REPORT

ON THE

ENGINEERING AND ECONOMIC FEATURES

OF THE

PACIFIC GREAT EASTERN RAILWAY

BY

J. G. SULLIVAN, Consulting Engineer.

THE GOVERNMENT OF
THE PROVINCE OF BRITISH COLUMBIA.

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Engineering and Economic Features of the Pacific Great Eastern Railway.

By J. G. Sullivan, Consulting Engineer.

Winnipeg, Man., June, 1922.

The Hon. John Oliver,
Minister of Railways, Province of British Columbia.

Dear Sir,—Your letter of instructions dated April 19th, 1922, handed to me on my arrival at Vancouver April 20th, 1922, is as follows:—

"*J. G. Sullivan, Esq.,*
Consulting Engineer, Vancouver, B.C.

"Dear Sir,—There is a very general opinion throughout British Columbia that the Pacific Great Eastern as built traverses territory, a great portion of which is never likely to produce traffic of moment, and that this particular portion—namely, from Green Lake to Clinton—should be abandoned, and that instead of completing the Pacific Great Eastern along the north shore of Howe Sound, connecting Squamish with North Vancouver by rail, a line should be built between Clinton and Ashcroft connecting with the Canadian National Railways or the Canadian Pacific Railway, or both, thus affording a direct entry into Vancouver, where the terminals of both lines would be available and interchange made practicable with Canadian and American trunk lines, with the British Columbia Electric Railway, and with all wharves and docks.

"It is also held by these same people that the uncompleted gap (45 miles in length) between Red Rock Creek and Cottonwood Canyon should not be finished now, but that even if it is considered necessary to finish the gap referred to, it should bo completed simultaneously with the Clinton–Ashcroft line, and an arrangement made with Canadian National or Canadian Pacific to operate, thus obviating the necessity of purchasing about $1,500,000 of extra equipment which would have to be procured if we should operate between Squamish and Prince George. Your opinion on the feasibility or desirability of the abandonment referred to and the construction of the Clinton–Ashcroft connection is sought.

"You will be furnished with profiles of the line showing the old and new work separately, and where any line changes have been made, and your opinion is desired as to whether these changes were beneficial or otherwise to the Pacific Great Eastern Railway.

"Copies of the original contract, documents giving reasons for decreases and increases made in prices from those in the original contract will be submitted to you for your consideration.

"You will also advise on the plans and profiles showing the various routes by which the Pacific Great Eastern might be extended to the eastern boundary of the Province, connecting with the Alberta lines.

"I have instructed the Railway Department to put at your disposal every record of any kind whatever which you may desire to enable you to make a report as to whether the work carried out since the line was taken over by the Government was economically performed.

"A complete bridge report as of December 31st, 1921, will be submitted to you, so that you may form your opinion as to a programme of bridge renewals, especially on the section between Chase and Squamish.

"I have only outlined a few things which occur to me at the moment, but of course many others will occur to yourself.

"'The Government desires to have a full and complete report on the work carried out under its control, and to have your advice as to what is best to do in the future with this line so as to make it able to meet charges in the near future, as it is at present almost an unsupportable burden on the people of the Province.

"Yours truly,
John Oliver,
Minister of Railways."

Complying with the terms of this letter and your further verbal confirmation that the economic features be fully discussed, I have arranged the questions and points to be discussed under the following heads:—

A.—Routes and Detail of Location.
B.—Physical Features of the Line.
C.—Amount constructed and General Type of Construction.
D.—Financial Conditions.
E.—Revenue and Traffic Expenses, Traffic Statistics, Equipment.
F.—Revenue necessary to pay Fixed Charges plus Operating Expenses.
G.—Rates and Ton-miles a Necessity in the Production of Revenue.
H.—Ability of Adjacent Country to produce Required Revenue.
I.—Was Government justified in making Revision of Line at Crossing of Cottonwood River?
J.—Was Government justified in making Revision at Crossing of Quesnel River?
K.—Should Portion of Line South of Clinton be abandoned and Line built from Clinton to connect with C.P.R. or C.N.R. at Ashcroft?
L.—Should the Line from Quesnel to Prince George be completed and put in Operation?
M.—Should Line be extended from Prince George to Peace River Country; and, if so, by what Route?
N.—Was the Work carried out since the Government took charge economically performed?
O.—Were decreases and increases in Unit Prices of Original Contract justified?
P.—Advisability of getting one of the Larger Railway Companies to operate the line.
Q.—Advice as to what should be done to enable Line to meet Charges in the Near Future.

The above subjects and questions I will deal with in detail to the best of my ability in non-technical terms, but when any of the conclusions or deductions are based on technical data, I will supply the same in the Appendices in order that your engineers may be fully advised as to the basis of my reasoning.

A.—ROUTES AND DETAILS OF LOCATION.

It is evident that the principal object in constructing the line was to make a rail connection between Vancouver and the Grand Trunk Pacific Railway. The route chosen was to start at North Vancouver, where practically no terminal facilities were provided, follow the sea-shore a distance of 42 miles to Squamish at the head of Howe Sound. Grades on this portion of line are undulating; maximum of 1 per cent. against traffic in both directions. From Squamish the line runs in a north-easterly direction over a divide and into the Pemberton Valley, where the Lillooet River is crossed; this is in the Harrison River drainage-basin. From Squamish the line follows the Squamish River Valley to the Cheakamus; thence up the valley of the latter to Mons Summit, a distance of approximately 40 miles, rising in this distance 2,100 feet, maximum 2.2 per cent. grade against N.B. traffic. Going down to Pemberton via valleys of the Green and Soo Rivers there is a drop of 1,400 feet on 2.2 per cent. maximum grade against S.B. traffic, a distance of 20 miles.

From the crossing of the Lillooet River the line continues in a north-easterly direction, going over the divide between the Harrison River drainage-basin to that of the Fraser River, which is crossed at the town of Lillooet.

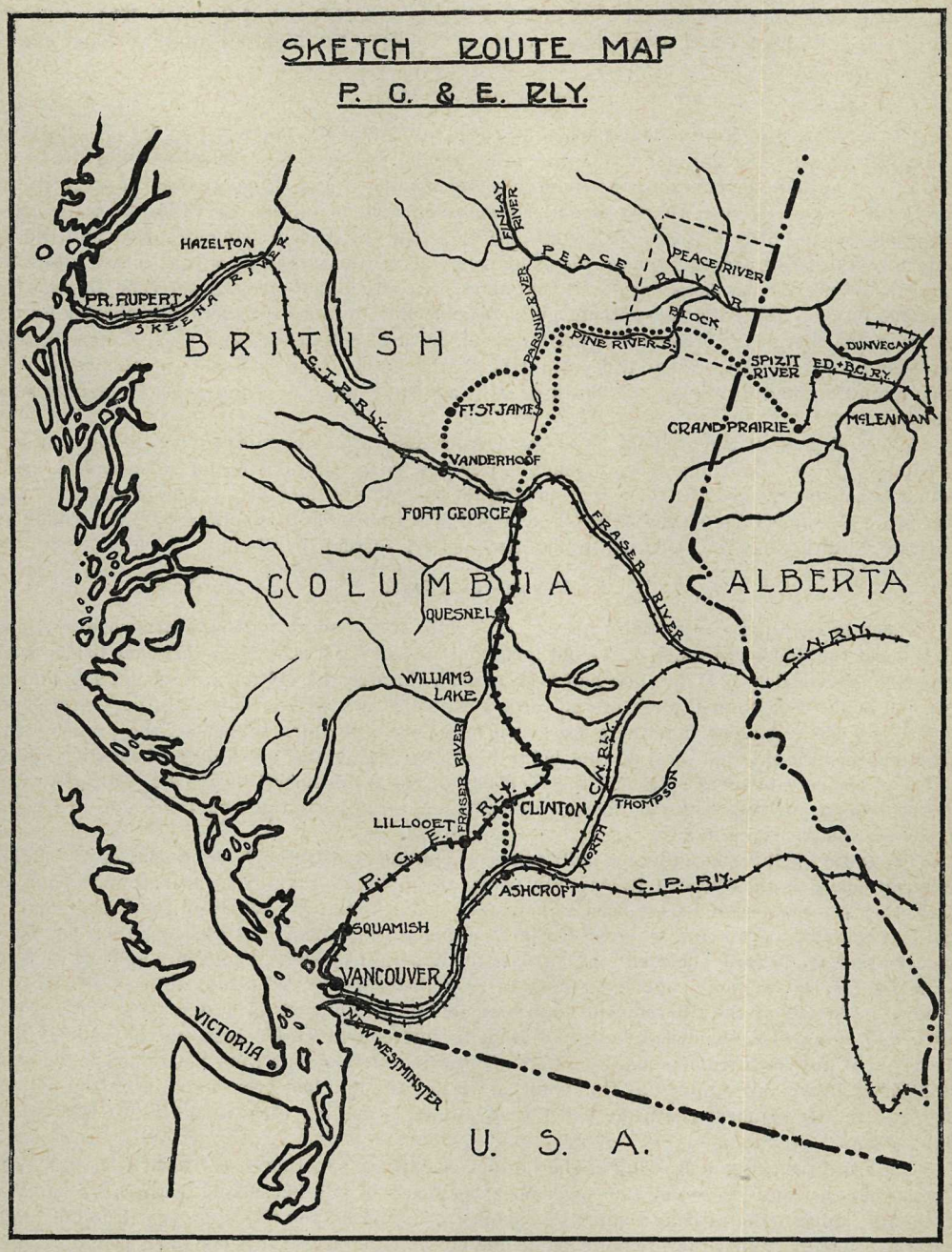
In crossing the divide the line follows the valley of the Birkenhead River a distance of 15 miles, rises a little over 900 feet on 2.1 per cent. maximum grade, then drops down the valley of Anderson Creek to Anderson Lake, a distance of 12 miles, using maximum grade of 2 per cent., dropping 730 feet. From D'Arcy to Lillooet, a distance of 35 miles, the grades are undulating; 1 per cent. maximum against traffic in both directions.

From Lillooet the line continues in a north-easterly direction, leaving the valley of the Fraser and going over the divide between the Fraser River drainage-basin and into that of the Thompson, reaching a maximum elevation of 3,865 feet above sea-level at Horse Lake, 85 miles from Lillooet. This point is on a high plateau between the headwaters of the Bonaparte River and Prize Creek, both tributaries of the Thompson River.

From Horse Lake Summit the line turns north-westerly to Williams Lake, a distance of 70 miles, entering the valley of the Fraser without crossing any apparent divide.

From Lillooet to Kelly Lake Summit, a distance of 33 miles, the line rises 2,750 feet, using a maximum 2.2 per cent. grade.

From Kelly Lake Summit to Horse Lake Summit, a distance of 52 miles, the grades are undulating; maximum of 1 per cent. against N.B. and 0.75 per cent. against S.B. traffic. From Horse Lake Summit to Williams Lake the maximum grade against S.B. traffic is 1 per cent.



From Williams Lake to Prince George, 150 miles, the line runs in a northerly direction, with a slight bearing to the west. It follows the valley of the Fraser River, but at an elevation above the water of the river varying from 200 feet to 700 feet until it reaches a point some 10 miles

south of Prince George. From this latter point to Prince George the line approaches nearer to high-water level. The one exception to this is at Quesnel, where the line is in the town at an elevation of a few feet above high water. The greatest distance between the line and the river is north of Quesnel, where the line was carried back some 10 to 15 miles to avoid bad country adjacent to the Fraser River and to obtain a favourable crossing of the Cottonwood River.

The grades between Williams Lake and Prince George are undulating, 1 per cent. against N.B. traffic, with the one exception of 10 miles of 2.2 per cent. N.B. out of Quesnel. The maximum S.B. grade is 0.75 per cent., with one exception of 5 miles of 0.85 per cent. south-bound out of Quesnel.

ALTERNATE ROUTES.

