

HUDSON AND BERKSHIRE RAIL ROAD.

LETTER

FROM

THE SECRETARY OF WAR,

ACCOMPANIED BY

*The Maps, Reports, and Proceedings of the Survey of the Hudson  
and Berkshire Rail Road.*

JANUARY 21, 1829.—Read, and laid upon the table.

DEPARTMENT OF WAR,

January 21, 1829.

SIR: In obedience to a resolution of the House of Representatives of the 14th instant, I have the honor of transmitting, herewith, "the maps, reports, and proceedings of the survey of the Hudson and Berkshire rail road, made under the direction of Lieutenant Colonel Perrault, of the Topographical Engineers."

In order that copies of the maps may be prepared for the use of the company, at whose instance the survey was made, I respectfully request that they may be returned to this department, after the object of the call shall have been answered.

I have the honor to be

Your obedient servant,

P. B. PORTER.

Hon. ANDREW STEVENSON,

*Speaker of the House of Representatives.*

GEORGETOWN, January 14, 1829.

SIR: I have the honor to transmit to you my report of the survey made last Summer by your order, for the intended Berkshire rail road, from Hudson city, State of New York, to Pittsfield, State of Massachusetts, together with those of my assistants, Lieut. Vail, and Messrs. Guion and Anderson, accompanied by the following maps and profiles.

1st. A map from Hudson river to Groat's, No. 1, with two profiles, No. 1, A.—No. 1, B.

2d. A map from Groat's to the State line, dividing the State of New York from that of Massachusetts, marked No. 2, with its profile, No. 2.

3d. A map from said State line to the Village of Pittsfield, marked No. 3, with its profile, marked 3.

I am very respectfully, sir,

Your obedient servant,

Lieut. Col. P. H. PERRAULT.

Col. C. GRATIOT, *Chief Engineer.*

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## REPORT

*Of Lieut. Col. P. H. Perrault on the survey of a Rail Road called the Hudson and Berkshire Rail Road, extending from Hudson city, State of New York, to Pittsfield, State of Massachusetts.*

On my arrival at Hudson city, after having consulted with the members of the committee, and ascertained their views, the operations of the surveys were divided between my three assistants, Lieut. Jefferson Vail, U. S. Army, and Messrs. C. Anderson and W. B. Guion, U. S. Civil Engineers. Mr. Anderson's survey beginning at Hudson river and extending to Steenie Kill creek bridge, near Groat's tavern.

2d. Mr. Guion's survey extending from Groat's tavern to the State line between New York and Massachusetts.

3d. Lieut. Vail's survey extending from the same State line to Pittsfield, Massachusetts.

Having added to my report those of my assistants, which give a very detailed account of the various circumstances and localities of the survey, I will confine myself with respect to the task of compressing in a general point of view the general features of the country through which runs the line, pointing out the difficulties that are to be encountered in the execution of the rail road.

These difficulties will be,

1st. The obstacles in the way of easy and cheap transportation.

2d. Those in the way of construction.

3d. The expenses in relation to the profits.

Each of them will be investigated after the summary exposition that follows shall be completed.

The general course of the line is in a northeast direction; it presents two summit levels, the first at the distance of 26 miles from the beginning, with an elevation of 1016 feet above mid tide in Hudson river; the second, distant 38 miles from the same, elevated 1225 feet above the same mid tide, averaging an ascent from 37 to 38 feet per mile. If this rising were uniform and gradual, there would be no difficulties in the way of transportation; but the following analysis of the route will present us with such abrupt and steep acclivities as to create the necessity of investigating the capacity of the powers to overcome them.

To proceed in the intended analysis, I will make three divisions of the line of the route.

1st. From Hudson river to Kline Kill creek bridge, or Groat's.

2d. From Groat's to State line.

3d. From State line to Pittsfield.

## FIRST DIVISION.—From Hudson river to Groat's.

In Hudson city, at the very outset of the line, we meet with the greatest difficulty that will occur in the whole course of the route; the ascent from the 1st station being in the first 521 yards at the rate of 259 feet per mile, and thence to the public square 138 feet per mile. Mr. Anderson proposes another line that will reduce the ascent to 62 feet per mile; (vide map No. 1, and profile No. 1 B;) the improvements he proposes are all designated by a blue line. In that space we meet with a ravine that will require a culvert. The soil is clay.

Proceeding from the public square, the line meets the Farmer's turn-pike, a distance of a little more than a mile, crossing four ravines, requiring each a culvert; the ground for that distance is gently undulating; the soil of clay: about the same distance farther on, Claverack creek crosses the line. This creek is subject to freshets, not rising more than 4 feet, and the elevation of the road along the side slopes of the valley makes these inundations of no consequence; there a bridge of 250 feet in length will be necessary; the soil is clay, undulating.

From Claverack creek the line continues nearly  $5\frac{1}{4}$  miles in the same direction, still undulating till it reaches within  $\frac{1}{4}$  of a mile from the school house, (see map and profile No. 1,) when, in a distance of 1.33 miles, or  $1\frac{1}{3}$  mile, the ascent is 8 feet per mile, and increasing to 115 feet per mile in the next following  $\frac{1}{4}$  of a mile.

Mr. Anderson proposed another route in which the ascent shall be only 74 feet per mile. I refer to his report. Three culverts will be necessary in that distance. The line next winds up a hill of easy ascent, till it reaches, at Tator's, a ravine containing a small stream, where a bridge or an embankment will be necessary.

From Tator's to Kliny Kill creek there is a distance of 2.75 miles; in that distance, a swamp of very unfavorable nature presents itself: Mr. Anderson proposes a route to avoid it.

Arrived at Kliny Kill creek, this stream, at the distance of 13.10 miles from Hudson, flows in a pretty flat valley: it is liable to sudden freshets, and there a bridge of 250 feet long, together with an embankment 1400 feet long and 6 feet deep, will be required.

The line, continuing upon a more northerly course, reaches Kliny Kill creek bridge and Groat's, there being no other difficulties, except several heavy embankments, and the construction of two bridges, one 300 feet, the other 250 feet long.

To the report of Mr. Anderson, as well as to those of Lieutenant Vail and Mr. Guion, are annexed tables, in which every item of localities, ascents, descents, distances, embankment, excavation, bridges, nature of the soil, culverts, &c., are minutely exhibited in columns, and which, compared with the maps and profiles, convey a complete information of the survey.

Each table is divided into sections, and each section into subdivisions.

**SECOND DIVISION.**—*From Groat's to State line.—Mr. Guion's survey.*

The very beginning of this division presents great difficulties, requiring an excavation of nearly a mile in length, and 29 feet in depth; it may possibly be avoided by following the course pointed out by Mr. Anderson, crossing Kliny creek and two bridges; still, for nearly the whole length of that part, great impediments in the way of construction are to be found: heavy embankments, and occasionally the support of one wall 10 feet high shall be requisite. (See Mr. Guion's report and table.)

For the next 2.35 miles the line follows the valley of Steenie Kill creek, meeting with no obstacles of consideration.

The line continues 4.32 miles along the southern valley of the Kliny Kill creek, with a gradual ascent of 46 feet till opposite Parson's, where the ascent to the first summit level is at the rate of 104 feet per mile in the distance of 1.42 miles; but, by excavation and embankments, it may be reduced to 80 feet per mile.

From the summit level at Killog to the State line, a distance of 2.50, we meet an easy descent not exceeding 54 feet in a mile, and reach the valley of Flatbrook creek, over which a bridge of 100 feet will be necessary.

**THIRD DIVISION.**—*From the State Line to Pittsfield.—Lieut. Vail's survey.*

Respecting this division, I will observe, that Lieut. Vail, having started from the village of Pittsfield, running his survey in a westward direction, while the course of the survey of the two first divisions was eastward, has counted his courses and distances, risings and depressions of the ground, according to that circumstance, so that what would be ascent following my first course, is a descent with him. This must be kept in mind in reading over this report, and inspecting the table annexed to it.

The line of the survey, at a distance of about 6 miles from Pittsfield, branches out in two experimental lines, distinguished in the report of Lieut. Vail by the name of eastern and western routes; and, from being compared, the last one offers so many advantages in every respect, that we will adopt it exclusively.

Starting from the State line, after an undulating course of 1.42 miles, we reach Griffin's creek: at that place, serious difficulties in the way of construction are to be found, on account of deep excavations and long embankments on both sides of the creek, over which a bridge of 120 feet in length shall be required. From this point to the second summit level, distant about 8 miles, there is an undulating ascent; little difficulty in the way of ascent occurs, the greatest rate being 72 and 76 feet in a mile for very short spaces. From the undulating character of the ascent to the summit level, a great deal of work in excavation and embankment will be necessary. The line, in crossing Nicholl's creek twice, will necessitate the construction of two bridges, each 25 feet in length.

From the summit level the route descends in a similar undulating manner till it reaches the banks of the Pontoosakee, a western branch of the Housatonic river, where again heavy embankments will take place, and a bridge of 200 feet must be erected. Hence, the line arrives at the hollow



west of Pittsfield, from which point Lieut. Vail started. In that course, the Housatonic river, where a bridge of 70 feet to cross it, will be required.

