

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS—MILTON WHITNEY, Chief.

SOIL SURVEY OF THE EVERETT AREA,
WASHINGTON.

BY

E. P. CARR AND A. W. MANGUM.

[Advance Sheets—Field Operations of the Bureau of Soils, 1905.]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1906.

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,

Washington, D. C., May 14, 1906.

SIR: The accompanying report covers a soil survey of the Everett area, Washington, which includes the western part of Snohomish County, lying in the northwestern part of the State, along Puget Sound. This is a region of varied soils which is now being opened up to settlement by the removal of valuable forests. Many of the settlers who are purchasing these cut-over lands are entirely or in part unfamiliar with the soils or the methods of cultivation best adapted to the conditions. The need for a survey of this area was called to the attention of this Bureau by a petition of the chamber of commerce at Everett, Wash., which was indorsed by the Hon. A. G. Foster. I recommend the publication of this report as advance sheets of the Field Operations of the Bureau of Soils for 1905, as provided by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
SOIL SURVEY OF THE EVERETT AREA, WASHINGTON. By E. P. CARR and A. W. MANGUM.....	5
Location and boundaries of the area.....	5
History of settlement and agricultural development.....	5
Climate.....	7
Physiography and geology.....	9
Soils.....	11
Galveston coarse sand.....	11
Muck.....	12
Swamp.....	13
Miami sandy loam.....	13
Snohomish fine sandy loam.....	15
Snohomish sand.....	16
Miami gravelly sandy loam.....	17
Miami stony loam.....	19
Snohomish silt loam.....	20
Puget silt loam.....	22
Puget fine sandy loam.....	23
Puget clay.....	24
Agricultural methods.....	26
Agricultural conditions.....	28

ILLUSTRATIONS.

TEXT FIGURE.

	Page.
FIG. 1. Sketch map showing location of the Everett area, Washington....	5

MAP.

Soil map, Everett sheet, Washington.

SOIL SURVEY OF THE EVERETT AREA, WASHINGTON.

By E. P. CARR and A. W. MANGUM.

LOCATION AND BOUNDARIES OF THE AREA.

Snohomish County lies in the northwestern part of Washington on the eastern shore of Puget Sound. The area embraced in the present survey comprises the western part of this county, and is included within parallels $47^{\circ} 46'$ and $48^{\circ} 18'$ north latitude and meridians 122° and $122^{\circ} 24'$ west longitude. This area is bounded on the north by Skagit County, on the east by an arbitrary north and south line, on the south by King County, and on the west by Puget Sound. It contains 336,064 acres, or about 525 square miles—approximately one-fifth of the area of the county, a large part of the remaining four-fifths being very mountainous and much of it as yet unsurveyed.

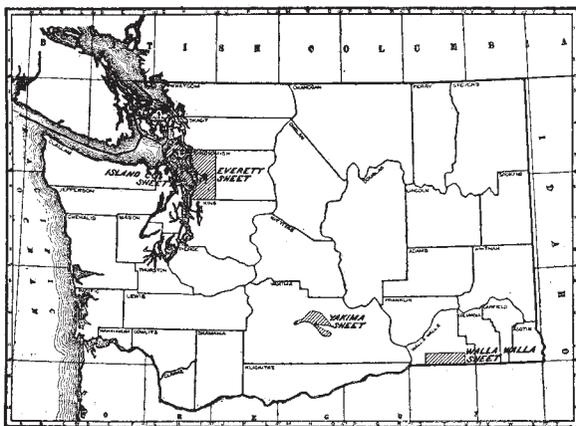


FIG. 1. Sketch map showing location of the Everett Area, Washington.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Snohomish County was first explored in 1855-56 by inhabitants of Whidbey Island and Port Townsend, a number of whom then settled along the Snohomish River. The county was originally inhabited by a mild-mannered race of Indians, who lived largely by fishing, and whose present home is the Tulalip Reservation in the northwestern part of the area. In January, 1861, the county was organized, and

when the railroads were built in 1888 this part of the county developed with wonderful rapidity. The city of Everett, now the county seat, grew from a population of none in 1891 to 20,000 in 1902. The rural sections, however, are as yet largely unsettled, with the exception of the valley lands along the rivers and the delta lands at their mouths, and most of the area is to-day still in imposing forests of fir, hemlock, and cedar, or but recently logged off.

Lumbering is the chief industry of the county, and Everett one of the first of log markets. The total annual output of lumber products is valued at over \$8,000,000.

The farming population comprises many different nationalities, but there is a preponderance of Scandinavians and Germans. The agricultural development of the area has been chiefly along the line of general farming, the important products being hay, oats, and potatoes, and along the more special lines of dairying, poultry raising, and berry growing. The valley and delta lands afford the very best of soils for oats, and their yields of hay are large and of fair quality, while the upland soils produce good yields of first quality potatoes.

A majority of the farmers in the area have found in dairying their best success. The heavy valley soils are naturally well adapted to this industry, and on the lighter and sandier uplands there occur here and there local moist depressions and loamy bottoms, which the dairyman has found it profitable to clear for hay and pasture. There are convenient creameries in many of the small towns, the demand for the produce is steady, and the industry is on a substantial business basis.

In several localities poultry raising has proven uniformly successful, and the good demand renders this one of the surest and most profitable forms of intensive farming on a small scale.

In recent years small-fruit culture has become an important industry in the area, and the prospects for this line of special farming are very bright. On the sandier and better drained valley soils choice crops of raspberries, blackberries, and dewberries are grown with very high yields, and these crops command a ready market. The Snohomish and Monroe Fruit Growers' Association was organized in 1903 and has been very successful in placing this industry on a firm business footing. The growing of other fruits, especially of apples, cherries, pears, and choice plums, is open to decided encouragement, although the industry is at present commercially in an undeveloped condition.

The Snohomish County Horticultural Society was established in 1900, and the office of county horticultural inspector has been in exercise since 1896. To the latter office the author is indebted for the courtesy of considerable information as to local agricultural condi-

tions. The Everett Chamber of Commerce has also been highly instrumental in forwarding the agricultural interests of this portion of the county.

Since most of the soils in this area, and especially the extensive uplands, are either heavily timbered or only recently cleared of timber, the greatest drawback to the agricultural development of this section, and the most pressing consideration with intending settlers, is the cost of clearing the land. On account of the large size of the fir and cedar stumps, the cost of clearing amounts to from \$100 to \$200 an acre, in general a prohibitive cost to any system of extensive farming. For this economic reason it follows that a highly specialized and intensive farming on a small acreage must be the condition of its future development. It should be borne in mind, however, that this cost of clearing is allowed in estimating the value of all farm lands in this part of the Northwest, and so represents an intrinsic value, and that there are no cheap open lands in this part of the country with which one must compete on these cleared lands. Moreover, the instances of intensive farming noted above, such as dairying, poultry raising, and berry culture, show that with proper management this investment can be made to yield very handsome profits.

CLIMATE.

The following tables from the records of the Weather Bureau stations at Silvana, Snohomish, and Granite Falls show a decided difference in the rainfall at different points in the area, amounting to over 20 inches. This difference is, however, readily explained by the influence of the neighboring mountains on the east and on the west.

