2-16-1899

Military road, Fort Washakie to Buffalo Fork, Snake River, Wyoming. Letter from the Secretary of War, transmitting, with a letter from the Chief of Engineers, a copy of a report on the construction of a military road from Fort Washakie, Wyo., to the mouth of the Buffalo Fork of Snake River, Wyoming.

55TH CONGRESS, 3d Session. } HOUSE OF REPRESENTATIVES. { DOCUMENT No. 245.

MILITARY ROAD, FORT WASHAKIE TO BUFFALO FORK, SNAKE RIVER, WYOMING.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING,

WITH A LETTER FROM THE CHIEF OF ENGINEERS, A COPY OF A REPORT ON THE CONSTRUCTION OF A MILITARY ROAD FROM FORT WASHAKIE, WYO., TO THE MOUTH OF THE BUFFALO FORK OF SNAKE RIVER, WYOMING.

FEBRUARY 20, 1899.—Referred to the Committee on Military Affairs and ordered to be printed.

WAR DEPARTMENT,
Washington, February 16, 1899.

SIR: I have the honor to transmit herewith, for the information of Congress, a letter from the Chief of Engineers, United States Army, dated February 14, 1899, together with a report by Capt. J. C. Sanford, Corps of Engineers, dated February 3, 1899, on the construction of a military road from Fort Washakie, Wyo., to the mouth of the Buffalo Fork of Snake River, Wyoming.

Very respectfully,

R. A. ALGER,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, February 14, 1899.

SIR: I have the honor to submit herewith a report, with maps, of February 3, 1899, by Capt. J. C. Sanford, Corps of Engineers, on the construction of a military road from Fort Washakie, Wyo., to the mouth of the Buffalo Fork of Snake River, Wyoming, for which an appropriation of $10,000 was made in the sundry civil act, approved June 4, 1897, and to recommend that the same be transmitted to Congress for its information.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

CONSTRUCTION OF MILITARY ROAD FROM FORT WASHAKIE TO THE MOUTH OF BUFFALO FORK OF SNAKE RIVER, WYOMING.

UNITED STATES ENGINEER OFFICE,
Sioux City, Iowa, February 3, 1899.

GENERAL: I have the honor to submit the following report on the construction, during the latter part of 1898, of a military road from Fort Washakie, Wyo., to the mouth of Buffalo Fork of Snake River, Wyoming, provided for in the sundry civil appropriation act approved June 4, 1897.

The item of appropriation reads as follows:

> Military road, Wyoming: For the construction of a military road from Fort Washakie, Wyoming, by the most practicable route near the Wind River and to the mouth of the Buffalo Fork of Snake River, near Jacksons Lake, in Uinta County, Wyoming, to be expended under the direction of the War Department, ten thousand dollars, or so much thereof as may be necessary.

I was directed to assume charge of this work by special order dated July 21, 1898, taking station at Fort Washakie, Wyo., the funds and property belonging to the work and in the hands of the Quartermaster's Department to be transferred to me. A subsequent order, of July 30, 1898, amending this, directed me to take station at Fort Yellowstone, Wyo., a change, which, as the proposed work was on an average about 100 miles nearer the Northern Pacific than the Union Pacific Railroad, effected, undoubtedly, a considerable saving in time and expense. By your indorsement of July 26, 1898, on letter of the Quartermaster-General, dated July 24, 1898, I was furnished with all the papers on file in the Quartermaster-General's Office relating to the work; and all information on this subject on file at the office of the chief quartermaster, Department of the Colorado, and at the office of the post quartermaster at Fort Washakie was sent me soon after.

HISTORICAL.

These papers showed that a bill providing for the construction of a road between the above points, and appropriating $20,000 therefor, had been introduced in the House of Representatives January 21, 1896, but had failed to become a law. The purpose of the proposed road, as shown by the correspondence, was to render it possible to move cavalry from Fort Washakie with their supplies, by as direct a line as possible, into Jacksons Hole, a noted game country, much frequented during the hunting season by Indians of the Fort Hall and Wind River reservations, and where conflicts between these Indians and the Wyoming State game wardens were to be feared. Troubles of this kind in the summer of 1895 had necessitated the sending of a considerable number of troops into the Hole. They, with their supplies, came in from the west, via Market Lake, on the Utah Northern Railroad, and the Teton Pass.

General Coppinger, then in command of the Department of the Platte, in his report on the above bill, says:

> So long as the Indians of the Fort Hall and Wind River reservations do not surrender the hunting privilege accorded them by treaty there will be danger of conflicts between them and lawless whites in the Hole, which the cavalry at Fort Washakie would be in the best position to put down. Even if the Indians relinquish this privilege, the troops might still have to police the hunting grounds to prevent encroachments thereon by the young bucks, naturally reluctant to forego their annual sport.

On the passage of the act of June 4, 1897, the work was placed in charge of the Quartermaster's Department; and on August 8, 1897, a

plan and map for locating the road, prepared by Lieut. Howard R. Hickok, Ninth Cavalry, were submitted, as directed, by the commanding officer of Fort Washakie, who states also:

> I am informed that a reconnoissance of To Gwo Tee Pass and the trail along Buffalo Fork and Black Rock Creek will be shortly made under the engineer officer of the Department.

On August 24, 1897, the Judge-Advocate-General decided that as the amount appropriated fell far short of the amount required to complete the work the appropriation could not, by its terms, be used as far as it would go, leaving the work incomplete. In August and September, 1897, a reconnoissance was made by Lieut. A. J. Perry, Ninth Cavalry, engineer officer of the department, and Lieut. J. A. Ryan, Ninth Cavalry, for the purpose of determining "the best practicable route over the Rocky Mountain Divide near the head of Wind River." Their report, dated September 5, 1897, with accompanying map, is appended (marked Appendix A). As a result of the reconnoissance, Lieutenant Perry suggested to the commanding general of the department that if the whole of the appropriation were expended on the section of the road from Clark's ranch to the mouth of the Buffalo Fork of Snake River that section could be made passable; and as the road from Washakie to Clark's was already passable during the greater part of the year, the result of spending the whole of the appropriation between Clark's and the mouth of Buffalo Fork would be to give a passable road over the entire route. The matter was, therefore, again referred to the Judge-Advocate-General, who decided, under date of February 15, 1898, that, as the road as a whole would be completed by such expenditure, the appropriation could legally be used in that way.

In March, 1898, Capt. John T. McBlain, Ninth Cavalry, was detailed to take charge of the construction, and preparations begun, in order that work might commence not later than June 15 (the necessity of beginning work about June 15 is also stated in Lieutenant Perry's report of February 2, 1898). He says:

> The season for working being very short, namely, between June 15 and September 30, it is recommended that the funds be made available, and such preliminary work, such as procuring labor, teams, etc., be done, so as to allow the working party to start work not later than June 15.

Tools to the value of $109.25, delivered at Fort Washakie, were purchased, but the breaking out of the war with Spain put a stop to further preparations. The approved project, recommended by Lieutenant Perry, may be stated to be the construction of a passable wagon road between Clark's ranch and the mouth of Buffalo Fork. Bridging the Buffalo was not recommended in view of the small appropriation, and it is thought, from the correspondence, that the bridging of smaller streams was also for the same reason not contemplated.