In this division,  $12\frac{1}{2}$  miles in length, the ascents and descents reach the rate of 76 and 72 feet only in three points, and for short distances; there will be a great deal of labor, but of facile execution. I am less circumstantial in my analysis of it, because I would have only copied the report of Lieut. Vail, and his table, to which I refer.

An investigation of the powers to be employed becomes now necessary to ascertain whether the difficulties in the way of transportation, stated in the preceding analysis, are within the range of the power.

*TABLE of resistances according to different degrees of ascent.*

Ascent per mile, in feet.	Gravity per ton, in pounds.	Friction per ton, in pounds.	Resistance for one ton, in pounds.	Resistance for 8 tons, in pounds.
16 feet	7 lbs.	11 lbs.	18 lbs.	144 lbs.
24	$10\frac{1}{2}$	11	$21\frac{1}{2}$	172
32	14	11	25	200
48	21	11	32	256
64	28	11	39	312
80	35	11	46	368
96	42	11	53	424
112	49	11	60	480
128	56	11	67	536
144	63	11	74	592
160	70	11	81	648
176	77	11	88	704
192	84	11	95	760
208	91	11	102	816
224	98	11	109	872
240	105	11	116	928
256	112	11	123	984
259	$113\frac{1}{2}$	11	$124\frac{1}{2}$	996

*Of the Power.*

The horse, being the power to be made use of in the intended rail road, connecting Boston and the Hudson river, of which this will probably form a branch, must be adopted, and the extent of his useful exertion investigated.

The impediments in the way of easy, cheap, and safe transportation, are, 1st, the gravity of the load; 2d, the asperities of the ground travelled over; 3d, the friction resulting from both the gravity and asperities. The amount of these obstacles will fix the extent of the power to be applied. Though but a few miles of rail roads have been attempted in this country, the subject has excited a vast deal of interest, and has been the object of both experimental and scientific investigation, resulting in several publications, establishing, in a satisfactory manner, many of the most essen-

tial principles concerning roads. Referring to these well known publications, I assume the following data :

1st. That the friction is proportional to the gravity, and not effected by change of velocity.

2d. That, upon a well constructed rail road, the friction is so far reduced, that a weight or power of one pound is sufficient to move a load of 210 pounds, or about 11 pounds to a ton, or 2,240 pounds ; this is called the power of friction.

3d. That, to enable the gravity to overcome the friction, the inclination must be at least 35 degrees.

4th. That the resistance is equal to the sum of the gravity and the friction, which last is an invariable quantity.

*Useful power of the horse.*

1st. Assumed data. A horse, working the whole year round, travelling at the rate of three miles per hour, exerts a power of 125 pounds, drawing a load of eight tons, carriage weight included.

2d. That, in proportion as we diminish the time of exertion and the rate of distance, or both together, we may increase the exertion of the horse, provided it does not exceed three times his daily exertions.

3d. That as the horse, upon an ascent, has to overcome his own gravity, an angle of eight degrees is the limit ; after which he will have no power of traction.

(A.) The consequence of the second data is, that, if the horse takes two hours, instead of one, to travel three miles, his power of exertion will be doubled, and amount to 250 pounds, and so on : next, if at that rate he works only one hour instead of two, his powers will increase to 500 pounds for a load of eight tons ; and that, if two horses are made use of, their joint power will amount to a fraction over 1000 pounds ; that is to say, that, if they work only three hours per day, travelling at the rate of  $1\frac{1}{2}$  miles an hour, they will exert a traction equal to that of eight horses, working six hours per day the year round, and travelling three miles an hour, and drawing the same load of eight tons. This estimate, deduced from the above assumed data, must be carefully remembered. I designate it by the letter A, that it may be recurred to, as hereafter it will have important applications.

With the view of facilitating the transportation, I will glance, for the present, at the relative proportion of trade eastward and westward. It is known that the tonnage of the last is five times larger than that of the first. Now, by an inspection of the profiles, it is evident that the westward, or largest trade, is on a constant descent, with the exception of four miles of easy ascent, while the eastward, or minor trade, is on a perpetual, and often difficult ascent ; consequently, I think that the load going up might be, with propriety, reduced to six tons, while the descending one would be eight tons ; by this, the horse would be relieved one-fourth of its load, and his rate of travelling increased to two miles an hour, which will more than compensate for the reduction of the load.

The annexed table of resistances gives the means of ascertaining how far, by combining time and velocity, we can increase the traction of horse power : 80 feet ascent in a mile being the limit adopted, I will confine my calculations to that elevation, and those that exceed it.

Looking in the table, we find that an inclination of 80 feet in a mile creates a resistance of 368 pounds for an eight ton load : to overcome it, travelling, through the year, three miles per hour, during six hours of the day, (the power of a horse being 125,) it will require the power of three horses upon a level iron road ; now, if we reduce the weight of travelling to a third, the necessary quantum of exertion will be reduced in the same proportion ; consequently, if the power travels only one mile an hour instead of three miles, a single horse will afford the same power of traction ; in case the load is brought down to six tons, he will be enabled to travel two miles.

The same reasoning will apply to every inclination under 80 feet, so far down as sixty feet per mile, with still more force ; under sixty feet, the balance is within the range of easy performance.

Of the inclinations above 80 feet in a mile, that are met with along the route, there is one of 259 at starting ; a second immediately following it, of 128 feet in a mile ; a third, of 115 feet, at the school house ; and a fourth, of 106 feet in a mile, at Killog Summit.

The first of these ascents, that of 259 feet, by the inspection of the table of resistance, will require a power sufficient to overcome a resistance of 996 feet, the load being eight tons ; that is, the force of eight horses, the power of one being assumed 125 : now, by recurring to the article A, we see, that, by reducing the travelling, &c. two horses will be amply sufficient to this emergency, *a fortiori*, for the three other inferior rates of inclination : in the case, however, of the ascent being 259 feet, it might be matter of consideration whether an inclined plane would not be preferable ; but, in the three last cases, no doubt but an additional horse shall be preferable, especially considering the whole distance to be travelled (at that rate of inclination) is only four miles altogether, and at a great distance of each other.

Returning, and referring to the very minute and explicit tables annexed to each of my assistants' reports, we will see that there will be two miles of ascent above 100 feet in the mile, and fifteen miles of easy performance in the first division from Hudson river to Groat's ; in the second, from Groat's to State line there will be 1.46 miles above the rate of 100 feet to the mile, five miles under eighty feet, between seventy-eight feet and sixty feet to the mile ; the balance, eight miles, being of easy performance.

In the 3d division, from the State line to Pittsfield, there will be five miles of ascent between 76 and 72 feet to the mile ; the balance, eight miles of easy performance.

It must be observed, that, in consequence of the heavy excavations and embankments resulting from the extreme undulating character of this route, these rates of ascent will be considerably reduced.

#### Construction.

The impediments in the way of construction may be summed up under the following heads :

- 1st. Undulations.
- 2d. Ravines and water courses.
- 3d. Precipices and abrupt slopes.
- 4th. Swamps and freshets.
- 5th. Curvature.

By reference to the profiles, it is immediately perceived that the route is very undulating on its whole extent, and will necessitate, of course, a great deal of excavation and embankment. Let us again recur to the synoptical tables annexed to the descriptive memoirs of my assistants: looking at the columns headed *Excavation* and *Embankments*, we obtain the following results:

N. B. That I consider only the undulations of the line actually surveyed, marked by the red line.

EXCAVATION.		Average length for one mile.	Average depth for one mile.
		<i>Feet.</i>	<i>Feet.</i>
<i>1st Division.</i>			
The whole length of excavation will be 16,120 feet, with an average depth of 9 feet, the length of the division being 16.5 miles, the average of excavation for a mile is - - - - -		1,007½	9
<i>2d Division.</i>			
The average length and depth will be found in the same manner, to be - - - - -		620	10
<i>3d Division.</i>			
The average length and depth will be found in the same manner, to be - - - - -		569	10
Making per mile, for the whole route, an average for a mile, of - - - - -		732	9.5
EMBANKMENTS.		Average length in one mile.	Average height.
		<i>Feet.</i>	<i>Feet.</i>
<i>1st Division.</i>			
In the same manner, the embankments of this division will be found to give for a mile an average of		442	9
<i>2d Division.</i>			
The average length of a mile will be found -		505	10
<i>3d Division.</i>			
The average length in one mile - - - - -		1,028	12
Hence, the average of an embankment for a mile, through the whole of the route, will amount to -		658	11



2d. *Ravines and Water Courses.*

Under this head are included all situations where culverts and bridges are necessary. The span of the culvert must be such as will admit a free passage under them; and it cannot be properly determined but on locating the rail road; nevertheless, I will adopt that the average cost of the smaller set will be 300 dollars, and the largest 500. This estimate is founded upon the average cost of the same kind of work up the Erie Canal, but I think it high.

