FURTHER PAPERS

RELATING TO THE

CONSTRUCTION OF RAILWAYS.

(NORTH ISLAND.)

(*In continuation of Papers presented 7th September*, 1871.)

VIII.—ADDITIONAL REPORTS AND ESTIMATES ACCOMPANYING PARLIAMENTARY SURVEYS.

I.—Waikato Railway: Auckland to Tuakau and Mercer.
II.—Wellington to Napier: (*a*) Masterton to Manawatu River.
(*b*) Napier to Takapau.
III.—Wanganui to New Plymouth.

PRESENTED TO BOTH HOUSES OF THE GENERAL ASSEMBLY, BY COMMAND OF HIS EXCELLENCY.

WELLINGTON.

1871.

SCHEDULE OF CORRESPONDENCE.

No.	Date.	From.	To.	Subject.
	1871.			
1	Aug. 28	Mr. Wrigg	Assistant Engineer-in-in-Chief	Reports and Estimates, Waikato Railway. Diversion to Mercer.
2	Sept. 19	Mr. J. Rochfort ...	The Hon. Minister for Public Works	Wellington and Napier Railway. Forwarding Plans of Section between Masterton and Manawatu River.
3	Oct. 7	Mr. C. Weber ...	His Honor J. D. Ormond	Ditto. Reports and Estimates, Section between Napier and Takapau.
4	Sept. 9	Mr. O. Carrington ...	The Under Secretary for Public Works	Railway, Wanganui to New Plymouth, Reports and Estimates.

FURTHER PAPERS RELATING TO CONSTRUCTION OF RAILWAYS.

I.—WAIKATO RAILWAY.

No. 1.

Mr. WRIGG to Mr. BLACKETT.

Waikato Railway—Diversion to Mercer.

SIR,— Auckland, 28th August, 1871.

I have the honor to forward, per steamer "Wellington," a general plan of the Waikato Railway lying between Auckland and the river Waikato, showing the termini at Tuakau and Mercer, and the alternative lines from Newmarket to Auckland, as well as one at the saddle of the watersheds of Tuakau and Pokeno.

Besides the parliamentary section of the diversion to Mercer from the point A to B on the plan, I have thought it desirable to show a reduction of the detailed section of the other portions of the line in order to afford you complete information as to the plan and sections from one end of the line to the other. The horizontal scales are the same throughout, and the vertical ones also. The datum line is the same for all the sections.

Regarding the heavy cutting on the diversion to Mercer, at about 35⅞ miles, there is every reason to believe that the bottom portion of the excavation will be sandstone rock, fit for ballasting, and if so, the cutting would of course be much reduced in quantity, while the material would pay for getting for the purpose of ballast. I can avoid this heavy cutting, if it were considered desirable, by the detour line I have surveyed and shown on the plan, securing somewhat easier gradients and a less costly line, but at the expense of 46⅓ chains added to the length of the line, and cutting up Young's farm somewhat injuriously. Nothing, however, will determine whether the line should pass over the saddle by the shorter route or by the detour line except a detailed survey and levels, upon which point I await your instructions, and without which a reliable estimate of the whole line, from terminus to terminus, cannot be made.

In the meantime, I am of opinion that the following estimates may be taken as fair approximations:—

ESTIMATES.	DISTANCE.			RATE.	AMOUNT.
	M.	F.	CH.		£
Via *Domain Line.*					
Newmarket to Auckland	2	3	1	...	14,409
Newmarket to point of diversion at Pukekohe ...	29	5	0	4,000	118,500
Thence to Mercer	11	1	6	4,300	47,838
Maungatawhiri Bridge, say		...		...	1,000
Onehunga Branch	2	4	9	4,000	10,450
Totals	45	6	6	...	192,197
Via *Tunnel Line.*					
Newmarket to Auckland	2	0	1	...	21,394
Newmarket to point of diversion at Pukekohe ...	29	5	0	4,000	118,500
Thence to Mercer	11	1	6	4,300	47,838
Maungatawhiri Bridge, say		...		...	1,000
Onehunga Branch	2	4	9	4,000	10,450
Totals	45	3	6	...	199,182
Via *Coast Line.*					
Newmarket to Auckland	3	3	1	...	21,509
Newmarket to point of diversion at Pukekohe ...	29	5	0	4,000	118,500
Thence to Mercer	11	1	6	4,300	47,838
Maungatawhiri Bridge, say		...		...	1,000
Onehunga Branch	2	4	9	4,000	10,450
Totals	46	6	6	...	199,297
Tuakau Line, via *Domain.*					
Newmarket to Auckland	2	3	1	...	14,409
Newmarket to Tuakau, with Branch to Onehunga ...	38	2	5	4,000	153,250
Totals	40	5	6	...	167,609

Estimates.	Distance.	Rate.	Amount.
	M. F. CH.		£
Tuakau Line, *via* Tunnel	40 2 6	...	174,644
Tuakau Line, *via* Coast	41 5 6	...	174,759

The whole of the approximate estimates are exclusive of rolling stock, workshops, machinery, and terminal stations.

As soon as I learn from you which of the alternative lines from Newmarket to Auckland is approved of I shall then proceed with the estimates in some detail, as far as the detailed levels are taken, which is to the point A on the plan where the diversion to Mercer commences.

The whole of the field work is now completed according to instructions, and I am ready to proceed with the detail survey and levels of the diversion to Mercer, and such further extension of the survey as you think proper to entrust to me.

I have, &c.,
HENRY WRIGG,
Engineer in Charge.

John Blackett, Esq., Acting Engineer-in-Chief,
Wellington.

II.—WELLINGTON TO NAPIER.

No. 2.

Mr. ROCHFORT to the Hon. W. GISBORNE.

SIR,— Wellington, 19th September, 1871.

I have the honor to send herewith plans and sections and key-plan of Section No. 2 of the Wellington and Napier line of railway, lying between Masterton and the Manawatu River. There still remains about four miles unfinished (between the Manawatu and Weber's line), owing to a misunderstanding caused by a suggestion from Mr. Weber. I thought it better, however, to send in as much as I had finished, as it will be a full month before I can possibly deliver the rest.* I start to-morrow for the gorge.

The line, after leaving Masterton, passes along plains and easy country to the Seventy-Mile Bush, crossing the only river of importance (the Ruamahanga) favourably. The line enters the bush at Stewart's, and follows up the Kopuerangi for a considerable distance, when it crosses a low saddle of the range, which is the watershed of the Island, and follows down the Makakahi (a considerable branch of the Manawatu) until it flows into the Manawatu, crossing the Tiraumea River on its way. After crossing the Manawatu, the line skirts a low hill called Hiatua, and then strikes across straight to the nearest point of Weber's line. After entering the bush, the line consists of alternate flats and sidings to some three miles beyond the saddle, after which it is nearly all level country. The gradients all through are exceedingly easy,—far more so than I expressed to you in my preliminary report. With the exception of four miles, the earthwork is all light.

The height of the saddle is 972 feet above the sea by the spirit level, which agrees within two feet with the height ascertained by aneroid observation on my preliminary survey, and not more than 150 feet above the level of the surrounding country.

The land is generally good, but there is a flat bush country of great extent and excellent quality in the Mongatainoko and Makakahi Valleys, the greater portion of which is traversed by the railway.

The timber in the higher country is generally tawa, and in the lower, pine, rimu, totara, and hinau.

The rocks of the country are limestone and a sort of blue marl.

The total distance by the line of railway to Napier, assuming the distance by Mr. Weber's line beyond my junction to be 85 miles, will be only 208 miles.

I have, &c.,
JOHN ROCHFORT.

The Hon. W. Gisborne, Minister for Public Works.

No. 3.

Mr. WEBER to His Honor J. D. ORMOND.

REPORT ON RAILWAY FROM NAPIER TO TAKAPAU.

SIR,— Napier, 7th October, 1871.

In my preliminary report of the 17th October, 1870, on survey of railway from Napier to Takapau, I have cursorily described the different lines which appear most suitable. Since then these lines have been properly surveyed, plans and sections prepared, and estimates formed, which I do myself the honor herewith to submit.

A schedule of enclosures is annexed, comprising, in addition to plans and sections of the lines, lithographed plans of the Province of Hawke's Bay and of the Town of Napier, showing the different lines.

* The remaining plans have since been received and attached to the others. Mr. Rochfort recommends the adoption of the upper crossing of the Manawatu where it is very narrow, and where there is a blue rock abutment on the North side, under which the current runs.—J. BLACKETT, C.E., 7th November, 1871.

The estimates for the formation have been based upon the present cost of labour and materials in this district, as far as earthwork, bridges, and ballasting are concerned, and I feel satisfied that on these items a considerable saving may be effected. In fact, the road works of the Provincial Government are being executed, in even small contracts, at a lower rate than that forming the base of my estimates. A further saving on the estimated cost can doubtless be effected by slight deviations from the survey line when the working sections are being set out. Under these considerations, I have made no allowance for contingent expenditure, feeling satisfied that the estimates leave sufficient margin for them.

All cuttings have been calculated for a base of 14 feet, with slopes of 1 to 1 in ordinary soil; all embankments for a width of roadway of 11 feet, with slopes of 1½ to 1; and both have been brought to account at 1s. 6d. per cubic yard of cuttings and the same rate for surplus embankments.

The formation for more than one-half of the whole length will have to be made up out of side drains: the cost of those portions appears in the estimates at per chain, and is calculated at from 7d. to 18d. per cubic yard, according to circumstances, but in every instance at the full rate for present road works.

