51ST CONGRESS, 1st Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 238.

UPPER COLUMBIA RIVER, WASHINGTON.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING,

With a letter from the Chief of Engineers, report of the examination and survey of Upper Columbia River, Washington.

FEBRUARY 27, 1890.—Referred to the Committee on Rivers and Harbors.

WAR DEPARTMENT,
Washington, February 25, 1890.

The Secretary of War has the honor to transmit to the House of Representatives, in compliance with the requirements of the River and Harbor act of August 11, 1888, a letter from the Chief of Engineers, dated 20th instant, together with a copy of the report of Maj. W. A. Jones, Corps of Engineers, upon the survey of Upper Columbia River, between Wallula and British line, Washington, and accompanying maps, and also a copy of his report upon the preliminary examination of the locality.

REDFIELD PROCTOR,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 20, 1890.

SIR: I have the honor to submit herewith a copy of the report, dated February 15, 1890, upon the survey of "Upper Columbia River, between Wallula and British line," Washington, made by Maj. W. A. Jones, Corps of Engineers, to comply with the requirements of the river and harbor act of August 11, 1888, and accompanying maps.

A copy of the report upon the preliminary examination of the locality dated October 15, 1888, is also herewith.

The field work of this survey was executed under the direction of Maj. W. A. Jones, Corps of Engineers, who was relieved from duty in the district by Maj. T. H. Handbury, Corps of Engineers, upon whom the duty of making a report devolved. The sum which could be allotted

from the appropriation for examinations and surveys contained in the river and harbor act of August 11, 1888, being insufficient to cover the whole distance to be surveyed (estimated to be 427 miles), was applied to the survey of the reach of the river between the head of Rock Island Rapids and the head of Cabinet Rapids. Data on which to base estimates for the improvement of the worst sections of the river, commencing at the lower portion, have been obtained by Major Jones, and he was requested to submit the information in form of a report with estimates for improvements. Major Jones's report covers the obstructed reach of 59½ miles, extending from the head of Rock Island Rapids to the foot of Priest's Rapids, and contemplates the removal of obstructions, which, it is stated, will open navigation for vessels drawing 5 feet of water from Celilo to Foster Creek Rapids, a distance of 339 miles.

Major Jones's project for improvement provides for assisting the passage of boats over the rapids by means of boats with auxiliary power, and for the removal of rock.

The aggregate cost of the whole improvement proposed by Major Jones, with plant, is given at $138,000.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

PRELIMINARY EXAMINATION OF THE UPPER COLUMBIA RIVER, WASHINGTON TERRITORY, BETWEEN WALLULA AND BRITISH LINE.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, October 15, 1888.

GENERAL: Referring to Captain Young's estimate for cost of a preliminary examination of the Upper Columbia River, I have the honor to report that such examination has already been made. (See Annual Report of Chief of Engineers, 1885, page 2445.) From this it will be seen that in my judgment the locality is worthy of improvement, and I therefore recommend that a survey be made of such portion of it as may be justified by the present appropriation. In 1884 the sum of $6,000 was allotted for surveying the reach from Snake River up to and was including Priest Rapids. This sum was applied by me to a detailed survey of the 11-mile obstruction at Priest Rapids and a boat reconnaissance and plane table examination of 50 miles beyond, including the obstructions at Cabinet Rapids. Report of this survey with extensive and detailed maps and information on a scale equal to that of The Dalles survey of 1878, were submitted in my annual report for 1886, (see Annual Report, Chief of Engineers, 1886, pages 1953–70), including a project for improvement.

I have now to recommend that an allotment of $10,000 be made from which this survey may be extended to the completion of the work at Cabinet and Rock Island rapids and the extension beyond as far as possible into the Foster Creek Rapids above the mouth of the Okanogan River.

Very respectfully, your obedient servant,

W. A. JONES,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SURVEY OF THE UPPER COLUMBIA RIVER BETWEEN WALLULA AND BRITISH LINE.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, December 31, 1889.

SIR: I have the honor to submit the following report relative to a survey of the Upper Columbia River, between Wallula and British line, for which an allotment of $4,000 was made by your letters April 1 and June 4, 1889, from the funds appropriated for examinations and surveys in the river and harbor act of August 11, 1888.

The field work of this survey was done under the direction of Maj. W. A. Jones, Corps of Engineers, U. S. Army, who was relieved from duty in this district by me just as the work was finished.

The allotment not being sufficient to cover the whole distance, estimated to be about 427 miles, it has been expended on the survey of the reach between the head of Rock Island Rapids and the head of Cabinet Rapids, a distance of about 6½ miles.

Not being able to obtain funds sufficient for the complete survey of the reach, it has been thought best to obtain from time to time reliable data on which to base estimates for the improvement of the worst sections of the river, commencing at the lower portion. The allotment of $6,000 made for this survey from the appropriation for surveys in the river and harbor act of 1884 was expended on this principle in the survey of Priest Rapids, and a reconnaissance of Cabinet Rapids.

The party for the survey of Rock Island Rapids was organized in the latter part of August, and September 2, commenced actual field work. During the organization and first operations the party was in charge of Mr. F. J. Carrel. He, however, was obliged to sever his connection with the work September 9, after the first week's operation. From this time until its close at the end of October the field work was in charge of Mr. J. C. Ensign.

During the time that the survey was in progress the stage of water was, as nearly as could be ascertained, 4 feet above low water. The soundings shown on the maps herewith are reduced to the low-water stage. The slope measurements shown are for the stage 4 feet above low water. From these it appears that the river within the reach surveyed has a fall to that stage of 23 feet. Over Rock Island Rapids, within a distance of 1½ miles, the fall is 12.5 feet.

A discharge measurement taken at the foot of this rapid gives 58,000 cubic feet per second as the quantity of water flowing in the river at this time.

At the close of the field work an attempt was made to establish connection by levels between Cabinet Rapids and Priest Rapids, 45 miles below. The party had gone but a short distance with this work when cold and snowy weather came on and caused it to be abandoned.

During the spring of 1888 a small steamer, length 125 feet, beam 22 feet, draught 26 inches, was built at Pasco, Wash. In July of that year she made a trip from thence to the mouth of the Okinakane River, distance about 200 miles, passing over Priest, Cabinet, Rock Island, and other rapids in this reach. At two other times during the summer this boat passed up over Cabinet and Rock Island rapids. These trips were made at a stage about 12 feet above low water. This boat makes frequent trips from the head of Rock Island to near the mouth of the Okinakane.

I inclose herewith a copy of Major Jones's instructions to Mr. Carrel, who was at first in charge of this party in the field, Mr. J. C. Ensign's

report on the survey, a tracing from a map made of Rock Island Rapids, scale 1 inch to 200 feet, and a tracing of the map made of the Columbia River between the head of Rock Island Rapids and the head of Cabinet Rapids, scale 1 inch to 400 feet.

Very respectfully, your obedient servant,

THOS. H. HANDBURY,
Major, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

LETTER FROM MAJOR W. A. JONES, CORPS OF ENGINEERS, TO MR. F. J. CARREL.

AUGUST 22, 1889.

SIR: You are instructed to take charge of the survey party assembled at Ellensburgh, Wash., and proceed with it to Rock Island Rapids, on the Columbia River, and there commence a survey of the river downwards. This survey is to be the same in character as that you made at Priest Rapids. It will cover the reach that includes Rock Island and Cabinet rapids, and thereafter if there is time a line of levels to Priest Rapids, with such other work in the way of soundings and slope at high and low water as may be done while leveling is going on.

Instead of float-current measurements near Rock Island Rapids for discharge, precise measurements for slope in a selected reach will be made for the determination of the discharge by means of Kutter formula. The following instructions cover this matter:

Select a straight reach free from large whirls and eddies with shore a uniform line (on both sides preferable). Select a section where bottom is uniform (sand or gravel), and set up a line at right angles for taking plenty of soundings for section. Take these soundings with extreme care, forward and back several times, reading the guage carefully all the time. At the same time this is being done take the slope measurements. Select two points above and below equidistant from the section and conveniently distant so that the whole slope between them will be the slope *at the section.*

There must be no eddies near these points and the banks near must be regular. Drive a stake at each point as far out from the shore as a man can wade and observe the hook gauge to be placed upon it, and handle the targets. Now place a hook gauge on the bottom of a target rod at each post, and so place these rods on the post as to make it easy for a man to keep the point of the hook set at the surface of the water, and at the same time control the movements of the target. Then set up level at some intermediate point (preferably near the section line) on shore and observe for difference of level. At least fifty readings forward and back should be taken so that the method of least squares may be used in determining the error.

Party can keep the field until November 10, on or before which date it must proceed in boats to Pasco, and there disband. Timely notice should be furnished me of the probable date of arrival at Pasco so I may have rail transportation at hand for the party.

At such time as you may find it necessary to leave the work, turn over entire charge of the party to Mr. J. C. Ensign, together with these instructions.

Very respectfully,

W. A. JONES,
Major of Engineers.

Mr. F. J. CARREL,
Ellensburgh, Wash.

REPORT OF MR. J. C. ENSIGN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, December 24, 1889.

SIR: I have the honor to submit the following report concerning survey of Rock Island Rapids, Columbia River, Washington:

This work was under direction of Maj. W. A. Jones.

The party, consisting of two instrument observers, four boatmen, two rod-men, one Chinese cook, were engaged in Portland. Boatman Machelle and I left Portland August 23; arrived at Pasco 6 p. m. same day. We were here for the purpose of getting the boats in order and shipping them.

We left for Ellensburgh August 25; arrived there same day in evening; made arrangements to have boats, freight, etc., hauled to Rock Island.

Mr. Carrel arrived in Ellensburgh August 26, p. m.; rest of party from Portland arrived August 27, 11.45 p. m., having been delayed one day by railroad. Upon arrival of the party Mr. Carrel took charge, and we proceeded August 28 to cross the mountain to Rock Island, arriving August 30; went in camp on the right bank of the river, below the foot of the island, having been three days on the road. Three teams were employed in making the transfer, one four-horse and two double. There are some very heavy grades on this road, and freighting over it is hard and slow. The work of making camp and preparing for field work, such as repairing boats, etc., consumed two days' time. Boatman Jennings' took sick and left the party September 5, leaving us with three boatmen, which was crew enough, the boats being small. Actual field work was begun September 2 and continued until October 26. Mr. Carrel left the party September 9, having placed the work in my charge. The system under which this survey was made was inaugurated by Mr. Carrel, and is the same as that of the survey he made of Priest Rapids in 1885, about 50 miles below Rock Island.

Careful triangulation was made to locate principal signals. Topography was taken with a plane table and by cross sections with level. Two water gauges were established, one above and one below the Rapids, from which daily readings were taken and recorded. The river stage during the survey was good, at one time getting down to 4 feet above low water. Soundings were taken with a line and located by observers stationed on shore with transits. Sextants were sometimes used on the boat. In leveling for water-surface slopes, great care was observed. A continuous line of levels was run and checked, establishing numerous bench marks on both sides of the river and on the island, admitting of all the levels being taken the same day, which was done. The water being on a stand, good results were obtained.

A cross section for discharge measurement was made below the Rapids; numerous floats were drifted across the section, were carefully timed, and were located with transits. This completed the survey of Rock Islands Rapids, October 12. Survey was then continued down stream about 5 miles to the head of Cabinet Rapids, under another system, that of locating signals by a transit line and sketching topography. October 19, camp was moved down stream about 3 miles to a point nearer the work. Survey was finished November 26, having had a season of good weather, excepting a few rainy days, some strong winds, and a short smoky spell. The members of the party are entitled to credit for good conduct and faithful duty; the boatmen being skilled and careful. October 27, Observer Harer, with two boatmen with the boats, started to Pasco, under the following instructions: To run a line of levels, beginning at the lower end of this work, to Priest Rapids, connecting with the bench marks established there by Mr. Carrel in 1885. Shortly after starting, heavy rains and snow drove them into shelter, and after waiting two days they gave up the work and proceeded on to Pasco, arriving November 2, and in Portland November 3, the rest of the party returning via Ellensburgh. Broke camp October 28, arrived in Ellensburgh October 30. For this tranfer one 4-horse team was employed, having a trail wagon. October 31, party arrived in Portland and was disbanded. The two skiff-boats used were brought from Pasco, off the U. S. E. drill-scow and shipped by rail to Ellensburgh, and were hauled across the mountain on the wagons, along with provisions, instruments, etc. They are ordinary flat-bottomed boats, about 15 feet in length, straight on the keel, are too small and not the right shape. Skiff-boats, with lots of sheer in keel, would be the proper things.

Accompanying this report are two tracings, one of Rock Island Rapids, the other showing the entire stretch covered by the survey. Also, a brief history of navigation through, from, and above Rock Island Rapids.

Very respectfully, your obedient servant,

J. C. ENSIGN,
Assistant Engineer.

Maj. THOS. H. HANDBURY,
Corps of Engineers, U. S. A.

The history of navigation through, from, and above Rock Island Rapids is confined to a stern-wheel steamer, *The City of Ellensburgh,* owned by Thomas H. Nixon, of Tacoma, Wash., and commanded by Capt. A. W. Gray. W. P. Gray was chief pilot on the first three trips.

The *Ellensburg* was built and launched at Pasco, Wash., in 1888. Her first trip was to the Okinakane River, in July, 1888, distant about 180 miles. Three days after starting she arrived at Port Eaton, about 20 miles below Cabinet Rapids. In attempting to pass Cabinet Rapids she met with a serious accident, by which her stern was knocked off. She was beached a short distance below and repaired, after which she made a safe passage, three days later arriving at Okinakane River. Since this she has made two round trips between Port Eaton and the Okinakane, returning once to Pasco. The stage of water during these trips was about 12 feet above

low water. She has since been confined to the route she now runs, from her landing above Rock Island to Casimo, near the mouth of the Okinakane, about 100 miles. In 1888, between September 10 and December 19, she made fifteen round trips. In 1889, from April 8 to October 20, forty-four round trips were made. By the kindness of Capt. A. W. Gray, I was asked to make a trip over this route on the steamer, which I did. The obstructions along the route are sunken rocks, gravel bars, and sharp, jutting points of rock. There are about twenty places along the route where improvements would be beneficial; this includes several very swift rapids. Proper boats with good power would have little trouble over this route.