The average for the whole route, the half of one for every mile	-	-	-	-	-	Average of Culverts for one mile.
						$\frac{1}{2}$ culvert.
There will be 1,705 feet of bridging, of which 1,160 feet in the first division, 100 in the second, and 445 feet in the third; making an average of $42\frac{1}{2}$ feet for every mile of the whole route; or being taken in yards, is 14 yards	-	-	-	-	-	Average of bridges for one mile, in yards.
						14 yds. or 42 feet.
I estimate each current yard at 45 dollars, from the data of several turnpike routes.						

3d. *Precipices and abrupt Slopes.*

There is one of this description near Groat's, described in Mr. Guion's report, which will require a deep excavation at 29 feet, for the distance of 1,573 feet, in a rocky ground: it will besides require the support of a wall ten feet high.

4th. *Swamps and Freshets.*

For this head I refer to the descriptive memoirs of my assistants. Every creek crossed by the line is more or less subject to freshets, especially Flatbrook creek; but the causeways will be generally under ten feet elevation. As to the swamps, one of the worst description occurs at a place in the first division, known by the name of Vraedenborg Fly, which will require piling. It is in the profile A, marked *quagmire*; and I would support the opinion of Mr. Anderson respecting the propriety of looking for another route. I will take this opportunity to suggest, that it would be better, in the crossing of the swamps of very soft bottoms, to use at first a wood rail road, to give to the foundations time to settle, when stone and iron rail road would be substituted in course of time.

5th. *Curvature.*

Though the route in some places, especially in the second division, may be termed serpentine, there is no place where the radius will be less than 400 feet, except in one place of the third division, where it is much under.

*Materials.*

By the statements of the tables, it appears they will be found in plenty, and can be supplied by the progressive use of the route, by beginning it at Pittsfield.

*Trade.*

It appears by the statistics obtained, that there will be 125,000 tons transported from Pittsfield to Hudson city.

*Construction.*

The plan of construction for the intended rail road will no doubt be that of an iron rail, supported by a continued foundation of granite.

The question may be now, whether it will be expedient to have a double or a single railway: this must be decided by the committee.

Before I proceed farther, I will draw the attention of the committee to the use of locomotive engines. These machines have of late risen into great favor, even into this country, where the application of their power seems to be better understood; and in New Jersey some have been ordered, and are expected. Should they be adopted for the present intended rail road, and should they perform as they are represented to do, every and all difficulties in the way of transportation would disappear at once; for, suppose one of these machines be possessed of the power of five horses, and such an engine will cost no more than the prime cost of horses, if we compare the performance, it will be seen that the five horses can exercise their power of traction no more than ten hours in the day, supposing them to travel even but two miles an hour; but the engine, working fourteen hours more, will consequently perform the work of twelve horses with a power of five only. An objection may be started; it is the expenses for the fuel. In order to enable the committee to solve the question, I will state the quantity of coal, as computed for the rate of performance.

One pound of coal, or  $\frac{1}{8\frac{1}{2}}$  part of a bushel, is computed equal to the conveyance of one ton upon a level road; consequently, about  $1\frac{1}{2}$  bushels will produce a fraction equal to that of a horse exercising his useful daily and annual power, and as many times the same quantity of coal is required as there are horses' power to be obtained. If it is to overcome an ascent, it requires only to look, in the table of resistance, its amount, and multiply the number of horses required by it, and multiply by  $1\frac{1}{2}$ : the result must be added, to what is required to pass through the horizontal distance.

For instance, in the case of the ascent of 259 feet in a mile, which we meet at our starting from Hudson, requiring the power of 8 horses; then  $8 \times 1\frac{1}{2} + 1\frac{1}{2}$ , as the horizontal distance, is one mile; or  $15\frac{1}{2}$  parts of a bushel will be required.

*Estimate of Expenses.*

My object, in this estimate, is to give an average amount of the expenses that will be necessary for a mile. These expenses accruing from the following items:

1st. *Excavations.* Under that head, I will distinguish that made in rock from that made in the soil; there will be an average of 216 feet per mile of the former, which, subtracted from 732 feet, established in page 8 of this report as the whole average excavation per mile, leaves 516 feet for the soil excavated. For rock excavation, I will state 75 cents per cubic yard, and 12 cents for the same of common earth.

2d. *Embankments.* These I divide into causeways and mere embankments. I will suppose the causeways 22 feet wide and 11 feet high, on an average of the causeways; the average length per mile is 277 feet. I will affix to them the price of \$ 18 the running yard.

3d. For the making the horse-path, and trenching for foundations, I will allow \$ 1,200.

4th. For foundation walls, I will allow 8 cents for the running foot.

5th. For rail stones in granite, with the cutting, 20 cents per cubic foot.

6th. For iron rails and nails, ready for fastening, \$ 120 per ton.

On these data, I establish the following estimate, to which must be added the expenses for culverts and bridges, which come for a 7th head of expenses.

Considering that the excavations will require a slope on both sides, I have, as a medium, taken 18 feet for the width of it; the estimate is for a single rail road.

Before ending this report, I must acknowledge and recommend the zeal displayed by my three assistants, Lieut. Vail, 1st Infantry, and Messrs. Guion and Anderson, as I cannot praise too much their activity and intelligence.

#### *Estimate.*

Excavation, { common soil, 3,268 cubic yds. at 10 cts. per yd.	\$ 326 80
{ rock, 1,584 cubic yds. at 75 cts per yd.	1,188 00
Embankment, common soil, 2,794 cubic yds. at 10 cts. per yd.	279 40
Causeways, 92 running yards, at \$ 18 per yard,	- 1,656 00
For the horse-path and trenching the foundations,	- 1,200 00
Foundation walls, 10,560 feet, at 8 cents per foot,	- 844 80
For the granite rail-stone, 10,560 feet, at 20 cents per foot,	2,112 00
Thirteen tons and 1,120 lbs. of iron rails and nails, ready for fastening, at \$ 120 per ton,	- - - 1,620 00
For drilling 22 holes per 3 yards, at 2½ cents per hole,	352 00
For levelling the rail-stone and securing the iron rails,	528 00
Culverts,	- - - 200 00
Bridges, 14 running yards, at \$ 45 per yard,	- - - 630 00
Total,	\$ 10,937 00

All of which is respectfully submitted.

**P. H. PERRAULT,**  
*Lt. Col. Top. Engineers.*

*Lieutenant J. Vail's report on the Hudson and Berkshire Rail Road.*

GEORGETOWN, D. C. December 12, 1828.

To Lieut. Col. P. H. PERRAULT,  
*U. S. Topographical Engineer :*

SIR : Agreeably to your orders, dated Hudson, July 30, 1828, respecting the experimental survey of that part of the contemplated Hudson and

Berkshire rail road, between the village of Pittsfield, Berkshire county, State of Massachusetts, and the line dividing the States of New York and Massachusetts, I have the honor to submit to you the following map, profile, and descriptive memoir.

Pursuant to those instructions, I reported myself to the gentlemen of the committee, appointed by the citizens of that part of the county to obtain information in relation to the object contemplated.

The object chiefly to be attended to being to ascertain the practicability of constructing a rail road between the two points abovementioned, a reconnaissance of the country was previously made, and afterwards experimental lines of levels were run.

The survey commences in a hollow west of the park at Pittsfield. This experimental line follows the western foot of the mountain, until the point where the southern end of the ridge takes a southeast course: the line then descends into a flat of meadow, till it reaches the valley of Flatbrook; then running up this valley, it terminates on a point on the State line.

From an examination of the annexed map and profile, (marked No. 3,) it will be perceived that the line runs over an undulating surface: a circumstance that will render the construction of a rail road expensive, on account of the frequent necessary excavations and embankments. There are few rocks that present themselves immediately on the route; and the ground being of a loose character, the excavations will easily be made.

From Pittsfield to the summit level, or bench mark No. 9, the ground offers no very serious difficulties to the location of a road. The cutting, however, will be considerable, if it is intended to reduce the ascent under 80 feet to the mile. The 3d subdivision in the first section offers the greatest difficulties, between Pittsfield and the summit level: the ground being undulating, and the ascent very rapid. When the line comes to be located, the ascent may, however, be reduced by an increase of distance; in this case, the excavations would also be considerably reduced.

From the summit level to bench mark No. 11, the ground descends gradually, (see profile marked X,) except in the 4th subdivision of the second section, where the fall is very rapid. From the 4th subdivision to the end of the 5th, lie the greatest difficulties on this route. The mountain taking a southeast course, and the point to be obtained lying nearly southwest of the ridge, the line could no longer be kept on the side hill; leaving no other alternative but in descending into Cone's meadow, (bench mark No. 12.) In the distance of 440 yards, the descent 87.930 feet descending at the rate of 351.720 feet to the mile, which can only be overcome by an inclined plane. From bench mark No. 12 to the State line, the surface of the ground is not so uneven, and the road could easily be graduated. The section of the road running up the valley of Flatbrook will be difficult and expensive, owing to the very gradual descent of this creek; in time of freshets, its banks are overflowed for some distance on each side; the country is low; consequently, it will require to construct the road on a causeway sufficiently elevated to keep the road from being overflowed during the high waters.

