 ha in the map area. It is common on the floors and lower walls of most mountain valleys, particularly in the valleys of the Coquitlam, Seymour and Alouette rivers. The soils are generally severely limited for agricultural uses and most areas are still in an undeveloped state. Soils of the Harrison management group are commonly closely associated with those of the Shalish group.

Shalish group soils have developed in coarse-textured, very stony and bouldery alluvial fan deposits, and less commonly in coarse-textured, stony alluvial deposits usually occuring as low terraces along some stream margins. Also included are small areas developed in stony and bouldery colluvial landslide deposits. Moderate to strong cementation is sometimes present in the lower subsoil.

Topography is variable although most areas are strongly to steeply sloping with gradients between 10 and 30%. A few areas, mostly composed of Seymour soils, are nearly level to gently undulating with slopes below 5%. Elevations generally lie below 300 m asl although a few areas range upwards to 500 m.

Soils in the Shalish group are mainly moderately well to well drained with inclusions of imperfect drainage (Seymour soils). They are rapidly pervious, and have low water holding capacity and slow surface runoff. During and after periods of heavy rainfall or during snowmelt, substantial downslope seepage occurs through the lower parts of the subsoil and in Seymour soils a fluctuating water table is present which varies with the height of water in the adjacent stream. During exceptionally high runoff periods some potential for flooding and stream course shifting exists.

Surface textures of Shalish group soils are generally either gravelly loamy sand or gravelly sandy loam and are very stony, and sometimes, bouldery. Subsurface and subsoil textures are either gravelly sand or sandy gravel and are extremely stony, cobbly and bouldery. Strongly cemented subsoils are sometimes present: if cementation is present it usually begins at about 50 cm below the mineral soil surface. Rooting depth and distribution is restricted by the high coarse fragment content and sometimes by the cemented layers and fluctuating water tables.

Shalish group soils have low to moderate nutrient holding capacity. Organic matter content is medium in the upper part, usually around 8 to 10%. Soil reactions are extremely to strongly acid in the upper mineral soil with pH around 4.5 to 5, these gradually increase to about pH 5.5 in the lower subsoil.

Management Considerations

1) Most areas of Shalish group soils are sufficiently stony, cobbly and bouldery to preclude development for agricultural uses. A few slightly less limited areas are interspersed but even these require substantial stone clearing to produce a cultivatable surface layer. Ground crops are generally not suited.
2) Low water holding capacities require that irrigation be available during the growing season for crop growth and maintenance.

3) Coarse textures and low to moderate nutrient holding capacities suggest fertilizers be applied as split applications over the growing season. Most crops require liming or similar soil amendments to lessen the extremely acid soil conditions. Increasing soil organic matter will help improve nutrient and water holding ability.
4) Land clearing requires extreme care to avoid exposure of the very stony and bouldery subsoil.
5) Adverse topography in most areas limit agricultural uses.
6) The potential for stream course shifting and flooding exists during periods of high precipitation or rapid snowmelt.

SPETIFORE SOIL MANAGEMENT GROUP

The Spetifore Soil Management Group occurs only in the central and southern parts of Delta Municpality and occupies about 800 ha. Spetifore is the only soil in the management group. The Delta management group is often closely associated with the Spetifore group; the Vinod and Lumbum groups are sometimes associated as well.

The Spetifore soil group has developed in saline, medium-textured deltaic deposits which are deeper than 1 m and overlie sandier material. Topography is nearly level to very gently undulating with slopes less than 2%. The group is usually slightly depressional in relation to adjacent management groups and elevations are less than 3 m asl.

Spetifore group soils are poorly to very poorly drained, moderately pervious and have high water holding capacity and slow surface runoff. Water tables are at or near the soil surface during the winter (except where artificially drained) but gradually recede to 50 cm depth or more during most summers. Surface ponding is common during heavy, prolonged rain. The subsurface and subsoil, and often the surface, are moderately to strongly saline. Compounds high in sulphur are usual in the subsurface and subsoil.

The very dark brown to dark grayish brown surface of the Spetifore group soils consists of friable silt loam. Under the surface is 70 cm or more of massive, grayish (strongly gleyed) silt loam or occasionally silty clay loam which contains a few vertical cracks and few to common, reddish-brown to yellowish mottles and, in the lower part, hard tubules around old root channels. At depths of 1 m or more saturated sand or alternating bands of silt and sand are present. Rooting is mainly restricted to 50 cm or less by high water tables and saline and massive soil conditions.

Spetifore group soils have very high nutrient holding ability. The cation exchange capacity in the surface layer is generally between 30 and 50 meq/100 g. Organic matter content in the surface layer is moderately high to high and usually varies between 15 and 25%. Extremely acid soil reactions are present throughout; pH values usually range between 4 and 4.5 in the surface layer and between 3.5 and 4 in the subsurface and subsoil. Electrical conductivity usually ranges between about 10 and 15 mS/cm in the subsurface and subsoil. Sometimes these high values are present in the surface as well.

Management Considerations

1) High water tables and surface ponding, especially during the winter months, severely limit Spetifore group soils for the production of perennial crops. Water tables retreat somewhat during the summer, allowing production of annual crops which are not highly susceptible to wet conditions. Artificial drainage is required to control the high water tables and also help control the strongly saline conditions which are also present.
2) Subsurface and subsoils are strongly saline; the surface layer is usually saline as well and this limits crop growth. Crops susceptible to high salt levels are usually not suited unless the salt content can be controlled. Irrigation, coupled with underdrains, helps wash excess salts downward and out of the system. Winter rainfall acts in a similar manner if underdrains are installed.