NARRATIVE OF THE WORK.

In accordance with the above-mentioned order of July 30, 1898, I reported at Fort Yellowstone August 8, and opened an office there for the hiring of labor and teams and the purchase of the necessary supplies and equipment. Lieut. G. O. Cress, Fourth Cavalry, post quartermaster, had kindly, at my telegraphic request, posted and sent out to towns in the vicinity notices announcing that labor and teams would be needed for this work. A clerk, an assistant engineer to take charge of locating party, a master laborer, a steward, a rodman, and a carpenter and blacksmith had previously been engaged. All these arrived

at Fort Yellowstone between the 9th and 11th. Previous investigation and correspondence having shown that the road would cross the mountains at an altitude of over 8,000 feet and that this pass was likely to be completely closed by snow as early as October 1, it was evident that a force should be provided for large enough to complete the work, so far as the appropriation would complete it, by about October 1, and that, as the season was already far advanced and as the point of beginning work was about 120 miles from Fort Yellowstone, no unnecessary time could be spent in organizing and outfitting the parties.

Two parties were provided for—a locating party, to precede the main party by as many days as possible and to be transported, with its supplies and outfit, by a pack train; and a construction party, to be transported, with its supplies and tools, by a wagon train and such saddle horses as would be afterwards needed for superintendence, messenger service, etc. Copies of maps and reports for the use of the locating party were prepared while the party was being organized and its outfit purchased or hired. This party, in charge of Asst. Engineer W. H. Wood, left Fort Yellowstone August 15. Their work is described in detail in the appended report of Assistant Wood (Appendix B). After their locating work was completed, the party made a survey of the road as constructed, a map showing results of which accompanies Mr. Wood's report. The pack train was returned to its owner in September when no longer needed.

In the organization of the construction party the rates of pay adopted were made to conform with those being paid at the time for similar work on the road system of the Yellowstone National Park. These rates, for a teamster with a 2-horse or 4-horse team, were, respectively, $3.24 and $4.98; but in the park work oats were furnished by the owners of the teams, which, as oats were very scarce in Jacksons Hole, and practically unobtainable at head of Wind River, made it necessary, in order that the teams might be used in hauling the tools and supplies from Fort Yellowstone, that the Government should furnish the oats and deduct therefor from the above figures, in order to equalize rates with park rates, what on an average throughout the territory covered by the park work would be the cost to the team owner. This rate was fixed at 2 cents a pound, and the daily oat ration for one team horse at 12 pounds. With each team, 2-horse or 4-horse, one wagon complete and in good condition was required to be furnished.

Arrangements were made at Fort Yellowstone for the delivery of oats at regular intervals at Snake River Station, a substation of Fort Yellowstone, 93 miles south of the fort and near the south boundary of the park; also for the delivery of the second month's subsistence stores and of mail at this station. Freight wagons were to be sent at fixed times from the road work to receive the supplies, while the mail was to be carried between the station and the road work by a mounted messenger. Through the energy and attention given to this service by Lieutenant Cress and by Sergt. Valentine Loeb, Fourth Cavalry, in charge of the station, the results, considering the difficulties due to distance and slow communication, were remarkably good. To complete the work within the time remaining would, it was estimated, require about 28 working horses in two and four horse teams, with their drivers and about 48 laborers experienced in various classes of road work.

A sufficient number of teams were engaged at Fort Yellowstone, but the number of men applying for work as laborers was comparatively small. It was necessary to engage every able-bodied man that applied,

and when the party left the fort the quota of laborers was not nearly filled. (After arriving in Jacksons Hole applications for work were numerous, mostly from settlers in the Teton Basin, Idaho, who came on an average about 75 miles to reach the work.) It was found impossible to secure a thoroughly competent cook for such a force in the vicinity. In the matter of procuring quickly the necessary tools and mess outfit great assistance was rendered by Capt. J. B. Erwin, Fourth Cavalry, acting superintendent of the park, in charge of road construction, and by Lieutenant Cress, post quartermaster.

On the afternoon of the 17th, all supplies, tools, tentage, etc., having been loaded on the wagons, the party moved up the long ascent between the fort and the head of the Golden Gate, or Kingmans Pass, 4 miles, and made camp. An early start was made on the morning of the 18th, and from that time until Snake River Station was reached, on the night of the 22d (camp was not moved on the 21st, Sunday), good progress was made.

On the 23d the party moved 21 miles to Pilgrim Creek, about 7 miles from the mouth of Buffalo Fork. The latter half of this day's march was over a very hilly and stony road, crossing the high ground on the east side of Jacksons Lake, and several accidents to the wagons occurred, which were temporarily repaired in the evening. At 8.10 a. m. on the 25th the party reached the ranch of Ed. J. Smith, on the Snake River, about 4 miles above the mouth of Buffalo Fork. Here I received a communication from Assistant Wood, stating that on account of shortness of time available his party had not been able to stake out the line selected up to the point where it crossed the Buffalo, about 14 miles from the mouth, and that Mr. Smith, who had accompanied the locating party, would point it out to me. In company with Mr. Smith, therefore, I rode ahead of the party to a point from which the crossing and the line leading to it could be plainly seen. A very bad ranch road led down the valley of the Snake and up that of the Buffalo as far as Joe Smith's ranch, about 6 miles above the mouth, where it crossed the Buffalo, and continued a few miles through the meadows on the south side of the Buffalo Fork and Black Rock Creek, terminating near the head of these meadows.

At Joe Smith's a ridge or mountain spur, about 400 feet high at the point, projected into the bed of the Buffalo, the slope toward the stream being very steep. A ravine, with wide bottom, had been found, which led by a very gentle slope to a point where the ridge could be crossed at a height of only about 350 feet above the stream. From this point, by following a succession of swales, located somewhat like the branches of a "switch back," the descent on the west side could be easily made down to a height of about 150 feet, from which point the general slope of the ridge became comparatively gentle. The ravine and swales were partly filled with small timber, pine and aspen. Considerable grading and one bridge would be required to make a good road. Beyond this point the work to be done consisted in preparing crossings of several tributaries, some of which had high steep banks, and in clearing considerable timber and brush on the low lands. In many places, side-hill grading would be advantageous, but it was believed that time and funds would not permit this. Much valuable information regarding the country between his place and the Black Rock Meadows was given me by Mr. Smith during this ride.

On my return to Joe Smith's, camp was made there (designated as camp No. 1 on map accompanying Mr. Wood's report). Much difficulty was encountered by the wagons in reaching this camp. One wagon

had been mired for about two hours in a marsh, and at two points where ridges encroached on the river the wagons were prevented from upsetting by the weight of several men on long levers.

From this camp construction work, beginning on the morning of the 25th, was carried on in both directions. The road over the ridge was constructed on the line above described, and some heavy grading done at the crossing of a wide stream with high steep banks, located about half a mile from the west toe of the ridge. A party also went back and made passable the ranch road leading to Joe Smith's. On the 27th camp was moved about 8 miles to the selected crossing of the Buffalo (designated as camp No. 2). In this move a large working party preceded the main party, to clear the road and prepare crossings of streams. One bridge was built. Whenever the main party was halted by an obstacle all the available men assisted.