The line from the end of the 5th subdivision would cross Lewis' creek once, and the outlet of Guilding's pond, requiring two bridges, with heavy embankments on each side.

Flatbrook being a very circuitous stream, the line will cross it at least four times, requiring four bridges.



Owing to the difficulties of this second section, and the great expense that would be incurred in constructing a rail road on this route, it became necessary to ascertain if another route could not be found, and if the expense of its construction could not be reduced.

From an examination of the country, it was ascertained that by diverging from a point on the line already surveyed, (station 65,) and running nearly through the centre of the township of Richmond, an easier graduation could be obtained, without incurring as much expense in the construction of the road as on the first route.

This third section cannot be said to offer very serious difficulties, except where the line will cross Griffin's creek, near Griffin's mill. A deep cut for about 440 yards, extreme depth 12 feet, would be necessary, as will a very considerable embankment, with a bridge at least 120 feet in length. This difficult point might, however, be avoided, by running the line in a west course from Col. Rowling's house: in this case it would increase the distance considerably; a circumstance to be considered, whether the expense in this case would not be greater than by deep cutting and embanking on the route above mentioned.

Two routes having been surveyed, they will be designated by the *eastern* and *western* route.

### EASTERN ROUTE.

This route runs from the hollow west of the park at Pittsfield to the eastern boundary line of the State of New York, following the west foot of the mountain. It is divided into two sections.

*First Section.*—From bench mark No. 1 to bench mark No. 9, or the summit level.

Distance	-	-	-	-	4 miles 1140 yards.
Ascent	-	-	-	-	247.080 feet.

*Subdivision 1st.*—From bench mark No. 1 to bench mark No. 3.

Total distance	-	-	-	-	1326 $\frac{1}{2}$ yards.
Total ascent	-	-	-	-	14.245 feet.

This subdivision runs on a very undulating surface; it crosses the western branch of the Housatonic: on this part of the line, some cutting will be necessary, and a bridge to cross the stream. The soil is loose and easily excavated.

*Subdivision 2d.*—From bench mark No. 3 to station No. 19.

Total distance	-	-	-	-	903 $\frac{1}{2}$ yards.
Total ascent	-	-	-	-	23.930 feet.

This subdivision, like the former, runs over undulating ground. There will be, on this part of the line, a considerable quantity of excavation; the embankments will also be considerable, principally on each bank of the river Tontoosack, a western branch of the Housatonic. These large embankments could not be avoided, as the bottom of the stream is at least 25 feet lower than the level of bench mark No. 1 at Pittsfield. This section may be considered circuitous, but not so much so as to admit of any degree of curvature.

*Subdivision Third.*—From station No. 19 to station No. 43.

Total distance,	-	-	-	-	2 miles 207 $\frac{2}{3}$ yards.
Total ascent,	-	-	-	-	161.025 feet.

This subdivision may be considered as the most difficult one on this section; the ground being undulating, and the ascent very rapid. The cuttings and embankments will be long, deep, and high, in order to reduce the graduation under eighty feet to the inch. These extra labors may, however, be reduced, as it has already been mentioned, when the road is to be located: that is, by increasing the distance.

*Subdivision Fourth.*—From station No. 43 to station No. 53.

Total distance,	-	-	-	-	1362 $\frac{1}{3}$ yards.
Total ascent,	-	-	-	-	23.200 feet.

In this subdivision the ground ascends gradually; but, owing to the uneven surface upon which the line runs, the embankments will be considerable.

*Subdivision Fifth.*—From station No. 53 to bench mark No. 9, or the summit level between Pittsfield and the State line.

Total distance,	-	-	-	-	860 $\frac{1}{3}$ yards.
Total ascent,	-	-	-	-	24.690 feet.

This subdivision ends at the highest point between Pittsfield and the State line, 247.080 feet; and is 1225.300 feet above mid tide in the Hudson river, at the city of Hudson. On this point of the line some embankments will be necessary.

*Second section.*—From bench mark No. 9 to the State line.

Distance,	-	-	-	-	8 miles 283 $\frac{2}{3}$ yards.
Descent,	-	-	-	-	312.040 feet.

*Subdivision First.*—From bench mark No. 9 to station No. 65.

Total distance,	-	-	-	-	1,736 yards.
Total descent,	-	-	-	-	56.750 feet.

Four hundred and forty yards from the summit level, the ground descends very rapidly; the embankments will be considerable. By commencing cutting immediately at the summit level, this embankment could be considerably reduced, and would probably be the best plan to be adopted, as the excavated earth would serve to make the embankments. This subdivision will require a bridge to cross Tracy's creek.

*Subdivision second, (profile X.)*—From station No. 65 to station No. 74.

Total distance,	-	-	-	-	1 mile 568 $\frac{1}{3}$ yards.
Total descent,	-	-	-	-	30.535 feet.

Although this subdivision has a very gradual descent, the ground presenting an undulating surface, the extra labors, such as excavations and embankments, will be considerable. From station 65 the line takes a southwest turn, but there is sufficient room to give it any degree of curvature.

*Subdivision Third.*—From station No. 74 to station No. 80.

Total distance,	-	-	-	-	-	-	1 mile 92 yards.
Total descent,	-	-	-	-	-	-	21.240 feet.

The localities on this subdivision are similar to those on the 2d, and will require considerable extra labor: the excavation and embankments along this part of the line will be nearly equal.

*Subdivision Fourth.*—From station No. 80 to station No. 95.

Total distance,	-	-	-	-	-	-	1 mile 250 yards.
Total descent,	-	-	-	-	-	-	85.345 feet.

Great many difficulties offer themselves on this subdivision: the line for some distance runs on the left bank of the valley of Lewis' creek, and crosses a succession of ridges at right angles. From the 87th to the 88th station, the line crosses the creek, the level of which is at least thirty feet below the level kept at that point: a long and high embankment will be necessary, as well as a bridge to cross the stream. The uneven and broken ground upon which this part of the line runs will make this subdivision expensive, on account of the extra labors that will be required. From bench 11 to very few yards of bench mark 12, the line runs on a very rocky hill side, the inclination of which is from 30° to 35°.

*Subdivision Fifth.*—From station 95 to station 103.

Total distance,	-	-	-	-	-	440 $\frac{2}{3}$ yards.
Total descent,	-	-	-	-	-	87.940 feet.

From the point where the line of this subdivision descends into Cone's meadow, the mountain and its spurs take a southeast course, and the point to be attained lying almost directly southwest of the ridge, left no other alternative than descending into this flat. In order to overcome this difficult point, an inclined plane will be required. It is to be observed, however, that the descent might be more gradual than is exhibited on the annexed profile. But from the general characteristic of the ground, the descent at the point where the line would leave the side hill would at any rate be abrupt.

*Subdivision Sixth.*—From station 103 to station 108.

Total distance,	-	-	-	-	-	-	1.630 yards.
Total descent,	-	-	-	-	-	-	14.875 feet.
Total ascent	-	-	-	-	-	-	10.303 feet.

This subdivision runs through Cone's meadow; and, on account of the character of the ground, the road will have to be constructed on causeway; in this case, the descent will be reduced to almost nothing. It crosses Lewis' creek, and will require a bridge.

*Subdivision Seventh.*—From station No. 108 to station No. 119.

Total distance,	-	-	-	-	-	1 mile 8 $\frac{2}{3}$ yards.
Total descent	-	-	-	-	-	27.385 feet.

This subdivision will require two bridges, one to cross the outlet to Guilding's pond, the other to cross Flatbrook. There will be some cutting and embankment.

*Subdivision Eighth.*—From station No. 119 to the New York State line.

Total distance	-	-	-	-	1 mile 838 $\frac{1}{2}$ yards.
Total ascent	-	-	-	-	2,940 feet.

This part of the line runs up the valley of Flatbrook, and will have to be constructed on a causeway for nearly the whole length of this subdivision, on account of the ground on each bank of the stream being overflowed during freshets: three bridges will be required to cross the creek. The excavation will be nearly half of a mile in length.

From the present survey, it appears that the length of the whole line of the eastern route is 12 miles 1424 yards; that is, the shortest levelled distance between Pittsfield and the State line, where a rail road could be constructed along this route.

### WESTERN ROUTE.

This route runs from the hollow west of the park at Pittsfield to the State line, passing nearly through the centre of the township of Richmond, and is subdivided into two sections.

The first section runs from Pittsfield to the summit level; the description of which has already been given in the analysis of the first section of the eastern route.

The second section, which is headed on the profiles as the *third section*, on account of its being the third part of the general operations performed in the field, commences at bench mark No. 9, or the summit level; follows the second section of the eastern route till it reaches the 65th station; thence, diverging from this point, and taking a S. W. course, passes through Richmond, and joins Mr. Guion's bench mark No. 27, on the State line.

*Second Section.*—From bench mark No. 9, or summit level, to Mr. Guion's bench mark No. 27, on the State line.

Distance	-	-	-	-	7 miles 647 $\frac{2}{3}$ yards.
Descent	-	-	-	-	285,830 feet.