3) The very to extremely acid soil reaction is detrimental for production of most crops. Soil amendments (e.g. liming) to raise the reaction of the surface layer to at least pH 5.5 or 6.0 is beneficial.
4) Material excavated or cleaned from ditches and spread over the adjacent land surface is detrimental because of its strongly saline and extremely acid characteristics.
5) Corrosion of underground installations, if not adequately protected, is likely because of the strongly saline, highly acid soil conditions.

SUMAS SOIL MANAGEMENT GROUP

The Sumas Soil Management Group, occupying about 2650 ha, occurs only on the lowlands of eastern Sumas Municipality and along the adjacent western margin of Chilliwack Municipality. Sumas is the only soil in the management group. The main associated management groups are Vedder and Fairfield.

The Sumas group has developed in coarse-textured (sandy) lacustrine deposits, mainly those which were exposed when former Sumas Lake was drained in the 1920's. The topography is level to very gently sloping or undulating and slope gradients are generally less than 2%. The group generally occupies the lowest landscape positions in the area where it occurs. The Vedder group, where associated with the Sumas group, occupies similar landscape positions while the Fairfield group lies somewhat higher. Elevations are all below 5 m asl.

Soils in the Sumas group are rapidly pervious but poorly drained. Water tables are presently controlled by a comprehensive system of ditches, floodgates and pumps which are manipulated, as required, to remove excess water during periods of high rainfall and provide subsurface irrigation during dry periods. Careful control is necessary to prevent surface ponding or conversely, surface drying in these coarse-textured soils. Water holding capacity is low. Surfaces are generally grayish-brown and grade to gray or olive gray in the subsurface and subsoil where variable amounts of reddish and brownish mottles are usually present. Rooting is generally restricted to the upper 50 cm by the high groundwater tables. The generally high winter water tables severely restrict overwintering of perennial crops.

The Sumas management group is coarse-textured. Surface texture is usually loamy sand, varying sometimes to sandy loam. This grades rapidly to medium or coarse sand in the subsurface and subsoil.

The Sumas soil management group is relatively infertile, due mainly to its low nutrient holding capacity and low organic matter content. The cation exchange capacity is generally less than 10 meq/100 g while organic matter content is less than 5%. Soil reaction in the upper soil is usually between pH 5.0 and 6.5 but varies substantially due to past management practises. Subsoil pH is in the vicinity of pH 6.5.

Management Considerations

1) Soils in the Sumas management group are relatively productive if a high level of managerial skill and other inputs (eg. fertilizers) are provided. Excellent water table control is required to prevent surface flooding during high rainfall periods while at the same time maintaining the groundwater level near the rooting zone. Excessive lowering of the water table will cause rapid drying of the upper soil due to its coarse texture and low water retention.
2) Low natural fertility and nutrient holding ability generally require that substantial amounts of fertilizer be added (the actual amounts and kinds are dependent on the crops being grown). Fertilizers added in large amounts may in part be lost through leaching because of the soil's inability to retain them. Several smaller applications over the growing season are probably preferable.

3) Organic matter contents are low and should be increased through barnyard manure applications and green manure crops. Increased organic matter contents will improve both the soils' nutrient and water holding ability.
4) Sumas group soils are friable and seedbeds are easy to prepare. Cultivation is possible shortly after even heavy rains if adequate water table control is present. Because of rapid infiltration and low water retention, the surface layer stays wet for only short periods.
5) The Sumas soil group is susceptible to periodic strong winds which may cause "sandblasting" of some row crops, particularly if the soil is maintained in a bare condition between the rows. Planting the rows perpendicular to the prevailing winds may provide some protection. Cover crops or maintenance of trash cover during the winter also provide protection from wind erosion during these periods.

Plate 25. Drainage and subirrigation are both provided through watertable control on soils of the Sumas management group.

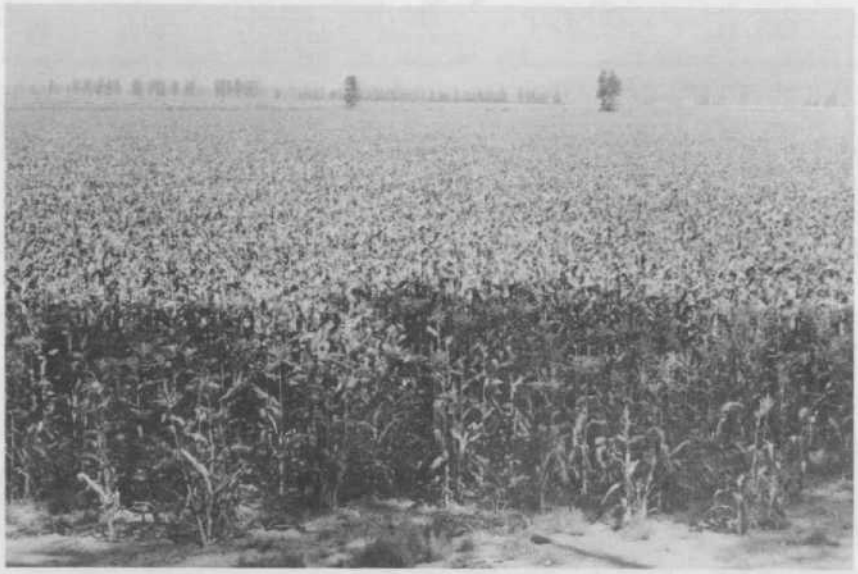

Plate 26. Canning corn being grown on soils of the Sumas management group. High rates of fertilizer are required on these coarse-textured (sandy) soils.

