THE BIENNIAL REPORT

OF THE

BOARD OF GEOLOGICAL SURVEY

OF THE

STATE OF WASHINGTON

FOR THE TERM

1909-11
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LETTER OF TRANSMITTAL

To the Legislature of the State of Washington:

The board of geological survey transmits herewith its biennial report for the term 1909-11, as required by statute.

Respectfully submitted,

M. E. Hay, President;
J. G. Lewis, Secretary;
T. F. Kane,
E. A. Bryan.
GENERAL PURPOSES OF SURVEYS.

TOPOGRAPHICAL SURVEYS.

The Topographical Map.—A topographical map is designed to represent the form and slope of the surface of the land and the elevation of all points above sea level. The positions of streams, lakes and ponds, public and private roads, towns and railroads, are shown in their correct relative positions. The map indicates boundaries of counties and the position of section lines wherever there have been land surveys. In the making of the necessary surveys for such maps permanent marks, consisting of iron posts, copper bolts or tablets, are set at frequent intervals to mark the exact elevation above sea level. To serve as datum points for further spirit level work, for engineering investigation, and for such public works as canals, water supply, railway and other public or private surveys.

The topographic map is made with such accuracy and in such detail that it is useful to almost every citizen. In a new state that is inviting immigration, the map is valuable in order to show the location of desirable farm lands and the general character of the country. From it the position of streams and lakes may be seen and the possibilities of these for purposes of water power or irrigation may be largely determined. The topographic map facilitates the construction of railroads and wagon roads, since upon it available routes and grades may be laid out without the preliminary surveys ordinarily necessary for improvements of this kind. In our public schools such a map is indispensable in that it places before the children truthful maps of our commonwealth, instead of those that are glaringly inaccurate.

In the making of topographic maps the areas selected for survey are defined by lines of latitude and longitude and are called quadrangles. Each quadrangle, and the topographic map which represents its features, is designated by the name
of the most prominent place or topographic feature included within it. The scale generally used in map construction is about two miles to the inch, and on this scale the area embraced in a quadrangle is about eight hundred square miles. In Washington the topographic map when completed will comprise, in round numbers, ninety sheets, complete and fractional, of which about twenty-five have already been surveyed.

HYDROGRAPHICAL SURVEYS.

A hydrographic survey is an examination of the water resources of the state or parts thereof, in order to determine the possible supplies of water suitable for domestic purposes, power plants, or for use in irrigation. The water supply of the state is of more importance to the life and pursuits of the people than any other natural resource, as the health and economic development of every community are directly dependent upon the character and volume of the available supply.

Hydrographic surveys have to do with both the surface and underground waters of the state. The rivers are used for domestic and industrial supplies, power purposes, navigation and irrigation. In order that there may be no useless expenditures in the development of these resources, studies are made to determine the amount of water that is available throughout the various seasons of the year and throughout a series of years. Along the principal streams of the state gaging stations are maintained in order to secure records of flow which indicate the fluctuations that might be expected in the quantity of the water. Profiles or level lines along the rivers are run in order to determine the possibilities of storage, and to secure data for the determination of available water power.

Investigation of underground water supplies is equally as important as in the case of surface waters. This work includes a determination of the areas that are underlaid by water-bearing strata, of the depths at which these strata occur, and of the amount and quality of water that may be obtained. A knowledge of the existence of water-bearing strata is very necessary, not alone for the purpose of irrigation, but in some parts of Washington settlement is well-nigh impossible because not even enough water for domestic purposes has as yet been obtained.

GEOLOGICAL SURVEYS.

Geological surveys have been organized in nearly all the states of the Union, and in some of the older states they have been continuously active for over fifty years. In most states
they are regular departments of the state government, and receive definite financial support in the way given to every other bureau or department. They are usually in charge of a board of three or five men, who direct the work of the survey, and who are responsible for its management.

