

REPORT  
OF THE  
CHIEF ENGINEER  
UPON  
RECENT SURVEYS AND PROGRESS OF CONSTRUCTION  
OF THE  
CENTRAL PACIFIC RAILROAD  
OF CALIFORNIA.

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DECEMBER, 1865.

Engineer's Office, C. P. R. of California, }  
 SACRAMENTO, November 25th, 1865. }

To the President and Directors of the Central Pacific Railroad of California :

GENTLEMEN :—The location surveys for the Second Division of your road, which, at the date of my last Report, (October, 1864,) had been extended to Dutch Flat, were subsequently revised, and changes made, wherever any improvements were found practicable.

From Lower Illinoistown Gap a survey was made, following the American River slope of the divide, avoiding the tunnel at Bear River Gap, and connecting with the original line at Long Ravine, developing a very favorable line, but involving a loss of altitude of twenty-six feet in reaching the latter point. This loss, however, did not affect the maximum grades above that point, and the compensating advantages of better alignment and reduced cost of construction were largely in favor of the new line. After a careful location between the points named—giving the following results—this line was adopted :

Distance by old line.....	22,800 feet.
“ “ new line.....	20,800 “
Difference in favor of new line.....	2,200 “
Difference in aggregate curvature in favor of new line.....	420°
Difference in cost in favor of new line.....	\$50,000 00
Difference in total rise of grade in favor of old line.....	26 feet.

Between Long Ravine and Dutch Flat, the original location has been generally adhered to. Some modifications of the line were made, improving the alignment, without materially increasing the cost of construction.

From Secrettstown Gap a line was surveyed, following the American River slope of Coldspring Mountain to Gold Run, but without satisfactory results, and the original location upon the northern slope of the mountain was adhered to.

At Tunnel Hill the line was so changed as to admit of an open

cut instead of a tunnel, as at first proposed. This change was made without any increase of grade or curvature, but at an additional cost of construction, as it was believed that the difference in the time required for the completion of the work, would, by permitting an earlier use of the road, more than compensate for the increased cost.

Other changes will be referred to hereafter under the head of construction.

During the Winter of 1864-5, but one small locating party was employed, and the field operations were confined to the line below Dutch Flat. Above that point, but one survey, extending to the summit of the Sierras, had yet been made—viz: Mr. Judah's Survey of 1861. His line, as described in his reports, followed the Bear River slope of the divide to the source of that stream, and thence, the valley of the South Yuba to the Summit.

A re-survey of the Bear River route, for a distance of nine miles above Dutch Flat, in the Fall of 1863, had developed a very heavy line, and a re-examination of the route, made in the spring of the present year, together with a careful study of the maps and profiles of the original experimental survey, led to the conclusion, that by the best location that could be made, the line would be extremely sinuous, involving ruling curves of the minimum radius allowed by Act of Congress, and would also be so much shortened that grades of one hundred and sixteen feet per mile, for a distance of nearly twenty miles, would be required, in order to attain the necessary altitude at the head of Bear Valley. The character of the work required to construct a road upon this line, though by no means impracticable, nor indeed, heavier than was originally anticipated, was certainly formidable, and rendered it desirable, if possible, to find a more available route. With this view, examinations of the American River slope were commenced early in the Spring of the present year.

From my own observations of the general topography of the country forming the southern water-shed of the South Yuba and Bear rivers, and the northern water-shed of the main North Fork of the American, and from such information as I could gather from others, I had been led to believe, that by following the latter stream and its tributaries, the Summit might be reached with a lighter grade, and with the additional advantage of a southern exposure for nearly the whole distance, and, possibly, a reduction in the cost of construction.

The results of these examinations and surveys, though not fully confirming my preconceived opinions respecting the practicability of the American River route, have nevertheless, been very satisfactory, leading to the discovery of a new route from Dutch Flat to Emigrant Gap, near the head of Bear River

avoiding the heavy work on the Bear River line, and entering the valley of the South Yuba at an elevation that enables us to carry our line to the Summit with comparatively light grades, and avoid much expensive work which a lower line would have encountered.

I am indebted to the Report of Mr. L. M. Clement, Engineer in charge of location of Second Division, for the facts embodied in the following account of explorations and surveys that were made before the route for a location above Dutch Flat was determined upon:

"The examinations, commenced April 17th, 1865, were first directed to Cañon Creek, with the view of following up that stream for a distance of seven or eight miles, and regaining the Bear River slope by crossing the divide at or near Dutchman's Gap. Two lines were surveyed, one crossing the divide at the above named point, and the other following a tributary of Cañon Creek, and crossing the divide about one-half mile farther west. Both were found impracticable, requiring respectively, tunnels of two and a half, and two miles in length.