The estimates for bridges, viaducts, and large culverts have been based upon the cost of totara and matai (for superstructure) at 10s. to 15s. per 100 feet delivered, according to circumstances, which leaves a fair margin. To be all simple pile bridges, with spans not exceeding 26 feet. No separate estimate has been made for small culverts, as these are included in the calculation for the formation.

Wherever culverts are covered over 4 feet they have been estimated of bricks, which can be burned almost everywhere along the line, with the exception, perhaps, of the Ahuriri Plains.

The cost of bridges is set down at from £2 15s. to £4 10s. per running foot; of viaducts, from £2 to £3 per foot; flooring of footpath being only contemplated.

Sufficient totara will be obtained out of the Te Aute Bush, through which the line runs, for the portion between Napier and Te Aute; the upper portion of the line to be supplied from the Manawatu, Ruataniwha, and Tokokino Bushes, which are all conveniently situated.

Sleepers, 7 feet (8″ x 5″), have been estimated at 2s. each, or at £200 per mile, inclusive of extra strength for joints.

Ballast is calculated at 2,000 cube yards per mile, at 2s. per yard. This rate is more than that paid at present to the road contractors, as limestone is convenient in the middle of the line, and river shingle at both ends.

Fencing has been estimated, for post and seven-wire fence, at £140 per mile, double line, reckoning posts at £4 per hundred, wire at £17 per ton; erection, £17 per mile.

Rails, with fittings, at £10 per ton in Napier, for 70 tons per mile; carriage and laying, £50 per mile.

As described in my preliminary report, the peculiar situation of Napier made it desirable to survey two lines to the inland district, namely, one from the Town of Napier and the other from Port Ahuriri, both lines intersecting the Ahuriri Plains; whence the Ruataniwha Plains, bordering on to the Manawatu Bush, can be reached by three leading valleys, each terminating in a saddle, which must be crossed to enter upon the upper plains, but each of which has at present a practicable dray road.

The line from the Town of Napier to the Karamu Junction is marked in the annexed plans and sections, Line A, and that from Port Ahuriri to the same point is marked B., by which designation I will describe them.

Line A.

Starts from the first mile-post (measured from the Post Office), the boundary of the Town of Napier. This point has been selected, as from it the line can be carried on the level to any part of the business portion of the town, and to Port Ahuriri round the southern base of the Island.

The selection of the terminus is (where, as in this instance, no difficulties exist) beyond the Province of the Engineer.

From the first mile-post, the line runs for four miles along the sea beach, on the crest of the shingle bank which connects the Island of Napier with the mainland. This beach is about 10 feet above ordinary high water, and is solid and in every respect safe. A road which has been formed there three or four years ago has never suffered, and, as it is not much used,—the inner natural beach track being generally preferred,—would serve as formation for the line. The estimate at £3 per chain will probably prove more than ample for this portion, and the fencing of at least one side line will be saved.

After leaving the beach, the line enters upon the plains, running over them to the junction with Line B and thence to Pakipaki, thirteen miles. The first 103 chains to the crossing of the main road near the bridge over the Ngaruroro, are subject to be flooded by the backwater from 1 to 6 feet, requiring embankments, the cost of which will average about £10 per chain, but the line will be safe. The Waitangi, a tidal stream 96 feet wide, taking its rise in the adjoining swamps, has to be bridged at an estimated cost of £400.

From the main road to the Karamu Junction, near the centre of the Ahuriri Plains, the line runs over rich alluvial lands, the only difficulties being the Tutaekuri-Waimata and the Ohiwia, two streams which have become of late formidable through the changing of the course of the Ngaruroro. These two creeks carry the water of the Ngaruroro, as will be described on their crossing by Line B.

Provision is made in the schedule for bridges of 120 feet and 320 feet, and for a viaduct of 420 feet, to provide for the storm water, which probably will give sufficient waterway.

The total estimated cost of those structures—£3,440—will prove ample.

From the Ohiwia to the junction with Line B the country offers no hindrances, and the average cost of formation will not exceed £6 per chain.

The distance from Napier to Karamu Junction is 12 miles 6 chains, and the estimated cost £9,067, which will probably prove over-rated.

Line B.

This line starts from the Government land at the boundary of the freehold sections at Port Ahuriri, but the starting-point can be fixed at any part of the port without altering materially the cost

of construction. This point has been selected for reasons stated at Line A, and can be changed to any part of the Spit. The Eastern Spit is separated from the mainland by the Ahuriri Lake, a shallow arm of the sea, so that the mainland can nowhere be reached from the Spit without crossing about one mile of water. The land, wherever reached, is covered at high water, and is subject to be flooded from 4 to 6 feet.

The line which I have selected is 97 chains long, but of this it is proposed to form 21 chains by embankments; and, as it strikes the highest ground, the remaining portion it is proposed to form as timber viaduct, the ground being all suited for piles. Depth of water, from 2 to 5 feet at high water, with 2 to 4 feet of soft mud; but in time of floods, with easterly weather, the depth of water is increased by 3 feet.

As considerable difference of opinion exists here respecting the best way of overcoming this difficulty—the cost of construction and tear and wear of timberwork being very considerable: more than that of embankments—I may be allowed to say a few words in justification of my views. I object, for two reasons, to embankments in this instance; firstly, they necessarily prevent the free egress of the water in time of floods, raising the water-level of the whole estuary, causing, in this way, increased height of embankments, &c.; and secondly, in this particular instance they will stop the tidal current through the inner harbour (the Iron Pot), necessarily causing its rapid silting up. I may add that the cost of embankments in the stream will be very heavy, owing to the great subsidence in the soft bottom, and owing to the cost of the necessary substantial rubble facings in such exposed positions. The road leading to the port, which is only formed at the edge of the water, cracked from the earthquake of 1863 in many places where nearest the water, and has subsided from 9 to 15 inches in several places.

I propose to cross, by a viaduct of 990 feet, to Gough Island, thence form an embankment of 16 chains, 4 feet 6 inches high; again a viaduct of 1,782 feet to Battery Point; thence 6 chains of embankment along the base of the hill, and thence a viaduct of 2,046 feet to Meanee Flats. Estimating the viaduct, with copper-sheathed piles, at £2 10s. per foot, the cost to reach Meanee Flats will be about £12,485. From the bottom of the Flats to the head of Purimu Creek, 202 chains, embankments averaging 3 feet 6 inches will be required, at £10 per chain, the land being subject to flood to that depth: thence only light formation is needed to the bank of the Tutaekuri. This river is here 1,848 feet wide, and may be bridged at the rate of £3 per foot. The north bank is above flood level, but the south bank is generally flooded after 3 inches of rainfall in 24 hours, when the ground is moderately saturated, and the country for a width of 45 chains is subject here to the overflow of the Tutaekuri, which has worn away its south bank about half a mile above the bridge,

A viaduct of 1,800 feet, at £2 per foot, is indispensable adjoining the bridge, as an embankment would necessarily flood the north bank of the river. From the embankment to the Tutaekuri-Waimata, the ground is safe, and requires only light formation.

From the rising ground south of the Tutaekuri-Waimata to Ohiwia, the land is generally subject to flood, as the Waitio, which is practically the Ngaruroro, fills, in time of floods, the lagoon about one mile above our line, and as the two streams which form the outlet of the lagoon are not capable of carrying the water, the country along our line, from the north bank of the Tutaekuri-Waimata to the rising ground south of Ohiwia, forms in time of floods a sheet of water with the exception of a few narrow strips of dry land. Considerable waterway will therefore have to be provided, as continuous high embankments would only increase the distress.

I propose, in addition to the bridges over the Tutaekuri-Waimata and the Owahou, to erect viaducts, in the aggregate, of 1,980 feet, at £2 10s. to £3 per foot, and 165 chains of embankments from 3 to 5 feet in height. From the embankments to Karamu Junction the line is sound and level, and requires only light formation.

The distance of the Line B is 12 miles 22 chains, at a cost of £35,561, against that of Line A of £9,067.

As the trial lines from Karamu Junction to Takapau diverge from that point, the merits of Lines A and B may be considered here, before proceeding with the description of those lines.

Line A has the following advantage:—

1. It will be cheaper by over £26,500; consequently save in interest £1,300 per annum.

2. The cost of maintenance will be very small, the aggregate of the timber work not exceeding 960 lineal feet, at a cost of £3,840, while on Line B the timber work will be 10,498 feet, at a cost of £26,900. Allowing the tear and wear of timber bridges to be only at the rate of 7 per cent. per annum, which I believe is below the real rate of decay, the yearly wear on Line A will be about £270 on that account, while Line B will cost yearly £1,953. Of course, during the first few years, the expense for repairs of bridges (not reckoning accidents) will be very trifling, but after five years it will tell very heavily, as proved by the experience of countries like Canada and America, where timber work is in use.

3. The speed to be obtained on Line A will be much greater than on B, as the maximum speed over bridges and viaducts probably cannot exceed two miles per hour (which is the American rule), and as those timber works are divided over the whole length of the line, preventing the train from obtaining full speed, a train would probably take nearly three hours to reach Karamu Junction from the Spit, a distance of twelve miles, while less than half the time should be sufficient from Napier.

4. The Line A is less subject to stoppages caused by the effect of floods than Line B, owing to the extensive timber works and embankments.

5. Line A supplies the requirements of the large agricultural population of Clive and Havelock, while it excludes only that of Meanee, where the lands are merely used for grazing purposes. The inhabitants of the district near Pakowai and Lower Karamu will likewise be served better by Line A.

Line B, on the other hand, has the advantage of being practically one mile shorter (the other being carried only to the first mile-post), and of leading direct to the port; but I do not think that these advantages can outweigh those in favour of Line A, the difference of interest and tear and wear alone amounting to nearly £3,000, a sum bearing a large proportion to the yearly earnings of the whole line.