During this march the most easterly house (Randolph's) in the Buffalo Fork Valley was passed, about 4 miles east of Joe Smith's; after which no building of any kind was found until on September 27 the party reached the "Hunters' Cabin," on the east side of the mountains and at the head of Wind River Meadows, 32 miles from Randolph's.

The 28th, Sunday, was spent by the master laborer, Fred L. Walker (afterwards overseer), and myself in reconnoitering the line by which the ascent from the Buffalo Fork to the top of the high divide, about 1,000 feet above the Buffalo, was to be made. A line had been blazed by the locating party, but as they were under orders to examine the entire length of the proposed route and to return and report results by September 1, their location of the road could only be regarded as provisional. The blazed line contained some long grades regarded as too steep to be adopted unless absolutely necessary.

A thorough exploration of the north slope of the divide, which for the most part was covered with heavy pine timber, containing much fallen timber, had to be made, resulting in the discovery before night of a practicable ravine, on the bottom and on the left bank of which a line, without extremely heavy grades, could be carried. The change in location involved crossing the Buffalo at a ford about a half mile above the point originally selected. The general location being thus chosen, daily reconnoissances in advance of the working party had to be made for the thorough examination of all alternative routes between points on the general line, in order to secure the best possible grades with the least expenditure of time and money and to place the road in positions promising the greatest permanency. These remarks, as to the large amount of reconnoitering needed and made, apply equally to the work of each succeeding day until the road was completed.

On crossing the Buffalo the character of the country changes greatly. As above stated, the road ascends directly from the Buffalo to the top of a high divide, whose elevation above sea level is about 8,000 feet, and for the next 34 miles the road is at or above that elevation. Beginning at the Buffalo, perhaps one-half of the country on the west slope of the mountains is covered with dense timber, mostly coniferous, the remaining spaces being mainly park-like openings along the courses of streams, and covered usually with an abundance of nutritious grasses. These parks are the fall and winter feeding grounds of great numbers of elk and deer. There is every indication of abundant rainfall.

On the 29th, work on the south side of the Buffalo was begun, and on that day and the 30th the ford of the Buffalo was improved and the road constructed to the site of camp No. 3, about 5 miles beyond camp No. 2, involving the building of five bridges, a large amount of timber

clearing, and considerable grading. Camp was moved on the 31st and camp No. 3 established.

From this camp the road was built to the Black Rock Meadows, about 5 miles. The first half of this distance was through timber, part of which was the heaviest that had yet been encountered. One bridge was built. The amount of grading required was comparatively small. Easy gradients were found. On September 3 camp was moved to the foot of Black Rock Meadows, about 5 miles, and camp No. 4 established. Snow had fallen during the night at the site of this camp, but had disappeared before the arrival of the party. Some still remained on the higher slopes.

In the Black Rock Meadows much heavy grading had to be done, the low ground being too soft to be used. Six bridges were built. It was thought best before moving camp again to carry the work, if possible, as far as the foot of the steep, final slope leading to To Gwo Tee or Two Gwo Tee Pass [the former is the spelling adopted by its discoverer in 1873, Lieut. Col. (then captain) W. A. Jones, Corps of Engineers]. For about 3 miles above the head of the meadows the trail follows, more or less closely, the right bank of the Black Rock Creek.

The line is crossed at frequent intervals by spurs of broken rock, projecting from the mountains, which are here close to the line. Between these spurs torrents have worn deep ravines with very steep sides. The construction of a passable road through this section would have been extremely slow (probably requiring several weeks) and difficult, and its subsequent maintenance very expensive; but it was believed, from the data at hand, that no better line existed. The fortunate intervention of a Sunday and a holiday (Labor Day) permitted a thorough exploration of the whole region and it was found that an excellent line, which had been hidden by about half a mile of heavy timber, existed on the high ground south of the creek. Less than one day's work with a portion of the party was required to build the road on the new line. It would seem proper to acknowledge here the very valuable assistance rendered in all of these reconnoissances by the overseer, Mr. Walker, who was almost tireless and showed remarkable skill and judgment in the discovery and exploration of possible routes. His energy and ability were no less marked in the superintendence of work, and he deserves a large part of the credit for the completion of the road within so short a time.

On September 9 camp was moved about 7 miles to the "Black Bowlder," a gigantic mass of black volcanic breccia lying near the foot of the main west slope. Just before reaching this, creek crossings had to be improved by the advance working party. The camp, No. 5, was established in a driving snowstorm (after this time the weather was good for nearly three weeks). The above change in the line had necessitated a change in the route to be followed in ascending the slope, which was densely timbered and intersected by numerous deep canyons, but a new and favorable route had been found before moving camp. From camp No. 5 the road was built across the summit to the outlet of a small lake, designated on the map as Walkers Lake. Eight bridges were built, much clearing and grading in earth and rock done, and camp moved about 3½ miles on the 13th to the above outlet, where camp No. 6 was established. The work had now entered the dense timber, which, beginning at the open country, about 1½ miles wide, at the summit of the pass, extends almost unbroken down the Wind River Valley to the Hunters' Cabin, 8 miles.

The location of the road line through this timber by the locating

party is described in Mr. Wood's report. Several minor changes were afterwards made in this line in order to lessen grading. In one case this advantage was obtained in addition to that of throwing the line near the only practicable camp site (that of camp No. 8) from which to carry on the heavy clearing and grading work necessary to make the descent into the Wind River bottom. The work between camps 6 and 9 was by far the heaviest required on the road, that between camps 8 and 9 being especially heavy. Reconnoitering in this forest was also extremely difficult on account of the dense growth, the large amount of fallen timber, and the frequent occurrence of deep canyons.

From camp No. 6 the road was built to the "Long Meadows," about 2 miles, involving a large amount of clearing, grading in rock and earth, and the construction of 6 bridges. Camp was moved on the 15th to the "Long Meadows" and camp No. 7 established. The work between camps 7 and 8 involved a descent from the "Long Meadows" into the valley of a tributary of Wind River, the crossing of this and six other streams by bridges, clearing of the line and of a short branch line into the "Big Meadows," and considerable grading in earth. Camp No. 8, in the "Big Meadows," 3 miles from camp No. 7, was established on the 19th, and no further move was made until the 27th.

From this point to the top of Wind River Point, about 1½ miles, the clearing was the heaviest found on the line. Near the "Big Meadows" many very large trees were found. One spruce, near the road, a double tree, forking about 5 feet from the ground, measured 15.2 feet in circumference 2½ feet above the ground. It was about 125 feet in height. Many of the single trees, pine and spruce, had a diameter of over 3 feet.