The general purpose of a geological survey is to disclose and make known the mineral resources of a state. Under such heading would naturally come the metalliferous deposits, coal fields, iron ores, building stones, soils, clay beds, road metals, water power, and kindred subjects. The field work of a survey consists in mapping accurately the locations of all such valuable products as those just mentioned, and determining the areal extent and quantity of each. The office work consists of careful tests and analyses of all samples collected in the field, and the preparation of reports which describe fully the mineral resources under investigation. The reports and maps when published are valuable alike to the citizens of the state and to outside capitalists and investors. Surveys examine and test those minerals, ores and rocks that are but little known and determine whether or not they are of economic value. They also suggest ways of preventing wastes in mining operations, and assist in all ways to conserve the natural resources. Surveys are potent factors in making available valuable information regarding the mineral resources of the state, which knowledge may be utilized by the poorest citizen as well as the wealthiest corporation.

**PRINCIPAL FEATURES OF STATE LAWS PROVIDING FOR SURVEYS.**

The law establishing a state geological survey was passed by the legislature at the session of 1901. As set forth in the various sections of the law, the principal objects of the measure are as follows: An examination of the economic products of the state, such as gold, silver, copper, lead, and iron ores, as well as building stones, clays, coal, and all mineral substances of value; an examination of the soils, road-building material, water supplies, artesian wells, water power, etc.; an examination of the physical features of the state with reference to their practical bearing upon the occupations of the people; the preparation of special geographic and economic maps to illustrate the resources of the state; and the publication from time to time of the results of the work of the survey in reports and bulletins, and the dissemination of these among the people.

At the session of 1903 the legislature amended the above law,
by providing for co-operative work between the federal and the state bureaus engaged in geological survey work. The amendment authorized the state board of geological survey to make provisions for topographic, geologic, and hydrographic surveys of the state, in co-operation with the United States geological survey, in such manner as would be of the greatest benefit to the agricultural, industrial and geological requirements of the state. The amendment carried a proviso that the director of the United States geological survey should agree to expend on the part of the United States upon such surveys a sum equal to that expended by the state.

At the last session of the legislature (1909) the work of the state geological survey was provided for (except as noted below) by a law having these provisions:

Section 1. In order to complete the topographic map of the State of Washington, and for the purpose of making more extensive stream measurements, and otherwise investigating and determining the water supply of the state, there is hereby appropriated the sum of thirty thousand dollars ($30,000), for co-operation with those branches of the United States geological survey engaged in this work. This appropriation, however, shall be contingent upon, and not become available unless the United States government apportions an equal amount to be expended for similar purposes within the state. The board of geological survey is hereby authorized and directed to enter into such agreements with the director of the United States geological survey as will insure that the said surveys and investigations be carried on in the most economical manner, and that the maps and data be available for the use of the public as quickly as possible.

Sec. 2. In order to enable the board of geological survey to carry on investigations authorized by law, there is hereby appropriated the sum of twenty thousand dollars ($20,000) for the use of said board in the geological and other investigations provided for in chapter 165 of the Session Laws of the State of Washington for 1901, and as amended in chapter 157 of the Session Laws of 1903.

Sec. 3. In order to carry out the purposes of this act, all persons employed hereunder are authorized to enter and cross all lands within the state: Provided, That in so doing no damage is done to private property.

Sec. 4. The sum of fifty thousand dollars ($50,000) herein appropriated for the purposes specified in this act shall be available in the following manner: One-half during the first twelve months after this act takes effect, and the unexpended balance during the second twelve months after this act takes effect.

The legislature at its last session also provided that the board of geological survey should cause to be made a field examination and survey of the state, for the purpose of ascertaining the existence and location of suitable road-making materials with necessary analyses and laboratory tests. The result of such surveys and laboratory tests were to be set forth in proper reports covering the entire matter. (Chapter 226, Session Laws, 1909).
REPORT FOR 1909-11.

ORGANIZATION.