The first question one would ask when looking at a map of the Pacific Great Eastern Railway would be, Why did the line not follow the valley of the Fraser from Lillooet to Prince George? The answer is that the nature of the country between Lillooet and Prince George, through which the Fraser passes, is such that it is entirely impracticable to follow the valley at water-level as is done on the Lower Fraser and Thompson Rivers, the obstruction being cut-banks and sliding material; therefore, starting where they did from the south end, there was no other alternate route to follow. It has been suggested that there is a possibility of a 2.2 per cent. line up the Capilano Canyon and from this summit get a feasible line to Mons Summit, thus shortening the line very considerably. I doubt the feasibility of getting such a line, and as any investigation into this matter at the present time would be in the nature of a post-mortem and have little bearing on the present problem, I did not deem it advisable to go to any expense in making such investigation.

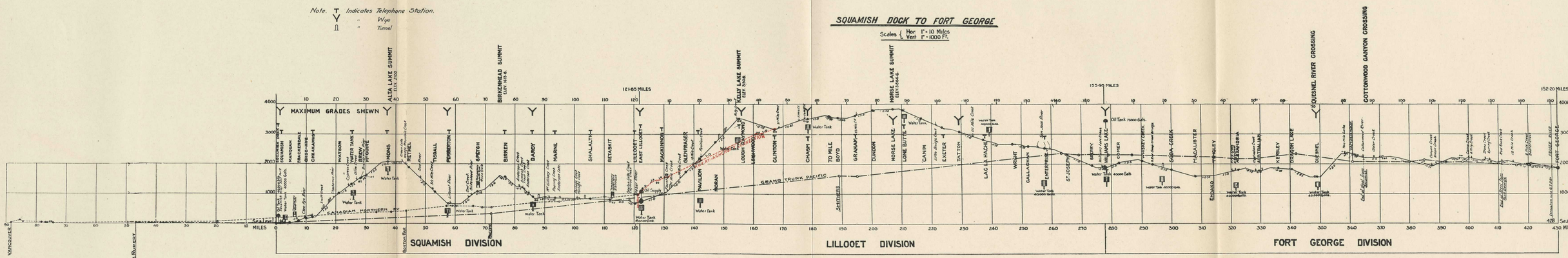
A second general route would be to go in from Ashcroft and connect with the present line at Clinton. This would have been a much better line to operate and would have made a great saving in construction costs. This route might not have suited the object of the promoters. The best route to connect the Grand Trunk Pacific with Vancouver is that followed by the Canadian National Railway. (*See* condensed profile attached for further details.)

DETAILS OF ROUTE.

There is very little to criticize about the details of the route with one or two exceptions. At Lillooet the line keeps south of the old town and crosses the Fraser by a very long bridge with expensive foundations. If the line had been carried through the old town, a very much shorter crossing could be obtained north of the town with solid rock foundations. My past experience would lead me to believe that there were two major factors which influenced the promoters in adopting the present line: First, this being a division-point, the possibility of making money out of a separate townsite; second, the tendency of the "old-timer" to place a fictitious value on his property and thus make the construction of a line through the town impracticable on account of the cost of the right-of-way.

The second point where there is a difference of opinion is at Quesnel, on account of the sliding material south of the Quesnel River. My personal opinion is that, from an economic point of view, the best route would have been to keep 3 or 4 miles farther back from the Fraser and go via Dragon Lake, cross the Quesnel River at a higher elevation, and avoid the 2.2 per cent. pusher grade north from Quesnel. As between the line built by the old company and the revision made by the Government engineers, there is very little, if any, economic difference, with the balance in favour of the Government engineers' line on account of the latter going through the town and being in a somewhat better position to interchange traffic between the railway and the river, if any such traffic should develop. The same factors that were mentioned in the case of Lillooet might have applied at this point, and after the line had been actually graded outside the town the Government engineers had the advantage in dealing with the matter of high-priced right-of-way.

The third point is the crossing of the Cottonwood River. In this case I have no hesitancy in saying that the route chosen by the Government engineers is in all economic features far superior to the line built by the railway company's engineers, and in making this statement I do not imply that the company engineers were not capable and efficient engineers; it is one of those unfortunate mistakes that we are all apt to make at times. It was probably caused by the reconnaissance engineer approaching the crossing from the wrong direction. More will be said about the latter cases under separate heads.


SQUAMISH DOCK TO FORT GEORGE
Scales { Hor. 1" = 10 Miles
Vert. 1" = 1000 Ft.
Note. T Indicates Telephone Station.
Y " Wye
" Tunnel
MAXIMUM GRADES SHEWN
ALTA LAKE SUMMIT
BIRKENHEAD SUMMIT
KELLY LAKE SUMMIT
HORSE LAKE SUMMIT
121·85 MILES
155·95 MILES
152·20 MILES
VANCOUVER
DR. RUMBERT
SQUAMISH
BRACKENDALE
BRIGHT
WATSON
RETREAT
TISDALL
PEMBERTON
BIRKEN
DANDY
MARNE
SHALALTH
REFASKIT
LILLOOET
EAST LILLOOET
MACKINNON
GLENFRASER
PAVILION
MOSAN
LOUGH
LEBARON
CLINTON
CHASM
70 MILE
BOYD
GRANAM
DUNDON
HORSE LAKE
LONE BUTTE
CANIM
EXETER
TATTON
LAC LA HACHE
WRIGHT
CALLAGHAN
ENTERPRISE
ST. JOSEPH
GERRY
GIPHER
SODA CREEK
McALISTER
KERSLEY
DOUGLAS LAKE
QUESNEL
COTTONWOOD CANYON CROSSING
FORT GEORGE
GRAND TRUNK PACIFIC
CANADIAN NORTHERN
Sea Level
MILES
SQUAMISH DIVISION
LILLOOET DIVISION
FORT GEORGE DIVISION

LOCATION.

The locating engineers of this line are to be complimented in their successful locating of a line to fit the contour of the country. I have never been over a line the length of the Pacific Great Eastern Railway where one could find so few points of detail in location to criticize. The curves of 2° and over are all spiralled and the line so located as to make excavation balance embankments, all of this tending to economic construction if it were not for the adverse physical features of the country.

B.—PHYSICAL FEATURES.

I have never before seen such a large area of country where the physical features were so adverse to the economic construction of a railway. First, the amount of clay, sand, gravel, gumbo, and other such material compared with the amount of solid rock is very much larger than would be expected in the mountains. Second, the unstable condition of all material (other than solid rock) when wet is the cause of forcing the line from the valleys of the Fraser to higher ground, thus preventing the line being built on a reasonably low rate of grade. In climbing out and dropping into the valleys, the line encounters either sheer rock bluffs with ragged contour, necessitating comparatively heavy tunnelling and heavy rock-cuttings, or encounters this unstable material which increases cost of construction and makes the cost of maintenance almost prohibitive.

I am sure that your present maintenance charges on the first 8 miles south of Quesnel are more than the total earnings of Quesnel Station, and that this condition will continue every year for three or four months each spring. All of these combined adverse conditions makes it impossible to construct an economic line. If it were not for these adverse conditions, combined with the adverse financial conditions during time of construction, there is no doubt but that the Pacific Great Eastern Railway would have compared most favourably with other lines in the matter of economic construction.

We were of the opinion that the Panama gave an unusual amount of trouble, but I believe that if the percentage of solid rock to other material in the Panama was as small as it is on the Pacific Great Eastern Railway, and if this other material on the Isthmus was as unstable as the material on the Pacific Great Eastern, then the canal would never have been completed.

C.—AMOUNT CONSTRUCTED AND GENERAL TYPE OF CONSTRUCTION.

The line is constructed and in operation from North Vancouver to Whytecliff, a distance of 12.7 miles. From Whytecliff to Squamish, a distance of about 29 miles, no construction has been undertaken. This portion of the line follows a very rugged shore of rock bluffs, and the construction of this portion of the line is estimated to cost from $3,500,000 to $4,000,000.

From Squamish to Quesnel, a distance of 350 miles, the line is constructed and in operation. From Quesnel to Prince George the grading is completed with the exception of cleaning out slides that have occurred since the line was graded some six years ago. The track is laid from Quesnel to Cottonwood River, a distance of 17½ miles, and also from junction of Pacific Great Eastern Railway with Grand Trunk Pacific Railway (about 1 mile east of Prince George) to Red Rock Creek, 18 miles south of Prince George, leaving a gap of 45 miles with no steel. The steel track fastenings and ties for this work are on the ground. Cottonwood River is to be crossed by a steel viaduct, requiring about 2,450,000 lb. of steel. Of this amount, 2,262,565 lb. has been fabricated and is now at Walkerville, Ontario. The cost of this steel and fabrication has been paid for. There yet requires to be ordered about 190,000 lb. The cost of this amount, with freight charges on the total, will have to be met if the line is completed. None of the concrete foundations for this viaduct have been started. In addition to this, there is some 8,000,000 feet B.M. of trestles to be put in. Nearly all this timber is on the ground and paid for excepting the stringer, about 840,000 feet B.M. To complete this gap and put the line in condition to be operated is estimated to cost from $500,000 to $600,000. If this additional line is put in operation it is estimated that extra equipment to the value of $1,500,000 will be required; that is, to put the line from Quesnel to Prince George into operation will require over $2,000,000 new capital. To complete both gaps between North Vancouver and Prince George would require about $6,000,000 new capital.

TYPE OF CONSTRUCTION.

The line is built in accordance with good branch-line standards; 70-lb. steel on grades of 2 and 2.2 per cent., with 60-lb. steel at other places, all very liberally supplied with a good type of tie-plates on curves. The bridges and culverts are of wood, which is a standard on new construction in a timber country. In my practice I have not found it economical to use wooden spans. On this road there has been constructed twenty-seven wooden spans varying in length from 60 to 150 feet, a total length of 3,180 feet. It is possible that, on account of the difficulty in getting or on account of the very high price of steel during the time of the construction of this line, the engineers were justified in the use of wood for this purpose. In addition to the 3,180 lineal feet of truss spans and the wooden foundations for same, there is already in place 27,000,000 feet B.M. of wooden trestles and culverts, with about 8,000,000 feet B.M. more to go in to complete the Quesnel to Prince George gap.

I estimate that to renew these wooden structures with permanent work, such as steel viaducts and trusses, concrete culverts and fills, and concrete foundations for the spans and viaducts, it will cost over $8,000,000. Some of your engineers are of the opinion that this estimate is too low, which I know is a fact if the work had to be done at present prices, but we are all hoping for lower prices in railway-construction. However, under the most favourable conditions the Government must be prepared to supply at least $8,000,000 new capital for these renewals within the next ten years. The alternative is to renew in wood at an enormous maintenance cost and one will about balance the other; that is, the extra cost of maintenance will balance the interest charges for more permanent construction.

There is one criticism to make on the track-laying, and it appears to be worse on that portion laid by the Government engineers. I refer to the expansion. Steel rails usually fail first by battered ends, and nothing tends more to hasten the battering of the ends of the rails than to have them laid with too much expansion.

D.—FINANCIAL CONDITIONS.

The total par value of the outstanding financial debt is $44,226,403.12. Of this amount, $5,925,195 is held by the company. This had been pledged to the Canadian Bank of Commerce by the former management as security for a loan of $4,800,000. The Government loaned the company $5,280,914.15 to repay the bank loan with interest. This leaves outstanding $38,301,208.12 as at December 31st, 1921, for which the company is liable. The interest charges for the year ending December 31st, 1921, amounted to $1,911,913.14. The total investment in road and equipment at December 31st, 1921, was $38,438,590.23. This is the net sum on the company's books after the sum of $5,618,248.41 has been credited. This amount was made up of various items as set out in the agreement of February 22nd, 1918, whereby Foley, Welch & Stewart agreed to waive all claims against the Province of British Columbia and the Pacific Great Eastern Railway, also subsidiary companies. On the other hand, the Government took over the railway and subsidiary companies, relieving the contractors of liability account of same companies on the payment of $750,000 in cash, turning over to the Pacific Great Eastern Railway Company the assets of the Pacific Great Eastern Development Company and those of the Pacific Great Eastern Equipment Company. Those assets consisted of lands, townsites, docks and wharves, locomotives, cars, and stores of all kinds. In addition to the above, the contractors waived claim to $245,000 unpaid estimates and $1,647,563.02 of retained percentages on progress estimates, the whole totalling $5,618,249.41, which has been credited to the various accounts as follows:—

Land for transportation purposes	$ 890,473 00
Grading	3,559,787 01
Tunnels and subways	91,276 59
Bridges, trestles, and culverts	821,489 30
Track-laying and surfacing	91,276 59
Interest	163,945 92
	$5,618,249 41

Of this $38,438,590.23 investment, $10,543,530.79 has been expended in paying interest charges during construction and deficit in operating revenue during construction.