*Subdivision 1st.*—From bench mark No. 9 to station 65.

Total distance	-	-	-	-	1736 yards.
Total descent	-	-	-	-	56,750 feet.

See subdivision 1st of the 2d section of the eastern route.

*Subdivision 2d.*—From station No. 65 to station No. 71.

Total distance	-	-	-	-	1347 yards.
Total descent	-	-	-	-	20,745 feet.

This subdivision will require, from station 68 to station 69, (see map No. 3,) a causeway, upon which the road should be constructed, in order to cross the swampy ground lying between these two stations; the length of which will be 272 yards, and its greatest height about 6 feet. The remainder of this subsection runs on a side hill of a gradual inclination.

*Subdivision 3d.*—From station No. 71 to station No. 77.

Total distance	-	-	-	-	1323 $\frac{1}{2}$ yards.
Total descent	-	-	-	-	38,490 feet.

On this subdivision one bridge will be necessary to cross Nicholl's creek. The line runs on pretty level ground, but undulating. From station 75,



the line takes a more northwest course, following the meander of Nicholl's creek.

*Subdivision 4th.*—From station No. 77 to station No. 88.

Total distance	-	-	-	-	-	1.680 yards.
Total descent	-	-	-	-	-	72.360 feet.

This subdivision follows the bend of Nicholl's creek for some distance, crosses it once, requiring one bridge. The ground on this part of the line falling rapidly, the excavation and embankment will be considerable. It is to be observed that this circuitous part of the line could, in some measure, be avoided, by striking from station No. 75 to station No. 85, almost in a direct line, the localities of the ground being nearly the same. In this case, the distance would be decreased, and two crossings of the creek avoided, or dispensed with. I deviated from this last course at the request of the gentlemen of the committee appointed by the town of Richmond to make an offset on a survey that had previously been made.

*Subdivision 5th.*—From station No. 88 to station No. 100, near Colonel Rowley's house.

Total distance	-	-	-	-	-	1 mile 808 $\frac{1}{2}$ yards.
Total descent	-	-	-	-	-	21.550 feet.

This subdivision runs over a surface that might be considered as almost level. That part of the line in Captain Gates' meadow will have to require the road to be constructed on an artificial foundation, owing to the ground being very swampy. Two bridges will be necessary to cross Nicholl's creek.

*Subdivision 6th.*—From station No. 100 to station No. 118.

Total distance	-	-	-	-	-	1 mile 146 yards.
Total descent	-	-	-	-	-	77.945 feet.

This subdivision, as it has already been observed, in the first part of this memoir, offers great difficulties to the construction of a road. The excavation will be very considerable for about 440 yards: the embankments on each side of Griffin's creek will be long and high, requiring also a long bridge. This excavation and embankments could, in some manner, be avoided by running the line in a S. W. course from Col. Rowley's house. In this case the distance would be considerably increased; and owing to the irregularities of the surface of the ground, and also to the line crossing a succession of ridges at right angles, the great quantity of small embankments, and also the frequent necessary excavation, it would require on this deviation of the former line, would, probably, combined, make the expense greater on this latter route than on the former, by deep cutting and embanking. These things are, however, to be determined by more minute examinations and surveys than were in my power to make, owing to the circumstances under which I was situated.

*Subdivision 7th.*—From station No. 118 to Mr. Guion's bench mark No. 27, on the State line.

Total distance	-	-	-	-	-	1 mile 677 $\frac{2}{3}$ yards.
Total ascent	-	-	-	-	-	20.470 feet.
Total descent,	-	-	-	-	-	3.660 feet.

This subdivision runs over ascending and descending ground. This

part of the line will be expensive on account of the embankments, which will be long and high. It is to be observed, however, that a better course could have been pursued by running the line from station No. 120, near S. Arnold's house, (see map No. 3,) to station No. 125, near J. Arnold's, as is exhibited on the map by a blue line. In this case the length of the line would be decreased, and the embankments would be much less. From J. Arnold's, the line runs on a side hill, the inclination of which is from 30° to 35°.

This line terminated 6.830 feet above Mr. Gaion's bench mark No. 27, but could, without any difficulty, join the level of his bench mark, as the ground admits of any graduation whatever. The terminating point of this route is 25.630 feet above the terminating point of the eastern route.

The total length of the western route, from the present survey, is 12 miles and 59 yards.

Comparing the two routes surveyed, it appears that the western route is 1365 yards, or little better than three-quarters of a mile shorter than the eastern route.

The western route will admit of an easier graduation.

The materials for construction, as relates to rocks, appear to be more abundant on the eastern than on the western route: as the distance, however, between these two lines, does not exceed one mile and a half at any point, and the country being well provided with cross roads, the difficulties of transporting the materials from one point to another will not be very great.

The rocks suitable to construction on both routes are limestone of the best quality, and are found in abundance between Pittsfield and the New York line. There are several marble quarries and iron ore beds along both lines, all of the best quality. The main growth of timber is elm, beech, maple, hemlock, ash, and few pines.

Owing to the want of proper assistance, it has not been in my power to make as detailed and minute a survey as would be necessary to give sufficient data upon which a plan and an estimate of a rail road could be predicated.

Having entirely limited myself to experimental lines, to ascertain the practicability of constructing a rail road between Pittsfield and the New York State line, I will not pretend to give a true statement of the extra labors on either route. What I have stated I here submit with diffidence, as approximate to what more minute examinations and surveys would more correctly determine. I will therefore beg leave to suggest that, previous to the location of a road, such surveys should be made, as many more routes, that were not in my power to survey, could probably be found.

It would be of importance that the road should commence on the park at Pittsfield, so as to obtain that point from bench mark No. 1: it would require an inclined plane, the ascent being 50.175 feet on a distance of 366 $\frac{2}{3}$  yards.

A route might probably be found, by commencing at the foot of the elm tree on the park, keeping down North street, crossing the Housatonic above Pomeroy's factory: the descent in this case would be considerably decreased.

The map annexed, marked No. 3, is plotted on a scale of 4 inches to the mile: the line surveyed is marked in red ink. The blue lines on the

[illegible]



## ITINERARY—Continued.

Number of Sections.	Subdivisions.	LOCALITIES.	Length of subdivisions, in yards.	RATE OF INCLINATION.		SOIL.		EXTRA LABORS.				GENERAL REMARKS.
				Ascent per mile, in feet.	Descent per mile, in feet.	Quality.	Nature of surface.	Excavation.		Embankment.		
								Length in feet.	Extreme depth.	Length in feet.	Extreme height in feet.	
5. 1st route, with an incld. plane. Total length, 2 m. 713½ yds.	1	From sta. 132 to sta. 135 - - - - -	379 2-3	8.	-	Alluvial meadow	Level	-	-	-	-	Two small culverts, 10 feet by 5. A bridge of 90 feet, or culvert of large dimensions, will be necessary, in crossing the brook at stations 41 and 42. A bridge will be required over Tator's brook, 120 feet in length.
	2	From 135 to station 154, at the school-house - -	1,234 2-3	115.96	-	Gravelly	Broken	1,000	12.50	880	11.5	
	3	From 154 to 160, by J. Kittle's - - - - -	583 2-3	15.47	-	-	Level	280	8.50	-	-	
	4	From Kittle's to sta. 191, beyond Cornelius Tator, b. m. 12 -	2,038 2-3	64.53	-	-	Side hill	690	7.30	430	7.75	
6. Total distance, 2 m. 1411 yds.	1	From sta. 191 to 218, near Garner's - - - - -	2,224 1-3	-	7.33	Gravelly	Broken	15.30	21.00	-	-	Small embankments over the sinuosities of Vradenborg's fly. The valley of Kliny creek, at the place where the line crosses, being low, wide, and subject to overflows, will require a heavy embankment, and a bridge 200 feet.
	2	From Garner's to 223, beyond b. m. 14 - - - - -	1,627	-	19.61	Gravel	Side hill	6.80	14.50	-	-	
	3	From 233 to 245, near Kliny kill - - - - -	1,079 2-3	-	20.52	-	-	980	13	500	6.50	
7. From Kliny-kill to Groat's, by 1st route, 2 m. 693 2-3 yds. by 2d, 2 miles 113½ yds.	1	From sta. 245 to 265, near Clark's - - - - -	1,731 2-3	26.51	-	Gravel	Undulat'g Partly lev.	1,400	6	1,700	12.50	A species of greywacke is met on this section at b. m. 12. Two bridges will be necessary over Steenie kill, one 300 feet, the other 200. This route will subject the line to a curve of a semicircular form, but will obviate the necessity of crossing Steenie kill.
	2	From sta. 265 to 281, on the bank of Steenie kill - -	1,505 2-3	34.60	-	-	-	770	7.20	800	6.50	
	3a	From 281 to 301, near bridge over Steenie kill - -	976 1-3	51.03	-	-	-	500	6.50	300	9.30	
	3b	From 281 to 301, by the southern bank of Steenie kill -	1,414 2-3	35.22	-	-	Partly undulating, partly side hill	830	7	490	16.00	
1st. sec. 2d route, by crossing Warren st. Total length, 1 mile 1128 1-3 yds.	1	From tide water to station 9 of the 1st route, by the public square - - - - -	521 2-3	259.30	-	Clay	Level	800	5.00	270	6.50	The two curves in this line are very gradual, the radius of each not less than 1000 feet. A bridge will be required over the road in Warren street, 100 feet in length.
	2	From sta. 9 to 11, as above - - - - -	463	36.76	-	-	Side hill	Rock 200	5	-	-	
	3	From station 11 to b. m. 3, in the Farmers' Turnpike -	1,903 2-3	62.20	-	-	Gradual slope	1,400	Warren street 18	100	23	
5th sec. 2d route, by a long excavation at the school-house.	1	From sta. 132 to Kittle's - - - - -	2,194 2-3	72.44	-	Gravel	Broken	1,600	11.50	100	4.96	Part of this long excavation at the school-house will be rock, a sort of argillite. Bridge as above noted, (2d route)
		From Kittle's to sta. 119, as above, (b. m. 12) -	2,038 2-3	64.53	-	Rock at the schl. house	-	15.30	21	-	-	
						Gravel	-	6.80	14.50	-	-	