SUMMER SOIL MANAGEMENT GROUP

The Summer Soil Management Group, consisting only of Summer soils, occupies about 650 ha on the uplands of the map area, mainly as small, scattered locations in the Langley and Hazelmere valleys. Commonly associated management groups include Heron and Sunshine.

The Summer group soils have developed in coarse to moderately coarse textured (sandy) littoral or glaciofluvial deposits, usually between 50 and 100 cm thick, which overlie moderately fine to fine-textured marine or glaciomarine sediments. Nearly level to gently undulating with slopes less than 5% is the usual topography of Summer soils. They usually are slightly depressional in relation to adjacent, better drained areas. Elevations range between 20 and 150 m asl.

The Summer management group consists of slowly pervious, imperfectly to moderately poorly drained soils that have low water holding capacity and slow surface runoff. During periods of high rainfall, particularly during the winter, perched water tables develop above the clayey subsoils and temporary surface ponding sometimes occurs as well. The perched water tables tend to dissipate during the latter part of the summer and moisture deficiencies are common toward the end of this period.

The very dark gray cultivated surface layer of Summer soils is generally friable sandy loam or fine sandy loam. The subsurface and upper subsoil vary from sand to loamy sand and contain at depths of usually between 25 and 50 cm, a reddish, strongly cemented zone which is extremely firm when moist and extremely hard when dry. The underlying clayey sediments are dense, massive and gray in color. Rooting is generally restricted to about 30 cm depth by the cemented zone.

Summer group soils have moderate to low nutrient holding ability. The cation exchange capacity generally varies between 10 and 20 meq/100 g in the surface layer and decreases to less than 10 meq/100 g in the lower part of the sandy material. Surface layer organic matter content is low and ranges around 5%. Soil reaction is extremely to strongly acid in the upper part with pH values between about 4 and 5. The reaction gradually increases to about pH 5.5 or 6 in the lower part of the sandy material.

Management Considerations

1) Agricultural use of the Summer Management Group is mainly restricted by high winter water tables which adversely affect perennial crops. Underdrains to control the perched water table during this period (as well as during high rainfall periods during the growing season) are required for good overwintering of crops and protecting susceptible crops during the summer. Earlier spring cultivation and planting will be possible and trafficability during the remainder of the year will be improved.
2) Rooting depth is restricted by the strongly cemented subsurface zone and subsoiling is required. Subsoiling increases rooting depth and also downward water movement, especially if underdrains are also present.
3) Low water holding capacities generally require that supplemental irrigation is available for good crop growth, particularly during the later parts of the growing season. Application amounts should be carefully controlled to prevent perched water tables from developing above the clayey subsoil.

4) Management practises (eg. barnyard manure, green manure crops) which increase organic matter content are beneficial for increasing water and nutrient holding capacity and maintaining soil tilth. Liming or other amendments which increase soil reaction to at least pH 5.5 or 6 are beneficial for good crop growth and production.

SUNSHINE SOIL MANAGEMENT GROUP

The Sunshine Soil Management Group occupies about 8000 ha in the map area. It occupies substantial area in the vicinity of Sechelt and south of Langley with smaller, although important, areas scattered throughout the uplands of Delta, Surrey, Langley, Maple Ridge and Pitt Meadows municipalities. The soils that occur in the highest landscape positions in the Sumas Valley are also included. The Lynden, Sechelt, Sunshine and Kennedy soils form the management group. Several management groups often occur in association with the Sunshine group and include, among others, Bose, Capilano, Heron and Whatcom.

The Sunshine group consists of coarse-textured (sandy) soils developed in a variety of geologic deposits including those of raised marine (littoral), glaciofluvial, fluvial and lacustrine origin. The sandy deposits are generally deep except where Sunshine soils occur. Underlying the Sunshine soils at depths of usually between 1 to 2 m are either clayey glaciomarine sediments or loamy glacial till.

Topography is variable. Most areas vary from very gently sloping to undulating with gradients less than 5% although areas ranging to steeply sloping or strongly rolling with gradients up to 30% are not uncommon. Elevations range from about 5 to near 400 m asl; most areas however lie between 20 and 150 m.

The reddish-brown soils of the Sunshine management group are well to rapidly drained and rapidly pervious. Waterholding capacity is low and surface runoff is slow. During periods of extended, heavy precipitation a temporary perched water table develops above the compact subsoil of the Sunshine soils. The water table is usually deep enough, however, to have little effect on most crops.

The texture of the surface layer of Sunshine group soils is usually loamy sand, varying sometimes to sandy loam and, occasionally, sand. Subsurface and subsoil textures are mostly medium or coarse sand. A few gravelly fragments, cobbles and stones are sometimes present. Rooting depth and distribution is essentially unrestricted.

Sunshine group soils have moderate to low nutrient holding ability. The cation exchange capacity is usually between 10 and 20 meq/100 g in the surface layer and becomes less with increasing depth. Soil reaction of the upper soil is moderately acid and falls between pH 5.5 and 6 then gradually increases slightly in the lower subsoil. Organic matter content is low, generally less than 5%.