Dimensions of steamer: Length, 125 feet; beam, 22 feet; depth of hold, 4 feet 6 inches; draught (light), 26 inches.

Engine: Twelve inches diameter; stroke, 3 feet. Steel boiler, 19.5 feet length, 54 inches diameter.

Very respectfully, your obedient servant,

J. C. ENSIGN,
Assistant Engineer.

REPORT AND PROJECT FROM MAJOR W. A. JONES, CORPS OF ENGINEERS, FOR IMPROVING ROCK ISLAND RAPIDS, CABINET RAPIDS, AND PRIEST RAPIDS, COLUMBIA RIVER.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., February 15, 1890.

The Columbia River crosses the international boundary, 26½ miles west of the boundary between Washington and Idaho Territory, and after flowing through mountainous country for a distance of 106 miles in a direction a little west of south, it enters the great plain supposed to have been occupied by an inland sea for a long period subsequent to the lava flows, which cut off the main drainage through the Cascade Mountains. Immediately upon entering this basin it trends directly to the west along the northern border of the great plain for a distance of 105 miles, when it strikes the foot of the hills of the Cascade Mountains and is turned to the south along the western confines of that plain. This is one of the two big bends of the Columbia River, and that portion of the great plain inclosed between its two arms is widely known as the Big Bend country. It is remarkable for its fertility and requires no irrigation, but is absolutely destitute of springs of running water. There is little doubt, however, but that water will be found abundantly by boring through the rock strata. Through this country the river is very new, geologically. It is still rapidly carving its way through the unstable lavas and basalts which generally form its bed. But the places where the waterway has not yet been cut out sufficiently to allow the river to pass through freely are very numerous. These are the places where navigation is now obstructed by rocks and rapids. From the point where the river debouches from the mountains westward to the Cascade Mountains they are particularly numerous. Over the reach of 105 miles between Spokane River and the mouth of the Methow River, fully 30 miles are badly obstructed by rapids and rocks.

Through this country and as far south as Priest Rapids the river flows at a level of several hundred feet below that of the plateau it inclosses. Over the whole reach described and as far down as the foot of Priest Rapids, there is no flood plain. The river is still expending all its energy in cutting downwards. This, taken in connection with the fact that outside of flood stages the river carries but little sediment, would seem to indicate that the average slope of the bed was considerable.

The reach of river extending from the head of Rock Island Rapids to the foot of Priest Rapids covers a line along which the Columbia River

has cut its way through a broad spur from the Cascade Mountains. Here over a distance of 59½ miles there are three extensive obstructions:

	Miles.
Rock Island Rapids	0.4
Cabinet Rapids	2.5
Priests Rapids	10.22

ROCK ISLAND RAPIDS.

At this point the river has cut around both sides of a large island of rock. The channel, however, on each side is very much obstructed with reefs, rocks, and points sharply projecting from the shore. The result is a waterway so much restricted at all stages as to dam up the waters to such an extent that they escape over lines of very steep slope and amidst great masses of reef, rocks, and high projecting islands. A great reef is found a short distance above the head of the island which has caused extensive deposits of gravel, nearly choking the channel at low water.

Observations were only taken at a 4-foot stage. Hence we only have the slopes at that stage. It will be reasonable, however, to assume that these slopes will increase at lower stages. A slight examination of the map will show how difficult and dangerous were the boating operations carried on. One line of soundings was carried through the main rapid—a great feat. The bottom, however, occupied by the rapids remains practically unexplored. Many reefs and sunken rocks may exist besides those shown. The great reef at the foot of the island, which nearly closes the section, is very imperfectly shown.

Below the rapids the river has a tolerably uniform width of from 800 to 1,000 feet, with depths from 20 to 30 feet at the stage observed. At Rock Island the least width on the right that would be obtained after removing all obstructions would be 450 feet with depths of 20 to 25 feet. The sum of the widths on both sides of the island can be made about 800 feet at minimum sections.

The approximate discharge at a 4-foot stage was 58,000 c. f. s. But my instructions for taking discharge measurements were not carried out and the very imperfect method of maximum surface velocity by floats was used. I am also much embarrassed by not having the field-notes of the survey before me and by having an entirely insufficient length of time in which to discuss the local conditions and prepare a project.

At and above the 4-foot stage the water passes around both sides of Rock Island. Below it—although the obstructions do not show it—from what I can gather, the flow along the left bank is entirely interrupted opposite Fish Hawk Point and the whole discharge is effected through the right-hand channel. If all the rock obstructions in this channel were removed the slope would only be reduced 1:450 at a 4-foot stage, because of the extensive obstruction produced by the reefs and gravel bars just above the head of the island. This is too steep for navigation. By removing this reef the gravel bar would probably disappear and a navigable slope be reached. By leaving the large peninsula in place the whole slope becomes concentrated over a line, AB, 2,000 feet long, and is 1:220. The problem would then remain to get boats over this reach.

It is very much obstructed with islands and peninsulas, as shown, but most particularly at the lower end, where the map does not show it. About on the line PQ the section is nearly closed by a reef, extending, with broken intervals, quite across the river. Across this reef at the above-mentioned stage the slope is 1:100.

PROJECT.

It is proposed to assist boats over this reach by power applied at the upper end of the large peninsula, as shown.

It is proposed to remove the following rocks, as marked and shaded on the map in red:

	Cubic yards.		Cubic yards.
a (exposed)	98	*f* (exposed)	1,472
b (exposed)	100	*g* (exposed)	2,880
c (submerged)	2,000	*h* (exposed)	6,720
d (exposed)	31,438	*i* (exposed)	350
e (exposed)	600	*k* (exposed)	168

This will afford a passage-way over which boats can go down freely and safely. In order to assist them while going up, auxiliary power is proposed. A steam-boat can easily get over a rapid whose velocity is 8 miles per hour. I mean such boats as have to be built for service on the Upper Columbia and Snake Rivers. So it will be safe to estimate an available current to run a current-wheel on a scow, of 8 miles per hour.

When the velocities become less than that, the boat can go up without help. As the velocities increase beyond that, the quantity of power required to help her along will gradually increase. There are no data that I know of from which reliable estimates can be based for this. A practicable way of determining the power developed by the rapid, would be to anchor a steam-boat in an 8 or 10 mile current. Take all the steam from the cylinders and observe the revolutions produced per minute of the wheel, by the current. Then take her into still water, anchor her, and observe by means of an indicator the horse-power necessary to produce the same amount of revolutions per minute, as was produced by the current.

An ordinary steam-boat wheel and scow is suggested. Such a wheel would be about as follows:

Diameter	feet	15
Length	do	30
Buckets	No	20
Width of buckets	feet	1.5

The useful power developed by such a wheel in an 8 mile current would be about 50 H. P. This with suitable gearing applied to a winding drum, would afford ample power to aid a steamboat in passing up over the rapid. I have had considerable personal experience with this question of passing steamboats over rapids and can state that there will be no difficulty in steering a boat while acted upon by auxiliary power, even in the swiftest water. The location of the scow can best be determined after the rocks are removed. Here she should be securely held by anchor lines, either to the bottom or to the shore. Then lead the towline from the drum to a pulley at the point X and from thence down past an open pulley at Y to the foot of the line AB where the boat can pick it up.

The ultimate improvement of this most difficult piece of river may be effected in two ways that appear to me:

(1) Remove all obstructing rocks and reefs until something near a normal section shall have been produced.

(2) By passing boats across at Fish Hawk Point by means of a short railway with lifts worked by power developed from the river.

There is not sufficient data before me from which to estimate a normal section at the various stages. Neither is there sufficient from which to

state the quantities of rock to be removed from the various localities shown, more than approximately. Such a statement of the quantity to be handled in removing rocks at l, m, n, o, p, q, and the reef PQ, shaded in black on the chart herewith, in addition to those previously enumerated, would be in round numbers:

Cubic yards (submerged)	88,000
Cubic yards (exposed)	218,800

In large quantities such rock should be handled at an average cost of $1 per cubic yard for exposed, and $6 per cubic yard for submerged. I have done similar work for about those figures.

This would make the whole cost of improvement that would involve no future expense:

88,000 cubic yards, at $6	$528,000
218,800 cubic yards, at $1	218,800
Total	746,800

The cost of a boat railway would be:

2 hydraulic lifts, at $100,000	$200,000
Water-power plant	10,000
500 feet of track, at $100	50,000
Total	260,000

Wear and tear and maintenance per year, $20,000. The whole representing a capital outlay at 4 per cent. of $760,000.

The cost of the project for furnishing boats with auxiliary power from a permanent station would be as follows:

(1) Rock removal:	
2,000 cubic yards submerged, at $6	$12,000
43,300 cubic yards exposed, at $1	43,300
	55,300
(2) Auxiliary power: Anchor a scow wheel in rapids and lead a line through pulleys at X and Y and from thence down to the boat to be assisted.	
Scow and wheel, with quarters for watchman, and outfit complete	2,500
Gearing and winding drum	500
Tow-line	500
Buoys, tackle, anchors, and fastenings	500
Total for scow and power	4,000
Blasting	55,300
Scow power	4,000
Contingencies	6,700
	66,000

CABINET RAPIDS.

No measurements of rock for quantities have been made here. Available facts have been obtained from the reconnaissance made in 1886. Hence no estimates for removing rock can be presented.

For a description of this rapid see Annual Report, Chief of Engineers, 1886, page 1965, from which the following is taken:

Cabinet Rapids are situated about 45 miles from the head of Priest Rapids. Referring to the accompanying map, which has been prepared from the plain table field map, it is seen that the chief obstruction is at the head of the rapids. At this point a mass of basaltic rock projects from the left shore nearly two-thirds across the channel of the river, deflecting the current and causing it to impinge upon the nearly vertical basaltic rocks on the right bank. This mass of rock is at its extremity much worn and channeled by the action of the water, presenting the appearance of a collection of high rock islands with narrow and winding passages between.

These passages are not channeled out to the same depth as the bed of the river; some of them are laid bare at low water. The general height of the islands, or masses of rock, is such that they stand about 12 or 15 feet above low water, and are mostly covered from 6 to 8 feet at ordinary high water. The extreme high water of 1876 just reached the tops of the highest knobs. On the right bank are rocks considerably above this height which show water-worn surfaces, proving the comparatively recent lowering of the river bed to its present level. On the left bank of the river it has formed a high-water channel running completely around the rock obstruction, which thus becomes an island at high water, having the main channel to the right, and a wide and shallow channel to the left. The total fall in the river from the top of the upper rapid to the foot of the group of islands 8,000 feet lower down-stream is at extreme low water only 10 feet, and is not greatly altered at any stage. The greatest slope is at the main rapid, and is at the rate of about 1 in 250 at low water, but is then quite short in distance. As the river rises this rapid lengthens and becomes more steep. Below the main rapids the river in rising from low water to high water of 1885 (a rise of about 22 feet) maintains a nearly uniform slope, indicating an increased obstruction below this part of the river. This is probably due to the large masses of rock on both sides of the channel of the river below. For a further rise in the river up to extreme high water of 1876 the slope increases but little.

About 4,000 feet below the main rapid the river is obstructed at low-water stages by a group of rocks on the right, a reef in mid-channel, and rocks on the left. This obstruction is not serious and can be removed at small cost. About 2,000 feet further down, or 6,000 feet from the main or upper rapid, is a group of large rock islands occupying the center of the channel, which is divided into two narrow channels fairly navigable. These islands are about 15 feet above low water, and are covered 18 to 20 feet at high water.

Below this place the river turns abruptly to the left, and is navigable without improvement, except that which is necessary at Eagle Rapids.

This rapid, owing to the precipitous character of the rocks between which it flows, becomes rapidly worse as the river approaches the higher stages, when it probably becomes impassable.

I would recommend auxiliary power as the best and quickest means of assisting boats here.

Anchor the scow at the best point in the rapids (see sketch herewith) and lead the tow-line thence through a pulley at X, and thence to the ascending boat in the eddy just below the reef. Descending boats can pass freely.

ESTIMATE OF COST.

One scow and wheel with quarters for watchman and outfit complete	$2,500
Gearing and winding drum	500
Tow-line	500
Buoys, tackle, anchors, and fastenings	500
	$4,000

From here down to Priest Rapids the distance is 45 miles over a good river.

PRIEST RAPIDS.

A description of these rapids will be found in Annual Report of the Chief of Engineers, 1886, page 1961, from which the following is taken:

A study of these maps, together with the accompanying profile of the river surface, shows that the obstruction to navigation consists of a series of rapids, seven in number. Of these, three are shown upon the detail map of the Lower Rapids, and two upon that of the Upper Rapids. The remaining two rapids are situated between these two groups, but being of little importance, are shown only on the general map. The total fall from the head of the Upper Rapid (near Station 31 L) to the foot of the Lower Rapid (near Station 1 L), a distance of 10.22 miles, is, at extreme high water, 63.50 feet, and at extreme low water, or thereabouts, 72 feet. This fall is by no means uniform, the greater part being concentrated at the Upper and Lower Rapids. Between these two groups the river is fairly good and the channel deep. The fall from the head to the foot of the Lower Rapids is 35 feet at extreme low water. This is reduced to about 20 feet at the extreme high stage, and at the moderately high water of 1885 was 26 feet.

Referring to the detail map of these three Lower Rapids, it is seen that a little above a line drawn through Stations 12 L and 12 R is the head of a long, low island, which

extends down to the Lower Rapid. The formation is basaltic; the island is in places covered with bowlders, but is mostly bare, and the exposed surface is cut and channeled in every direction by the constant action of the river at the high stages, when the island is submerged. The main body of the river flows through the channel on the left, forming a rapid opposite Station 12 L, having at low water a fall of 12 feet, which at high water is reduced to only 4 or 5 feet.