E.—EQUIPMENT, REVENUE, AND TRAFFIC EXPENSES.

The rolling-stock consists of twelve locomotives very well assorted for this class of road. The heaviest are about up to the limit that the standard of construction will admit.

There are two gas-electric cars and two gas-motor cars operating out of North Vancouver. There are twelve passenger, one combination, and two baggage cars in passenger service. In freight service there are 258 cars of various types. There are sixty-eight cars in company service; the majority of these cars are for construction purposes. The management claims that the present equipment is sufficient for operation as far as Quesnel, but that if they put the line under operation between Quesnel and Fort George they would require at least to spend $1,500,000 in new equipment. My opinion is that, if new business sufficient to justify the completion of the line to Fort George would develop, this estimate is too low.

Revenue and Expenses.

During the year 1921 the Pacific Great Eastern Railway carried 15,290 passengers for a total of 1,462,871 passenger-miles; total receipts from this business, $63,889.87, or at the rate of $0.043 per passenger-mile. Passenger earnings per mile of road operated, $323.86. During the same year they handled 53,351 tons of freight for a total 4,634,231 ton-miles at a rate of $0.057 per ton-mile. Revenue per mile of road operated, $844.70.

Average number of ton-feet per loaded-car mile	16.98
Average number of ton-feet per train-mile	89.26
Total operating revenue per mile of road	$1,076,458 00
Total operating expense per mile of road	2,239,033 00
Operating deficit per mile of road	1,162,575 00
Total gross income from all sources	484,326 88
Total gross corporate expenses	2,689,205 14
Net corporate loss	$2,204,878 26

This was charged:—

To interest during construction	$1,911,913 14
To operating loss during construction	292,965 12

On account of there being earned from rent of equipment in construction during the year, $88,632. For the purpose of studying future prospects I have based my studies on the actual loss shown in operating account; $368,542.02 as the actual loss or deficit in operating for the year.

F.—REVENUE NECESSARY TO PAY FIXED CHARGES AND OPERATING EXPENSES.

If the road is completed from North Vancouver to Prince George it will require to complete and equip an additional $6,000,000 of new capital, and within the next ten years, to replace wooden structures, another $8,000,000. Adding this to the present investment of $38,438,950 will give a total final investment of $52,438,950.23 for 470 miles of railway, or nearly $112,000 per mile of road.

The interest charges will be	$1,911,913 14
Plus 5 per cent. on $14,000,000	700,000 00
	$2,611,913 14

Or over $5,500 per mile of road.

If only the Quesnel–Prince George gap be completed, then the new capital would only be $10,000,000, making a total of $48,438,950.23 for approximately 440 miles of road, or $110,000 per mile of road. The interest charges would be:—

Present interest charges	$1,911,913 14
Plus 5 per cent. on $10,000,000	500,000 00
	$2,411,913 14

Or nearly $5,500 per mile of road.

If no more construction be done and the line from Quesnel to Prince George be abandoned, there should be at least $250,000 of salvage, and to replace the wooden structure south of Quesnel should not require over $6,500,000.

In this case the total investment would be	$38,438,950 00
Plus new capital for renewals, less salvage	6,250,000 00
	$44,688,950 00

There would be 360 miles of road on an investment of $124,000 per mile of road.

The interest charges would be	$1,911,913 14
Plus 5 per cent. on $6,250,000	312,500 00
	$2,224,413 14

That is over $6,100 per mile of road. Therefore it is self-evident that, regardless of what action the company may decide to take, they are faced with an ultimate interest charge of about $5,500 per mile of road. Some one, either the taxpayers of British Columbia or the patrons of the road, must pay, in addition to the cost of operating the road, a charge of $5,500 a mile in interest for the use of the plant. To emphasize this feature I wish to compare this figure with what the patrons of the Canadian Pacific Railway have to pay per mile of road for the use of this plant. In the year 1921 the Canadian Pacific Railway paid out of railway revenue, fixed charges, dividends on preferred stock, and dividends on common stock, $32,946,448.81, or at the rate of $2,450.64 per mile of road operated, a figure considerably less than half of what the fixed charges will be on the Pacific Great Eastern Railway. If you add to the above amount 3 per cent. on common stock, paid from profits from subsidiary companies and outside operation, the total amount paid out will be $40,746,448.81, or at the rate of $3,030.83 per mile of road operated. To make $5,500 a mile above operating expenses, the road would have to take in $22,000 per mile and operate at a ratio of 75 per cent. The Canadian Pacific Railway operating ratio last year was 82.28 per cent. If the Pacific Great Eastern Railway could not do any better it would require a revenue of over $31,000 per mile of road.

G.—RATES AND TON-MILES A NECESSITY IN THE PRODUCTION OF REVENUE.

A railway operating through a country similar to that through which the Pacific Great Eastern runs, with a very small ratio of population to mileage and no hopes of any through passenger business, is more than fortunate if they can make their passenger business pay the cost of same, and freight traffic is the only other source of revenue from which a profit can be expected. This profit, if the concern is to be a success, must at least be sufficient to pay interest on investment (fixed charges). There are two all-important factors in the production of freight revenue: First, ton-miles of traffic; second, and just as important, is the rate per ton-mile. Management is a factor, but without ton-miles and a reasonable rate per ton-mile the best management in the world cannot make a success of a road similar to the Pacific Great Eastern Railway.

Freight rates is the subject of more contention than any other business matter, and I realize that I will be criticized for discussing same, but it is of so much importance to the very existence of the Pacific Great Eastern Railway that it would be a neglect of duty not to discuss this matter, for the reason that it must be apparent to everybody that the freight rates on the Pacific Great Eastern Railway will have to be increased to enable the road to pay operating expenses, to say nothing of paying fixed charges, and, as I have indicated before, the Government is fully justified in increasing the rates to within a reasonable margin of the rates charged by their competitors.

The deficit of $368,542.02 in your operating account of 1921 is caused almost entirely by too low a freight rate. You may not agree with the above statement, but let us analyse the same. All shippers and business-men will argue to the contrary. They will tell you that your average rate of 5.7 cents per ton-mile is ridiculously high and that it should be about 1.25 cents, something near the average for the entire continent. They will tell you that there are about 1,000 miles of privately owned and operated logging-roads in British Columbia, and if a private company can build and operate a railway, why cannot the Government do so? The answer is that the private road is built and operated on sound business principles. The owner of timber lands will estimate how much timber he has to cut, how long it will take him to cut the timber, and how much it will cost to build and operate the road. He will then divide the sum by the

number of thousand feet of timber he has to haul out. The result, be it at a rate of 2 cents or $1 per ton-mile, he will add to his cost of production, and if there is still a chance to sell the product at a profit the road will be built; that is, the traffic must bear the expense of operating plus the cost of construction. If the operation was to be continuous, then the traffic would have to bear the cost of operation plus the interest on the capital invested. If he finds that the traffic will not bear the expense the road is not built. Is there any business-man who will argue that the cost per ton-mile is the same on all or any two of these various roads that go to make up 1,000 miles mentioned above? Is there any logical argument that can be put forward to prove that because the New York Central Railway can operate at a profit at 1 cent per ton-mile, a four-track road between Buffalo and New York with over 100 trains per day, with light rates of grade, with capital charges per mile for construction not much, if any, greater than that of the Pacific Great Eastern Railway, that the rates on the Pacific Great Eastern Railway, with heavy grades and light traffic, should not exceed 1 cent per ton-mile?

What were the conditions before the Railway was constructed? The rate, I am informed, from Ashcroft to Barkerville was 11 cents per pound. This, I compute, amounted to about 80 cents per ton-mile. This was over a highway built by the Government on which the freighters paid no toll or any item to defray interest charges and at a time when the dollar was worth much more than it is to-day. The freighters, during the construction of the road, hauling construction materials, oats and other farm products, using modern motors on roads constructed and maintained without any cost to them, charged from 75 cents to $1.25 per ton-mile. Now when the road is in operation they complain because they have to pay a rate of 1.2 cents and for short haul or less than car-load lots up to 10 cents or more per ton-mile. I fully realize the difficulty in making satisfactory rates or equitable rates. There are certain commodities that cannot move if they had to bear a rate to pay the cost of operation plus interest. These commodities, I know, will have to be moved at low rates. Providing the rate is not actually below operating cost, no railway management, either private or public, is justified in carrying any class of freight at less than cost, thereby imposing an unjust burden on the other patrons of the road or upon the taxpayers, as the case may be. Another factor is competition that you must meet, providing the traffic can be carried at a rate not less than the cost of operation. Let us put the question in this light: Would any sane business-man build a factory where the construction costs, on account of adverse conditions, were from three to five times what they would be in more favourable locations, where the operating costs would be from 50 to 100 per cent. greater than in more favourable conditions, and where the production would be limited to one-tenth or one-twentieth of the capacity of the plant, if under all these adverse conditions he would be compelled to sell his products at the same price as his competitors who were working under the most favourable conditions? On the other hand, if the expediency demanded the construction of the plant under these adverse conditions, what would he think of those who would argue that the products of this plant be sold to local patrons at the same price local patrons of the more favourably located plant would pay?

When the price charged for motor-haul running on a Government-constructed highway is from 50 to 100 times the rates charged by a railway with an operating ratio of 191.6 per cent. and the deficit made up by the taxpayers, there is created an injustice that should not be tolerated.

If the Eskimos are discussing the railway question, they cannot blame their small amount of trade on railway rates, as they have no railway. Their adverse condition which restricts their trade is location. Now, if railway connections were made with all parts of their country and the possible trade of that country was required to bear the cost of operation and interest on investment, trade would not be increased because the traffic could not bear the expense. We might then, however, hear the Eskimo join in the popular cry that they were victims of unjust freight rates. There is one objection to raising freight and passenger rates on the Pacific Great Eastern Railway—namely, that those who are opposed to Government ownership and operation of railways will use the fact as an argument to further their ideas, but such an argument will not be a logical one or a just one. It has nothing whatever to do with Government ownership or Government operation. It is a business matter, pure and simple. A road is constructed over mountains involving very heavy construction charges, very heavy rates of grade involving heavy operating expense, and the traffic is very limited. For argument's sake, we will assume that the traffic is sufficient to pay interest on fixed charges plus operating expenses at rates of 50 per cent. of these charged by the railway's competitors (freighters). Is it not an economical proposition to build the road and reduce transportation charges by 50 per cent.? Have the people of that

district any right to say that they should not pay more than 2 or 3 per cent. of what they previously had to pay and that the balance should be paid by the taxpayers? They are not suffering from unreasonable freight rates, but rather from unfavourable location, exactly as is the case of the Eskimo. I am not criticizing the rates of grade on the Pacific Great Eastern Railway as the most economical rates for the country were used. Nothing can be gained on long hills by sacrificing distance and curvature to reduce the rate of grade.

H.—ABILITY OF ADJACENT COUNTRY TO PRODUCE REQUIRED REVENUE.

The Canadian National Railways have a much shorter and much cheaper line to operate to Vancouver than via the Pacific Great Eastern Railway connection. No business of any moment can be expected from that source; therefore the Pacific Great Eastern Railway must depend almost entirely on business developed along its own line.