"Returning to Towle's mill, near Dutch Flat, and using a grade of one hundred and five feet per mile, we followed our former line to a point about one-half mile below Herbert's ranch, where we crossed Cañon Creek, and with a very good line, were enabled to reach a low depression in the divide between Cañon Creek and the North Fork of the American River, known as the Hog's Back. The line here passes near Bradley & Co.'s large reservoir, and turning sharply to the left, attains a comparatively uniform bench upon the American River slope. Continuing our line with the grade above stated, no serious obstacles were encountered until we reached Prospect Hill, a sharp spur forming the eastern slope of Little Blue Cañon, and distant about eight miles from Dutch Flat.

"The summit of this spur was two hundred and fourteen feet above our grade, and required a tunnel of over one-half mile in length. Carrying our line forward to Blue Cañon, about four miles farther, we found the grade at that point was too low to admit of a practicable crossing, the cañon being so narrow that we were unable to make the necessary curvature to gain the opposite slope.

"A reconnoissance of the country for a few miles beyond Blue Cañon gave very satisfactory results, and with an additional altitude at that point of about one hundred feet, the most serious obstacles could be overcome. Being unable to make a sufficient increase of distance to gain the desired altitude, a new survey, based upon a grade of one hundred and sixteen feet per mile, was commenced near Towle's mill and carried along the general route above described, attaining a sufficient altitude at Prospect Hill, to enable us to pierce that spur with a tunnel of

four hundred feet in length, and giving a very satisfactory crossing of Blue Cañon.

"Subsequent surveys enabled us to reduce the grade for a portion of this distance, and still maintain a desirable location at Blue Cañon.

"Running down the left bank of this cañon for nearly a mile, our line turns abruptly to the left, and cutting Lost Camp spur, strikes the slope of one of the main tributaries of the North Fork of the American, known as Wilson's Ravine. Following the same, and crossing its tributaries, viz: Sailer's Ravine, Owl Cañon and Heath's Ravine, we reach the summit of the divide between Wilson's Ravine and Bear River, at a point called *Emigrant Gap*, distant about seventeen miles from Dutch Flat. For about four miles below this point we have been able to maintain an average grade of eighty-five, with a maximum of ninety feet per mile.

"There being no further question regarding the practicability of regaining the Yuba Valley via the North Fork of the American and Wilson's Ravine, it was thought best to continue the examination of the American River route towards the Summit. Diverging from the *Emigrant Gap* line about four miles below that point, we crossed Wilson's Ravine and made instrumental examinations of Six Mile Cañon and Lake Valley, following the latter to its head, and crossing the divide to the Yuba through Lake Valley Pass.

"The country passed over between Wilson's Ravine and the head of Lake Valley was very rugged in its character, being mostly a granitic formation, much broken, and presenting many formidable obstacles to the construction of a road.

"Though ascending this valley with a grade of one hundred and sixteen feet per mile, we found it impossible to reach the main North Fork of the American River by crossing the crest of the ridge, as we had hoped, and could only reach the Yuba by tunneling thirty-five hundred feet. This line was accordingly abandoned. Still desiring to test the practicability of the main North Fork route, we returned to the foot of Lake Valley, and thence made a reconnoissance along the southern slope of Bear Mountain for a distance of six miles, to Monumental Cañon, which we crossed and continued our line in a southerly direction until we reached the (so called) East Fork. The country over which we had passed, after leaving Lake Valley, as well as that before us at this point, was of the most rugged and formidable character, and as our line for nearly ten miles had been carrying us from instead of towards the Summit, and that too without enabling us to avail ourselves of the increase of distance by reducing the grades, it was determined to abandon this route above Wilson's Ravine, and return to the Yuba River line."

Subsequent examinations of the American River slope in the

vicinity of the Devil's Peak proved still more conclusively the impracticability of reaching the Summit by following that stream. For had the slope of the main North Fork, above Monumental Cañon been gained, it would only have been to reach, about midway of its height, a sheer perpendicular wall of rock, rising three thousand feet above the bed of the stream, along which the construction of a road would have been impracticable, within the limits of cost which such an enterprise will warrant. Above this cliff, which extends for two miles or more, the country in the vicinity of the Devil's Peak is scarcely less forbidding in its character, being deeply furrowed by narrow rocky cañons, and presenting otherwise many serious obstacles to a favorable location.