Under these circumstances, it appears the best to select Line A, and connect it with the port either by tramway *viâ* Coote Road and Shakespeare Road, which can be constructed, inclusive of the

lowering of the saddle of Coote Road, for about £800 per mile. The cost of conveying merchandise per tramway to the port would not exceed 6d. to 7d. per ton, for which sum it would be delivered at the warehouses, while it would have to be moved from the station even if the terminus was at the Spit.

If the tramway should be considered insufficient for the requirements of the port, the rail could be carried from the first mile-post round the southern base of the island to the port, a distance of two and three-quarter miles; the first mile not expensive, but the second mile to Battery Point and the line through to the Spit would necessarily be rather costly.

If the Line B should be selected, the town would have to be connected with the port, by tramway, as nearly all the most bulky produce, such as timber and firewood, which will form a large proportion of the goods traffic, will be required at Napier.

From the Karamu Junction (Line A and B) three lines have been surveyed to Takapau, namely:—

1. The line *viâ* Paki-Paki, Te Aute, Waipawa, and Waipukurau, described on plan and sections as Line A.
2. *Viâ* Foster's Gorge, Patangata, and Waipukurau, described as Line C.
3. *Viâ* Marakakaho and Gwavas.

Of the last line no plans or sections are being forwarded, as no saddle over the dividing range between the watershed of the Ngaruroro and the Tuki Tuki could be found offering gradients in conformity with the general instructions. In fact, even a gradient of 1 in 40 could be obtained only at a cost putting the line out of question.

The lowest practicable saddle is 1,054 feet, whence the line would have to dip again to 680 feet. I trust that I will be justified in having, under these circumstances, abandoned this line to save further unnecessary expense.

Line A (Upper).

From Karamu Junction to crossing of main road at Paki-Paki, 319 chains, the line runs over sound, level ground,—the formation will not exceed £5 per chain. The bridge over the Ngaruroro, 680 feet, at £3 10s. per foot, will cost £2,380. The river bed is here generally dry, owing to the Ngaruroro being drained by the Waitio into the lake at Waipiro-piro, as referred to on alluding to the danger arising to the line from Port Ahuriri from the overflow of the lake. As the difference of level between the old river bed and the new one (the Waitio), is about 40 feet, at the distance of a mile from Ray's Hill (the head of the Waitio), there is no chance of the Ngaruroro filling its old bed again, and the proposed bridge on our line may be considered perfectly safe with 20 feet spans.

From the road crossing at Paki Paki for a distance of 3 miles 16 chains, the line follows up the narrow valley of the Poukawa, a sluggish stream with raupo banks, muddy soft bottom, in many places 12 feet deep, but not subject to floods, and not carrying any timber. The Poukawa has to be crossed and recrossed twice, in addition to the crossing of several of its raupo branches. This expense is unavoidable, as high spurs from the hills on both sides make the watercourse very tortuous, and the cutting through those hills would be very expensive.

To obtain the necessary stuff for the embankments over branches of the Poukawa, the line has been carried through the points of the Whenuakura (an island in the swamp) and three spurs, occupying and crossing the main road, which will have to be diverted. The cost of this will be fully recouped, as those spurs are limestone, and every yard of the cutting will be required for embanking and ballast. Under those circumstances I have treated those cuttings as ordinary ones, estimating their cost at 1s. 6d. per yard.

The bridges over the Poukawa and the viaducts on the section amount in the aggregate to 2,779 feet, at a cost of £3 per foot. This item can be greatly reduced by expending about £1,600 in cutting a straight watercourse for the Poukawa, and by clearing and straightening its course below Whenuakura (Paki-Paki). Most of the land affected is still in the hands of the Natives: some of it is leased for long periods to Europeans.

Only one line has offered itself to avoid the objectionable portion of the line, and this only with a grade of 1 in 42 for a distance of 60 chains. This steep gradient being on the south side, from whence all heavy traffic is expected, that line has been considered impracticable. The main road will have to be crossed again on leaving the Poukawa Valley, and, as the elevation at the road is only 39 feet 9 inches above high water, at the distance of 19 chains 16 links from the starting point, we may consider this point the real head of the plains.

From this point the line ascends to the Te Aute saddle with the following gradients, namely:—

72	chains	...	1 in 78½
16½	„	...	1 in 114
62	„	...	1 in 144
110½	„	...	1 in 137½ (descends.)
47	„	...	1 in 66
70¾	„	...	1 in 453 (descends.)
67½	„	...	1 in 50
73	„	...	1 in 50
50½	„	...	1 in 59

The summit level at the entrance into the Te Aute Bush, 365 feet above high water, distance 7 miles 17 chains, with a rise of 326 feet.

The cuttings on this section are very heavy, amounting in the aggregate to about 249,000 cubic yards, at an estimated cost of £18,500. As no rock will probably be met with, and the soil is dry light loam, that estimate will not be exceeded.

From the entrance of the Te Aute Bush the line descends into the Te Aute Valley at Rotoatara, a distance of 3 miles 12 chains, by the following gradients, namely:—

51	chains	...	1 in 67 (descends.)
43½	„	...	1 in 50 (ascends.)
37½	„	...	1 in 112½ (descends.)
48½	„	...	1 in 104 „
46½	„	...	1 in 53 „

The cuttings on this section are less heavy than in the last, but two heavy embankments are required to cross narrow valleys. No rock is likely to be met with, the soil being light dry loam, as on the north side of the saddle. The total amount of cuttings is about 37,000 cubic yards, and that of extra embankments about 10,000 yards, which, with three small bridges and road-crossings, will bring up the cost of this section to about £3,900.

The loss of level from the entrance of the bush is 109 feet, the elevation here being only 256 above high water. From Te Aute the line runs over undulating easy country to the Waipawa River. On the first 3½ miles to the Otane Bush it skirts the Rotoatara Swamp, crossing the main road twice, which will have to be diverted at a cost of £350. The greater portion of the soil excavated for the road will be required for embankments. The diversion of the road at the Round Hill will open limestone quarries for ballast. The creeks crossed are not much subject to floods, and in two instances small creeks will have to be diverted to avoid crossing and re-crossing. The total cost of this section to Waipawa River is estimated at £5,740 for the distance of 8 miles 20 chains. The gradients are easy, none exceeding 1 in 103. This section crosses the Waipawa River about 15 chains north of the Waipawa Township, follows then along the edge of the Tarewa Bush to the Tuki Tuki, crosses that river at the township of Waipukurau, and joins Line C (Middle Road Line) in the township, near the Telegraph Station.

With the exception of the two rivers, the line offers no obstacles of any moment. There is one rather heavy cutting of 24,000 cubic yards, but as no rock is likely to be met with, and the drag is short, the work will be done at the rate of 1s. 6d. per yard, as estimated.

The bridge over the Waipawa, which is 2,376 feet wide here, is estimated at the rate of £3 per foot, with spans of 26 feet. The banks at the site for the bridge are alluvial and subject to encroachments, but as, immediately above, the banks are sound on both sides, being formed of low spurs, groynes erected there will, without doubt, prevent encroachments. The river bed is formed of light shingle to the depth of 8 to 12 feet, as far as ascertained; and, to prevent scour of the piles, it may be necessary to drive detached fender-piles. For groynes and fender-piles I have estimated, in addition to the bridge, £600. The river carries but very little drift-wood, that being generally deposited on the Ruataniwha Plains, where the different head branches have very wide and shallow shingle beds.

The Tuki Tuki is only 990 feet wide, and a bridge of the same construction, at £3 per foot, has been estimated. Groynes and detached fender-piles have been estimated at £500. The nature of the river bed is the same as that of the Waipawa, but the Tuki Tuki is subject to higher floods than the Waipawa. The cost of this section, inclusive of two road diversions and road-crossings, is £14,792, for a distance of 4 miles 58 chains, the level of the terminus being 4,342 feet above high water.

From Waipukurau to Takapau, the end of the line, a distance of 11 miles 56 chains, the line runs over level country, requiring only light formation, with the exception of about 2½ miles, where it enters through the Maraekiki Pass on the Ruataniwha Plains; but even there it offers only slight difficulties, having only one line of 64 chains of 1 in 62.

From the crossing of the Maraekiki, which is 100 feet, and can be bridged for £350—it carries no timber—the line ascends the Ruataniwha towards Takapau entrance of the Manawatu Bush over dry shingly land, at the average rate of 1 in 170, and terminates at the elevation of 702·2 feet above high water at Port Ahuriri. The total cost of this section is estimated at £7,732, being only at the rate of £660 per mile of formation. The total cost from Karamu Junction to Takapau, a distance of 43 miles 40 chains, is estimated at £67,484 2s. 6d., being at the rate of about £1,406 per mile for formation.

Line C (Middle Road).

This line follows generally the valley which is traversed by the line of road known in this Province as the Middle Road. It crosses the Karamu Plains from Karamu Junction to the Ngarururo River, distance 1 mile 54 chains, requiring formation at the rate of £5 per chain, the ground being sound.

The bridge over the Ngarururo (which carries more water here than at the crossing of Line A, having taken in several tributaries, but no timber,) is 450 feet long, and will not exceed in cost £1,800.

From the Ngarururo the line crosses the Pakahu Flats, and strikes the base of the hills bordering the Pakahu Swamp. It follows along the edge of the swamp, from spur to spur, cutting through the points at six different places, to the head of the swamp. The Middle Road, which is crossed five times at the edge of the swamp, will have to be diverted by cutting a line deeper into the spurs; but as the material is required for filling the intervening portions of the shallow arms of the swamps, no loss will be suffered on this account. The present road-cuttings are on clay, but there is but little doubt that good limestone quarries will be laid open by those cuttings. The length of this section, from the Ngarururo to Foster's Gorge, is 4 miles 47 chains, and the cost of formation is estimated at £4,700.