Opposite Station 9 L, water flows into the main channel through two or three chutes or channels, crossing the island from the minor channel to the right, in which the water is 8 feet higher than in the main channel.

There is no obstruction to navigation opposite Station 8 L. Here the shore on the left juts out into the channel at nearly right angles, forming a shoulder of bed-rock averaging from 2 to 6 feet high, and extending 1,400 or 1,500 feet down the river.

The channel here makes a fork or V, of which one branch, carrying the main body of water, passes to the right, cutting diagonally across the island a narrow, straight passage having vertical walls of basaltic rock 7 or 8 feet above the surface of the water, which rushes and whirls between them. This passage is colled Tumwater, and is from 60 to 70 feet deep. The other branch of the channel forms a rapid, extending from opposite Station 6 L to 7 L, and continues its course along the left bank through a channel full of rocks and bowlders, the water being about 5 or 6 feet deep at low water.

Opposite the lower end of the island, and between stations 4 and 5 L, is another rapid, which may be considered the first or lower rapid of the Priest Rapid series; for, although there is a rapid extending from the island to the right bank, near Station 4 R, the channel above this rapid has no navigable outlet save through Tumwater. There is a passage on the right of the island which is quite similar in appearance to Tumwater. The water here is from 70 to 80 feet deep, and there is very little current, but at the head of this passage is a vertical fall of about 7 or 8 feet, and in the channel above these falls there is but little depth of water, the average being from 3 to 4 feet and the bottom flat bed-rock.

It is proposed to overcome these rapids with auxiliary power, the same as at the rapids above, and also to clear out the channel-way by blasting a portion of the submerged rocks shown in red on the charts herewith. The quantities are:

	Cubic yards.
Rapid No. 1	500
Rapid No. 2	2,500
Rapid No. 3	600
Rapid No. 6	1,200
Rapid No. 7	150
	5,000 at $10 = $50,000

Place a scow-wheel in Rapid No. 1, with leading pulley at X. Cost of scow and all appurtenances, $4,000.

An analysis of the slopes shows that boats can pass Rapid No. 2 after the two large rocks in the channel are removed.

At Rapid No. 3, place a scow-wheel with leading pulley at X. Cost of scow with all appurtenances, $4,000.

No further improvement will be needed until we reach Rapid No. 6, where a scow-wheel should be placed with leading pulley at X. Cost of same, $4,000.

Summary for Priest Rapids.

5,000 cubic yards of rock, at $10	$50,000
3 scow-wheels, at $4,000	12,000
Contingencies	6,000
Total	68,000

Summary for whole reach, including Rock Island Rapids, Cabinet Rapids, and Priest Rapids.

Rock Island	$66,000
Cabinet	4,000
Priest	68,000
Whole cost for 59½ miles of river, with over 5 feet at low-water stages	138,000

Annual maintenance.

Five watchmen, at $900	$4,500
Wear and tear and maintenance of five scows and outfits, at $500	2,500
Total maintenance	7,000
The whole, with interest at 4 per cent., representing a capital outlay of	313,000
Say per mile	5,260

STEAM.

This discussion will not be complete without a statement of the cost of a steam plant for furnishing the auxiliary power.

Five 50 horse-power stationary engines, with boilers and all appurtenances complete, at $2,000	$10,000
Five engine houses and engineers' dwellings complete, at $3,000	15,000
Towlines	2,500
Buoys, tackle, etc	2,500
Gearing and winding drums	2,500
Total	32,500
Summary:	
Blasting	105,300
Power plant	32,500
Contingencies	13,200
Total	151,000
Maintenance five engineers, at $1,200	6,000
Fuel:	
Say 1 ton coal per day for 180 days per year, 180 tons, at $6	1,080
Oils and waste	60
Total	7,140
Wear and tear, say 6 per cent., on $32,500	1,950
Annual maintenance	9,090
Annual maintenance:	
Water plant	7,000
Steam plant	9,090

The project for opening the reach of river which includes Priest, Cabinet, and Rock Island Rapids to navigation by means of auxiliary water power as described is recommended.

The following maps are herewith: (1) Priest Rapids, lower end; (2) Priest Rapids, upper end; (3) Cabinet Rapids; (4) Rock Island Rapids; (5) Rock Island Rapids and River down to Cabinet Rapids; five small sheets, Priest Rapids; one small sheet, Cabinet Rapids.

Respectfully submitted.

W. A. JONES,
Major, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

C

52D CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { EX. DOC. No. 39.

UPPER COLUMBIA RIVER, WASHINGTON.

LETTER

FROM

THE ACTING SECRETARY OF WAR,

TRANSMITTING,

With a letter from the Chief of Engineers, report of the examination of Upper Columbia River, Washington.

DECEMBER 7, 1892.—Referred to the Committee on Rivers and Harbors and ordered to be printed.

WAR DEPARTMENT,
Washington, December 5, 1892.

SIR: I have the honor to inclose herewith a letter from the Chief of Engineers, dated December 5, 1892, together with a copy of a report from Capt. Thos. W. Symons, Corps of Engineers, dated October 12, 1892, of a preliminary examination of Upper Columbia River, Washington, from the international boundary to Rock Island Rapids, made by him in compliance with the provisions of the river and harbor act of July 13, 1892.

Very respectfully,

J. M. SCHOFIELD,
Major-General, Acting Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 5, 1892.

SIR: I have the honor to submit the accompanying copy of report, dated October 12, 1892, by Capt. Thomas W. Symons, Corps of Engineers, of the results of a preliminary examination of Upper Columbia River, Washington, from the international boundary to Rock Island Rapids, made to comply with requirements of the river and harbor act approved July 13, 1892.

Capt. Symons states that, in his opinion, there are two portions of the river within the limits named that are worthy of improvement by the General Government—one is from Little Dalles to the international boundary line, a distance of 15 miles, and the other is from the head of Rock Island Rapids to Foster Creek Rapids, just above the mouth

of the Okanogan, a distance of 90 miles, and he submits an estimate of $4,000 as the amount required to make necessary surveys to prepare plan of improvement of the latter section.

His views are concurred in by the Division Engineer and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. S. B. ELKINS,
Secretary of War.

PRELIMINARY EXAMINATION OF UPPER COLUMBIA RIVER, WASHINGTON, FROM THE INTERNATIONAL BOUNDARY TO ROCK ISLAND RAPIDS.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, October 12, 1892.

GENERAL: I have the honor to submit the following report of a preliminary examination of "Upper Columbia River, Washington, from the international boundary to Rock Island Rapids."

It was not found necessary at the present time to make an actual examination of the entire portion of the river named, either in person or by an assistant, for the reason that in 1881 I made a personal examination and reconnoissance survey of the river, and during the past two years the river from the international boundary line to the mouth of the Okanogan has been carefully surveyed under the direction of this office by Mr. William Cuthbert, who also traversed the remaining portion of the river from the mouth of the Okanogan to Rock Island Rapids. The maps and a full report on this portion of the river will be sent to you in a short time. I did, however, make a personal examination of that portion of the river at present navigated from the international boundary line to the Little Dalles.

DESCRIPTION.

The Columbia River from the international boundary line to Rock Island Rapids is 294 miles in length. It has an average fall of about 2½ feet per mile, a low-water discharge of 50,000 cubic feet per second, and a high-water discharge of 300,000 cubic feet per second. The average velocity of the current is 3½ miles per hour; in many places this increases to 8, 10, 12, and even 15 miles per hour.

Throughout the river, as far as ascertained, there is generally ample depth of water for purposes of navigation.

The portion of the Columbia from the international boundary line to the mouth of the Spokane River passes through a mountainous, wooded country with, however, much fine agricultural land. From the Spokane to Rock Island Rapids the timber becomes less in quantity. This portion of the river incloses, on the north and west, the famous "Big Bend" country, one of the choicest agricultural sections of Washington, and of which Davenport, Wilbur, Almira, Coulee City, and Waterville are the principal cities. The Okanogan, coming in from the north, has in its vicinity mines of gold, silver, and lead of great extent and richness, besides large areas of agricultural and grazing lands. At the outlet of Lake Chelan, a thriving town has been started; there are steamers running on the lake, and the country about the lake is rapidly settling up. Wenatchee, at the mouth of the Wenatchee River, is becoming a place of importance, and the population of the "Vale of Wenatchee" is rapidly increasing.

RAILROADS.

Two railroads reach the Columbia in the portion of its course under consideration. One, the Spokane and Northern, starts at Spokane and runs northerly, striking the river at Kettle Falls, and then running along the left bank of the river as far as Little Dalles.

The second, the Great Northern Railroad, runs from Spokane westerly, reaching the Columbia at Rock Island Rapids, thence running northerly along and across the Columbia and up the Wenatchee River and over the Cascade Mountains to Puget Sound. This road is not yet completed, but work is progressing as rapidly as possible, and it is expected that it will be completed within a year.

NAVIGATION.

The present navigation of the Columbia River, in the section under consideration, is limited to two stretches. First, from the northern terminus of the Spokane and Northern to the international boundary line; and, second, from the head of Rock Island Rapids to the mouth of the Okanogan and vicinity. From the Little Dalles there is a line of steamers running up the Columbia to Revelstoke, on the Canadian Pacific Railroad, and connecting at Robson with the railroad up the Kootenai River to Nelson, on Kootenai Lake. Between the mouth of the Okanogan and Rock Island Rapids a steamer is plying. This is a part of a route from Ellensburg, on the Northern Pacific, via wagon road, to the Columbia above Rock Island, thence by river to the mouth of the Okanogan. As soon as the Great Northern is completed and in operation this portion of the river will furnish the commercial highway from and into the great Okanogan mining, agricultural, and grazing region, and will furnish a needed outlet for a large part of the Big Bend country.

It is my opinion that the Columbia River from the international boundary line to Rock Island Rapids is worthy of improvement to a limited extent. A pretty thorough knowledge of the river and a careful study of all transportation and economic questions connected with it convince me that this river can not, at least in the near future, become a through highway of commerce upon which will be transported the products from and supplies to the region drained by it. There are too many things against its ever occupying this high position in the world of commerce. These may be summarized as the obstructions, such as rapids and falls of greater or less magnitude, which can only be passed by expensive canals and locks, boat railways, or portage roads; the many lesser rapids, where auxiliary power or lining would be necessary; the generally swift currents, requiring a large expenditure of fuel to surmount, combined with a lack of fuel and high cost of the same; the economic character of the country in the immediate vicinity of the river, which is of such a nature as to furnish or promise but little local business; the topographical character of the river and its immediate vicinity, which will render it difficult to get to and from the fertile regions above it, for it must be remembered that the Columbia flows through a great cañon or depression from 2,000 to 3,000 feet and more below the general level of the country drained by it, and the dangers which boats must ever take in navigating many portions of its course. The function of the Columbia in this upper portion of its course in the commercial world is and will be, at any rate for many years, that certain portions of it will be navigated as feeders to railroads. As such, cer-

s of the river will be of great value, and can well receive
n of the General Government.

as previously stated, two portions of the river that are
ow, and upon which it is a matter of little doubt that the
vill greatly increase in the near future. One is from Little
e international boundary line, a distance of 15 miles, and
from the head of Rock Island Rapids to Foster Creek
above the mouth of the Okanogan, a distance of 90 miles.
e sections of the river which are recommended as at pres-
of improvement by the General Government. For the first-
on no further survey is necessary, it having been included
y made by Mr. Cuthbert. This survey shows that at three
s there need of work: At Two Mile, Steamboat, and Sheep
ls.

* * * * * *

mouth of the Okanogan to Rock Island Rapids a survey is
etermine the extent of obstruction and character of the
nake this survey on the same plan as that of the river
equire an expenditure of $4,000.

on of the Columbia from Little Dalles to the international
ne is a link in the line of communication between the Cana-
Railroad at Revelstoke and the Great Northern, Northern
Union Pacific Railroads at Spokane, and incidentally by
Columbia and Kootenai Railroad with the Kootenai Lake
nd the Great Northern Railroad at Bonners Ferry.

tion of the route for the transportation of supplies into and
e great and rapidly developing mining centers of the Upper
locan, and Kootenai regions.

portion of the Columbia in British Columbia, to the south
e, the Dominion Government last year expended $19,000
the river. This was mainly expended at two points, one
Revelstoke and the other at the Kootenai Rapids.

respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

, THOMAS L. CASEY,
ef of Engineers, U. S. A.

Col. G. H. Mendell, Corps of Engineers, Division Engineer,
ion.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., October 17, 1892.

lly forwarded.

ns herein given the Columbia River, from the boundary to
Rapids, is considered to be worthy of improvement by the
vernment over two stretches: namely, that extending from
ry to Little Dalles, a distance of 15 miles; and, secondly,
Rock Island Rapids to Foster Creek Rapids, a distance
miles.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

62D CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { DOCUMENT No. 693.

FILE COPY

Return to Publications Section
Office Chief of Engineers

COLUMBIA RIVER, MOUTH OF SNAKE RIVER TO WENATCHEE, WASH.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING,

WITH A LETTER FROM THE CHIEF OF ENGINEERS, REPORTS ON EXAMINATION AND SURVEY OF COLUMBIA RIVER, WASH., FROM THE MOUTH OF SNAKE RIVER TO WENATCHEE.

APRIL 11, 1912.—Referred to the Committee on Rivers and Harbors and ordered to be printed.

WAR DEPARTMENT,
Washington, April 10, 1912.

SIR: I have the honor to transmit herewith a letter from the Chief of Engineers, United States Army, dated 9th instant, together with copies of reports from Maj. C. W. Kutz, Corps of Engineers, dated June 9, 1909, and July 11, 1911, on preliminary examination and survey, respectively, of Columbia River, from the mouth of Snake River to Wenatchee, Wash., made by him in compliance with the provisions of the river and harbor act approved March 3, 1909.