The gross corporate expense per year if the line was completed to Prince George from Squamish only would be $3,000,000 annually. If passenger service could be doubled it would amount to less than $200,000, leaving $2,800,000 to be collected from freight revenue. To meet this demand:—

At 5 cents per ton-mile would require	56,000,000	ton-miles.
„ 10 „ „ „	28,000,000	„
„ 15 „ „ „	18,333,333	„
„ 20 „ „ „	14,000,000	„

This without any allowance for extra cost of doing the extra business that would produce this ton-mileage. The total ton-mileage for the year 1921 was 4,634,231 ton-miles, less than one-third of the amount required at the high rate of 20 cents per ton-mile. The number of tons of revenue freight handled in the year 1921 was 53,351. With the amount shipped out of Vancouver slightly in excess of the amount received, the amount shipped out of Vancouver was less than 20,000 tons. If we assume that as population increased this amount might reach 80,000 or 100,000 tons.

To ascertain approximately how much the line would have to develop, let us assume that all freight is hauled one-half the total length of line, and that the road can be operated at an operating ratio of 67 per cent., and that the receipt will be 5 cents per ton-mile, then there will be required to pay the fixed charges of $5,500 per mile, 917,000 ton-miles at 1⅔ cents profit for every ton-mile for each mile of track over 400,000,000 ton-miles for 440 miles of road. It may be asked why 400,000,000 ton-miles is compared with 56,000,000 ton-miles mentioned above. The former comparison is made to show what high rates would have to be charged to simply pay fixed charges and was based on the absurd assumption that from three up to ten times the present business could be handled without increasing the operating expenses. In this study we contemplate getting a high rate for freight and for that reason have assumed a very low operating ratio of 67 per cent., much better than has been realized in years on any road of 400 miles or more. To complete the study, say 100,000 tons of outgoing freight at 220 miles equals 22,000,000 ton-miles, leaving a balance of 378,000,000 ton-miles to be produced from business from the line, or dividing 378,000,000 ton-miles by half length of line, 220 miles gives 1,700,000 tons of freight to be developed on the line; about 4,000 tons per mile of track per year. It may be argued that my estimate of freight shipped in is too low. Let us assume that the inward freight would amount to one-third of the total, or 140,000,000 ton-miles, leaving 250,000,000 ton-miles for outward freight. This would mean the handling of at least 1,200,000 tons, or a production of nearly 3,000 tons per mile of track per year. During the year 1921 the outward freight from the line amounted to 36,505 tons. Average number of miles in operation was 292, or 125 tons per mile. It requires some optimism to believe that the business of this line can increase between 2,400 and 3,200 per cent. If you could double the rate to, say, 10 cents per ton-mile and operate the road at three times the expenses of 1921, then it would require to pay expenses seven and one-half times the business done in 1921, or an increase of 750 per cent. There would be a possibility of obtaining this result were it not for three prominent adverse conditions: First, very limited area capable of producing any traffic; second, while the valleys are most fertile when irrigated, very little can be produced on the majority of the land adjacent to the line without irrigation; third, the water available for cheap irrigation is very limited, and on account of the unstable nature of the ground, other than solid rock, it is very doubtful if any large irrigation scheme could be made an economical success.

For the above reasons no large agricultural development can be expected in the country adjacent to the Pacific Great Eastern Railway.

For the same reasons, on account of the long winter and the difficulty in procuring winter feed, and while there are some fine, large cattle-ranges in Upper Lillooet and in the Cariboo, no further development of any account can be expected in the stock-raising industry.

The timber industry is limited to the first 60 to 70 miles, and with the exception of the first 20 miles the timber areas are quite patchy. There might develop some business in pulp-wood timber, but on account of the necessary heavy freight charges and heavy operating expense on account of the heavy grades this development is in the far future.

The mining industry does not offer much, no matter to what extent the gold-mines may develop. Free-gold mining, be it placer or quartz, does not produce tonnage for a railway like that produced by the mining of coal, iron, or copper ores, etc.

There is only one conclusion that can be reached—namely, that as a local line between Vancouver or Squamish and Prince George the country will not produce enough traffic at any reasonable rate to pay operating expenses plus fixed charges. Regarding further extension of line, this matter will be discussed under another heading.

I.—WAS THE GOVERNMENT JUSTIFIED IN MAKING THE REVISION OF LINE AT CROSSING OF THE COTTONWOOD RIVER?

Six trains per day loaded for a 0.75 per cent. grade is the minimum number that would justify the building of the Pacific Great Eastern Railway at rates that the promoters would expect to obtain. I have therefore assumed that the promoters expected at least that much business and on that assumption. The annual saving in operating over the line adopted by the Government I calculate to be $31,777. The economic features in favour of the Government engineers' line was a saving of 5 miles in distance, a saving of 1,103° of curvature, and a saving of 137 feet in rise against traffic in both directions.

Another favourable feature was the capitalized value of maintaining 5 miles of track, the value of 5 miles of track material, track-laying, ballasting, fencing, and telephone-line. But the largest item was a saving of over $400,000 in favour of the Government line in the difference in the cost of the materials and the cost of erecting the river crossing. The total saving would justify an extra expenditure on the line constructed of $1,456,175, which fully justified the revision of the line. Your engineers may have submitted more favourable figures on account of their assuming the traffic at ten or more trains per day. (For further details *see* Appendix No. 1.)

J.—WAS THE GOVERNMENT JUSTIFIED IN MAKING REVISION OF LINE AT CROSSING OF QUESNEL RIVER?

The same remarks about the amount of traffic required to justify the building of the railway applies to this case as to the Cottonwood River.

In this case the economic operating features in favour of the revised line was a shortening of the distance by 1 mile and a saving in curvature of 318°, and against the revision was an additional 67 feet of rise against traffic in both directions. A slight saving in operating the revised line, capitalized and added to a considerable saving in the cost of the crossing of the Quesnel River, would justify an extra expenditure in grading the new line of $439,215, as against an expenditure by the Government of $861,028.82, indicating that from an economic point this revision was not justified. To justify this charge it would have to be assumed that an extra annual revenue of $21,090 would be received from Quesnel Station without any extra operating expense. I do not believe that the moving of the station into the town will make anything like that much of an increase in a revenue from that point.

The statement has been made that it would be more difficult to maintain the original line than the revised line. I could not see any reason for this conclusion; both lines are in very bad sliding and unstable ground for a considerable distance.

Another statement I have heard is to the effect that the Government engineers used a steeper rate of grade than was used on the original line. This is not the fact; the rates of grade are exactly the same on both lines. It is unfortunate that the Government did not adopt a rate of 3 or 4 per cent. south of the town, and thus save a large portion of the expenditure made, and leave the building of the 0.85-per-cent. grade until the traffic would justify the construction of the lower-grade line. (For further details *see* Appendix No. 2.)

K.—SHOULD PORTION OF LINE SOUTH OF CLINTON BE ABANDONED AND LINE BUILT FROM CLINTON TO CONNECT WITH C.N.R. OR C.P.R. AT ASHCROFT?

The reasons in favour of this change is the non-productive nature of the country for a distance of over 100 miles south of Clinton on the present line. The total receipt from freight, both forwarded and received, on this section during the year 1921 (after the line has been in operation for a number of years) did not exceed $400 per mile.

The cost of operation on account of heavy grades. (*See* condensed profile attached.)

The fact that there are over 8,000,000 feet B.M. of trestle timber on this section that will have to be renewed within a few years, also about 1,000,000 feet B.M. truss spans, besides the timber foundations at the crossing of the Fraser River at Lillooet.

There are three principal objections to the change: First, the cost of constructing 46 miles of new line; second, the necessity of making a division of revenues with another line; third, making another break in the railway, which increases the cost of operation.

The cost of the proposed line will not be less than $3,500,000, which will increase fixed charges by at least $175,000 per year. In addition to this, it is planned to use some 4,000,000 feet B.M. in wooden trestles on this line, which partially offsets one of the advantages in abandoning the old line.

There have been no negotiations as to making connections or division of revenue with the connecting road at Ashcroft, but it is doubtful if the Pacific Great Eastern Railway could get much better division than 2 in 1 on a mileage basis. As practically all the business handled by the connecting roads would be between Vancouver and Ashcroft, a distance of 209 miles, while, on the other hand, the average haul on the Pacific Great Eastern Railway on local business could not be assumed at more than half the length of the road, this means an average division of revenue on the basis of 3 to 2 in favour of the Pacific Great Eastern Railway. This assumption is based on ordinary rates. If the Pacific Great Eastern Railway should establish higher local rates they would be able to get a much better division, but in any case I do not believe they would succeed in retaining more than two-thirds or three-quarters of their revenue. To sum up, the company can do twice the business they are now doing without any real increase in expenses (practically all trains are running light). If this increase should take place the freight business to and from Vancouver to points north of Clinton might amount to $360,000 per year. A third of this, $120,000, or a quarter, $90,000, added to the fixed charges of $175,000 would equal loss of at least $265,000 per year, to be offset by a saving in train operation of 208 trains per year for a distance of 100 miles, less 46 miles of new line, or $208 \times 54 = 11,232$ train-miles.

The operating expenses per train-mile in 1921 was $8.67. Multiplying this figure by 11,232 train-miles gives a saving in this item of $97,381.64. It may be argued that the train-mile saving would be greater than this on account of running less than two trains per week on south end. This is doubtful, and in addition there will be considerable loss on account of operating the separate line out of Squamish and maintaining two shops, or either transferring equipment for repair over 250 miles from Ashcroft to Squamish over foreign lines. The saving on maintenance of 8,000,000 feet B.M. wooden trestles over that of 4,000,000 feet B.M. on the new line cannot amount to over $25,000 per year. Therefore, at more than double the present business the company would face an annual increase in deficit of over $120,000 by constructing this new line after crediting the cost with the salvage from the abandoned line.

While there is no doubt that the proposed line is far superior to the line constructed to handle business to Clinton and points north, the present development of the country will not warrant the construction of this line.

Do not spend money and increase your liability until the saving will more than pay interest on the investment; this is a very good rule to follow. I may be mistaken in the future possibilities of this country and there may come a time when this line would be justified.

If it is decided that, regardless of cost, the line from Clinton to Quesnel must be operated with a service as good as the present, must be maintained during the winter and summer, I would recommend that the entire line south of Clinton be abandoned, providing the timber interest at the south end could raise enough money to purchase any portion of the south end out of Squamish at a cost of from $15,000 to $20,000 per mile. If this portion of the line will not pay interest on that sum it should be abandoned. If such an arrangement could be made there would be some justification in spending money at once on the construction of the Ashcroft–Clinton line.

The salvage should amount to:—

66 miles at $20,000	$1,320,000 00
Salvage on balance, 100 miles, say	500,000 00
	$1,820,000 00

Or about half the cost of the Clinton cut-off.

The saving in operating expenses and the saving in renewals on the abandoned line would show a substantial saving over the interest on half the cost of the Clinton–Ashcroft Line.

L.—SHOULD THE LINE BE EXTENDED FROM PRINCE GEORGE TO PEACE RIVER COUNTRY; AND, IF SO, BY WHAT ROUTE?

The surveyed line extends north from Prince George, reaching the eastern boundary of the Province via Parsnip River and Pine River Pass in a distance of about 318 miles; to reach present railway connections in Grande Prairie country would require extension of 63 miles. Grande Prairie is south of the Peace River and with Spirit River country, which is also south of Peace River, contains about one-half of the developed area which is generally known as the Peace River country. The Peace River District proper is north of Peace River, and products from this district to reach the proposed extension of the Pacific Great Eastern Railway at the eastern boundary of the Province would require a rail-haul of nearly 300 miles, via Peace River Crossing, McLennan, and Grande Prairie, on the Edmonton & Dunvegan Railway. The alternative of this long haul is for a second line to be constructed west from the end of the Peace River extension of the Edmonton & Dunvegan Railway, west of Peace River Crossing to a point where a feasible crossing of the Peace River could be obtained. This involves the construction of 100 or more miles of extra new line. There is no feasible crossing of the Peace River north of Spirit River or for a long distance west.