map denote the routes to be surveyed, in order to ascertain their comparative merit with the one already surveyed. The horizontal distances of the axis of the profile marked No. 3 are plotted on the scale of 4 inches to the mile. The altitudes to the axis, or plane of comparison, are on a scale of 50 feet to the inch. The base line of the profile, or the plane of comparison, is the level of bench mark No. 1, in the hollow west of the park at Pittsfield. In the annexed itinerary table is given the length of each section and its subdivisions, the ascent and descent in feet per mile in each subdivision, the quality of the soil, the nature of the surface of the ground, the *probable* excavation and embankment, the *probable* length of the bridges.

The profile marked X is the second section of the eastern route. The point is A and B, corresponding to A and B on the first profile, station 65.

Before closing this report, I beg leave to tender my thanks to the gentlemen of the different committees of the townships of Pittsfield, Richmond, and West Stockbridge, for the useful services they have rendered in the execution of the duties you were pleased to intrust me with.

I have the honor to be,

Sir, very respectfully,

Your obedient servant,

JEFFERSON VAIL,

1st Lieut. 1st Reg't. U. S. Inf.

*W. B. Guion's report on the Hudson and Berkshire Rail Road.*

GEORGETOWN, November 17, 1828.

Lt. Col. PERRAULT :

SIR : In obedience to your orders, I have the honor to submit the following report on the survey of a section of the route for the Hudson and Berkshire rail road, which you were pleased to entrust to my care.

This portion of the line of survey is comprehended between Groat's (Chatham township) and the line dividing the States of New York and Massachusetts; commencing at the former point, and terminating at the latter. It pursues a general northeastern direction, in a distance of about five miles; then, turning suddenly to the southeast, continues this course, in a distance of about nine miles, to the State line, where it is connected with the line of survey from Pittsfield, Massachusetts, executed by Lieutenant Vail.

It will be readily perceived, by a glance at the accompanying map and profile, from the lofty and precipitous character of the country traversed by this line, that the route to be pursued must be along the valley of the Steenie Kill creek, which rises in one of the hills dividing the waters which flow into the Hudson from those that flow into the Housatonic; and from the rapid descent in this stream, and the ruggedness and abruptness of the hills that mark its course, which often leave it but a narrow valley, and sometimes approach it to the brink, that an uniform ascent can not be effected; and that the line must generally run very near the bank of the creek, and consequently possess the serpentine character of this stream.

Agreeably to the arrangement prescribed in your instructions, I have

divided the route into sections, where natural distinctions in the features of the country passed over seemed to exist; and for greater perspicuity, each section is subdivided, wherever a change in the grade of the route occurs. Accompanying this, I have given a tabular statement, displaying the different sections and subdivisions, their characters, and the facilities for, and obstacles to, easy construction, to be found in them; but it must be remarked, that, as the survey was rather general in its objects, this statement cannot be received as *strictly* correct; and that a more minute examination might effect many beneficial alterations. Besides this table, only a few general remarks, on some points of the route, will be necessary.

Section first is comprised between station 1, which is near bench mark 18 at Groat's, and station 114, which is between bench mark 22 and Rowe's; and embraces a distance of 4 miles and 1,019 yards, as surveyed. It may be distinctly termed *rough and broken*. The ranges of hills, which traverse the country in a general northern direction, and which, in advancing from Hudson city, become more frequent and formidable, appear to have united near Groat's, to form a part of a great line of separation between the tributaries of the Hudson and those of the Housatonic; and the waters from the upper parts of this range, flowing down, and forming the Steenie Kill creek, here burst through them in a *devious* course, leaving sometimes a narrow valley, and sometimes precipitous banks of earth and rock. This section obviously presents more difficulties in the way of easy construction than any equal distance on this part of the whole line: but one obstacle (the spur of rock passed over in subdivision first) would be avoided, if a previous passage could be effected up the valley of the Kliny Kill, thereby attaining the table land on which stands Groat's house: the route might then be pursued to the beginning of subdivision second, on nearly level ground. The next important difficulty is found in subdivision second, where a heavy embankment appears to be unavoidable, in consequence of a sudden and great change in the direction of the second or upper bank of the creek, along which the line had previously been conducted. And near the beginning of subdivision third, an item of expense, which is not enumerated in the accompanying table, will probably be found unavoidable. It will consist in a *wall of masonry*, from station 25 to bench mark 19, 120 feet long and 10 feet high, to resist the action of the Steenie Kill, which, sweeping down in a direction nearly direct against the bank, has undermined it, and caused an avalanche of rocks and earth; and although this bank is composed of a loose gravelly soil, and the line runs along it at an elevation of near 30 feet above the surface of the water in the creek, a low wall will probably be made to give sufficient support, by a slight increase, at this point, of the usual width of the road.

A source of considerable expense is also found in this subdivision in the ridge of rock encountered opposite Backus' paper mill. It extends from the adjacent heights to very near the bank of the creek, decreasing in altitude as it approaches it, until it sinks beneath the surface of the ground. A longitudinal section of it was taken, and will be found on the profile and map marked G. It will be seen from these that the cutting may be diminished by crossing at a lower point; but that, by the same operation, the line will be made to describe a curve, whose radius will be proportionably less than 400 feet. The only material alterations that may be made in this section, are, first, in crossing the Steenie Kill at Dean's mill, and continuing on the north side of it to Tompkins' mill, where it

would be recrossed ; and, second, in crossing the same at Dow's carding mill, and pursuing the north bank to near Rowe's, where the line would return to the south side. These routes were not surveyed ; but they appeared to possess nearly equal advantages and difficulties with those which were : a minute examination of them, however, might be rewarded.

Section second is limited by station 114, and a point between stations 143 and 144, and includes a distance of 2 miles 626 yards. It differs from the preceding one in presenting a broader valley and fewer obstructions from the approaches of the adjacent hills. The main obstacle in it is, a ridge of argillite, which extends from the high lands in the vicinity to the brink of the Steenie Kill at Rowe's, and which cannot be avoided, without making a curve that would be thought inadmissible.

Section third embraces a distance of 4 miles 538 yards, between a point near station 143 and the summit at Kellog's. The line advances through the valley of the southeastern branch of the Steenie Kill, which has an average breadth of about half a mile, from the highest point of cultivation on one side to that on the other. The water in the creek has a rapid fall from Kellog's to a point nearly opposite Parsons', from whence it flows slowly through a narrow swamp, about one-fourth of a mile, and then again descends rapidly to the other extremity of the section. The line, as run, for the most part preserves the inclination of the bottom of the valley, sometimes passing over soft, wet ground, which may easily be made firm by ditching : but as the declivities of the adjoining hills are easy and gentle, a uniform ascent of about 80 feet to a mile might be obtained from station 162, near bench mark 24, to the summit, by an embankment across the little creek opposite Parsons', 35 feet high, and about 300 yards long. The line would then run along a gentle slope of gravelly soil to the summit.

Section fourth extends from the summit to station 211, on the bank of the Flatbrook, a distance of 1 mile and 1,027 yards. From bench mark 25, the line runs for about 200 yards over a rich and apparently level meadow, and then follows the course of a little stream, which has its source in a ridge of limestone in this meadow, to the valley of Flatbrook. Flatbrook is a broad and shallow stream, which flows into the Housatonic, with but little current, through a broad valley, the bottom of which is, at the point approached by the line, inundated, during freshets, for a distance of near half a mile in breadth, and to a depth of three or four feet : the line was, therefore, carried down the valley, to a point where a projecting ridge offered greater facilities for throwing a bridge across it. And even at this point the bed of the creek is very broad : but as the current is not strong, and the water does not rise high during freshets, the span of the bridge may be considerably reduced, by embankments to the abutments and low *return walls*.