In accordance with the law, and at the call of the governor, the following gentlemen met upon April 16, 1909, at Olympia, and organized the board of geological survey: Governor Hay, State Treasurer Lewis, President Kane of the State University, and President Bryan of the State College. The board elected Governor Hay as its chairman, and Treasurer Lewis as its secretary. Professor Henry Landes of the State University was elected state geologist, and Professor Solon Shedd of the State College was elected assistant state geologist. Governor Hay was authorized to sign the necessary agreements with the officials of the United States geological survey, arranging for co-operative work in topography and hydrography, as provided by law. At a subsequent meeting plans for the more purely geological work were arranged as follows: A survey of the coal fields of the state, beginning with those in King county; a report upon the materials of the state suitable for making Portland cement; surveys and reports upon some of the metal mining districts; an economic soil survey of the logged-off lands; and a report upon the rocks of the state suitable for road-building purposes.

TOPOGRAPHICAL SURVEYS.

The accompanying progress map indicates the locations of the quadrangles surveyed, under co-operation with the United States geological survey, during this biennium. In selecting the quadrangles for survey the board chose those areas where the demand for the maps was very great and where they were most likely to be used to advantage.

In Central Washington, immediately east of the Columbia river, and lying between the Great Northern and Chicago, Milwaukee & Puget Sound railways, an area of 1,025 square miles has been entirely surveyed and engraved copies of the maps are about ready for distribution. In this area there are five quadrangles, viz: Quincy, Winchester, Moses Lake, Beverly, and Red Rock. Each quadrangle was mapped on a scale of two-thirds of a mile to one inch, with contour intervals or level lines
every twenty-five feet. This region lies in arid Washington, where irrigation must be followed to insure the greatest economic development. Topographic surveys were made as the first necessary step to secure the reclamation of this dry belt by irrigation.

The Mount Vernon quadrangle, having an area of 662 square miles, was surveyed in the summer of 1909. The map has already been engraved and is now ready for distribution. The map was prepared on a scale of about one and one-half miles to the inch, with contour intervals or level lines every fifty feet. In this area are some of the richest agricultural lands of the state.

The survey of the Cedar Lake quadrangle was begun in the summer of 1910, and it has been about one-fourth completed. The map will be made on a scale of approximately one and one-half miles to the inch, with contour intervals or level lines every one hundred feet. The board chose this quadrangle for survey in order to assist in the development of the great water resources of the area. The quadrangle contains snow-fields, glaciers, lakes, and many streams, and the waters from these will be invaluable for municipal and power purposes to the growing cities of Puget Sound.

Copies of the topographic maps may be purchased of the United States geological survey, Washington, D. C., at five cents each.

HYDROGRAPHICAL SURVEYS.

The water resources have been investigated jointly by the federal and state surveys, each party assuming one-half of the expenses. The chief object has been to obtain accurate information of the amount of water that could be depended upon for irrigation and for power purposes. All of the water that can be secured by storage that is tributary to arid Washington will soon be needed for irrigation. The rapid industrial development of Western Washington demands the continued utilization of the available water power. The detailed investigations have been along two lines, viz., establishment of gaging stations, and running of surveys for the determination of river profiles.

Gaging Stations.—As shown on the progress map, gaging stations are in operation upon a large number of streams of the state. At each station the daily discharge of the stream is obtained and the amount of water available for any purpose made
known. The gage readings are particularly valuable at the times of minimum flow, which occur on some Washington streams in mid-winter and upon others in mid-summer.

River Profiles.—In the summer of 1909 profiles were run along five rivers at the southern end of the Cascade range, viz., the Klickitat, White Salmon, Little White Salmon, Lewis and Toutle rivers, with some of their principal tributaries. At the same time the profiles were being made discharge data were obtained in order to know the average low water flow of the streams at various points along the lines of the survey. On the bases of the measured fall of the streams and their discharge, the total available horse-power of the rivers has been estimated. These results have been published in a report entitled, "Water Powers of the Cascade Range, Part 1, Southern Washington." Copies may be had upon application to the United States geological survey, Washington, D. C.