The second route mentioned was to leave the Grand Trunk Pacific Railway at Vanderhoof, some miles west of Prince George, and go north via east end of Stewart Lake and finally reach the eastern boundary of the Province on the surveyed route. The advantage claimed for this route is that it traverses a much better country than that through which the survey was made. I did not have data sufficient to warrant an opinion as to which of the two would be the more desirable. I did not deem it advisable to spend time in collecting data or making a trip over these routes, as the traffic offered at present in the Peace River country will not justify construction of a line on either route.

The present freight rate on export grains from Grande Prairie to Vancouver by the longer routes is less than 1 cent per ton-mile, and these rates are very apt to be lowered, so that to get any business the Pacific Great Eastern Railway could not expect to get a revenue of over 1 cent per ton-mile, and making the favourable assumption that they could handle this business at an operating ratio of 75 per cent. that would give them ¼ cent per ton-mile profit. From Vancouver to Grande Prairie via Pacific Great Eastern would be about 850 miles. Two million bushels of grain per year is more than this country (Grande Prairie and Spirit River country) will produce annually as at present developed. If this were all wheat it would only amount to 60,000 tons; 60,000 tons × 850 miles × .0025 = $127,500, or a sum much less than one-tenth of the interest charges on the probable cost of the line from Grande Prairie to Prince George.

A second and more conclusive reason why it was unnecessary to study routes to Peace River country is that after making a very exhaustive study of routes from Prince George to Prince Rupert, to Squamish and to Vancouver, via Ashcroft, shows conclusively that if there is traffic enough offered in the Peace River country to warrant the construction of a line from the Grand Trunk Pacific Railway, either from Prince George or Vanderhoof to the Peace River District, such traffic will not reach tide-water either at Vancouver or Squamish, but at Prince Rupert. The reason for this is that taking the operating expense of hauling traffic from Prince George to Prince Rupert, a distance of 467 miles, at 100 per cent., then the operating expense for the same traffic over the Pacific Great Eastern Railway and Canadian National Railways via Ashcroft to Vancouver, a distance of 517 miles, would be 132 per cent.; to haul the same traffic over the Pacific Great Eastern Railway to Squamish, a distance of 429 miles, the expense would be 137 per cent. If the junction with the Grand Trunk Pacific Railway was made at Vanderhoof, taking the expense from Vanderhoof to Prince Rupert, a distance of 398 miles, at 100 per cent., then the expense over the other routes added to the expense of the portion between Vanderhoof

and Prince George over the Grand Trunk Pacific Railway would be respectively 164.9 per cent. to Vancouver and 171.5 per cent. to Squamish. It may be argued that if the Pacific Great Eastern Railway build the line to the Peace River country they would have control of the routing of traffic, but such is not a logical conclusion, for the reason that if there is business sufficient to warrant the Pacific Great Eastern Railway in constructing this line, then the same business would warrant the Canadian National building an independent line to get this business, if the Pacific Great Eastern Railway would not turn it over to them at the junction with the Grand Trunk Pacific Railway, because if it reached them at either Prince George or Vanderhoof they could make an enormous profit in hauling it to Prince Rupert at rates that would just cover the cost of operation over the other routes. Such duplication of lines would of course bankrupt the Pacific Great Eastern Railway proposition. As examples to further explain this matter, if the Grand Trunk Pacific Railway would operate between Prince George at the low ratio of 67 per cent., then for every dollar they spent they would have 33 cents profit with which to pay interest or dividends. To take this traffic to Vancouver via Ashcroft would cost $0.67 × 132% = $0.884, leaving $0.116 for interest charges. To take this traffic to Squamish would cost $0.67 × 137% = $0.918, leaving $0.082 for interest charges. This is on the basis of assuming a very low operating ratio for the Grand Trunk Pacific Railway. You can see that if a higher ratio was assumed, say 75 per cent., which is low for a road handling grain traffic, which usually carries a very low rate, then when the Grand Trunk Pacific Railway would spend $1 they would have a profit of $0.25, but the other two lines would have to spend respectively $0.99 and $1.028 to earn a dollar. It naturally follows that if the junction is made at Vanderhoof there is no possible hope of the traffic going via the southern routes. There is a further objection to the Squamish route—namely, that I have assumed that if this traffic develops to an amount that would warrant the construction of the line, the Government would build elevators at Squamish; this, I presume, would be more strenuously opposed by Vancouver business interests than the construction of elevators at Prince Rupert. Another feature adverse to the southern routes that has not been mentioned nor taken into account in the calculations is that, in calculating operating expenses, light loading, east and north bound, was assumed on the Grand Trunk Pacific Railway as well as on the Pacific Great Eastern Railway, but this would not work out that way in practice. If the grain business developed at Prince Rupert the Canadian National Railway could expect some east-bound traffic to develop, but the Pacific Great Eastern Railway can never expect to get any amount of east-bound through business out of either Vancouver or Squamish. (For more detailed information and figures *see* Appendix No. 3.)

M.—SHOULD THE LINE FROM QUESNEL TO PRINCE GEORGE BE COMPLETED AND PUT IN OPERATION?

It is estimated that to complete this line and acquire sufficient rolling-stock to meet the operating requirements will cost $2,000,000. There are about 45 miles of track to lay, some 70 miles will have to be ballasted, and about 8,000,000 feet B.M. of timber trestles to be erected. Most of this timber is on the ground, the exception being some 840,000 feet B.M. in stringers. The Cottonwood Viaduct remains to be erected with the foundations; the steel is nearly all purchased and fabricated at Walkerville, Ontario. The material for the floor system is not as yet purchased. Both the operating and fixed charges will be increased, and the question to be decided is, will the added revenue meet the additional fixed charges, amounting to at least $100,000 per year, and the additional operating charges? Taken on the basis of the company's experience in 1921, on the balance of the road the additional operating charges would not be less than $200,000, thus increasing the expenses by $300,000, without taking into account any additional charges, if the Pacific Great Eastern Railway should operate over the Fraser River Bridge on the Grand Trunk Pacific into Prince George, for interest on the cost of this bridge, or any additional operating expense for wheelage and terminal expense. The territory between Quesnel and Prince George is not developed to produce any traffic of any account to support or justify the building of a railway. As has been pointed out under previous headings, the possibility of the Pacific Great Eastern Railway getting any through traffic is so remote, and, further, as has been indicated, if it did get any such traffic, the cost of handling same over the Pacific Great Eastern Railway would equal, if not exceed, the revenue paid on such traffic. Therefore the question narrows down to what local business and what Vancouver business the Pacific Great Eastern Railway can get out of Prince George. The average total revenue from Prince George

during the past three years (after deducting what the Pacific Great Eastern paid on construction material for their road) will not pay two-thirds of the added expense. The Pacific Great Eastern Railway could not expect to get a third of this revenue. Therefore, instead of this extension being an aid, it would be a further burden on the railway and Province. I recommend that the road from Quesnel to Prince George be abandoned at once and the track taken up and salvaged. There may be a market for some of the viaduct at Walkerville. The track steel and fastenings with some of the ties could be salvaged, and it might be possible to realize from $250,000 to $350,000 from this source.

N.—WAS THE WORK CARRIED OUT SINCE THE GOVERNMENT TOOK CHARGE ECONOMICALLY PERFORMED?

To answer this question fully would require a detailed study away beyond the scope of my investigation. As the work was performed on a cost plus percentage basis, it would involve an investigation of the methods and organization in detail of the contractor's operations. I would not be justified in undertaking such an extensive detailed investigation without further instructions, and I cannot see any object to be gained by going further into this matter, other than to state that I do not believe that the cost plus percentage basis is an economical method of performing work unless you can introduce into the contract a bonus clause that will act as an incentive to the contractor to keep the cost of the work down. No matter how honest or efficient your contractors may be, the foremen and the labourers will not work efficiently when they have the idea that the more the work costs the more the contractor will make, and the less they will do the more work there will be. In the case of the Pacific Great Eastern Railway contract this feature was taken care of by the contractors submitting a schedule of the estimated cost of the work. With an undertaking that the sum on which a percentage would be paid would not exceed the sum the work would cost if figured at the unit prices in the schedule, and a further stipulation that if the actual cost of the work was less than what the work would have cost, figured at the schedule price, then the contractor was to receive as a bonus 25 per cent. of such saving in addition to their agreed percentage on the cost. This agreement, coupled with the fact that the company engaged a firm of contractors with a national reputation, would indicate that the work should be performed as economically as it was possible to do the work in 1919 and 1920, when prices were uncertain and wages at the highest point they have ever reached and the efficiency of labour at the lowest ebb in our time. Under such conditions it would have been impossible to do work under any plan that would be considered economical. If you had decided to have the work done on straight unit prices, I believe the contractors, to protect themselves, would have tendered a figure so high that the work would have cost even more than it did under the plan adopted by the company. If there is any criticism to make on the action of the Government management it would be for proceeding with the work when construction costs were from 50 to 100 per cent. higher than normal, and when the rates paid for money was at least 25 per cent. higher than normal, and at a time when practically all other industrial expansion was at a standstill.

O.—WERE DECREASES AND INCREASES IN UNIT PRICES OF ORIGINAL CONTRACT JUSTIFIED?

I do not believe in the principle of altering the terms of a contract, for the reason that if the possibility of changes in conditions of a contract becomes public, the result is that irresponsible contractors will take all kinds of chances in order to get work, depending on their being protected against loss by their ability to get changes in the contract. In this particular case there were many extenuating circumstances. In the first place, the schedule of prices was only an estimate of cost on which the percentage and possible bonus was based. Second, the original schedule was for a considerably less amount of work than what was finally accomplished under the original agreement. Third, in the spring of 1919, when the first reduction was made, it was generally believed at that time that the peak of high prices had been reached. The first of these reasons does not seem to be fully understood; as a matter of fact, the contract itself is a unit price form, and it is only by a study of the tender attached to the contract that one can determine the type of contract as between a unit price contract and a cost plus percentage contract. There is no doubt whatever as to the class of contract; it is a cost plus percentage contract with a bonus clause, and some criticism in the Legislature to the effect that the con-

tractors were paid some $700,000 more than they were entitled to by the original agreement is not a fact. The increase in unit prices in 1920 for percentage purposes had this effect: Under that schedule the work estimated by the engineers' figures at the increased prices increased the total on which a percentage of 5½ per cent. was calculated by $644,335.44, thus increasing the amount the company paid the contractors by $35,434.45, and up to date the cost of the work to the contractors has been some $300,000 greater than the engineers' estimate of the work computed at the revised unit prices; therefore, to date, the question of bonus has not entered into the question. Another criticism was that the head contractors let the work to stationmen and small contractors at prices less than the schedule in force at the time. This practice was perfectly justified and a most economical method. In the spring of 1919, when prices began to drop, it certainly looked like good business to reduce the schedule prices on which a bonus would be calculated, and the company had an opportunity of doing this when they were ordering more work under the original agreement; however, having made this reduction in 1919, when prices rose in 1920 the only logical action the company could take was to follow the precedent they had themselves established. The results so far are as follows: The lowering of the schedule in 1919 lowered the amount on which percentage was calculated by $16,924.46, making a saving to the company of $930.85. The net loss to the Government to date on account of change in schedule is $34,503.60. How these changes in schedule will affect the bonus is yet to be determined, while the cost of work performed to December 31st, 1921, is some $300,000 greater than the amount of the engineers' estimates. Multiplied by the schedule prices, the crediting of stores on hand and the final estimate may very materially affect these figures. The present information at hand is not sufficient to warrant my passing an opinion as to whether or not there should be any bonus under the terms of the agreement. I may suggest that on account of the nature of some of the work, cleaning out mud-slides, etc., where the cost is out of all proportion to quantities handled at usual unit prices. The cost in such cases might be the controlling factor rather than measurements in estimating amount of material moved; the Government would be well advised to carefully look into these features before paying any bonus on this contract.

P.—ADVISABILITY OF GETTING ONE OF THE LARGER RAILWAY COMPANIES TO OPERATE THE LINE.