From Foster's Gate to Patangata the line meets with difficulties which almost make it impracticable,—at least the gradient of 1 in 50 could not be obtained without commencing the ascent much sooner, which would have forced the line into very broken country, causing an outlay quite beyond the means probably available for the purpose. The line follows up the narrow valley between the Kohinorakau Spur and the Patangata Range with very light cuttings; it then skirts the Kaokaroa Flat, rising to the summit level of 528·5 above high water, and thence descends to the Patangata Flats. There are no heavy works on the section, but the first pinch could not be avoided. The gradients are as follows:—

115	chains	...	...	...	...	...	1 in 40
44	„	...	...	...	...	...	1 in 55
51	„	...	...	...	...	...	1 in 240
44	„	...	...	...	...	...	1 in 145 (descends.)
52	„	...	...	...	...	...	1 in 167
111	„	...	...	...	...	...	1 in 135
156½	„	...	...	...	...	...	1 in 71
68½	„	...	...	...	...	...	1 in 67 (descends.)

40	chains	...	1 in 50 (descends.)
130	„	...	1 in 186 „
46	„	...	1 in 209

There are only three small bridges and eight large culverts on the section, the total cost of which, a length of 10 miles 58 chains, is calculated at £13,474.

From Patangata to Waipukurau, 15 miles 51 chains, the line runs, the first three miles, to the Papanui, over easy undulating country, and thence over the almost level Homewood Flats and the valley of the Tuki Tuki, with very easy grades to Waipukurau, the junction with Line A.

The only expensive works required are bridges:—1st. Over the Papanui, 100 feet long, perfectly safe, carrying no timber, at £400. 2nd. Over the Waipawa, which forms here a shingle bed of 5,016 feet in width, the whole of which will have to be bridged, although at ordinary times the Papanui carries nearly all the Waipawa water, so that the river bed may be called the old Waipawa, carrying water only in freshets. This bridge, at £3 per foot, will cost £15,048. 3rd. The Tuki Tuki, 340 feet wide, with sound banks, but carrying timber from the Tarewa Bush. The cost of the bridge, inclusive of protective works, should not exceed £1,190. The total cost of this section is estimated at £23,469, making the total cost from Karamu Junction to Takapau (after adding the cost from Waipukurau to Takapau, as specified on Line A,) £52,366, for a distance of 44 miles 26 chains, or at the rate of about £1,100 per mile.

After comparing both lines, I have no hesitation in declaring my preference for Line A, although its cost will exceed that of B by £14,000. The reasons are as follows:—1st. The steep gradient at Kaokaroa (1 in 40) will be a great drawback to heavy traffic. 2nd. The uncertain nature of the Waipawa River, which shows a tendency to break over the line at the head of the Homewood Flats. 3rd. The central position of the Te Aute line opening up more land than the middle line. 4th. The absence of bush on Line C, while the Te Aute Bush will not only cheapen the construction of the line, but likewise bring traffic with timber and firewood.

On comparing the cost of the different lines we come to the following result, without taking into account rolling stock and buildings, &c., of which no proper estimate can be framed here:—

Line A.

From Napier (first mile-post) *viâ* Karamu, Waipawa, and Waipukurau, to Takapau. Distance, 54 miles 46 chains.

1. Formation	£76,551
2. Fencing, 53 miles, at £140 per mile	7,420
3. Sleepers, 53 miles, at £200 per mile (2s. each)	10,600
4. Ballast, 53 miles, at £200 per mile (2s. per yard)	10,600
5. Rails, Plates, &c., 3,825 tons, at £10 per ton	38,250
6. Cartage and Laying, at £50 per mile	2,678
	£146,099

Line B.

Port Ahuriri *viâ* Karamu, Waipawa, and Waipukurau, to Takapau. Distance, 54 miles 62 chains.

1. Formation	£103,045
2. Fencing, 52 miles, at £140 per mile	7,280
3. Sleepers, 52 miles, at £200 per mile	10,400
4. Ballast, 52 miles, at £200 per mile	10,400
5. Rails, Plates, &c., 3,829 tons, at £10 per ton	38,290
6. Cartage and Laying, at £50 per mile	2,688
	£172,103

Line AC.

Napier *viâ* Karamu, Patangata, and Waipukurau, to Takapau. Distance, 56 miles 32 chains.

1. Formation	£62,438
2. Fencing, 55 miles, at £140 per mile	7,700
3. Sleepers, 55 miles, at £200 per mile	11,000
4. Ballast, 55 miles, at £200 per mile	11,000
5. Rails, Plates, &c., 3,950 tons, at £10 per ton	39,500
6. Cartage and Laying, at £50 per mile	2,820
	£134,458

Line BC.

Port Ahuriri, by Karamu, Patangata, Waipukurau, to Takapau. Distance, 56 miles 48 chains.

1. Formation	£88,442
2. Fencing, 54 miles, at £260 per mile	7,560
3. Sleepers, 54 miles, at £200 per mile	10,800
4. Ballast, 54 miles, at £200 per mile	10,800
5. Rails, Plates, &c., 3,954 tons, at £10 per ton	39,540
6. Cartage and Laying, at £50 per mile	2,830
	£159,972

The comparison shows the line from Napier *viâ* Patangata the cheapest by about £11,640, but as

the above-stated objections cannot be considered as overbalanced by the saving of that sum, the result appears decidedly in favour of Line A from Napier *viâ* Te Aute and Waipawa.

Should objections be taken to the crossing of the two creeks at Pakowai,—the Tutaekuri-Waimata and the Ohiwia,—on account of the possible encroachment of the new course of the Ngaruroro, another line has been surveyed, marked Clive Line C No. 1 on the plan and section, which crosses the Ngaruroro twice, but nevertheless shows a saving of about £800 upon Line A by Pakowai. The objection to this line is that the valuable block of land near Pakowai and upper portion of the Papakura Block would be benefited but very little by the road.

Should Line A be selected, the port can be connected with it either by a tramway *viâ* Coote Road, at a cost of about £2,000; or the rail can be carried by Hyderabad Road, distance 2 miles 60 chains, from the first mile-post, at about £17,000.

I have, &c.,
CHARLES WEBER,
In Charge of Railway Survey, Napier to Manawatu Gorge.

His Honor J. D. Ormond, Napier.

ESTIMATED COST of CONSTRUCTION of LINES.

Line A.

From First Mile-post at Boundary of Town of Napier, by Waitangi, Pakowai, Paki Paki, Waipawa, and Waipukurau, to Takapau.

No. 1.—Napier to Karamu Junction

	£	s.	d.
1. First to fifth mile-post, 320 chains, at £3 per chain	960	0	0
2. Fifth mile-post to Waitangi, 35 chains, at £5 per chain	175	0	0
3. Bridge over the Waitangi, 100 feet, at £4 per foot	400	0	0
4. Waitangi Bridge to main road, 68¼ chains, at £10 per chain	682	10	0
5. 3 Culverts at last portion, 28 feet, at £2 per foot	56	0	0
6. Main road to Merritt's Junction at Karamu Line, 41 chains, at £4 per chain	164	0	0
7. Road-crossing (main road)	25	0	0
8. Merritt's to Waka's Paddock, 47¾ chains, 1 in 985, at £5 per chain	238	15	0
9. Waka's Paddock to Pakowai Paddocks, 120⅓ chains, 1 in 2,479, at £7 per chain	842	7	0
10. Pakowai Paddocks to Upper Bank of Tutaekuri-Waimata, at Pakowai, 46¾ chains, 1 in 1,058, at £7 per chain	327	5	0
11. 2 Road-crossings, at £25 each	50	0	0
12. 10 chains Road Diversion (natural track)	40	0	0
13. Tutaekuri-Waimata, at Pakowai, to West Bank of Ohiwia, 35¾ chains, 1 in 5,898:—			
(A.) Viaduct over Swamp, 420 feet, at £4 per foot	1,680	0	0
(B.) Bridge over Tutaekuri-Waimata, 120 feet, at £4 per foot	480	0	0
(C.) Bridge over Ohiwia, 320 feet, at £4 per foot	1,280	0	0
(D.) 22¾ chains formation, at £8 per chain	182	0	0
14. West of Ohiwia to Wellwood's Paddocks, 101¾ chains, 1 in 763, formation, at £6 per chain	610	10	0
15. 1 Road-crossing	25	0	0
16. Wellwood's to J. N. Williams', 119¾ chains, 1 in 988, formation, at £4 per chain	479	0	0
17. 2 Road-crossings, £25 each	50	0	0
18. To Boyle's Corner (Upper Junction), 64 chains formation, at £5 per chain	320	0	0

No. 2.—Karamu Junction to Paki Paki, 19th Mile-post.

1. From 18 to Ngaruroro, 133 chains, 1 in , at £5 per chain	665	0	0
2. 3 Culverts, 24 feet, at £2 per foot	48	0	0
3. 1 Road-crossing	25	0	0
4. Bridge over Ngaruroro, 680 feet, at £3 10s. per foot	2,380	0	0
5. Ngaruroro to crossing main road at Paki Paki, 176 chains, at £5 per chain	880	0	0
6. 2 Road-crossings, £25 each	50	0	0
7. Crossing of main road at Paki Paki to 19th Mile-post, 42¼ chains:—			
(A.) Viaduct (over swamp), 280 feet, at £3 per foot	840	0	0
(B.) Bridge over Awanui, 36 feet, at £4 per foot	144	0	0
(C.) Bridge over Poukawa, 20 feet, at £3 10s. per foot	70	0	0
(D.) 3,600 cube yards cutting through Whenuakura Island, at 1s. 6d. per yard	270	0	0

No. 3.—From 19th Mile-post to 32nd Mile-post, Paki Paki to Te Aute.