The rain-bringing winds generally approach from the southwest and condense upon the Olympic Mountains, and the western part of Snohomish County is so sheltered by this range that the winds are already deprived of a large part of their moisture before reaching this section. The low precipitation at Silvana is indicative of this influence. The higher precipitation at Granite Falls, situated just outside the area, is doubtless due to the fact that this entire portion of the area lies to the windward of the Cascade Mountains, which again subject the winds from the southwest to condensation.

It is evident from these monthly tables that there is a fairly defined dry season during June, July, August, and September, and winter is known as the rainy season on account of the protracted light rains.

The tables showing the dates of killing frosts indicate a growing season of about one hundred and seventy days. Since the growing season coincides largely with the dry season, this fact should be taken into account in adjusting the farming methods to local conditions.

As the climate of this area is of so much agricultural importance, it is necessary to go into some detail on the point. The area is sheltered from continental blizzards by the lofty Cascade Range, and its climate is further modified by its location on Puget Sound. The result is an equable marine climate, with cool summers and mild winters. The thermometer rarely reaches as high as 90° F. or as low as 20° F. There is, however, except in midsummer, a rather large proportion of foggy and overcast weather. Snows in winter are very infrequent and thunderstorms in summer are almost unknown.

It is well to summarize here the influence of these peculiar climatic conditions upon the character of the agricultural products. This cool and on the whole rather moist climate is well adapted to growing grass, although the curing of hay is somewhat uncertain. A specific climatic influence is seen in the different success in growing wheat and oats. The wheat produced is too soft for milling purposes, and is used mostly for chicken feed, while the cool, moist conditions favor the production of unsurpassed oats, which do not require the maturity of hard kernels for milling. Again, the climate is too cool to mature corn to the best advantage, or to color and mature choice peaches; while on the other hand it favors the production of berries of much firmer shipping quality than warmer localities, and is adapted to the growing of hops and cauliflower. Other details of climatic influences will be brought out in other parts of the report.

Normal monthly and annual temperature and precipitation.

Month.	Silvana.		Snohomish.		Granite Falls.
	Temperature.	Precipitation.	Temperature.	Precipitation.	Precipitation.
	°F.	In.	°F.	In.	In.
January	36.9	4.56	39.0	5.08	4.32
February	40.0	5.18	41.7	5.55	5.33
March	41.0	3.51	43.7	4.42	6.91
April	47.2	3.57	49.7	3.80	5.36
May	53.5	3.44	55.6	3.77	5.00
June	57.5	1.82	59.5	2.58	4.46
July	60.5	.82	62.8	1.21	2.02
August	61.2	1.27	62.8	1.00	1.87
September	55.2	1.76	57.0	3.12	3.96
October	50.3	2.48	51.5	3.83	5.14
November	42.2	4.62	44.1	6.06	6.27
December	38.0	4.40	40.7	6.27	8.75
Year	48.6	37.43	50.7	46.64	59.39

Dates of first and last killing frosts.

Year.	Silvana.		Snohomish.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1897.....			Apr. 27	Nov. 27
1898.....	Apr. 4	Oct. 8	Mar. 21	Oct. 8
1899.....	May 15	Oct. 12	Apr. 12	Oct. 13
1900.....	Apr. 27	Sept. 26	Apr. 26	Sept. 24
1901.....	May 10	Sept. 30	July 12	Sept. 29
1902.....	Apr. 24	Oct. 23	Apr. 13	Oct. 22
1903.....	Apr. 28	Oct. 14	Apr. 10	Nov. 10
Average.....	Apr. 28	Oct. 9	Apr. 26	Oct. 19

PHYSIOGRAPHY AND GEOLOGY.

This area may be conveniently divided into three physiographic divisions: First, the valley region along the Snohomish and Stilaquamish rivers, including the delta lands at their mouths; second, the rolling hills and benches that make up the bulk of the area; and third, the mountainous uplands that extend with a well-defined bend around the northeastern corner of the map.

The valley region comprises the alluvial bottom lands along the Snohomish and Stilaguamish rivers, and their tributary creeks, together with the delta "flats" at the mouths of these rivers. These valleys attain a width of from 1 to 2 miles in their lower courses, and most of these lands do not exceed an elevation of 20 feet. The immediate banks of these streams have been built up by deposits of fine sand, giving the Puget silt loam, while the lower bottoms farther back from the streams represent the finer deposits of silt and clay, giving rise to the Puget clay. Some parts of these bottoms are so low, wet, and subject to overflow that they form areas of muck or of swamp. The delta flats at the mouths of the rivers have been formed by deposition of these finer materials, silts and clays, reworked by tidal action and modified by marsh growths. These two valley soils are the most valuable in the area.

The second physiographic division embraces the lower hills and bench lands, from 25 to 600 feet in elevation, constituting the majority of the upland area. These hills are in general of easy slope, with more or less flat tops, and are built up of glacial deposits of sand, clay, and gravel. They are a part of the well-defined morainic area that lies between the foothills of the Cascade Mountains and the waters of Puget Sound. The characteristic soil of this region is the Miami sandy loam, while the Miami gravelly sandy loam is a type representative of the coarser deposits of sand and gravel. Deposits of bowlder clay are generally to be found at no considerable depth throughout this region, and the Snohomish silt loam is formed where

the material comes sufficiently close to the surface or where it has been exposed by erosion. Only an occasional small kettle hole is to be seen, while but few glacial erratics or boulders of any large size are found. In fact, these glacial hills seem to show the results of a rather uniform and moderate ice action, or of having been extensively modified by glacial floods and subsequent stream action on a large scale. This is indicated by the terraces along many of the streams and by the extensive bench lands extending from the streams well up the flanks of the hills. The Snohomish fine sandy loam, as well as the Snohomish silt loam, is fairly characteristic of such bench lands and terraces. This region is still but little used for agriculture, and is composed largely of land in heavy forests of fir and cedar or of land from which the timber has been removed. A number of lakes of glacial origin are scattered through this section of the area, Lake Stevens and Lake Goodwin being the largest among them.

The third physiographic division consists of the mountainous uplands in the northeastern corner of the area, rising from an elevation of about 400 up to 1,800 feet. This region is separated from the lower hills and benches by an abrupt escarpment along its whole western border at its base. While likewise subjected to glaciation, it shows frequent and extensive outcroppings of diorite, granite, and schists, and the soils are influenced by the residual weathering of these rocks.

Its characteristic soil is the Miami stony loam, and it is almost entirely uncleared. The geology of this mountainous region differs greatly from that of the rest of the area. Its backbone of igneous rocks (diorite and granite) is of earliest geological age, and contains various ore-bearing seams, intrusions, etc.

On the other hand, the remainder of the area has a geological foundation of sedimentary shales, sandstones, and conglomerates of Tertiary and Eocene age, which have been thrown into folds, and which outcrop occasionally along some of the streams. These sedimentary formations of the Puget Sound Basin underwent a subsidence by which the tilted shales and sandstones were sunk below sea level, the rivers drowned, and Puget Sound formed.

Later still, glacial sediments from 500 to 1,000 feet deep, consisting of plains of till with local deposits of stratified sand, clay, and gravel covered this portion of the area, while the mountainous uplands were to a less degree likewise subjected to ice activity.

The area, as a whole, is well watered, the main drainage being by the north and south forks of the Stilaguamish River, which converge at Arlington, and flow westward into the sound at Stanwood, and by the Skokomish and Snoqualmie rivers, which converge just inside the area, below Monroe, to form the Snohomish River, flowing thence in a northwesterly direction into the sound above Everett.