"Returning to Emigrant Gap, we ran an experimental line up Wilson's Valley to Bear Trap Summit, but though using a grade of one hundred and sixteen feet per mile, the grade line was two hundred and forty-seven feet below the surface of the ground at the above named summit, which could only be passed by a tunnel, thirty-five hundred feet in length."

Having thus become fully satisfied that our best route for location above Emigrant Gap lay through the South Yuba Valley, we entered upon a careful survey of that route. Not feeling confident of the practicability of maintaining an uniform grade from this point to the Summit, or even of making the distance indicated by the experimental surveys, our first surveys were based upon a grade of one hundred and five feet per mile; but encountering a very rugged country above Crystal Lake and finding that the maintainance of so high a grade was unnecessary to attain the desired elevation at the Summit, we dropped our line at a point opposite the New Hampshire Rocks, a distance of two hundred and fifty-four feet, vertical, and thence to the Summit, continued the survey upon a grade of eighty-five feet per mile. This lower line was subsequently extended back from the offset point to Emigrant Gap, upon the same grade, which by the later location has been in many places still further reduced.

"So much time had already been consumed in the experimental surveys, thus briefly alluded to, it was found that the location of the line to the Summit, now a matter of urgent necessity, in consequence of the rapid advance of the work of construction, could not be accomplished by one party before the commencement of winter. Accordingly on the 18th of July another party was organized and placed in the field to assist in the location of this portion of the line."

Mr. Robert L. Harris, to whom was assigned the work of location upon the eastern slope of the mountains, entered the field with a full party, July 12th. A fourth party, in charge of Mr. W. F. Boardman, placed in the field to assist in making

necessary experimental surveys between the Summit and the Truckee River, was disbanded after a service of sixty days. Before commencing the location from the Summit eastward, the following experimental lines were run :

First—From mouth of Donner Creek (continuation of Judah's Line) via Truckee River to Hunter's Crossing. Second—From Summit to Truckee River via Coomb's Ravine and north side of Donner Lake, joining first line about one and a half miles below Coburn's. Third—From Summit to mouth of Donner Creek (initial point of first line) following the general course of Judah's Line, via Strong's Cañon south side of Donner Lake and Coldstream, but increasing the distance sufficiently, by running farther up the valley of Coldstream, to permit the use of a maximum grade of ninety feet per mile, instead of one hundred and five as at first contemplated.

Examinations were made of a route from Donner Lake to Crystal Peak, via Prosser Creek, Russell's Valley, Little Truckee and Dog Valley, and also via Prosser Creek, west side of Little Dog Mountain and the Little Truckee to its mouth, connecting at that point with the first line via Truckee river.

These examinations demonstrated conclusively the superiority of the Truckee River line in every respect, and it only remained to decide upon the most eligible route from the Summit to the valley of the Truckee. The choice lay between the two lines already mentioned. The one bearing to the left from the Summit Pass, and running north of Donner Lake, the other bearing to the right, and running south of Donner Lake. They are designated respectively as the North and South Lines.

The principal difficulties to be encountered in the work of construction upon either of these lines, occur within a distance of two and a half miles from the Summit; the descent for the remaining portion of the distance being accomplished with uniform grades, good alignment and easy work.

After a thorough survey of all the approaches to the Summit Pass, a careful location and estimate of the most difficult portions of the North and South lines, resulted in the choice of the latter. The reasons governing this choice were, first, lighter maximum grades, and secondly, less cost of construction on the adopted line.

The survey of the North line was based upon a grade of one hundred and five feet, and the South line upon a grade of ninety feet per mile. These grades can be reduced respectively to ninety-eight and eighty-five feet. Besides the consideration of grades, alignment, and cost of construction, the question of possible obstruction by snow, formed an important element in the comparison of the merits of the two lines. In this respect, the North line doubtless possesses some advantages, though upon a

careful consideration they are of much less importance than would at first appear.

The heavy snowfall in the immediate vicinity of the Summit, amounting in the aggregate to ten, and sometimes even twelve feet in depth, and a much heavier accumulation at some points by drifting, will render it necessary to provide a substantial protection, either of timber or masonry, to ensure the successful and uninterrupted operation of the road during the winter months.

The principal points requiring such protection occur upon the eastern slope, and within two miles of the Summit; and though the liability to a heavy accumulation of snow is apparently much greater on the South, than on the North line, there is but little difference in the cost of an adequate protection for either.

In consequence of the North line having a southern exposure for a portion of its length, the snows will melt more rapidly than upon the shaded hillside of the corresponding portion of the South Line. Yet during the prevalence of the storms, when the real difficulty of operating occurs, the necessity of a protection against snow, or the labor of removing it from the track, will be as great in the one case as the other.