Management Considerations

1) The low waterholding capacity of Sunshine group soils limits crop productivity during most growing seasons if precipitation is the sole source of water. Irrigation is generally required for good production of most crops. Water applications should be relatively frequent and of small amounts (because of low soil waterholding capacity).
2) Because of low natural fertility and nutrient holding ability, substantial amounts of fertilizer are generally required for good crop production (the actual amounts should be determined by soil test and crop requirements). The limited nutrient holding ability suggests that fertilizer be applied as split-applications over the growing period.

Portions of large individual additions are likely to be lost to leaching. Amendments such as liming to improve soil reaction in the surface to at least pH 6 are beneficial for most crops.

3) Management practises which increase the organic matter content in the surface layer (eg. barnyard manure, green manure crops) are highly beneficial. Increased organic matter will improve nutrient and waterholding ability as well as improving soil structure and tilth.
4) Due to their well drained characteristics and coarse-textures, the soils stay wet for only short periods after water additions. This allows them to be cultivated shortly after irrigation or rain. The group soils also tend to warm early in the spring, a positive benefit for some early season crops.
5) The steep slopes associated with some areas of Sunshine soils may limit some types of mechanical equipment and this should be considered when determining cropping and management practises. Even though coarse-textures and rapid perviousness allow for rapid water infiltration, surface erosion is likely on the steeper areas if adequate controls are not developed (e.g. cover crops, contour planting, etc.).
6) Areas of Sunshine group soils generally provide good soils for farmsteads and similar uses.

TRIGGS SOIL MANAGEMENT GROUP

The Triggs Soil Management Group occupies about 4800 ha, mostly on the lowlands of the map area. It occurs mainly in Delta Municipality (Burns Bog), Glen Valley, Richmond and Pitt Meadows municipalities, Pitt Polder, and in the northern parts of Surrey and Langley municipalities near the Fraser River. The group consists of Triggs and Glen Valley soils. Lumbum is the most commonly associated management group.

The Triggs group has developed in deep, undecomposed organic deposits consisting of reed and sedge remains, moss or combinations of both. The deposits are at least 1.5 m in depth and commonly exceed 3 m.

Slightly depressional or nearly level to gently domed in the larger areas is the usual topography. Slope gradients are less than 2%. Substantial areas of the Triggs management group are currently undeveloped and still in more-or-less natural condition. Lowland elevations all lie below 5 m asl; the occasional upland location ranges to 75 m.

Triggs group soils are very poorly drained. Water tables are generally at or near the soil surface throughout the year. They are the result of depressional or low lying landscape positions, runoff and seepage from adjacent higher land and, sometimes, overflow and seepage from adjacent water courses. Water holding capacities are very high.

The organic materials of Triggs group soils are essentially fibric (undecomposed) in the surface, subsurface and subsoil and have very low bearing strength. The potential for subsidence is substantial if they are overdrained and decomposition is accelerated in the subsurface and subsoil. Woody material (old tree roots, trunks and branches) are present in the organic material, usually in minor amounts.

The Triggs soil management group is relatively infertile under natural conditions due mainly to the undecomposed nature of the organic material and extremely acid soil reaction. The reaction ranges around pH 4 in the upper part and increases to slightly in some areas to about pH 4.5 or 5 at about 1 m depth. The surface layer, when decomposed by liming, fertilization, cultivation and adequate drainage, has very high nutrient holding ability.

Management Considerations

1) The main agricultural limitation of Triggs group soils is poor drainage. If high water tables are controlled the soils can, over a period of time, be developed for a relatively wide range of crops, particularly annuals and those that are not strongly susceptible to periodic wetness and relatively low pH. Overdraining should be avoided since this is likely to cause excessive subsidence. Artificial drainge which provides an adequate aerated root zone for the crop being grown and trafficability for required equipment is usually sufficient.
2) Newly developed areas are relatively infertile. A few years of cultivation, fertilization and liming are generally required to provide a friable, fertile seedbed for most crops. Some crops such as blueberries and cranberries require little initial soil preparation.

3) Trigg group soils have low bearing capacity. Machinery equipped with low pressure, oversized wheels may be required to provide adequate field access, especially during initial stages of land development.
4) After initial development by water table control and practices which promote decomposition of the surface soil, the Triggs group soils approach the Lumbum group in management methods. The characteristics of the underlying mineral soil is usually less critical however, since the depth of organic material is generally deeper.

Plate 27. Blueberries are a common crop on soils of the Lumbum and Triggs management groups. Those in the photo are located in the Pitt Meadows area.

Plate 28. Cranberry field in the Richmond area. Soils of the Triggs and Lumbum groups are usually utilized for this crop. The combination dyke and roadway provide both access and water control on these wet soils. (R. C. Wood)

VEDDER SOIL MANAGEMENT GROUP

The Vedder Soil Management Group occupies about 4700 ha, mainly in the Sumas, Matsqui, Hatzic and Serpentine valleys. Smaller, scattered areas occupy other portions of the lowlands as well. Included in the managment group are Vedder, Dixon, Beharrel, Hazelwood, Hatzic, Katzie, McLellan, Pelly and Westlang soils. Commonly associated management groups are the Fairfield, Page, Alouette and Lumbum groups.