The Snohomish River flows with an easy fall, and is navigable with small steamers throughout its course in the area, while the Stilaguamish River develops frequent small shoals, especially above the junction of its north and south forks as the mountainous uplands are approached.

SOILS.

Eleven types of soil, exclusive of Swamp, were encountered in this area. The following table shows the acreage of these types and the proportion which each one forms of the total area surveyed:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Miami sandy loam	184,320	54.8	Snohomish fine sandy loam.	9,728	2.9
Puget clay	25,792	7.6	Puget silt loam	8,448	2.5
Miami stony loam	23,488	7.0	Swamp	6,080	1.8
Miami gravelly sandy loam.	23,360	7.0	Puget fine sandy loam.....	4,928	1.5
Snohomish sand	21,504	6.4	Galveston coarse sand	256	.1
Snohomish silt loam	16,192	4.8	Total	336,064	
Muck	11,968	3.6			

GALVESTON COARSE SAND.

The Galveston coarse sand soil type consists of 3 feet or more of medium to coarse loose gray sand, containing gravel of various sizes. Its extent in the area is so limited that it is indicated on the map merely for the sake of completeness. It is confined to a few small sandy spits and beaches along the shore of Puget Sound, formed by the action of the waves, and possesses no agricultural value.

The following table shows the results of a mechanical analysis of a typical sample of the Galveston coarse sand.

Mechanical analyses of Galveston coarse sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
14064.....	Soil.....	2.2	33.3	51.5	12.2	0.1	0.4	0.3

MUCK.

Muck consists of vegetable mold in a more or less decomposed condition, mixed with silt or other earth, and extending to a depth of from 1 to 3 or more feet.

The main bodies of this soil are found along the Snohomish River, between Everett and Snohomish, and southeast of Snohomish. Smaller areas are found here and there along most of the smaller

streams throughout the area and around many of the small lakes, while other larger tracts are found in the uplands east of Edgecomb, southwest of Silvana, and west of Bryant.

The topography of the Muck areas is very low and flat. They consist of the lowest depressions along streams which are subject to overflow and of upland bogs. The drainage is very poor or wholly lacking, and artificial drainage is necessary on a systematic and extensive scale to make these tracts fit for cultivation.

The soil owes its origin to the decomposition of peat and other organic matter that has accumulated to a marked depth in these wet depressions. These lands are locally spoken of as "beaver dam lands," and the beavers have doubtless flooded small areas by means of their dams and rendered them wet and mucky; but this action of beavers was rather an accompaniment of the naturally wet and swampy conditions than the cause of them. The type has been formed either in depressions kept wet by overflow from the streams, or where glacial interference has blocked the established drainage with the consequent formation of upland bogs, much in the manner of the more pronounced formation of glacial lakes. The margins of lakes are frequently of this soil type.

When properly drained the Muck is especially adapted to the growing of celery, and some good crops were seen on a few patches of the type. It is also especially adapted to cranberry culture in cases where sand is at hand to "sand" the bogs. The demand for both these products is very active. Cabbage and onions likewise do well on drained areas, while the acid conditions induced by the rich organic content encourages the growth of potatoes free from scab.

At present the Muck is but little cultivated, and much of it is in a semiswampy condition. It is utilized mostly for pasture, where cleared, and on the light sandy uplands it proves a very valuable soil to the dairymen for pasturage. Some small portions of it that are better drained are cultivated in oats and hay. The yield of oats is good, ranging from 50 to 75 bushels, but hay, while the yield is very heavy, is said to be coarse in quality and mixed with a variety of wild grasses.

This type is extremely variable in value, depending largely upon the conditions as regards drainage, etc. Some of it is at present practically worthless, while other tracts bring fancy prices in localities where the acreage of other soils suitable for pasturage is very limited.

Cedar and alder are characteristic growths on the Muck, for which reason it is sometimes loosely spoken of as "alder bottom land."

One or two small areas of salt marsh along the shore of Puget Sound, with a similar mucky texture, are placed with this type.

SWAMP.

The term "Swamp" is used to designate areas of soil that are at present too wet and swampy for cultivated crops of any kind or for pasture.

The main body of Swamp in the area consists of the islands just east of Everett, lying between the main mouth of the Snohomish River and the eastern mouth or channel known as Ebey Slough. These islands are at present so subject to overflow that they are kept constantly in a swampy condition. A project is, however, well under way to reclaim most of these islands by a system of dikes and drains, and work has already been begun. This should prove a very feasible undertaking, and when reclaimed the soils will be very valuable, as their texture is similar to the Puget clay or to Muck. This Swamp needs only to be properly drained to permit classification with one or the other of these two types.

MIAMI SANDY LOAM.

The surface soil of the Miami sandy loam consists of 0 to 15 inches of brown sandy loam of medium texture, containing a good proportion of fine gravel. The subsoil to a depth of 36 inches or more consists of a yellow or gray light sandy loam or sand, containing fine gravel. From 5 to 10 per cent of larger gravel and glacial cobbles is scattered through both soil and subsoil, and occasional glacial erratics of larger size are found. Irregular bands of gravel are found here and there at different depths throughout the type.

This soil is the most widely distributed type in the area, and constitutes in extent about two-thirds of the area mapped. Its topography is gently rolling to hilly, varying in elevation from 50 to 600 feet, and it occupies the bench lands, hills, and ridges that comprise the bulk of the uplands of the area.

Its drainage is in general well established, and some areas would be subject to slight washing when cultivated, although the rainfall is seldom very heavy at one time. In some of the upland hollows a small amount of ditching would generally give sufficient drainage for such a light soil.

This type is derived from the glacial sediments of sand and gravel that constitute the upland hills and benchlands, modified by a smaller or greater accumulation of organic matter from the heavy forests of fir, cedar, and hemlock that cover these tracts. This organic content is very different according to topography and forest conditions. On the steeper hillsides where the drainage is excessive, and wherever the soils have been subject to the influence of forest fires or other burning, the organic content is low and the top soil is a thin sandy loam. But in other more level tracts, as in the hollows or

depressions between the upland ridges, and on the flatter bench lands, where the drainage is not so ready and where fires have not occurred, the organic content is quite high from the accumulation of forest litter and the remains of the ferns that grow in rank profusion under the moister conditions. In these cases the soil tends to become a heavier black sandy loam.

On the whole, the Miami sandy loam is too light for general farming, and would prove too costly to clear for growing such staple crops as oats and hay. It is adapted rather to intensive truck and fruit farming, especially where an early market is prized above heavy yields. It is well suited to growing early potatoes, and very profitable yields of 150 to 250 bushels per acre are reported. A few small tracts are planted to strawberries and during favorable seasons produce early crops of good quality and yield. They are, however, somewhat liable to suffer from drought during June and July. The growth of red clover is also surprisingly strong for such a light soil, and is influenced by the cool climatic conditions during the growing season. The presence of occasional seams of impure lime throughout the type indicates another favorable condition for the growth of clover.