At about 1 mile east of the "Big Meadows" the growth becomes smaller, quite uniform in size, and very dense, the average size being about 9 inches in diameter and 75 feet in height, the trees being spaced over areas of considerable size, at an average distance apart of about 3 feet. An immense forest fire had swept the eastern part of this growth, beginning just west of Wind River Point and extending to the Hunters' Cabin. The same fire had also destroyed much of the timber on the north slopes below the Hunters' Cabin. Part of the burnt timber was standing, but more than half had fallen. The road having been cleared to Wind River Point, grading on this, the most serious obstacle on the whole line, was begun. The point lies in the acute angle formed by the canyon of Wind River and by that of a small tributary. Slides had occurred on the sides of the point into both canyons, narrowing the point at top and preventing much development of line on the descent.

The natural slope, in the direction of the road, was at the top about 25 per cent, and at two other points considerably exceeded 20 per cent. By cutting down the top of the slope 14 feet at one side of the point and by heavy sidehill grading at the two other sections mentioned, the maximum gradient was reduced to 20 per cent, the total length of which in the three sections is 1,200 feet. A bridge was built over the tributary, the road cleared to the Hunters' Cabin, the ford of Brooks Lake Fork improved, and considerable grading in earth and rock done between the point and Hunters' Cabin. On the 27th camp was moved 3½ miles to a point on the Wind River a short distance above Hunters' Cabin.

From this latter point the road was carried about 3½ miles along the slopes on the left of Wind River Meadows, clearing and grading being required on portions of the line; it then turned east from the meadows and followed a natural depression, about 1½ miles in length, between two high ridges, to the west branch of Long Creek. One bridge was built.

On the afternoon of the 29th camp was moved 7 miles, and camp No. 10 established on the west branch. Since leaving Fort Yellowstone, morning frosts, more or less heavy, had been the rule, and on September 10 the minimum temperature had been about zero, Fahrenheit. From that time until the 28th, while the morning frosts had usually been quite heavy, the days had been clear and warm. Cold weather, with heavy winds and snow, set in on the 28th, and from that time to the close of the work the weather was cold and wintry.

On arriving at camp No. 10 the trail down Long Creek was at once examined. It was evident that a good and permanent road could not be built on this line without great expense. By night, however, enough had been learned about the country to indicate that a practicable line could be found to the De Noir Valley. A reconnoissance made early on the following morning showed that the two intervening divides could be crossed with easy gradients through a network of ravines and swales.

A great many bowlders of all sizes covered the divides, one of the ravines being for a short distance almost filled with them. During the reconnoissance a bridge was built across the west branch and approaches to it graded. Work was then begun on the new line and pushed rapidly. On the evening of the 30th a heavy snowstorm began, which continued through the following day. From the 30th to the evening of October 6, when the party on their return reached the lower and much warmer Buffalo Fork Valley, all work and moving of camp was done with snow on the ground, and during a large part of the time in the midst of snowstorms. On October 1 a party of 6 men and 2 horses, with seven days' provisions, was sent back to widen the timber cutting on the east slope of the mountains where necessary, and to build a few bridges which had been omitted during the advance. On the 3d a practicable road had been built to the De Noir Valley, where it joined two fairly good existing roads on opposite sides of the De Noir River, leading, respectively, to Clark's ranch and to the Fort Washakie road below Clark's.

A terrific snowstorm, with a driving wind, prevailed on the 3d, the depth of snow on the ground in the afternoon being about 6 inches. This interfered greatly with finding and removing the smaller bowlders on the line of the road; and it is probable that many of these, where the road crosses diagonally the divide between the east branch of Long Creek and the De Noir, were not removed. On the morning of the 4th the grades leading from the valley of the west branch of Long Creek to the divide between the two branches were improved; and at 1 p. m. the return journey to Fort Yellowstone was begun.

About 6½ miles were covered during the afternoon, camp being made near the Hunters' Cabin. On the 5th the steep east slope of the mountains was climbed, the day's march being about 8½ miles, and camp made close to the summit in snow averaging about 9 inches in depth. An advance party, composed of all available men, was employed during this march in removing, mostly by blasting, the worst stumps that had been left in this part of the road.

All stumps in the road had, it should be said, been cut down close to the ground, and the work of this day was confined to the removal of stumps left in or close to the wheel ruts. On the 6th the summit was crossed. In this open country the snow had drifted badly, some of the drifts on the road being about 2½ feet deep and of considerable length. After passing the head of Black Rock Meadows, the snow gradually diminished in depth, and at the Buffalo ford, where camp was made

for the night, after a march of 19 miles, had entirely disappeared. At 3 p. m. of this day the party of six that had been sent back October 1 had practically completed their work near the summit and started west in a heavy snowstorm to overtake the main party, which they joined on the evening of the 7th. Camp was moved about 16 miles on the 7th to a point about 2 miles below the mouth of the Buffalo. The grading crew stopped on this day's march to change the line of the road just below Joe Smith's, carrying it along the slope around a marsh or soft meadow, instead of through the marsh, as formerly. They reached camp in the evening.

On the morning of the 8th a considerable number of the laborers and teamsters were discharged and the march resumed. The survey party completed on this day the survey of the road as built. Considering the time allotted, a large amount of survey work had been accomplished by this party under the direction of Assistant Engineer Wood.

Fort Yellowstone was reached on the afternoon of the 13th, and the office reopened for the settlement of accounts. The return journey through the park had been difficult on account of the condition of the roads, which were covered with snow on the three divides crossed and were very muddy on the lower ground.

The Fort Yellowstone office was closed on the 21st, since which time the platting of survey notes, computations of work done, and preparation of reports have been carried on at the Sioux City office.

The following statement shows the cost of different classes of work, the character of the work being described in Mr. Wood's report:

Cost of work.

Classification.	Cost per item.	Total cost.
Grading, including removal of bowlders, 5,816 cubic yards	$0.7762	$4,514.53
Clearing and partial grubbing, 37.65 acres	48.33	1,819.75
Building 44 bridges	14.90	655.82
Rock grading (ledge), 40 cubic yards	3.53	141.21
Administration		816.64
Engineering, including location, survey after completion, mapping, and reports		1,564.05
Tools and mess outfit		*a* 488.00
Total		10,000.00

a Includes $109.25 expended by Quartermaster's Department prior to July 21, 1898.

CHARACTER OF ROAD BUILT.

The length of the road as built, from the mouth of the Buffalo Fork to the junction with the roads in the De Noir Valley, is 53.8 miles; or 57.1 miles from the mouth of the Buffalo to Clark's ranch. Lieutenant Hickok, Ninth Cavalry, in his report of August 7, 1897, on the best route for a road from Fort Washakie to the mouth of Buffalo Fork says:

> The roads of this section are undefined and unimproved, other than the removal of the great obstructions, and it is recommended that the above outlined road be of the same general character.

While this description would probably apply to the existing roads (there are two lines followed, depending on the season) in the open and comparatively level country between Fort Washakie and Clark's and perhaps to any road that is likely to be built between these points, it would scarcely apply to the road just built across the mountains.