Very respectfully,

H. L. STIMSON,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, April 9, 1912.

SIR: I have the honor to submit herewith for transmission to Congress reports dated June 9, 1909, and July 11, 1911, by Maj. C. W. Kutz, Corps of Engineers, on preliminary examination and survey, respectively, of Columbia River, from the mouth of Snake River to Wenatchee, Wash., authorized by the river and harbor act approved March 3, 1909.

This stretch of river is about 147 miles long. It is now navigable at all stages, except when closed by ice, for boats drawing from 3 to 4 feet for about 130 of the 147 miles. When the river is from 12 to 15 feet above low-water stage continuous navigation is possible, though difficult and hazardous in places, from the mouth of the Snake to Wenatchee. The principal obstacles are Rock Island, Cabinet and Priest Rapids, where some open-channel work was done by the United States between 1890 and 1895. The physical conditions, however, are such that a navigable low-water channel can not be maintained by open-channel methods, and canalization will be required to overcome Rock Island and Priest Rapids.

It being evident that the cost of canalization would not be justified solely in the interest of navigation, the district officer gave consideration to the coordination of navigation improvement and water-power development with a view to the possible reduction of the expenditures directly in the interest of navigation to an amount which would be justified by the resulting benefits to commerce.

He presents several plans for improvement, all of which are fully discussed in his report, but the one preferred by him as the most favorable for combined development contemplates the following work: The construction of a single lock at Rock Island Rapids at an estimated cost of $1,410,000, exclusive of power house and machinery, or with the cost of the excluded items ($500,000), a total for coordinate development of $1,910,000; the construction of three locks to surmount Priest Rapids at an estimated cost of $3,400,000, exclusive of power house and machinery, or, with the cost of the excluded items ($1,650,000), a total for coordinate development of $5,050,000; and the removal of bowlders to clear the channel and other necessary open-channel work, $65,000, or a total for coordinate development in the entire stretch of $7,025,000.

The total actual cost of improvement for navigation is $1,925,000 on the assumption that the balance of the cost of the project would be chargeable to the power developed, which, of course, can not be assured. The actual expenditure required to carry out this project, however, including power development, would exceed this amount by $5,100,000, thus making a total expenditure of $7,025,000 necessary for coordinate development, as stated above. On the basis of the United States creating navigation by carrying out the project suggested, exclusive of the power development, the cost over this reach would be $4,875,000. The cost of maintenance of the locks is estimated at $50,000 per annum.

The district officer is of opinion that the amount of traffic in prospect is not sufficient to warrant the expenditure of $7,025,000 even if $5,100,000 of this amount may be considered as income producing, and therefore he reports that the improvement is not worthy of being undertaken by the United States at this time. The division engineer concurs in this view.

These reports have been referred, as required by law, to the Board of Engineers for Rivers and Harbors, and attention is invited to its report herewith, dated January 9, 1912. The board has held a public hearing on this subject in this city, to which interested parties were invited, and after a careful review of all the information presented, including a number of communications received, concurs in the opinion expressed by the district officer and the division engineer.

After due consideration of the above-mentioned reports, I concur in general with the views of the district officer, the division engineer, and the Board of Engineers for Rivers and Harbors, and therefore, in carrying out the instructions of Congress, I report that the improvement by the United States of Columbia River, from the mouth of the Snake River to Wenatchee, Wash., in the manner apparently desired by the interests concerned, as described in the reports herewith, is not deemed advisable at the present time.

Very respectfully,

W. H. Bixby,
Chief of Engineers, U. S. Army.

The Secretary of War.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS ON SURVEY.

[Third indorsement.]

The Board of Engineers for Rivers and Harbors,
Washington, January 9, 1912.

Respectfully returned to the Chief of Engineers, United States Army.

The results of the survey of Columbia River from the mouth of the Snake to Wenatchee show that this reach is susceptible of improvement by the removal of bowlders so as to secure fairly good 6-foot navigation at moderate cost, except at Rock Island Rapids and at Priest Rapids. These are serious obstructions and can only be satisfactorily improved for useful navigation by canalization.

At Rock Island Rapids there is a drop of about 12 feet at low water. A large island divides the river into two channels. It is proposed to surmount this reach by means of a lock and dam in the left channel, which will make practicable a water-power development of about 8,000 to 12,000 horsepower. The estimated cost of this improvement, exclusive of power house and machinery, is $1,410,000, the approximate estimate of the power plant being $500,000, making a total of $1,910,000. There is practically no market for power in the immediate vicinity of these rapids, but the district officer believes that with the increasing development of the country adjacent there would eventually be a demand for the full amount, at least during the irrigation season. Assuming that all power is sold at the rate of $15 per horsepower, and capitalizing the income at 10 per cent to cover all expenses of operation, repairs, depreciation, and shortage in demand for power, gives an investment of $1,200,000 and makes the net cost for navigation $710,000.

Priest Rapids. This stretch extends over a distance of about 9¾ miles, having a total fall of 68 feet at low water. There are seven rapids. A part of the power of this reach has been developed by a private company, now the Washington Irrigation & Development Co., by means of a canal on the right bank of the river, at the head of which a small crib dam was thrown across one of the river channels. This plant develops a power of 1,200 to 2,500 horsepower.

Four plans for the improvement of Priest Rapids are discussed by the district officer. These are designated by the latters N, P, H, and L, and plan L is selected by the district officer as the most favorable

one for combined development of navigation and water power. It contemplates the construction of a longitudinal dam in the river founded on three islands with a flight of two locks at the lower end which will overcome the fall of the lower three rapids, utilizing the open river through the fourth and fifth rapids and building a single lock to overcome the sixth and seventh rapids. *This plan will permit the development of 18,000 horsepower at the lower lock with 12,000 additional horsepower during the irrigation season. The estimated cost of this project, exclusive of power house, machinery, etc., is $3,400,000, the excluded items amounting to $1,650,000, making a* total of $5,050,000. This plan represents an investment of $3,900,000 for power development and $1,150,000 for navigation purposes. The L project is the only one which could be executed without acquiring a right of way, but even in this project some doubt appears to exist as to the ownership of the islands to be occupied.

The Washington Irrigation & Development Co. has plans for the enlargement of its plant to a capacity of 30,000 horsepower, but permission to carry out these plans has been at least temporarily refused by the War Department. It is stated that the ultimate aim of the company is to develop the entire power of Priest Rapids by a high dam across the river, drowning out all the rapids, and to construct a flight of locks without cost to the United States and provide the necessary power for operating them.

The total cost of the improvement of the Columbia River between Snake River and Wenatchee in the interests of navigation may be summarized as follows on the basis of using plan L:

Above Rock Island Rapids, removal of bowlders	$25,000
Rock Island Rapids	710,000
Cabinet Rapids, removal of bowlders	25,000
Cabinet Rapids to Priest Rapids, removal of bowlders	15,000
Priest Rapids, L project	1,150,000
Total	1,925,000

The actual expenditure required to carry out this project, including power development, would exceed this amount by $5,100,000, making a total of $7,025,000. While, as figured above, the navigation cost would be $1,925,000, this is on the assumption that the balance of the cost of the project would be chargeable to the power developed, which, of course, can not be assured. On the basis of the United States creating navigation by carrying out the project suggested, exclusive of the power development, the cost over this reach would be $4,875,000. The cost of operation and maintenance of the locks is estimated at $50,000.

The commerce reported between Priest Rapids and the mouth of the Snake for 1908 is 11,712 tons; that for the Columbia between Wenatchee and Bridgeport 54,000 tons, and the district officer states in his report on preliminary examination that even if all this tonnage was carried to and from Portland by river it would not be sufficient in itself to warrant the probable cost of the work. It appears from the within report that there has been a decrease in the tonnage below Priest Rapids to 10,035 tons and a decrease in the section above Wenatchee to 23,722 tons, the latter reduction being accounted for by the district officer from the fact of the building of the Waterville branch of the Great Northern Railway, which now carries the greater

part of the wheat formerly shipped to Wenatchee by boat. With reference to the use of the river as a through transportation route the district officer states that if the river were made navigable to Portland some freight would be shipped by that route, but that the amount would probably be small, as it would mean a 380-mile haul by water as compared with a 165-mile rail haul. The district officer concludes that the amount of traffic in prospect is not sufficient to warrant the expenditure of $7,025,000 even if $5,100,000 of this amount may be considered as income producing, and he therefore concludes that the improvement is not at this time worthy of being undertaken by the United States. The division engineer concurs in this view.

The board has given careful consideration to this subject, has reviewed a number of communications received, and on December 11, 1911, gave a public hearing, at which Hon. George E. Chamberlain, Hon. W. L. Jones, Hon. Miles Poindexter, United States Senators; Hon. William A. La Follette, Hon. William E. Humphrey, Members of Congress; Mr. J. N. Teal, and Capt. Fred McDermott appeared in advocacy of the improvement. Much interest has been displayed in this subject since the announcement of the district officer's unfavorable report. Interested parties apparently realize the advantages of through water transportation, both in relieving possible congestion in traffic and its effect as a regulator of rates.

The board fully appreciates these benefits and advantages. It believes, however, that the section to be benefited has not developed sufficiently to produce a commerce commensurate with the cost of the work involved. Allowing 3 per cent of the actual cost of the work necessary to create navigation alone, not taking into account returns from water power, which under existing conditions can not be assured, and adding the annual charge for maintenance, we have an annual outlay of $196,250. It is obvious that the present commerce on this river would have to be multiplied many times in order to justify the expenditure required. While this section of country is rapidly developing, it does not seem to the board that there will be sufficient commerce in the near future to warrant the large expenditures now contemplated, and therefore the board concurs with the district officer and the division engineer in the opinion that it is not advisable for the United States at this time to undertake the improvement of Columbia River from the mouth of Snake River to Wenatchee.

For the board:

WM. T. ROSSELL,
Colonel, Corps of Engineers,
Senior Member of the Board.

PRELIMINARY EXAMINATION OF COLUMBIA RIVER FROM THE MOUTH OF SNAKE RIVER TO WENATCHEE, WASH.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., June 9, 1909.

SIR: In compliance with instructions contained in letter of March 8, 1909, I have the honor to submit the following report upon preliminary examination of the Columbia River from the mouth of Snake River to Wenatchee, authorized by the act of Congress approved March 3, 1909.

This stretch of the river is about 147 miles long, and is shown on the accompanying map[1] compiled from the records of the office. It is crossed by three transcontinental railway lines. The Northern Pacific crosses a few miles above the mouth of the Snake; the Chicago Milwaukee & Puget Sound crosses at Beverly, about 90 miles above the mouth of the Snake; and the Great Northern crosses at a point 139 miles above the mouth of the Snake, or 8 miles below Wenatchee. About 130 miles out of the 147 is now navigable at all stages of the river, except when closed by ice, for river boats drawing from 3 to 4 feet of water. When the river is from 12 to 15 feet above low-water stage continuous navigation from the mouth of the Snake to Wenatchee is possible.

There are three main barriers to continuous low-water navigation—Rock Island Rapids, Cabinet Rapids, and Priest Rapids. The first two are only 6 miles apart, and considering them as one obstruction the river is naturally divided into three parts. The first of these extends from Wenatchee to the head of Rock Island Rapids, about 12 miles, and is now in fairly good condition, though obstructed by a number of rapids over which upstream navigation would be difficult at times of low water, and also by a number of bowlders at different points which would render low-water navigation more or less hazardous. This stretch, however, will admit of improvement at relatively small cost. It was surveyed in 1894, and a report thereon, with map, published in the Annual Report of the Chief of Engineers for 1895, page 3534.

Between the lower end of Cabinet Rapids and the head of Priest Rapids (about 42 miles) the river is said to be in good condition, with relatively small slope and depth sufficient for ordinary Columbia River boats at all stages of the river. It was used recently for hauling material required in the construction of the Chicago, Milwaukee & Puget Sound Railway bridge, material being brought by barges and river steamer from Vulcan, on the line of the Great Northern Railway. There is ordinarily no traffic on this stretch of the river, at least not sufficient to support a steamboat, and upon completion of the bridge the steamer used by the railroad company was taken to Wenatchee.

From the lower end of Priest Rapids to the mouth of the Snake the river is in good navigable condition except for some shoals of a minor character in the vicinity of White Bluffs, where the bed of the river is considerably wider than at points above and below. This obstruction, however, is not serious and the difficulty can probably be remedied at slight cost by the construction of a few wing dams. One and occasionally two steamers operate on this stretch of the river, making regular trips every other day to Hanford and White Bluffs, with biweekly trips to the foot of Priest Rapids. The waterborne commerce between Priest Rapids and the mouth of the Snake for 1908 is reported by the steamboat company as 11,712 tons. Practically all of it is upstream traffic, the recent agricultural development in the vicinity of Hanford and White Bluffs not having advanced far enough to afford any downstream tonnage.

The three main barriers above referred to (Rock Island Rapids, Cabinet Rapids, and Priest Rapids) were surveyed a number of years ago with a view to open-river improvement, but no continuous survey of the Columbia River from the head of Rock Island Rapids to the mouth of the Snake River has ever been authorized. These detached

[1] Not printed.

surveys showed that Rock Island Rapids had a fall of 12½ feet in 8,000, and Cabinet Rapids a fall of 10 feet in 8,000, both at a stage of about 4 feet above low water, while Priest Rapids was shown to have a total fall of 72 feet at low water in a distance of 10 miles, the most of it being concentrated in seven rapids. The act of September 19, 1890, contained an item of $70,000 for the improvement of these rapids, and of this sum about $50,000 was expended in the removal of rocks and bowlders. As a result of this work the conditions at Cabinet Rapids were bettered, but the work at Priest Rapids and Rock Island Rapids was not sufficient to produce any noticeable improvement. Results obtained were so unsatisfactory that the district officer in his report of 1895 on the improvement of the Columbia River from the head of Rock Island Rapids to the foot of Priest Rapids stated:

> As the improvement of this river by any system of regularization to give practical navigation appears to be chimerical, and as there is no navigation of the river, no further appropriation is suggested for the work.