1. 46¾ chains, 1 in 3,082, 5,400 cube yards, partly limestone, at 2s. per yard	540	0	0
2. Road Deviations, deep limestone cuttings, 2,400 yards	300	0	0
3. Viaduct over swamp, 310 feet, at £3 per foot	930	0	0
4. Viaduct over swamp, 60 feet, at £3 per foot	180	0	0
5. 42 chains, level, 1,787 cube yards cutting, 3,539 cube yards filling (extra), 5,326 yards, at 1s. 6d. per yard	399	9	0
6. Viaduct, 230 feet, at £3 per foot	690	0	0
Carried forward			

No. 3.—From 19th Mile-post, &c.—continued.

		£	s.	d.
	Brought forward			
7.	Viaduct, 230 feet, at £3 per foot	450	0	0
8.	61 chains, level (deviation on plan), 6,000 yards side cuttings	450	0	0
9.	Bridge over Poukawa, 360 feet, at £3 per foot	1,080	0	0
10.	Bridge over Poukawa, 285 feet, at £3 per foot	855	0	0
11.	22 chains, 1 in 650, 1,820 yards	136	10	0
12.	Viaduct over swamp, 460 feet, at £3 per foot	1,380	0	0
13.	47½ chains, 1 in 945, 4,100 yards cutting	307	10	0
14.	Bridge over Poukawa, 924 feet, at £3 per foot	2,772	0	0
15.	Crowning of main road	25	0	0
16.	72 chains, 1 in 78½, 19,254 yards cutting	1,444	0	0
17.	16½ chains, 1 in 114, 5,103 yards cutting	382	14	6
18.	62 chains, 1 in 144, 12,700 yards cutting	952	10	0
19.	110½ chains, 1 in 137½, 28,000 yards cutting	2,100	0	0
20.	Road-crossing	25	0	0
21.	1 Culvert, 10 feet	20	0	0
22.	47 chains, 1 in 66, 2,400 yards cutting	180	0	0
23.	70¾ chains, 1 in 453, 5,900 yards cutting	442	10	0
24.	67½ chains, 1 in 50, 21,000 yards embankment, £1,575 0 0 759 yards cutting 56 18 6 21,759 yards	1,631	18	6
25.	Bridge over Mangawehi, 60 feet, at £3 per foot	180	0	0
26.	Cross-road	25	0	0
27.	73 chains, 1 in 50, 68,000 yards cutting	5,100	0	0
28.	58½ chains, 1 in 59, 85,000 yards cutting	6,375	0	0
29.	51 chains, 1 in 67, 16,000 yards cutting	1,200	0	0
30.	43½ chains, 1 in 50, 5,400 yards cutting	355	0	0
	10,000 yards embankment	750	0	0
31.	Bridge over Waipata Kakahu, 20 feet	60	0	0
32.	Road-crossing	25	0	0
33.	80-feet Bridge over deep gully	240	0	0
34.	37½ chains, 1 in 112½, 5,300 yards cutting	397	10	0
35.	48½ chains, 1 in 104, 5,200 yards cutting	340	0	0
36.	Bridge, 16 feet, at £3 per foot	48	0	0
37.	Bridge, 20 feet, at £3 per foot	60	0	0
38.	Road-crossing	25	0	0
39.	46½ chains, 1 in 53, 6,008 yards cutting	450	12	0
40.	Main Road-crossing	25	0	0
41.	23½ chains light formation, at £5 per chain	117	10	0
42.	130 chains Bush Clearing (Te Aute Bush), at £3 per chain	390	0	0

No. 4.—32nd Mile-post to Waipawa.

1.	40 chains level, 2,000 yards cutting	150	0	0
2.	1 10-feet Bridge	30	0	0
3.	30 chains, 1 in 1,320, edge of swamp, 4,000 yards filling embankment	300	0	0
4.	50 chains, 1 in 150, 3,220 yards cutting	241	10	0
5.	Road Diversion, main road metalled, 44 chains, at £7	308	0	0
6.	46 chains, 1 in 287, 2,560 yards cutting	192	0	0
7.	58 chains, 1 in 106, 3,100 yards cutting	232	10	0
8.	Bridge over Silver Stream, 20 feet	80	0	0
9.	Crossing, branch road	25	0	0
10.	38 chains, 1 in 385, 1,600 yards filling	120	0	0
11.	Road Diversion at Round Hill, main road, 3 chains (limestone cutting) ...	45	0	0
12.	Culvert, 8 feet	16	0	0
13.	36 chains, 1 in 130, 3,500 yards excavating	262	10	0
14.	Kaikora Bridge, 26 feet, at £4 per foot	104	0	0
15.	1 Culvert, 8 feet	16	0	0
16.	Road-crossing (bye-road)	25	0	0
17.	72 chains, 1 in 185, 3,100 yards filling	232	10	0
18.	52 chains, 1 in 312, 1,120 yards cutting	84	0	0
19.	36 chains, 1 in 1,188, 2,100 yards filling	157	10	0
20.	3 Bridges, 41 feet total, at £4 per foot	164	0	0
21.	62 chains, 1 in 103, 5,100 yards cutting	382	0	0
22.	20-feet Bridge, at £4 per foot	80	0	0
23.	Diversion of stream	20	0	0
24.	46 chains, level, 5,800 yards cutting	435	0	0
25.	Bridge, 12 feet, at £4 per foot	48	0	0
26.	42 chains, 1 in 129, 6,100 yards cutting	457	10	0
27.	4 small Bridges, total 42 feet, at £4 per foot	168	0	0
28.	Road-crossing (at Patangata)	25	0	0
29.	48 chains, 1 in 105, 6,850 cube yards cutting	513	15	0
	Carried forward			

		£	s.	d.
	No. 4.—32nd Mile-post to Waipawa—continued.			
	Brought forward			
30.	Diversion of Creek	25	0	0
31.	52 chains, 1 in 572, 8,679 yards cutting	650	0	0
32.	2 Bridges, each 10 feet, 20 feet, at £4 per foot	80	0	0
33.	Road-crossing, Waipawa to Tamumu	25	0	0
24.	15 chains Bush Cutting, at £3 per chain	45	0	0
	No. 5.—Waipawa to Waipukurau.			
1.	Bridge over Waipawa, 2,376 feet, at £3 per foot	7,128	0	0
2.	2 Groynes, and other protective works	600	0	0
3.	24 chains, 1 in 792, 8,800 yards embankment	660	0	0
4.	Culvert, 8 feet at £2 per foot	16	0	0
5.	Roard Diversion, 2 chains	24	0	0
6.	36 chains, 1 in 101, 24,156 yards cutting	1,811	14	0
7.	Road-crossing (branch Tamumu)	25	0	0
8.	62 chains, 1 in 148, 3,000 yards	225	0	0
9.	74 chains, 1 in 336, 4,200 yards	315	0	0
10.	Culvert, 10 feet, at £2 per foot	20	0	0
11.	Road Diversion (main road), 6 chains (metalled)	60	0	0
12.	46 chains, 1 in 138, 2,048 yards cutting	153	12	0
13.	2 Road-crossings, each £25 (branch road to bush)	50	0	0
14.	Road Diversion	20	0	0
15.	24 chains, 1 in 396, at Tuki Tuki, level, light formation, at £3 per chain ...	72	0	0
16.	2 Culverts, 10 and 8 feet, 18 feet, at £2 per foot	36	0	0
17.	Bridge over Tuki Tuki, 990 feet, at £3 per foot	2,970	0	0
18.	Groynes, and other protective works	500	0	0
19.	27 chains, 1 in 1,237, light formation, at £3 per chain, to road-crossing at Waipukurau	81	0	0
20.	Road-crossing at Waipukurau	25	0	0
	No. 6.—Waipukurau to Takapau.			
1.	47 chains, 1 in 1,237, light formation, at £3 per chain from Waipukurau Road ...	141	0	0
2.	48 chains, level, light formation, at £3	144	0	0
3.	10-foot Bridge	30	0	0
4.	82 chains, 1 in 433, light formation, at £3	246	0	0
5.	2 Bridges, 12 and 20 feet, 32 feet, at £3 per foot	96	0	0
6.	76 chains, 1 in 1,672, 9,500 yards filling	712	10	0
7.	4 Bridges, 15, 15, 8, and 20 feet, total 58 feet, at £3 per foot	174	0	0
8.	26 chains, 1 in 214, formation, at £3 per chain	78	0	0
9.	Bridge, 10 feet, at £3 per foot	30	0	0
10.	1 Culvert, 8 feet, at 2 per foot	16	0	0
11.	24 chains, 1 in 288, 6,298 cube yards cutting	474	7	0
12.	38 chains, 1 in 278, 6,157 cube yards cutting	461	15	6
13.	2 Culverts, 8 feet each, total 16 feet, at £2	32	0	0
14.	2 Bridges, 20 feet each, 40 feet, at £3	120	0	0
15.	64 chains, 1 in 325, 6,700 yards cutting	502	10	0
16.	1 Culvert, 8 feet	16	0	0
17.	Bridge, 10 feet, at £3 per foot	30	0	0
18.	Deviation of Creek Pegs, 20 to 23	20	0	0
19.	44 chains, 1 in 103, 4,100 yards cutting	307	10	0
20.	1 Culvert, 8 feet, at £2 per foot	16	0	0
21.	Bridge, 20 feet, at £3 per foot	60	0	0
22.	64 chains, 1 in 62, 6,200 yards cutting	465	0	0
23.	2 Bridges, 20 and 8 feet, 28 feet, at £3 per foot	84	0	0
24.	8-foot Culvert	16	0	0
25.	60½ chains, 1 in 163, 6,600 yards cutting	495	0	0
26.	2 Culverts, 8 feet each, 16 feet, at £2	32	0	0
27.	2 Bridges, 20 and 10 feet, 30 feet, at £3	90	0	0
28.	41 chains, 1 in 150, 10,370 yards cutting	777	15	0
29.	10-foot Bridge, at £3 per foot	30	0	0
30.	150 chains, 1 in 173, formation at £4 per chain	600	0	0
31.	Bridge over Maraekiki, 100 feet, at £3 10s. per foot	350	0	0
32.	180 chains, 1 in 142, namely :—			
	166 chains light formation, at £4 per chain	424	0	0
	22 chains, 8,072 cubic yards cutting	605	8	0
33.	48 chains, 1 in 181, 748 feet cutting (sidling from last section)	56	2	0
	Line B.—Port Ahuriri, viâ Meanee, Waipawa to Takapau.			
1.	Port Ahuriri to Gough Island :—			
	Viaduct, 990 feet, at £2 10s. per foot...	2,425	0	0
2.	Over Gough Island and Mud Flat :—			
	Embankment, 16 chains, at £25 per chain	400	0	0
	Carried forward			