On account of the wide variation in its moisture supply, the agricultural value of this soil is quite variable and it is difficult to compute characteristic yields, especially since less than 1 per cent of the type is under cultivation and its possibilities are at present almost entirely undeveloped. This variation in its moisture supply is due to differences in topographic position rather than to variation in soil texture, as well as to the changes in its content of organic matter attendant upon the topographic differences. For example, the lowland areas, either bottoms along streams or depressions that serve to catch the seepage from the adjacent hills, possess a different agricultural value from the steeper hillsides. This is especially noticeable in this area because of the moderate annual rainfall and of the dry growing season. These moister lowlands are in a measure adapted to general farming, and are used to some extent for dairying, whereas the thin and poorly watered hillsides have not a sufficient moisture supply to support crops during a long growing season, and would require some irrigation. In some localities this is practicable by pumping from streams or some of the upland lakes. The safest recommendation for this type of soil would be to devote a very limited acreage to early market crops, potatoes, vegetables, and fruit, with, if possible, means for an occasional irrigation and to make full use of the growth of clover to enrich it with humus, and so increase its moisture supply.

Lands of this type of soil range in value from \$10 to \$100 an acre, according to location, amount of standing timber, etc., and some of it is at present so inaccessible that the agricultural value can be only

approximated. Such hilly and inaccessible areas should be lumbered under some system of forestry, and so kept in timber crops, as only under exceptional conditions would it prove profitable to clear them for agricultural purposes.

The following table shows the average results of mechanical analyses of fine-earth samples of the Miami sandy loam:

Mechanical analyses of Miami sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14085, 14087.....	Soil.....	2.2	9.7	8.2	27.7	18.6	23.4	9.9
14086, 14088.....	Subsoil.....	2.6	10.0	9.7	28.1	21.2	20.1	8.0

SNOHOMISH FINE SANDY LOAM.

The surface soil of the Snohomish fine sandy loam consists of 0 to 15 inches of brown fine sandy loam, with a small proportion of gravel. The subsoil consists of 15 to 36 inches or more of brown to yellow heavy fine sandy loam or silty loam, with a like small proportion of gravel. A few glacial cobbles are found scattered through both soil and subsoil.

Narrow bodies of this type are located here and there on the upper bench lands along the Snohomish and Stilaguamish rivers, and in the less developed valleys of their tributaries. Its total extent is small.

The topography is level to gently rolling, the areas occupying a characteristic position on the upper stream terraces or lower bench lands, with an elevation not exceeding 200 feet. The drainage is adequate, being in general well established by the more or less regular fall from these benches to the stream bottoms.

This type owes its origin to a modification of the glacial deposits of sand and gravel by the action of streams, probably combined with the action of erosion in exposing to an appreciable degree the underlying beds of silt and boulder clay. The soil is intermediate both in texture and position between the heavy Snohomish silt loam on the one hand and the lighter types of Snohomish sand and Miami sandy loam on the other. It occurs where marginal areas of the two latter types near streams have been modified in texture by heavier materials, but not to such a degree as to pass into the still heavier Snohomish silt loam. Its content of organic matter is rather high, owing to the heavy forests of fir, cedar, and hemlock that still cover the most of its area.

The Snohomish fine sandy loam is best adapted to growing late truck, or crops for such purposes as canning, where quantity of yield is more to be considered than early maturity. Potatoes produce well,

yielding 200 to 300 bushels per acre, but not for the earliest markets. Some of the lower lying and better watered areas are also available for general farming, and would give fair yields of oats and wheat, while clover makes a uniform strong growth. This soil should prove adapted to strawberries, giving surer yields but probably somewhat later crops than the Miami sandy loam.

Some small but vigorous orchards were observed on this soil, and it seems to be well adapted to fruit trees. It is, however, a question of business how far it will pay to clear these lands to devote them to such moderate yields of the staple crops as are commensurate with its moderate moisture capacity.

Not 5 per cent of the Snohomish fine sandy loam is as yet under cultivation. The price of this land ranges from \$15 an acre for such of it from which the timber has been removed up to much higher figures, depending upon the character of the forest growth.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of the Snohomish fine sandy loam:

Mechanical analyses of Snohomish fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14051, 14093	Soil	1.8	6.4	4.7	18.9	22.4	32.5	12.9
14092, 14094	Subsoil	1.0	4.4	4.0	12.9	17.4	44.2	15.8

SNOHOMISH SAND.

The surface soil of the Snohomish sand consists of 0 to 15 inches of brown medium sand, overlying a subsoil of gray to greenish-yellow loose sand extending to a depth of 3 feet or more. Both soil and subsoil are largely free from gravel and stones.

The type occupies a characteristic position in a well-defined plain extending between Marysville and Arlington and covering the upper terraces of the Stilaguamish River to the northward around Arlington.

In topography it is flat and fairly level, rising with a gentle incline from tide water at Marysville to an elevation of 150 to 200 feet northeast of Arlington. The drainage is in general adequate on account of the easy fall and loose open texture, and since the wetter areas within this body of soil are represented by other types.

The position of the Snohomish sand and its uniform texture indicate more uniform conditions of glacial deposition, while the character of the inland plain between Marysville and Arlington is such as to evidence the probable course of the post-Glacial floods that swept down the Stilaguamish River and sought here another outlet. Over this inland plain and along the rather extensive upper terraces

formed around the confluence of the two forks of the Stillaguamish the Snohomish sand has been laid down in a nearly continuous body.

The forests once covering this soil have largely been removed, though some portions of the type are still occupied by forests of fir and cedar. Little of the area has been cleared for agricultural purposes. The quantity of organic matter in the soil is very variable, the lands that have been burned showing a much lower humus content than the forested areas, which are generally quite rich in this constituent. The soil is rather poorly watered, and its light texture would make it subject to drought.

Considerably less than 1 per cent of this type is devoted to crops. Only an occasional small garden patch or orchard was to be noted upon it. The soil is entirely too light for general farming, the loose and leachy subsoil furnishing a poor moisture supply. There could be little chance for profit in these lands to devote them to oats, hay, or general farm crops, considering the very light yields. The soil is, however, the very model of some of the eastern truck soils, and would, under suitable conditions, be a typical early truck soil. It is adapted to the earliest crops of potatoes, and satisfactory yields of this crop are obtained. It should likewise prove well adapted to very early crops of the other vegetables, if advantage is taken of the good growth of clover it gives to enrich the soil with humus and so insure an adequate water supply for the short growing season demanded by such crops. This would involve a very intensive system of farming, on say 3 to 10 acres, with special reference to early markets, and the extra prices on the early crops should justify an expenditure for fertilizers to maintain or increase the productiveness of this light soil.

The lumbered areas of this type are valued at from \$10 to \$25 an acre, while timbered tracts may of course run much higher.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of the Snohomish sand:

Mechanical analyses of Snohomish sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
11079, 14081.....	Soil.....	2.6	19.2	17.3	34.8	11.1	8.2	6.7
11080, 14082.....	Subsoil....	1.7	16.6	17.7	40.3	13.4	5.9	4.1

MIAMI GRAVELLY SANDY LOAM.

The surface soil of the Miami gravelly sandy loam consists of 0 to 10 inches of medium to coarse brown light sandy loam, overlying a subsoil of yellow to gray medium to coarse sand, extending to a depth

of 3 feet or more. Both soil and subsoil contain from 25 to 50 per cent of medium to coarse gravel, while occasional larger stones and small boulders are present.