In the summer of 1910 profiles were run along a number of rivers directly north of those surveyed in 1909. These were the Cowlitz, Cispus, Nisqually, Puyallup, Carbon and White rivers on the west slope of the range, and the Yakima, Naches and Tieton rivers on the east slope of the range. Careful measurements are now being made along these streams to determine the discharge of each. This work will be completed early in 1911, and from the stream gradients and stream flows the total available horse-power of the rivers will be estimated. The results will be published as "Water Powers of the Cascade Range, Part 2."

GEOLOGICAL SURVEYS.

The accompanying table gives a summary of the principal mineral products of Washington for the years 1900 to 1908, inclusive. While the production is already large, it is capable of a very much greater extension when the economic minerals are investigated and made better known. So many lines of investigation were suggested to the board as of vital importance that it was with difficulty a selection was made for this biennium. The principal geological work was done in mapping certain coal fields, investigating the cement resources, surveying some of the more promising metal mining districts, and in making an economic survey of a portion of the logged-off lands.
## Mineral Production of Washington from 1900 to 1908, Inclusive (a)

<table>
<thead>
<tr>
<th>Non-Metallic Products</th>
<th>1900</th>
<th>1901</th>
<th>1902</th>
<th>1903</th>
<th>1904</th>
<th>1905</th>
<th>1906</th>
<th>1907</th>
<th>1908</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>$4,700,086</td>
<td>$4,371,076</td>
<td>$4,572,995</td>
<td>$5,380,079</td>
<td>$5,120,931</td>
<td>$5,141,258</td>
<td>$5,908,494</td>
<td>$7,079,501</td>
<td>$6,600,412</td>
</tr>
<tr>
<td>Clay products</td>
<td>625,460</td>
<td>644,786</td>
<td>905,231</td>
<td>928,295</td>
<td>1,300,910</td>
<td>1,175,032</td>
<td>1,400,884</td>
<td>1,021,054</td>
<td>2,104,280</td>
</tr>
<tr>
<td>Portland cement</td>
<td>(b) 214,300</td>
<td>(b) 290,000</td>
<td>(b) 360,000</td>
<td>(b) 214,300</td>
<td>(b) 290,000</td>
<td>(b) 360,000</td>
<td>(b) 214,300</td>
<td>(b) 290,000</td>
<td>(b) 360,000</td>
</tr>
<tr>
<td>Granite</td>
<td>48,900</td>
<td>48,900</td>
<td>147,273</td>
<td>200,000</td>
<td>442,908</td>
<td>681,739</td>
<td>450,925</td>
<td>502,329</td>
<td>850,944</td>
</tr>
<tr>
<td>Sandstone</td>
<td>68,183</td>
<td>80,174</td>
<td>30,725</td>
<td>47,490</td>
<td>88,185</td>
<td>124,910</td>
<td>109,500</td>
<td>905,595</td>
<td>464,387</td>
</tr>
<tr>
<td>Limestone</td>
<td>10,141</td>
<td>24,916</td>
<td>27,744</td>
<td>75,049</td>
<td>71,837</td>
<td>52,470</td>
<td>49,102</td>
<td>62,312</td>
<td>31,690</td>
</tr>
<tr>
<td>Marble</td>
<td>11,690</td>
<td>22,816</td>
<td>61,176</td>
<td>49,117</td>
<td>28,908</td>
<td>60,000</td>
<td>59,085</td>
<td>60,000</td>
<td>31,690</td>
</tr>
<tr>
<td>Lime</td>
<td>255,022</td>
<td>316,541</td>
<td>186,070</td>
<td>222,052</td>
<td>216,454</td>
<td>160,968</td>
<td>247,024</td>
<td>238,968</td>
<td>228,333</td>
</tr>
<tr>
<td>Mineral waters</td>
<td>8,200</td>
<td>12,010</td>
<td>9,300</td>
<td>10,500</td>
<td>10,308</td>
<td>10,101</td>
<td>10,800</td>
<td>10,220</td>
<td>10,650</td>
</tr>
<tr>
<td>Sand and gravel</td>
<td>3,700</td>
<td>2,010</td>
<td>1,300</td>
<td>1,050</td>
<td>1,050</td>
<td>1,050</td>
<td>1,050</td>
<td>1,050</td>
<td>1,050</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>$8,711,789</td>
<td>$9,618,399</td>
<td>$8,589,814</td>
<td>$9,613,387</td>
<td>$7,174,480</td>
<td>$8,406,480</td>
<td>$8,050,419</td>
<td>$11,165,677</td>
<td>$11,061,436</td>
</tr>
</tbody>
</table>

