WASHINGTON GEOLOGICAL SURVEY

HENRY LANDES, State Geologist

BULLETIN No. 18

The Country about Camp Lewis

By MORRIS M. LEIGHTON

OLYMPIA
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LETTER OF TRANSMITTAL

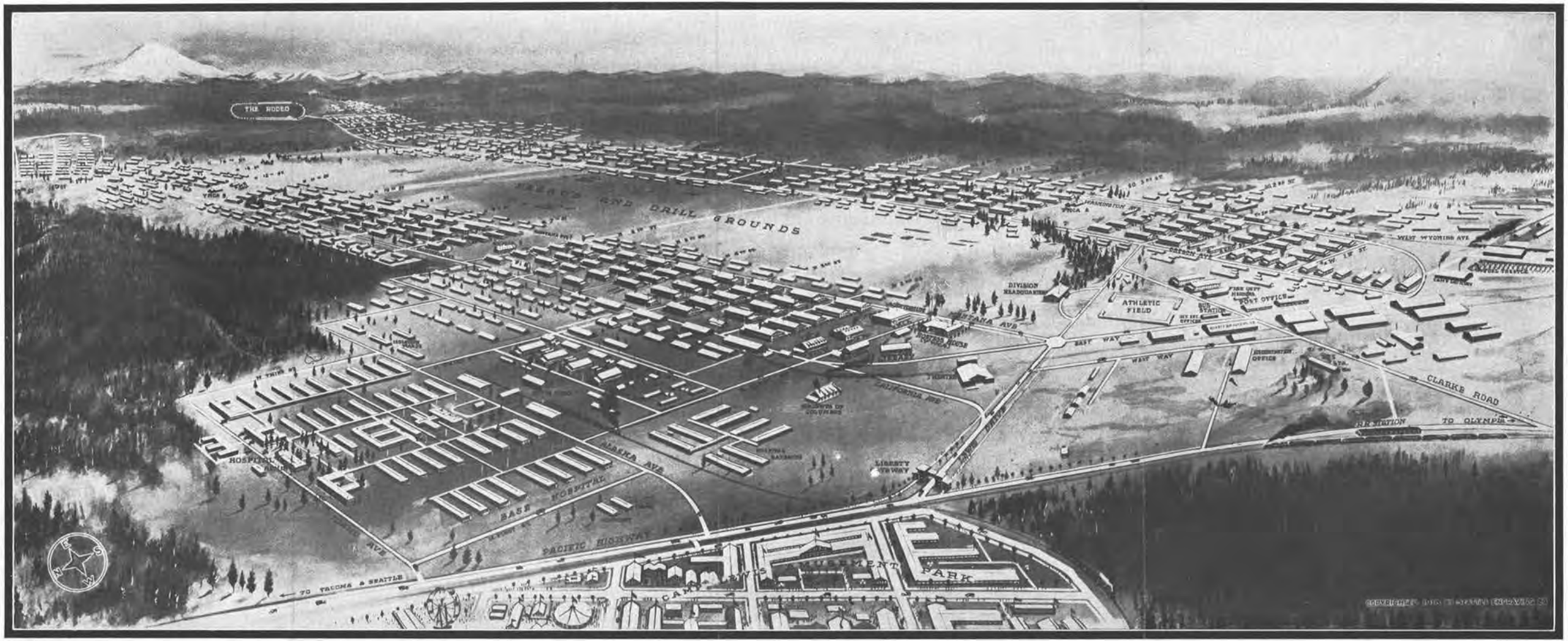
Governor Ernest Lister, Chairman, and Members of the Board of Geological Survey:

GENTLEMEN: I have the honor to submit herewith a report entitled "The Country About Camp Lewis," with the recommendation that it be printed as Bulletin No. 18 of the Survey reports.

Very respectfully,

HENRY LANDES,
State Geologist.

University Station, Seattle, July 1, 1918.



Picture-map of Camp Lewis.

—By courtesy of Seattle Engraving Co.

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PREFACE

The situation of the Camp Lewis Cantonment is scenic, strategic, and historical. It possesses an environment of mountain, plain, and water; a position with all the necessary qualities for a land base; and a location in the vicinity of the first American settlement in the Northwest. Consistent with the national ideals of education, the Board of Geological Survey of Washington has authorized the publication of this bulletin dealing with these things.

The aim has been to include the topics of chief interest, without attempting to give a complete history, and to make the account void of technical discussions.

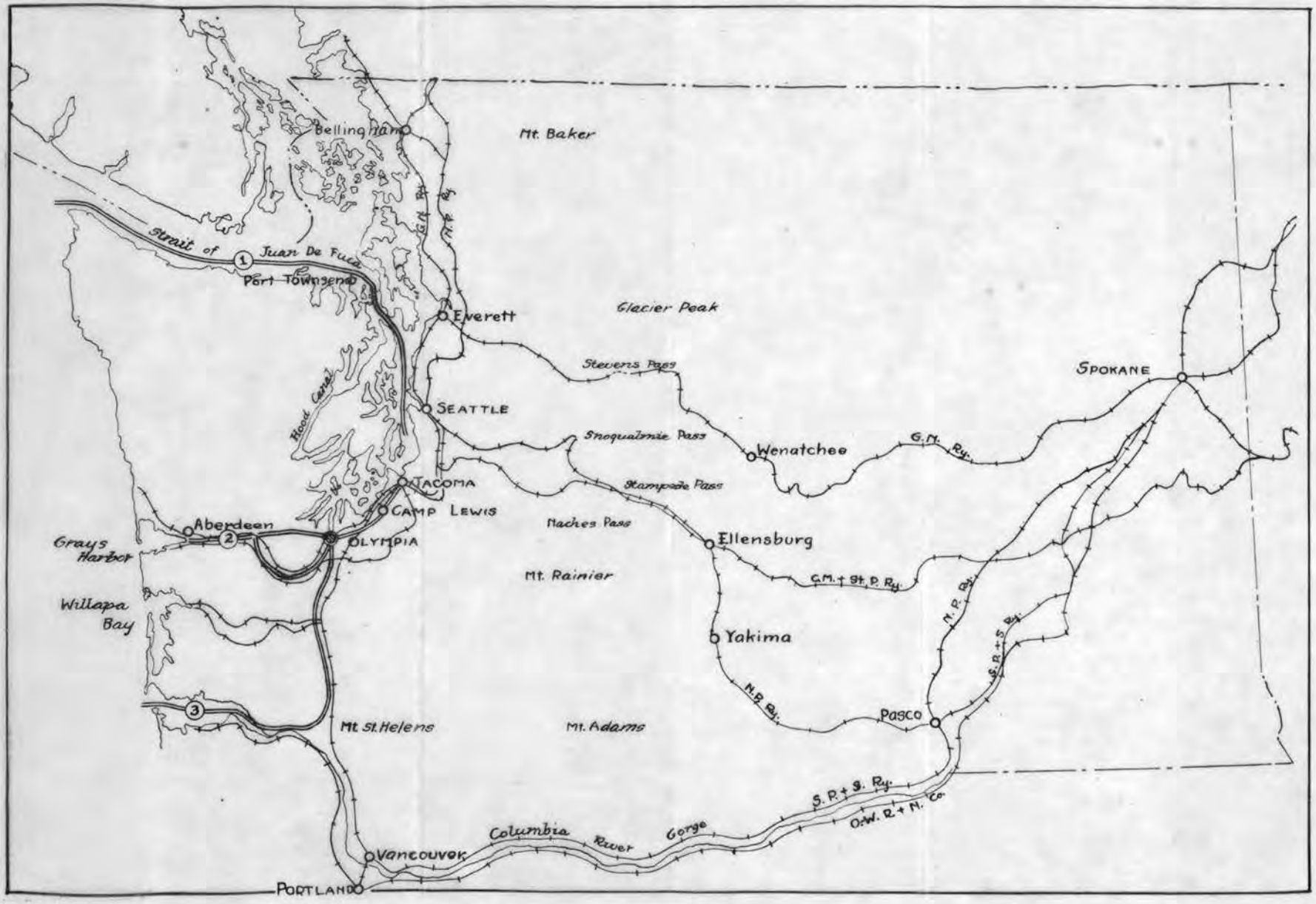
The writer has drawn very largely on the work of Director George Otis Smith, of the U. S. Geological Survey, Professor Bailey Willis, of Leland Stanford, Jr., University, and Dr. Chas. E. Weaver, of the University of Washington, for the broad outlines in the geological history of the region; on the work of Dr. J. Harlan Bretz, of the University of Chicago, for the glacial history; on the reports by Professor E. J. Saunders, of the University of Washington, for the climate; and on various bulletins of the U. S. Weather Bureau for weather records. Acknowledgment is hereby given to all scientific workers concerned.

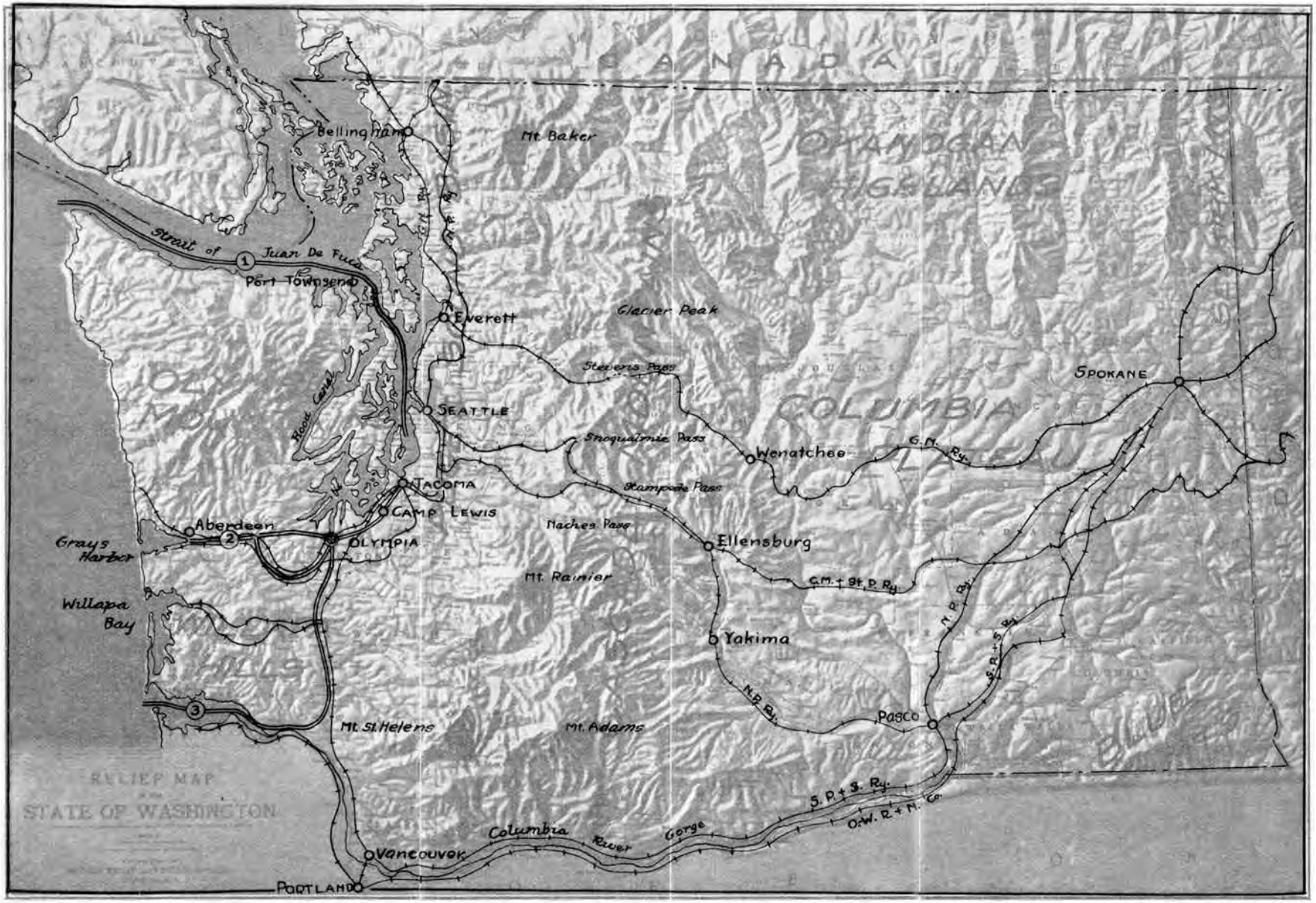
Many courtesies were shown by Brigadier-General Foltz; Major F. W. Manley, Division Adjutant; Lieutenant-Colonel Ehrnbeck of the 316th Engineers; Captain Wm. R. White of the Quartermaster Department; Major John G. Strohm of the Medical Corps; Professor N. F. Coleman, Educational Secretary of the Y. M. C. A.; and Mr. L. C. Fisher of the U. S. Weather Bureau. To these the writer expresses his appreciation and thanks.

Especially grateful is the writer to Professor Edmond S. Meany, Mr. Victor J. Farrar, and Dr. George B. Rigg, all of the University of Washington. Professor Meany and Mr. Farrar prepared the excellent chapter on human history, and Professor Rigg the authoritative chapter on the plants in the vicinity of Camp Lewis.

MORRIS M. LEIGHTON.

A relief map of Washington showing the major topographic features. Scale, about 44 miles to the inch.


Mt. Baker
Bellingham
Strait of Juan De Fuca
1
Port Townsend
G.N. Ry.
N.P. Ry.
Everett
Glacier Peak
Stevens Pass
SPOKANE
Hood Canal
SEATTLE
Snoqualmie Pass
Wenatchee
G.N. Ry.
TACOMA
Stampede Pass
CAMP LEWIS
Aberdeen
Grays Harbor
2
OLYMPIA
Naches Pass
Ellensburg
Mt. Rainier
G.N. + St. P. Ry.
Willapa Bay
N.P. Ry.
Yakima
S.P. + S. Ry.
N.P. Ry.
3
Mt. St. Helens
Mt. Adams
PASCO
S.P. + S. Ry.
O.W.R. + N. Co.
Columbia River Gorge
Vancouver
PORTLAND



A relief map of Washington showing the major topographic features. Scale, about 44 miles to the inch.

CHAPTER I

CAMP LEWIS AND VICINITY

Camp Lewis is the great National Army Camp of the northwest, named in honor of Captain Meriwether Lewis, who with Captain William Clark, made an exploration of this territory during the early years of 1804 to 1806. This seems wholly appropriate, for it may be said that at that time these men set the standard for daring, hardihood, and iron-will-to-do.

This name is now familiar to all of the homes of the northwest and many of the eastern states, for here is assembled the Division of the National Army which Wyoming, Montana, Idaho, Utah, Nevada, California, Oregon, Washington, and other states contribute. (Fig. 1 shows the Camp's geographical position.) Situated in the Puget Sound country of western Washington, its environment is one of mild climate, of gently broken and partly forested topography, of mountain ranges within view, and conveniently near vigorous cities of thrift. It is about 17 miles south of Tacoma, 50 miles southwest of Seattle, 17 miles northeast of Olympia, and about 120 miles north of Portland. (A vicinity map is given in Fig. 2.)

THE CANTONMENT

The Cantonment, the Campus of the Military School, is roughly rectangular in form and includes 70,000 acres, or adjacent parts of several townships. It is the largest of all the cantonments in the United States. It is located on a plateau-like divide of gravel, dotted with forested hills, ending northwestward in a sea-cliff overlooking one of the southernmost reaches of Puget Sound from a height of about 160 feet. Although 70 miles by air-line from the Pacific Coast, it is bordered in part by marine waters which have found their way from the

great ocean around the Olympics through the straits and passages of the Puget Sound.

THE CAMP

The little city of barracks is located in the western part of the Cantonment. They are arranged in orderly fashion in two great curving arcs which face each other convexly. Avenues, named after the states, run longi-

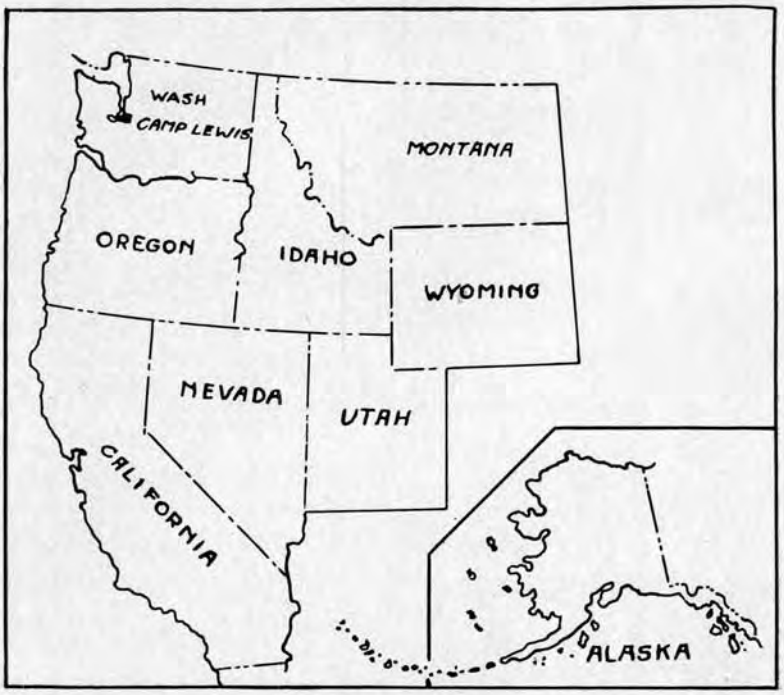


FIG. 1. Map showing the geographical position of Camp Lewis.

tudinally through the two long curves of barracks, while intersecting streets divide the sections into blocks. Two main drives lead into Camp, converging from two entrances, the Lewis Drive and the Clark Road. (The general plan is shown in Plate I.) The wide vista between the two curving arcs of barracks open southeastward

toward Mt. Rainier. Here in view of this great sentinel the activities of the Camp take place.

TRANSPORTATION FACILITIES

Railroad transportation is afforded by the Northern Pacific Railway and the Chicago, Milwaukee & St. Paul Railway, which make direct connections with their own and other transcontinental lines. The paved Pacific Highway passes by the Camp and serves as an excellent automobile thoroughfare to Tacoma and Seattle on the north, Olympia and Grays Harbor points on the west, and Portland on the south. Licensed auto stages and the street car to Murray, supplemented by jitneys the remainder of the distance, afford convenient facilities for getting back and forth between Tacoma and Camp. Frequent train service on various lines, electric interurbans, and several steamships offer a choice of travel for week-end trips to Seattle.

CITIES NEAR THE CANTONMENT

TACOMA

Tacoma, the nearest city to Camp Lewis, is the county seat of Pierce County, and is located on a peninsula between Commencement Bay and the Narrows of Puget Sound. It has an area of about 40 square miles. The city has beautiful residential districts and parks, progressive churches and schools, and extensive interests in lumbering, ship-building, flour-milling, and meat-packing. The present harbor has 14 miles of water front. In 1910 Tacoma had a population of 83,743, which increased to 108,094 in 1915, and 112,770 in 1916.

SEATTLE

Seattle is the largest city of the Northwest, lying on a harbor probably unsurpassed by any in the world. It is situated on a group of hills which rise from sea-level to 500 feet in altitude and cover 58½ square miles. Here

several trunk railroads meet the deep sea navigation of various steamship lines that ply between Seattle and China, Japan, Alaska, Hawaii, the Philippines, Australia, and other foreign countries. Seattle possesses several large ship-building plants and nearly all phases of manufacturing, mining, fishing, and agriculture occupy the tributary region. The high hills are fine residential sites. The State University is located in the northern section of the city overlooking Lake Washington and Lake Union. Since 1880, Seattle has grown from a village of 3,000 to a city of 348,639 in 1916.