This soil occurs in scattered areas throughout the greater part of the uplands; for example, north of Snohomish, east of Edmonds, west of Marysville, and south of Florence, and occupies a well-defined belt separating the higher terraces from the bottom lands of the Stilaguamish River about Arlington.

In its topography it varies from nearly level, along streams and about the margins of lakes, to very hilly on the steeper slopes of the upland ridges, the areas nowhere exceeding an elevation of 600 feet. The drainage is rapid and in many areas excessive, and the coarse texture of the subsoil affords perfect underdrainage, serving to increase the tendency of this soil to leach. It is too subject to drought to insure regular crops under average conditions.

The type owes its formation to coarser glacial deposits of sand and gravel throughout the uplands, or to the coarser sediments laid down about the margins of lakes and along streams that were at one time more pronounced channels of glacial floods. Along these stream courses are found at times irregular beds of compact gravel, while the gravel content may also occur in more or less compact but erratic bands throughout the upland areas. These lands are practically wholly uncultivated, and have either been lumbered or are covered by forests of fir, with some cedar in a few of the loamier hollows. The accumulation of organic matter is thin, and has been retarded by erosion on the hillsides and by the coarse and porous texture of the soil.

The Miami gravelly sandy loam is in general too light and leachy for general farming, although some of the better watered bottoms could be utilized for hay and pasture. Except under such special conditions as regards seepage or the presence of streams the type is liable to suffer seriously from drought before the close of the growing season. It is doubtful if this soil could be put to better use than to forestry.

Under favorable conditions the soil can be used in the growing of potatoes and truck for the earliest market, and fruit trees would be well worthy of trial if due attention were given to getting the trees properly started. Some means of irrigation would be necessary, however, to insure success even with the earliest crops, and provision should be made for the use of fertilizers for such crops, especially after the first few years. High prices would have to be relied upon to compensate for light yields. Fair yields of very early potatoes are reported for this type in favorable seasons, but its agricultural possibilities are almost wholly undetermined.

The land of this type of soil is valued at from a nominal price of \$10 up to much higher prices, according to quantity and quality of timber standing upon it.

The following table shows the average results of mechanical analyses of fine earth samples of the soil and subsoil of the Miami gravelly sandy loam:

Mechanical analyses of Miami gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14101, 14103.....	Soil.....	6.9	21.6	12.7	22.0	11.1	17.4	8.0
14102, 14104.....	Subsoil....	7.9	31.7	12.6	25.7	7.3	9.3	5.3

MIAMI STONY LOAM.

The surface soil of the Miami stony loam consists of 0 to 18 inches of brown loam to silty loam, containing from 20 to 60 per cent of large gravel and stones. The subsoil, to a depth of 3 feet or more, consists of a brown to yellow loam or silt loam of about the same texture as the soil, and likewise containing 20 to 60 per cent of large gravel and stones. The stone found in this type is composed both of rounded glacial gravel and of angular fragments that have disintegrated more or less in place.

This soil is located in the northeast corner of the survey in a continuous body between Pilchuck, Cicero, and Jorden, except where it is cut through by the valleys of Jim Creek and the North Fork of the Stilaguamish River. The topography is very hilly to mountainous, varying in elevation from 400 to 1,800 feet. The type occupies in position the sharply defined mountain ridge that constitutes an outlier of the Cascade Range, crossing the northeastern corner of the area. The western margin of the area is formed by a precipitous escarpment separating it from the lower hills and bench lands. The drainage is in general excessive, and much of the type is too steep for cultivation. There are, however, considerable tracts of plateau land that could readily be cultivated, and in some places glacial interference with the natural drainage has caused the formation of wet depressions along the small streams or about the small lakes that would be improved by artificial drainage. The northwestern part of this body of soil, especially, shows some easy slopes and loamy depressions that would make acceptable farm locations.

The Miami stony loam owes its origin to two distinct agencies. First, the weathering of the igneous bed rock of diorite, granite, and schist that makes up the backbone of this part of the area; and,

second, the modification of this residual product by an overlay of glacial deposits composed largely of these same igneous materials in comminuted form. There occur, therefore, rounded gravel and glacial cobbles in such deposits, and also, wherever the ice had an abrading action or where erosion has been more pronounced, areas of angular stone fragments or of bed rock. The western escarpment shows in many places extensive exposures of the bed rock.

This soil is still almost entirely in forests of cedar, hemlock, and fir, and scarcely at all cultivated. There are no farms now upon it, but only here and there a patch of fruit or vegetables around some lumberman's hut. The texture of this type is, however, such as to adapt it to general farming and to fruit, and in many cases the stone content is such as not to impede cultivation. The climatic conditions vary considerably at the different elevations and the resulting influences on crops are undetermined. It is impracticable to assign yields to a soil so little of which is cultivated, but, judged by its texture and content of organic matter, it has decided agricultural possibilities for growing oats, grass, potatoes, and wheat, and next to the Snohomish silt loam the less stony tracts of this type constitute the best uplands in the area. The bodies of this type are still very inaccessible.

The land of this type of soil is valued largely according to the character of the standing timber.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Miami stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14105, 14107.....	Soil.....	4.4	7.2	3.5	9.1	12.4	43.7	19.6
14106, 14108.....	Subsoil....	4.0	9.4	4.7	13.6	16.4	37.0	14.8

SNOHOMISH SILT LOAM.

The surface soil of the Snohomish silt loam consists of 0 to 12 inches of reddish-brown light silty loam, overlying a subsoil of yellow or drab silt loam to silty clay extending to a depth of 3 feet or more.

The chief developments of this soil are southeast of Snohomish and near Monroe, between Hartford Junction and Jorden, along Jim Creek, and around Cedarhome.

Its topography is level or gently rolling, and it occupies chiefly lower river terraces or bench lands near the streams, not exceeding

an elevation of 300 feet. The drainage is, on the whole, sufficient, although some of the lowest river terraces adjoining the bottoms proper would be improved by artificial drainage.

The Snohomish silt loam owes its origin to the modification of glacial sediments of sand and gravel by the action of streams. This action is seen prominently along the South Fork of the Stilaguamish River and along Pilchuck and Jim Creek, where the floods of these streams have built up lower terraces of finer silty materials, or where lateral erosion on some of the lower bench lands that drain into these valleys has been so marked as to expose the underlying boulder clay. It will be observed that this type becomes more prominent along the upper courses of the streams, where the valleys are narrower, and where the depositions of Puget clay are curtailed or lacking, so that it tends to take the place of the latter type as the bottom soil in these higher and less developed valleys. In these locations occasional erratic beds of gravel have been deposited through the type. The content of organic matter in this soil is rather high, as its moist location has been favorable to the vigorous growth of cedar forests and of ferns.

This is the best bench-land soil in the area, and is next to the Puget clay and Puget silt loam in its value for general farming. Its heavy texture favors the carrying of the general farm crops through the entire growing season without injury from drought. The type is still largely composed of land from which the timber has not been removed, and probably but 10 to 20 per cent is cleared and cultivated. It offers favorable opportunities for general farming, including dairying, and clearing it for these purposes should prove profitable.