## Metallic Products

<table>
<thead>
<tr>
<th>Metallic Products</th>
<th>1900</th>
<th>1901</th>
<th>1902</th>
<th>1903</th>
<th>1904</th>
<th>1905</th>
<th>1906</th>
<th>1907</th>
<th>1908</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>$718,300</td>
<td>$590,700</td>
<td>$272,200</td>
<td>$507,885</td>
<td>$304,640</td>
<td>$405,078</td>
<td>$211,648</td>
<td>$202,300</td>
<td>$256,700</td>
</tr>
<tr>
<td>Silver</td>
<td>224,500</td>
<td>200,640</td>
<td>328,070</td>
<td>201,789</td>
<td>89,831</td>
<td>75,737</td>
<td>30,738</td>
<td>50,000</td>
<td>46,400</td>
</tr>
<tr>
<td>Copper</td>
<td>60,242</td>
<td>43,788</td>
<td>16,958</td>
<td>45,300</td>
<td>24,453</td>
<td>21,411</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>10,750</td>
<td>69,987</td>
<td>28,437</td>
<td>72,787</td>
<td>29,786</td>
<td>32,844</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>8949,700</td>
<td>7877,140</td>
<td>5900,270</td>
<td>7085,060</td>
<td>5048,100</td>
<td>4056,078</td>
<td>2118,648</td>
<td>2023,000</td>
<td>2567,000</td>
</tr>
<tr>
<td>Grand totals</td>
<td>$6,654,469</td>
<td>$6,405,409</td>
<td>$6,540,084</td>
<td>$7,700,508</td>
<td>$7,682,056</td>
<td>$7,952,680</td>
<td>$9,000,922</td>
<td>$11,587,676</td>
<td>$11,416,781</td>
</tr>
</tbody>
</table>

(b) Approximate production.
Surveys of Coal Fields.—This work was in charge of George W. Evans, assisted in the field by Charles E. Weaver, Edwin J. Saunders, H. E. Taylor, W. M. Stephen and Charles R. Fettke. The work has been carried on with great thoroughness, and the idea has been to make the surveys in such detail that they would not need to be repeated for many years. In the two field seasons the coal survey has been engaged in making a minute study of the classification and geologic structure of the coal fields of King county. The field work has been greatly retarded because of the deep soil covering as well as heavy forest growth under which the coal seams lie. By going over the ground with great care and using all possible sources of information, the detailed structure of the coal formations has been accurately made out.

The office work in connection with the coal survey is now being done. It consists in the preparation of reports describing the results of the field examination. Maps are being prepared showing accurately (1) the boundaries of the developed fields, (2) the limits of the probable workable fields, (3) the locations of the fields where coal outcrops occur but where the coal is not believed to be commercially valuable, and (4) those localities underlaid by formations other than coal measures and where coal is an impossibility. One of the greatest results of the coal survey has been to extend largely the areas where commercially valuable coal occurs and to assure us of a fuel supply much in excess of previous estimates.

In co-operation with the United States geological survey (each party assuming one-half of the expense), the state survey has collected about two hundred and twenty-five samples of coal, from all the commercial coal seams of the state, and these have been analyzed and their heating values determined. This information is now ready to be printed, and it will be of value to all consumers of coal.