The Vedder group of soils has developed in moderately fine to fine-textured, fluvial floodplain (mainly vertically accreted) and overbank deposits of the Fraser River and other smaller streams and rivers which flow across the lowlands. Some are also formed in lacustrine deposits which have characteristics similar to the floodplain sediments.

The usual topography of the group is level to gently undulating with slopes less than 5%. The group tends to occupy the lower to intermediate landscape positions in the areas where it occurs. The Page management group, which is distinguished form the Vedder group by having medium rather than fine textures, occupies similar landscape positions while the Fairfield group lies somewhat higher. The Alouette and Lumbum groups are usually lower in landscape positions. Elevations all lie below 10 m asl.

Soils in the Vedder group are poorly drained and slowly to moderately pervious. Groundwater tables are near the surface for substantial parts of the year, particularly during and after periods of prolonged, heavy precipitation. Surface ponding in level or depressional locations is also common at these times, due to slow permeability. Water holding capacity is high. Surfaces vary from dark gray to black while subsurface and subsoil layers are gray (strongly gleyed) and contain variable amounts of reddish and brownish mottles. Rooting is generally severely impeded below depths of 25 to 40 cm by high water tables and dense, clayey layers. Overwintering perennials and other crops susceptible to "wet-feet" are particularly restricted.

Soils of the Vedder group are moderately fine to fine textured and stone-free. The surface soil layer is generally silty clay, varying sometimes to clay or silty clay loam and is friable to firm when moist and sticky and plastic when wet. Subsurface and upper subsoil textures are usually dense, silty clay or clay. Substantial vertical cracks form on drying. At depths below 50 cm gradation to silt loam and eventually sand is common. Occasionally the sand occurs within 50 cm of the surface (shallow variants of Dixon and Vedder soils).

Vedder management group soils have high to very high nutrient holding ability. The cation exchange capacities range between about 25 and 50 meq/100 g. Organic matter content generally ranges between 5 and 15% in the surface layer except in Hazelwood soils where contents commonly range between 15 and 25%. Soil reaction usually ranges between about pH 5 and 6 in the upper soil to pH 5.5 or 6.5 in the subsoil.

Management Considerations

1) Poor drainage is the main agricultural limitation of soils in the Vedder management group. Artificial water table control (and removal of surface ponded water) is required for this group of soils to achieve its agricultural potential. Depressional or lowlying landscape positions as well as intermixing with soils of better drained management groups

sometimes provides problems in drainage system design. Underground drains require protection from 'washing-in" and clogging by the sandy subsoils.

2) Periodic subsoiling is beneficial to improve and maintain water infiltration and permeability as well as aiding in root distribution. The best results occur if the subsoiling is conducted during times when the soils are relatively dry.
3) Vedder group soils are susceptible to puddling, compaction and structure deterioration if traversed or cultivated when wet. Equipment traction is severely reduced. The clayey textures of Vedder group soils require high power requirements for cultivation.
4) Where adequate drainage is not present, wet field conditions generally delay spring cultivation and planting. Harvesting (particularly late-maturing crops) is also frequently difficult due to wet conditions. Most perennial crops suffer severe winter damage if adequate drainage is not installed.
5) Irrigation on Vedder soils is usually not required for adequate crop production. However, if high value crops are being produced, particularly those that are shallow-rooted, availability of supplemental irrigation is good insurance against the extended, low rainfall periods that sometimes occur during the summer.

VINOD SOIL MANAGEMENT GROUP

The Vinod Soil Management Group occupies about 900 ha in the map area, mostly in the Serpentine-Nicomekl valley south and west from Cloverdale. Vinod is the only soil in the managment group. Associated management groups are generally Lumbum and Delta groups; sometimes the Vedder group occurs as well.

Vinod soils have developed in moderately fine textured, mixed marine and non-marine deltaic deposits which are capped by between 15 and 40 cm of organic material, usually well-decomposed (humic). The mineral soil below the organic capping is generally saline and sometimes the lower part of the organic material is saline as well. Compounds high in sulphur content are usually present in the mineral underlay.

Topographically, Vinod soils are nearly level or very gently undulating: slope gradients are usually less than 2%. The soils generally occur as either slight depressions in areas of soils which are mineral to the surface or as gentle ridges in areas where organic material is more than 40 cm thick. The mineral soils in the former case are usually part of the Delta management group while the organic soils in the latter fall in the Lumbum group. Elevations all lie below than 3 m asl.

The Vinod management group is moderately to slowly pervious and poorly to very poorly drained. It has high waterholding capacity and slow surface runoff. The water table is usually near, and often at, the soil surface during the winter and early spring, then recedes somewhat over the growing season, due in part to artificial drainage which has been installed. In the slightly depressional or level areas, temporary surface ponding is common during and after heavy rain.

The surface of Vinod group soils generally consists of black, well-decomposed, friable organic material containing, where the organic capping is shallow, variable amounts of admixed clayey mineral material from below. Where the organic material is deeper, a firm, compact zone (plow pan) is often present immediately below the zone of cultivation. The underlying mineral soil is gray (strongly gleyed), massive, silty clay loam or silty clay in the upper part and becomes siltier with increasing depth. Below about 1 m sandy material is often encountered. Yellow mottles and hard brownish tubules around old root channels are common. Observations since the soil survey was completed indicate that many organic areas contain a significant component of sedimentary peat, particularly near the contact with the underlying mineral soil. This organic material has especially high shrinkage when dried and is difficult to rewet (hydrophobic) and may present special management problems. Rooting is generally restricted to the upper 50 cm by the combination of high water tables and saline, dense subsoils.