A personal examination of the river from Wenatchee to Kennewick was made on May 9 to 12, on which dates the gauge at Wenatchee showed a stage of about 12 feet. Interviews were had with interested parties at Wenatchee and Kennewick and with residents of the valley at different intermediate points. From Wenatchee to Beverly the trip was made in a rowboat, from Beverly to the foot of Priest Rapids by team, and from the latter point to Kennewick by river steamer. At this stage of the river Cabinet Rapids forms no obstruction to navigation, nor is there any serious obstruction at Priest Rapids, though "lining" would be necessary at a number of points. At Rock Island Rapids, however, the currents were so swift, and the channel so obstructed by reefs and bowlders that any attempt to navigate a steamer through the rapids would have been extremely hazardous.

From the results of work heretofore done, from experience of steamboat men familiar with the river, and from what could be seen during the examination, the conclusion has been reached that Rock Island and Priest Rapids can be made navigable at low water only by resort to canalization. The same is also probably true of Cabinet Rapids.

From the Great Northern Railway Bridge to the head of Priest Rapids the river flows through a deep canyon, and the country immediately bordering the river is rocky and sterile. At places there are limited areas under cultivation, and there are other limited areas suitable for cultivation if the land is properly irrigated, but the total area cultivated, or capable of cultivation, that lies near the river, is so small that its products, under the most favorable conditions, will never furnish much river traffic. Back from the river the proportion of arable land becomes considerably greater, but considering the cost of hauling to the river bank it is questionable whether much river traffic will ever originate between these two points. If the radical improvement of these rapids is undertaken, its commercial value will rest not on local commerce, but on through commerce, as with these obstacles overcome and the authorized work on the Columbia River below the mouth of the Snake completed, there will be continuous navigation from Bridgeport to the Pacific Ocean, a distance of about 560 miles.

There is now an annual tonnage on the Columbia River between Wenatchee and Bridgeport of 54,000 tons, the bulk of which is wheat. Even if all of this tonnage was carried to and from Portland by river it would not be sufficient in itself to warrant the probable cost of canalization at the three rapids above referred to, so that the worthiness of this improvement must depend upon prospective commerce. It is difficult to estimate future commerce, but if this region continues to develop as it has in the past there is every reason to believe that the Columbia River, when open for through navigation to the sea, will form an important highway of commerce the benefits from which will be very great.

The prospective development of this country is shown by the fact that the Great Northern Railway Co. is now building a branch line from its Columbia River station to Waterville, which will be completed in time to handle this season's crop, and the same company has just formally announced its intention of building a line from Wenatchee to Oroville, following generally the Columbia and Okanogan River Valleys. The Chicago, Milwaukee & Puget Sound Railway Co. has begun grading for a line along the right bank of the Columbia River, from a point opposite Beverly to Hanford, and surveys are now in progress by the same company for a branch line running north from Beverly. These large railroad investments are a good index of the future commercial importance of this region.

Just what influence these railroads will have upon through river commerce is dependent largely upon the cost of water transportation between Portland, Oreg., and upper Columbia River points. The capacity of the existing upper Columbia River steamers is not large, and owing to the swift currents upstream navigation is expensive, in consequence of which present river rates for local commerce are high. An effort was made to obtain from steamboat men an approximate idea of the cost of carrying wheat by boat over an improved river from Wenatchee and points above to Portland, but without success. One of them even questioned the ability of upper Columbia River boats to successfully compete with the railroads on a 500-mile haul. This view, however, is not held by the undersigned, who believes that an improved river will have a distinct value of its own as a highway of commerce, and that in addition it will serve as a regulator of freight rates over a very large extent of territory. Whether the country has developed sufficiently to warrant the inauguration of this work will depend largely upon the magnitude of the undertaking, and this can be determined only by a complete survey.

In connection with the canalization of these rapids a large amount of power can be developed, particularly at Priest and Rock Island Rapids, and this question should be fully investigated if a survey is authorized. There is now a power plant at Priest Rapids, which develops about 1,200 horsepower. The development of this power required the construction of a small dam across one of the river channels, which was done under revocable permit issued by the Secretary of War. The power is transmitted electrically about 15 miles downstream, and there used principally in pumping water from the river into irrigating ditches, and it is believed that any power developed by the United States could be advantageously disposed of for the same purposes. Similar schemes are under consideration, and if the United States decides to do no work it is probable other power plants will be installed at Priest Rapids under existing State laws.

In the present stage of development on the Columbia River it is not believed that the question of terminal facilities merits serious consideration, at least not in the stretch of river between Wenatchee and the mouth of the Snake, though if any radical improvement is undertaken it would probably be advisable to include in the project the installation of transfer and terminal facilities at the points where the river is crossed by the three transcontinental railway lines, the cost of which should be borne in whole or in part by the city at which they are located.

To determine the cost of an adequate improvement on the Columbia River between the mouth of the Snake and Wenatchee it is recommended that a survey be authorized at an estimated cost of $11,000. This includes an item of $1,000 for expert opinions and assistance in the development of water-power plants as auxiliaries to canal structures.

Such a survey can be advantageously made only at low-water stage, so that it is doubtful whether a complete project can be prepared prior to December 1, 1909.

Very respectfully,

C. W. Kutz,
Major, Corps of Engineers.

The Chief of Engineers, United States Army
(Through the Division Engineer).

[First indorsement.]

United States Engineer Office,
Northern Pacific Division,
San Francisco, Cal., June 14, 1909.

Respectfully forwarded to the Chief of Engineers, United States Army.

It is not thought that any open river treatment of this part of the Columbia would prove satisfactory for navigation. The local traffic would not for many years, if at all, justify the cost of canalization. It is doubtful whether the through navigation would develop sufficiently to warrant the cost, except, perhaps, as a regulator of freight rates.

The railroads are gradually extending to the various points along the river and as soon as constructed the navigation of the river usually closes to those points, due in part of course to the difficulties of the channel. It is a question of cost, however, and the only way to ascertain the cost is by a survey. It is, moreover, considered desirable to have a survey of as important a river as the Columbia.

The recommendation of the district officer is therefore approved.

John Biddle,
Lieut. Col., Corps of Engineers,
Division Engineer.

[Third indorsement.]

BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
Washington, D. C., June 28, 1909.

Respectfully returned to the Chief of Engineers, United States Army.

The physical condition of this stretch of the Columbia River is such that a navigable channel can not be maintained by open-river methods. It is equally clear to the board that the cost of canalization would not be justified by the probable resulting advantages solely in the interests of navigation.

As this section of river is susceptible of water-power development, the question is presented whether the development of the water power can be so coordinated with the improvement of the river for navigation as to make it economically justifiable.

The solution of this question can be determined only after a careful investigation and survey, with estimates of cost. The board therefore concurs with the district officer and the division engineer in recommending that a survey be authorized.

For the board:

D. W. LOCKWOOD,
Colonel, Corps of Engineers,
Senior Member of the Board.

[Fourth indorsement.]

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, July 7, 1909.

Respectfully submitted to the Secretary of War.

This is a report on preliminary examination of Columbia River from the mouth of Snake River to Wenatchee, authorized by the river and harbor act of March 3, 1909.

Inviting attention to the report of the Board of Engineers for Rivers and Harbors in the preceding indorsement, I recommend that a survey of the locality, as proposed, be authorized.

W. L. MARSHALL,
Chief of Engineers, U. S. Army.

[Fifth indorsement.]

WAR DEPARTMENT, *July 8, 1909.*

Approved as recommended by the Chief of Engineers.

ROBERT SHAW OLIVER,
Acting Secretary of War.

SURVEY OF COLUMBIA RIVER FROM MOUTH OF SNAKE RIVER TO WENATCHEE, WASH.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., July 11, 1911.

SIR: In compliance with instructions contained in letter of July 14, 1909, I have the honor to submit the following report upon survey of the Columbia River from mouth of Snake River to Wenatchee. The report on preliminary examination of this section of the Columbia River was dated June 9, 1909, and survey was authorized by the Secretary of War July 8, 1909.

The work of making this survey and preparing estimates of cost was in the immediate charge of Assistant Engineer Eugene Ricksecker, with Junior Engineer H. J. M. Baker in charge of the survey party in the field. Field work was in progress from September 5, 1909, to February 18, 1910, but the submission of the report has been delayed by a number of unavoidable causes, and is now not as complete as could be desired, due to the recent death of Assistant Engineer Ricksecker. Mr. Ricksecker devoted much of his spare time during the past year to a study and consideration of the problems involved in the improvement of this stretch of the Columbia River for purposes of navigation and in the incidental development of power at the principal rapids, and this report is based upon the results of his work and that of A. S. Fleet, draftsman (since transferred to the Portland district). The detailed studies made by them can not be prepared for submission with the report without a considerable amount of work, which does not seem to be warranted.

The survey was limited to the stretch of river between the head of Rock Island Rapids and the mouth of the Snake River, as the 12-mile stretch between Wenatchee and the Rock Island Rapids had been surveyed in 1894 by C. F. B. Haskell, under the direction of Capt. T. W. Symons, Corps of Engineers. The results are plotted on a series of charts (not printed) numbered from 25 to 45, inclusive. This series of numbering is a continuation of that adopted by the Symons survey, above referred to, so that the charts of this river, from the international boundary to the mouth of the Snake River, are all numbered continuously.

In addition to the charts above referred to, detail charts (not printed) of Rock Island Rapids and of Cabinet Rapids are also submitted, together with an index and vicinity map (not printed), which shows the relation of this stretch of the Columbia River to the river as a whole.

Detail charts of Priest Rapids were not made, as large scale charts of these rapids made in 1885 served for the purpose of preparing estimates. Copies of the 1885 charts are not submitted, as the information contained on them is believed to be sufficiently well shown on the charts of 1,000 feet to the inch.

When work was started, the river was not low enough to permit reliable soundings to be taken; therefore the party started in at Beverly, working upstream, mapping only the shore line and adjacent topography, expecting to reach Rock Island Rapids when the river was at a low stage, so that soundings and low-water data could be readily and precisely secured on the down trip. River conditions, however, that year were unfavorable. Starting with a 14.3-foot (Wenatchee) stage on September 5, 1909, it fell to a 7-foot stage on October 31, rose to a 13-foot stage on December 2 (an unusual occurrence), and reached its lowest stage (3 feet) on February 26, 1910. This condition prevented the collection of low-water hydrographic data on the upper stretch of the river, delayed the work, and generally increased the cost. In addition to the general survey of the river, a detail survey was made of the left channel of Rock Island Rapids, as this, upon examination, proved to be best adapted to canalization. Only such portions of Priest Rapids were resurveyed as appeared

likely to be included in comprehensive plans for their improvement. These localities were at the sixth and seventh rapids and the island and opposite shores at the lower end of the rapids.

The azimuth of the initial course of the survey was taken to be the same as that of the Chicago, Milwaukee & Puget Sound Railway bridge across the Columbia River at Beverly. Connection was made between the transit line and the United States Geological Survey triangulation station "Hill." This check on "Hill" showed a difference of 13 feet in azimuth. Bench marks were established at intervals of about a mile and a half, marked where possible by crosses cut into the rock. Wherever practicable connection was made with United States Geological Survey bench marks, and at Kennewick connection was made with the United States Coast and Geodetic Survey bench mark.

Gauges were established at the critical points and readings made covering an entire year. From these hydrographs and from a study of the gauge readings at Wenatchee, which are continuous for a considerable period of time, it was possible to compute approximately the elevations of the water surface at different points corresponding to different stages at Wenatchee. By this means all soundings were reduced to low water of 1910, and so plotted. An equation has been added to each chart by which soundings can be reduced to extreme low water, but this relation between low water of 1910 and extreme low water as computed from the Wenatchee gauge is approximate only, and not to be relied upon at points principally below Priest Rapids, where the river bed is unstable.

In 1894 the Columbia River at Wenatchee reached a 58-foot stage—the highest of which there is any record. The high water at Wenatchee during the last 10 years has ranged from 27.4 to 47.2, with a mean of 38.3. The crest of the flood wave is usually reached in June, and extreme low water usually occurs in February. As in the case of high stages, the extreme low stage is seldom reached, and the average low-water stage is from 2 to 3 feet higher than extreme low water.

No discharge measurements were made in connection with this survey. Such measurements were made several years ago at Entiat, a short distance above Wenatchee, and several measurements were made since by an engineer in the employ of one of the power companies interested in the development of Priest Rapids. Combining these measurements a discharge curve was plotted which shows that the run-off of the Columbia River at Priest Rapids varies from minimum of 28,000 cubic feet per second to an average high water maximum of 335,000 cubic feet per second.

The physical conditions, as shown by the survey of 1909–10, do not differ materially from those described in the report on preliminary examination, except as to Cabinet Rapids, concerning which the opinion was expressed that "they can probably be made navigable at low water only by resort to canalization." The several examinations made of these rapids during the progress of the survey now lead to the belief that they can be materially improved by the removal of bowlders, and that when so improved they will offer no greater obstruction to navigation than do many other stretches of swift water on this river that are successfully navigated. The main channel through these rapids along the right bank carries sufficient water for purposes of navigation, but the current is so swift and bears so strongly against the right bank at the foot of the rapids that navigation is dangerous for any but powerful boats. It is estimated that a 6-foot low-water channel near the left bank can be cleared of bowlders and reefs at a cost not to exceed $25,000.

Other rapids are Nixon, Lodged Pole, Quilamene, Island, Cohasset, and Coyote. All these are unimportant, being short stretches of swift water, most of them disappearing as the river rises above its low stage. It is estimated that the removal of low-water obstructions at these points, aggregating 1,500 cubic yards of rock, will cost $15,000. Between Priest Rapids and the mouth of the Snake there are several short bars that show less than 6 feet of water over them at extreme low water. These bars are located at mile 384, carrying less than 4 feet of water; at miles 372¾, 375½, 396⅓, and several places above Kennewick, all carrying 5 feet of water at extreme low. There is also a long bar above Richmond carrying 3 feet of water at extreme low. The steamers now operating on this portion of the river experience no serious difficulty, probably due to the fact that the river rarely reaches its extreme low stage, and when it does is frequently closed to traffic by ice. It should also be remembered that the extreme low-water depths are computed depths, and that the actual depths below Priest Rapids at that stage may be, and probably are, greater than those indicated. This portion of the river is considered to be in such condition that no improvement is warranted or needed at this time.