OLYMPIA

Olympia is the State Capital and a city of about 7,000 inhabitants. It is located at the southernmost reach of Puget Sound, on the lines of the Northern Pacific Railway and Oregon-Washington Railroad & Navigation Co. It has a good harbor, but is rather remote from the main steamship lines to the Sound. On the tidal flats, large areas are devoted to oyster beds, and the bordering territory is important agriculturally.

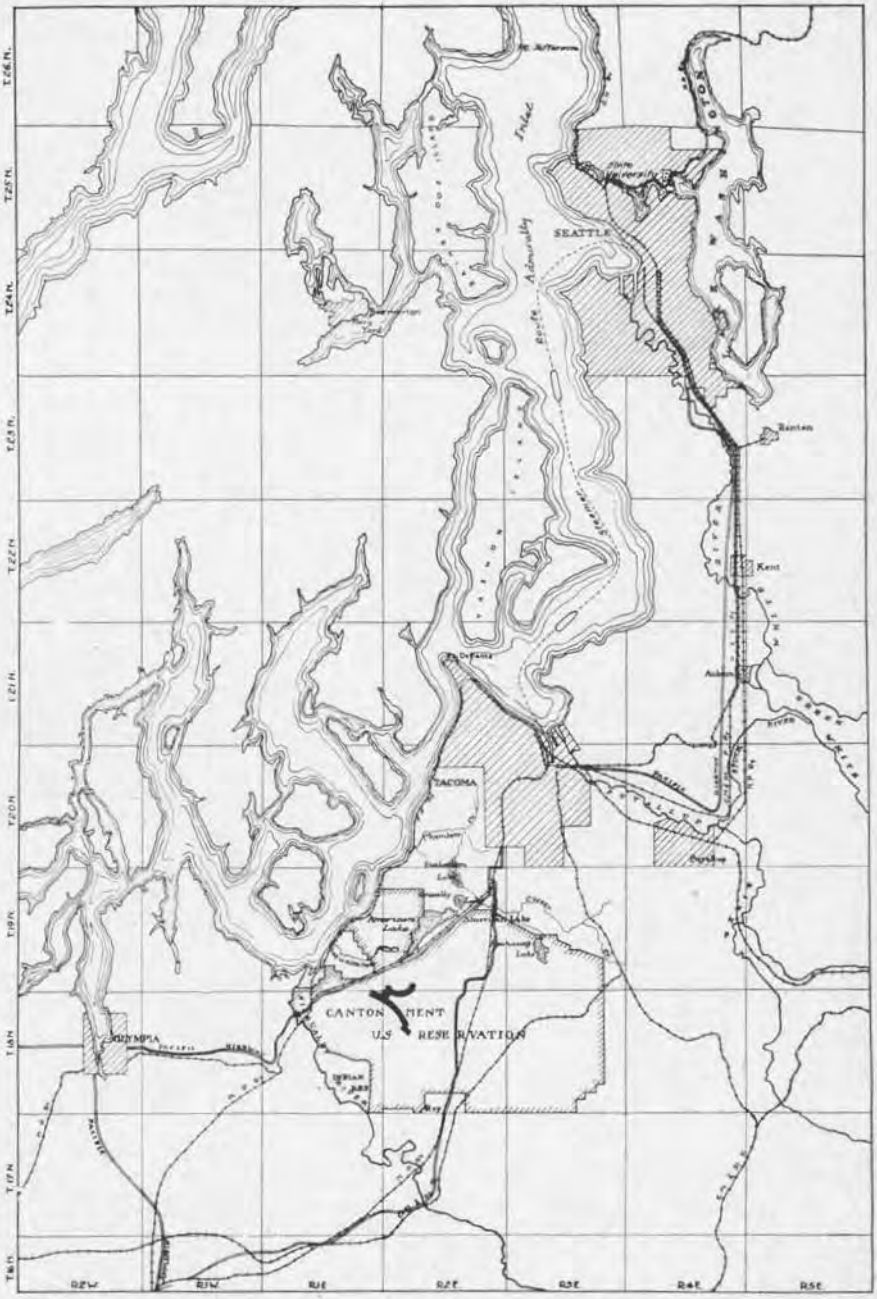


FIG. 2. Vicinity map showing the relation of Camp Lewis to the nearby cities

CHAPTER II

THE SURFACE FEATURES OF WESTERN WASHINGTON AND OF THE CAMP LEWIS CANTONMENT

Nature has endowed western Washington with special features. She has given it a position adjacent to the greatest ocean of the globe, an inland harbor system of superior character, and a most diverse landscape. From the Pacific Ocean on the west to a north-south line running through the middle of the state, there are two mountain ranges separated by a broad trough-like depression known as the Puget Sound Basin.

The western range, which lies along the coast, is sometimes called the Coastal Range. It includes the Olympic Mountains in the northwest and the Willapa Hills in the southwest. The mountain range to the east is the Cascade Range. (Plate II shows the position of these features and the location of Camp Lewis with reference to them.)

On clear days and from many points of vantage, both the Olympics and the Cascades may be seen from Camp, in practically their whole relief.

THE OLYMPIC MOUNTAINS

The Olympic Mountains constitute nearly the whole of the Olympic Peninsula, north of the Chehalis River Valley and west of the Puget Sound Basin. In either direction their dimensions are about 50 miles. From the vicinity of Camp, they are seen to the northwest.

They are a group of peaks, ridges, and passes with canyon-like valleys cutting their slopes. On the east they rise abruptly from Hood's Canal (Plate III), the westernmost inlet of Puget Sound, but on the north, west, and south they are bordered by a relatively narrow and more or less broken plateau of approximately 500 feet elevation. Although not so extensive as the Cascade Range,

they excel in ruggedness. Many sharp ridges rise to approximately 4,000 feet in height, with some higher peaks exceeding 8,000 feet. Mt. Olympus is 8,150 feet high. As seen from a distance the jaggedness of the crest line has sometimes given it the name of "Sawtooth Range." With their perpetual fields of snow, they present a view of impressive grandeur.

THE WILLAPA HILLS

The Willapa Hills are high hills or low mountains which border the Pacific Coast from the Chehalis River Valley on the north to the Columbia River Valley on the south. Their maximum elevation is much lower than the Olympics, being about 3,000 feet, and lower than the Coastal Range of Oregon which has a similar position along the coast, south of the Columbia River. Nowhere do they rise above the tree-line.

These hills are too low to be seen from Camp, but soldiers from that part of the state are well aware of the immense quantities of lumber which their forests yield. On the west side especially, the forests are almost impenetrable.

THE CASCADE MOUNTAIN RANGE

To the east from Camp, the most extensive surface of major prominence in the state of Washington can be seen—the Cascade Mountain Range (Plate IV). Keeping an average summit altitude of 5,000 to 6,000 feet above sea, with some points much higher and some passes lower, the Cascades stretch from north to south and extend beyond one's vision and the boundaries of the state. Indeed, they are a part of a great mountain chain which extends most of the distance from southern California to Alaska.

Snow fields linger on the higher peaks during the summer and in winter their mantle of white is extended

over much of the range. At its base lie the foothills, covered by luxuriant forests of tropical density.

Across the mountain range the Columbia River has cut a deep gorge, which is regarded as the natural boundary between Washington and Oregon. This pass has been cut nearly to sea-level and through it the explorers, Lewis and Clark, gained ready access to western Washington. The other passes of the Cascades have been formed where the heads of drainage lines on either side meet. Of these the lowest and most conspicuous is Snoqualmie Pass, which has an elevation of 3,010 feet and which is used by the Sunset Highway and the Chicago, Milwaukee & St. Paul Railway.

Several peaks of diverse origin rise above the general summit level of the Cascades. There are peaks of granite, such as Mt. Stuart, which reaches an altitude of 9,470 feet above sea-level, and extinct volcanoes which surmount the Cascades and tower still higher than Mt. Stuart. These are Mt. Rainier, 14,408 feet; Mt. Adams, 12,307 feet; Mt. Baker, 10,750 feet; Glacier Peak, 10,436 feet, and Mt. St. Helens, 9,671 feet. Their positions in the range are shown in Plate II. Mt. Adams and Glacier Peak occur near the summit line of the Cascades, while Mt. Rainier, Mt. Baker, and Mt. St. Helens are situated on the flanks.

MT. RAINIER

By virtue of its position and comparative nearness, Mt. Rainier is the Great Sentinel of the Camp. Looking slightly south of east, the soldier at Camp Lewis may view its towering slopes and rounded summit, almost hidden by snow-fields and glaciers, with only here and there the dark lines of rock appearing. Above where he stands the mountain rises more than 14,000 feet, or over 2½ miles. This accounts for its seeming nearness, even though it is 35 miles away. It is the bulwark of the line; compared with the Cascades it stands 2½ times

their average height. To the Indians of early days this was the "Mountain that was God."

The realm into which it reaches is quite different from the ordinary conditions at the surface of the earth. From its base, its slopes gradually ascend until they penetrate the higher rarified and frigid atmosphere where neither plants nor animals can exist. It is estimated that the atmosphere around its summit on a quiet day contains about 40 per cent less oxygen and other gases, by weight, than the atmosphere at Camp. Its temperature is also colder by 48 degrees, if one reckons the usual one degree decrease in temperature with every 300-foot rise. With such a temperature the moisture in the atmosphere above a certain level is condensed as snow instead of rain and in consequence eternal snow caps its summit and mantles its slopes, accumulating to such great thicknesses that it is transformed into glacial ice. These glaciers, which now number at least 26, are gouging and furrowing its slopes and have been for ages, carving many ramparts, cliffs, and canyons. (Plate V.)

The appearance of Mt. Rainier seems never to be quite the same. From hour to hour the sun's rays shine on it from different angles and with changing intensity, from the glow of dawn to the brightness of mid-day and the purple of sunset. At times the mountain stands out bold and clear, and then again clouds form about its summit, or hide its base, or roll like thunder clouds up its slopes. These and other touches of Nature, together with the changing position and mood of the observer, give the Great Sentinel new aspects from time to time.

THE RESOURCES OF THE CASCADES

The resources which the Cascades hold for man's economic development are important. The mineral deposits comprise coal, gold, silver, copper, lead, zinc, tungsten, molybdenum, arsenic, antimony, mercury and

other minerals. The forests which clothe the western slopes contain millions of feet of lumber, and the water-power resources are greater than in any other state in the Union. Although many projects have been installed, there remains much to be developed. During the present coal crisis, when coal had to be conserved for the use of war industries, the value of Washington's water powers was emphasized.

THE PUGET SOUND BASIN

Between the Olympics on the west and the Cascades on the east lies the broad Puget Sound Basin. Plate II shows this depression, beginning north of the Canadian boundary and extending southward between the Olympics and the Cascades to and beyond the Columbia River. Its northern part is extensively developed, having a width between the Olympics and the Cascades of about 50 miles.

GENERAL CHARACTER

The Puget Sound Basin is a plain country averaging 400 to 500 feet above sea, incised by ramifying troughs averaging one to four miles in width. A part of these troughs or inlets is occupied by marine waters and connected with the ocean by the Strait of Juan de Fuca, which lies to the north of the Olympics. In Plate VI is shown a view across one of the troughs at sunset. Interspersed with the various inlets, passages, and bays, are flat-topped islands, peninsulas, and border land, most of which rise in sea cliffs from the water's edge, 100 to 250 feet high. As seen on the fancy tissue of Plate II, there are two major inlets extending south from the Strait of Juan de Fuca. The one to the west at the foot of the Olympic Mountains is Hood's Canal, the one to the east is Admiralty Inlet. The latter carries practically all of the Commerce of Puget Sound. The northern part of the Basin is mostly submerged, with many rock-islands

The Olympic Mountains as seen from Puget Sound.

rising above the water-level and comprising a group known as the San Juan Islands.

AN OLD DRAINAGE SYSTEM

The troughs of Puget Sound and the Strait of Juan de Fuca are, for the most part, former river valleys which have been partly submerged by a general depression of the land area, permitting the sea-water to come in eastward for 100 miles, southward for 85 miles, and northward for a still greater distance. During the Glacial Period, the inlets were gouged still deeper by the great glacier. These events have given rise to one of the best and largest harbors in the world. For a proper appreciation of the size of this inland body of water in Washington it should be stated that the distance from the northern boundary to the southern limit is about 150 miles, or greater than the average length of the state of Massachusetts. The waters are surprisingly deep, averaging from 300 to 1000 feet, and ships of any tonnage can reach the ports of Seattle and Tacoma at lowest tide. Another advantage is protection from storms. The inlets are sufficiently narrow that the small expanse of water does not permit large waves to be generated by the winds. During 1917, over four hundred and eighty-five million dollars' worth of imports and exports were handled on Puget Sound.

TOPOGRAPHY OF THE CAMP LEWIS CANTONMENT

The Cantonment is located on an upland which borders the Nisqually River on the southwest, the Puget Sound on the west and northwest, and the Puyallup River on the north and east. South of Camp the surface is quite rolling and heavily timbered, but to the northeast lies a level stretch with only a few scattered hills rising above the general level. (Plate VII.)

Approaching Camp along the Pacific Highway, from the northeast, these hills, with their covering of timber,

break the sky-line and give relief to the otherwise level landscape. North and west from Camp the flat country is wooded with a forest that has partly sprung up since the early settlement of the region.

The grounds near the Northern Pacific depot are about 250 feet above the Sound. From here east there is an imperceptible rise of about 40 feet to the east end of the Camp and westward a gentle decline of about 70 feet for two miles or more to the brink of a 180-foot cliff, at the foot of which lies Puget Sound. Twenty miles north and slightly east the upland terminates in Pt. Defiance.

DRAINAGE

Surface streams are few, owing to the flatness of the upland and the favorable underground drainage. They consist entirely of little brooks flowing quietly in shallow trenches of more or less winding nature. The first stream north of Camp is Murray Creek, which empties into American Lake, and the second and larger is Clover Creek, which flows into Steilacoom Lake and thence into the Sound by way of Chambers Creek.

Northeast of Camp, four lakes occur in a series, curving from north to southwest and west—Steilacoom Lake, Gravelly Lake, American Lake, and Lake Sequalitchew. More beautiful bodies of water are rarely found. The water is clear and of moderate depth, the shores are of gravel and rise about 25 feet above the lake-levels, and the bordering groves of trees and the distant mountain give a wonderful setting. Lake Sequalitchew is the only one which occurs within the confines of the Cantonment, but the southern shores of American Lake lie along the boundary. The latter lake is nearly four miles long and about one mile wide in its widest portion, with several small islands and inlets and bays to add to its charm. (Plate VIII.) As a bathing resort during the summer it is the Camp's chief attraction.

American Lake has an elevation of 238 feet above sea-level, and Sequalitchew Lake is 215 feet; the two are separated by a gravel barrier about 300 yards wide. This discrepancy in level with only a gravel dam between is to be accounted for. It is believed that the pores in the bed of American Lake, in at least that portion near Sequalitchew Lake, have been so thoroughly filled with silt that there is no underground connection with Sequalitchew Lake.

Another beautiful little lake, Lake Spanaway, occurs near the east end of the Cantonment.

Due to the extensive gravel formation and the uniformly level topography of the upland, much of the rain which falls seeps into the ground and disappears by underground drainage. Some of the ground-water of the Cantonment seeps into the lakes and some of it feeds the springs along the cliff that borders the Sound and along the side slope of Nisqually River Valley.

The ground-water level is usually at varying depths beneath the land surface, but in the case of permanent lakes or swamps, it is at the surface. Where it is beneath the land, seasonal differences in rainfall will cause a variation in the height to which it rises. Since most of the rain at Camp Lewis occurs in the winter, the ground-water surface is highest at that time. When the rains cease, the gravels drain the water away so promptly that during the dry season the ground-water level is much lower.

The factor of ground-water must be reckoned with time and again in the many-sided activities of military life. Besides being useful as the common source of water-supplies, it may be a constant menace to camp drainage and sanitation, to trench warfare, to the crossing of bogs and swamps, to the maintenance of roads and railroads, to the transportation of heavy artillery, to the use of tunnels and caverns, and other military

projects. At Camp Lewis, many of these difficulties are not confronted in their most serious phases, due to the excellent site of the Camp, but the difficulties of trench drainage are well illustrated in the practice trenches on the hillcrest south of the Camp.

This hill has a loose, stony soil and sub-soil of three or four feet in depth, but below this the material is hard and compact and quite impervious to water. In consequence the water which seeps in at the surface penetrates but a few feet and then moves laterally according to the slope of the contact of the soft and hard material. This, in addition to the water which runs in from the surface in wet weather, keeps the trenches wet and necessitates other measures to make them of any use. If the loose material extended deeper so that the contact with the impervious formation were well below the bottom of the trench, or if the trenches were in a sandy soil, the drainage would be much more satisfactory. In a permanent line of defense such factors must necessarily be considered.

WATER-SUPPLIES

The water-supplies of the Camp are obtained from springs. In consideration of their importance the location is not here given. Examination was carefully made to determine whether their source is local or not. The waters are entirely free from bacteria, which shows that they cannot have any near surface connection. Their source must be a sufficient distance away from any possible contamination so that the bacteria are destroyed by long under-ground filtering and non-exposure to substances upon which bacteria can live.

The volume of the springs thus far seems adequate, there being but little fluctuation in the flow in wet and dry seasons. During February, 1918, the 63 gallons of water required per man for the 31,000 men at the Camp were amply supplied by the springs.

Three storage tanks have been erected on a hill within the Cantonment, 100 to 150 feet above Camp. Each has a capacity of 200,000 gallons. In March, 1918, seven months after their initial use, there was occasion to expose the bottom of one of these and no silt accumulation was found. This and the analyses for bacterial content indicate that the water is of first quality.

SANITATION

The excellent drainage afforded by the gravel formation on which the Camp is located has already been noted. There are but few pools of standing water close to Camp which may be infested with mosquitoes and other germ carriers, and they can easily be brought under sanitary control. Extensive marshes are far distant.

Disposal of the sewage is made in Puget Sound, three miles to the west. In excavating for the sewage line, gravels and sands were found throughout the whole distance. The general westward slope of the formation made excessive digging unnecessary to give the proper gradient for the sewage line.

ROAD CONDITIONS

The gravel plain furnishes all of the requisite conditions for good road-building. The topography is essentially level, the gravel affords an ideal foundation and proper drainage, and abundant material is available, either for ordinary surfacing or any first-class type of pavement.

The Pacific Highway is paved the whole distance from Tacoma to the Nisqually River, with a minimum width of 18 feet. Plans are now under way to widen this to meet the greatly increased traffic which the existence of Camp Lewis has brought about. The only grade of consequence is at Tacoma where the ascent is made from near sea-level to the low pass in the southwest part of the city, having an elevation of 230 feet. From here to

Camp the grade is nearly level. In approaching Camp from the direction of Olympia there is a grade at Nisqually River, but this is also moderate.

When the Camp was first instituted it was predicted that since the Pacific Highway was not paved for such heavy traffic as is now brought to bear on it, the life of the pavement would be of only a few months' duration. With the exception of a few instances the pavement was in good condition in May, 1918. Its success in surpassing the predictions is probably due in part to the superior foundation which the gravel formation affords.

Quarries of solid rock are nowhere to be found in this vicinity, but their absence is of no consequence in view of the abundance of gravels.

MILITARY USES

Artillery positions require a foundation which is firm and elastic, and, for practice work, hills which will minimize the dangers to the territory beyond. The situation at Camp Lewis meets these conditions admirably. After the removal of the surface soil and the proper placement of the heavy guns, the gravel formation yields but slightly to vibration effects and its return to the former condition is instantaneous and quite perfect.

The broad expanse of the Cantonment, the association of hills with the prairie, and the forest covering of the hills and of the area west of Camp make possible almost any type of army maneuver on a large scale. These maneuvers may be extended to mountain topography, 35 miles away.