From 200 to 300 bushels of potatoes are produced per acre, and from 5 to 6 tons of hay. Good yields of wheat and oat hay are reported, but these crops have not been grown in sufficient quantities to be thrashed. Estimated yields of soft wheat are 50 bushels, and of oats from 75 to 90 bushels. Tree fruits do well, especially apples, pears, plums, and cherries, and some vigorous small orchards were observed. The heavy texture tends to encourage a slower growth and more substantial shape of tree, and on account of its moisture capacity the trees are not so subject to vicissitudes of temporary dry spells. For this reason cherries and plums are not so subject to gummosis as they were observed to be on some of the lighter soils that have a lower moisture supply and tend to encourage a too rapid growth of tree. When planted in orchards the soil would be uniformly improved by being drained, and the trees should be planted farther apart than is now the general practice.

The lands of the Snohomish silt loam range in value from \$20 to \$50 or more an acre, depending on the standing timber, character of improvements, etc.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Snohomish silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14095, 14097.....	Soil.....	1.3	4.0	2.4	5.3	8.3	60.2	18.0
14096, 14098.....	Subsoil.....	.5	2.5	1.7	5.4	10.3	53.2	26.2

PUGET SILT LOAM.

The surface soil of this type consists of 0 to 15 inches of light silty loam of drab color, while the subsoil consists of from 15 to 36 inches or more of a drab to yellow compact fine silty sand.

The type occurs as the immediate banks or narrow first bottoms along the greater part of the courses of the Snohomish and Stillaguamish rivers and of Pilchuck Creek, but disappears as the delta lands are reached, and also as these valleys become narrower in their upper courses. Its topography is nearly level and rather low, not exceeding at any point an elevation of 20 feet above the contiguous stream. The contour of its surface rises away from the streams with a very gentle incline to the lower level of the heavier second bottoms of Puget clay.

Because of this characteristic easy slope and of the sandy subsoil, the drainage of this soil is excellent, while nevertheless the relative slight depth to the water table in a large measure insures the crops against drought.

The Puget silt loam has been formed by the deposition of coarser, sandier materials in narrow bands along the banks of the streams, indicating deposition by swifter currents. The immediate margins of these banks are in fact quite sandy throughout their profile, but pass into a silty loam within a distance of a few feet.

On account of the gentle rise in its position this bottom soil has not sustained any accumulation of organic matter under swampy conditions, and the organic content is much lower than in the Puget clay.

The type, on account of its well-watered position, is fairly well adapted to general farming; while it is especially adapted, on account of its light texture and adequate drainage, to the production of earlier crops of vegetables, potatoes, and berries, and to hops.

Oats yield from 75 to 100 bushels, and hay from 2½ to 3½ tons at a cutting per acre. Potatoes yield from 300 to 400 bushels of good quality. This type of soil has been used near Silvana and Monroe for growing hops. From 1 to 1¼ tons per acre of prime quality are usually secured, but the industry has languished because of uncertain

market conditions, and only a few growers still pursue it. Since the early nineties the hop aphid has also become a serious pest. It is combated by spraying with whale-oil soap and quassia. The growers have their own drying kilns on the premises, where the hops are dried and baled for market. The price of the product varies from 8 to 30 cents a pound.

The Puget silt loam is well adapted to the Cuthbert and Antwerp raspberries, and to the Snyder, Lawton, and Kittatinny blackberries, and the berry industry on this soil is very promising. Under the best management yields will average about 600 crates or more per acre, and prices run from \$1 to \$1.50 a crate. The extent of this type is very limited, but it is one of the most valuable soils in the area, combining as it does the rare advantages of good drainage and, at the same time, a high water table. It is, however, subject to some variation in texture, and consequently in adaptation, according to its distance from the rivers. The sandier phases nearest the river are the best adapted to early truck and potatoes, while general farming is more at home on the heavier phase, some distance back from the stream, where the type gradually passes into the heavy Puget clay.

The land of this type of soil is nearly all cleared and in pasture or under cultivation, and is rarely if ever subject to overflow. It is valued at about the same figures as the Puget clay.

The following table shows the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Puget silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14069, 14071	Soil	0.2	1.0	0.4	4.4	23.1	57.5	13.3
14070, 14072	Subsoil .....	.1	.4	1.4	36.3	36.0	19.9	5.9

PUGET FINE SANDY LOAM.

The surface soil of the Puget fine sandy loam consists of 0 to 12 inches of drab fine sandy to silty loam, generally rich in organic matter, overlying a subsoil of gray or yellow sand extending to a depth of 36 inches or more.

The body of this soil is almost continuous, being located south of Arlington and between Edgecomb, Stimsons Crossing, and Marysville. In its topography it is low and flat, occupying a rather depressed position at the head of Cedar Creek and along some of its tributaries, and probably not exceeding an elevation of 60 feet. The drainage is poorly established, and most of the type would require systematic draining for cultivation. The Puget fine sandy loam is

intermediate in its texture between the Puget clay and the Snohomish sand, and it has been formed where marginal areas of the latter type along or near streams have been so modified by the lowland conditions and the accumulation of the remains of water-loving vegetation that its surface has been given a heavier texture, or where wet areas of Puget clay have passed into the higher-lying Snohomish sand with an easy gradation of such extent as to warrant an intermediate type between the two. A characteristic feature in the type is its position at the foot of the upland ridges that bound the plain of Snohomish sand between Marysville and Arlington, where the seepage from these ridges has gathered into narrow depressions or given rise to the formation of small stream courses.

The surface soil is fairly rich in organic matter in a well-decomposed state, but is lower in its organic content than the Puget clay. The most of the cleared area of this soil is devoted to pasturage, while areas used for grass, Alsike clover, and Italian rye grass give yields of 4 or 5 tons of hay per acre. Oats are also grown on some areas, yielding from 40 to 70 bushels per acre. On account of its poor drainage, pasturage is doubtless the safest use to which the soil can at present be put, while oats and hay are best adapted to the better drained areas. If properly drained the soil is adapted to growing celery, cabbage, onions, and potatoes.

The Puget fine sandy loam land has a value of from \$50 to \$150 an acre.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Puget fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14065, 14067.....	Soil.....	0.3	2.5	2.5	20.2	15.8	37.4	21.1
14066, 14068.....	Subsoil....	2.4	18.9	16.2	32.7	12.7	11.3	5.7

PUGET CLAY.

The Puget clay consists of 0 to 18 inches of drab, heavy silt loam or silty clay, generally rich in organic matter, overlying a subsoil of drab or mottled blue and yellow silty clay which reaches a depth of 36 inches or more. The soil contains from 10 to 15 per cent of undecomposed organic matter which, with the large silt content, gives it a silty feel. As this organic matter decomposes the soil will become closer and heavier.

The type is located along the courses of the Snohomish and Stilaquamish rivers, and some of the larger tributary creeks, and spreads out in the shape of a delta fan around Stanwood, at the mouth of the

Stilaguamish River and at the mouth of the Snohomish above Everett.

It is low lying and the topography is flat. It occupies the position either of alluvial lower or second bottoms, or of delta tidal flats. On account of its low position the soil is uniformly in need of artificial drainage, and in most cases can not be cultivated until it is drained. Parts of these lower bottom lands are subject to overflow, or require to be protected by dikes, while considerable areas of the delta flats are under dike to keep out the high tides and freshets. Very efficient dikes are made out of this heavy soil, especially where peat is incorporated with it, and plans are on foot to reclaim other tracts now in a swampy condition by means of them. Drainage is generally effected by open ditches, while flume outlets with head gates, to be opened at ebb tide, are necessary on such diked lands as are below the level of high tide. Underdrainage is to be recommended for more general use on these soils, either by tiles, or by the use of cedar boards, which are said to give good service.