The objection at first urged against the South line, from the apprehension of danger from 'snow slides' along the northern face of Donner Mountain has been entirely obviated by the location surveys. At the only point where any real danger of obstruction from this cause existed, the line has been thrown so far into the hill that the entire road-bed will be cut in the solid granite, and so protected by masonry and timber work, that any 'slides' that may occur will pass harmlessly over the track without interfering in the least with the passage of trains.

That portion of the line requiring this rather unusual protection, does not exceed one hundred yards, and with the road properly constructed, I do not entertain the slightest apprehension of any stoppage or disturbance of trains from the causes alluded to.

The engineering difficulties here encountered are far less than have been met upon many portions of your road already constructed, and I allude to this particular point thus in detail, only for the reason that much doubt has been expressed regarding the practicability of operating a road along this mountain side during the winter months.

Before leaving this subject, I will remark, that our location has developed a line much more favorable for overcoming the difficulties incident to the snow-belt than was formerly anticipated. Lighter grades and better alignment are secured, as we approach the Summit, and for the greater portion of the distance through the snow-belt, the road-bed will be formed by

light side-cutting or embankments, thus greatly facilitating the removal of snow from the track.

The most important features of the North line having been noticed in a former Report (dated September 30th, 1865), a repetition here is unnecessary. The South line will be more fully described in its proper place, under the head of Location Surveys.

Mr. Harris commenced the work of final location of the Third Division early in October, and at the present date has carried his line as far as the Truckee Cañon, and by the 20th proximo will have reached Crystal Peak, Nevada, about six miles from the point of crossing the State line.

### LOCATION OF SECOND DIVISION.

The limits of the first and second divisions (heretofore alluded to as comprising fifty miles each) have been changed as follows: The first division to extend from Sacramento to Colfax, fifty-four miles; the second division, from Colfax to the Summit, fifty-one and one-half miles; and the third division, from the Summit to the State line, thirty-two and a half miles.

A detailed description of the located line below Dutch Flat has been given in a former Report, and the late changes in the line have already been referred to in the preceding pages.

The terminal point of the location survey of 1863, was at Station 3610, nearly opposite Dutch Flat. In consequence of the change of line, already noted, from the Bear River to the American River slope, a slight modification of about one mile of the old line became necessary. From Dutch Flat to Emigrant Gap the route of the new location, as already briefly noticed in the account of preliminary surveys, lies via Reservoir Gap and Cañon Creek, to the Hog's Back—thence along the slope of the North Fork of the American River via Blue Bluffs, Little Blue Cañon, China Ranch, Horse Ravine, Blue Cañon and Lost Camp Spur to Wilson's Ravine, and following the latter and crossing Sailors' Ravine, Owl Cañon and Heath's Ravine, reaches Emigrant Gap, in a distance of seventeen miles from Dutch Flat. Crossing the divide at Emigrant Gap, with a cut but ten feet in depth, and passing along its northern slope, which for about two miles forms the southern water-shed of Bear River, the line enters the valley of the South Yuba, which it follows to the Summit, a distance of twenty miles.

The general character of the work between Dutch Flat and Owl Gap, a distance of thirteen miles, does not differ materially from, and will not exceed in cost of construction, the work for an equal distance below Dutch Flat, the construction of which,

commenced in August last, will be nearly or quite completed during the present year

Five tunnels, of an aggregate length of eighteen hundred feet (the longest being six hundred feet), occur on this portion of the line. The material through which they will be excavated, is soft slate, cement, and conglomerate. These tunnels, with perhaps one exception, will require a lining of masonry.

The water courses, which with the exception of Cañon creek and Blue Cañon, are all small, will be provided with substantial stone culverts, and no trestling or other bridging will be required between Dutch Flat and Crystal Lake.

From Owl Gap to the Summit, a distance of twenty-four and one-half miles, the work is of a much less expensive character, and a good location has been made upon a grade of eighty-five feet per mile. From Owl Gap to Emigrant Gap, a distance of three miles, and thence for four miles along the northern slope of the divide to the Yuba Pass, the work will be light. From the Yuba Pass to Holt's Ravine, the cuttings, though generally light, are mostly in granite or gneiss, and for a short distance in the vicinity of Butte Cañon, in trap. For nearly three fourths of the distance between the Yuba Pass and Holt's Ravine, the work will consist of light side cutting and embankment, and between Holt's Ravine and the Summit, almost wholly of the latter. Two tunnels opposite Coolbroth's and Jones' of three hundred, and two hundred feet, respectively, will be required. Trestling will probably be required at Butte Cañon and Holt's Ravine. Both those crossings will be at a height of seventy feet, and five hundred feet in length. These, with truss bridges in single spans of one hundred and fifty, and two hundred feet, at the upper and lower outlets of Kidd's Lakes, and a single span of one hundred feet across the South Yuba at the foot of Summit Valley, are the only wooden structures required on this division.