CHAPTER III

THE ORIGIN OF THE MOUNTAIN RANGES AND OF THE PUGET SOUND BASIN

There is no doubt in the minds of those who have made a careful study of the earth that immense lapses of time have transpired since it was formed. A knowledge of how rocks are made, of the great thickness to which they have accumulated, of the profound changes which they have undergone, of the widespread and repeated shifting of the shore-lines, of the revolutionary changes in hills, valleys, and plains, and of the imperceptible rate at which these changes take place—a knowledge of these things convinces the investigator that the earth is extremely old, that if the time since its early stages could be expressed in years, the figures would be beyond all comprehension. The length of a thousand years is difficult for the human mind to grasp, and a hundred thousand years impossible. Yet by adding one's conception of the length of a certain epoch to that of another, and then to that of another, until all of the known epochs of the earth's history have been considered, the summation mounts into millions of years.

THE CASCADE RANGE

During this prodigiously long history, mountain ranges have come and gone. In the ancient past, there were mountains in existence in some parts of the continents where now the land surface is a plain. This is true, for example of southern Canada. On the other hand, certain regions which were once plains are now folded into mountain chains. Such has been the history of the Cascade Mountains.

The Cascade Mountains came into existence through the action of great earth forces bowing up immense thicknesses of rock. These forces were applied not so much

Scene in the Cascade Mountain Range.

from below, as is commonly thought, but from one or both sides, in a compressive manner. They owe their origin to deep-seated changes in the earth. Very modern studies show that the earth is as rigid a body as if it were made of steel, and hence probably mostly solid throughout. With increasing depth from the surface pressure increases, and the material of the interior is forced to combine into denser and denser compounds. Heat also is produced. By the recombination of the material into denser forms and the loss of this heat the interior shrinks more than the outer part. As a result, the outer part must adapt itself to fit the shrinking interior and in so doing it wrinkles or folds and produces mountain ranges. To bow up such immense masses of hard and resistant strata, forces of astonishing magnitude are required, and a mountain range, such as the Cascades, is a monument to the power of these forces.

Before the present Cascades were folded an undulating plain existed in their place, close to sea-level. This ancient plain was worn down by streams and other eroding agents of Nature from a previously existing mountain range. In other words, the Cascades, as viewed in their massive structure today, are not regarded as the first generation of mountains that existed in their location, but rather as the successors of others which had their own long period of history but which were gradually eroded away by Nature's persistent agents.

The production of a mountain range by the foregoing method of Nature is not accomplished quickly or violently, but requires thousands of years. There is abundant evidence to prove that such movements are slow. In the yielding, however, which must take place to such overpowering forces, the rock sometimes gives short, quick slips, which results in earthquakes.

Since the Cascades were folded they have been subjected to extremes of weather. Heating from sun-action

and cooling at night, rain-wash, stream erosion, frost-action, and glaciers—all have accompanied and aided each other in weathering the rocks, etching a rugged crest-line and carving canyons and valleys down their flanks, threatening the mountains with the same destiny as that of their predecessors. But with all of this, they still stand as a mountain range of the first importance in Washington.

MT. RAINIER AND OTHER SIMILAR PEAKS

In Mt. Rainier and its related peaks, Mt. Adams, Mt. Baker, Glacier Peak, and Mt. St. Helens, we have an example of another type of mountain-building. After the birth of the Cascade Mountains, or possibly during their formation, these peaks came into existence in an altogether different way than by folding. At the points where these peaks are now located, molten rock from the interior of the earth broke through and formed volcanic craters, and as lava poured forth and volcanic ash and cinders were thrown out, lofty cones were built on the flanks and summit of the Cascades themselves, until they reached altitudes thousands of feet above the range. With their summits in the high atmospheric zone of snow and ice, glaciers formed and these agents of destruction are now slowly but constantly wearing and grinding away the rock substance of which the peaks are made.

Whether Mt. Rainier and the other extinct volcanoes will ever become active again cannot be determined or safely predicted. During the period of eruption, the lavas had their source probably in local reservoirs deep beneath the earth's surface. A renewal of their activity depends partly upon whether these reservoirs were exhausted or whether more lava has been or will be produced by the heat of compression and other sources, and whether the forces necessary to bring the molten material to the surface will be generated again.

THE OLYMPIC MOUNTAINS

The Olympics were made in much the same way as the Cascades, and were not constructed by volcanic action. None of the higher peaks of these mountains are of volcanic origin, but they owe their prominence to uplift and to the superior hardness of the rocks which compose them as compared to the rocks around them. This is an example of the difference which results from the prolonged action of rain, frost, and glaciers on a mountain group made up of rocks of unequal hardness. All of the present summit levels are probably considerably below what they once were when the Olympics were first uplifted and before Nature's erosional agencies had had time to accomplish much.

The Willapa Hills are due to folding and warping, but they probably were never so high as either the Cascades or the Olympics, and their reduction since their birth has probably been more rapid, due to the soft character of much of the rock.

THE PUGET SOUND BASIN

A study of the conditions of origin of this remarkable basin between the two mountain ranges, with its 1900 miles of shore line and superb harbor, has resulted in the discovery of some very interesting natural history for western Washington and the vicinity of Camp Lewis.

Just as the history of the ranges was not one of sudden violence but a gradual progression of events, so has been the history of Puget Sound itself. Its record of known events seems to begin with the period of mountain-building and to have included still more recent history.

When the Cascade Mountains were folded, a general depression took place along their west base, beginning in Canada and continuing southward nearly the whole extent of the range. This was the first step, it seems, in the history of this great trough. Then deposits of clay, sand and gravel accumulated within the trough, brought

by streams from a distant glacier in British Columbia. So thick did these new sediments become and so widespread, that the old valleys were completely filled, most of the former hills buried, and a new plain constructed, above the old topography. The material which was laid down at this time is now exposed in the high bluffs at the Tacoma docks and Pt. Defiance.

Following this deposition, the lowland was slowly uplifted, as the result of internal changes in the earth, until it reached an elevation of nearly 1,500 feet above sea. At this height, the streams of the area began to cut deep channels and in the course of time they were deepened to canyon proportions. The whole region was so deeply dissected that it became exceedingly rough. The Strait of Juan de Fuca became a great valley, having as tributaries Admiralty Inlet and other troughs. The amount of time consumed by Nature in changing the original flat surface to this condition must have been thousands upon thousands of years, for streams are not capable of making much change in the general land surface during the life-time of an individual.

Such was the character of the Puget Sound country until a lowering of some 1,000 feet of the whole region permitted the ocean waters to enter the lower portions of these valleys, drowning them and converting them into inlets and bays. At about this time the climate became glacial and a great ice-sheet, the character of which will be described hereafter, overrode the basin, modified the surface, gouged out the troughs to greater depth, and left a mantle of glacial debris scattered unequally over the area. But with all of this, it failed to destroy the major troughs which furnish the important clue to the former history of Puget Sound. Thus the old drainage system became a most excellent harbor system.

At the same time that the sinking of the Puget Sound Basin took place, the same thing happened to the western

coast, producing the bay of Gray's Harbor at the mouth of the Chehalis Valley, Willapa Bay at the mouth of Willapa Valley, and a bay in the lower portion of the Columbia River. This is characteristic of all the world's best harbors. London, New York, Boston, San Francisco and other ports are all on coast-lines which have sunk during the latter part of the earth's history, and they owe their importance to this event.

"The hills are shadows, and they flow
From form to form and nothing stands;
They melt like mists, the solid lands,
Like clouds they shape themselves and go."

—*Tennyson.*

CHAPTER IV

THE CLIMATE OF CAMP LEWIS

TEMPERATURE

If the climate of Camp Lewis were determined by latitude alone it would be the coldest camp in the United States. The forty-seventh parallel of latitude lies along the south boundary of the Cantonment. Tracing this across the map of the United States, it is found to pass north of Duluth, Minn., and through the very northern part of Maine. The fact, then, that Camp Lewis lies so far north in the United States and yet has a mild climate demands an explanation.

The secret for this lies in two factors: First, the existence of the Pacific Ocean with the Japan current off the western shores of Washington, and second, the prevailing winds from the west. Such a large body of water as the Pacific Ocean is not responsive to daily or seasonal changes of heating and cooling, and, therefore, during both summer and winter, it maintains a remarkable uniformity of temperature. In this latitude the ocean's warmth is increased by the Japan current which drifts from the equatorial belt south of the islands of Japan. With the winds blowing from the west these conditions of uniform mildness are transferred to western Washington throughout the year.

Taking into consideration the present climatic conditions of the earth, this combination of westerly winds and oceanic influences are more efficient than any other combination that Nature might make in this latitude. If an arctic current were to replace the Japan current, the climate would become very raw and unpleasant. On the other hand, if the winds were to blow from the east instead of from the west, even with the warm Japan current washing the western coast, the winters would be very cold.

TEMPERATURE RECORDS AT TACOMA

During 17 years of weather recording at Tacoma, which may be taken to apply to Camp Lewis, the lowest and highest temperatures have been read for each day in the year. These records show some interesting facts. During the summer the average temperature of the day has been 71 degrees; of night, 52 degrees. This shows that the days are comfortably warm and the nights refreshingly cool. During the winter, the temperature has had an average daily range from 45 degrees above zero during the day to 35 degrees above zero at night. Frequently there is only five degrees difference between day and night. This low range is due partly to the great ocean, partly to the southerly winds in winter, and partly to clouds which prevent excessive heating in the day and excessive cooling at night. Toward the latter part of the winter, the winds temporarily shift to the northeast and blow from east of the Cascades, or descend from the high cold regions of the atmosphere, producing sharp, frosty spells of short duration. Such days are always bright and clear.

COMPARISON OF TEMPERATURE CONDITIONS AT THE DIFFERENT CANTONMENTS

A comparison of the temperature conditions at the different cantonments is of general and official interest. It is of general interest to know the conditions under which the soldiers at the different cantonments live, and of official interest in the issuing of food, clothing and equipment, and in formulating plans for training. The following data have been compiled from the records of the United States Weather Bureau and tabulated on the following page. Since in most cases the cantonments are not located in cities where there are Weather Bureau stations, the records of the nearest official stations have been taken, provided the station is in the vicinity of the cantonment.*

* The names of the stations which furnish the data for each camp are given in the table.

TABLE I.

NAME OF CAMP	Name of Weather Bureau Station whose results were taken	TEMPERATURE								PRECIPITATION			SUNSHINE (Per cent. of possible hours)		
						SUMMER		WINTER							
		Highest recorded temperature.	Lowest recorded temperature.	Average number days per year above 90°.	Average number days per year below 32°.	Av. lowest temperature.	Av. highest temperature.	Av. lowest temperature.	Av. highest temperature.	Average annual.	Number days with .01 inches or more.	Average depth of snow.	Per cent. winter.	Per cent. summer.	Average annual.
Camp Custer, Mich.	Kalamazoo, Mich.	100	—19	6	119	60	81	19	33	34.8	124	51.5	67*	36*	52*
Camp Devens, Mass.	Boston, Mass.	102	—13	8	112	61	78	21	37	43.7	130	45.4	60	53	55
Camp Dix, N. J.	Moorestown, N. J.	103	—15	17	100	51	94	5	60	45.6	111	27.3	69	57	62
Camp Dodge, Iowa	Des Moines, Iowa	109	—30	19	124	64	83	14	32	32.4	109	32.8	67	53	60
Camp Funston, Kans.	Agricultural College, Kans.	115	—32	62	122	64	90	20	42	30.5	65	22.0	69**	57**	61**
Camp Gordon, Ga.	Atlanta, Ga.	110	—8	20	20	60	86	36	52	49.9	125	3.0	64	51	61
Camp Grant, Ill.	Beloit, Wis.	105	—25	13	136	60	82	12	29	32.8	75	32.3	69†	46†	57†
Camp Jackson, S. C.	Columbia, S. C.	106	—2	64	38	70	90	37	57	46.7	115	4.5	.....	.....	.....
Camp Lee, Va.	Richmond, Va.	102	—3	36	63	68	87	29	47	43.6	119	14.7	.....	.....	.....
CAMP LEWIS, Wash.	Tacoma, Wash.	**98**	**9**	**4††**	**37††**	**52**	**71**	**35**	**45**	**42.3**	**155**	**16.1**	**57**	**20**	**39**
Camp Meade, Md.	Washington, D. C.	104	—15	.....	.....	66	85	27	43	43.1	126	22.5	64	51	57
Camp Pike, Ark.	Little Rock, Ark.	106	—12	72	62	70	89	35	51	49.6	108	10.5	75	51	64
Camp Sherman, Ohio	Portsmouth, Ohio	106	—18	37	89	64	87	24	42	40.4	113	18.7	73‡	40‡	56‡
Camp Taylor, Ky.	Louisville, Ky.	107	—20	32	70	67	86	29	44	44.5	128	14.4	70	44	58
Camp Travis, Tex.	San Antonio, Tex.	106	4	94	12	72	93	44	64	28.4	85	0.3	.....	.....	.....
Camp Upton, L. I.	New York City	100	—6	6	89	65	80	25	39	44.8	132	37.0	59	54	56

* Sunshine data taken from records of Detroit Station, in lieu of no record at Kalamazoo.
** Sunshine data taken from records of Topeka Station, in lieu of no record at Agricultural College.
† Sunshine data taken from records of Chicago Station, in lieu of no record at Beloit.
†† From records of Olympia Station, in lieu of no record at Tacoma.
‡ From records of Cincinnati Station, in lieu of no record at Portsmouth.

The highest temperature which has ever been recorded in the vicinity of any of the cantonments has been at Camp Funston (Kan.), a temperature of 115 degrees. The second highest is at Camp Dodge (Iowa), 109 degrees; and the third highest at Camp Taylor (Ky.), 107 degrees. Camp Lewis holds the most attractive record in not exceeding 98 degrees, whereas all of the others have had maximum temperatures of 100 degrees and above.

The lowest temperature record is also held by Camp Funston, it being 32 degrees below zero, and the second coldest by Camp Dodge, 30 degrees below zero. Camp Lewis again occupies the most favored position, for its absolute minimum temperature has been the highest of all, namely 9 degrees above zero. This is especially remarkable in view of the fact that it is over 300 miles farther north than any other cantonment in the United States, and 1200 miles north of the southernmost cantonment, Camp Travis (Tex.), which has experienced 4 degrees above zero.

Camp Lewis has the coolest summers, as shown by its average daily temperature of 71 degrees for June, July, and August. Camp Devens (Mass.) ranks second, and Camp Upton, on Long Island, third. The winters at Camp Lewis are very mild. The average daily temperature during December, January, and February is 35 degrees, which is the same as Camp Pike's in Arkansas. This is exceeded only by Camp Travis' (Tex.), Camp Gordon's (Ga.), and Camp Jackson's (S. C.) records.

The average number of days with the maximum temperature above 90 degrees is 4 for Camp Lewis, 6 for Camp Upton (N. Y.) and Camp Custer (Mich.), 8 for Camp Devens (Mass.), 13 for Camp Grant (Ill.), 17 for Camp Dix (N. J.), 19 for Camp Dodge (Iowa), 20 for Camp Gordon (Ga.), 32 for Camp Taylor (Ky.), 36

Mount Rainier from Paradise Park.

—By courtesy of Asahel Curtis, Seattle

for Camp Lee (Va.), 37 for Camp Sherman (Ohio), 62 for Camp Funston (Kans.), 64 for Camp Jackson (S. C.), 72 for Camp Pike (Ark.), and 94 for Camp Travis (Tex.).

The camp which has the greatest number of days with the temperature below 32 degrees is Camp Grant (Ill.), with 136 days. Camp Dodge (Iowa), is next, with 124 days, and Camp Funston (Kans.), third, with 122 days. Camp Lewis, with 37 days, Camp Gordon (Ga.), with 26 days, and Camp Travis (Tex.), with 12 days, close the list with the smallest number.

In winter, Camp Lewis has a more uniform temperature between night and day than any other cantonment. The difference averages only 10 degrees.

EFFECTS OF UNIFORMITY OF WINTER TEMPERATURE ON THE HEALTH OF THE CAMP

During the past winter (1917-1918), Camp Lewis has had one of the most remarkable health records of any army camp in the United States. From health reports issued by Captain F. R. Mount, Acting Division Sanitary Inspector, and Lieut.-Col. P. C. Field, Division Surgeon, for six consecutive weeks from January 18 to March 8, 1918, inclusive, it was found that out of an army averaging 30,241 men there averaged but 4 new cases of Lobar Pneumonia per week, 6 of Broncho Pneumonia, 5 of Diphtheria, 32 of Measles, 3 of German Measles. 156 of Mumps, and 1 of Cerebro-spinal Meningitis. In all of the six-weeks period, there were but 2 cases of Pulmonary Tuberculosis, 1 of Erysipelas, and 3 of Chicken Pox, and 14 deaths, two of which were suicidal. This health record excels the average of all camps, without any exception for any one week, according to official statements.

The surprisingly few cases of pneumonia and other diseases, which are favored by extremes of temperature, emphasize the health value and importance of the uniform climatic conditions which prevail.

EASTWARD LIMITATIONS OF WESTERN WASHINGTON'S CLIMATE

The moderacy of the climate at Camp Lewis is distinctive only for western Washington and not for the area east of the Cascade Mountains. The difference between the two emphasize the part which the Cascades play in modifying or controlling the climate. Rising to heights of 5,000 to 6,000 feet and more, these mountains act as a great barrier and prevent the free sweep of the winds from the ocean to eastern Washington and thereby prohibit the transfer of the temperature of the Japan current beyond the western slopes. In consequence of this the summers are hotter and the winters colder east of the mountains than west, and the differences between night and day are usually greater.

THE RAINFALL OF WESTERN WASHINGTON

The more abundant rainfall of western Washington as compared with the region east of the mountains is strikingly emphasized to the traveler. Leaving Spokane, westbound, the traveler soon passes into the sage-brush plains of the Columbia Plateau. For mile after mile not a tree is in sight, and the sombre landscape continues in its sameness to the Columbia River. Once the ascent of the eastern slopes of the Cascades is begun, the stunted tree and the thicket appear. The trees increase in size and numbers with the rise of slope until at the summit and on the western slope are seen the dense forests. The traveler has crossed from the semi-arid region of eastern Washington to the rainfall area of the western portion.

SOURCE OF THE RAINS

Practically all of the rain has its primary source in the Pacific Ocean. By evaporation, the westerly winds pick it up and carry it over the land areas, where if the temperature is proper, it will be condensed as rain. It is fortunate indeed, for other reasons than those pertaining to temperature, that the rotation of the earth causes the

winds in this latitude to blow prevailingly to the eastward. If the winds blew to the westward this would be a desert-like region, for in that case there would be no adequate source for the moisture.

RAINFALL MAP

Fig. 3 shows graphically the rainfall in different parts of Washington. The height of the lines indicates the amount which a given place receives, and each line represents a month, from January to December. It is striking how much longer the lines are for the western part of the state than for the eastern. It is equally striking how much longer the lines are for the winter months, such as November, December, January, and February, than for the summer months. This illustrates the two chief points about Washington's rainfall: the area west of the Cascades receives much more than the area to the east, and most of the rainfall occurs during the winter months.

For the difference in rainfall between eastern and western Washington, the Cascade Mountains are largely responsible. When the westerly winds reach the Cascades they rise in order to pass over them. In rising they expand and become chilled and are forced to deposit much of their moisture on the western slopes. When they reach the summit and begin their descent of the eastern slopes they become warmer and as they do so they precipitate less and less moisture and eventually become evaporating rather than rain-giving. Pasco, at the eastern foot of the Cascades, receives less than seven inches of rainfall per year on the average.