Section fifth is included between station 211, on the bank of the Flatbrook and bench mark 27, on the State line, and embraces a distance of 1 mile 1,567 yards. The line in this section crosses the Flatbrook, and pursues a level along its bank, which is sometimes quite steep, but which, being composed of light gravelly soil, may be excavated at a trifling expense ; but, as the line, of necessity, traverses all the indentations in the outline of the bank, considerable expense will be incurred in embankments.

The aggregate length of these 5 sections gives a little more than 14½ miles for the length of the whole line, as may be seen by reference to the

map or profile. It may be termed *serpentine* throughout: indeed its direction varies so often, that the only remark to be made on its curvature is, that there is no point at which it may not be brought within the limits of a curve whose radius of curvature is 400 feet.

The country embraced within the limits of this line affords good timber, of from 10 inches to a foot diameter, and some of the larger size: the principal varieties are, oak of several kinds, hemlock, white pine, and chesnut. Good gravel, and rock fit for masonry, and rubble stone, are abundant; but there is probably but one point on the route where rock, suitable for rails and rail-chairs, may be procured, and that is in the vicinity of Kellog's, where it is said primitive limestone is found.

In conclusion, I must observe that the foregoing remarks and results are, with diffidence, offered as *approximate* to what a more minute investigation may hereafter develope.

Very respectfully,

Your obedient servant,

W. B. GUION,

*Ast. Civil Engineer.*

NOTE.—A broken line in the profile, whether of blue or black, represents that the line may have been run, where it indicates, on the natural surface of the ground. A blue line on the same represents the probable grade of the road. And a blue line on the map represents alterations in the original line, to correspond with the profile.

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*Charles E. Anderson's report on the Hudson and Berkshire Rail Road.*

GEORGETOWN, D. C., Nov. 18th, 1828.

To Lieut. Col. P. H. PERRAULT,

*U. S. Topographical Engineer:*

SIR: In compliance with your instructions, I lay before you the following description of that part of the Hudson and Berkshire rail road route with the survey of which you were pleased to entrust me. It embraces an extent of from 15 to 16 miles, commencing at the corner of Fleet and Water streets, in the city of Hudson, and terminating in the valley of the Steenie Kill, a branch of Kinderhook Creek, near Groat's, in Chatham township. At this latter point, it intersects the route examined during the last year, under the authority of the State of Massachusetts, for a rail road from Boston to the Hudson river at Albany. By an inspection of the accompanying map and profiles, it will be seen that the general formation of the country therein represented is strongly characterized by a series of low gravelly ridges, lying parallel to each other, in a direction nearly north and south, giving a succession of alternate ascents and descents, which it would be difficult, if not impossible, to avoid. As the inclinations, however, are gradual, and the differences of level but slight, these do not, except in one instance, present any serious obstacles.

The map is accompanied by two profiles: the first (A) exhibiting the line actually levelled, being that which is denoted on the map by a red line; the second (B) showing a line shorter than the preceding by three-fourths of a mile, which is supposed also to have other material advantages.



ITINERARY TABLE of an Experimental Survey of the contemplated Hudson and Berkshire Rail Road, from Pittsfield, Berkshire county, Massachusetts, to the New York State Line.

[illegible]

It was determined by the several sections made during the survey, and from a close and minute inspection of the annexed drawings; and, although it cannot be considered perfectly accurate, it may safely be taken as affording fair and sufficient grounds for a correct general estimate. This method of proceeding was rendered necessary by the peculiar circumstances under which the survey was made. The previous reconnoissance having been extremely slight and casual, we were obliged to trust entirely to the guidance of the gentlemen forming the Committee of Conference; and although an accurate knowledge of a long settled and well cleared country enabled them to point out a line wonderfully favorable, when the undulating nature of the ground over which we passed is considered, it was found that too close and rigid adherence to an apparently straight line led us frequently over ground which was thought sufficiently bad to warrant a change in the course. These alterations are traced in blue on the map. The two several lines are respectfully submitted for your consideration.

The corner stone of Power's Store, in Fleet and Water streets, was chosen as the point of beginning, and to it all the levels are referred. It was found, by subsequent observations, to be 21.12 feet above mid-tide in Hudson river: the distance to it from the wharf is 100 feet. To obtain the height of any point above *tide water*, therefore, 21.12 feet must be added to the amount exhibited in the level book.

As a matter of convenience, the whole line has been divided into several sections. When the change from the line actually levelled was not material, the remarks have been made in reference only to that line which was considered the best. In other points, where a marked deviation has been made, the points of difference have been stated, and the several advantages and disadvantages of each route put into comparison. In the observations which follow the analysis of the line, the reasons for such variations are assigned, and a more detailed account given of the particular subjects referred to in your instructions.

As this route is to be considered as ultimately forming a part of the great line of rail road communication through the Eastern States to the Hudson river, we were particularly requested to keep in view the principles upon which it is in contemplation to construct that work. Upon a reference to the report submitted to the Massachusetts Legislature, by the Chief Engineer to the State, and the committee appointed for that purpose, it was found that as great a rate of ascent as 80 feet in one mile would be allowed; or, in other words, that the load would be adapted to the moving power in such proportion that it would not be necessary to resort to stationary power, except where the rate of inclination exceeded that above stated. It is necessary that so striking a deviation from the principles universally received in the construction of a work of this nature should be noticed, as it produced a corresponding change in the manner of conducting the survey. Wish this view, then, extra or stationary power will have to be employed in one place only, and that is in ascending the hill forming the bank of the river.

Commencing at bench mark No. 1, at the corner of Fleet and Water streets, the line surveyed follows Partition street, in a course S. 40° E. to the corner of Fifth street, whence it crosses the square diagonally into Union street, and resumes the same direction in that street until it reaches the intersection of Sixth street. At this point, a curve, in the form of a

quadrant of a circle, with a radius of 300 feet, is made, until we reach the public square, from which a direct line (N.  $75^{\circ}$  E.) may be drawn to bench mark 3 in the Farmer's turnpike. This point is one mile and a half +  $392\frac{1}{2}$  yards from the starting point: its height above mid-tide is 162.04 feet. Being in the lowest part of the depression in the ridge separating Claverack creek from the Hudson, it may be considered as an established point. The greater part of the above elevation is encountered in the first mile, the public square being 151.44 feet above tide. Should it not be considered absolutely essential to pass through the square, another plan may be followed, by which the same point in the turnpike may be reached in a line shorter than the preceding by 144 yards. It gives a more direct line, obviating the necessity of the sharp bend met with at the public square: and by crossing below the level of Warren street, all interference with the usual business of the place (a consideration of some importance) will be avoided. Besides, from Third street, the rate of ascent will not exceed 62.20 feet per mile, while, by the first line, a second inclined plane will be necessary, the rate of inclination being 138.38 feet per mile. With this exception, the cost of construction on the two lines will be nearly in the same ratio. The soil on this section is clay: a small spur of silicious slate, forming the bank of the river, must be excavated, as shown on the profile.

From the Farmer's turnpike, the line is nearly direct (N.  $63^{\circ}$  E.) to bench mark 4, on Claverack creek. By keeping on the western bank of the ravine intersecting the line, the embankment here necessary will be brought to its least dimensions, and the distance will not be increased. Claverack creek is subject to high freshets, which inundate the adjoining flats: the high level at which it is crossed will prevent the necessity of encountering any risk from this source.

From Claverack creek, the course varies but little from a straight line, (N. E.) and upon ground extremely favorable, until it reaches the commencement of the steep ascent at the school-house ridge. This comprises sections 3d and 4th, the particular features of which are exhibited in the foregoing table. The spurs of the ridges crossing the line in different points, being generally low, and of easy excavation, afford no obstacle of moment. They, in many places, furnish stone suitable for the construction of the road-bed. Near station 77, where we cross the road from Stott's factory, the ridge is formed of an argillite of firm texture: at bench mark 5, and near station 100, on the old post road, graywacke, of good quality, is found in abundance. A quarry has been opened at the first of these places, and also within a quarter of a mile of bench mark 8, near J. Skinkie's. The vallies or swales through which we passed are generally of a firm loamy soil, bounded by gravelly ridges, sloping towards them with an angle of from  $3^{\circ}$  to  $5^{\circ}$ .

The ridge, the commencement of the rise upon which is encountered at section 5th, is distant from Hudson, by the line surveyed, 8 miles 51 yards: it may be looked upon as the only serious difficulty met with after leaving Hudson. The table exhibits two methods of overcoming the rapid ascent: by the first, which will not need any unusual excavation, an inclined plane will be necessary, the rate of ascent being 115.96 feet per mile. This may be obviated by having recourse to the second line, which, leaving the meadow land at station 132, by a cut of 3000 feet in length, at an average depth of 8 feet, reaches J. Kittle's, at a rate of ascent not exceeding 74 feet per mile. At the school-house, where the excavation is deepest, rock (argillite



of firm texture) appears above the ground: the remainder of the hill seems to be formed of a loose gravelly soil. So far, the line continues nearly straight; but from this point, we are compelled, in order to keep a proper ascent, to wind gradually around the brow of this hill, (sections upon which gave a slope of  $8^{\circ}$ ,) until we reach the ravine of a small stream by J. Tator's, which may be crossed favorably, either with an embankment or bridge. Upon crossing this, we come upon a limestone ridge, which must be crossed in a transverse direction. Two lines were levelled across it, the results of both of which are given in profile A: the summit level of the most favorable of these is 354.97 feet above bench mark 1; and as this is already 21 feet too high, it was thought unnecessary to give a detailed statement of the other route, that being 371.87 feet above the same level, or requiring an excavation of 37.90 feet in depth. The rate of ascent in this portion of the route, by means of the deep cut delineated on the profile, will be 64.53 feet per mile. The latter part of this portion of the line has several sudden changes of direction: the radius of curvature, however, is, in no instance, less than 600 feet.