Vinod group soils have very high nutrient holding ability. The cation exchange capacity is well in excess of 50 meq/100 g in the organic surrface layer. Soil reaction in this layer is somewhat variable depending on past management history but usually is strongly to extremely acid and ranges between pH 4 and 5. The underlying mineral soil is extremely acid (between pH 3.0 and 4.0) and the electrical conductivity is usually well in excess of 4 mS/cm.

Management Considerations

1) Poor drainage is one of the main agricultural limitations of Vinod group soils. Improved artificial drainage to control both high water tables and surface ponding during the

winter and other periods of high rainfall is required to maintain most perennials, allow earlier spring cultivation and prevent flooding-out of annual crops. Underdrain spacings should be relatively close due to the slowly pervious nature of the underlying mineral material.

2) Soil salinity is also an important management consideration that may become more serious in the future. The Vinod soils are generally saline in the underlying mineral soil and, where the organic capping is shallow, this probably restricts root development at the present time. Management that maintains the depth of organic material (minimizes its decomposition) is required. Minimum cultivation is one method. Improved drainage, coupled with irrigation, will help control the salinity of the subsoils by leaching excess salts. Capillary rise of saline water from the subsoil into the rooting zone will also be controlled if sufficient irrigation is used during dry periods.
3) Periodic subsoiling to loosen the dense subsoil and disrupt the plow pan in the organic material (where present) is beneficial for improving downward water movement, especially if underdrains are installed. It also improves aeration and root distribution.
4) Soil reaction generally is very acid and amendments which improve and maintain the pH at 5.0 or more is beneficial for most crops. The extremely acid subsoil conditions are more difficult to control. Improved water table control and increased aeration tends to increase the oxidation of the sulphur compounds in the subsoil thereby increasing the acidity even further.
5) Cover crops and trash cover are beneficial for erosion control. The finely divided, light weight organic surfaces when dry are easy to remove by wind. Their light weight also makes them susceptible to erosion by moving surface water.
6) Although waterholding capacities are very high, extended climatically dry summer periods sometimes occur which make the availability of irrigation beneficial for maintaining good crop growth and production, particularly if high-value, shallow rooted crops are being produced. Irrigation, as mentioned earlier, also helps control soil salinity.
7) Underground concrete or metal installations, unless adequately protected, are likely to severely corrode due to the saline, acidic subsoil conditions.
8) Distribution of subsoil material on the land surface from ditch construction and cleaning may be detrimental to crop production because of the clayey, saline, extremely acid nature of the material.

Plate 29. Aerial view of part of the Serpentine - Nicomekl lowlands near Cloverdale. The lighter tones are soils in the Vinod management group while the darker areas are part of the organic Lumbum group. Intricate intermixing of soils of different character often makes field boundaries and cultivation and cropping methods difficult to determine. (M. G. Driehuyzen photo)

WHATCOM SOIL MANAGEMENT GROUP

The Whatcom Soil Management Group is the largest agricultural soil management group in the map area and occupies about 29 550 ha. It is widespread on the uplands of Matsqui, Langley, Surrey and Maple Ridge municipalities and occupies a substantial area in the northern part of the Hatzic Valley. Smaller areas are scattered elsewhere, such as in the vicinity of Gibsons on the Sunshine Coast. Whatcom and Nicholson soils by far contribute the largest area to the group; Milner, Durieu and Coquitlam soils though locally important, are less prevalent. The commonly associated soil management groups are Scat and Cloverdale; the Berry group is also associated in some areas.

This large group of soils is developed dominantly in medium to moderately fine textured glaciomarine deposits (Whatcom, Nicholson and Durieu soils). Smaller areas are developed in raised, fine-textured marine (Milner soils) and medium-textured glaciolacustrine deposits (Coquitlam soils). A shallow capping of silty eolian material is present in most areas.

Topographically, the group is variable, ranging from nearly level or gently undulating to steeply sloping and strongly rolling. Slope gradients vary from less than two to over 30%; most slopes, however, fall between 2 and 15%. The soil group generally occupies the tops and slopes of the undulating and rolling landscapes in which it occurs. The intervening lowlying or depressional areas usually fall in the Scat or Cloverdale management groups. Elevations range from about 10 to 150 m asl.

The Whatcom management group is composed of reddish-brown, moderately well to well drained soils that are moderately pervious in the upper 40 to 75 cm or so and slowly pervious below that. Water holding capacity is high. During periods of high rainfall temporary perched water tables develop above the slowly pervious subsoil and lateral downslope seepage occurs in this zone. Reddish to brownish mottles are common in the zone affected by the perched water table. Rooting depth is slightly to moderately restricted by the compact, slowly pervious subsoil and periodic perched water tables.

Soils in the Whatcom group are stone-free, friable and medium-textured in the upper part. The subsoils are compact and usually moderately fine or fine-textured although some medium-textured inclusions also occur. Surface and subsurface textures are dominantly silt loam, varying sometimes to silty clay loam or loam. Subsoils are somewhat variable, ranging from silt loam to clay; clay loam or silty clay loam are the most common textures, however. In most areas the upper part of the subsoil is enriched by illuvial clay. In forested areas 5 to 10 cm of organic forest litter is usual on the soil surface and may be as deep as 25 cm in some locations (Coquitlam soils).