The river channel between Wenatchee and the head of Priest Rapids is rather thickly studded with bowlders, and while the survey chart of 1894 shows a channel with depths exceeding 6 feet at low water, it is a tortuous and more or less dangerous one. The estimated cost of removing the worst obstructions is $25,000.

The only important obstacles to navigation in the entire stretch of the river under consideration are Rock Island and Priest Rapids, both of which require canalization. In the preparation of estimates for this work lock chambers of the same size as those adopted for the Dalles-Celilo Canal, 45 feet wide by 310 feet between quoins, have been assumed.

Rock Island.—The river in the left channel has a drop of 12 feet at low water in a distance of 2,700 feet; 6.5 feet at average high water (38.5, Wenatchee) and 4 feet at extreme high, most of the fall lying within a distance of 1,000 feet. In the right channel the fall is distributed over a distance of 5,100 feet. Boats have passed through these rapids on several occasions by lining, using the right channel when the water was above the 10-foot stage, but large rock masses make the trip hazardous, much too dangerous and tedious an operation to be included in a regular run. The right channel was improved by the General Government early in 1892 by removal of certain rocks and the placing of a number of ringbolts for use in lining through. It might be further improved along the same lines, but the work would be an expensive makeshift, inadequate for commercial development. For permanent improvement and economical navigation the construction of a lock is a necessity. The site selected for this lock is shown on the detail sheet of Rock Island Rapids drawn to scale 1 inch to 200 feet. Three other locations for the lock were considered, but from the standpoint of economy the site selected is the most advantageous.

The lock, as planned, is to be of concrete with steel mitering gates. The top of the upper gate is at the elevation of extreme high water

and the walls are 6 feet higher. Considering navigation alone, this height is probably unnecessary as at high stages boats could navigate the right channel, but to insure the continuous development of power, which is essential to the commercial success of any work at this point, the walls should be carried to the height indicated.

The present low-water flow through the left channel is approximately 10,000 second-feet, and it is estimated that a low-water head of 11 feet at the lock can be secured without appreciably reducing the flow in the left channel, thus permitting the development of about 8,000 horsepower under an assumed generator and turbine efficiency of 66 per cent. As the river rises the head decreases, but the flow largely increases, so that with a suitable number of turbines supplemented by fall increasers about 12,000 horsepower can be developed when the river at Wenatchee is at the 8½-foot stage. Above this stage the power developed would decrease, due to the decreasing head, unless the number of turbines was still further increased. The determination of the most advantageous power installation is a matter that calls for more extended discharge measurements in the two channels, but for purposes of estimate it is not safe to count on the development of more than 8,000 horsepower. The annual periods when more than 8,000 horsepower could be created economically occur in the spring and fall while the peak of the demand curve will occur in midsummer for irrigation pumping and in midwinter for lighting, so that the peak power would have no commercial value.

There is no market for power in the immediate vicinity of Rock Island Rapids, but with the steady increase in the amount of land in the Columbia River Valley that is being irrigated by pumping it is believed that a market within economic radius would eventually be obtained for the full amount of power that could be generated during the irrigating season. To obtain a market for the power that would be available for the balance of the year would involve greater difficulty and maximum returns from the amount invested in the power plant could not be expected until the surrounding country is further developed.

The estimated cost of this plan of improvement, exclusive of power house and machinery, is as follows:

Lock and approaches:	
37,700 cubic yards rock excavation, at $4	$140,800
42,400 cubic yards concrete, at $10	424,000
19,000 cubic yards fill, at 30 cents	5,700
Lock gates:	
1,430,000 pounds, at 10 cents	143,000
Gates, anchorages, valves, operating machinery, etc	32,000
Lock-keepers' dwellings	7,600
Cofferdam:	
23,000 cubic yards rock fill, at $2	46,000
14,000 linear feet piling, at 40 cents	5,600
200,000 feet b. m. lumber, at $50	10,000
Concrete dam:	
39,200 cubic yards concrete, at $10	392,000
11,000 cubic yards rock fill, at $2	22,000
	1,228,700
Engineering and contingencies, about 15 per cent	181,300
Total	1,410,000

Preliminary designs of a power plant indicate that the cost would amount to approximately $55 per horsepower, or, allowing for spare units, about $500,000—making the total cost $1,910,000.

Assuming that the entire output can be sold at the power plant at $15 per horsepower, and capitalizing this gross income on a 10 per cent basis, the power development at Rock Island Rapids will represent an investment of $1,200,000, and make the net cost, so far as navigation is concerned, $710,000. It may be alleged that a gross income of 10 per cent is greater than the United States should expect upon its investment when it is able to borrow money for 3 per cent, or even less. Taking into consideration, however, the operating expenses, and making due allowance for repairs, depreciation, accidental damages, which in a commercial plant would be covered by insurance, and the possible failure to market all the power developed, it does not seem businesslike to make estimates on a more liberal basis. The United States is the owner of the islands in the river at this point, and it is not practicable to develop power in any quantity without making use of one or more of these islands. For this reason it is believed that the United States, if it undertook to develop power at this point, would not be involved in any controversy over water-power rights that may have been or may in future be granted by the State of Washington.

The project outlined contemplates leaving the right-hand channel in its natural condition. By throwing a low dam across this channel the possibilities for power development can be greatly increased, at the same time improving the channel for navigation between Rock Island and Wenatchee. The present limited market for power in this vicinity, and the fact that such a dam would merely reduce but not entirely obviate the necessity for work between Rock Island and Wenatchee, led to the conclusion that such a dam should not be included in the project at this time.

Priest Rapids.—This is a stretch of swift water extending over a distance of 9¾ miles and having a total fall of 68 feet at extreme low water and 67 feet at extreme high water. The obstructions to navigation are confined to seven rapids, with quieter reaches between, the worst obstructions being at the first, second, third, sixth, and seventh rapids. The fall at the first three was 29 feet at low water of 1910, probably 28.7 feet at extreme low and 17 feet at extreme high water, the distance being 2½ miles. The fall at the sixth and seventh rapids is 11.9 feet at extreme low, in a distance of 3,400 feet.

A number of plans for the improvement of these rapids have been considered. First, the construction of a lateral canal on the left bank of the river from the head of the rapids to the foot of the rapids, with three locks of approximately equal lift, two at the lower end of the rapids and one about halfway up at the site indicated on sheet 33 (not printed). This plan contemplates using Moran Slough (now dry) as a part of the canal trunk. The axis of this canal is designated on the charts as "Project N." The canal section assumed in the estimates is the same as that adopted for The Dalles-Celilo Canal—bottom width 65 feet and a depth of 6 feet at extreme low water. The upper lock is planned for an ordinary high-water stage, the water entering the canal above the stage to be carried off by a spillway placed at the lower end of a through cut above the upper lock.

This plan is designed primarily for navigation, but it is proposed to allow a velocity of 2.7 feet per second so that power can be developed at both the upper and lower locks. At the upper lock site this amounts to about 1,800 horsepower at extreme low water, and at the lower lock site to 4,000 horsepower at the same stage. As the river rises the first of these amounts increases, due to increased flow in the canal above the upper lock, while the second decreases, due to decreased head. By operating the two power houses in conjunction, 5,800 horsepower can be developed throughout the year.

The estimated cost of this project, exclusive of power houses, power machinery, and auxiliaries thereto, amounts to $3,700,000, and the excluded items will cost $360,000, a total of $4,060,000. Power here will have an equal or greater value than at Rock Island, but assuming the same value the power plants of the "N" project will represent an investment of $870,000, making the net cost in the interest of navigation about $3,200,000.

With the expectation of reducing the net cost to the United States a second project was prepared, designated as project "P." This consists of a canal located on the left bank of the river suitable for navigation purposes, but built with a view to developing power. This canal is designed with a bottom width of 200 feet, side slopes of 1 on 1 and 2 on 3 to carry 10 feet at extreme low water. This will leave the river at Bend, lie in through cut for a distance of 1⅓ miles, will have a spillway and regulating gates where it emerges from the through cut to care for the flow at river stages higher than the average high water, these features and its alignment being common to the "N" project to this point. The remainder of the canal to be in balanced cut and fill with lower portion lined with reenforced concrete. A flight of three locks at the lower end of Priest Rapids will overcome the total fall of the rapids and hold the water in the canal at the level of the river at upper end of the rapids.

In the vicinity of the locks pressure mains will lead water to a power house located on the river bank below the locks. The minimum flow corresponding to a zero (Wenatchee) stage will yield 24,000 horsepower, and the minimum during the irrigation season, April 15 to September 15, as shown by the records of the last five years, corresponding to 6½-foot (Wenatchee) stage will yield 35,000 horsepower.

The estimated cost of this project, exclusive of power house, power machinery, and auxiliaries, is $7,000,000, and the excluded items will cost $1,750,000—a total of $8,750,000. Assuming that the power continues throughout the year, 24,000 horsepower can can be marketed at $15, that the excess, 11,000 horsepower, developed during the irrigation season, can be marketed at $10, and, capitalizing the gross income at 10 per cent, the power investment would amount to $4,700,000 and the net investment for the benefit of navigation would amount to $4,050,000.

Comparison with the "N" project shows that by increasing the dimensions of the canal the net cost has been increased instead of decreased. In other words, it is apparently not economical to develop the power of Priest Rapids in this manner unless it can be marketed at prices greater than those assumed.

The Columbia Valley Reclamation Co. is proposing to develop part of the power of Priest Rapids by the construction of a lateral canal on the left bank of the river similar to project "P," outlined above, differing, however, from the latter in that power is developed at two points and Moran Slough is used as a reservoir. It is understood that the right of way for this project has been entirely acquired, partly from the State and partly from individuals, and some work has been done during the past year by a steam shovel. This work has been desultory in character, and is apparently for the purpose of keeping alive the company's water rights.

It is possible that a modification of the "P" project, to make it conform more closely to the project of the Columbia Valley Reclamation Co., would result in decreased cost or in increased power development, but revised estimates were not made, as the information obtained was sufficient to show that, whatever arrangement was adopted, a lateral canal would be far more costly than the "L" project, to be described hereafter.

Part of the power of Priest Rapids was developed a number of years ago by the Hanford Irrigation & Power Co., now the Washington Irrigation & Development Co., by means of a canal on the right bank of the river, at the head of which a small crib dam was thrown across one of the channels into which the river divides at low water. This dam was authorized by revocable permit issued by the Secretary of War on April 21, 1906. The primary development amounted to 1,200 horsepower and a year ago was increased to 2,400 horsepower.

With the object of utilizing the Hanford Canal an outline plan was prepared, designated as project "H," which contemplates extending this canal in both directions, deepening it, and constructing two locks at the lower end to overcome the fall of the first, second, and third rapids. The open river is to be used through the fourth and fifth rapids and a single lock constructed to overcome the fall of the river at the sixth and seventh rapids.

This project would involve the excavation of a large amount of rock, estimated at 895,000 cubic yards, and the total cost would exceed $6,000,000. This could be reduced either by developing power or by cooperating with the power company whereby it would bear part of the expense in return for the privilege of developing the increased power, but as a superficial examination showed that this plan was not an economical one, either from a power or navigation standpoint, further consideration was abandoned.

The fourth project, designated as project "L," contemplates the construction of a longitudinal dam in the river, founded on the three rocky islands shown on the map, with a flight of two locks at the lower end to overcome the fall in the first, second, and third rapids at all stages of the river. Above the third rapids the project is identical with the "H" project, that is, it involves the use of the open river through the fourth and fifth rapids and the construction of a single lock at the sixth and seventh rapids to overcome the difference in level from extreme low water to 30-foot (Wenatchee) stage. Above this stage boats will use the open river. No provision is made for the development of any power at the upper (single) lock, but at the lower lock 18,000 horsepower can be developed continuously throughout the year, with 12,000 horsepower additional during the irrigation season, April 15 to September 15.

The estimated cost of this project, not including power development, is as follows:

PROJECT "L."

FIRST AND THIRD RAPIDS.

Two locks in flight:	
27,800 cubic yards rock excavation, at $4	$111,200
50,000 cubic yards concrete, at $10	500,000
11,000 cubic yards fill, at 30 cents	3,300
Lock gates, 865,200 pounds, at 10 cents	86,520
Dam:	
22,000 cubic yards rock excavation, at $4	88,000
146,000 cubic yards concrete, at $10	1,460,000
37,800 cubic yards fill, at 30 cents	11,340

SIXTH AND SEVENTH RAPIDS.

Single lock:	
11,000 cubic yards rock excavation, at $4	44,000
25,300 cubic yards concrete, at $10	253,000
8,300 cubic yards fill, at 30 cents	2,490
Lock gates, 630,000 pounds, at 10 cents	63,000
Dam:	
2,200 cubic yards rock excavation, at $4	8,800
15,100 cubic yards concrete, at $10	151,000
General:	
Gate anchorages, valves, operating machinery, etc	90,000
Lock keeper's houses	13,800
Cofferdams	80,000
Engineering and contingencies, 15 per cent	433,550
Total	3,400,000
The power house, machinery, etc., necessary to develop 30,000 horsepower is estimated to cost	1,650,000
	5,050,000
If all the power can be sold to a distributing company at $15 and $10 per horsepower, the income will amount to $390,000, representing a power investment of	3,900,000
Thus making the net investment for purposes of navigation	1,150,000

In the "N" and "P" projects allowance was made in the estimates for purchase of right of way at prices which represent the value of the land for agricultural purposes, but nothing was included for the water rights of the Columbia Valley Reclamation Co. These rights would unquestionably have to be acquired if the projects are to be carried out, but the cost is wholly a matter of conjecture. If based on work actually done it would be small, but if based on prospective profits it would probably be large.