In the total length of 53.8 miles built there are 8$\frac{3}{4}$ miles of grading,

14.1 miles of clearing, and 44 bridges. Many of the latter are located in an open country, and help to define the road. At a few points, however, and, for comparatively short distances, the road is undefined, except by the tracks made by our wagons and by the stakes driven by the survey party. Drainage of the road was not attempted except in a few bad places. As to gradients, the purpose of the road, viz, to make a practicable crossing of the mountains for troops and their supplies in heavy wagon loads, the latter being the essential matter, was constantly kept in mind, and advantage taken of all opportunities to lessen grades without too great cost. Considering both length and steepness, the Wind River Point is much the worst grade on the road, the maximum gradient here, as above stated, being 20 per cent. On our return, with several inches of melting snow on the ground, a heavy freight wagon, with a load estimated at 2,600 pounds, was pulled by its 4-horse team to the top of this grade, without greater difficulty than the necessity of resting the horses a few minutes at the summit of each of the three sections of the grade.

I am informed by the acting superintendent of the Yellowstone Park that on the main system of roads in the park, on which large sums have been expended, there are, in the first 4 miles south of Fort Yellowstone, two grades each of 23 per cent, and some of the gradients adopted for streets in this and other cities do not fall far short of 20 per cent. Many of the grades on the road might, however, be improved, should funds be available and travel over the road show the necessity therefor; and, in many places, grading would be advantageous, where, on account of the smallness of the appropriation, no work was done. The bridges built, as described in Mr. Wood's report, are substantial, and should remain in good condition for several years. A few other small bridges would improve the road, and a bridge over the Buffalo would prevent this river becoming an impassable obstacle in time of flood. It is stated that this river often reaches its highest stage in the early part of July, and that its floods are not of long duration.

To Gwo Tee Pass, so far as I can learn, can be crossed about July 1. A bridge over the Buffalo would probably, therefore, prolong by a few weeks the season during which the road, as a through route, can be used. The width of clearing in timber should be increased, both to admit more sunlight and thereby keep the road drier and to lessen the danger of the road being obstructed by falling trees. The road is now, however, believed to be, with the exception of the Yellowstone Park roads, the best mountain road in that part of the country. By it the distance between Fort Washakie and the northern part of Jacksons Hole, and between Fort Washakie and the Yellowstone Park, is from 50 to 60 miles shorter than by the only other existing road—that over Union Pass—which latter road is said to be practically impassable for even moderate loads. The road as built is also better than that on the east side of Jacksons Lake, and is believed to be better than the Fort Washakie road just below Clark's.

CHARACTER OF COUNTRY TRAVERSED.

A few statements on this subject have been made under "Narrative of the work." Some information in regard to it is also given in the appended reports of Lieutenants Perry and Ryan and of Assistant Wood. A bird's-eye view of the region about the Buffalo Fork and Black Rock Creek, looking toward To Gwo Tee Pass, copied from Plate

XLIII, Annual Report of the United States Geological and Geographical Survey of the Territories, 1877, accompanies this report. Mr. H. E. Wadsworth, of Lander, Wyo., with a hunting party, passed over the new road shortly before its completion, coming from the Yellowstone Park. Through his kindness I have been furnished with copies of kodak views taken by him at points along the line of the road and of the road leading from Clark's to Fort Washakie. While these views were not taken to illustrate the road work and do not show the difficult parts of the work, they nevertheless give a very good idea of the character of the country both west and southeast of Clark's. For this reason they are submitted herewith. Nos. 1 to 6 are views taken along the military road, while Nos. 7 to 10 indicate the character of the country and of the present road below Clark's.

The elevated valley known as Jacksons Hole (elevation of Jacksons Lake, between 6,800 and 6,900 feet) is bounded on the west by the Teton Mountains, whose eastern scarp, rising abruptly from the lake and reflected in its waters, presents probably the grandest mountain view to be found in the United States. On the east the valley is bounded by the main divide of the Rocky Mountains, which in a sinuous line follows one of the western ranges of the Shoshone or Absaroka Mountains and the Wind River Mountains, the average distance from the Teton Mountains to the main divide being about 40 miles. On the south the valley is closed by a spur of the Wind River Mountains, while on the north no marked natural boundary exists between the valley and the Yellowstone Park, even the main continental divide being here but little raised above the general level. The eastern portion of the valley is a high and rolling country, intersected by mountain spurs and watered by numerous streams, which in their upper courses have cut deep canyons.

The whole region, in common with the Yellowstone Park, is remarkable for its heavy annual rainfall, a quite exceptional feature in the arid portion of the United States. The cause of this heavy precipitation has been stated as follows:

> The principal southwest air current, moving over a low portion of the mountain mass of the Pacific Coast, reaches the Tetons and Sierra Shoshone range without being deprived of much of its vapor. It is not only checked in its course by this high cool wall, but the tremendous acicular ridge of the Tetons stands in such a position as to produce a strong eddy about the head waters of the Snake and over the [Yellowstone] lake basin. (Reconnoissance in northwestern Wyoming, 1873. Jones.)

As a result of the heavy precipitation, most of the region is densely timbered, and streams and lakes are abundant. In winter the country is covered with a tremendous depth of snow, communication in the valley being possible only by the use of snowshoes, and the mountain passes remain closed by snow until about July 1. This part of the Rockies has been called the "Crown of the continent," on account of the number of great rivers which here take their rise. Reclus, in The Earth and its Inhabitants, says:

> Union Park [27 miles southeast of To Gwo Tee Pass] * * * must be regarded as the chief central point of the United States for the dispersion of its running waters to the surrounding marine basins; here is the true continental divide.

Within 25 miles of the To Gwo Tee Pass lie the sources of the Yellowstone, Snake, Wind, and Green (main headstream of the Colorado) rivers. The Shoshone Mountains, crossed at their southwestern angle by the military road, are thus described by Captain Jones:

> The Sierra Shoshone range is probably the most remarkable one in the great Rocky Mountain chain. The original range, if there ever was one, and of this there are

many indications, lies buried beneath an outpouring of material from the fluid interior of the earth, which it is safe to estimate as being now from 4,000 to 5,000 feet thick. * * * The peaks are all over 10,000 feet, and many reach an elevation of over 12,000 feet, and are composed entirely, so far as our observation went, of this material (except the Washakie Needles, which is granite). It will be more appropriate to speak of it as a mountain mass, which extends from latitude 43° 10′ in a northerly direction to 45° 10′, with a general width of over 60 miles in peaks that will certainly average over 10,000 feet in elevation. * * *

This mountain mass has been eroded to a remarkable extent and the streams have cut their channels into it accordingly in the most irregular manner. * * * Their valleys are simply huge canyons, except the usual park-like opening near their sources.

The mountain slopes are covered with forests of coniferous trees wherever it is possible for trees to grow, and streams are very numerous. Perhaps more water is shed from this mass of mountains than from any of equal size in the Rocky Mountain chain.

There are no roads across the Sierra Shoshone range, and this expedition is the first that ever crossed it, a feat that had been previously considered very difficult, if not impossible. (Reconnoissance in Northwestern Wyoming, 1873.)