The line through the valley of the Yuba is in every respect much more favorable than was originally anticipated. Light grades, good alignment, and work admitting of rapid and economical construction constitute its most salient features.

### THIRD DIVISION.

Before commencing the location of this division the determination of the line at the Summit was a question of the utmost importance. Although the grades upon either slope admitted of a location with a very light cutting at the Summit Pass, the surveys eastward, pointed to a lower summit grade, as calculated to greatly reduce the cost of construction, and afford better alignment over the most rugged portions of the line. After a

careful consideration of the matter, a tunnel of seventeen hundred feet in length was determined upon.

I will here state, that in addition to the lines heretofore noted in this connection, a line was run cutting the crest of the mountain one-third of a mile south of the Pass, and joining the present line about one mile from the Summit. This line requiring a tunnel of four thousand two hundred feet in length, and affording no advantages in regard to grade, was abandoned.

By the final location, the summit of the grade is made at the western end of the tunnel, and thence descends uniformly at the rate of ninety feet per mile for a distance of six and a quarter miles. Leaving the tunnel, the line bears to the right, and skirting the terraced slope of Donner Mountain and its main spur, for a distance of two and a half miles, enters Strong's Cañon. This portion of the line, heretofore alluded to, comprises all the formidable work on the eastern slope; two tunnels, through cement and granite, of four hundred and two hundred feet in length, respectively, occur within this distance. Running up the west side of Strong's Cañon, crossing the same, and thence along its eastern slope, the work for a distance of three miles will be extremely light, and the material of the most favorable character. Emerging from Strong's Cañon, the line passes along the hill-side south of, and about four hundred feet above Donner Lake, for two and a half miles, when curving sharply to the right, it pierces the hill with a tunnel nine hundred feet in length and enters Coldstream Valley. Thence to the valley of the Truckee, a distance of seven and three-quarter miles, with the single exception of Donner Creek crossing, the work is very light, and will compare favorably with the same length of line in the Sacramento Valley. The crossing of Donner Creek will be at a height of eighty feet above the bed of the stream, and a length of seven hundred feet at grade. The general characteristics of the line from Donner Creek to Hunter's Crossing are succinctly stated in the following items from the Report of Mr. Harris:

"The line follows the Truckee River at an elevation varying from thirty to one hundred and fifty feet above its bed—and the surveys have demonstrated the fact, indicated by a previous reconnoissance, that a line, very favorable for the construction of a railroad, can be obtained; the grades averaging less than forty, and none exceeding eighty feet per mile, with but three miles of heavy work, twelve miles of ordinary railroad work, and nineteen miles of very light construction."

The line, in this distance, crosses the river five times, requiring truss bridges at three points of single spans of two hundred feet each, and at each of the other points, probably, two spans of one hundred and fifty feet.

"Of the above river crossings, there is but one place where

the work will be expensive, which is at Devil's Grip—corresponding to the *Easterly Summit* of some other routes, as here the river cuts through the easterly chain of mountains."

The increased expense at the latter point will be incurred in the extra strength required for abutments and protection walls, to guard the embankments from the encroachments of the river, which is here confined to a narrow channel, and when swollen by rains or melting snows, acquires a velocity, which nothing short of the most substantial masonry will withstand.

The difficulties of the Truckee Cañon, heretofore so much dreaded, because so little known, have dwindled to three miles of heavy work, which can be built at less cost than the three miles next below Gold Run—on the Second Division—upon which, ninety days since, not a day's work had been done, and which half as many more working days will fully complete.

For full details, respecting the lines and work thus briefly alluded to, reference is made to the accompanying maps and profiles :

#### LIST OF TUNNELS ON SECOND AND THIRD DIVISIONS.

LOCALITY.	Length in feet.	Material.	Probable time required for construction	REMARKS.
Boulder Hill.....	200	{ Cement and Conglomerate	60 days..	
Prospect Hill.....	400	{ Clay, slate & Cement.....	100 days	Will require lining.
Fort Point.....	300	" .....	75 days..	" " "
Grizzly Hill.....	600	Conglomerate....	150 days..	A portion "
Lost Camp Spar.....	300	{ Slate & Sand- stone.....	100 days..	
Red Hill, above Cryst- tal Lake.....	300	Schist .....	120 days..	
Opp. Jones' Station...	200	Granite.....	100 days..	
Summit of Sierras....	1,750	" .....	18 month;	Will be constructed
Cement Hill.....	400	Cement.....	120 days..	for double track.
North Strong's Cañon	180	Granite.....	90 days..	" " " "
Coldstream.....	900	Cement.....	1 year.....	" " " "
Devil's Grip.....	175	" .....	80 days..	
Total feet.....	5,655			

Being less than one-third the aggregate length of tunneling contemplated by the original surveys.