The "L" project is the only one that could be executed without acquiring right of way from either one or the other of the two companies now in the field, and even in this project some doubt exists as to the ownership of the three islands upon which the longitudinal dam rests. These islands were shown on the official land-office plat of the Interior Department made prior to the admission of Washington as a State. The islands, however, were not meandered and it is admitted that they are annually submerged by ordinary high water. By reason of their annual submergence, title to these islands was claimed by the State of Washington, and within the past year it duly conveyed this title to the Washington Irrigation & Development Co. Prior to that time, however, at the request of this office, an Executive order had been issued (No. 1207, May 27, 1910), under the terms of which these islands were withdrawn from entry and reserved for the use of the War Department in connection with the improvement of the river. This doubt as to ownership does not affect in any way the right of the United States to execute this project in the interest of navigation, for its jurisdiction in such matters extends to high-water mark.

In December, 1910, the Washington Irrigation & Development Co. filed plans for the enlargement of its plant to a capacity of 30,000 horsepower. Its plans for this enlargement contemplated a longitudinal dam in the river resting on the islands above referred to, similar in this respect to the "L" project, with a canal at the lower end leading to a power house on the right bank adjoining the present power house. Permission to erect these structures was denied by the Chief of Engineers, on the grounds that the islands were Government property, or at least would be so considered until the Washington Irrigation & Development Co. had proved its title, and that there was no authority of law that would permit the permanent occupancy of Government land.

The ultimate aim of this company is to develop the entire power of Priest Rapids by the construction of a high dam across the river, drowning out all the rapids. In connection with complete development, it is understood that the company is willing to construct a flight of locks without cost to the United States and provide the necessary power for operating them. It is not willing to assume the construction of locks in connection with its proposed 30,000 horsepower installation, but will furnish power for operating such locks if constructed by the United States.

The next question that arises concerns the right of the United States to develop the power of these rapids in excess of the amount required for the operation of structures erected in the interest of navigation. The State of Washington recognizes the paramount interest of the United States so far as navigation is concerned, but claims title to the bed and consequently to the power of all navigable streams within its borders. Its laws provide for the development and utilization of this power through a system of filing, under the terms of which prospective users must post notices of their intentions and file copies of their notices with designated authorities. In the acquisition of water rights by this method the principle prevails of "first in time first in right."

Acting under these laws the Hanford Irrigation & Power Co., a number of years ago, filed on the entire low-water flow of the Columbia River at Priest Rapids, but as it has thus far only applied to beneficial use a small part of this flow it is questionable as to how far its rights extend. On the left bank of the river the Columbia Valley Reclamation Co. has also made or acquired filings on the flow of the Columbia River. These filings, it is understood, are subsequent to the filings of the Hanford Irrigation & Power Co.

Very little development work has been done by the Columbia Valley Reclamation Co., nevertheless its water rights as well as those of the Hanford Irrigation & Power Co. (Washington Irrigation & Development Co.) have a property value which must be recognized in any plan for the improvement of navigation which

involves the creation of power to an extent that will encroach upon the rights of these companies.

A lateral canal, such as is contemplated in the "N" and "P" projects, would provide a better means of surmounting these rapids than the "L" project, but the cost, even assuming the incidental development of power, is believed to be prohibitive. The "L" project would provide means of passing the worst obstructions and permit regular traffic. Its cost, if power is developed, is very much less than any of the other projects and the resulting waterway would be in keeping with the remainder of the river which contains a number of reaches of swift water that will necessitate lining during periods of low water.

The total cost of improving the Columbia River between Wenatchee and the mouth of the Snake River in the manner outlined above would be:

Above Rock Island Rapids	$25,000
Rock Island Rapids (net cost)	710,000
Cabinet Rapids	25,000
Cabinet Rapids to Priest Rapids	15,000
Priest Rapids, "L" project (net cost)	1,150,000
Total	1,925,000

The actual expenditure to carry out the project would exceed this amount by $5,100,000, making the total expenditure $7,025,000.

The cost of operation and maintenance of the locks is estimated at $50,000, about three times the cost of maintaining and operating the single lock at the Cascades. This is based on the assumption that the same crew will operate both locks at the lower end of Priest Rapids.

COMMERCE.

The present local commerce of the river was described in the report on preliminary examination and the only changes since are a slight decrease in tonnage below Priest Rapids from 11,712 tons to 10,035 tons, and a decrease in the section above Wenatchee from 54,000 tons to 23,722 tons. The latter decrease was due to the construction of the Waterville branch of the Great Northern Railway, which now carries the greater part of the wheat formerly shipped to Wenatchee by boat. No local commerce has developed between Trinidad, on the Great Northern Railway, and Beverly, on the Chicago, Milwaukee & Puget Sound Railway, though there is ample depth for river steamers throughout the year, nor is there any local commerce between Wenatchee and Rock Island Rapids.

As no work is proposed below Priest Rapids and as there is not sufficient population to create even local commerce on the existing stretches of good water, any improvement, if made, will be for the benefit of commerce originating in or destined to Wenatchee plus the local commerce on the river above Wenatchee.

Wenatchee has a population of 4,050 and is the commercial center of an irrigated area of 20,000 acres, devoted principally to the raising of apples. It is not a manufacturing town. If the Columbia River were navigable to Portland, some apples would be shipped to the Pacific coast by that route, but the tonnage would be small. Some of the miscellaneous supplies which the people of Wenatchee use

would come by the river, if navigable, but it would mean a 5[illegible]-mile haul against the swift currents of the Columbia, as compared with a 165-mile rail haul across the Cascade Mountains.

The construction of a railroad along the Pend Oreille River from Newport to Box Canyon, 60 miles, resulted in putting out of business all the steamers on that river (five in number), as they were unable to successfully compete with the railroad. The general manager of the Columbia & Okanogan Steamboat Co., operating on the Columbia River between Wenatchee and Bridgeport, states that his boats will all be withdrawn if a railroad is built between the towns named. These two cases indicate that boats on rivers of this character can not compete with the railroads in the carrying of passengers and package freight, and that unless there is sufficient bulky freight to justify a regular continuous service they do not operate at all.

Very little interest has been shown in the project except by the Open River Transportation Co., whose letters on the subject in response to a series of questions are appended hereto. The letters have received careful consideration, but, even assuming as correct the statements made as to the cost of water transportation on the Columbia River, the amount of traffic in prospect is not sufficient in my judgment to warrant the investment of $7,025,000, even if $5,100,000 of this amount is income producing.

In most canalization projects on navigable streams the creation of power is incidental to the improvement for navigation, but in this case the power created will do far more to develop the country and increase its prosperity than will the providing of a navigable channel; in other words, Priest Rapids and Rock Island Rapids should be developed primarily for power with incidental consideration for the needs of navigation. To prosecute such a development economically means that it must be gradual so as to keep pace with the demands for power, and yet each step must conform to a comprehensive plan in order that when completed the full power of the rapids will be developed and suitable provision made for navigation.

There is immediate need for additional power in the Columbia River Valley, but no real present need for navigation between Wenatchee and the mouth of the Snake River. For this reason the problem should be approached from a power standpoint. If the United States possesses a legal right to develop the power of this river it then becomes a question of policy as to whether it should proceed on a power basis or whether the creation of power should be left to private enterprise.

Unless the United States is willing to adopt the methods in use by commercial power companies—that is, advertise, educate the people, and thereby create a demand for its output—it will be advantageous to leave the question of power development to private companies. This course need not involve the United States in any financial loss nor need it cause the loss of any right to guard against monopoly—for in the granting of permits to build structures in these waters conditions can be imposed which will safeguard these as well as any other rights which the public possesses.

Considering the cost, the uncertainty as to the right of the United States to develop power in excess of its own requirements, and the limited amount of commerce to be benefited, I am of the opinion that the improvement of the Columbia River from the mouth of

hee is a work not worthy of being undertaken
t the present time.
ed.

C. W. KUTZ,
Major, Corps of Engineers.

NEERS, UNITED STATES ARMY
ivision Engineer).

[First indorsement.]

NITED STATES ENGINEER OFFICE,
NORTHERN PACIFIC DIVISION,
San Francisco, Cal., July 17, 1911.

led to the Chief of Engineers, United States
e views of the district officer.

JOHN BIDDLE,
Colonel, Corps of Engineers,
Division Engineer.

Board of Engineers for Rivers and Harbors,

O

63D CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { DOCUMENT No. 1112.

COLUMBIA RIVER, WASH., FROM RICKEY (OR GRAND) RAPIDS TO INTERNATIONAL BOUNDARY LINE.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING,

WITH A LETTER FROM THE CHIEF OF ENGINEERS, REPORT ON PRELIMINARY EXAMINATION OF COLUMBIA RIVER, WASH., FROM AND THROUGH RICKEY (OR GRAND) RAPIDS TO THE INTERNATIONAL BOUNDARY LINE, WITH A VIEW TO OPEN RIVER NAVIGATION.

JULY 7, 1914.—Referred to the Committee on Rivers and Harbors and ordered to be printed, with illustrations.

WAR DEPARTMENT,
Washington, July 6, 1914.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

SIR: I have the honor to transmit herewith a letter from the Chief of Engineers, United States Army, dated July 3, instant, together with a copy of a report from Maj. J. B. Cavanaugh, Corps of Engineers, dated May 14, 1914, with maps, of a preliminary examination made by him in compliance with the provisions of the river and harbor act of July 25, 1912, of Columbia River, Wash.

Very respectfully,

LINDLEY M. GARRISON,
Secretary of War.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, July 3, 1914.

From: The Chief of Engineers, United States Army.
To: The Secretary of War.
Subject: Preliminary examination of Columbia River, Wash.

1. There is submitted herewith, for transmission to Congress, report dated May 14, 1914, by Maj. J. B. Cavanaugh, Corps of Engineers, on preliminary examination called for by the following item contained in the river and harbor act approved July 25, 1912:

Columbia River, Wash., from and through Rickey and Grand Rapids to the international boundary line, with a view to open river navigation.

2. The section of river under consideration has a length of 48 miles and flows through a deep canyon. It has a steep slope, made up of a series of pools and rapids or falls, and is obstructed by dangerous rocks. Some places are impassable, and one of them, Kettle Falls, can not be made passable at any stage of the river by regulation. In view of the enormous cost of any practicable improvement and the small and doubtful benefit to commerce that would result therefrom, the district officer is of opinion that the improvement is not worthy of being undertaken by the United States at the present time. The division engineer concurs in this opinion.

3. These reports have been referred, as required by law, to the Board of Engineers for Rivers and Harbors, and attention is invited to its report herewith, dated June 16, 1914, concurring in the views of the district officer and the division engineer.

4. After due consideration of the above-mentioned reports, I concur with the views of the district officer, the division engineer, and the Board of Engineers for Rivers and Harbors, and therefore report that the improvement by the United States of Columbia River, Wash., from and through Rickey (or Grand) Rapids to the international boundary line, with a view to open river navigation is not deemed advisable at the present time.

DAN C. KINGMAN,
Chief of Engineers, U. S. Army.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS.

[Third indorsement.]

THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
June 16, 1914.

To the CHIEF OF ENGINEERS, UNITED STATES ARMY.

1. The following is submitted in review of the district officer's report on preliminary examination of Columbia River, Wash., from and through Rickey (or Grand) Rapids to the international boundary line, with a view to open river navigation.

2. The distance from Rickey (or Grand) Rapids to the international boundary line is 48 miles. This portion of the river flows through a deep canyon, has a very steep slope, is obstructed by numerous rocks and rapids, and has generally a very swift current. One of these obstructions, known as Kettle Falls, can not be made passable at any stage of the river by regulation. The fall at this rapids is 33 feet, and the fall at Grand Rapids is 20 feet. Kettle Falls City, having a population of about 500, is the chief town on this reach.

3. The district officer states that to put the river in a good condition for a commercially practicable through navigation from the international boundary line to below Grand Rapids would involve the construction of extensive canalization works or boat railways or other suitable means of passing boats from one level to another at several points, and the removal of many obstructive ledges and dangerous rocks. He quotes descriptive matter from a former report, from which a very good idea of the serious obstructions at the several rapids may be had.

4. There is at present no commerce on this reach of river, and the district officer states that his efforts to secure statistical data have not met with success, although such information was promised by local interests. In view of the enormous cost of any practicable

improvement and the small and doubtful benefit to commerce that would result therefrom, the district officer is of opinion that the locality is not worthy of improvement by the United States at the present time. The division engineer concurs in this view.

5. Interested parties were informed of the unfavorable tenor of the district officer's report and given an opportunity of submitting their views to the board, but no communications on the subject have been received.

6. It is clear from the information now in hand that it is impracticable to secure navigation over this reach of river at anything like justifiable cost. There is no navigation at present, and it seems doubtful if any extensive commerce would develop if the river were improved. The board therefore reports, in concurrence with the views of the district officer and the division engineer, that in its opinion it is not advisable at this time for the United States to undertake the improvement of the Columbia River from Rickey (or Grand) Rapids to the international boundary line.

7. In compliance with law, the board reports that there are no questions of terminal facilities, water power, or other related subjects which could be coordinated with the suggested improvement in such manner as to render the work advisable in the interests of commerce and navigation.

For the board:

W. M. BLACK,
Colonel, Corps of Engineers,
Senior Member of the Board.

PRELIMINARY EXAMINATION OF COLUMBIA RIVER, WASH.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., May 14, 1914.

From: The District Engineer Officer.
To: The Chief of Engineers, United States Army
(Through the Division Engineer).
Subject: Preliminary examination of the Columbia River, Wash., from and through Rickey (or Grand) Rapids to the international boundary line, with a view to open river navigation.

1. In compliance with section 2 of the river and harbor act dated July 25, 1912, I have to submit the following report on the preliminary examination of Columbia River Wash., from and through Rickey (or Grand) Rapids to the international boundary line, with a view to open-river navigation, with map as required.