SEASONAL DIFFERENCES

The seasonal differences in rainfall are due primarily to temperature conditions. In the winter the land area is sufficiently cool to cause the winds to condense their moisture, and storms are more frequent. In the summer the heat of the land warms the moisture-bearing winds,

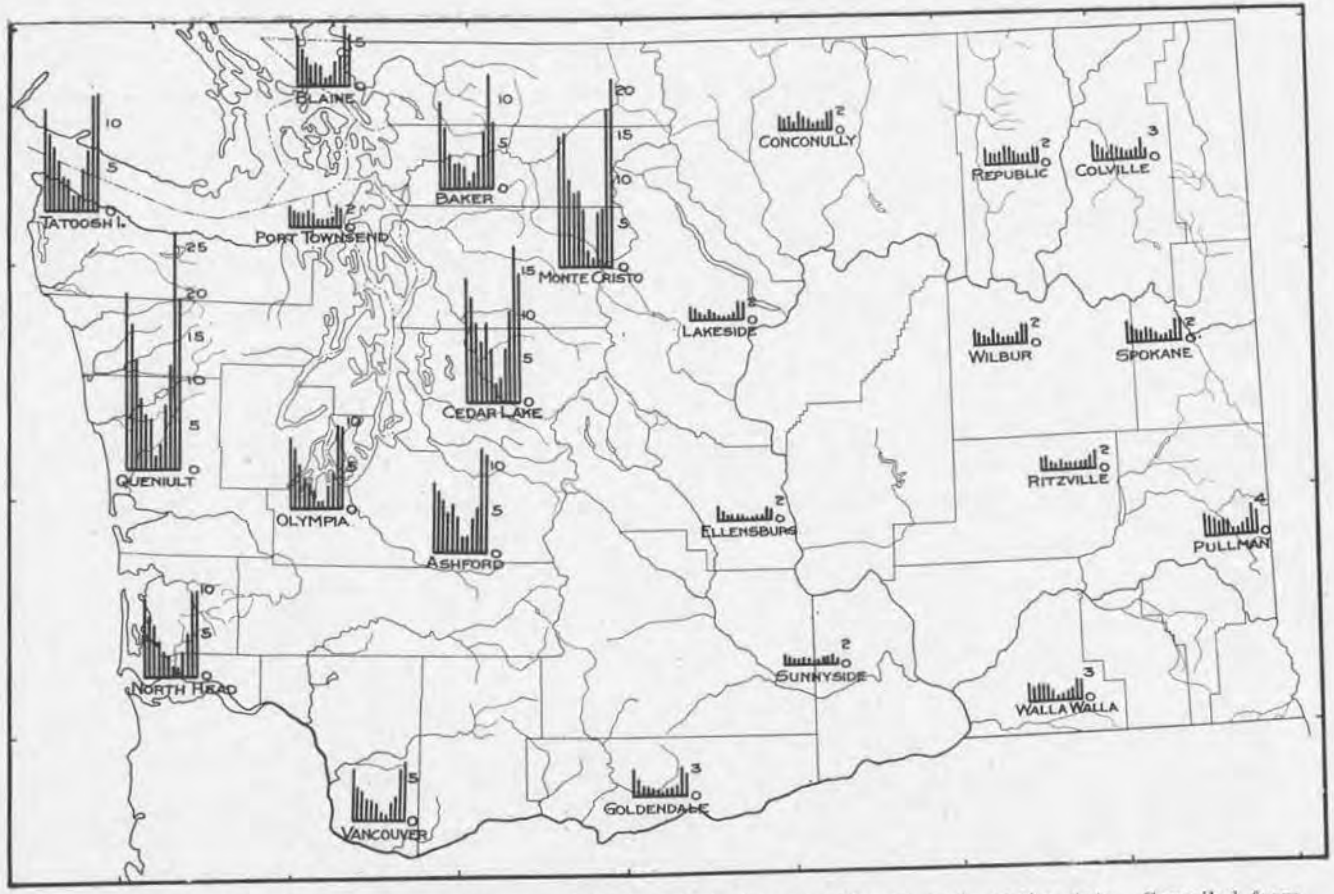


FIG. 3. Rainfall Map, showing the monthly precipitation, in inches, in different parts of the state. Compiled from the records of the U. S. Weather Bureau.

increases their capacity to hold moisture, and thereby prevents rainfall.

At Camp Lewis, 80 per cent of the precipitation occurs from October 15 to May 15. The greater part of this falls during the night, which gives many days of no rainfall during daylight or several hours of fair weather. During July and August there is usually less than one inch of rain for each month.

LOCAL DIFFERENCES

In western Washington it generally holds that distance from the Pacific Coast and altitude above sea affect the amount of rainfall of a given place. Of two points having the same elevation, the one which is nearer to the Pacific Coast receives the greater rainfall. This is illustrated by Aberdeen and Olympia, which have the same altitude. But Aberdeen is nearer the Pacific Coast by 40 miles than Olympia, as shown on Plate II, and receives an average of 85.5 inches, while Olympia receives 55 inches.

Of two points situated the same distance from the coast, the higher one has the heavier rainfall. The western slopes of the high Olympics, for example, have more than 120 inches of rain, but the lower Willapa Hills south of Aberdeen receive from 60 to 100 inches.

In some cases altitude is a more important factor in influencing rainfall than distance from sea. Many points near the summit of the Cascades receive more than 80 inches, as compared with Olympia's 55 inches and Tacoma's 42 inches.

The rainfall at Camp Lewis is undoubtedly a little greater than it is at Tacoma and considerably less than it is at Olympia. Forty-five inches is a close estimate. If the Camp were at Port Townsend, in the northern part of the Puget Sound Basin, the rainfall would be less than half what it is at the present location. Port Townsend has an average of only 20.5 inches. But Port Town-

send is scarcely any farther from the Pacific Coast than Camp Lewis and its elevation is about the same. Then why this marked difference in precipitation? There are two causes for this: the direction of the prevailing winds, and the position of Port Townsend with respect to the Olympics. (See Plate II.) The winds of Puget Sound blow more from the southwest in the winter than from the west, and this makes Port Townsend directly in the lee of the Olympics. The southwest slopes of the Olympics, therefore, catch most of the moisture and but little is left for places situated northeast of the mountains at low elevations.

RAINFALL AT OTHER CANTONMENTS

Although Camp Lewis and vicinity receive a generous rainfall, it is interesting to note that at least four other cantonments in the United States receive a still greater amount. The average annual precipitation at Camp Gordon (Ga.) is 50 inches; at Camp Pike (Ark.), the same; at Camp Jackson (S. C.), 47 inches; and at Camp Dix (N. J.), 46 inches. As has been stated heretofore, the rainfall at Camp Lewis is probably about 45 inches. This is equalled at Camp Taylor (Ky.) and Camp Upton (N. Y.). Camp Travis (Tex.) has the least rainfall of all the cantonments, the amount there being slightly in excess of 28 inches.

The number of days with .01 inch or more of rain averages 155 per year for Camp Lewis, which is 23 more than for Camp Upton (N. Y.), the next in the list. Camp Funston (Kans.) has the least number of rainy days, averaging but 65 each year. The comparatively large number of rainy days at Camp Lewis is the only objectionable feature of its climate. This, however, is partly compensated by the gentleness of its rains, the moderation of the temperature during the rains, and the ease with which the gravel formation at the Camp drains away the water, thus preventing flood conditions which

have seriously affected other cantonments. Severe thunderstorms, accompanied by winds of high velocity, such as occur in the middle west and eastern states, are practically unknown at Camp Lewis.

SNOWFALL

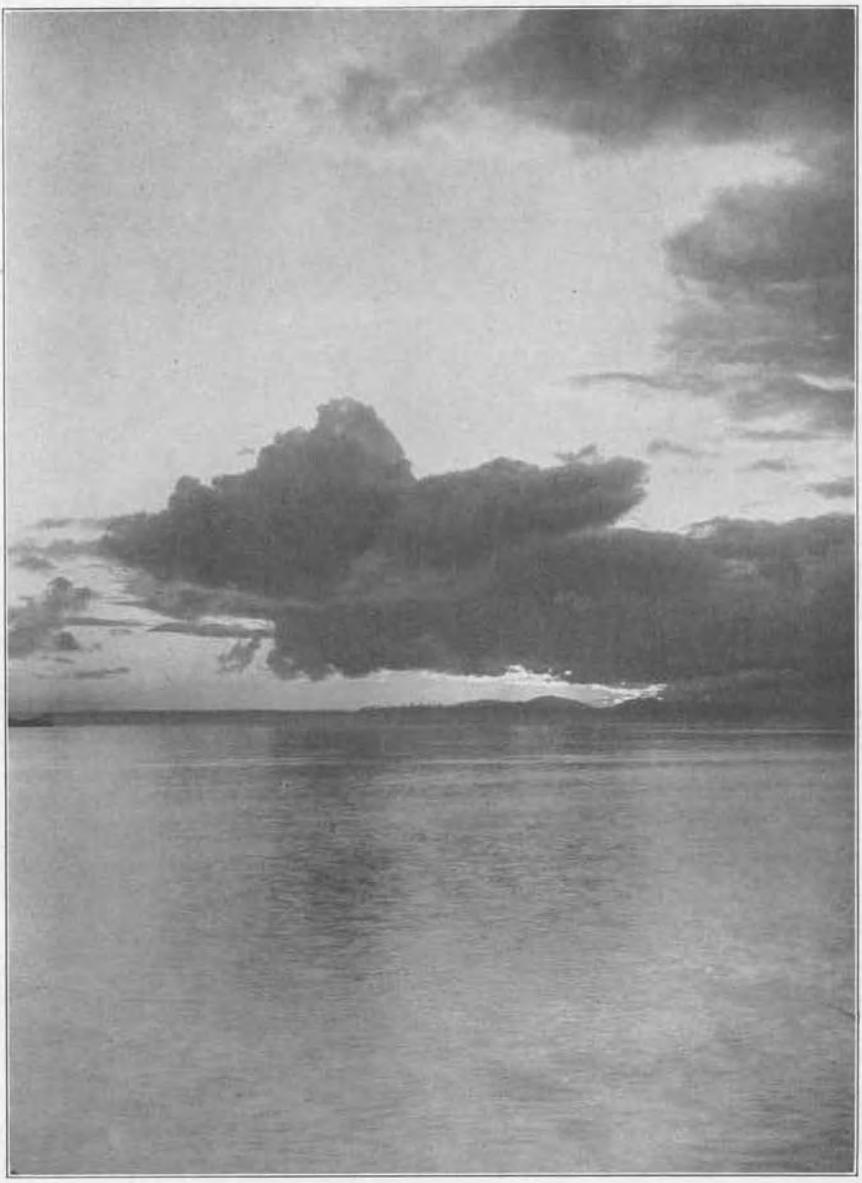
Snow is infrequent, and when it does occur, the fall is usually light. During 17 years of observation the amount has averaged about 16 inches per year. This takes into account all that falls, even though much of it melts away promptly. This is the least snowfall of any of the cantonments north of the latitude of St. Louis. Camp Custer (Mich.) has the greatest, 51.5 inches, and Camp Travis (Tex.) the least of all, 0.3 inches.

Not over 50 miles away from Camp Lewis, in the Cascade Mountains, the snowfall is much heavier, 100 inches being not unusual. During one winter season 48 feet was recorded. Snow which falls in the mountains lingers until late summer, and much of it is perennial. This provides a valuable source of water-supply for the streams during the summer when the rainfall is the least, and gives rise to valuable water-power resources.

SULTRY WEATHER

Sultry weather is due to warm temperatures and a relatively high content of moisture in the air. In the eastern part of the United States, when the air on summer days has a high relative humidity, or when it contains almost as high a percentage of moisture as it can hold, the perspiration of the body is not evaporated with the usual rapidity and the atmosphere seems depressive. This sort of weather is called sultry.

In the Puget Sound Basin such days are rare. The summer months are comparatively dry and the relative humidity of the air, especially during the warm part of the day, is low. At five o'clock in the afternoon it



Sunset View across Puget Sound.

averages but 53% at Tacoma, whereas in all of the eastern cantonments it ranges all the way from 57% to 73%, except at Camp Travis (Tex.), which has the exceptional average of 51%.* If summer were a wet season in the Puget Sound Basin instead of a dry, the weather would be very sultry, and although its temperature might not be excessively warm, the days would be enervating. Such is the case in the middle and eastern states on an occasional day during the summer.

WIND VELOCITY

In the Puget Sound Basin, near sea-level, 100 feet above the surface, the wind velocity ranges from an average of five miles per hour during August to seven miles per hour during January. An authentic record of a tornado is unknown in Washington.

SUNSHINE

The vicinity of Camp Lewis averages more hours of sunshine during the summer than Camp Upton (N. Y.), and almost as many as Camp Devens (Mass.) and Camp Gordon (Ga.). For June, July, and August, the vicinity of Camp Lewis has averaged 795 hours during the 16 years' record, Camp Upton, 749 hours, and Camp Devens, 808 hours, and Camp Gordon, 830 hours. Of all records obtained, Camp Pike (Ark.) has the highest standing, with an average of 974 hours.

During the winter, on account of its rainy climate, Camp Lewis holds the lowest sunshine record and Camp Pike the highest. But in spite of this, its average minimum temperature equals that of Camp Pike.

* All records on which these averages are based were taken at the same time in all parts of the country. Since 5 o'clock Pacific Time is 8 o'clock Eastern Time and 7 o'clock Central Time, these records do not represent the same stage of the day, and therefore some allowance must be made for the higher percentages of the East.

COMPARISON OF THE CLIMATE OF CAMP LEWIS WITH THAT OF FRANCE AND BELGIUM

Thus far in this chapter exclusive attention has been devoted to the climate of Camp Lewis and a comparison of the same with that of other National Cantonments in the United States. It appears from this comparison that the climate of Camp Lewis has many superior qualities.

In the first place, it has no zero weather in winter; secondly, the temperature is nearly uniform in winter, there being no rapid or extreme changes which tax vitality; thirdly, the snowfall is light and of short duration; fourthly, the summers are moderately warm without oppressive heat; fifthly, there is sufficient difference between night and day to permit refreshing sleep at night and maximum efficiency during the day; sixthly, there are neither tornadoes nor thunderstorms with attendant flood conditions.

The stay, however, of the soldiers at Camp Lewis is mostly temporary. After their preliminary training they are destined for service in France and Belgium, where climate will be as much a factor of health and interest as here. For this reason it does not seem out of place to compare briefly the climate of the two places.

Fig. 4 shows a map of France and Belgium placed upon a map of the northwest states with regard to latitude and relative size. From this it will be observed that their position corresponds to a position on the Pacific from southern Oregon to north of Vancouver, British Columbia. That part of France which has been the scene of the war's activities, lies north of the latitude of Camp Lewis. Paris would be located approximately on the northern boundary of Washington, Verdun on a line with Vancouver, B. C., and Lens, Calais, Dunkirk, and Brussels still farther north.

The winds of France and Belgium generally blow from the west or southwest, as in Washington. This means that the climate there is under a marine influence as here, the winds blowing from the sea to the land, and that the temperatures are comparatively uniform. Very similar to the Japan current, the Gulf Stream washes the eastern shores of the Atlantic and the winds transfer its moderate temperatures to the land area. There are no mountains in France having a position similar to the

FIG. 4. Comparative map of the northwestern states and of France and Belgium, showing their positions by latitude.

Cascade Range, and so the marine influence is carried far inland, beyond Paris. In the eastern and northeastern parts of France, the elevations are higher, and there is a wider range of temperature, but it is less than would ordinarily be expected for this latitude.

The winters are not severe but there is usually some moderately cold weather. The number of days during the winter that the temperature is continuously below 32 degrees average 11 at Paris and 11 at Arras,* as compared with two at Camp Lewis. In the vicinity of St. Mihiel colder weather prevails, because the elevations are higher and farther from the coast. Snowfall is fairly frequent from November to April, inclusive, but is of lighter character over the lowlands. Heavier and more frequent snows occur in the higher areas in northeastern France, in the vicinity of Verdun, St. Mihiel, Toul, and in eastern France.

The summers of northern France and Belgium are cool, with some moderately hot weather, but without extremely high temperatures. No temperatures above 100 degrees have ever been recorded in France. In northern France the thermometer usually registers less than 80 degrees during the day and below 60 degrees at night.

On the low plains in northern France and Belgium the rainfall averages from 20 to 30 inches, while in the Vosges Mountains in northeastern and eastern France it ranges from 60 to 70 inches. It is a little heavier in the fall and early winter, but the minimum occurs in the spring. The rains are frequent but are gentle and of short duration. A rainfall heavier than one inch in 24 hours at Paris is rare, and at Arras, on only one day in five years has there been a rainfall exceeding one inch. The amount of cloudiness is about the same as that at Camp Lewis.

* Arras is near the northern end of the present battle-line. March 1, 1918.

In general, it may be stated that the winters are a little more rigorous and unpleasant than at Camp Lewis, with damp and chilly winds from the west and southwest. The days are somewhat shorter than here and the nights correspondingly longer. In April and May the length of day increases rapidly, with much more sunshine and with light and rather frequent showers. The summers are pleasant. The days are moderately warm and the nights cool. In the latter part of June the days are about 16 hours long. The autumns are usually agreeable, with the rainfall a little more frequent and of greater intensity. On the whole, the climate of northern France and Belgium is very much like that of Camp Lewis. Indeed, it is more nearly like that of Camp Lewis than any other camp in the United States.

CHAPTER V

ANCIENT CLIMATIC CHANGES

The present climate has not always been characteristic of this region. Just as Nature has brought about revolutionary changes in the land forms so has she effected great changes in the climate.

FORMER PERIOD OF TROPICAL CLIMATE

The question is frequently raised as to how it is possible to determine what kind of climate the earth has had in the ancient past, preceding the earliest written records. The method is by no means mysterious, neither is it as speculative as is popularly supposed. In the last century or so, students of earth science have come to understand how the rock strata of the earth were formed, and how their ingredients frequently indicate the kind of conditions which existed at a particular time. With this knowledge, some facts which are hidden to the casual observer are revealed with surprising clearness to the investigator.

The coal beds that are now being mined at various places on the east and west flanks of the Cascades, as at Roslyn, Carbonado, Black Diamond, or Newcastle, are made up in part of palm leaves and branches. These indicate that at the time this material was accumulating a tropical or sub-tropical type of climate must have prevailed in this region to permit the growth of this sort of vegetation. This particular period occurred ages ago, even before the present mountains were uplifted, for the coal beds are tilted and included in the structure of the mountains.

But the existence of this climate with this vegetation was none the less real. Just how different the landscape appeared then as compared with the present can be pictured mentally by supposing that the present mountains

were leveled, Mt. Rainier removed, and by substituting for our present pines, firs, and cedars, the palm type of vegetation.

Such a climate this region must have enjoyed for a long time. Due to causes that are still problematical, a change to another extreme came, when instead of the temperature being tropical or sub-tropical there was a slow transition to a temperate and then to a frigid climate, which resulted in a large part of North America being over-ridden by an immense ice-sheet. This ice-sheet was so extensive that it invaded the middle states as far south as St. Louis and beyond.

GLACIAL CLIMATE

It would be expected that the severity of the climate which would make this possible would also make itself felt in the Puget Sound region. This has been found to be true. An extensive ice-cap over-rode this region, transformed much of its topography and produced the gravel plain at Camp Lewis.