The above tunnels can all be worked from both ends, and with the exception of the Summit Tunnel, will require no shafting.

## GRADIENTS AND ALIGNMENT.

In a former Report a table was given presenting the grades upon the located line from Sacramento to Dutch Flat. No material changes in grades upon that portion of the line have since been made. Above Dutch Flat, as before stated, the maximum grade of one hundred and sixteen feet per mile, for an aggregate distance of ten and a half miles, has been resorted to; the longest plane being 3 18-100 miles. The ruling curves upon this grade do not exceed eight degrees, or a radius of 716 feet, and upon all the long curves of this radius, the grade has been reduced from ten to twenty feet below the maximum.

But five curves of a less radius than seven hundred and sixteen feet occur between Dutch Flat and Emigrant Gap, viz: one at the Hogsback having a radius of six hundred and eighty-eight feet; one at Little Blue Cañon with radius of six hundred and thirty-seven feet; one at Stony Gulch, and one at crossing of Blue Cañon of the same radius, and one at Lost Camp Spur, having a radius of six hundred and seventy-five feet.

From Owl Gap to the Summit, a distance of twenty-four and one-half miles, the average grade is eighty-one, and the maximum eighty-five feet per mile. From the Summit to the Truckee River, the average grade is eighty-four, and the maximum ninety feet per mile, and down the Truckee, as before stated, the grades average less than forty and at no point exceed eighty feet per mile. The location upon the higher slopes of the Sierras has generally admitted of a very favorable alignment. Curves of 573 feet radius have in but a few instances been resorted to, and only at points where the grade could be sufficiently reduced to compensate for the increased curvature; and as before stated, the curves are generally lighter, and the per centage of tangent line much greater than upon the lower portion of the Second Division.

## WORK OF CONSTRUCTION.

The most satisfactory progress has been made in this department during the past year. Up to the first of January last, but little work had been completed above Newcastle, with the exception of the heavy cut at Bloomer Divide. The force employed, which in December, 1864, had been raised to about three hundred men, was still further increased in January and February, and the work prosecuted as rapidly as the inclemency of the season would permit. Steady additions were made to the working force as the season advanced, until in April it numbered about twelve hundred, in June two thousand, and the

latter part of July four thousand men. It became apparent early in the season, that the amount of labor likely to be required during the summer could only be supplied by the employment of the Chinese element of our population. Some distrust was at first felt regarding the capacity of this class for the service required, but the experiment has proved eminently successful. They are faithful and industrious, and under proper supervision, soon become skillful in the performance of their duties. Many of them are becoming very expert in drilling, blasting, and other departments of rock work.

The road was completed from Newcastle to Auburn—five miles—and the cars commenced running to the latter place May 13th, and on the 10th of June to Clipper Gap, seven miles further. Eighty days later, September 1st, the road was completed and trains ran to Colfax (near Illinoistown), distant eleven miles from Clipper Gap, and fifty-four from Sacramento.

August first, the work of grading above Colfax was commenced, but the full force employed below that point was not removed to the new work until September first. Considerable loss of time necessarily occurred in the removal of so large a force, and its proper distribution upon the line, yet the heaviest portions of the work were all well under way early in September, and at the present date, the grading upon the thirteen miles between Colfax and Dutch Flat—comprising some of the most expensive work on the line—is two-thirds completed, and with ordinarily favorable weather will be ready for the track in the month of January, 1866. The work at Cape Horn has proved less difficult and expensive than was first anticipated.

The line was thrown into the hill sufficiently to form the road-bed in solid cutting, with the exception of two points, where for a distance of one hundred and two hundred feet respectively, heavy retaining walls have been built, and the road made as secure as if upon the solid ledge.

The work of construction between Dutch Flat and Blue Cañon has already been commenced with a force of six hundred men, which number will be increased as the work below is completed.

Camps have been established at all the tunnels and heavy points on the section named, and it is confidently expected that by the opening of spring the grading will be so far advanced as to admit of its completion to Emigrant Gap early in July, and to Crystal Lake in the month of August. Work has been commenced on both ends of the Summit Tunnel, and will be prosecuted vigorously during the winter, and the heavy work upon the eastern slope will be opened as early as the season will permit.