Investigation of Materials for Portland Cement.—Because of the great importance now assumed by Portland cement, the board arranged for a report upon the materials of the state suitable for the manufacture of this product. The work was
placed in the hands of Solon Shedd, who has been assisted by
A. A. Hammer. All the localities where limestone and clay de-
posits occur were examined, and the area and quantity of these
materials determined. Large numbers of samples of limestones,
clays and shales were collected in the field, and these have been
analyzed in the laboratory to determine their value in cement-
making. The maps and descriptive matter of the report are
now in preparation in the office. The maps will show the locali-
ties and extent of the deposits suitable for the manufacture of
cement, while the descriptive portion of the report will contain
about 250 pages.

Reports on Metal Mining Districts.—In planning the survey
work for the biennium the board arranged for field work and
reports upon some of the metal mining districts of the state. It
was decided to select comparatively small areas and work out
the extent, quality and other characteristics of the ore bodies
with much detail. The reports were planned to describe fully
the economic geology of the areas, and to be illustrated by maps
representing in colors the areal extent of all the rock formations.
In the summer of 1909 this work was placed in charge of Joseph
B. Umpleby, assisted by Olaf Stromme. The district about Re-
public was first surveyed, embracing fifty square miles. The re-
results of this work are given in Bulletin Number 1 of the survey,
entitled "Geology and Ore Deposits of Republic Mining Dis-
trict." An edition of twelve hundred copies of this report has
been published, bound in cloth.

In the last half of the summer of 1909 Messrs. Umpleby and
Stromme made similar surveys of Myers Creek district, con-
taining 35 square miles, and the Oroville-Nighthawk district,
with an area of nearly 32 square miles. The reports covering
these mining districts have been prepared with care and with
much detail and are now in press.

In the summer of 1910 the surveys were made by Charles
E. Weaver, assisted in the field by Charles R. Fettke. Two
metal mining districts were surveyed, viz., the one embracing
the country about Blewett, and the other including the area
around Index, where bodies of ore occur. All the necessary field work for these districts has been done and the office work is now in progress. The reports will include detailed maps showing the distribution of the rock formations, as well as ample descriptive matter regarding the ore deposits.

Soil Surveys of the Logged-Off Lands.—Strong pressure was brought to bear upon the board to authorize an economic survey of the logged-off lands, especially those that are located near the cities, and are unoccupied. The work was eventually undertaken under a co-operative arrangement with the bureau of soils, United States department of agriculture. By this arrangement the bureau of soils agreed to assume the major portion of the expense of the field work, and all the expense of printing the reports. In the field work the bureau of soils has been represented by A. W. Mangum, chief of party, assisted by H. L. Westover and A. E. Kocher; while the state survey has been represented by H. K. Benson, assisted at different times by T. C. Frye, R. E. Rose and Olaf Stromme.

In the survey of the logged-off lands the various kinds of soil have been studied with care, and they have been classified into types based upon origin, texture, agricultural value and topography. A map has been prepared in colors, showing the character of the soils which occur in every locality embraced by the survey.

All the factors that have a bearing upon the utility of the soils, such as topography, drainage, climate, etc., have been investigated and will be set forth in detail in the reports.

A land-classification map has also been prepared in colors, showing approximately the extent of the logged-off lands, the areas still covered by virgin forests, the tracts which have been developed agriculturally, and the swamp or marsh lands. The lands surveyed have been further classified into the following seven different groups, and these are shown on the land-classification map by means of symbols: (1) Land adapted to general farming and justifying immediate agricultural development; (2) lands which are capable of being developed agricul-
urally and are adapted to intensive farming, fruit growing and pasturage; (3) land which can be utilized for orchards and pasturage, but not well adapted to farming; (4) non-agricultural lands, suitable for reforestation only; (5) mixed lands or areas where small tracts of agricultural land are scattered throughout more extensive areas of non-agricultural land; (6) sparsely timbered gravelly prairie; and (7) areas of forests, unclassified.