SOURCE OF THE PUGET SOUND GLACIER

The Puget Sound Glacier had its source in a snowfield somewhere in British Columbia. Accumulating by degrees under the influence of a climate which made snowfall exceed the melting of summers, the snowfield assumed immense proportions and eventually, when its thickness became great enough to generate motion, it gave rise to a glacier. The snowfield had frozen to loose material on the surface, and so was already shod with rock fragments when it assumed the nature of a glacier. When movement began, these fragments grooved and scraped and scratched the bedrock over which the ice passed. The bare rock surfaces of the San Juan Islands and at Victoria preserve many of these markings and in almost all cases they trend north and south. Many of the stones found in the clay deposits throughout the

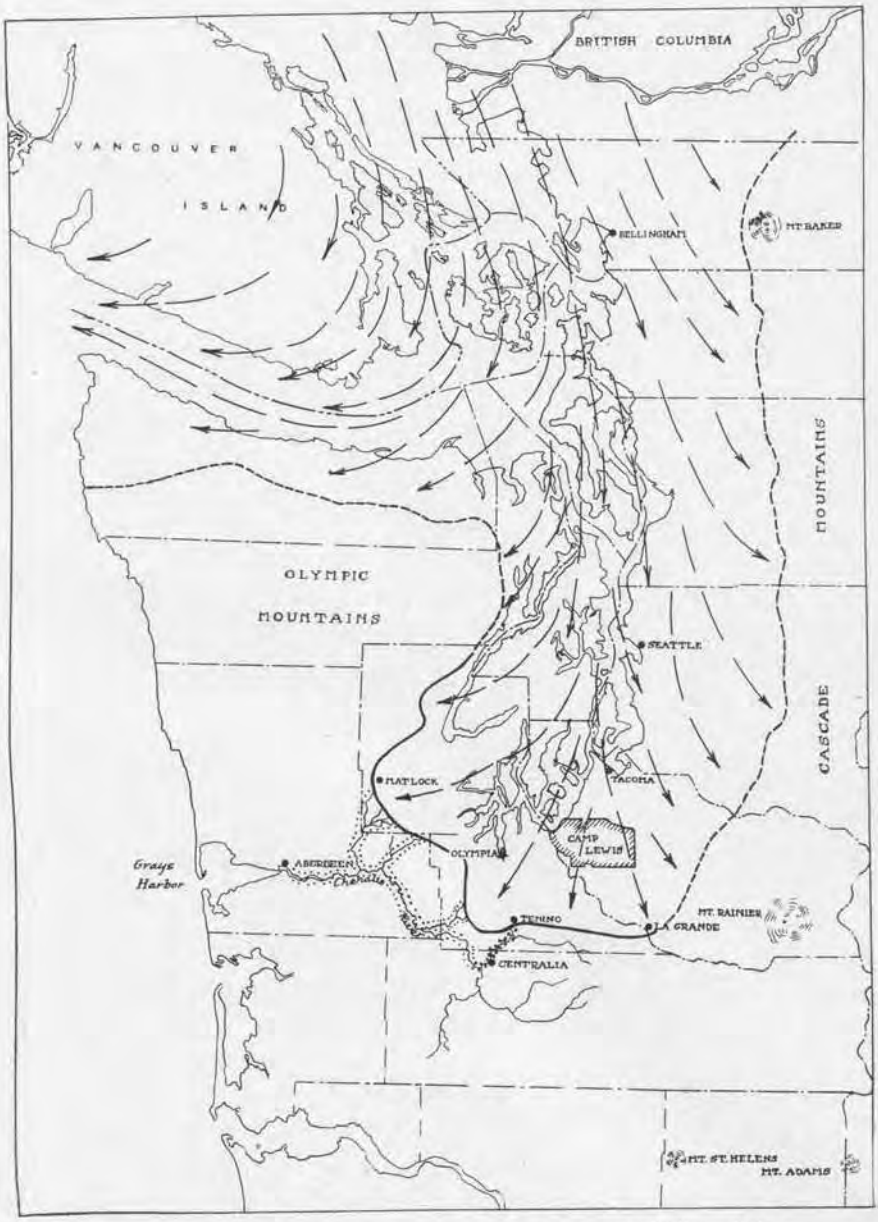


FIG. 5. Sketch map showing the extent of the glaciation of the Puget Sound region.

Puget Sound country belong to native ledges in British Columbia, thus making it quite clear that the glacier came from that direction.

SOUTHERN LIMITS OF GLACIATION

The great glacier filled the Puget Sound Basin, as shown in Fig. 5, from the Cascade Mountains on the east to the Olympics on the west, a breadth of 50 to 60 miles. The deposits of debris, which afford traces of where the ice moved, are found throughout the Puget Sound country to a point about 20 miles south of Camp Lewis, and about 15 miles south of Olympia. From the north line of the state this is distant 150 miles. How much farther north was the source of the glacier is not exactly known, but these proportions in Washington suggest the immensity of the ice-sheet.

North of the Olympics, Vancouver Island was overridden, the Strait of Juan de Fuca was filled, and the ice projected into the Pacific far enough to form an ice-bridge from the Olympic Peninsula to the southwest shores of Vancouver Island.

THICKNESS OF THE ICE

The ice is known to have been sufficiently thick not only to fill the troughs of Puget Sound, which off Pt. Jefferson is nearly 1,000 feet deep, but to have overtopped some hills or small mountains over 3,000 feet high. This shows that the ice was at least 4,000 feet thick, and probably it was considerably thicker, in order to generate the necessary motion to over-ride the rough surface of the area.

THE RETREAT OF THE GLACIER

The melting back of the glacier is spoken of as its retreat. This could not have taken place until the climate changed from a glacial to one approximating that of the present. This change probably was gradual, so that by degrees the glacial front retreated. The time involved was necessarily long, probably thousands of years.

View of the Pacific Highway and the level topography northeast of Camp Lewis.

—By courtesy of Asahel Curtis, Seattle

The melting of such an immense field of ice, which was being constantly fed at its source by newly fallen snow, must have created great floods of water. The courses followed by this outwash, when the ice was at its maximum limit, are shown in Plate VI to have been by tributaries to the Chehalis River and thence to Grays Harbor and the Pacific Ocean. Enormous quantities of silt, sand, and gravel were either carried in suspension in the streams or rolled or moved along the bed of the streams until they were buried by the onrush of other gravels. The great gravel benches now existing along the Chehalis River and its tributaries represent the remnants of what was an enormous fill in the valleys.

CONSTRUCTION OF GRAVEL PLAIN AND HILLS OF THE CANTONMENT

It was during these retreating stages of the glacier that the gravel flat and hills of the Cantonment came into existence. The amount of debris carried in any glacier is unequally distributed. Consequently, upon the melting of the ice, the land surface that was formed from these deposits was left irregular, with hills and ridges of unequal height and dissimilar form, and pond-basins and marshes promiscuously distributed. Such irregularity was in some cases increased or modified by the original irregularities of the old surface, or by readvances of the ice-sheet, or both.

The hills south of Camp and to the north are of glacial origin. They are made up of debris of glacial character. The intricate system of trenches on the hill slope just south of the barracks were dug in this material, which geologists call *glacial till*. Much difficulty was experienced by the soldiers in digging, due both to the compactness of the material and the numerous pebbles and cobblestones mixed with clay. Commonly this material is known as "hard-pan." For an army to intrench itself in such a terrain under fire would be well nigh

impossible and would probably result in great loss of life. These hills were made while the ice was still present and the compactness seems to be due to the burdening pressure of the great glacier rather than to any cementing action since.

The barracks are located on a nearly flat gravel deposit which extends northward along the Pacific High-

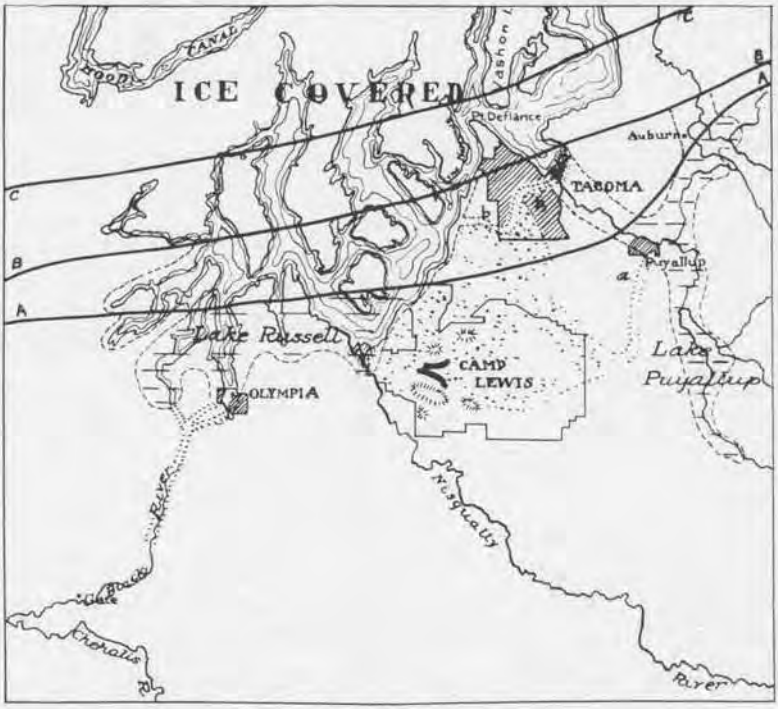


FIG. 6. Diagram showing the positions of the ice front when the gravel-plain of the Camp Lewis Cantonment was made.

way to Tacoma. Wherever excavations of any sort are made on this flat, gravel is encountered. This gravel plain was made after the hills were made and the construction of all of the upland between Puyallup River on the east and Puget Sound on the west, was finished before the ice had melted back beyond Pt. Defiance, north

of Tacoma. In order to make clear how this is known, the reader's attention is invited to Fig. 6.

This diagram shows three stages in the retreat of the ice after it had melted back from the Camp Lewis Cantonment. The line A-A shows the position of the front of the ice at one stage, B-B at a later, and C-C still later. When the front of the ice lay along the line A-A, the waters of Puget Sound were shut off from their northward connection with the ocean and a lake gathered in front. This lake lay to the west of the Cantonment in the vicinity of Camp Lewis and has been named Lake Russell. After the waters had risen to a level of about 160 feet above present sea-level, they found an outlet over the low divide southwest of Olympia and discharged, as indicated on the diagram, by way of Black River to the Chehalis River, and thence to the ocean. Another reference to Fig. 6 will show that the stream in the Puyallup Valley, to the east of the Cantonment, was also obstructed by the ice and another lake formed, called Lake Puyallup. This lake received drainage from the melting ice to the north, from the glaciers in the Cascades, and from the glaciers on Mt. Rainier.

Where did the waters of this lake escape? This involves the important point of the origin of the gravels at Camp Lewis. The waters raised until they reached an outlet southwest of Puyallup, as indicated in the figure, at about an elevation of 400 feet above present sea-level. The site of the present town of Puyallup was then under nearly 350 feet of water. These waters pursued the course "*a*," crossed the Camp Lewis area to Lake Russell on the west, and thence escaped by way of Olympia and the Black River outlet. In passing across the Cantonment these waters, together with those from the ice-front itself, distributed an immense amount of gravel and gradually built up the broad gravel flat around the scattered hills of glacial debris. All of the

gravels of the Cantonment were deposited at this time, and their rounded and worn character is due to their rolling by the torrential waters. Several "kettle-holes" appear here and there in the surface of the flat, which show that huge ice-blocks became isolated from the glacier, washed out, and later were partially or wholly buried by the gravels. After melting, depressions were left.

As the ice-front receded northward lower ground was uncovered in the vicinity of Steilacoom and the waters were diverted along Clover Creek in the direction of Chambers Creek. A wide channel was cut by the large volume of water, and it is within this broad channel that the present small Clover Creek, north of the boundary of the Cantonment, winds aimlessly.

Still further recession of the glacier to the line B-B uncovered a lower outlet for Lake Puyallup at the present site of Tacoma. This outlet is the low col now followed by the Northern Pacific Railway and the Pacific Highway in leaving Tacoma for Camp Lewis. It has been named the South Tacoma outlet and its position is shown in the diagram at "*b*."

Once the ascent is made from the lower business section to this col, one finds himself in a wide, flat-bottomed valley which curves southward to South Tacoma and then westward to Steilacoom. This huge channel, 75 to 80 feet deep at Tacoma, was cut by the escaping waters of Lake Puyallup as they pursued this course to the vicinity of Steilacoom, where they emptied into Lake Russell. The gravels which were obtained from the glacier and from cutting this channel were deposited as a great delta in Lake Russell, and it is these gravels which are so well exposed in the large gravel pit at Steilacoom.

When the South Tacoma outlet was uncovered, the older outlet "*a*" at Puyallup was abandoned, for the newer outlet "*b*" was lower than "*a*" by 90 feet. The

flood of water which this sudden drop permitted from such a large lake as Lake Puyallup is easily imagined; likewise its power for rapid cutting.

By referring again to the diagram in Fig. 6, it will be observed that while the outlet "*b*" was being used, the front of the ice must have had a position somewhere between Tacoma and Pt. Defiance, for just as soon as the glacier's front had receded to the line C-C, north of Pt. Defiance, Lake Tacoma merged with Lake Russell by way of The Narrows and assumed Lake Russell's level, 70 feet lower. Outlet "*b*" was then no longer used.

The construction of the Camp Lewis area was then complete and the sound of torrential rivers was no longer to be heard. Its glacial history was at an end. Save for slight changes, its surface has remained essentially the same ever since.

Lake Russell continued to exist to the west, east, and north of Pt. Defiance until the ice front had melted northward to the Strait of Juan de Fuca, when its union with the ocean was permitted. Then the waters of Puget Sound changed from fresh to salt-water conditions.

ORIGIN OF THE LAKES

American Lake and the other lakes which occur in a successive series north of Camp Lewis owe their origin also to the glacial epoch. There appears to have been a former valley along the line of their position which was partly filled with ice when the gravels of Camp Lewis were being deposited. The gravels were washed around the stagnant ice-blocks until they were buried and then more gravels were distributed farther westward, developing a nearly level plain. When the deposition ceased and the ice melted, irregular depressions were left which became the basins for the present lakes.

OTHER GLACIAL EPOCHS

Beneath the glacial deposits which occur so widely in the Puget Sound area, there is a still older glacial deposit which is separated from the one above by old soils, peat-beds, and rusty gravels. This relationship is shown along some of the cliffs of Puget Sound. The presence of the old soil and peat between the two deposits shows that two different glaciers have been in the Puget Sound Basin and that enough time intervened between the two glacial epochs for the climate to become warm and vegetation to creep back into the area. The rusty gravels also are thought to show weathering during a warm climate. And so it seems safe to say that this region has experienced at least two epochs of glacial climate, during both of which the life suffered seriously.

In the middle states there are evidences of at least five distinct glacial invasions rather than two. And the time between each one was much longer than the time since the last, and the inter-glacial climates were at least as warm. During each inter-glacial epoch the land was reinhabited with plants and animals, only to be destroyed or driven southward by the extreme cold of the next glacial epoch.

That evidences for only two glacial epochs have been found in Puget Sound localities should not be taken to mean that only two occurred. It would seem that if the climate became sufficiently cold to cause five glaciations as far south as Iowa, Missouri, and Illinois, Puget Sound was probably similarly affected. Perhaps the evidences of the older glaciations have been obscured by the younger deposits or wholly obliterated.

LENGTH OF TIME SINCE THE LAST GLACIATION

Just how long it has been since the last glaciation it is impossible to say. The best measure of post-glacial time for this continent seems to be the amount of recession of Niagara Falls. Niagara Falls is known to have

come into existence during the closing stages of the glaciation which last affected that part of the continent. Since that time the falls have receded some seven miles. Taking into consideration the present rate of recession of the falls and the factors which have affected the rate in time past, it has been estimated that something like 20,000 to 30,000 years have elapsed since their origin.

If the change in climate which caused the Puget Sound glacier to melt took place at the same time as the change in the eastern part of the continent, then we might assign the above figures to the length of post-glacial time in the Puget Sound Basin.

During post-glacial time, the Puget Sound Basin has been at varying heights above sea-level. Fragile marine shells occurring in a bed beneath soil have been found up to 290 feet above sea-level, showing that for at least a brief time the land was lowered relative to sea-level to that extent, and subsequently uplifted. This would have submerged the place where the barracks at Camp Lewis are built, but not the bordering hills. The absence of any quiet water deposits shows that this was only for a brief time geologically, although, if measured in terms of a life-time, it may have lasted a generation or more. Wave-cut terraces as wide as 50 to 100 yards occur quite commonly along the shores at a height of about 30 feet above the present waters, showing that the waters of the Sound were approximately at that level for some time.

Deltas have been built and extended a considerable distance at the mouths of the Puyallup and Nisqually Rivers, lakes on the upland have been partially filled with sediment, the bed of American Lake has been silted, and peat has accumulated in marshes and swamps, as below the outlet to Lake Sequalitchew. The upper few feet of the glacial material has been somewhat weathered and stained and made into soil, and the land reclothed with vegetation of various kinds.

CHAPTER VI

HUMAN HISTORY OF THE CAMP LEWIS REGION

By Edmond S. Meany

The vicinity of Camp Lewis has an interesting history. The first homes of white men to be established on Puget Sound were located there and for a dozen years there seemed great likelihood that the region would become British rather than American territory.

During the period of discovery, exploration and occupation, four nations—Spain, Great Britain, Russia and the United States—sought the ownership of the Pacific Northwest. In the very year, 1792, in which the United States established claims by Captain Robert Gray's discovery of Grays Harbor and the Columbia River, the British and the Spanish government were settling the conflict over their rival claims. The Spaniards withdrew southward to the coasts of California and the British remained active as to their claims along the northern shores. These claims were in conflict with those by the United States and Russia. The American claims were based on Gray's discovery of the Columbia River, on the Lewis and Clark Exploring Expedition, 1803-1806, and on the establishment of the fur trading post on Fort Astoria at the mouth of the river, 1811. The British had also explored and had established fur trading posts on the upper Columbia River.

During the War of 1812, the British bought the American fort at Astoria, but by the terms of the treaty of Ghent, 1814, which ended the war, it was made clear that Astoria, as a settlement, was American. The two governments made a treaty in 1818 providing that the Pacific Northwest should be open to the citizens and subjects of both powers on equal terms for a period of ten years. In 1827, just before the ten-year limit came to an end, another treaty was signed in order to extend the feature

of joint occupancy indefinitely. Either nation could end this agreement by giving the other one year's notice in writing.

All this time, Russia was building forts and trading posts in what we now know as Alaska. They also claimed the lands southward along part of the shores jointly claimed by Great Britain and the United States. That was protested by the United States when the Monroe Doctrine was announced in 1823. In the spring of 1824, Russia and the United States made a treaty fixing the boundary between their claims at 54° 40′, north latitude, and in 1825 Russia and Great Britain made a similar treaty. This eliminated Russia from the claims and left Great Britain and the United States as undisputed joint-owners of the Pacific Northwest.

The Americans practically disappeared after their post at Astoria was sold and their claims were held alive through governmental diplomacy. The British increased their number of trading posts, which were doing a successful business. This work was begun by the North West Company of Montreal, but in 1821 that company was absorbed by the older Hudson's Bay Company. The name of Astoria had been changed by the British to Fort George, in honor of their king. In 1825, the headquarters of the British trade were moved from Fort George to a new post farther up the Columbia River which they named Fort Vancouver. Their fur trade centered there.

When it was decided that the furs, harvested along the banks of the Fraser River and its tributaries, could best be handled by a central post, Fort Langley was established near the mouth of the Fraser River in 1827. Fort Vancouver still remained headquarters. Fort Langley could be reached by vessels going down the Columbia River, by sea to the Strait of Juan de Fuca and thence up the Fraser River. Vessels were not always to be had, however, and frequent trips were made overland.

American Lake. —*By courtesy of Asahel Curtis, Seattle*

Canoes were paddled and poled up the Cowlitz River to about the present site of Toledo and from there a portage was made to Puget Sound, where Indian canoes were secured for the rest of the journey to Fort Langley.