Soils of the Whatcom group, in their natural state, are relatively leached and therefore only moderately fertile. However, they have moderate to high nutrient holding ability with cation exchange capacities between about 15 and 30 meq/100 g. The fertility of presently cultivated areas is variable depending on the management applied to them in the past. Organic matter in the surface layer is usually medium and generally between 5 and 8%. The organic matter in Coquitlam soils is somewhat higher, ranging to about 15%. Soil reaction in the upper soil is moderately to strongly acid and usually ranges between pH 4.7 and 5.8. It gradually increases with depth to between pH 5.5 and 6.5 in the subsoil.

Management Considerations

1) Soils in the Whatcom management group, with good care and management, are generally suited for a relatively wide range of crops. They are moderately well drained, friable and moderately fertile and have high water holding capacity. In some areas they are closely intermixed with soils of other management groups (mainly Scat and Cloverdale) which have different management requirements causing some problems in determining field boundaries and cropping patterns.
2) Topography is variable and in some areas may be limiting for crops requiring uniform maturity. Some of the steeper areas may limit the type of machinery that can be used.
3) The periodic perched water tables and associated seepage may be detrimental to some overwintering perennials and other crops sensitive to periodic "wet-feet". Installation of interception drains (or ditches) perpendicular to the slope will tend to control the seepage and lower the water table. The amount of water seeping into adjacent depressions will also be reduced.
4) The friable silty surfaces of the Whatcom soil group are prone to water erosion and gullying. The susceptibility increases with steepness of slope. Management practices which concentrate water discharge on slopes (eg. ditch or drain outlets) should be avoided. Row crops should be planted along the contour to minimize surface waterflow and concentration. Sloping areas should have trash cover or cover crops during the wet winter months and the very steep areas should probably be maintained in permanent grass or similar cover.
5) If land leveling is undertaken, the friable, silty surface to depths of about 50 cm should be removed and stockpiled and the underlying compact, clayey material leveled. The stockpiled material should be then redistributed after leveling is complete. Some admixing of the clayey subsoil and silty overlay at the contact of the two should be attempted to provide a gradational texture change to assist downward water movement. Exposure of the clayey subsoil will severely retard water infiltration, limit root distribution and cause trafficability problems.
6) Soils in the Whatcom management group have high waterholding capacity and irrigation usually is not necessary in most years for moderate production of most crops. However, if high-value crops are being grown, particularly those that are shallow rooted, the availability of supplemental irrigation is good insurance against the very low rainfall summers that sometimes occur.
7) Addition of soil amendments (eg. liming) to raise and maintain the pH between at least 5.5 or 6.0 is beneficial for most crops. Organic matter additions either by manure application or green manure crops will improve and maintain the tilth and nutrient holding ability of the surface layer. Fertilizer additions should be based on soil test and the requirements of the crops being grown.

Plate 30. Forage production on soils of the Whatcom management group. Note the undulating to rolling nature of the topography. The depressional areas are often occupied by soils of the Scat management group.

Plate 31. Water erosion after a heavy, prolonged rain on clean-cultivated soils of the Whatcom management group. The erosion has developed along furrows produced by cultivating up-and-down slope. (R. C. Wood photo)

Plate 32. Rill erosion on a newly cleared area of soils in the Whatcom management group. The land in this instance was cultivated up-and-down the slope. (R. C. Wood photo)

Plate 33. Water erosion between strawberry rows. Note that the crop has been planted parallel to the slope of the land. (R. C. Wood)

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APPENDIX A

SUMMARY OF SOIL MANAGEMENT GROUPS, INCLUDED SOILS, MAIN AGRICULTURAL CONSIDERATIONS AND AREA

SOIL MANAGEMENT GROUP	INCLUDED SOILS	MAIN AGRICULTURAL CONSIDERATIONS	AREA (ha)
Abbotsford	Abbotsford, Marble Hill, Keystone, Laxton, Stave, Peardonville	Droughtiness; sometimes adverse topography and erodibility	12 600
Alouette	Alouette, Sturgeon, Annis, Hallert	High watertables; surface ponding; high acidity; minimizing organic decomposition	6250
Benson	Benson	High watertables; salinity; droughtiness	200
Berry	Berry, Tunbridge	Fluctuating watertables; compaction and structure deterioration	1300
Blundell	Blundell	High watertables; surface ponding; minimizing organic decomposition	750
Bose	Bose, Langdale, Porpoise	Droughtiness; stoniness, often adverse topography; nutrient retention; coarse-textures	18 050
Buntzen	Buntzen, Steelhead, Surrey	Adverse topography; stoniness; seepage and fluctuating watertables	16 750
Capilano	Capilano, Roach, Haney	Droughtiness; coarse-textures; stoniness; nutrient retention; often advserse topography	11 700
Carvolth	Carvolth, Ross	High watertables; flooding; sometimes poor access	1050

APPENDIX A (CONTINUED)