I will here remark, that although a portion of the line on the Second and Third Divisions will require a longer time for its

construction, the cost of grading the thirteen miles next above Long Ravine is fully equal to the cost of the same number of consecutive miles upon any portion of the line. The rapid accomplishment of this heavy work can only be attained through the medium of that class of labor heretofore alluded to. Indeed had it not been for this element, it would have been impossible to have completed your road to Clipper Gap at this date.

With this force at your command, and with the assurance of its large augmentation the coming year, the work of construction, which by some has been deemed the labor of years, will be reduced to months, and judging from what has been accomplished during the past season, I confidently predict that within the year 1866 your trains will run to the summit of the Sierras, and by the fourth of July, 1867, to Hunter's Crossing of the Truckee, fifteen miles beyond the eastern boundary of the State.

Geo. E. Gray, Esq. (late Chief Engineer of the N. Y. Central Railroad), who examined the line of your road from Sacramento to Crystal Peak (Nevada), in July last, expresses the following opinion regarding the character of the work upon the completed portion :

"That portion of the Railroad constructed and in operation from the city of Sacramento to Clipper Gap, a distance of forty-three miles, and which attains an elevation of 1,785 feet above the sea, will compare most favorably in every respect with any railroad in the United States. The road bed and mechanical structures are well constructed, ample provision being made for drainage, the cross ties are of redwood, and the whole laid with a rail of 60-lb. weight per yard, and set in wrought iron chairs. The locomotives, cars and machinery, are all of the first quality and of the best material, and are maintained in good order."

Of the line upon the Eastern slope, he says :

"The recent surveys down the Truckee River, from the mouth of Donner Creek, through the cañon where the river pierces the eastern range of the Sierra Nevadas, have developed an excellent line, with light grades, all descending eastwardly, and comparatively easy of construction.

"The ease with which this eastern range is passed by your route is one of its most important features. In addition to its other advantages, it enables you to pass rapidly out of the snow belt, and with a shorter snow line than could otherwise be attained. That portion of the line along the Truckee River will be comparatively free from snow, and by properly constructing your road over the mountains the snow will not form any insuperable difficulty in operating it."

## BRIDGING.

But few timber structures have been found necessary. Those originally designed for crossing the deeper ravines and gaps, between Newcastle and Colfax, have mostly been discarded, and embankments built instead. The Newcastle trestling, sixty feet in height and five hundred feet long, one similar structure near Auburn, thirty-eight feet in height and four hundred feet in length; two of the same height at Lovell's Gap; one near Clipper Gap station fifty feet high and four hundred feet in length; two in Clipper Ravine fifty and ninety-three feet in height and three hundred and fifty, and five hundred feet in length, respectively, and one trestling of four bents at Lower Illinoistown Gap (introduced for the convenience of a road crossing), are the only wooden structures between Newcastle and Colfax.

Long Ravine bridge, consisting of five hundred feet of trestling in spans of sixteen feet, and extreme height of sixty feet, and three spans of Howe truss, two of one hundred and fifty feet each, and one of one hundred and twenty feet, crossing the main ravine at a height of one hundred and fifteen feet; and the Secrettown trestling, one thousand feet in length, nine hundred feet of which is fifty, and the remainder ninety feet in height, are the only wooden structures between Colfax and Dutch Flat. Beyond the latter place the structures required upon the second and third divisions have already been noticed.

The American River bridge has recently been covered and painted, and a similar protection will be provided for all truss bridges hereafter constructed.

## ROLLING STOCK.

The rolling stock upon the road consists of six locomotives, six first-class passenger cars, two cabooses, one baggage and express, thirty-nine box-freight, and sixty-five platform cars. The materials for twenty dump cars have arrived and they are now being put together. A new locomotive, 16 by 24 inch cylinders and 5 feet drivers, built by Booth & Co., San Francisco, is expected to arrive in a few days.

Seven heavy freight locomotives, cylinders 18 by 22 inches, with six drivers each, four feet diameter, and one passenger locomotive, 15 by 22 inch cylinders, 5 feet drivers, have been purchased.

Advices have been received of the shipment of four of the above, and the others were to be shipped during the present month.

Orders have been given for four others of a similar class, cyl-

inders to be 18 by 24 inches, six drivers, four feet diameter. Materials for one hundred freight cars have been purchased and were to have been shipped the present month; and orders have been given for as many more, all of which are expected to arrive in season for next spring's business.

### GENERAL REMARKS.

The prospect of the speedy completion of your road to the eastern boundary of the State is most flattering. The financial difficulties incident to the initiation of all public enterprises of great magnitude, have been successfully overcome, and, as will be seen by the report of the Secretary, the future prospects of the company are highly encouraging.