Line B.—Port Ahuriri, &c.—continued.

		£	s.	d.
	Brought forward			
3.	To Battery Point, Viaduct, 1,782 feet, at £2 10s.	4,455	0	0
4.	6 chains embankment on Battery Point, at £15 per chain	90	0	0
5.	Viaduct to Meanee Flat, 2,046 feet, at £2 10s. per foot	5,115	0	0
6.	To head of Purimu, 202 chains formation, at £10	2,020	0	0
7.	4 chains of light formation to Purimu, at £5 per chain	20	0	0
8.	Bridge over Purimu, 120 feet, at £2 10s.	300	0	0
9.	62 chains formation, at £5	310	0	0
10.	Crossing, main road (Puketapu)	25	0	0
11.	44 chains formation, to Tutaekuri, at £4	176	0	0
12.	Road-crossing on bank of river	25	0	0
13.	Bridge over Tutaekuri, 1,848 feet, at £3	5,544	0	0
14.	Groyne on north bank	250	0	0
15.	Viaduct, 1,800 feet, south bank of Tutaekuri, at £2	3,600	0	0
16.	36½ chains of formation, at £5	182	10	0
17.	Road-crossing at Omahu	25	0	0
18.	46 chains to Tutaekuri-Waimata, formation, at £5	230	0	0
19.	Bridge over Tutaekuri-Waimata, 130 feet, at £3 10s.	455	0	0
20.	99 chains formation to bridge over Ohiwia (about 16,000 yards), at £12 per chain	1,188	0	0
21.	Bridge over Awahau, 40 feet, at £3	120	0	0
22.	Bridge over stream, 12 feet, at £3	36	0	0
23.	Viaduct, 660 feet, at £2 10s.	1,650	0	0
24.	Bridge and Viaduct at Ohiwia, 1,320 feet, at £3	3,960	0	0
25.	82 chains, level, south of Ohiwia, high bank, 24,000 yards, at £20	1,640	0	0
26.	76 chains, 1 in 401, light formation, at £5	380	0	0
27.	32 chains, 1 in 862, 6,000 yards, cutting in sandy soil	300	0	0
28.	118 chains, 1 in 925, very light formation, at £5	590	0	0
29.	2 Road-crossings, each £25	50	0	0
		£36,571	10	0

Clive Line C.

		£	s.	d.
1.	First Mile-post (Napier) to Merritt's			
2.	Pakowai, as per Line A, page 1	2,462	10	0
3.	Junction of Line A to Ngaruroro, 12 chains formation, at £5	60	0	0
4.	Bridge over Ngaruroro, 335 feet, at £5	1,675	0	0
5.	Ngaruroro to bed of river at main road, 57⅓ chains, at £7	401	6	8
6.	Deviation of main road, 4 chains, at £8	32	0	0
7.	Main road to R. T. William's, 1 in 5,280, 72 chains, at £5 per chain	360	0	0
8.	Crossing main road	25	0	0
9.	R. P. Williams' to Karamu Paddocks, 167¾, at £8	1,342	0	0
10.	2 Culverts, 10 feet each, 20 feet, at £2	40	0	0
11.	1 Bridge, 16 feet, at £3	48	0	0
12.	2 Road-crossings at Karamu, each £25	50	0	0
13.	Bridge over Ngaruroro, 210 feet, at £4	840	0	0
14.	To J. N. Williams' Paddocks, 72¾ chains, 1 in 585½, at £5	363	15	0
15.	J. N. Williams' to junction of Line B, 86¾ chains, at £5	433	15	0
16.	3 Bridges, 46 feet, at £3	138	0	0
17.	Road-crossing	25	0	0
		£8,296	6	8

Line C, Middle Road.

From Junction of A and B at Karamu, *viâ* Pukahu, to Waipukurau and Takapau.

A.—From Junction at Karamu to Foster's Gorge.

		£	s.	d.
1.	From junction of A and B, at Karamu, to Ngaruroro River, at Boyles', 134 chains, at £6 per chain	876	0	0
2.	3 Culverts, each 8 feet, 24 feet, at £2 per foot	48	0	0
3.	Bridge over Ngaruroro, 450 feet, at £4 per foot	1,800	0	0
4.	Bridge to Reynolds', 53 chains, at £6 per chain	318	0	0
5.	2 Road-crossings, main road and branch road, each £25	50	0	0
6.	Reynolds' to Pukahu Block, 87½ chains, at £5 per chain	437	10	0
7.	Louisa Creek Bridge, 40 feet, at £4 per foot	160	0	0
8.	Road-crossing (branch road)	25	0	0
9.	42½ chains to base of hills, at £6	255	0	0
10.	1 Road-crossing	25	0	0
11.	1 Culvert, 8 feet, at £2 per foot	16	0	0
12.	70½ chains along edge of Pukahu Swamp, 19,760 cubic yards, at 1s. 6d. per cubic yard	1,482	0	0
13.	18 chains Road Diversion, not metalled, at £6 per chain (middle road) ...	108	0	0
14.	94½ chains along edge of Pukahu Swamp through point of hills, 20,071 cubic yards cutting, at 1s. 6d. per cubic yard	1,506	0	0
15.	24 chains Road Diversion, at £5 per chain (middle road—not metalled) ...	120	0	0
16.	2 Culverts, 8 feet each, 16 feet, at £2 per foot	32	0	0
17.	32½ chains to Foster's Gorge, 2,620 yards cutting, at 1s. 6d. per cubic yard ...	197	0	0
18.	1 Culvert, 8 feet, at £2 per foot	16	0	0
		£7,471	10	0

B.—From Foster's Gorge to Patangata.

		£	s.	d.
1.	From Foster's Gorge, 115 chains, 1 in 40, 7,200 cubic yards cutting, at 1s. 6d. per cubic yard	540	0	0
2.	44 chains, 1 in 55, 28,000 yards	2,100	0	0
3. 4.	51 chains, 1 in 240; 44 chains, 1 in 145 } 12,000 yards filling (extra), at 1s. 6d. per yard	915	0	0
5.	2 Culverts, 8 feet each, 16 feet, at £2 per foot	32	0	0
6.	52 chains, 1 in 167, 3,500 yards cutting; 1,500 yards embankment (extra); Total 5,000 yards	375	0	0
7.	1 Culvert, 8 feet, at £2 per foot	16	0	0
8.	111 chains, 1 in 135, 15,200 yards cutting; 10,000 yards embankment (extra); Total 25,200 yards, at 1s. 6d. per yard	1,875	0	0
9.	1 Bridge, 16 feet, at £3 per foot	48	0	0
10.	2 Culverts, 8 feet each, 16 feet, at £2 per foot	32	0	0
11.	156½ chains, 1 in 71, 42,000 cubic yards cutting	3,150	0	0
12.	3 Culverts, 8 feet each, 24 feet, at £2 per foot	48	0	0
13.	68½ chains, 1 in 67, 7,400 yards cutting; 2,100 yards embankment; Total 9,500 yards	713	0	0
14.	Bridge, 12 feet, at £3 per foot	36	0	0
15.	Culvert, 8 feet, at £2 per foot	16	0	0
16.	40 chains, 1 in 50, 22,000 yards cutting	1,650	0	0
17.	130 chains, 1 in 186, 24,500 yards cutting	1,838	0	0
18.	1 Bridge, 14 feet, at £3 per foot	42	0	0
19.	3 Culverts, 8 feet each, 24 feet, at £2 per foot	48	0	0
		£13,474	0	0

C.—*From Patangata to Waipukurau* (*Junction with A*).