In the succeeding section, I have ventured to suggest a line entirely different from the one surveyed, presuming that it will have advantages over that line in every respect. The great expense of securing a firm and permanent basis in the meadows known as Vraedenborg's Fly, would, in itself, be a sufficient reason for changing the line, even if it were possible to maintain the level of bench mark 19. But the middle of the Fly is 22.06 feet below that level, rendering it necessary to make that depression in the road, or to construct an embankment of half a mile in length. The Fly is of such a nature that piling would be requisite; and even that would not ensure sufficient stability. The other line, which is traced in blue on the map, and the profile given in sheet B, was suggested to the committee at the time, but owing to a misapprehension on their part that it would be much longer, more serpentine, and encounter a deeper cut through Vraedenborg's ridge, it was not thought deserving of a minute examination. The difference of length, however, is 419 yards in favor of this line: its course is nearly straight, and the amount of excavation at the ridge, as was ascertained by a cross section at station 209, considerably less. This ridge is composed of limestone, covered with a stratum of sandstone. The experimental line passes through a quarry which seems to have been opened for the sake of obtaining building stone.

From Vraedenborg's to bench mark 14, a gravel hill, with a slope of from  $3^{\circ}$  to  $5^{\circ}$ , furnishes the best possible ground for the construction of the road; and upon crossing the swamp at that station, another side hill, sloping in the opposite direction, will give a line equally favorable.

We now approach the valley of the Kliny Kill, which we intersect at the distance of 13 miles + 160 yards from Hudson, and cross in a line at right angles to its course. This stream is liable to sudden freshets, which at times cover the whole of the adjoining flats: an embankment of some extent, the precise dimensions of which are given in the table, will be required, the earth for which will be afforded by the excavation necessary in approaching and leaving the valley. At the ridge beyond bench mark 15, a curve of 300 feet radius will be necessary, as the line takes a more northerly direction, over an undulating surface, as far as bench mark 16. Near this latter point, there is a bed of excellent stone, apparently gray-



wacke, in horizontal strata. It is easily worked, although of a firm and durable texture.

Half a mile beyond bench mark 16, we come upon the slope of a high gravelly hill forming the bank of the Steenie Kill; and from this to the bridge at Groat's, two routes were levelled, profiles of each of which are given in sheet A. If the southern bank of the creek be chosen, it will be necessary to follow this side-hill in all its windings, as a high level must be preserved, with a view to that part of the line immediately beyond Groat's. By sections upon this slope, the angle of inclination was found to vary from  $30^{\circ}$  to  $45^{\circ}$ : the top of the hill is upwards of 100 feet above the level of the creek. The opposite side furnishes an alluvial bottom, sufficiently high above the surface of the water to avoid all risk from freshets, and ascending in the direction of the line with an inclination admirably suited to the location of the line. The distance by this route will also be less by  $384\frac{1}{2}$  yards; but, on the other hand, the construction of two bridges over Steenie Kill, at a high level, must be taken into consideration: the high and steep banks are, however, extremely favorable for this purpose; and it will readily be supposed that the advantages of a direct line upon ground of the most favorable kind, will counterbalance the extra expense thus incurred in the first instance, and be much preferable, as regards the future interests of the work.

The terminating point of this section (bench mark No. 19) is, by the line surveyed, 16 miles  $336\frac{1}{2}$  yards from the place of beginning: by the proposed alterations, it may be reduced to 15 miles  $849\frac{1}{2}$  yards.

It is thought that subsequent examination would furnish a better locality for crossing Kliny Kill at some point farther south, and a more direct and better route from that place to the level land at Groat's. A line passing to the south and east of Chatham pond, if in other respects equally favorable, would, perhaps, answer this purpose; and by reaching Groat's at a level 20 feet higher than bench mark No. 19, would go far towards obviating some of the difficulties immediately beyond. As far as could be conjectured from the slight examination made of the ground between the two creeks, and from such general knowledge of the formation of the country as could be obtained, this plan would not seem impracticable. Time and means were not given to enable us to make a more thorough examination.

I am, sir, respectfully,

Your obedient servant,

CHAS. E. ANDERSON.

ITINERARY TABLE of an Experimental Survey of the contemplated Hudson and Berkshire Rail Road, from Groat's, Chatham County, to the New York State line.

No. of Sections.	Subdivisions.	LOCALITIES.	Length in yards.	Distance from Sta- tion No. 1.	RATE OF INCLINA- TION.		SOIL.		EXTRA LABOR.				BRIDGES AND CULVERTS.		ROCKS APPLICABLE TO CONSTRUCTION.			
					Ascent in feet, per mile.	Descent in feet, per mile.	Quality.	Nature of the sur- face, in transverse direction.	Embankment.		Excavation.		Span.	Height	Quality.	Quantity.		
									Length in feet.	Extreme height.	Length in feet.	Extreme depth.						
1	1	From station 1, near b. m. 18, to station 14	906	M. Yds.	68.4	-	Rock & gravel	Average slope of 30°	-	-	{ Rock 15.73 }	{ 29.00 }	-	-	Hard argil- lite	Abundant		
	2	From station 14 to station 20	465	906	-	-	- -	Level	{ 150 } { 620 }	19.00 17.00	{ 280 } { Rock 545 600 }	{ 3.50 }	-	-				
	3	From station 20 to station 50, Dean's mill	1,563	1371	78.4	-	Rock, gravel, and clay	Slope 4° 216 yards, the rest level	-	-	{ Rock 360 Earth }	{ 18.00 11.00 6.50 }	15.00	15.00				
	4	From station 50, at Dean's mill, to 58	777	1 1185	-	-	- -	Slope 45° 156 yards, rest level	-	-	-	-						
	5	From station 58 to station 63, near b. m. 21	655	2 203	63.40	-	Gravel & clay	Level	-	-	{ 617 } { 255 } { Gravel 270 250 }	{ 2.50 10.00 15.00 7.00 }	-	-				
	6	From station 63 to station 84	1,188	858	34.60	-	- -	Slope 20° 535 yards, the rest level	249	8.00	{ Soil - }	{ - }	-	-				
	7	From station 84 to 91, Doris carding mill	583	3 287	76.9	-	Rock & gravel	Level	617	5.00	-	-	-	-			Argillite	Abundant
	8	From station 91 to station 114	1,908	3 870	10.2	-	- -	520 yds. level, rest slope 25°	-	-	-	-	-	-				
2	1	From station 114 to a point between 132 and 133	2,392	4 1019	22.9	-	Clay & gravel	Slope 25° 385 yds. rest level	-	-	{ 738 } { Rock 482 } { Soil 4.61 }	{ 11.00 9.50 }	-	-	Sand stone	Small quantity		
	2	From between 132 and 133 to a point between 143 and 144	1,254	6 391	68.6	-	Rock & gravel	Slope 40° 150 yds. the rest level	-	-	{ Soil 2.00 } { Rock }	{ 4.50 10.50 }	{ - }	-				
3	1	From stations 143 and 144 to station 155	1,880	6 1645	73.00	-	Clay & gravel	Slope 3°	175	16.	-	-	-	-	Argillite			
	2	From station 155 to 162	1,032	8 90	66.8	-	Gravel & loam	Level	-	-	-	-	{ 10 } { 10 } { 10 }	3.00 3.00 3.00				
	3	From station 162 to station 171	1,897	8 1122	25.9	-	Clay & loam	Slope 3°	{ 375 } { 473 }	7.00 5.00	-	-	-	-				
	4	From near station 171 to near station 186	1,825	9 1259	106.3	-	Gravel & loam	Level	-	-	-	-	10	3.00				
	5	From near 186 to summit at Kellog's	635	10 1324	75.1	-	-	-	-	-	-	-	-	-				
4	1	From summit to station 200	1,582	11 117	-	54.9	- -	- -	1322	8.00	{ 10.60 } { Rock 12.99 }	{ 6.00 }	{ 10 } { 10 }	8.00 4.00	Lime stone	Abundant		
		From station 200 to station 211, on the bank of Flatbrook	1,205	11 1699	-	2.4	Gravel	Average slope 15°	{ 1000 } { 300 }	5.00 9.00	{ Rock 12.99 } { Rock }	{ 13.00 }	100	8.00				
5	1	From station 211 to State line	-	14 952	-	-	Gravel	-	787	20.00	Gravel	-	-	-				