Puget clay owes its origin to the deposition of fine materials under quiet conditions back from the main currents of the rivers and over the broad deltas at their mouths. In the case of these delta flats the deposits have been somewhat reworked and spread out by the tides, while the salt water has doubtless also served to precipitate the suspended silts and clays brought down by the rivers.

The surface soil is generally very rich in organic matter in a more or less decomposed state, due to the accumulation of the remains of swamp vegetation. In some of the lowest lying areas the accumulation of peat, etc., has been so marked that the soil has changed into muck. Accordingly, the low-lying areas of this type nearer the mouths of the rivers are, in general, the richest in organic matter and the organic content becomes less and less with the distance up the valleys, where also the area of this soil perceptibly decreases.

The Puget clay is a very superior soil for general farming, and is the most valuable one in the area. Probably three-fourths of its area is cleared, the native timber being mostly cedar and hemlock, with some spruce. The type is especially adapted to oats, and the yield on the delta flats ranges from 100 to 150 bushels per acre. This is the chief crop produced on the soil, and in view of the high yields a better adaptation could scarcely be suggested. Wheat likewise gives good yields, but the kernel is too soft for milling and liable to blacken, and but little of this grain is grown. Potatoes likewise yield well, from 300 to 400 bushels per acre, but are liable to scab. In other ways the quality is not quite so good as on some of the lighter soils of the area. The type is well adapted to the growing of hay and to pasture, and dairying is extensively practiced upon it. Timothy and clover or Italian rye grass yield from 3 to 4 tons of hay

at a cutting, 2 to 3 cuttings being secured. The wetter areas and those subject to overflow are devoted mostly to pasture. Heavy crops of apples, pears, plums, and cherries are secured, but in most cases the trees observed were planted too close for best results. Cabbage, cauliflower, and the root crops develop well, and celery does well where the organic content is high. Where it is sufficiently drained the soil also produces large yields of berries—from 500 to 800 crates per acre. The varieties best adapted to this heavy soil are the Washington Evergreen dewberry, the Himalaya Giant, and Lucretia blackberries, and the Logan and Phenomenal crosses. The growth of the Cuthbert raspberry tends to be prolonged by the heavy texture, the Antwerp variety being not so much affected.

It will be seen from the foregoing paragraph that this soil has exceptional possibilities for the production of heavy yields of the staple farm products, excepting hard wheat. By its heavy texture and consequent large moisture capacity, as well as by the nearness of the water table to its surface, it is fitted to secure the heaviest yields and to be exempt from drought. The chief suggestion to be made as to its improvement is a more systematic drainage, according to the varying local conditions.

The land of this type of soil brings from \$100 to \$200 an acre, depending upon location and state of improvement. That such high prices are commanded is evidence of its great productiveness and of the ready markets for its produce.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Puget clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
14073, 14075.....	Soil.....	0.2	2.4	0.6	1.5	3.2	58.0	33.8
14074, 14076.....	Subsoil.....	.1	1.0	.4	1.0	5.6	62.2	29.6

AGRICULTURAL METHODS.

The agricultural methods in use in the area have been developed with reference chiefly to the cool and rather dry character of the growing season. The coolness of the summers, together with the considerable proportion of fog and overcast weather, tends to compensate in a measure for the shortage in rainfall during the mid-season. Grass and clover thrive remarkably well, even on light, sandy soils, because they are not burned out by hot summer suns. Italian rye grass seems to be preferred to timothy, giving somewhat larger yields of hay, besides affording excellent winter pasture. The most approved practice, however, is to keep the cattle off the grass

and feed it as a soiling crop, utilizing the manure. In moist locations Alsike clover is preferred to the red clover for sowing with the rye grass. Three cuttings are obtained, and where silage is provided for two of these cuttings are put in the silo and the third made for hay. Disking is considered very beneficial for heavy moist soils in grass where the growth tends to be rank and of a promiscuous character.

Oats and wheat are planted with the drill in the spring, about the first of April, and cut about the middle of August. No manure is used for the crops, and they are planted fairly late, so as to avoid lodging. An increasing practice is to sow sweet corn for silage, the crop being cut for the silo when the ears are in the glaze. The climatic conditions encourage a rank growth of stalk at the expense of immature ears, and growing for silage is the only way to profit by this valuable grain.

There is no recognized system of rotation followed in growing the staple crops. The lowlands are in general so rich in organic matter that the need of rotation has not as yet been apparent upon them, while the cleared portions of the uplands are so limited that no system of rotation has had occasion to develop there. A three-year rotation of oats (or wheat), clover, and potatoes is practiced perhaps more than any other, and seems to answer very well. An obvious advantage in this rotation is that potatoes are made to follow clover and do not scab so badly on account of the acidity of the clover sod. In general the potatoes suffer markedly from scab on the burned uplands and on the diked delta lands, by virtue of the alkalinity resulting from the potash in the ashes or from the seepage of salt water favoring the development of the scab fungus. The formalin treatment is used as a preventative, while the Bordeaux mixture is also employed against the rather prevalent blight. There are no potato bugs.

The use of commercial fertilizers is almost unknown in the area; and a more economical use of manure needs to be emphasized. There is a growing realization of the value of clover and vetch as green manures, and of vetch as a winter cover. The plowing under of clover as an aid to the conservation of moisture should be specially taken advantage of on the lighter upland soils, so as to minimize the danger from drought in midsummer. Vetch is coming into use as a winter cover crop, especially for berry crops. Strawberries are not grown in matted rows. They are plowed out every third year and the land sowed to spring vetch as a cover crop, turned under, and replanted to berries. Vetch is also grown between the rows of brambles during winter and turned under in spring. The favorite practice with orchards seems to be to keep them in sod, cutting the rye grass and clover and leaving it for the benefit of the trees. The

system of culture in vogue for brambles, perfected by Mr. Littooy, reduces pruning to a minimum and emphasizes methods of training in accordance with the habits of growth of the different berries.

As a very special instance of the adaptation of methods to climatic conditions may be mentioned the culture of tomatoes^a by pruning the plants so as to lie low on the ground and insure development of the fruit. Unless so pruned the plants suffer excessive growth from the coolness of the season, and the fruit buds shrink and fall off.

The climatic conditions in this area are also favorable to the special industries of bulb and cauliflower-seed production. Although they are not as yet grown in this area, experiments in adjoining counties have proved very promising for these specialties on soils rich in organic matter and somewhat similar in other ways to the Puget clay, the Puget silt loam, and the Puget fine sandy loam. They require very heavy fertilizing and the most careful intensive culture, but should prove worthy of trial on the soils mentioned.

In conclusion it is well to call attention to the decided advantages of the practice of subsoiling on such heavy soils as the Puget clay and the Snohomish silt loam. This not only serves to deepen the seed bed and increase the moisture supply, but is useful in breaking up the hardpan that tends at times to form on a soil like the Miami sandy loam from the cementing of its sandy and clay materials under the plow.

AGRICULTURAL CONDITIONS.