		£	s.	d.
1.	37½ chains, 1 in 90, 5,150 cubic yards (extra) embankment, at 1s. 6d. per yard	385	0	0
2.	1 Culvert, 8 feet, at £2	16	0	0
3.	42½ chains, 1 in 122, 8,100 yards cutting	607	10	0
4.	66⅔ chains, 1 in 266, 15,000 yards cutting	1,150	0	0
5.	34 chains, 1 in 149, 4,000 yards embankment (difference)	300	0	0
6.	1 Culvert, 8 feet, at £2	16	0	0
7.	97 chains level, 4,200 yards cutting	315	0	0
8.	Crossing main road			
A8.	Bridge over Papanui, 100 feet, at £4	400	0	0
9.	48 chains, 1 in 301, 6,100 yards,	457	10	0
10.	64 chains level, 2,980 yards	224	10	0
11.	1 Culvert, 8 feet, at £2	16	0	0
12.	118 chains, 1 in 207, formation, at £4 per chain	472	0	0
13.	2 Culverts, 8 feet each, 16 feet, at £2 per chain	32	0	0
14.	69 chains, 1 in 128, formation, at £4 per chain	276	0	0
15.	1 Culvert, 8 feet, at £2 per foot	16	0	0
16.	60 chains, 1 in 360, formation, at £4 per chain	240	0	0
17.	62 chains, 1 in 170, formation, at £4 per chain	248	0	0
18.	1 Culvert, 8 feet, at £2 per foot	16	0	0
19.	1 Road-crossing	25	0	0
20.	66 chains, 1 in 544, formation, at £4 per chain	264	0	0
21.	Bridge over Waipawa River, 5,016 feet, at £3 per foot	15,048	0	0
22.	26 chains, 1 in 190, 4,212 yards	316	0	0
23.	Road-crossing (branch)	25	0	0
24.	124 chains level formation, at £4 per chain	496	0	0
25.	Bridge over Mataweka, 30 feet, at £3 per foot	90	0	0
26.	Bridge over Tuki Tuki, 340 feet, at £3 10s. per foot	1,190	0	0
27.	Road-crossing (to Waipawa)	25	0	0
28.	118 chains, 1 in 299, 5,800 yards	435	0	0
29.	1 Culvert, 8 feet, at £2 per foot	16	0	0
30.	84 chains level formation, at £4 per chain	336	0	0
31.	1 Culvert, 8 feet, at £2 per foot	16	0	0
32.	46 chains, 1 in 209, to Junction with Line A, at Waipukurau Township, formation, at £4 per chain	184	0	0
33.	1 Road-crossing	25	0	0
34.	1 Culvert, 8 feet, at £2 per foot	16	0	0
		£23,694	0	0

SCHEDULE of PLANS and DOCUMENTS forwarded with Report on Railway from Napier to Ruataniwha.

1. Plan, on 20-inch scale, of Lines A and B, from Napier and Port Ahuriri to Karamu Junction and Ngaruroro Crossings.
2. Plan of Line A, on 10-inch scale, from Ngaruroro to Te Aute (32nd mile-post).
3. Plan of Line A, on 10-inch scale, from Te Aute (32nd mile-post) to Takapau.
4. 9 Sections of Line A, marked Line A No. 1 to No. 9, from Napier to Takapau.
5. 1 Section of Clive, deviations of Line A, marked Clive C. No. 1.
6. 2 Sections of Line B, marked Line B. No. 1 and 2, from Port Ahuriri to Karamu Junction with A.
7. 3 Sections of Line C, (middle line), marked Middle Line C No. 2 to No. 4.
8. Lithographed Plan of Town of Napier, showing proposed connection of Port with Town of Napier.
9. Lithographed Plan of Province of Hawke's Bay, showing the three lines reported upon.
10. Detailed Estimates of Line A.
11. Detailed Estimates of Line B.
12. Detailed Estimates of Line C.

CHARLES WEBER,
Engineer in Charge of Survey.

III.—WANGANUI TO NEW PLYMOUTH.

No. 4.

Mr. CARRINGTON to Mr. KNOWLES.

SIR,— Public Works Office, Taranaki, 9th September, 1871.

I have the honor to forward herewith a report from Mr. Hogg, of the survey of the proposed line of railway between Wanganui and Whenuakura, on which he is now employed. I regret that no plan or tracing of the district, showing the direction of the line, accompanies his report. I will endeavour to obtain the information from Mr. Hogg, and forward a tracing with as little delay as possible.

I have, &c.,
OCT. CARRINGTON,
In Charge of Road Works, West Coast.

The Under Secretary, Public Works Office, Wellington.

Enclosure in No. 4.

Mr. HOGG to Mr. CARRINGTON.

SIR,— Wanganui, 26th August, 1871.

I have the honor to report to you that I have reached the valley of the Okeku with the survey of the proposed line of railway from Wanganui to Patea, a distance of about eleven and a half miles. The section line is completed up to that point, as also cross sections made where necessary, and levels taken along all roads crossed by the line. The traverse of the line is also complete from Teake's Saddle to the Okehu Valley, a distance of 4 miles 63 chains.

The leading features of the country are very favourable for the construction of a line of railway between Wanganui and Patea, as all the principal gullies run east and west, and debouch upon the valleys of the rivers to be crossed, all of which can be bridged at the level of the top of their banks. The line crosses the Wanganui River about two miles above the town, and opposite the Brunswick Valley. From the crossing of the river to the entrance of the Brunswick Valley is over flats of pumice; 32 chains from this it follows along the southern faces of the valley, rising to the table lands at the head of the Goat Valley, on a gradient of 1 in 40. Of this distance 1 mile 24 chains is through bush, which is of a mixed description. The character of the work will be ordinary side cutting, with occasional cutting through narrow points or spurs, and embanking across shallow gullies which cross the line. Abundance of excellent conglomerate gravel is to be found all along this face.

From the head of the bush gully which brings the line on to the table lands, the line takes through "Lily Bank Farm" grass paddocks on the flat for a distance of 42 chains, where it then runs down an open gully on siding for a distance of 16 chains; then for a distance of about 24 chains it is partly side cutting and through cutting. It then crosses the Great Western Road (side cutting down into Goat Valley) on the level, and follows down the southern slopes of the Goat Valley, on a gradient of 1 in 40, for a distance of 89 chains, which is side cutting of an ordinary description through grass and fern. It then runs along the bottom of the valley, occasionally touching on the base of the slopes, for a distance of 72 chains, when it then crosses the Mouhanau Creek and ascends the north side of the Goat Valley, on a grade of 1 in 40, side cutting, through cutting, and embankment, a distance of 56 chains, of which 27 chains are through bush. It here reaches Peake's Saddle, which divides the Goat Valley from the Puketapou Valley. On the saddle it crosses the Great North-western Road on the level, and runs down the southern slopes of the Puketorau Valley, on a sidling of 1 in 40, for a distance of 142 chains. In this distance it crosses the Great North-western Road three times more, once on the level, once 3 feet above the level of the road, and once 20 feet above the level of the road. At 142 chains it runs on the flat for about 14 chains, and crosses the Puketorau Stream at 8 miles 50 chains 74 links. It then enters the Kai Iwi Valley by cutting through a saddle 5 chains in length, which brings it into the bottom of the valley, along the bottom of which it runs until it reaches the crossing of the Kai Iwi Stream at 9 miles 11 chains 70 links.

On the west side of the Kai Iwi Stream it continues flat to 9 miles 23 chains 90 links, where a sidling begins along the southern slopes of a long gully running from the Kai Iwi towards the Okehu. This sidling continues, on a gradient of 1 in 49, to 10 miles 29 chains 90 links, where it will run under a high table point jutting into the gully to the distance of 10 miles 42 chains 90 links, where it crosses a shallow gully, and cuts through a spur at the distance of 10 miles 42 chains 90 links, where the sidling again begins, and continues on to 10 miles 65 chains 90 links, where it will enter and run through a high narrow ridge, 131 feet above the formation level, which divides the Kai Iwi Valley from the Okehu Valley, into which it debouches at 11 miles 16 chains 26 links.

Up to the above point, the section line is completed, cross sections taken, and the traverse from Peake's Saddle.

From the entrace to the Okehu Valley to one mile and a half farther on in the neighbourhood of Patterson's, the line is defined and the trial levels taken, which give gradients of 1 in 65, 1 in 67, 1 in 40, 1 in 73, and horizontal. This part is through bush.

From Patterson's the line will keep to the north of the Great North-western Road, and run into the head of a long straight and deep bush gully, which will take it out on the Waitotara River inland of Weraroa Redoubt, and, crossing the river at the site of the late pa at Perakama, it will then ascend to the high lands of the Okotoko Block, by a side cutting about one mile and a half in length, partly bush. When on the top, the line will run almost straight for Wairoa and the Whenuakura River, over a succession of fern flats requiring little formation. When within about two miles of the Whenuakura River, it will enter the head of a long straight gully, partly wooded, which will take it by a side cutting straight down to the river on a grade of about 1 in 41 or 2. Abundance of ballast will be found in the cuttings along the line between Wanganui and the Waitotara River, consisting of good conglomerate gravel and indurated shells run together, and lying in beds of great depth, much of which is nearly pure lime. If neither of these be found between the Waitotara and Whenuakura Rivers, plenty of grey sandstone will. No curve on the line will exceed 60 degrees. The line is very direct in its course, and the work, which is principally side cutting, between Wanganui and Waitotara is not heavy. Between Waitotara and Whenuakura it will nearly all be the ordinary flat formation.

The work has been very much hindered by the wet season, which has been extreme, but it has now taken a slightly favourable turn.

I have, &c.,
JAMES HOGG, C.E.

O. Carrington, Esq.,
In Charge of Public Works, West Coast.

No. 5.

Mr. CARRINGTON to Mr. KNOWLES.

SIR,— Public Works Office, Taranaki, 23rd September, 1871.

I have the honor to forward herewith a tracing of part of the West Coast District, to accompany Mr. Hogg's report, of the 26th ultimo, upon the survey of the proposed line of railway north of Wanganui, forwarded by me on the 9th instant, showing the direction of the line from Wanganui to where it is laid off, and also showing about the direction from that point to the Whenuakura River.