The following description of To Gwo Tee Pass and the characteristics of the Shoshone Mountains is taken from the Annual Report of the United States Geological and Geographical Survey of the Territories for 1877:

The approaches to the summit of To Gwo Tee Pass are easy, and the spot itself is one of the most interesting, both for its geologic as also its picturesque surroundings. It is filled with open, grassy undulations, whose hollows hold pretty lakelets, the declivities dotted with beautiful groves of pine and spruce, and threaded by tiny rivulets bordered by charming little intervales, and miniature terraces bright with many-hued flowers and the white blossoms of a delicate clover. Densely wooded taluses sweep up into the mountain heights on either hand, whose lofty, precipitous walls form a majestic gateway to the pass across the great watershed.

The mountain on the south side of the pass afforded a good opportunity to gain a general knowledge of the character of the vast sedimented volcanic accumulations out of which these mountains have been sculptured. The summit of this peak rises 1,000 feet above the pass, and on all sides its slopes are steep, on the east precipitous. The above-mentioned somber volcanic breccia enters largely into the formation of the basis of the mountain, reaching more than halfway to the summit. Then succeeds several hundred feet thickness of partially exposed breccias, the steep slope covered with débris up to the shoulder, from which rises the huge angular block that crowns the summit of the mountain. The basis of this block is formed of drab breccia and incoherent or partially consolidated volcanic sands. A thickness of 20 feet of conglomerate forms the plinth.

* * * The uppermost deposit shows a thickness of above 50 feet of a brecciated mass, consisting of angular fragments of various kinds of volcanic rocks held in a fine, soft, drab-gray paste. These masses, by weather action, are wrought into many curious shapes, rent and fissured and pinnacled, with cornices and ashy, sandy taluses, which give to the mural exposures, seen at a distance, the somber and light-gray banded appearance which render their recognition so certain wherever they appear.

Notwithstanding the smoky state of the atmosphere the view from this high station was of unusual interest. The opposite side of the pass is walled by far grander escarpments of the fragmental volcanics which have intimate connection with a mountain ridge extending many miles to the eastward, where it merges into that portion of this great volcanic highland belt to which Captain Jones applied the name Sierra Shoshone.

This east-west ridge, itself of Titanic proportions, forms the water divide between the sources of Buffalo Fork and the northern affluents of Wind River, and throughout it presents the same stupendous mountain wall. The main Wind River heads in the angle formed by this ridge and the northern extension of the Wind River range on its southwest. The latter ridge is capped for a few miles by the volcanic breccias. * * *

This whole region is one of most forbidding grandeur. The volcanic crests all rise above timber line, while their precipitous sides show the dull, banded volcanic ledges almost destitute of vegetation. But the taluses are generally heavily wooded, and at the time of our visit immense columns of smoke from forest conflagration rose high in the air, in places blotting out the view of distant mountains.

A good idea of the structure of the Shoshone Mountains is given in photograph No. 4, which shows a portion of the spur that divides the

valleys of Wind River and the west branch of Long Creek. A finer view of these mountains is to be had from points on the military road where it crosses the divides between the west branch of Long Creek and the De Noir. On the east slope from To Gwo Tee Pass heavy timber and abundant vegetation are found as far down as the Hunters' Cabin; and the east slopes of the Wind River Mountains, as far as they could be seen from the road, are densely wooded. Proceeding down the valley from the Hunters' Cabin, the slopes on the left of Wind River show a rapidly diminishing amount of rainfall, and at Clark's the "arid" or "semiarid" region, extending to the Missouri River and beyond, has about been reached. Photographs Nos. 7 to 10 show that the road between Clark's and Fort Washakie lies in such a region.

VALUE OF THE ROAD AS PART OF A THROUGH ROUTE.

Previous to the construction of this road the Yellowstone Park could not be reached from the southeast except by the circuitous and difficult road through Union Pass. In 1881 Governor John W. Hoyt, of Wyoming, made an extended reconnoissance to discover a practicable wagon route to the Yellowstone Park from the southeast. He examined two routes, viz, via the Wind River, To Gwo Tee Pass, and Two-Ocean Pass, and thence down the Upper Yellowstone and via the Stinking Water Valley to Yellowstone Lake, these two being the routes discovered by Captain Jones in 1873. He also endeavored to find a practicable crossing of the Shoshone Mountains at the head of several tributaries of the north fork of Wind River, but none was discovered. His comparison of the merits of the two routes is as follows:

> The route up the Wind River and across the divide by the To Gwo Tee and Two Ocean passes to the head of the Yellowstone Lake is remarkable not only for its interesting—ofttimes captivating—scenery, but also for having an abundance of grass, timber, and pure water all the way, as well as much wild game and mountain trout. And what is yet more important, it is characterized by a very easy grade both ascending and descending the mountains. As compared with the Stinking Water route, it has the disadvantage of requiring the building of more new road inside the park as a means of connecting it with the roads and trails already made. Moreover, as this route, after it leaves the Indian reservation, lies through a section whose altitude will forbid its improvement for agricultural purposes, or even for grazing purposes the year round, the building of the proposed road on that line would not, to the same extent, aid the industrial development of the country.
>
> The route by which we returned has the advantage of running through a section already filling up with ranches for nearly a hundred miles, and has for more than that distance a wagon trail which with small outlay could be made a good road. It also has the advantage of leading almost at once, after crossing the divide, to the foot of Yellowstone Lake, where the most important improvements are likely to be placed. Nor is it wanting, along the Stinking Water, in fine scenery, timber, or good water, for the mountains are covered with forests, and the river, so outraged by its name, is a pure and beautiful stream as far down as we saw it, having its sources among the loftiest of the Sierras and being well supplied with trout. It has the disadvantage of partly lying through a section (between the Wind River and the Ishawooa) not well supplied with water at all points in the dry season, of requiring many more bridges than the Wind River route, besides a considerable amount of rock in the canyon, and, finally, of having a much less easy grade at and near the summit of the divide. (Messages and Documents, Interior Department, 1881-82.)

The disadvantage, that the route via To Gwo Tee Pass and Two Ocean Pass would require the building of more new road inside the park to connect with existing roads, does not apply to the route via To Gwo Tee Pass and Jacksons Lake. In fact, as a road has already been built by the Government from the Yellowstone Lake to the south boundary of the Yellowstone Park timber land reserve (designated on

map accompanying Mr. Wood's report as Yellowstone Park forest reservation), no new road inside the park or timber land reserve would need to be built. Governor Hoyt, in his above-quoted report, argues that as the Yellowstone Park lies principally in Wyoming the people of that State should naturally be most interested in it, and that a reasonably direct and good road by which they may reach it ought to be provided. This argument would appear to be a sound one. The above requirement as to directness is certainly fulfilled by the military road.

Other military advantages of the road besides the one spoken of in the early part of this report are the connecting of forts Washakie and Yellowstone and of the Northern Pacific and Union Pacific railroads by a direct and fairly good road.

FURTHER REQUIREMENTS.