It has been suggested that one of the larger connecting lines might be induced to take over the Pacific Great Eastern Railway on account of the advantage of having it as a feeder to their main lines. The reason given to the people of British Columbia for the Government aiding and guaranteeing the bonds, both as to principal and interest, of the Pacific Great Eastern Railway is contained in the first paragraph of Schedule A, attached to chapter 34, February 27th, 1912, and ratified by said Statute: "Whereas the Government of the Province of British Columbia deems it in the public interest to aid in the construction of the line of railway hereinafter mentioned, *for the purpose of securing to the people of British Columbia reasonable passenger and freight rates* and to assist in the opening-up and development of the Province." It is very doubtful if this was the real reason. One would not expect a city with three or four first-class hotels, with business not sufficient to keep one busy, to guarantee bonds for the purpose of building a second-rate hotel in order to improve hotel service or rates. It would appear more logical to suppose that business interests in Vancouver and Victoria for selfish reasons, aided by the Grand Trunk Pacific influence, was the real force that brought about the Pacific Great Eastern Railway. The Grand Trunk Pacific Railway Company might be expected to favour a rail connection with Vancouver, providing the same was constructed at the expense of some other party and such a connection would have some value to that company, but now that the Grand Trunk Pacific Railway and one of its chief competitors, the Canadian Northern Railway, have been made one under the management of the Canadian National Railway, the Pacific Great Eastern Railway is of no value to the system, other than a feeder to the extent that it may collect traffic from local inland points. The road has no strategic advantages, excepting the possibility that if the craze for building railways should ever demand an Alaskan rail connection, and the possibility of the Pacific Great Eastern Railway becoming a link in the system, therefore it cannot hope to get from a larger road more than the value of the Pacific Great Eastern Railway as a collector of traffic. A railway company that would investigate this matter will find that in 1921 about 36,000 tons of freight was the total of inward and forwarded from Vancouver for this road. They would naturally investigate and say, how much of this can

we get and how far can we haul it and at what rates? If we assume that the entire 36,000 tons would be hauled the average distance for traffic on the larger roads, say 450 miles, and that the rate received would be 25 per cent. greater than the average rate per ton-mile, say 1.5 cents, then the 16,200,000 ton-miles this traffic would make on the above assumptions would bring in a revenue of $243,000, a sum less than two-thirds the deficit in the cost of operating the Pacific Great Eastern in 1921; that is, if one of the other roads operated the Pacific Great Eastern Railway at the same expense as the company, and received, in addition to what was paid to the Pacific Great Eastern Railway, $243,000, there would still be over $120,000 loss in operating the Pacific Great Eastern Railway plus the cost of hauling the traffic 450 miles over its own rails, plus a fair proportion of interest on its own plant. There are thousands of miles of railways in Canada where the total receipts from traffic, both in and out, will not pay operating expenses of the line plus interest on cost, leaving nothing to pay for the hauling of the traffic over the main lines or foreign lines. But in the case of the Pacific Great Eastern Railway the present revenue from traffic in and out will not pay operating expenses of the Pacific Great Eastern Railway, to say nothing about interest on plant or cost of hauling traffic over foreign lines. It has been suggested that the Pacific Great Eastern Railway might build extensions. I have been driven over some of the proposed lines, and if they are built they will be a further burden to the Pacific Great Eastern Railway Company, for the reason that the total receipts with ten times the present development will not pay interest on the cost of these proposed lines, leaving nothing for the cost of operating the branch or hauling the traffic over the main line or foreign lines.

Q.—ADVICE AS TO WHAT SHOULD BE DONE TO ENABLE LINE TO MEET CHARGES IN THE NEAR FUTURE.

The present development of the country makes this desirable result an absolute impossibility. There is nothing in sight at the present time to indicate that this can ever be accomplished. It certainly cannot be done if the present method of financing is followed; that is, charging to capital the accrued interest and deficit in operating expenses. The interest charges will increase faster than the business. *See* Table No. 3, page 21, for two studies on this subject, both based on assumptions more favourable than present conditions would justify. The results show that in either case the total indebtedness at the end of ten years will be nearly doubled, without taking into account the extra expenditure that would be necessary to purchase sufficient new equipment to handle a greatly increased business. It will make very little difference what suggestions or what recommendations I may make, the Government of British Columbia must give the people of that Province what the majority think they want. Nevertheless, I will not shirk the responsibility of making some suggestions:—

First: The construction of the line between Vancouver and Squamish cannot be justified on any ground; therefore I would suggest that some readjustment of agreements be made with the municipalities on the North Shore that may have granted concessions in the matter of right-of-way and stop operating this section at once. Either hold the property or sell it to some private corporation. There can be very little doubt but that Vancouver will be one of the greatest cities in Canada and that something will be realized from this portion of the property. My personal opinion is that this property is more valuable to a private corporation than to the British Columbia Government, and that the Government should realize on the same as soon as they could remove any obligations that may exist which tends to depreciate the value of the property as a revenue-producer.

Second: Under no consideration, as conditions are at present, should the company undertake any construction north of the Grand Trunk Pacific Railway: First, because there is no development to justify the building of such lines; and, second, if such lines were built, the Pacific Great Eastern Railway would not get the business, and if they did, could not haul same over heavy grade at a profit at rates competition would force them to accept.

Third: Abandon the line from Quesnel to Prince George and salvage everything that can be sold.

Fourth: Do as hundreds of other small roads are doing on the continent. Abandon the operation of steam-trains for passenger and express business requiring five men to a train and replace same by gas-driven motor-cars, which are being developed to a high degree of perfection and require only one or two men to operate and require less than one-fifth of the fuel. To raise

money for the necessary expenditure, sell some of the locomotives now owned by the company, cancel mail contracts for the winter months, and close down that portion of the line where snow trouble occurs during the winter months. Operate a freight-train as often as there is business to warrant during the summer months, be that one a fortnight or one a month. Do not send out an engine unless there is a full load at least in one direction. Raise rates, both passenger and freight, to all the traffic will bear; that is, meet competition. Stop hauling freight at less than cost, to say nothing of paying interest charges. Encourage development as much as possible by giving commodity rates to low-grade freight as long as it can bear a rate slightly above cost. Any other action is not just to taxpayers of British Columbia. They have been obliged to pay the interest on the cost of this plant, and they should not be taxed to maintain a service for the people adjacent to the Pacific Great Eastern Railway that these people are unwilling or unable to pay for themselves. Abandon the operation of the line between Dragon Lake and Quesnel, unless the municipalities north of that point who may be interested will pay each year the cost of maintaining the line from Dragon Lake to Quesnel in excess of $1,250 per mile of main line. This is only justice to the other patrons of the road and to the taxpayers of British Columbia. If these suggestions are carried out the road should do better than paying operating expenses, for a few years at least, until such time as heavy renewals or replacements will be required.

Fifth: If the fourth suggestion on any modification, if same be put in force, that the company engineers keep in mind the possibility of abandoning the entire line south of Clinton, if a sufficient saving can be made in operating expenses to pay the interest on the construction cost of the line from Clinton to Ashcroft, less the value of the salvage of the line south of Clinton. Study the possibility of selling the south end of the line to the lumber interests. They cannot object to the abandonment of the line unless they are willing to pay more than the salvage value of the line and operate the same for their own use as they see fit.

Sixth: That the Province does not guarantee any more bonds, either as to principal or interest, for the construction of branch lines; if such lines are demanded to develop resources of any section, then let the owners of these resources, be they owned either privately or by the Government, give to the railway company an interest in the resources, which they may in turn pledge as security for the money with which to construct the lines. If money cannot be raised in this manner the line should not be constructed.

Seventh: If the people of British Columbia are not prepared to continue paying from $2,000,000 to $2,500,000 per year on the investment already made and what will be necessary in the next ten years, that the company be ordered at once to abandon the whole system and recover what salvage is possible, and in this way slightly reduce the liability and also prevent any further increase in their obligations.

In conclusion, I wish to thank you, sir, for facilitating my efforts to obtain all the facts bearing on this study. I also wish to express my appreciation for the courtesies and assistance rendered by the officers and engineers of the Pacific Great Eastern Railway.

Yours truly,
J. G. SULLIVAN.

TABLE No. 3.

Possible operating results for ten years, assuming that the line to Prince George would be completed during 1922 at a cost of $2,000,000 capital expenditure for construction and extra equipment; further assuming the operation income for 1922 would show an increase of 10 per cent. over that for 1921 and the operating expenses an increase of only 5 per cent., that in the year 1923 the income would increase by 300 per cent. and the operating expense by only 33⅓ per cent., and that for succeeding years the revenue would annually increase 10 per cent. and the expenses only increase 5 per cent. until operating expenses reached 75 per cent. of income.

Year.	Interest Charges as of 1921.	Revenue.	Expense.	Surplus or Deficit.	Interest on Deficit at 5 %.	Total Loss for Year.	Total Loss on which 5 % Interest is paid.	Remarks.
1921	$1,911,913 14	$ 383,389 51	$ 751,931 53	-$368,542 02	.....	$2,280,455 16	$ 2,280,455 16	
1922	1,911,913 14	422,000 00	788,000 00	- 366,000 00	$ 114,022 76	2,391,935 90	{ 2,000,000 00 4,672,391 06 }	New capital.
1923	1,911,913 14	1,266,000 00	1,051,000 00	+ 215,000 00	333,619 55	2,030,532 69	8,702,923 75	
1924	1,911,913 14	1,393,000 00	1,103,000 00	+ 290,000 00	435,146 19	2,057,059 33	10,759,983 08	
1925	1,911,913 14	1,532,000 00	1,158,000 00	+ 374,000 00	537,999 15	2,075,912 29	12,835,895 37	
1926	1,911,913 14	1,685,000 00	1,266,000 00	+ 419,000 00	641,794 77	2,134,710 91	14,970,606 28	
1927	1,911,913 14	1,854,000 00	1,390,000 00	+ 464,000 00	748,530 31	2,196,443 45	17,167,049 73	Operating expense, 75 % of income.
1928	1,911,913 14	2,039,000 00	1,529,000 00	+ 510,000 00	858,352 49	2,260,265 63	19,427,315 36	
1929	1,911,913 14	2,243,000 00	1,682,000 00	+ 561,000 00	971,365 76	2,322,278 90	21,749,594 26	
1930	1,911,913 14	2,467,000 00	1,850,000 00	+ 617,000 00	1,087,479 71	2,382,392 85	24,131,987 11	
1931	1,911,913 14	2,714,000 00	2,036,000 00	+ 678,000 00	1,206,599 35	2,440,512 49	26,572,499 60	Total annual interest charges, 1931, $3,118,512 49.

Table similar to above, but deducting operating results of North Shore line and assuming that operating income for 1923 would increase 500 per cent., and that, commencing 1923, $1,000,000 a year new capital must be provided to replace wooden structures, and further assuming that North Shore should carry interest on $1,270,000 of bonds, assuming an operating ratio of 67 per cent.

Year ending	Interest Charges as of Dec. 31, 1921.	Revenue.	Expense.	Surplus or Deficit.	Interest on Deficit at 5 %.	Total Loss for Year.	Total Loss on which 5 % Interest is paid.	New Capital, etc.	Remarks.
Dec. 31, 1921	$1,854,763 14	$ 314,325 72	$653,797 88	-$ 339,472 16	.....	$2,194,235 00	$ 2,194,235 00	.....	
" 1922	1,854,763 14	346,000 00	687,000 00	- 341,000 00	$ 109,712 00	2,305,475 00	6,499,710 00	$2,000,000	Completing work.
" 1923	1,854,763 14	1,730,000 00		+ 577,000 00	324,985 00	1,602,748 00	9,102,458 00	1,000,000	Making bridges and culverts permanent.
" 1924	1,854,763 14	1,903,000 00		+ 634,000 00	455,123 00	1,675,886 00	11,778,344 00	1,000,000	
" 1925	1,854,763 14	2,093,000 00		+ 698,000 00	588,917 00	1,745,680 00	14,524,024 00	1,000,000	
" 1926	1,854,763 14	2,302,000 00	Expense ⅔ of revenue	+ 767,000 00	726,201 00	1,813,964 00	17,337,988 00	1,000,000	
" 1927	1,854,763 14	2,532,000 00		+ 844,000 00	866,899 00	1,877,662 00	20,215,650 00	1,000,000	
" 1928	1,854,763 14	2,785,000 00		+ 928,000 00	1,010,782 00	1,937,545 00	23,153,195 00	1,000,000	
" 1929	1,854,763 14	3,063,000 00		+ 1,021,000 00	1,157,660 00	1,991,423 00	26,144,618 00	1,000,000	
" 1930	1,854,763 14	3,369,000 00		+ 1,123,000 00	1,307,231 00	2,038,994 00	29,183,612 00	1,000,000	
" 1931	1,854,763 14	3,706,000 00		+ 1,235,000 00	1,459,181 00	2,078,944 00	31,262,556 00	.....	
					$1,563,128 00 1,854,763 00				
					$3,417,891 00	fixed charges	end of 1931.		