The Indians could not always be depended upon and in fact they had to be punished for an attack on the first traders, in 1828. These conditions caused the Hudson's Bay Company to decide upon establishing another post or way station near the head of Puget Sound. Thus arose the famous Fort Nisqually or Nisqually House on the ground now occupied by the Dupont Powder Works. In the spring of 1832, Archibald McDonald, a chief trader of the Hudson's Bay Company, while on a trading trip, picked on Nisqually Bay as a good place for the proposed post and left there Pierre Charles, William Ouvrie and one other man with a few blankets, a couple of kegs of potatoes and some garden seeds. The next spring Chief Trader McDonald returned and in the usual spirit of carefulness of the Hudson's Bay company he made the first entry in a book called "Journal of Occurrences at Nisqually" as follows:

"May 30th, 1833, Thursday. Arrived here this afternoon from the Columbia with four men, four oxen and four horses, after a journey of fourteen days, expecting to have found the schooner Vancouver lying here. She sailed the afternoon of the same day we started, with trading goods, provisions, potatoes, seeds, etc., bound for Nisqually Bay, where we have now determined, should everything come up to expectation, to locate an establishment."

There was with this first party a young Scotch surgeon, William Fraser Tolmie, who was on his way for service with the more northern posts of the company. The serious illness of Pierre Charles kept him at Nisqually for some time. During that time the young doctor made a number of botanical excursions. On one of these he took Indian guides and attempted to climb Mount

Rainier. He succeeded in ascending one of the foothills overlooking the glaciers on the larger mountain. That little mountain is now called Tolmie Peak and his diary of the trip is the prized record of civilized man's first approach to the great mountain.

Chief Trader McDonald did not stay long at Nisqually House. He had already requested retirement for age, and soon he was relieved by Chief Trader Heron. The new trader did not like the location selected. He explored the shores as far as Whidbey Island and later decided to build the fort at the water fall where Tumwater now stands, near Olympia. A band of Indians arrived at Nisqually for trade and would go no farther. That incident decided the case and Nisqually House became the first settlement by white men on the shores of Puget Sound.

The new fort served its purpose well from the very beginning. When it was three years old an important occurrence was recorded in the journal when the Hudson's Bay Company steamer Beaver arrived for work on this coast. This historic boat was the first steamboat to ply the waters of the Pacific Ocean. The fur trade was greatly stimulated by this new means of transportation and of course the Indians were profoundly affected by such a manifestation of the white man's power as this great "fire canoe".

The Hudson's Bay Company men at Fort Vancouver had given attention to lumbering and agriculture from the foundation of the fort in 1825. Similarly, those at Fort Langley had found fish packing a good addition to their regular fur trade. Nisqually House was to become an agricultural center. One reason for Chief Trader Herron's dissatisfaction with the site was the poorness of the soil on the south side of the Sequalitchew Creek where the warehouse had been built on the beach. There was better soil on the north side of the creek but that

would necessitate an expensive bridge near the mouth of the creek to the only suitable place on the beach for the warehouse. A road was built from the warehouse on the beach to a level tract above. There the first fort was constructed near two large oak trees known as "The Twins". The sunken outlines of the old stockade may still be seen and some evidences also of the first fruit trees and garden site. These old relics of the beginnings of civilization are now mingled with such signs as "Nitro-glycerine—Beware!" of the powder works.

In a few years the fort was moved a mile to the eastward to be nearer a source of fresh water and the new fort there erected was larger and more substantial. It also gave better command of the expanding prairies where the proposed agricultural enterprise could be attempted. Many of the old Hudson's Bay Company officers were opposed to such experiments. "We are in the fur trade. Let those raise potatoes who wish to," was a form of their protest. Others urged the case until they won the day by the organization of the Puget Sound Agricultural Company, about 1839. Chief Factor John McLoughlin at Fort Vancouver was given charge of the new company, though the real supervision of its work was made from Nisqually House. One of the larger experiments was on Cowlitz Farm Prairie south of the present city of Chehalis. The care of cattle, sheep, hogs and crops began to add largely to the activities of Nisqually House.

This all fitted well into the plans of the Hudson's Bay Company officers in the far west, or Oregon Country, which was still jointly owned by the British and Americans. In 1834 the American missionaries began to arrive and Dr. McLoughlin, the chief factor, directed them south of Columbia River. He continued that policy as other missionary parties arrived and as Nisqually House enterprises increased. He felt sure that when the joint

occupancy treaty was settled the British would get the Columbia River as the boundary.

News from these American missionaries and of the new British posts caused the United States Government to awaken its interest. On November 11, 1835, Secretary of State John Forsyth instructed William A. Slocum to visit the settlements on the Columbia River and, without exciting British suspicions, to bring back a report. He performed his mission and his report of 1837 included a strong and earnest plea for the United States to cling most firmly to Puget Sound which he described as of great value.

The missionaries sent by the Methodist Episcopal Church had accepted the advice of Dr. McLoughlin and had settled south of the Columbia, in the Willamette Valley. They received large reenforcements in 1840 and began to expand. One of the new missionary stations was established at Nisqually House, where Dr. J. P. Richmond and wife and W. H. Willson and wife were located. Though this was contrary to the advice of Chief Factor McLoughlin, he gave orders that the missionaries should be treated with kindness. The home of Dr. Richmond was blessed by the birth of a baby boy, the first American white child born on Puget Sound. This mission's work among the Indians did not prosper and it was abandoned in 1842.

While the American missionaries were at work there the keeper of the journal recorded a most important visit by a squadron of American vessels in command of Commander Charles Wilkes. The official title of the party was United States Exploring Expedition. For four years, 1838 to 1842, this expedition sailed around the world making scientific explorations for the United States Government. The officers and men were cordially welcomed at Nisqually House in 1841. Temporary headquarters were fixed upon there while small parties were sent in

different directions for the work of explorations. One of these parties, under command of Lieutenant Robert E. Johnson, passed across the parade grounds of the present Camp Lewis on the way across the Cascade Mountains to inspect the missionary stations and mining camps in the Walla Walla, Spokane and Colville districts. The report of that trip constitutes one of the valuable sources of early Northwestern history. It is one of the very first records we have of white men crossing those mountains.

Other excursions were made from the Nisqually headquarters which gave rise to many such names as Budd Inlet, where the present Olympia is located. It was named in honor of Acting Master Thomas A. Budd of the expedition. Another excursion passed through the Narrows and began surveys at a place which they called Commencement Bay, now known as Tacoma Harbor.

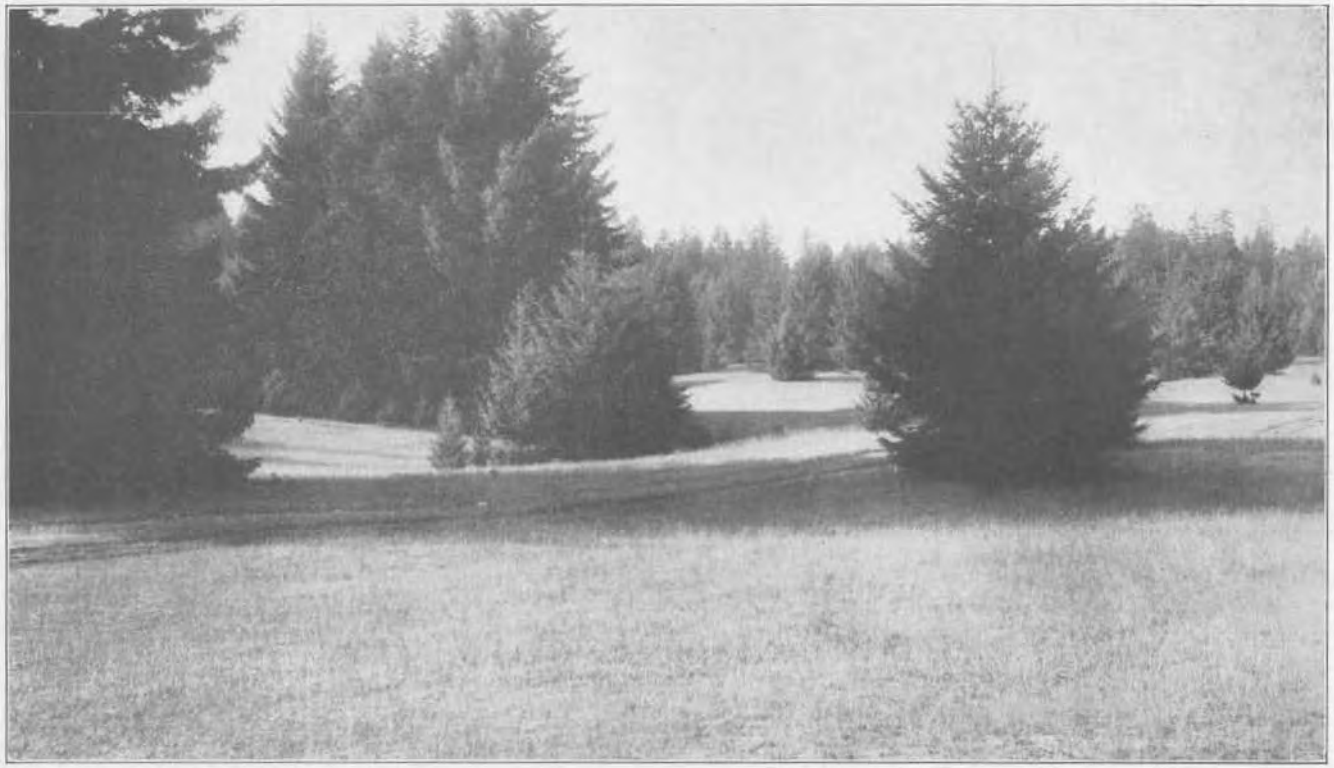
Independence Day was celebrated near Nisqually House in 1841 by the officers and men of the American squadron. There was an imposing parade, barbecue of a beef, programme and various sports. There was one casualty. A sailor died from injuries received while firing a salute. In 1906, the Washington State Historical Society, assisted by other organizations, unveiled a monument with elaborate and appropriate ceremonies to commemorate the sixty-fifth anniversary of that first Fourth of July celebration in the Puget Sound region. That celebration and the arrival later of American settlers gave rise to the well known name of American Lake. Commander Wilkes in charting and naming other places paid his respects to the British officers who had been kind to him. McNeil Island he named in honor of Captain William Henry McNeil of the steamer Beaver and Anderson Island was named in honor of Alexander Caulfield Anderson, chief trader at Nisqually House.

It is singular that the vicinity of Camp Lewis should have had a military character almost continuously from

the beginning to the present time. The Hudson's Bay Company and the Puget Sound Agricultural Company were semi-military in their methods. Chief Factor McLoughlin was commander-in-chief, under whom worked the various chief traders. Under them were the clerks and lastly were the companies of employees, usually called servants. Commander Wilkes maintained military discipline while his men were in camps on shore. In 1846, Robert Mills Inskip, royal navy, naval instructor in her majesty's ship Fisgard, established a regular camp at Nisqually for the instruction of junior officers. In 1849, the United States Government established and manned Fort Steilacoom for protection against Indian attacks or outbreaks. Even during the long season of peace and quiet after the Indian dangers had passed, the State of Washington maintained National Guard encampments at American Lake in the summer months. The First Washington Infantry, United States Volunteers, was mobilized and drilled there for the Spanish-American War of 1898. In 1917, there came the greatest military quality the region has known by the construction and maintenance of Camp Lewis.

While the British were still hoping for the Columbia River as the boundary there came a shock to those at Nisqually House when the Americans elected James K. Polk as President under the political battle cry of "Fifty-four, Forty or Fight!" War was imminent but was finally averted by adopting the present boundary and giving the Puget Sound Country, including the vicinity of Camp Lewis, to the Americans in the treaty of 1846. During the year previous to that treaty the first real American settlers arrived under the leadership of Michael Troutman Simmons and established themselves at Tumwater, near the present Olympia. Many of them were well treated and some of them were given employment at Nisqually House.

The British did not leave their establishment as soon as the treaty was signed because the United States Government had promised compensation for improvements and property taken. Dr. William Fraser Tolmie was one of the last officers and he finally moved to Victoria, B. C. The claims for property and improvements at Fort Vancouver, Nisqually and elsewhere in the Northwest dragged along until September 10, 1869, when a decision of award was rendered by which the United States was to pay to the Hudson's Bay Company $450,000 and to the Puget Sound Agricultural Company $200,000. The last clerk in charge at Nisqually House was Edward Huggins, who became an American citizen and secured the site of Fort Nisqually as a homestead. It remained the Huggins homestead until the property became a part of the holdings of the company now operating the powder works.



View of the edge of the fir forest on the gravel plain near Camp Lewis.

CHAPTER VII

NOTES ON PLANTS FOUND IN THE VICINITY OF CAMP LEWIS

By George B. Rigg

The flora in the vicinity of Camp Lewis is of two distinct types—that of the level prairie and that of the neighboring hills.

TREES OF THE HILLS

The hills in the main are covered with a forest of Douglas fir. On the borders of this forest, especially on the rather steep slopes extending down to the prairie, there is a good deal of white oak. Oaks are also found mixed with the young fir in the forest and to a certain extent on the level prairie itself. Some fir trees are found on the prairie, too. A good many trees of both oak and fir are found in the vicinity of the buildings of the Camp.

The fir is the only coniferous tree that is at all common in the immediate vicinity of the Camp. (Plate VIII.) It is the commonest conifer in the Puget Sound region. It may be distinguished from the other conifers of the region by the three-pointed projection (bract) which grows just outside of each scale of the cone. The mature cone is about three or four inches long. These cones are woody and are found commonly on the ground in the forest. The leaves of the fir are borne singly, not in clusters. They are an inch or a little more in length and about an eighth of an inch wide.

That the Douglas fir is a natural covering of the ground on the hills near Camp Lewis is indicated by the large number of small trees and even very small seedlings in the open places.

Occasional specimens of the western hemlock are found in the ravines. The hemlock is readily distin-

guished from the fir. Its branches are soft and very flexible at their growing tips, while those of the fir are stiff. The same is true of the growing point at the top of the young tree. The leaves are of three different lengths and project outward from the two sides of the branch, giving it a flat appearance. The leaves of fir come out more all around the stem, though sometimes there are not quite so many at the top and bottom as at the sides. The leaves of the hemlock are of three distinct lengths on each branch, while those of fir are practically all of the same length. The leaves of the hemlock are decidedly white underneath, so that the whole branch presents a whitish appearance when viewed from below.

A good many willows are found along the borders of the fir forest. In some cases they are found among the fir trees farther back in the forest.

Some madrona trees are also found in this forest, especially on the hills to the north of the Camp. These trees are conspicuous and attractive. They reach a height of 30 feet or more. The trunks of many of them are somewhat crooked. Occasionally one is found with a large burl at the base. The bark peels off in small pieces, leaving the reddish new bark of the stem smooth and with a polished appearance.

The leaves are evergreen and are thick and leathery. They are from 3½ to 5 inches long and 1½ to 2½ inches wide. The tree has large clusters of white flowers in spring. The berries are red and frequently remain on the tree through the winter. They are not edible, but are among the most conspicuous and attractive appearing berries of the region.

FOREST UNDERGROWTH

The fir forest, especially to the north of the Camp, is of a rather open type. The undergrowth is not so dense as is the case in much of the forest of the Puget Sound region. The undergrowth in the forest to the south of

the Camp is a little more abundant than that on the north. Salal is the commonest shrub forming this undergrowth, though the common Oregon grape and the shiny Oregon grape are also abundant. The last mentioned species is confined more to the rather open and dry places in the forest, particularly the crest of the rise from the prairie.

Lichens, mosses and fungi are abundant in the forest around Camp Lewis. Thready lichens hang from the branches of the trees. There are also several species of somewhat leaf-like lichens growing on the trunks and on soil. Various species of moss grow upon the tree trunks, decaying logs and also upon rocks and soil. Practically none of these have common names. One leafy liverwort grows with these mosses on tree trunks and is moss-like in its appearance.

The woody bracket fungus frequently forms large, hard shelf-like growths on the coniferous trees. The hard convex upper portion sheds water readily. The lower surface is creamy white in color and porous, with very numerous holes, large enough to be seen with the unaided eye.

The leathery bracket fungus is thinner and is tough, rather than woody. It is common on trees other than coniferous. Its lower surface resembles that of its woody relative.

TALLER SHRUBS

Among the taller shrubs growing in the forest on these hills are hazel, Indian plum, service berry, buck brush (red root), and ocean spray. All of these lose their leaves in the autumn.

The hazel of this region grows much taller than the familiar "hazel brush" of regions farther east. It is commonly 10 to 15 feet tall, occasionally 30 feet in ravines. Light is probably a factor in this. It also grows more among the trees and does not form such dense

growths in the open. It does not produce nuts so abundantly as its eastern relative. In winter the staminate catkins form rather stiff bud-like projections upon the branches. In the early spring the shrubs are conspicuous because of the great abundance of slender dangling staminate catkins, shedding the yellowish powdery pollen. On careful examination at this season of year the small red pistillate flowers are found, usually coming from the terminal bud of the branch. A little later leaves come. These are velvety to the touch.

The Indian plum blossoms about the same time as the hazel catkins come. It has white flowers, borne along a pendant stem only a few inches in length. The flowers come before the leaves but are quickly followed by them. The fruit is a bluish berry.

Buck brush, or red root, is a stout shrub 4 to 12 feet high. It is common in the edge of the forest on the hills bordering Camp Lewis on the south and is also reported to be found on the prairie. It has thin leaves whose edges are very finely saw-toothed. Its flowers are white.

The service berry is a white-flowered shrub 2 to 10 feet high. It has a small black or purplish fruit which is sweet and edible.

Ocean spray is a rather slender shrub whose stems do not grow strictly erect, but curve gracefully outward from the center of the clump. Its numerous, very small white flowers, produced in numerous large clusters, give it its common name. These gradually change to cream color, then become darker and the brownish clusters of fruit and dried bracts remain on the plants through the winter. The wood is rather tough and is sometimes known as Indian arrow wood.

SMALLER SHRUBS

Salal is a shrub reaching a height of 2 to 4 feet in these woods. It is an evergreen. Its leaves last a little over a year, so that the old crop do not wither until the

new ones are fairly mature. The leaves are four inches or more in length and more than half as wide as long. Their edges are very finely saw-toothed. They are tough and leathery as are the leaves of the other broad-leaf evergreens of these forests, such as common Oregon grape, shiny Oregon grape, evergreen huckleberry, and pipsissewa.

Salal has a whitish, rather sticky flower. The fruit is black and is about half an inch in diameter. It is said to be edible, but is not very commonly eaten. Its qualities as a food berry are certainly very poor as compared with huckleberries and blackberries.

The common Oregon grape is a low shrub with a very short stem. In winter its most conspicuous feature is its long leaves, curving upward and outward from the stem. These leaves have stiff leaflets, arranged in pairs along the central stalk, and an odd leaflet at the end. The leaflets are very stiff and have a few short spines on them. When the leaflet is looked at from the back it shows three rather prominent nerves all originating from the base of the leaflet. The wood of the stem is distinctly yellow, though the outer surface of the bark is brown. The stems grow from long underground shoots. The flowers are yellow and the fruit is a bluish berry, sometimes used for making jelly and pies.

The shiny Oregon grape is much taller than the common one. Its leaves are distinctly shiny and have sharper spines than its relative. It is sometimes called western holly. The leaflets do not have the three distinct nerves from the base. Many of the specimens have brilliant coloration of the leaves, far surpassing the common ones in this particular. The flowers and fruit of the two are similar. The underground portion of the tall one is the source of an official drug, known as Oregon grape root. It has a distinct odor and a bitter taste.

The dried leaves of pipsissewa also constitute an official drug. They are evergreen and are from 1¼ to 2 inches long and the widest point is above the middle of the leaf. The leaf is leathery and its edges are saw-toothed. The flowers are white or pinkish and the fruit is a dry capsule, splitting into five parts. This is a low plant. Its height does not usually exceed one foot. It is very abundant in the woods on the hills just to the south of Camp Lewis.