By Presidential proclamation dated February 22, 1897, a large area adjoining and to the south of the Yellowstone Park timber land reserve was set apart as a forest reservation (designated in the proclamation as "Teton forest reserve") and withdrawn from future settlement. The law under which the proclamation was issued provides means by which present settlers may, if they desire, be given land elsewhere in lieu of that held by them within a forest reserve. Of the 53.8 miles of the military road 39½ miles lies within the Teton forest reserve. There being very few settlers at present in the upper part of Jacksons Hole (and future settlement prohibited), and only one ranch on the military road east of the forest reserve, it is evident that this road, which, as in the case of every other road, will require repairs from time to time, at least annually, to keep it in good condition, will have to be maintained by the Government. Portions of the road, moreover, are liable during the winter to be completely obstructed by falling timber. This should be removed each summer as soon as the pass is open. In view of the distance of the road from railroads and sources of supply and labor, I should estimate the annual cost of maintenance at $1,000.

Considering the whole route from Fort Washakie to the Yellowstone Park timber reserve, about 151 miles, it is seen by the map that about 54 miles of this distance falls within the Wind River Indian reservation, about 58½ miles within the Teton forest reserve, and only about 38½ miles on land not within Government reservations. This latter section is very sparsely settled, and is completely surrounded by high mountains and the two reservations mentioned, for which reason it is not likely to become thickly settled in the near future. If, therefore, a good road between Fort Washakie and the Yellowstone Park is needed it will have to be built (or existing roads improved) and maintained by the Government throughout its whole extent. While I had no opportunity to examine the line between Clark's and Fort Washakie, and only hurriedly passed over the line of the road between the mouth of the Buffalo and the timber reserve, the location of which line can undoubtedly be improved, I believe that the further expenditure of $50,000 would result in a through road, as above, which would satisfy all present requirements. Roughly and from insufficient data I would divide this expenditure as follows:

Between Fort Washakie and Clark's	$25,000
Improving military road built 1898	15,000
Between mouth of Buffalo and timber reserve	10,000
Total	50,000

The improvement of the military road would consist in constructing a bridge over the Buffalo Fork and several smaller bridges, in improving present grades and grading at other points, in widening and straightening the timber cutting, in draining portions of the road, and in marking distances, camping grounds, etc. The annual cost of maintenance of the through route I would estimate at $4,000.

Very respectfully, your obedient servant,

J. C. SANFORD,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

APPENDIX A.

REPORT OF LIEUTS. ALEX. W. PERRY AND J. A. RYAN, NINTH CAVALRY.

HEADQUARTERS DEPARTMENT OF THE PLATTE,
Camp on Buffalo Fork of Snake River, Wyoming, September 5, 1897.

SIR: In accordance with letter of instructions from the department commander dated Fort Washakie, Wyo., August 12, 1897, the following report of the best practicable route for a wagon road over the Rocky Mountain Divide, near the head of Wind River, is hereby submitted:

Upon examination there were found near the head of Wind River three trails passing over the divide—Union Trail, Sheridans Trail, and To Gwo Tee Trail. Union Trail, which has also a wagon road, was examined from Clark's ranch to the mouth of Buffalo Fork, a distance of 115 miles.

Sheridans Trail was followed most of the distance, far enough for as much examination as was considered necessary.

The To Gwo Tee Trail was carefully examined its entire length, which from Clark's ranch to the mouth of Buffalo Fork is about 60 miles.

After reaching the summit of the pass an examination was also made of the route down Cottonwood Creek. The entire length of Elkhorn Creek was gone over; also that of Black Rock Creek and the Buffalo Fork as far up as the junction of its north and south forks.

Beginning at Clark's ranch on the Wind River the route should follow the Sheridans Trail as far as Long Creek, which flows into Wind River from the north. Crossing Long Creek it should be ascended almost to the timber line; thence due west to the Hunters' Cabin near Wind River and close to the To Gwo Tee Trail, keeping well up on the bench to avoid the coulees near the river. From the Hunters' Cabin the route lies on the north side of the Wind River, which for 5 miles abounds in standing and fallen timber. There are some ravines which may be avoided by going farther to the north of the stream.

After passing through this timber the summit of the pass is reached by gentle slopes, the route being free from timber. From the summit, To Gwo Tee Trail down Black Rock Creek should be followed for a distance of about 10 miles, which would place the route through a succession of parks on the high land to the north of this creek. At this point on the trail there is a long swale stretching in a northwesterly direction toward Buffalo Fork and reaching it a little to the west of the mouth of Lava Creek; the route should leave the trail and pass down this incline, which is very gentle, and cross Buffalo Fork at the most suitable place; thence to foothills to the mouth of that stream, where the ground is dry and free from timber. It can be extended to the mouth of this river on the north side along the base of these hills, thus completing the route and making the entire distance about 65 miles, thus making a saving of about 50 miles over any other wagon trail between the head of Wind River and the mouth of Buffalo Fork.

The accompanying map will show approximately the proposed route.

Very respectfully, your obedient servants,

ALEX. W. PERRY,
First Lieutenant, Ninth Cavalry, Aid.
J. A. RYAN,
First Lieutenant, Ninth Cavalry.

The ADJUTANT-GENERAL,
Department of the Platte, Omaha, Nebr.

APPENDIX B.

REPORT OF MR. W. H. WOOD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sioux City, Iowa, January 30, 1899.

CAPTAIN: I have the honor to submit the following report on the location and survey of the military wagon road between Fort Washakie and the mouth of the Buffalo Fork of Snake River:

I left Fort Yellowstone on August 15, 1898, three days in advance of the main party, with a pack train and party of five, including cook and packer. I was to push through as rapidly as possible, marking the first few miles of the road that was to begin at the mouth of the Buffalo Fork, and then to go through to Clark's ranch on Wind River, making a rough reconnoissance of the country to determine the general route of the road.

I reached the top of the big hill beyond the Buffalo ford, about 20 miles from the mouth of the Buffalo, on August 23. This ascent is a steep climb, 20 per cent in places, but of the whole grading. At this camp we struck the pack trail over To Gwo Tee Pass and reached it followed it all the way to Clark's. Coming back, I left the trail 2 miles north of Joe Smith's, went up Long Creek 5 miles, crossed back to Wind River at the Hunters' Cabin, where the heavy timber begins, and spent several days exploring in the vicinity between Hunters' Cabin and the top of the pass. It was certain the road could not follow the pack trail down Wind River from the pass. Where the trail is close to the river, as it is for the first 4 miles, the ground is altogether too rough and too miry. The trail there leaves the river and climbs the mountain slope to the south side of the river, to go around the canyon of the river. The ground is rough, and being on the north slope is very wet and boggy, almost impassable for pack animals. So I spent all my time on the north side of the river where the slopes facing south are much drier. The timber is so dense and so much of it down that traveling was very slow. I was to return and report to you on September 1. The week available between the 23d and that date was not enough to find a location for the road, but it did satisfy me that the road should be built on that side of the river.

According to programme, I returned on the 1st and found you in camp where I had camped on the 23d. On the 3d I moved east again to the top of the pass, taking six axmen with me. I set them at work near the divide and spent several days locating the road from the summit down the east slope.