APPENDICES.

APPENDIX No. 1.

ECONOMICS OF PROPOSED CHANGE OF LINE AT CROSSING OF COTTONWOOD RIVER.

An economical plant is one where the interest charges plus operating expenses are a minimum.

The principal operating expenses of a railway that are affected by short changes of line are usually wages of train and engine crews, controlled by distance; fuel-consumption, controlled by engine-miles and work performed; maintenance-of-way, controlled by distance and special conditions, and structure also by curvature; maintenance of equipment, controlled by distance and curvature. Rate of grade, which, if the ruling grade of the division is changed, would affect the train-loading for the entire division.

In this particular case the temporary grades introduced to facilitate and hasten the completion of the grading south of Cottonwood River have not been taken as ruling. They can be easily eliminated whenever the traffic will justify the necessary small expense. Fuel-consumption is controlled by the engine-miles run plus the work performed by the locomotive. This work consists of overcoming friction, which for fully loaded freight-cars amounts to 4 lb. per ton in summer-time on level track to twice that amount in zero weather. For empty cars these figures are doubled. In this case I assumed that the average resistance per ton would be 6.8 lb.; that is equivalent to the resistance of a 0.34 per cent. grade, or the work done in hauling a train over 1 mile of level track is equivalent to lifting the entire train a distance of 18 feet. The work done in overcoming a degree of curvature is taken as the equivalent of lifting the train 0.04 foot. The lifting of 1,000 tons 1 foot is the equivalent of 1 horse-power hour. From a very extended study of this matter we calculate that 3.5 lb. of ordinary coal is consumed in performing 1 horse-power hour of work. We also calculate that the large Pacific Great Eastern Railway locomotive will consume 80 lb. of coal per mile run in keeping up steam, running the locomotive, and wasted while standing on side-tracks, running downhill, etc. The maintenance-of-way will cost a certain sum plus a variable depending on the amount of traffic, but in this case we have assumed the conservative sum of $2,400 per mile for both maintenance-of-way and maintenance of equipment. Train and engine crew wages taken at $0.30 per mile.

The favourable economic features of the line adopted by the Government engineers consist of a saving of 5 miles in distance and 137 feet in rise and 1,103° less curvature. In addition, there is the saving of the cost of 4,700,000 lb. extra steel required in the crossing of the river on the line located by the company engineers, in addition to the cost of 5 miles track material, etc.

Data from profiles and personal examination and based on the assumption that the traffic over this portion of the line would be carried at a rate of 2 cents per ton-mile, and that the cost of operating would not exceed a ratio of 75 per cent., which would mean a profit of 0.5 cent per ton-mile. As this railway was costing nearly $100,000 per mile to construct and equip, and as the diversion was estimated to cost considerably more than this sum per mile on account of the expensive crossing of the Cottonwood Creek, before the construction of the line could be justified it must have been assumed that the railway would earn at least $5,000 (interest at 5 per cent. on $100,000) per mile of road in addition to operating expenses; and, further, to be on the conservative side, we will assume that $1,000 per mile of this interest charge would come from profit of passenger business, that would leave to be earned from profit on freight business $4,000 per mile of track. This sum divided by one-half of 1 cent equals 800,000 tons of pay-freight per year over this portion of the road to pay expenses. On the assumptions made above, from the nature of the country and conditions obtaining, the majority of this freight would be south-bound; but assuming that it was balanced in both directions, and as an offset assuming that the tare and light cars and O.C.S. traffic, such as fuel, etc., would amount to 100 per cent. of the pay-load, that would mean an annual gross tonnage of 1,600,000 tons, or 4,380 gross tons per day.

To haul this tonnage would require at least four trains; that is, two trains in each direction.

To make $1,000 profit per mile per year from passenger business would require at least one passenger-train per day in each direction; that is, two daily passenger-trains or a total of freight

and passenger of six daily trains as a minimum number that would justify the construction of the railway. A study of the profiles show that the diversion made the following saving in the factors that affect the economics of railway operation:—

	Equivalent Rises. Feet.
Distance, a saving of 5 miles at 18 feet	90
Rise and fall, a saving of 137 feet	137
Curvature, a saving of 1,103° at .04 foot	44
Total extra resistance	271

Steel structures, 4,700,000 lb. extra steel viaduct.

The above affects operations as follows: Assuming passenger annual tonnage 400,000 tons, the total annual tonnage would be 2,000,000 tons.

COAL-CONSUMPTION PER YEAR.

$\frac{2{,}000 \times 271' \times 3.5 \text{ lb.} \times \$8.00}{2{,}000 \text{ lb. in ton}}$	$ 7,588 00
Engine-mileage, $\frac{365 \times 6 \times 5 \times 80 \text{ lb.} \times \$8.00}{2{,}000 \text{ lb.}}$	3,504 00
Engine and train wages, 365 × 6 × 5 × $30.00	3,285 00
Ordinary maintenance-of-way and maintenance equipment, account of extra 5 miles per year	12,000 00
Extra maintenance on large viaducts, 2 per cent. on $275,000	5,400 00
Calculated annual saving in operation	$31,777 00

In addition to the saving in operation, there must be taken into account the cost of regrading the old line, cost of track-laying, ballasting, as well as the cost of track material, for 5 miles of extra line; also cost of 5 miles of extra fencing and telephone-line; also the extra cost of the larger steel viaduct. The details of these items are as follows:—

Mile 22.5 to Mile 23.5, old line, developed into a continuous slide over which it would be impossible to construct a permanent line. The only way a railway could be carried over this mile would be to trestle, and during the spring break-up for three or four months to keep repair-gangs maintaining this trestle.

A very conservative estimated cost of construction with the capitalized cost of maintaining would be	$ 100,000 00
Estimated cost of regrading balance of abandoned line	100,000 00
Cost of 5 miles, 60-lb. steel and fastenings at $6,300	31,500 00
Cost of 15,000 track-ties at 78 cents	11,700 00
Cost of 5 miles track-laying at $1,255	6,275 00
Cost of 5 miles ballasting at $1,500	7,500 00
Cost of 5 miles telephone-line at $530	2,650 00
Cost of 5 miles double fence-line at $1,140	5,700 00
Extra steel, 3,250,000 lb. at 11.44 cents	371,800 00
Cost of hauling same from Victoria	6,400 00
Extra deck-timber, 192,000 feet B.M. at $100	19,200 00
Large south approach would have to be eventually replaced by steel structure, amounting to 1,300,000 lb. steel at 8 cents	104,000 00
1,560 cubic yards masonry at $25	39,000 00
Deck-timber, 213,000 feet B.M. at $70	14,110 00
Total	$ 819,835 00
Capitalized value of annual saving in operation is $31,777 at 5 per cent.	635,540 00
Total extra expense warranted in making change	$1,455,375 00

The cost of trestles that were to be built on both lines would balance each other. The grading of the proposed line at enormous cost, being done by men working on force account at the peak of the high prices when men were the least efficient, was $1,066,266.08, showing that

if the building of the railway was justified there is no doubt that the Cottonwood diversion was fully justified. It has been claimed that the ruling south-bound grade of 75 per cent. of the old line has been changed. This is not a fact; it is true that temporary grade of 1.2 per cent. has been introduced for very short distances on 3 miles of the diversion, but the line was located on a 0.75 per cent. south-bound maximum grade and the extra grading necessary to make 0.75 per cent. grade permanent would not amount to over $50,000 even at present high prices.

APPENDIX No. 2.

ECONOMICS OF QUESNEL CHANGE, USING SAME FACTORS AS MENTIONED IN APPENDIX No. 1.

To complete grading on old line and bridge, Quesnel River, would require the removal of 150,000 cubic yards of material, and the crossing of the old line would require an excess of 300,000 lb. steel, an excess of 4,700 cubic yards concrete, and an excess of 273,000 cubic yards train-fill material.

An adverse item is an excess of timber trestle on the new line, amounting to excess trestle timber, 470,000 feet B.M.; excess piling, lineal feet piling, 13,500 feet; excess iron, 27,000 lb.

Economics for six daily trains and total annual tonnage of 2,000,000 gross tons.

Figuring train- and engine-crew wages at 30 cents per train-mile, and estimating maintenance of equipment at $2,400 per mile, it works out, after deducting the adverse coal-consumption, to an annual saving of $2,721 per year. This capitalized at 5 per cent. amounts to $54,420.

ECONOMIC AND CONSTRUCTION COST.

	In Favour of New Line.	In Favour of Old Line.
Capitalized value of saving in operation	$ 54,420 00	.....
150,000 cubic yards grading old line at $1	150,000 00	.....
4,700 cubic yards concrete at $29	86,900 00	.....
273,000 cubic yards train-fill at $50	136,500 00	.....
Value of track material, track-laying, and ballasting	11,395 00	.....
470,000 feet B.M. trestle at $75	.....	$ 35,250 00
13,500 lineal feet piling at 50 cents	.....	6,750 00
27,000 lb. iron in trestles, 8.10	.....	2,700 00
Grading of new line	.....	816,328 82
Totals	$439,215 00	$861,028 82

This balance in favour of the old line would require an extra annual revenue of $21,090 from Quesnel without extra operating expense to justify the expenditure.

APPENDIX No. 3.

To be able to judge of the comparative operating economics of various lines, one must know the amount of work that has to be performed, as well as the distance and the rates of grade which control the train-loading. This is in addition to the special features and conditions that may make operation more expensive in one case than in another. In Appendix No. 1 it was explained how fuel-consumption is calculated, and in order to be able to estimate approximately the comparative operating costs on various routes I have made a very extensive study of the detailed profiles of the Grand Trunk Pacific Railway from Prince George to Prince Rupert, those of the Pacific Great Eastern Railway from Prince George to Squamish and to Ashcroft via Clinton, and those of the Canadian National Railway, Ashcroft to Vancouver. The results of these studies are shown in Table No. 1.

In making any study of this kind it is necessary to make some assumptions, and in this case I assume that north-bound traffic on the Pacific Great Eastern Railway would not require the loading of cars to more than one-third capacity. On this assumption I calculated that the frictional resistance against south-bound traffic would be 6.4 lb. per gross ton, or equivalent to

raising the train 17 feet as the resistance for each mile of level track. For north-bound traffic I calculated that the resistance would be 7.5 lb. per gross ton, or the equivalent to lifting the train 20 feet for each mile of resistance. These figures were used on all routes in making the comparison. I assumed that the largest type of engine on the Pacific Great Eastern Railway was within 15 per cent. of the limit that the standard of construction on that road would permit, and the locomotives on either the Grand Trunk Pacific Railway or the Canadian National Railway would be one-third heavier and consequently capable of handling one-third greater load on the same grade. Then, for comparative purposes, I calculated how many train-miles and engine-pusher miles would be required to take over the various routes a full load for such a locomotive for an 0.4 per cent. grade. This information is found in Table No. 2.