The farmers of this area, while as yet very limited in number, are generally in a prosperous condition. Although the initial cost of taking up and clearing land is high, most of them have already paid these obligations and have an exceptionally bright future. To achieve success in farming under local conditions, a certain degree of the pioneer spirit is necessary, which enables a man to bear the hardships of clearing and improving his land without discouragement in case the first few years do not bring him net returns. Under such circumstances a small amount of capital is desirable to support the farmer while he is clearing his land or, better, to enable him to have the land cleared and get returns from it from the start. This hardship must be undergone, and it is merely a question whether the business prospects are such as to justify it. On a great part of the soils of this area the farming prospects do justify it fully, and, as a matter of fact, many farmers have already received handsome returns from their investments. This is understood to apply in general to farmers who operate a small acreage more or less intensively.

Wages in the logging camps and sawmills here in the Northwest have, however, been so good that as yet but few laborers have been

^a Littooy's "Tomato Culture."

willing to consider farming, despite the fact that it offers some exceptional opportunities. About nine-tenths of the farmers own their own places, many of which were secured by homesteading or by taking up timber claims. There is, however, no land at present subject to entry in this area. A few tracts of land, mostly of Puget clay, are rented at from \$6 to \$8 an acre. These lands are, however, cleared and diked, and of exceptional fertility and advantageous location. They are generally rented with certain conditions as to maintaining dikes and making further clearings. In general, it is an easy matter to buy land on good terms from the land or logging companies. The agreement merely to do an amount of clearing is considered a fair guaranty for the future payment of the land, and a certain amount of logging or of cutting cedar bolts is thus generally involved in taking up the farm lands.

The average size of the farms in the county lies somewhere between 80 and 100 acres, but the area actually under cultivation varies extremely on different soil types. In the valley soils—Puget clay and Puget silt loam—a large part of the farm is under cultivation to oats and hay and the rest is generally devoted to pasture, while in the upland soils hardly any area at all is cleared, and upon a farm of 80 acres only an acre or two can be found under cultivation—say potatoes, or perhaps several acres of lowlands devoted to pasturage—while the rest would be in timber.

The farm labor is very efficient, mostly German or Scandinavian, and commands good wages, averaging about \$30 a month, with board in addition. During the harvesting of oats on the larger farms upon the Puget clay extra hands are secured from Seattle or Everett, and these are given wages of from \$2 to \$3 a day for that period. On account of the small acreage under cultivation in the uplands and the tendency toward intensive farming, few farm hands are employed. Indians of both sexes are employed to gather hops on some of the farms.

By far the most prominent industry in the area is lumbering, and numerous sawmills and shingle mills are in operation. The largest acreage of agricultural products is devoted to grass; the next largest to oats; the third to potatoes. A large amount of timothy, clover, or rye-grass hay is produced, but does not sell at as high a price as the more uniformly cured alfalfa hay from the eastern part of the State. Orchard grass and bluegrass and the red, white, and alsike clovers also grow vigorously and furnish excellent pasturage. Dairying is the most flourishing side of farming in the area, Snohomish County ranking second in the State in the value of its dairy products, and fully two-thirds of the farmers owe their success to this industry. Next to dairying and the production of hay, comes the growing of oats, which is the chief grain crop, and which constitutes the charac-

teristic industry on the Puget clay. The acreage in wheat is small and the grain soft, the cool and moist climate being much more favorable to oats. The wheat produced is used for "chicken feed," or to adulterate the harder varieties in grinding flour. The climate is not suited to maturing corn, and the plants make excessive growth and fail to set developed ears. Sweet corn can, however, be grown to sufficient maturity to make good silage, and the more progressive farmers are growing it for the purpose. Stowells Evergreen variety has proved well adapted to this climate for silage purposes. The quality of table sweet corn is inferior. Potatoes are grown nearly everywhere with success, the yields being large and the quality good. Early Rose and Burbank potatoes are the most popular varieties. The root crops, such as ruta-bagas, parsnips, beets, and carrots, give large yields of fine quality where the moisture supply is adequate. Cauliflower, cabbage, celery, rhubarb, and peas likewise make a strong growth, the climatic conditions being especially suited to cauliflower and cabbage when grown on the heavier soils. Tomatoes, however, on account of the cool climate, tend to run all to leaf and set fruit poorly unless pruned. On the heavy soils orchards of apples, pears, plums, and cherries give large yields of good fruit. Peaches do not mature and color well, and grapes are successful only in a few favored locations near the water. Small fruits do exceptionally well on the valley soils, and the berries from the Snohomish Valley are of very superior size and quality, and are shipped considerable distances east.

The adaptation of different soils to different crops has been recognized in quite a specific way in the case of several crops in the area. For example, Puget clay is recognized as adapted to oats, its heavy texture insuring an adequate moisture supply during a long growing season. The Puget silt loam is recognized as best adapted to hops in that it gives good yields, and yet without sacrificing the quality of the hops. The lighter upland soils are utilized for growing early crops of potatoes and early garden produce, their lower moisture supply and higher temperature serving to hasten the maturity of the crops. The adaptation of varieties of berries to the different valley soils has been carefully superintended by Mr. Littooy, with the result that the erect growing varieties of brambles—the Cuthbert and Antwerp raspberries, the Snyder, Lawton, and Kittatinny blackberries—are utilized for planting on the Puget silt loam, while the vinous varieties—the Washington Evergreen dewberry, the Himalaya Giant and Lucretia blackberries, and the Logan and Phenomenal crosses—are selected for the heavier Puget clay.

The transportation facilities of the area are exceptionally good, the main line of the Great Northern Railway entering near Monroe and terminating at Everett, while the coast-line branch of the same

road, from Seattle to Vancouver, British Columbia, runs near the western shore line of the county.

A branch of the Northern Pacific Railway also traverses the area from north to south through Maltby, Snohomish, and Arlington, with local branches from Arlington east to Darrington and from Hartford Junction east to Montecristo. Everett is a port of importance, with frequent steamers to Seattle via Edmonds, and local steamers ply from Stanwood, Marysville, and other points, as well as up the Snohomish River. A trolley line is in operation between Everett and Snohomish, and Seattle also will soon be connected by trolley.

The county roads are in fair shape, but are so limited in extent that large areas are inaccessible with teams. Through heavily forested sections the surface of the roads is so soft that extensive stretches of plank road and corduroy are necessary for heavy teaming. Gravel is used for surfacing the roads, being readily obtained from local beds and seams.

One of the most favorable factors in farming in this section is the good local market. The fact that so small a proportion of land is under cultivation, while the sound ports are growing rapidly in population, creates a demand considerably greater than the supply, so that there is a ready market at all times of the year for produce of the farm. Everett and Snohomish are the chief local markets in the area, but Seattle may be considered the standard market for the staple products. Large quantities of Government supplies are purchased in Seattle for use in the Philippines, and a characteristic advantage of this area in the question of markets is its ready access, via Seattle, to foreign markets in China and Japan, the Philippines, and Alaska. The export of food supplies to these points is very large, and creates an exceptionally favorable market for the agricultural sections that are situated near the ports of entry. Alaska, especially, has been a prominent market for local produce, and promises to increase its demand, while the oriental markets offer great possibilities for extension of trade in agricultural products. Moreover the lumbering and mining population of the Northwest live well, and choice fruits and vegetables bring fancy prices. Berries, grown in the area, are shipped to Montana and the Dakotas, etc., and find ready buyers in these more distant markets.

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