SOIL MANAGEMENT GROUP	INCLUDED SOILS	MAIN AGRICULTURAL CONSIDERATIONS	AREA (ha)
Cloverdale	Cloverdale, Albion, Langley	High watertables; surface ponding; low perviousness; compaction and structure deterioration	5950
Coghlan	Coghlan, Errock	Droughtiness; coarse-textures; stoniness; cemented subsurface; fluctuating watertables	450
Columbia	Columbia	Droughtiness; nutrient retention; sometimes stoniness; coarse-textures	5700
Crescent	Crescent, Kitter	Fluctuating to high watertables; structure deterioration and compaction; low perviousness	3450
Delta	Delta, Westham, Deas, Embree, Mathews, Nicomekl, Sandel	High watertables; structure deterioration and compaction; sometimes subsoil salinity; low perviousness	6300
Elphingstone	Elphingstone	High watertables; harsh climate; high elevation; poor accessibility; low bearing strength	60
Fairfield	Fairfield, Bates, Dewdney, Bonson, Grigg, Fadden, Henderson, Vye	Fluctuating watertables; sometimes adverse topography	10 050
Grouse	Grouse, Hollyburn	High elevations; harsh climate; coarse, stony textures; shallowness to bedrock; adverse topography; fragile vegetation	9300

APPENDIX A (CONTINUED)

SOIL MANAGEMENT GROUP	INCLUDED SOILS	MAIN AGRICULTURAL CONSIDERATIONS	AREA (ha)
Grevell	Grevell, Tsawwassen, Neptune, Seabird	Droughtiness; nutrient retention; danger of flooding in some areas; coarse-textures	1700
Gulchon	Gulchon, Seaview	High watertables; surface ponding; salinity	450
Harrison	Harrison, Isar, Chehalis	Droughtiness; stoniness; sometimes adverse topography; nutrient retention; coarse-textures; potential for flooding	3400
Heron	Heron, Livingstone	High watertables; droughtiness; sometimes surface ponding	2550
Ladner	Ladner	High watertables; compaction and structure deterioration; low perviousness	1700
Lehman	Lehman, Elk, Boosey Calkins	High watertables; droughtiness; sometimes stoniness and surface ponding	1700
Lumbum	Lumbum, Lulu, Richmond, Gibson, Judson, Banford, Goudy, Annacis, Widgeon	High watertables; organic subsidence; high acidity; sometimes flooding; low bearing strength	12 700
Miscellaneous Land Type	Tidal Flats, Recent Alluvium, Gravel Pits, Anthropogenic Materials	Flooding; salinity; adverse topography; unsuited growth medium; generally not suited for arable uses.	5850

APPENDIX A (CONTINUED)

SOIL MANAGEMENT GROUP	INCLUDED SOILS	MAIN AGRICULTURAL CONSIDERATIONS	AREA (ha)
Monroe	Monroe, Matsqui, Lickman	Sometimes droughtiness and adverse topography; maintenance of organic matter content	3400
Murrayville	Murrayville, Fellows, Defehr	Droughtiness; fluctuating water-tables; sometimes adverse topography and erodibility	3750
Non-Agricultural	Burwell, Cannell, Eunice, Golden Ears, Poignant, Sayres, Strachan, Whonnock, Blaney, Cascade, Dennett, Devil, Hoover, Kenworthy, Marion, Palisade, Paton, Lions, Rodgers; Ice, Talus and Rock Outcrop land types	Very steep topography, stoniness, coarse-textures, shallowness to rock, rock outcrop, harsh climate; not suited for arable uses	163 000
Page	Page, Arnold, Blackburn, Buckerfield, Hjorth, Hopedale, McElvee, Sim, Niven	High watertables; surface ponding; compaction and structure deterioration	6350
Pitt	Pitt, Hammond, Neaves	High watertables; surface ponding; strong acidity; compaction and structure deterioration	2400
Prest	Prest, Addington	High watertables; surface ponding; flooding	1650

APPENDIX A (CONTINUED)

SOIL MANAGEMENT GROUP	INCLUDED SOILS	MAIN AGRICULTURAL CONSIDERATIONS	AREA (ha)
Ryder	Ryder, Lonzo Creek	Often adverse topography; droughtiness; erodibility	14 450
Sardis	Sardis, Eastcap	Often flooding; fluctating watertables; droughtiness; stoniness; nutrient retention; coarse-textures	3150
Scat	Scat	High watertables; low perviousness; often depressional locations; compaction and structure deterioration	1950
Shallsh	Shallsh, Dean, Seymour, Cheam	Stoniness; droughtiness; usually adverse topography; nutrient retention; coarse-textures	9050
Spetifore	Spetifore	High watertables; salinity; surface ponding; high acidity	800
Sumas	Sumas	High watertables; nutrient retention; increased organic matter content; coarse-textures	2650
Summer	Summer	Fluctuating watertables; droughtiness; cemented subsurface; nutrient retention	650
Sunshine	Sunshine, Lynden Sechelt, Kennedy,	Droughtiness; nutrient retention; sometimes adverse topography; coarse-textures	8000

APPENDIX A (CONTINUED)

SOIL MANAGEMENT GROUP	INCLUDED SOILS	MAIN AGRICULTURAL CONSIDERATIONS	AREA (ha)
Triggs	Triggs, Glen Valley	High watertables; excessive acidity; low bearing strength; undecomposed organic material; subsidence	4800
Veddor	Vedder, Dixon, Beharrel, Hazelwood, Hatzic, Katzie, McLellan, Pelly, Westlang	High watertables; sometimes surface ponding; low perviousness; compaction and structure deterioration	4700
Vinod	Vinod	High watertables; surface ponding; high acidity; salinity; low perviousness; minimizing organic decomposition	900
Whatcom	Whatcom, Nicholson, Milner, Durieu, Coquitlam	Sometimes adverse topography; slowly pervious subsoil; sometimes temporary, fluctuating perched watertables; erodibility	29 550