2. Previous examinations and surveys of the upper Columbia River are reported in Executive Document No. 238, Fifty-first Congress, first session; Executive Document No. 39, Fifty-second Congress, second session; House Document No. 440, Fifty-ninth Congress, second session; Senate Executive Document No. 186, Forty-seventh Congress, first session; Annual Report, Chief of Engineers, United States Army, for 1893, pages 3381 to 3399, inclusive.

3. The Columbia River crosses the international boundary line in longitude 117° 37′ west of Greenwich and flows in a southerly direction for 110 miles, then turning westward about the same distance forms the so-called "Big Bend" region. Rickey (or Grand) Rapids is situated 48 miles below the international boundary line. The data given on the maps herewith are from the original survey maps of 1891 and amendments and additions made in 1909 and 1910.

The portion of the river considered in the present examination flows through a deep canyon, the valley containing a large amount of rich bench land along both sides, and the adjacent hills being well timbered.

The Kettle River from the west and the Colville River from the east at 38 and 45 miles, respectively, from the international boundary line, are the only important tributaries of this section of the river, and both of them are unnavigable.

Measurements made during the 1891 survey above the mouth of the Okanogan River indicate a low-water flow of about 50,000 second-feet and a high-water flow of 300,000 second-feet.

The Columbia River in this reach has a very steep slope, made up of a series of pools and rapids or falls. The principal falls are at Little Dalles, Kettle Falls, and Grand Rapids, and the obstructions to navigation consist of these falls, numerous rapids, and dangerous rocks, and a generally swift current. Some of these places are impassable, and one of them, Kettle Falls, can not be made passable at any stage of the river by regulation. The obstructive character of other places can be lessened by the removal of rocks from the bed and sides of the river.

The stretch from the boundary to Kettle Falls has a fall of 1.973 feet per mile, but can be improved by regulation. At Kettle Falls there is a drop of 33 feet at low water, and 6 miles below it is Grand Rapids, with a fall of 20 feet, giving a total fall from the head of Kettle Falls to below Grand Rapids of 58 feet.

To put the river in a good condition for a commercially practicable through navigation from the international boundary line to below Grand (or Rickey) Rapids involves the construction of extensive canalization works or boat railways or other suitable means for passing boats from one level to another at several points and the removal of many obstructive ledges and dangerous rocks.

At the international boundary line the Columbia River is well suited to navigation and is at present navigated up to its source in Upper Columbia Lake. The Canadian Dominion Government has spent and is at present spending considerable money in improving this stretch of river.

4. From Annual Report of the Chief of Engineers, 1893, pages 3384 et seq., the following description of the obstructions in the Columbia River from the international boundary line through Grand Rapids is taken, with suggested method of treatment. No improvements, except partial removal of rock in Grand Rapids, have been made on this stretch of river since the time of the original survey in 1891, and conditions are still practically as described in the report of 1893.

Detail drawings of obstructions are shown on accompanying maps.

Twomile Rapids.—After leaving the boundary line the first obstruction met with is at Twomile Rapids. Here the channel is obstructed by three rocks and a reef jutting out from the left shore. The betterment of the river at this point involves the removal of these rocks and this reef, aggregating 70 cubic yards of rock, of which 30 cubic yards are under water and 40 are above water at ordinary stages.

Steamboat Rapids.—Seven miles below the boundary is an awkward place for boats. Here there is a large shoal area, about which the channel makes a sharp detour, and just below this is a jutting point of rock and 11 small rocks. There are in these rocks about 90 cubic yards of submerged rock which should be removed.

Sheep Creek Bend.—Nine miles below the boundary is a bad place in the river. This is a point where Sheep Creek comes in from the west and Deep Creek comes in from the east. Just before reaching a sharp bend in the river known as Sheep Creek Bend the navigable channel passes between two large rock islands, and in the middle a smaller rock stands, the removal of which is necessary for safety.

Just below the bend the channel hugs the right shore, but it is studded with small lone rocks, 13 of which require removal. All this work involves the removal of 230 cubic yards of rock, which at the ordinary stages would be submerged.

The Little Dalles.—The Little Dalles is 15 miles below the boundary. Here the Columbia forces its way through a confined channel studded with rocks. At the head of the Little Dalles the river is only 130 feet wide, and it continues narrow, though somewhat wider, for 2,000 feet.

While the problem of improving the Little Dalles to give practical navigation at dead low water is not difficult, it becomes seriously so at higher stages of the river. As the water in the river rises the engorgement produces more and more of a fall, until at extreme high water there is a fall of 20 feet. To make the river navigable at the low stage of the water involves the removal of 3,400 cubic yards of rock from the reef at the entrance, and from the rapid below the Little Dalles proper. But this would give but imperfect navigation at low-water stages only. The river from Steamboat Rapids down to and through the Little Dalles is very rapid.

To make the Little Dalles navigable at ordinary stages it will either be necessary to widen the channel by the removal of a vast amount of rock, or to supply some auxiliary, as a lock and dam, or boat railway.

Josephs Rapids.—These rapids are 25 miles below the boundary. At this place there are 9 rocks and 1 jutting reef to be removed, aggregating 135 cubic yards of rock under water and 500 cubic feet above water. Three miles below there is a cluster of 14 rocks, the removal of which would be desirable. This cluster of rocks aggregates 140 cubic yards under water.

Pingstone Rapids.—These rapids commence at a point 30 miles below the boundary, and are 2 miles in length. In this stretch there are 16 rocks to be removed, aggregating 180 cubic yards under water and 1,500 cubic yards above water. Through these rapids the current runs at a rate of 8 miles per hour when the river is at nearly low water.

Marcus Rapid.—This is 35 miles below the boundary and is short, with quiet water above and below. To benefit it the point of rock jutting out from the right shore and 23 rocks just below should be removed. These aggregate 700 cubic yards of rock under water.

Kettle Falls.—The next obstruction of the river is Kettle Falls, situated 41 miles down from the boundary. This is the most complete and absolute bar to navigation at all stages in the river. Kettle Falls consists of two falls, which are indicated on the plat.

At this point the river is separated into channels by Hayes Island. The left-hand channel is about 160 feet wide for the first half of its length and then narrows up very much, in one place to 50 feet. The lower half of its length is a cascade; the fall in this distance of three-fourths of a mile is equal to the principal fall in the main channel, which is 25 feet. This main fall of 25 feet in the principal

channel is caused by a ledge of limestone rock extending from the island to the right shore a length of 380 feet. The lower fall is caused by a promontory jutting out from the left shore below the island and extending to within 65 feet of the right shore. The low-water height of this lower fall is 7 feet.

The total fall at high water is the same as at low water, but it is differently distributed. At high water the lower fall becomes greater than the upper fall on account of the engorgement of the river, caused by the jutting reef at the lower fall.

If it should ever be deemed of sufficient importance to the interests of commerce to improve Kettle Falls so that boats could make the passage, it could be very properly done by locating locks in the promontory or ledge which juts out from the left shore, and the continuation of which forms the lower fall, at the same time damming up the outlet of the river channel between Hayes Island and the left bank, and cleaning it out where necessary to give good passage.

The total lift which would be required in these locks from low water below the falls to high water above the falls would be 60 feet.

Grand Rapids.—Grand Rapids are situated 7 miles below Kettle Falls, and these, while of a different nature, are nearly as impassable at any stages of the water for steamboats.

Grand Rapids are situated 48 miles below the boundary. The length of the rapids is 3,000 feet, the average width 1,200 feet, and the fall 20 feet. The river here is studded with rocks, through and about which the water flows with great rapidity in a very violent manner.

To pass boats up these rapids would require either a dam and locks, a canal with locks, or a boat railway. On account of the proximity of Kettle Falls and Grand Rapids, a plan to pass both obstructions by a boat railway about 8¾ miles long suggests itself. There is a very good alignment for such a road along the left bank of the river.

5. The following summary of conditions affecting the improvement of the upper Columbia, taken from report in Executive Document No. 39, Fifty-second Congress, second session, is believed to be thoroughly sound:

> A pretty thorough knowledge of the river and a careful study of all transportation and economic questions connected with it convince me that this river can not, at least in the near future, become a through highway of commerce upon which will be transported the products from and supplies to the region drained by it. There are too many things against its ever occupying this high position in the world of commerce. These may be summarized as the obstructions, such as rapids and falls of greater or less magnitude, which can only be passed by expensive canals and locks, boat railways, or portage roads; the many lesser rapids, where auxiliary power or lining would be necessary; the generally swift currents, requiring a large amount of fuel to surmount combined with a lack of fuel and high cost of the same; the economic character of the country in the immediate vicinity of the river, which is of such a nature as to furnish or promise but little local business; the topographical character of the river and its immediate vicinity, which render it difficult to get to and from the fertile regions above it, for it must be remembered that the Columbia flows through a great canyon or depression from 2,000 to 3,000 feet and more below the general level of the country drained by it, and the dangers which boats must ever take in navigating many portions of its course. The function of the Columbia in this upper portion of its course in the commercial world is and will be, at any rate for many years, that certain portions of it will be navigated as feeders to railroads. As such, certain portions will be of great value, and can well receive the attention of the General Government.

6. *Railroads.*—A branch of the Great Northern Railway coming from Spokane follows down the valley of the Colville River to its

junction with the Columbia River and crosses the Columbia at Marcus, 39 miles below the international boundary line. From this point one railroad line follows the river to the international boundary line and thence to Nelson, British Columbia, on Kootenai Lake, and another line runs up the valley of Kettle River and westward to Republic and Oroville, Wash., connecting with the Canadian Pacific Railway. A branch line of the Northern Pacific Railway has been graded (but no rails laid or bridges built) from west of Spokane, Wash., northward down the valley of Hawk Creek to the big bend of the Columbia River at Peach, Wash., and thence up the left bank of the river to the mouth of Spokane River, 57 miles below Grand Rapids, and its ultimate completion and extension upstream to Grand Rapids and Kettle Falls is not improbable. Improvements at present under way will make the entire stretch of river from Grand Rapids to Peach safely navigable for 6-foot-draft steamers at low water. One boat, *The Enterprise*, now occasionally plies on this stretch of stream.

The portion of the Columbia from Marcus to the international boundary line is a link in the line of communication between the Canadian Pacific Railroad at Revelstoke and the Great Northern, Northern Pacific, and Union Pacific Railroads at Spokane and incidentally by means of the Columbia & Kootenai Railroad with the Kootenai Lake and the Great Northern Railroad at Bonners Ferry, but its importance has been lessened in recent years by the construction of parallel railroads.

From Marcus northward to the international boundary line the territory tributary to the Columbia River is served by two railroad lines, one along the east bank of the river from Marcus to Nelson, British Columbia, and the other from Marcus up the valley of the Kettle River westward to Republic and Oroville. From Marcus south to Grand Rapids, 10 miles, a fine stretch of bench-land country is at present highly cultivated and must haul its produce out of the valley by a steep wagon road to the nearest railway station, at Meyers Falls, 4½ miles from Kettle Falls City. All of the Columbia River Valley, from Grand Rapids southward as far as the Spokane River, must haul its produce a distance of 15 to 45 miles up grade to the nearest railroad. To reach the plateau or table-land from the valley, the roads overcome a height of 1,500 to 3,000 feet in 4 to 10 miles.

7. *Resources.*—The chief products of the Columbia River Valley from Grand Rapids northward to the international boundary line are fruits and a medium quality of timber in the lowlands; cattle and a considerable quantity of grain and hay on the uplands. The Kettle River, on the east bank, and the Colville River, on the west bank, are used for irrigating the bench lands.

Kettle Falls City is the chief town in this vicinity and has about 500 inhabitants.

There is at present no commerce on the section of the Columbia River under consideration, and in view of the heavy expense of operating boats in such swift water it is not believed that any traffic other than that originating at Kettle Falls City would be diverted from the railroad even if the river were improved.

To learn the desires of interested parties regarding improvements to navigation on the upper Columbia River, a public hearing was held at Kettle Falls City on February 7, 1913. This hearing was attended by the chamber of commerce and most of the prominent

citizens of Kettle Falls and vicinity. It was clearly stated that the present policy of the Government toward river improvement work was favorable to improvements only when the volume of present and reasonably prospective commerce warranted the expenditure as a good business venture. Local interests, recognizing the fact that improving the entire stretch of river from and through Grand Rapids to the international boundary line would entail a prohibitive expense when compared with the existing and immediately prospective commerce, expressed a desire to have an open river suitable for navigation through Rickey (or Grand) Rapids up to Kettle Falls City, so that produce might be taken southward from this point to the new railroad which is projected to a terminus at Lincoln, north of the mouth of the Spokane River. Information was requested by the district engineer regarding the products of the country, existing and prospective tonnage for river transportation, and upon other facts and considerations affecting the advisability of the improvement desired. Lists of questions, sample reports containing similar data, and every assistance were furnished to the Chamber of Commerce of Kettle Falls City, which promised to supply information as to commerce and commercial conditions. Repeated inquiries up to the present time have failed to secure any additional information regarding the upper Columbia River Valley, and therefore no such information can be submitted with this report.

8. *Terminal facilities.*—There are no terminal facilities. Landings are made alongside the banks. No terminal facilities are needed.

9. *Flood control, water power, etc.*—No questions of flood control or land reclamation enter into consideration in this report. Since there are valuable water powers in this stretch of river, supervision over any dams to be authorized should be exercised by the United States, with a view to lessening the cost of any needed locks or works for navigation.

10. *Recommendations.*—In view of the enormous cost of any practicable improvement for open-river navigation of the Columbia River from and through Rickey Rapids to the international boundary line, and the small and doubtful benefit to commerce that would result therefrom, I am of the opinion that the improvement is not worthy of being undertaken by the United States at the present time.

J. B. CAVANAUGH,
Major, Corps of Engineers.

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
NORTHERN PACIFIC DIVISION,
Portland, Oreg., May 18, 1914.

To CHIEF OF ENGINEERS:

Forwarded, concurring with the recommendations made in paragraph 10 by the district officer.

C. H. MCKINSTRY,
Lieut. Col., Corps of Engineers,
Division Engineer.

[For Report of the Board of Engineers for Rivers and Harbors see page 2.]

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