There are two huckleberries found in this region—the red and the evergreen. The one producing the red berries loses most of its leaves in winter. Frequently a few of the lower branches have evergreen leaves. The twigs are green and somewhat angled. This is a somewhat straggling plant from 3 to 12 feet high. It grows in ordinary soil in the woods, but is also common in the moss on stumps and fallen tree trunks. The berries are small and are very bright red. They are rather acid, but are good in pies.

The foliage of the evergreen huckleberry is very attractive and is much used for winter decorations in houses. Most of the leaves are green, but beautiful shades of red are sometimes found. The flowers are rose color or nearly white. The berries are acid but are commonly eaten either raw or cooked.

Another broad-leafed evergreen shrub, *Pachistima myrsinites*, looks somewhat like the evergreen huckleberry. It is smaller, however, and its foliage is less attractive and its flowers and fruit are inconspicuous. It is here mentioned by its scientific name because it has no common name.

WOODY VINES

There are a number of woody vines in these woods. The honeysuckle is an opposite-leafed vine which climbs to the tops of the taller shrubs. It loses its leaves in winter. The trailing blackberry is a spiny evergreen

plant with whitish flowers. It trails over other low vegetation and over the ground. Its flowers are white and its fruit is edible.

The twin flower is an evergreen vine forming dense growths on the ground. Its flowers are showy and rather drooping. They are borne in pairs on erect stalks.

The tea vine is sometimes confused with this, but is readily distinguished by the odor of its leaves when crushed, also by the fact that its leaves are broader and its flowers much less conspicuous.

Kinnikinnik is a prostrate, diffusely branched, woody plant, rooting at the joints. It has white flowers and red berries. It is common in the more open places in the woods south of Camp Lewis. Its leaves are leathery and evergreen and are an official drug.

HERBACEOUS PLANTS

The list of herbaceous plants in these woods is necessarily incomplete, since it is based on a single visit made in March.

A strawberry is common in the open places. One of the common thistles is also found. A false dandelion, known also as cats-ear, is very abundant. It is readilly distinguished from the common dandelion by the fact that its leaves are somewhat hairy and have rounded lobes, while the common dandelion has smooth leaves with more angled lobes. Its flower stalks branch while those of the common dandelion do not.

A wild geranium is also common in the open places. It is a slow-spreading plant whose somewhat elongated fruits split at maturity into five parts, each part curling upward.

Common yarrow is also abundant. It may be distinguished from other plants of the region by the fact that its leaves are dissected into numerous small divisions, giving them an appearance that is sometimes described as

A virgin forest in Western Washington.

"fern-like." The plant is 1 or 2 feet high and has whitish or sometimes pinkish flowers.

Fire-weed is a conspicuous plant. The plant is 4 to 6 feet tall. In early summer it has numerous conspicuous rose-colored flowers along the upper part of the stem. In fall the pods split open and the numerous hairy seeds are distributed by the wind.

Rattle-snake plantain is very common in the humus in shady places. It is a very low plant having several thick evergreen leaves at its base. Its leaves are green and are much blotched with white. This will distinguish it from other plants of the region. It has small flowers on an erect stalk. The whole plant is not more than one foot high.

The field sorrel belongs to the dock group. Its leaves may be identified by the peculiar projection at each side of the base. They taste sour. The plant is not much more than one foot high, and has numerous very small reddish flowers.

Sanicle is common in the woods north of Camp Lewis. In winter it shows only a few leaves, these lying flat on the ground. They have rounded lobes. The flowers are numerous, yellow and very small. They are borne in clusters at the top of the plant.

The bitter cress found here may be recognized by the taste of its leaves. Its leaves are composed of several pairs of leaflets. The flowers are white and the pod is somewhat elongated.

Rice-root is one of the wild lilies. It has an erect leafy stem growing from a scaly bulb. It has distinctly lily-like flowers and produces a six-angled pod with numerous seeds.

Calypso is a small orchid with a showy terminal flower. It has one green leaf at the base and a few smaller scale-like leaves on the stem.

Coral-root is another orchid. It has no green leaves at all. Such leaves as are present are reduced to mere scales. The plant has a somewhat reddish appearance. Its roots are coral-like and are branched.

Fairy bells is a branched, leafy plant growing from running underground stems. The flowers are rather small and not very numerous. The parts of the flower are arranged in sixes. The fruit is a berry with 3 to 6 seeds.

At least three ferns are common in the woods south of the Camp. The brake is the commonest one. It is frequently six feet or more high and grows from a thick, tough underground stem. As it comes up in spring its growing tip is turned back and somewhat rolled in. The term "fiddle neck" is sometimes used to describe its appearance at this time. In summer it is the coarsest and least attractive of our ferns.

The Christmas fern has very attractive leaves, frequently 3 to 5 feet tall. They grow in clusters. They are evergreen. This is one of our most attractive ferns.

The licorice fern grows in moss on tree trunks and rocks. It is only rarely that it grows in soil. Its leaves have cinnamon-colored "fruit dots" on their backs. The stems grow in the moss and are yellowish. It tastes like licorice.

THE PRAIRIES

The forest mostly stops short at the edge of the prairies, its gravelly soil acting as a rather complete barrier to trees. Occasional firs are found, however, and there are also a good many oaks. There is only one species of oak found in the region and there is no other tree that is likely to be confused with it. In general the oaks tend to form a fringe around the edge of the prairie, next to the forest. The forest is evidently advancing slowly upon the prairies. This is evident from the fact that seedlings are found farther out than the older trees,

and is confirmed by the reports that the prairies were largely treeless when first seen by white men. The oak seedlings are usually found farther out in the prairie than the fir seedlings.

Two species of pine are also found—the yellow pine and the lodge pole pine. These may be distinguished from the fir and the hemlock by the fact that their leaves are in clusters. The lodge pole has two leaves in a cluster and the yellow pine has three. The lodge pole pine is a smaller tree than the yellow pine under usual growing conditions. The cones of the lodge pole pine are small and remain on the tree many years. The cones of the yellow pine are much larger and are frequently in clusters.

In spring these prairies are beautifully carpeted with flowers. In summer they are dry and barren. The soil is outwash gravel, about equally mixed with black powdery material. This accumulates sufficient moisture during the rainy winter to grow a profusion of early spring plants, but becomes so dry during the practically rainless summer that most of the vegetation withers.

A good many of the plants of these prairies occur also in the rather arid area east of the Cascade Mountains, though most of these do not range farther east, their distribution being mainly from California to British Columbia, on both sides of the Cascades. Among the smaller plants belonging to this list the following may be mentioned as characteristic examples: Goat chicory, lady's mantle, shining chickweed, everlasting, caraway, hedge parsley, blue lips, pretty fleabane, hawkweed, Indian consumption plant, wild cucumber, stonecrop, Menzies pink, fringed lace-pod, and death camas.

There are few species of trees on these prairies, but most of the trees and shrubs occurring belong to the list having the distribution above mentioned. These are yellow pine, white oak, choke cherry, and buck-brush.

There is also a considerable list of plants occurring on these prairies, but not elsewhere in Washington or Oregon. Among these are the sandwort, the shooting star, the dog-tooth violet, the herald-of-summer, the buttercup, the golden rod, and the blue violet.

A partial list of plants is appended. It is based on Piper's list and on several spring and summer visits by the writer, most of them to the prairies at points a few miles distant from the Camp Lewis site.

CAMP LEWIS PLANTS

I. Forests.

A. Trees:

1. Pseudotsuga taxifolia (Douglas fir)
2. Tsuga heteroyphylla (Western hemlock)
3. Quercus garryana (White oak)
4. Arbutus menziesii (Madrona)
5. Prunus demissa (Choke cherry)
6. Salix spp. (Willows)
7. Acer circinatum (Vine maple)
8. Juniperus scopulorum (Rocky Mountain juniper)

B. Taller Shrubs:

1. Corylus californica (Hazel)
2. Holodiscus discolor (Ocean spray)
3. Osmaronia cerasiformis (Indian plum)
4. Ceanothus sanguineus (Buck brush or red-root)
5. Amelanchier florida (Service berry)

C. Smaller Shrubs:

1. Gaultheria shallon (Salal)
2. Berberis nervosa (Common Oregon grape)
3. Berberis aquifolium (Shiny Oregon grape)
4. Pachistima myrsinites
5. Vaccinium parvolifolium (Red huckleberry)
6. Vaccinium ovatum (Evergreen huckleberry)
7. Chimaphilla umbelata (Pipsessewa)

D. Woody Vines:
1. Lonicera sp. (Honeysuckle)
2. Linnaea americana (Twin flower)
3. Micromeria douglasii (Yerba buena or tea vine)
4. Arctostaphylos uva-ursi (Kinnikinnick)
5. Rubus ursinus (Trailing blackberry)

E. Herbaceous Plants:
1. Fragaria sp. (Strawberry)
2. Hypochaeris radicata (False dandelion)
3. Carduus sp. (Thistle)
4. Geranium sp. (Wild geranium)
5. Achillea millefolium (Yarrow)
6. Peramium decipiens (Rattle-snake plantain)
7. Rumex acetosella (Field sorrel)
8. Sanicula manziesii (Sanicle)
9. Epilobium angustifolium (Fireweed)
10. Cardamine sp. (Bittercress)
11. Fritillaria sp. (Rice-root)
12. Calypso bulbosa (Calypso)
13. Disporum sp. (Fairy bells)
14. Corallorhiza sp. (Coral-root)

F. Ferns:
1. Polystichum munitum (Christmas fern)
2. Polypodium occidentale (Licorice fern)
3. Ptendium aguilinum (Brake)

G. Mosses:
1. Polytrichum juniperinum
2. Dicranum fuscescens
3. Eurynchium oregonum
4. Hylocomium splendens

H. Liverworts:
1. Porella sp.

I. Lichens:
1. Usnea sp.
2. Cladonia sp.
3. Peltigera sp.

J. Fungi:
1. Fomes sp. (Woody bracket fungus)
2. Polyporus sp. (Leathery bracket fungus)

II. Prairies.

Pinaceae—
Pinus contorta (Lodge pole pine)
Pinus ponderosa (Yellow pine)
Pseudotsuga mucronata (Douglas fir)

Melanthaceae—
Zygadenus venemosus (Death camas)

Liliaceae—
Erythronium giganteum (Dog-tooth violet)
Fritillaria capitata (Rice-root)
Hookera coronaria (Fool's onion)
Hookera hyacintha (Fool's onion)
Hookera pulchella (Fool's onion)

Smilaceae—

Orchidaceae—
Iris tenax (Flag)

Fagaceae—
Quercus garryana (White oak)

Caryophyllaceae—
Arenaria tenella (Sandwort)
Silene menziesii (Menziis pink)
Stellaria nitens (Shining chickweed)

Ranunculaceae—
Ranunculus orthorhynchus (Buttercup)

Papaveraceae—
Platystigma oreganum (White cream-cups)

Cruciferaceae—
Athysanus pusillus
Thysanocarpus curvipes (Fringed lace-pod)

Orassalaceae—
Sedum douglasii (Stone crop)

Saxifragaceae—
- Heuchera cylindica (Alum-root)
- Lithophragma parviflora

Rosaceae—
- Alchemilla arvensis (Lady's mantle)

Amygdalaceae—
- Prunus demissa (Choke cherry)

Leguminaceae—
- Lotus decumbens (Bird-foot trefoil)
- Lotus gracilis (Bird-foot trefoil)
- Lupinus albicaulis (White-stemmed lupine)
- Lupinus lepidus (Lupine)
- Trifolium hallii (Clover)
- Trifolium tridentatum (Clover)

Rhamnaceae—
- Ceanothus sanguineus (Buck brush)

Malvaceae—
- Sidalcea campestris

Violaceae—
- Viola howellii (Blue violet)

Onagraceae—
- Boisduvalia stricta
- Godetia amoena (Herald-of-summer)
- Godetia quadrivulnera (Farewell-to-spring)

Umbellaceae—
- Carum gairdneri (Caraway)
- Caucalis microcarpa (Hedge-parsley)
- Lomatium utriculatum (Hog-fennel)
- Lomatium nudicaule (Indian consumption plant)
- Lomatium triternatum (Hog-fennel)

Primulaceae—
- Dodecatheon latifolium (Shooting-star)

Polemomiaceae—
- Gilia gracilis
- Gilia tenella

Hydrophydaceae—
Polemomium micranthum (Greek valerian)

Boraginaceae—
Pectocarya penicillata

Scruphulariaceae—
Collinsia grandiflora (Blue-lips)
Orthocarpus attenuatus (Owl clover)
Synthyris rotundifolia
Tonella collensioides

Valerianaceae—
Valerianella congesta (Common salal)

Lobeliaceae—
Githopsis specularioides
Heterocodon rariflorum

Compositaceae—
Agoseris heterophylla (Goat chicory)
Antennaria howellii (Everlasting)
Balsamorhiza hookeri (Balsam root)
Balsamorhiza deltoidea
Crocidium multicaule
Erigeron speciosus (Pretty fleabane)
Grindelia integrifolia (Gun-weed)
Hemizonella durandi
Hieracium scouleri (Hawkweed)
Psilocarphus elatior
Scorzonella oregana (Wild cucumber)
Senecio fastigiatus (Ragwort)
Sericocarphus rigidus (White-topped aster)

This account of Camp Lewis plants is not written for botanists. Those interested in these plants from the technical standpoint are referred to the following books:

1. Frye and Rigg—Northwest Flora. (Out of print, but copies may be consulted in public libraries.)

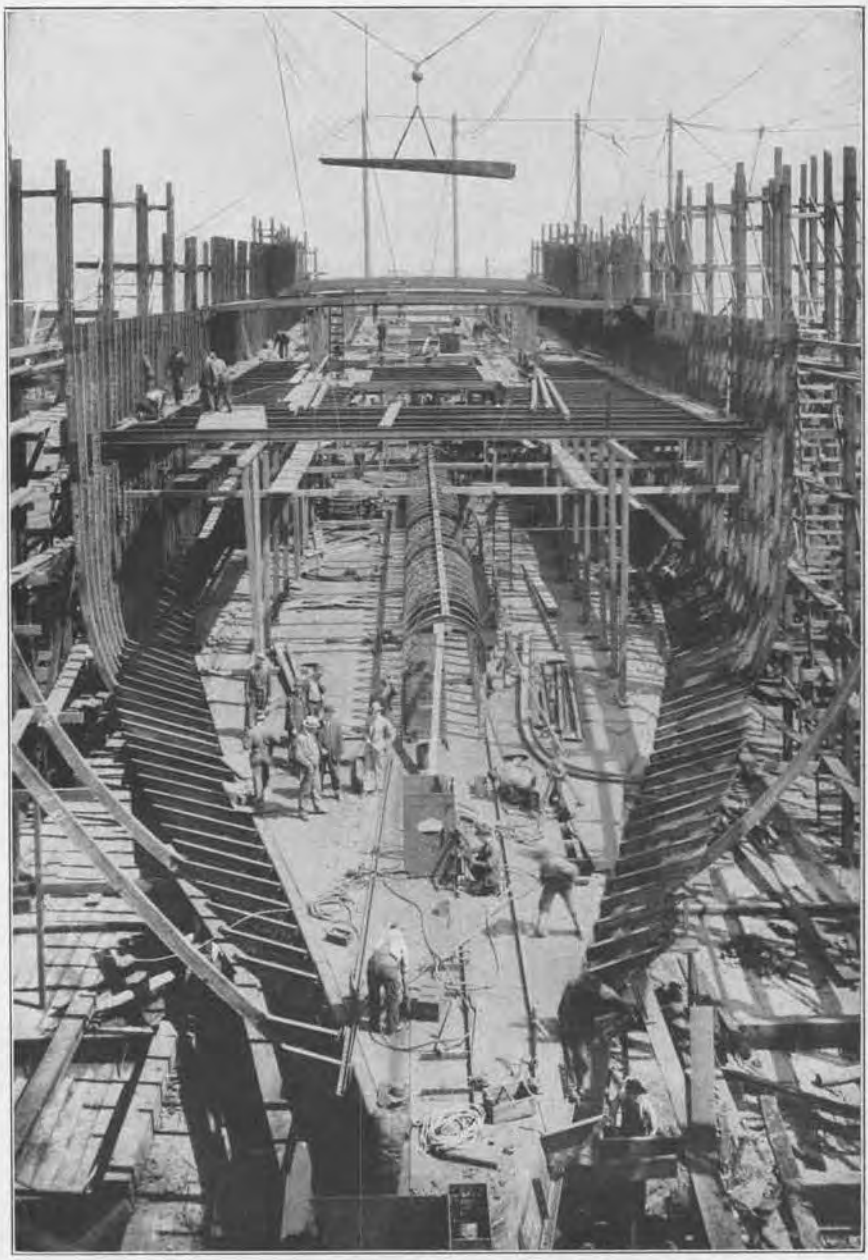
2. Frye and Rigg—Elementary Flora of the Northwest. American Book Company.

3. Frye and Jackson—The Ferns of Washington. University Book Store, University Station, Seattle.

4. Howell—The Flora of Northwest America. (Reported to be out of print, but copies may be consulted in public libraries.)

5. Piper—Flora of Washington, Volume XI. Contributions from the United States National Herbarium. (Out of print, but copies may be consulted in public libraries.)

6. Piper and Beattie—Flora of the Northwest Coast. State College, Pullman, Washington.



Ship construction in one of the Puget Sound Shipyards.

—By courtesy of Webster & Stevens, Seattle

CHAPTER VIII

THE RELATION OF THE GEOLOGY OF WESTERN WASHINGTON TO MEASURES OF MILITARY DEFENSE

During the scores of years of peace, attention was turned toward civil rather than military questions. In consequence of this, general knowledge of the relation of Washington's physical features to the plausible routes of invasion which an enemy would pursue, and of the conditions which the topography along these routes afford for defense, is more or less vague. It seems appropriate, therefore, to call attention to these matters and discuss in a general way the relation of the geological features of Washington to war strategy.

WESTERN WASHINGTON AS A PRIZE OF CONQUEST

If war were to be brought to the very doors of the United States, western Washington would likely face hostile attack, for on the one hand it is the gateway to the Great Northwest, and on the other to Alaska, Siberia and the Orient. Eight transcontinental railways terminate in western Washington, four of them entering on their own lines and two by water. These, with ocean-going vessels, have developed a trade which in 1917 totaled more than $376,000,000, making the Port of Puget Sound the sixth in importance in the entire country. As has been mentioned hereinbefore, Puget Sound is a harbor unsurpassed in the world. Its natural protection, its great depth of water, its connection at Seattle with a large fresh-water harbor, the absence of shoals, the low cost of maintenance of the docks, the freedom of entrance of all vessels into the harbor under their own steam and pilot—all of these factors give it an enviable rank and insure it unlimited possibilities of trade in the future.

This alone would make the conquest of western Washington an important one. But there are fundamental re-

sources to go with it. Perhaps the first of them is the mild climate which enables industrial activity the year round. Then there are the great forests. Washington ranks first in the output of lumber, and over 40 per cent of the public wealth of the state comes directly from this industry. The great bulk of the forests grows west of the Cascades where the rainfall is adequate. (Plate IX is a scene in one of Washington's forests.) About four hundred billion board feet is estimated now to remain uncut, with a value in excess of four hundred billions of dollars. Scientific reforestation will make, in time, this means of resource endless.

Another resource having direct relation to the climate and the topography of this state is the water-power of the mountains. In official reports, it is estimated that there is an amount of energy in the streams of Washington equivalent to 4,932,000 horse-power, which is greater than the water-power of any other state in the Union. Thus far only about 500,000 horse-power have been developed. At a time when industries are entering an epoch of accelerated activity, and when the power will be increasingly electrical, the water-power resources of this state have become of immense value.

All of these resources, together with others, such as the fisheries, agricultural lands, mineral deposits, shipbuilding, and manufacturing, make western Washington an area of wonderful opportunity, and a prize-capture for an enemy-power.