In the field season of 1910 an area of about 3,467 square miles was surveyed, extending from the international boundary on the north to the southern boundary of Pierce county, including all of the townships in Whatcom, Skagit, Snohomish, King and Pierce counties which lie west of range 7 east, except those townships of Pierce county which lie on the western side of Puget Sound. The results of this survey are being published by the bureau of soils, United States department of agriculture, under the title of "Reconnaissance Soil Survey of the Eastern Part of the Puget Sound Basin, Washington."

In the field season of 1910 the area surveyed included San Juan, Island and Kitsap counties, and portions of Clallam, Jefferson, Mason, Pierce, Chehalis, Thurston and Lewis counties. A report giving the results of this survey is now being prepared for publication.

ROAD MATERIAL SURVEYS.

In the interests of good roads the legislature at its last session directed the board of geological survey to prepare a report upon the rock deposits of the state suitable for use as crushed stone in the construction of macadam highways. The state geologist was directed to select four or more quarry sites, where road material of good quality could be had economically, which were to be equipped and operated as state quarries. The quarry sites so selected are at Deception Pass, Meskill, North Yakima, Dixie and Marshall.

In searching about the state for rocks suitable for use in road-making all possible occurrences of such along the railway lines and navigable waterways were examined. Not only was the quality of the rock considered, but also its location as re-
**Board of Geological Survey**

**U. S. Geological Survey:**
- Expenditures in co-operation, coal surveys .................................. $2,047.26

**U. S. Department of Agriculture, Bureau of Soils:**
- Expenditures for field work in co-operation, logged-off land surveys ........................................ $8,938.95

**ROAD MATERIAL SURVEYS.**
- Appropriation for 1909-1911 .............................................. $5,000.00
- Expenditures to Dec. 1, 1910 .............................................. $3,779.22

**Balance on hand Dec. 1, 1910 .............................................. $1,220.78**

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**RECOMMENDATIONS.**

It is the recommendation of the board of geological survey that the law now in operation be re-enacted for the biennium of 1911-13, appropriating thirty thousand dollars for topographical and hydrographical surveys, and twenty thousand dollars for geological surveys. The present appropriation was made contingent upon the allotment by the United States geological survey of at least thirty thousand dollars for work on the topographical and hydrographical surveys in this state. In addition, through co-operation, the United States geological survey has spent in the state $2,047.26 on coal surveys, and the United States department of agriculture, through its bureau of soils, has spent $8,938.95 on soil surveys. All told, the federal bureaus in this biennium have spent for purely geological surveys a sum equal at least to one-half the amount spent by the state. It is probable that arrangements can be made with the federal bureaus whereby they will expend as much money on geological surveys as that expended by the state, just as the United States geological survey now spends on the topographical and hydrographical surveys, an amount equal to that appropriated by the state.

In the matter of the topographical surveys the completion of the detailed map of Washington is very necessary. Especially are these maps needed in those portions of the state where the largest amount of engineering work is being done, as in the arid
districts where irrigation is necessary and in the vicinities of the rapidly growing cities. The Cedar Lake quadrangle, now one-fourth surveyed, should be completed, since from this area both Seattle and Tacoma expect to draw all their water supplies, and the topographic map will render them great assistance in their engineering work.

In the work of the hydrographical surveys the present stream measurements should be continued, and gages placed upon all streams of the state of any consequence. Not until this is done will we have full information as to the quantity of water available for irrigation, municipal supplies, and power. At the present time level lines have been run along the streams of the southern half of the Cascade range, and the available horse-power accurately determined. With a continuance of the present appropriation it will be possible in the next two years to run level lines along all the streams of the northern Cascades, and so complete the measurement of available horse-power for the entire Cascade range.