I have, &c.,
O. CARRINGTON.

The Under Secretary, Public Works Office, Wellington.

No. 6.

Mr. CARRINGTON to Mr. KNOWLES.

SIR,— Public Works Office, Taranaki, 9th September, 1871.

I have to report that Mr. C. W. Hursthouse has completed the plan and section of the proposed line of railway north of Wanganui, between Whenuakura and Waingongoro, and I have now the honor to forward the documents as per margin.

Railway Survey, Plan and Section from Whenuakura to Waingongoro.

Sketch tracing, Patea District.

Copy of Report from Mr. Hursthouse.

Approximate Estimate.

I deemed it advisable not to include, in the approximate estimate, the cost of rolling stock, as it can be more accurately ascertained from data in the office of the Engineer-in-Chief.

I have, &c.,
O. CARRINGTON,
In Charge of Road Works, West Coast.

The Under Secretary, Public Works Office, Wellington.

Enclosure in No. 6.

Mr. C. W. HURSTHOUSE to Mr. O. CARRINGTON.

SIR,— New Plymouth, 9th September, 1871.

I have the honor to transmit herewith the preliminary plan and section of twenty-five miles and a quarter of railway from Whenuakura, in the Province of Wellington, to Waingongoro, in the Province of Taranaki, erroneously stated at twenty-four miles and three-quarters in my report of 9th June last, plotted to a scale of 10 chains to an inch horizontally, and 100 feet to an inch vertically, according to your instructions; also, a tracing, on a scale of one mile to an inch, showing generally the direction of the line through the district, and some deviations, marked in red, which I think it would be well to carefully inspect, with a view to lessen the expense of the work.

The datum line I have adopted is 100 feet below high water at spring tide in the Patea River, at Hukatere. The traverse was done with a prismatic compass, and is checked and tied in at the numerous crossings of the already surveyed lines, with which it agrees very well. The traverse line is shown in red on the plan, and the proposed course of the railway in a thick black line. The section is taken on the traverse line, without any attempt to lay out curves, more than by cutting the line

with the turns as easy as could be judged by the eye, so that the section does not show exactly the features of the ground over which the railway will have to be made. This is especially the case on steep sidling ground, where a deviation of a few feet would make as much difference in the level. I have therefore considered it better to delineate the ground on each side of the line, as far as could be conveniently done without materially adding to the cost of the survey.

By reference to the plan and section, it will readily be perceived that there is no more difficulty in obtaining a grade of 1 in 57 (dotted on section) between the points marked A and B, near Whenuakura, by taking the railway along the line dotted on the plan, than there would be in taking it along the firm lines on the plan and section, on which the grades are 1 in 40 and 1 in 1,624. And, again, between the points marked "A" and "B" on the 1 in 40 grade, the section shows a very large embankment, which would not appear if the section were taken on the black line between the same points.

These remarks will also apply to that part of the line marked C to D on the descending grade to the Ingahape, and H to I at the Iangahoe, and in a less degree to all the levels taken on sidling ground, excepting where the section line and railway line are identical.

The portion of line marked E to F at the crossing of the Ingahape is not traversed or levelled, but I am confident that it is the best way of crossing the stream, and that it is practicable. It was my intention to have taken the line across the stream near E, and then along the foot of the cliff, following nearly the course of the stream, and then curve back to F. A good line, with a grade of about 1 in 50, could have been got in this way, but the distance between F and the stream was too short to give even the minimum radius of 5 chains.

The dotted red line marked on the plan "Abandoned Line" is a line cut, surveyed, and levelled, but I was forced to abandon it on account of not finding a sufficiently easy place to cross the Iangahoe, and also the very expensive work it would have entailed in ascending from the Iangahoe.

The curved line from G to H would be preferable to the traverse line, as it would considerably lessen the cutting shown near H, and would require less embankment at the stream near the fifteenth mile.

At the point marked J it will be necessary to cross the Tawiti Stream twice in order to make the curve of a sufficiently large radius. The bridges required for this purpose will be from 20 to 30 feet span, according to the obliquity at which they cross the stream. The cutting through the neck will be considerably diminished from what is shown by keeping a little lower down the hill.

The line from the point J up the valley will cross the Tawiti several times. The stream may be either bridged or turned so as not to cross the line, there being no difficulties in the way of either, so that the most economical would appear to be the best plan to adopt, and with this view I have shown, in dotted blue lines, where it appears to me the cheapest and best to turn the stream, and where no deviation is shown I have estimated for bridges. The earth removed in cutting the races to turn the stream would be required in forming the line along the valley, and has been estimated for as part of the earthwork.

The Tawiti Stream differs from most of the others in this neighbourhood in not being subject to heavy freshets, as it rises and flows entirely through a flat country.

Referring to the deviations shown on the tracing, that marked A would, I think, strike the gully leading to the Patea River nearer its source, and enable the railway to reach a lower level before arriving at the cross gullies marked C and D on the tracing, and shown on the plan and section at 3 miles 60 chains and 4 miles 10 chains respectively, and thereby reduce the expense of crossing them at so high an elevation.

The deviation marked EF on the tracing would have its chief advantage in passing through less private property and in crossing the Mangaroa Stream at a lower level, but would be considerably longer than the one surveyed. I should not, therefore, recommend this deviation unless it offered very decided advantages over the other.

The line surveyed is one which, at first sight, appears the most practicable and direct, and, with the questions I have mentioned settled, I do not think a better can be found between the two points. The steepest grade on the line will be 1 in 40, and the sharpest curve 5 chains radius.

For a general description of the line I beg to refer you to my report of the 9th June last.

Enclosed is an approximate estimate of the cost of constructing the line, exclusive of rolling stock, stations, turn-tables, points, switches, signals, &c.

I have, &c.,
C. W. Hursthouse,
Surveyor.

O. Carrington, Esq.,
In Charge of Public Works, West Coast.

Approximate Estimate of Cost of Constructing 25¼ Miles of Railway from Whenuakura, Province of Wellington, to Waingongoro, Province of Taranaki, 3 feet 6 inches Guage.

	£ s. d.	£ s. d.
Earthwork—		
Mostly ordinary side cuttings, 685,000 cubic yards, at 9d. per cubic yard		25,687 10 0
Clearing Line—		
240 chains Bush, 5 chains wide, at £4 per acre	480 0 0	
110 chains Scrub, 2 chains wide, at £2 per acre	44 0 0	
1,670 chains Fern, 2 chains wide, at £1 per acre	334 0 0	
		858 0 0
Bridges—		
At 3 miles 60 chains, 1 60-feet opening, at £10 per foot ...	600 0 0	
„ „ 8 22-feet openings, at £7 per foot ...	1,232 0 0	
		1,832 0 0
Carried forward		

	£	s.	d.	£	s.	d.
APPROXIMATE ESTIMATE—*continued.*						
Brought forward						
At 4 miles 10 chains, 2 60-feet openings, at £10 per foot ...	1,200	0	0			
„ „ 8 22-feet openings, at £7 per foot ...	1,232	0	0			
				2,432	0	0
At 5 miles 45 chains, (Patea), 1 120-feet opening, at £15 per ft.	1,800	0	0			
„ „ „ 2 70-feet openings, at £12 per foot	1,680	0	0			
				3,480	0	0
At 7 miles 47 chains, 1 60-feet opening, at £10 per foot ...	600	0	0			
„ „ 8 22-feet openings, at £7 per foot ...	1,232	0	0			
				1,832	0	0
At 9 miles 33 ch., (Mangaroa), 1 120-feet opening, at £15 per ft.	1,800	0	0			
„ „ „ 14 22-feet openings, at £7 per foot	2,156	0	0			
				3,956	0	0
At 13 miles 48 ch., (Ingahape), 1 60-feet opening, at £10 per ft.	600	0	0			
„ „ „ 8 22-feet openings, at £7 per foot	1,232	0	0			
				1,832	0	0
At 15 miles 5 chains, 1 22-feet opening, at £7 per foot ...	...			154	0	0
At 16 miles 40 chains, 1 100-feet opening, at £13 per foot ...	1,300	0	0			
(Tangahoe) 6 22-feet openings, at £7 per foot ...	924	0	0			
				2,224	0	0
At 17 miles 25 chains, 2 22-feet openings, at £7 per foot ...	...			308	0	0
At 17 miles 70 chains, 2 16½-feet openings, at £6 per foot ...	...			198	0	0
At 19 miles 10 chains, 2 16½-feet openings, at £6 per foot ...	...			198	0	0
At 22 miles 65 chains, 1 22-feet opening, at £7 per foot ...	...			154	0	0
At 25 miles 20 chains, 1 100-feet opening, at £13 per foot ...	1,300	0	0			
(Waingongoro) 10 22-feet openings, at £7 per foot ...	1,540	0	0			
				2,840	0	0
Culverts—						
2,890 lineal feet, at 15s. per foot				2,167	10	0
3,400 lineal feet small culverts on side cuttings, at 5s. per foot ...	...			850	0	0
Fencing—						
50½ miles, at £100 per mile	...			5,050	0	0
Ballast—						
25¼ miles, at 1,920 cubic yards per mile, 48,480 cubic yards, at 4s. per yard	...			9,696	0	0
Sleepers—						
50,500, at £6 per 100	...			3,030	0	0
Rails, &c.—						
69 tons per mile, at £9 per ton, 25¼ miles	...			15,680	0	0
Crossings—						
13 level crossings, at £20	...			260	0	0
Laying Permanent Way, 25¼ miles, at £50	...			1,262	0	0
				£85,981	15	0
Average cost per mile, about	...			£3,405	0	0