The character of the line developed by the recent location surveys is remarkably favorable for rapid construction, and the comparatively low grades attained through the snow belt, divest it of its objectionable features.

The success attending the running of freight trains on the high grades upon the completed portion of your road is very gratifying, and fully sustains the opinions heretofore expressed that no apprehension of serious difficulties need be entertained in regard to the practicability of working a road constructed upon these grades.

The completion of the road to Dutch Flat will enable you to command the freight and passenger traffic with Nevada, Utah and Idaho, and its further advance into the mountains will add materially to the dispatch of business with those localities. The business of the past season as shown by the Secretary's Report, has been very satisfactory, and the discovery of the new mines in the Excelsior District, Nevada County, will tend to largely increase the business over your road the coming season.

These mines are situated within ten miles of the road at Crystal Lake, and though at present but partially developed, they bid fair to rival in extent and richness the famous Comstock mines in Nevada. Other developments of mineral wealth in various portions of Placer and Nevada counties are constantly being made, creating an active demand for labor and capital.

I omitted to mention in connection with the subject of experimental surveys, that a reconnaissance was made of the Henness Pass route from Bear Valley to the Little Truckee. The observations taken fully confirmed the opinion expressed by Mr. Judah in his report of 1863, in which he says:

"This line we found impracticable on account of the crossing of the South Yuba, and objectionable from the absolute necessity of making a long detour either to the north or south, in order to avoid Dog Mountain and reach the valley of the Truckee:

also from its moderately descending grade eastward and consequent high elevation through the snow region."

The altitude of this pass was ascertained by level and found to be 7,031 feet, or sixty feet lower than the Donner Pass. A railroad line carried through this pass would, from the necessity of constructing sufficiently above the natural surface to avoid obstruction by snow, attain a greater altitude than the summit grade of your road. These and other measurements were taken for the purpose of correcting the false impressions that have obtained, relative to the comparative altitudes of the most prominent passes across the Sierras. I will here state that these altitudes all date from low tide at San Francisco.

The altitude at Sacramento is taken from the barometrical calculations of Major Williamson and Thos. Logan, M. D., by which the new grade of Front street, Sacramento, (28 feet above low water mark), is made 56 35-100 feet above low tide at San Francisco.

The apparent discrepancy between the altitudes here given and those given by Mr. Judah, are due to the different bases from which the levels were taken—the latter being run from the old Front street levee as a base, and our present lines from tide water.

The following altitudes of prominent points upon the line of your road, also of Lake Tahoe and the Summit Passes of other routes, may be of interest :

Sacramento (Front street grade).....	56 feet.
Junction.....	180 "
Auburn (Railroad station).....	1,185 "
Clipper Gap.....	1,785 "
Colfax.....	2,448 "
Jones' Mill, near Dutch Flat.....	3,416 "
Emigrant Gap.....	5,286 "
Grade opposite Crystal Lake.....	5,775 "
Surface of Water in Crystal Lake.....	5,997 "
Summit of Grade, west end of Summit Tunnel.....	7,042 "
Donner Lake.....	5,964 "
Lake Tahoe.....	6,247 "
Webber Lake, near Henness Pass.....	6,904 "
Summit at Henness Pass.....	7,031 "
Summit at Donner Pass.....	7,091 "
Summit at Georgetown Pass (levels run from Summit to Lake Tahoe in 1863).....	7,154 "
Summit at Johnson's Pass (Bishop's Report).....	7,374 "

But one location party will be kept in the field during the winter. The location now completed to Crystal Peak, will be extended to the Big Bend of the Truckee, a distance of fifty miles, beyond which point the route of your road is not yet de-

terminated upon, and in the absence of reliable data, any discussion of the relative merits of the various proposed routes thence to Salt Lake, must be entirely speculative and unsatisfactory.

I need not, however, urge the importance of commencing the explorations and surveys necessary to an intelligent choice of route, at the earliest practicable moment.

The labor of several well organized engineer parties, will be required to make the necessary surveys during the coming year, and I would recommend that a force, adequate to ensure the early completion of the work, be placed in the field as soon as the season will permit.

I wish here to express my obligations to Messrs. L. M. Clement and Robt. L. Harris, and to those employed under their direction, for the faithful and efficient manner in which they have discharged the duties assigned them. My acknowledgments are also due to Messrs. Chas. Cadwalader and S. M. Buck, assistants in charge of construction, for valuable assistance in their department.

Very respectfully,

SAM. S. MONTAGUE.

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