PROBABILITY OF ATTACK ON PUGET SOUND

In a conquest of western Washington, the capture of the Puget Sound country would be most vital to the enemy. Although the counties adjoining Puget Sound comprise only about one-fifth of the area of the state, yet they contain one-half of the total population. Here are located Seattle, the metropolis of the Northwest, with its

population of 348,639; Tacoma, 112,770; Bellingham, 32,985; Everett, 35,486; Olympia, 6,996; and many small urban towns.* Seattle and Tacoma are the terminals of the transcontinental railroads and the steamship lines, and also the centers of most of the shipbuilding plants (Plate X) which are of such necessity to the nation at this time, and of the large lumber industry, flour mills, packing-houses, and other essential industries.

NATURAL DEFENSES OF WASHINGTON

Washington's mountain ranges constitute two lines of natural defense. The first or most western line is the Olympics and the Willapa Hills, and the second line is the Cascade Range. In the case of the Olympics, they constitute a barrier of the first order for nearly 60 miles of coast-line. Rising to heights of 5,000 to 8,000 feet above sea-level with a most rugged surface, mantled with heavy snow-fall in winter, and fringed on the north, west, and south with a narrow sand and gravel plain, covered by an impenetrable forest that runs well up on the mountain slopes, these mountains effectually safeguard their part of the coast.

The Willapa Hills to the south of Grays Harbor and the Chehalis River Valley have only moderate qualifications in regard to their height, for they range from less than 1,000 to 3,000 feet high, but they have a very irregular surface and heavily timbered slopes which would greatly retard an advancing army. Indeed, little advantage would there be to the enemy to gain entrance to Willapa Harbor, even if he could, for any further advance would have to be made along the single highway which crosses the mountains, or along the two railroad lines. In any case the roadways are narrow, and prominent hills of great defensive value command them. Al-

* These populations were quoted from estimates of the Census Bureau, July 1, 1916, with the exception of Olympia, whose population is based on the census returns of 1910.

though not a barrier of the first order, the Willapa Hills could easily be made impassable by a relatively small but well equipped army. Then 45 additional miles of coast would be protected.

The Cascade Mountains constitute the second line of defense for all of the country to the east of them, and a barrier to a flanking attack of the Puget Sound area, except by a long circuitous route through the Columbia River Gorge, to intercept the railroad lines which supply western Washington. This possibility will be considered a little later. There are five passes which might be used for the bringing of supplies from the east: Stevens Pass, between the headwaters of the South Fork of the Skykomish River and Nason Creek, which has an elevation of 4,061 feet above sea; Snoqualmie Pass, between the headwaters of the South Fork of the Snoqualmie River and the Yakima River, 3,010 feet; Stampede Pass, between the headwaters of the Green and Yakima Rivers, 3,925 feet; Naches Pass, between the headwaters of Clearwater River and the Middle Fork of Naches River, 4,988 feet; and the Columbia River Pass which is cut down nearly to sea-level. (These and other features involved in this discussion are shown on Plate II.) Three of the transcontinental railroads use three of the passes for crossing the mountains; the Great Northern, Stevens Pass; the Chicago, Milwaukee & St. Paul, Snoqualmie Pass; and the Northern Pacific, Stampede Pass. The Spokane, Portland & Seattle Railway and the Oregon-Washington Railway and Navigation Company follow the Columbia River. One automobile highway, the Sunset Highway, has been completed across the mountains at Snoqualmie Pass, and this is improved nearly the entire distance from Seattle to Ellensburg, with a maximum grade of five per cent. Another is nearly completed across Stevens Pass on a maximum grade of about seven per cent, which will connect with the Pacific Highway at

Everett and the Sunset Highway at Wenatchee. Thirty-two miles of this road through Snohomish County is on concrete pavement. A third road, the McClellan Pass Highway, which will eventually cross and connect the Pacific Highway at Auburn with the Inland Empire Highway at Yakima on a relatively low grade, lacks about 16 miles of being completed near the summit; elsewhere it is surfaced with gravel or crushed rock most of the distance. Another road, partially completed, will in time be continued up the western flanks of the mountains along the North Fork of the Cowlitz River to Carlton Pass and thence to the McClellan Pass Highway at the mouth of Bumping River. A highway follows the north side of the Columbia River from Vancouver eastward to a few miles beyond Stevenson, and ends at the rock cliffs of the Columbia. When the gaps in this road between Stevenson and Maryhill are completed, connection by automobile may then be made, by way of Goldendale, with the Inland Empire Highway west of Grandview, in Yakima County. The Columbia River Highway on the south side of the Columbia River extends from the western coast of Oregon into eastern Oregon and connects by ferry with points across the river at The Dalles.

All of the highways across the mountains would be an aid to the railroads during a crisis, except during the winter, and then the highways along the Columbia River would be of exceptional value. It would seem that all proposed highways crossing the mountains should be completed at the earliest possible date, for otherwise what has been partially built would be of little or no avail. During heavy snowslides or washouts in the mountains, the Spokane, Portland & Seattle Railway and the Oregon-Washington Railway and Navigation Company's line through the Columbia River Gorge would be overburdened with traffic.

STRATEGIC ROUTES OF ATTACK

If the enemy were to succeed in overpowering our navy, the routes of invasion would then be determined primarily by topography. We have seen that the Olympic Mountains are impassable and the Willapa Hills would be difficult for a large army to cross in the face of fire. It is obvious then that if there are any lines that would offer less resistance, they would likely be attempted. Of these there are three: (1) The Strait of Juan de Fuca to Admiralty Inlet, the trunk passage to Puget Sound; (2) Grays Harbor and the Chehalis Valley; (3) the Columbia River to the Cowlitz River Valley, thence north across the low divide at Napavine to the Puget Sound country. (These are indicated on Plate II.)

(1) THE STRAIT OF JUAN DE FUCA AND ADMILALTY INLET

From the open ocean to the beginning of Admiralty Inlet is a distance of nearly 90 miles; from Port Townsend, which commands the head of Admiralty Inlet, to Seattle about 40 miles; and to Tacoma about 28 miles farther. The Strait has a width of 12 to 15 miles, the passage at Port Townsend about four miles, and the Inlet on the east side of Maury Island two miles.

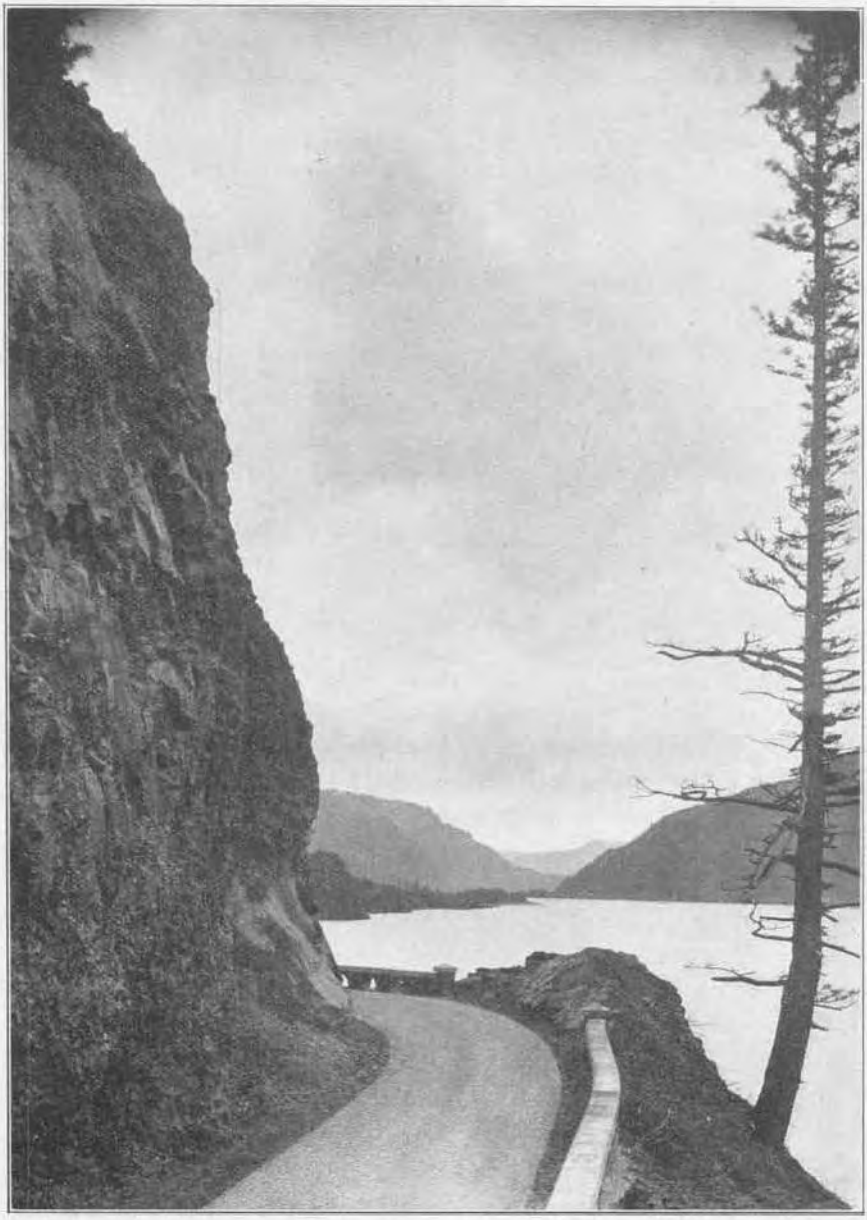
Most of these waters are deep. At the mouth of the Strait they are about 900 feet deep, and in going eastward they gradually shallow until at the passage east of Port Townsend they are about 240 feet in depth. From here south, along Admiralty Inlet, they cease shallowing and for practically the whole distance to Tacoma they exceed a depth of 300 feet. Indeed, off Pt. Jefferson, they reach a depth of a little over 900 feet, and at the entrance to Seattle's harbor, nearly 600 feet.

Of course, without previously prepared defenses of modern artillery, mines, and fighting ships, this would be the quickest way to capture the whole Puget Sound country. This in itself would invite a surprise attack

three geological factors would have to be taken into account, namely: The depth of water, the tides, and the kind of material in which the anchors for the mines would be placed. The depth has already been stated, and this might be a determining or limiting factor as to what type of mines could be used. The ebb and flow of the tides in Puget Sound are rather strong, and in the narrower passages they are especially so. Free floating mines would, therefore, be too dangerous to our own necessities of shipping within the Sound to permit their use. Anchoring would be resorted to, and whether they should be anchored from the sides of the channels or the bottom would depend on whether or not low tide would make them visible. This raises the question as to the character of the materials in the sides and bottom of the channels, in which the anchors would have to be placed. Chart 6400 of the Coast and Geodetic Survey shows that mud, sand, and gravel underlie most of the Sound, and that there is very little solid rock, except at the entrance to Admiralty Inlet, east of Port Townsend, and in the passages of the San Juan Islands and at a few other points, where the bottom is described as rocky. Whether the sand is in some places "quick-sand" and incapable of holding the anchors is a factor that would have to be determined.

The depth of Puget Sound would make feasible the use of submarines in addition to the other types of defenses which the Sound and bordering cliffs afford.

Intercourse between the land bases during an attack by water would be quite possible by means of the present railways and highways. The Great Northern Railway from Seattle to Everett follows the coast along the foot of the cliffs. If the time should come that this would be under fire of the enemy, the Northern Pacific Railway and Interurban line of the Pacific Northwest Traction Company could be resorted to. The defenses along the



View of the Columbia River Gorge, from Mitchell Point.

—By courtesy of Weister Co., Portland

three geological factors would have to be taken into account, namely: The depth of water, the tides, and the kind of material in which the anchors for the mines would be placed. The depth has already been stated, and this might be a determining or limiting factor as to what type of mines could be used. The ebb and flow of the tides in Puget Sound are rather strong, and in the narrower passages they are especially so. Free floating mines would, therefore, be too dangerous to our own necessities of shipping within the Sound to permit their use. Anchoring would be resorted to, and whether they should be anchored from the sides of the channels or the bottom would depend on whether or not low tide would make them visible. This raises the question as to the character of the materials in the sides and bottom of the channels, in which the anchors would have to be placed. Chart 6400 of the Coast and Geodetic Survey shows that mud, sand, and gravel underlie most of the Sound, and that there is very little solid rock, except at the entrance to Admiralty Inlet, east of Port Townsend, and in the passages of the San Juan Islands and at a few other points, where the bottom is described as rocky. Whether the sand is in some places "quick-sand" and incapable of holding the anchors is a factor that would have to be determined.

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south side of the Strait of Juan de Fuca would have to be supplied by boats, chiefly, and supplemented by the Olympic Highway from Olympia to Port Townsend, which has been graded and surfaced for the greater part of the distance.

Climatic Factors

Certain climatic factors might have an important part in the defeat or success of the enemy's naval forces. This is also true of any land operations that would take place. The climate of western Washington and the causes for it have been discussed in Chapter I, but we will recall here only the points of vital importance to our topic. The year is divided into a wet and a dry season. The wet season comes in winter and the dry season in summer. Generally during the summer the skies are clear, and cloudy days are few. In winter, clear days are the exception. Beginning in October, the mornings are foggy, and the fogs gradually become heavier, morning after morning, until the rains begin. These fogs would aid in giving cover to an enemy in a surprise attack. Fogs are fairly prominent in the spring, but not so much as in the fall. Snowstorms would also give aid to the enemy, but they are so uncommon and undependable as to give little concern.

During the cloudy days of winter, airship patrol would be more or less handicapped. This would perhaps be a greater disadvantage to the enemy than to our forces, for his observations necessarily would have to be over a larger and less familiar area than ours.

On land, the strength of the roads to withstand heavy traffic would also be much less in winter than in summer, because of the frequent rains. Floods are also more frequent and bridges are more likely to be unsafe or destroyed. The wide bottom lands of the Puyallup Valley, Duwamish Valley, Snohomish Valley, Stilaguamish Valley, and the La Conner Flats of the Skagit River are

sometimes completely inundated, and transportation is cut off for days at a time. If this were to happen during an attack on Puget Sound it would be a very serious matter and the construction of pontoon bridges would have to be resorted to.

(2) THE GRAYS HARBOR AND CHEHALIS VALLEY GATEWAY

This gateway lies betwen the Olympics on the north and the Willapa Hills on the south. Grays Harbor owes its east-west elongation to the fact that a lowering of the land area during pre-historic times permitted the sea-water to enter the lower portion of the Chehalis River Valley as far eastward as the present site of Aberdeen. The bars or spits at the entrance are composed of sand which has been brought by shore currents and thrown up by the waves. These provide a protection to the harbor during severe ocean storms, but the constant shifting of the material by the shore currents threatened some years ago to close the harbor. To prevent this jetties were built. Silt, sand, and gravel, brought down by the Chehalis River, has also tended to make the harbor shallow, so that frequent dredging is necessary to keep a channel open for large ships. In some places this channel is but 20 feet deep and comparatively narrow, and elsewhere the sand and mud bars come nearly to the water's level.

With such a situation, Hoquiam, situated 12 miles from the entrance, and Aberdeen, four miles farther, are much safer and more easily protected than if the harbor were deep enough to give the invading fleet free play. Added to these difficulties is the fact that several miles of low swampy land, covered with forests, intervene between the western coast and the hill region to the east, both on the north and south sides of the entrance. This would handicap the landing and use of troops. A railroad right-of-way on the north side from Moclips to the harbor and a railroad and highway on the south side would aid in defense.

Beginning at a point about five miles west of Hoquiam, a cliff escarpment overlooks the water's edge and continues up the valley of the Chehalis River on both sides, except where broken by tributary valleys. Many points along the way rise 300 feet and higher above the valley flat and the railroads and highways below, thus giving a commanding position over any situation in the valley. Most of these hills are wooded. It is true that the width of the valley, about two miles, would be somewhat in the enemy's favor, but on the other hand its marshy character and the absence of roads except along the foot of the bluffs would seem to react to any advantage that the width of the valley might give.

At Elma, admitting that the enemy thus far might have overcome resistance, he would have to choose between two possibilities: (1) to proceed northeast over the low summit north of the Black Hills toward Olympia, Camp Lewis and Tacoma, or (2) to continue along the Chehalis River to Gate or Grand Mound, and thence north toward Olympia and northeast toward Camp Lewis and Tacoma. (See Plate II.) The first has the advantage of the shorter distance and of the Olympic Highway, but a considerable part of the distance is through timber. The second has the advantage of a wider valley and a more open country beyond Gate. But both would be at the disadvantage of the strategic positions of defense offered by the Black Hills which lie between and which rise to an elevation of 1,000 to 1,500 feet above sea-level.

The distance from Aberdeen, the most eastern point of Grays Harbor, to Olympia, by way of the shorter route, is 55 miles. Camp Lewis lies about 17 miles farther. An enemy would hardly be attaining any of his ultimate aims until he could reach a point within striking distance of Camp Lewis.

At all events, it is clear that the topography along the Grays Harbor and Chehalis River route offers many excellent positions for successful defense.

(3) THE COLUMBIA RIVER-COWLITZ VALLEY ROUTE

From the mouth of Columbia River to the Cowlitz Valley is about 65 miles; from the mouth of Cowlitz River to Olympia by air-line is another 65 miles.

The Columbia River is broad for some distance above its mouth, due to the same subsidence of the land area which made Grays Harbor. For 20 to 25 miles its width ranges from 4 to 10 or 12 miles, and for the remainder of the distance to the Cowlitz River its width averages one mile or more. The upland on either side is high and breaks with many precipitous bluffs to the river below, thereby providing excellent natural positions for defense.

The valley of the Cowlitz River is relatively narrow and crooked. The railroad and the Pacific Highway hug the base of the east valley-wall most of the way. Any attempted invasion along this line would be in the face of a terrific resistance, if the admirably situated bluffs were at all adequately equipped with batteries.

No highway runs continuously from the Cowlitz River to the coast. The transportation of troops along the Columbia would have to be either by water or along the railroad line or the Columbia Highway on the south side, taking chances on crossing by building a long pontoon bridge, if possible, or by boats, or by both. There is no bridge short of Vancouver, 25 miles to the south. In either case such crossing would likely be under the fire of our forces from the commanding bluffs.

This route of invasion obviously would present many disadvantages which probably exceed those of the Grays Harbor and Chehalis Valley.

COLUMBIA RIVER, THROUGH THE CASCADE GORGE, TO THE COLUMBIA PLATEAU

An invasion along the Columbia River, passing eastward through the gorge of the Cascade Mountains to the Columbia Plateau, and intercepting the transcontinental railways which supply the Puget Sound Basin, is a

strategic move that might possibly be attempted. The distance, however, is great. From the mouth of the Columbia to the nearest point of interception at Pasco is about 400 miles, but a further traverse of a hundred miles or more would be necessary to complete the capture of all of the railroads. The total would seem prohibitive. In addition to the problem of distance would be the difficulty of passing through the Columbia Gorge. A short distance east of Vancouver are the foothills of the Cascades. These pass rapidly into relief of mountainous proportions, and both walls of the Columbia, high and projecting, are wonderfully adapted to military defense. (Plate IX.) If any route can be made impassable by modern batteries, this one undoubtedly could be.

After considering these geographical and geological conditions, it would seem that we possess the first essentials for blocking an invasion by this route.

SUMMARY AND GENERAL CONCLUSION

The presence of the Olympic Mountains and the Willapa Hills along the western coast serve as natural barriers in guarding the greater part of the coast-line. They leave but three plausible entrances for invasion, and these are of such a topographical character that they can easily be turned into lines of adequate defense. The existence of the Cascade Range to the east of the Puget Sound country would prevent a flank attack, except by a long forbidding circuitous route through the Columbia Gorge.

With such a topography, so admirably adapted for defense against hostile invasion, it would seem that the rest of the question of a successful resistance would lie with the Government.

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