In the geological work some of the surveys that have been under way during this biennium are only partially completed, and much of the good that has been accomplished will be lost unless they are continued during the next two years. In some instances the field work is completed and the manuscripts about ready for the printer; but another appropriation is necessary before the reports can be published and distributed. This is practically true of the bulletins on the coal fields, the cement materials and the Index mining district.

In the coal surveys the fields in King county have been mapped in detail, and the areas of commercial coal outlined. The excellent results of the survey thus far, particularly in the discovery of extensions of the known fields, and in the working out of the structure of the coal seams lying between neighboring mines, warrant the continuance of the coal surveys over the remaining fields of the state. As early as possible accurate maps should be prepared, giving the boundaries of the commercial coal areas, so that the useless expenditures of large sums of money in prospecting and in development work may cease.
In this biennium five of the metal mining districts of the state have been surveyed in detail, the different geological formations mapped, and the ore bodies studied and described. In the belief that such work is of great benefit to the mining industry, it is the recommendation of the board that such surveys be continued until all the promising metal mining districts of the state have reports made upon them.

The report upon the cement materials of the state is practically complete and ready for the printer. It is recommended, however, that additional field work be done in order that a map may be prepared showing the locations of all the limestone deposits of the state. Not only is limestone a necessary ingredient in cement making, but it is valuable as a fertilizer, as a flux, for lime burning, and for other uses.

In the soil survey of the logged-off lands over half the area has been finished, and the reports prepared. In some counties no work at all has been done, particularly in Pacific, Wahkiakum, Cowlitz, Clarke, Skamania and Klickitat. It is urged that provision be made for co-operative work with the United States department of agriculture in a continuance of the soil surveys over these counties.

It is highly desirable that an examination be made of the minerals and rocks of value which may occur upon all the lands belonging to the state. Some states, notably Minnesota, have found that the mineral resources of their state lands were of much value, and these have been utilized in such a way that the state taxes have been greatly reduced. With the possibility that our own state lands may yield similar returns, it is urged that at least a reconnaissance survey be made of them at once.
PUBLICATIONS OF THE WASHINGTON GEOLOGICAL SURVEY.


Bulletin 3.—The Coal Fields of King County, by George W. Evans. In preparation.


Bulletin 6.—Geology and Ore Deposits of the Blewett Mining District, by Charles E. Weaver. In press.

Bulletin 7.—Geology and Ore Deposits of the Index Mining District, by Charles E. Weaver. In preparation.


PUBLICATIONS OF THE U. S. GEOLOGICAL SURVEY, IN CO-
OPERATION WITH THE WASHINGTON GEOLOGICAL SURVEY.

(For copies of these publications address the Director, U. S. Geologi-

Topographic Maps of the Following Quadrangles: Mount Vernon,
Quincy, Winchester, Moses Lake, Beverly and Red Rock. Price, 5 cents
each.

Water Supply Paper No. 253: Water Powers of the Cascade Range,
Part I., Southern Washington.

Water Supply Paper No. --: Water Powers of the Cascade Range,
Part II. In preparation.

Water Supply Paper No 272: Results of stream gaging in Wash-
ington for 1909.

PUBLICATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS, IN CO-OPERATION WITH THE
WASHINGTON GEOLOGICAL SURVEY.

(For copies of these publications address one of the members of
congress from Washington).

Reconnoissance Soil Survey of the Eastern Part of the Puget Sound

Reconnoissance Soil Survey of the Western and Southern Parts of
PROGRESS MAP
WASHINGTON GEOLOGICAL SURVEY
1909-1911

- Quadrangles surveyed by U.S. Geological Survey, previous to 1909.
- Quadrangles surveyed under co-operation during 1909-11.
- Locations of rock deposits tested for use in road building.
- Gauging stations for stream measurements.
- Areas covered by Water Power Reports.
- Soil surveys of Logged-off-Lands.
- Locations of materials tested for making cement.

Completed Surveys of Coal Fields.
Metal Mining Districts.
State quarries located for road building.