During this time you had found an easier route than following the valley of the Black Rock to the summit, as I had done. Your new route brought you within 2 miles of the summit without any grading. On the 8th I connected your new line with the line I had marked over the summit. On the 11th my pack outfit was discharged and I joined the main party, now close to the summit. By the 15th I had marked the road to the big descent into Wind River, near the Hunters' Cabin. On the 15th I leveled and cross sectioned two lines down the big hill. One, the line adopted, on a 20 per cent grade, the cross slope light, so that the total grading was less than 600 cubic yards. On the other line the grade could be made much less, but the cross slope was so very steep, 5 on 7, that the amount of grading would have been much greater and the cut always sliding in.

On the 19th of September I began the survey of the road. This survey was started just east of the summit, was run east for two days, to station 89; then began at station 1 again, near the summit, and was run west to Joe Smith's ranch, to station 369; then was taken up at station 89 and run east to the end of the road and continued to the bridge over Wind River, 1 mile east of Clark's ranch. When I had brought the survey to this point you had finished the road, October 4, and started back for Fort Yellowstone. I traveled back with you, and when we reached the camp at the Buffalo ford, I took up the survey where it had ended on September 27, near Joe Smith's, and continued it to the mouth of the Buffalo, where we joined the main road up Snake River to Jacksons Lake and the park on October 8.

The survey was entirely a stadia survey. The transit had a large and delicate level under the telescope and a good vertical circle. The vertical angle was read every time the stadia rod was held up; this angle being to the same height above the ground as that at which the transit stood.

This survey has been platted on a scale of 500 feet to the inch, and the length of every course scaled from this map.

Of course an accurate measurement of the center line of the road would be a little in excess of this scaled measurement. Now you had the whole road measured in both directions during its construction, by counting the revolutions of a wagon

wheel, carefully measured. Two different wagons were used on different portions of the line—a light spring wagon and a heavy freight wagon. Any measurement duplicated by either wagon agreed very closely. But both wagons gave less than the scaled distance, as shown by table below.

Comparison of scaled distances with wagon-wheel measurement.

SPRING WAGON, WHEEL 10.11 FEET IN CIRCUMFERENCE.

	Scaled.	By wheel.	Per cent.
	Feet.	*Feet.*	
Joe Smith's to Buffalo Ford	44,700	44,382	99.29
Bridge No. 9	36,740	36,436	99.17
Bridge No. 10	14,130	14,093	99.74
Station 156	14,485	14,336	98.97
Total	110,055	109,247	99.27

FREIGHT WAGON, WHEEL 11.65 FEET IN CIRCUMFERENCE.

Station 156 to Station 1	35,880	35,084	97.78
Station 381	25,750	25,065	97.34
Station 456	23,540	22,898	97.27
Station 494	27,260	26,807	98.34
Station 556 (De Noir Creek)	29,885	29,183	97.65
Total	142,315	139,037	97.70

The basis of the elevations given on the profiles is the summit of To Gwo Tee Pass, as given by Capt. W. A. Jones, Corps of Engineers, in 1873. This makes our levels agree with those of the United States Geological Survey at the Buffalo ford within about 10 feet.

There were 584 instrument stations, all marked with a large stake, well driven, with the number of the station in red chalk, except from Joe Smith's to mouth of Buffalo. There were 1,967 pointings of the instrument to points on the road, with vertical angles at each, and 259 pointings to points off the road to locate topography, most of them with vertical angles.

Grading was done in 150 different stretches of all lengths, aggregating a total length of 45,735 feet, with a total quantity of material removed of 5,856 cubic yards, of which 210 linear feet and 40 cubic yards was rock and the balance earth. There were 50 pounds of dynamite used in the rock excavation.

This grading was almost entirely sidehill work, was done with plow and scrapers, and with picks and shovels, and varied from a single furrow to a 14-foot cut. The only place where the top of a hill had to be taken off to reduce the grade was at the last long hill to Wind River, where the greatest cut was 14 feet.

The clearing extended over 74,540 feet, or about three-tenths of the length of new road constructed. At an average width of 22 feet this makes 37.65 acres of clearing. The width of clearing varied a good deal, being least in the live timber and greatest when the standing timber was burned and dead. The timber varied greatly, from very scattering and small timber to very dense large timber, the largest timber cut being over 2 feet in diameter and over 100 feet high. One hundred and fifty pounds of dynamite were used in blowing out stumps.

The following table gives the location, by distances from Snake River, of all bridges, with clear span and total length. The bridges were all made of round, live timber, three stringers of large size, with flooring of round, live timber not over 6 inches at the butt, and 14 feet long, laid alternately butt and top.

Details of bridges.

No.	Profile distance.	Span.	Total length.	No.	Profile distance.	Span.	Total length.
			Feet.				*Feet.*
1	24,695	2	4	24	175,285	10	14
2	33,300	8	14	25	175,500	2	4
3	59,180	8	12	26	176,230	4	6
4	77,095	16	28	27	178,635	10	15
5	77,205	12	20	28	180,515	14	18
6	78,135	10	14	29	184,245	22	26
7	78,405	10	14	30	184,380	11	15
8	80,135	*a*32	40	31	185,280	4	6
9	113,160	20	30	32	185,425	14	18
10	127,290	6	14	33	190,765	3	4
11	129,125	10	13	34	191,820	4	7
12	129,280	7	14	35	193,040	12	21
13	129,660	4½	8	36	195,230	10	16
14	131,800	4	7	37	195,955	5	7
15	131,990	9½	13	38	198,705	14	16
16	159,400	8	12	39	201,475	8	12
17	159,630	8	12	40	211,845	20	23
18	163,855	9	12	41	220,685	6	8
19	164,885	6	9	42	251,000	6	18
20	165,145	10	14	43	266,670	18	23
21	165,405	9	12	44	267,155	10	15
22	165,530	7	10				
23	168,145	6	8	Total			626

a Two 16-foot spans.

The office work, done in Sioux City, consists of first reducing all stadia readings to the true horizontal distances, and finding the difference of level of every station; then plotting the road, on a scale of 500 feet to 1 inch, on four large sheets, each about 8 feet long. From this plotting the length of every course, between stadia readings, was scaled, and a continuous table of "profile distances" was made up, with the elevation of every reading opposite its distance. From this table a profile, on a horizontal scale of 200 feet to 1 inch, and a vertical scale of 40 feet to 1 inch, was made. On this profile all grading is shown, with the area of the excavation given at numerous points, and the total quantity in each cut. The length of every separate piece of clearing is also shown. From this large scale map and profile another map and profile was made to a horizontal scale of 5,000 feet to 1 inch, and vertical scale of 1,000 feet to 1 inch. On this map the topography from the United States Geological and Land surveys was shown. Three tracings of this map and profile have been made, and triplicate tracings of small drawings.

Very respectfully,

W. H. WOOD,
Assistant Engineer.

Capt. J. C. SANFORD,
Corps of Engineers, U. S. A.

Money statement.

Amount appropriated by act of June 4, 1897		$10,000.00
Amount expended by Quartermaster's Department to July 21, 1898	$109.25	
Amount expended by Engineer Department to February 2, 1899	9,720.20	
		9,829.45
February 3, 1899, balance unexpended		170.55
February 3, 1899, outstanding liabilities (estimated)		170.55