In arriving at these figures the Pacific Great Eastern Railway was given every advantage; for instance, on account of the light loading N.B. it was assumed that only 60 per cent. of the N.B. trains would use pushers, while we know that in practice pushers are generally used on all freight-trains on a 2.2 per cent. grade even if the load is not up to the limit. Also in calculating the train-miles between Clinton and Ashcroft the N.B. load of light cars was taken as the controlling factor, thus making a turn round at Clinton for some trains from Williams Lake. This is not generally done in actual practice.

In order to eliminate as far as possible inaccuracies that might exist by using present-day prices either for fuel or wages, the comparison is made on a percentage basis, based on the controlling facts. For instance, train-crew and engine-crew wages are almost directly proportional to the train and engine mileage. The other items, such as preparatory time and overtime, would probably be in about the same proportion; therefore the cost of these items are based on the train and engine mileages. Fuel-consumption is based on engine-miles plus work done, and the work done is in direct proportion to the resistance calculated from the profiles and show as the total resistance. The comparative cost of fuel is made on the basis of engine-miles and resistance, calculating that the larger locomotives on the Canadian National Railway and Grand Trunk Pacific Railway will use 7 per cent. more fuel in keeping up steam, etc., than the smaller Pacific Great Eastern Railway locomotives.

The maintenance-of-way is based on more uncertain factors. If both roads were of the same class of construction and used the same grades and about the same class of country, the comparative cost would be on a mileage basis plus a factor for curvature. As a matter of fact, the mileage was given more precedence than the facts would warrant. Note that while the comparative cost of Ashcroft route is calculated at 127 per cent. of the Prince Rupert–Prince George route, that Prince George to Squamish is only 115 per cent. The engineers who are familiar with these routes will, I believe, say that on account of all the heavy trestles, heavy grades, snow troubles, and heavy curvature south of Clinton, this latter line, although shorter, will probably cost more to maintain than the Ashcroft line. In the matter of maintenance of equipment this item is controlled by the number of engines and car-miles, also by curvature and grades to a certain extent. In making the comparison it was calculated that repairs to larger Grand Trunk Pacific Railway and Canadian National Railway locomotives would cost 20 per cent. more per mile run than the smaller Pacific Great Eastern Railway locomotives.

Having made a comparison of the various items on a percentage basis, then these percentages were applied to total operating cost in the summation. It may be said that the Pacific Great Eastern Railway's present operating costs are not in the proportions given—namely, 25 per cent. for maintenance-of-way and maintenance of equipment, 9 per cent. train and engine wages, 12.5 per cent. fuel, and 28.5 per cent. other items; but it is believed that these percentages are not far from the facts on a road doing much business. It must be remembered that this study is made on the assumption that the Pacific Great Eastern Railway would have to handle considerable business, and it must be remembered that maintenance of equipment, fuel, train and engine wages all go up faster with business than maintenance-of-way, and that the present ratio of percentages of these items on the Pacific Great Eastern Railway is not a representative figure.

TABLE No. 1.

A study of comparative resistance on various lines by calculation of work done, reduced to equivalent in rise. In calculating frictional resistance, the resistance of a fully loaded train for 1 mile of level track south- or west-bound is assumed equivalent to a vertical lift of 17 feet; for a partially loaded north- or east-bound train the same resistance is assumed as 20 feet.

Mile.		Elevation.	Curvature.	Grade.	Resistance, North-bound.				Resistance, South-bound.				Notes.
From	To				Friction.	Rise.	Curvature.	Total.	Friction.	Rise.	Curvature.	Total.	
		110			*Squamish Division, P.G.E. Rly.*								
			Degrees.										
0.0	5.5	125	335	Level	110	15	13	138	93	−15	13	91	
5.5	13.0	314	335	1 per cent. N.B.	150	189	13	352	....	....	....	*Nil*	
13 0	36.0	2,181	3,884	2.2 per cent. N.B.	460	1,867	155	2,482	....	....	....	*Nil*	
36.0	42.5	2,181	826	Level	130	....	33	163	110	....	33	143	
42.5	57.5	794	2,698	2.2 per cent. S.B.	....	....	....	*Nil*	255	1,387	108	1,750	
57.5	61.5	774	290	Light	80	−20	12	72	68	20	12	100	
61.5	75.0	1,714	1,927	2.1 per cent. N.B.	270	940	77	1,287	....	....	....	*Nil*	
75.0	86.0	987	1,479	2 per cent. S.B.	....	....	....	*Nil*	187	727	59	973	
86.0	90.0	1,010	832	Undulating	80	23	33	136	68	−23	33	78	
90.0	117 5	879	6,742	Undulating	550	−131	270	689	468	131	270	869	
117.5	120.0	790	195	1 per cent. S.B.	....	....	....	*Nil*	42	89	8	139	
120.0	121.85	840	251	1 per cent. N.B.	37	50	10	97	....	....	....	*Nil*	
0.0	121.85		19,794					5,416				4,143	Total.
		840			*Williams Lake Division, P.G.E. Rly.*								
0.0	34.0	3,609	7,460	2.2 per cent. N.B.	680	2,769	298	3,747	23	....	....	23	
34.0	44.5	3,275	956	0.75 per cent. S.B.	....	....	....	*Nil*	179	334	38	551	Junction, South Line.
Squamish	44.5		28,210					9,163				4,717	Total, Squamish to 44.5
0.0	44.5	3,275	8,416	.....	....	....	....	3,747	. .	....	....	574	
44.5	45.0	3,266	89	0.75 per cent. S.B.	....	....	....	*Nil*	9	9	4	22	Clinton.
45.0	62.0	3,725	1,897	1 per cent. N.B.	340	459	76	875	....	....	....	*Nil*	
62.0	65.0	3,650	220	0.90 per cent. S.B.	....	....	....	*Nil*	51	75	9	135	
65.0	74.0	3,701	934	Undulating	180	51	37	268	153	−51	37	139	
74.0	80.0	3,930	556	1 per cent. N.B.	120	229	22	371	....	....	....	*Nil*	
80.0	85.0	3,965	319	Undulating	100	35	13	148	85	−35	13	63	
85.0	120.0	2,760	3,734	1 per cent. S.B.	....	....	....	*Nil*	595	1,205	149	1,949	
120.0	137.5	2,580	1,527	Undulating	350	−180	61	231	298	180	61	539	
137.5	152.0	1,973	2,068	1 per cent. S.B.	....	....	....	*Nil*	247	607	83	937	
152.0	156.0	S. 1,965 N. 1,916	371	Undulating	80	....	15	95	68	49	15	132	
0.0	156.0	1,916	20,131					5,735				4,490	Total.

		1,916		*Prince George Division, P.G.E. Rly.*									
			Degrees.										
0.0	6.0	2,094	798	1 per cent. N.B.	120	178	32	330	....	....	....	*Nil*	
6.0	9.0	2,125	219	Undulating	60	31	9	100	51	−31	9	29	
9.0	27.0	1,595	2,534	0.75 per cent. S.B.	....	....	....	*Nil*	306	530	101	937	
27.0	37.0	1,600	412	Undulating	200	5	16	221	170	−5	16	181	
37.0	39.0	1,650	165	0.7 per cent. N.B.	40	50	7	97	....	....	....	*Nil*	
39.0	45.5	1,825	283	0.1 per cent. N.B.	130	175	11	316	....	....	....	*Nil*	
45.5	48.5	1,727	167	0.75 per cent. S.B.	....	....	....	*Nil*	51	98	7	156	
48.5	56.5	1,860	281	0.1 per cent. N.B.	160	133	11	304	51	....	....	51	51-foot short rises.
56.5	63.5	1,758	169	Undulating	140	−102	7	45	119	102	7	228	
63.5	68.5	1,552	543	0.85 per cent. S.B.	....	...	....	*Nil*	85	206	22	313	
68.5	70.5	1,552	286	Undulating	40	....	11	31	34	....	11	45	Quesnel.
70.5	80.0	2,330	1,405	2 per cent. N.B.	190	778	56	1,024	....	....	....	*Nil*	
80.0	82.0	2,368	81	Undulating	40	38	3	81	17	..	3	20	
82.0	87.5	2,205	581	0.75 per cent. S.B.	....	....	....	*Nil*	94	163	23	280	Temporary grades 1.2 per cent.
87.5	98.5	2,205	1,415	Undulating	220	....	57	277	187	....	57	244	
98.5	110.0	1,960	674	0.75 per cent. S.B.	....	....	....	*Nil*	196	245	27	468	
110.0	116.0	2,208	603	1 per cent. N.B.	120	248	24	392	....	....	....	*Nil*	
116.0	118.5	2,229	447	Undulating	50	21	18	89	43	−21	18	40	
118.5	121.0	2,205	85	Undulating	50	−24	3	29	43	−24	3	70	
121.0	125.5	2,120	456	Undulating	90	−85	18	23	77	85	18	180	
125.5	127.0	2,164	48	1 per cent. N.B.	30	44	2	76	....	....	....	*Nil*	
127.0	131.5	2,100	512	0.75 per cent. S.B.	....	....	....	*Nil*	77	64	20	161	
131.5	136.5	2,107	207	Undulating	100	7	8	115	85	−7	8	86	
136.5	149.5	1,873	502	0.75 per cent. S.B.	80	....	....	80	221	234	20	475	4 miles N.B. resistance.
G.T.P. Rly.	1 mile	....	....	.....	20	....	....	20	17	...	....	17	G.T.P. Rly., 1 mile.
0.0	150.5		12,873					3,670				3,981	Prince George.
		3,277		*Clinton-Ashcroft Proposed Line.*									
0.0	45.8	991	6,343	1 % and 2.2 % N.B.	916	2,286	254	3,456	....	....	....	*Nil*	
		991		*Ashcroft-Vancouver C.N. Rly.*									
48.0	125.5	448	8,788	0.4 % max. undulating.	1,550	543	352	2,445	1,317	−543	352	1,126	Boston Bar.
0.0	131.8	9	7,543	0.4 % max. undulating.	2,636	439	302	3,377	2,241	−439	302	2,104	Vancouver.
209.3	miles		16,331					5,822				3,230	Total.
Prince George–Squamish, 428.5 miles			52,798	.....	....	....	....	14,821	....	....	....	12,614	
Prince George–Ashcroft, 307 miles			30,931	.....	....	....	....	9,114	....	....	....	7,897	
		9.0		*Prince Rupert to Prince George.*									
0.0	119.5	367.0	5,306	Level or light W.B. 0.4 per cent. E.B.	2,390	358	212	2,960	2,032	−358	212	1,886	Pacific.
119.5	226.5	1,616.0	7,174	Less 0.2 % W.B., 0.4 % E.B.	2,140	1,249	287	3,676	1,819	−1,249	287	857	Smithers.
226.5	351.5	2,237.0	4,231	0.3 % or less, W.B., 0.4 % E.B.	2,500	621	169	3,290	2,125	−621	169	1,673	Endako.
351.5	398.0	2,089.0	1,828	0.4 % W.B. Down or light E.B.	930	−148	73	855	790	148	73	1,011	Vanderhoof.
398.0	467.0	1,862.0	2,880	0.4 % E. and W.B.	1,380	−227	115	1,268	1,173	227	115	1,515	Prince George.
0.0	467.0		21,419					1,249				6,942	Pr. Rupert–Pr. George

TABLE No. 2.

Showing some of the more important economic features of various routes from Prince George, first, to Prince Rupert; second, to Vancouver via Ashcroft; third, to Squamish; and from Vanderhoof, first, to Prince Rupert; second, to Vancouver via Ashcroft; third, to Squamish; the object being to find out the possibilities of various routes from an economic point of view, to better judge the route that grain and other products from the Peace River country should take if a line were built from the Peace River District to either Vanderhoof or Prince George. Comparison is on a basis of a fully loaded-car train for 0.4 per cent. grade, 4,000 total gross tonnage south- and west-bound, 2,222 tons north- and east-bound.

Point to Point.	Mileage.	Pusher-engine Miles.	Train-mileage.	Total Engine-mileage.	Train and Engine Wages.	Fuel Consumption.	Total Resistance.		Total Curvature.	Maintenance of Way.	Maintenance of Equipment.
							E. and N. Bound.	S. and W. Bound.			
					Per Cent.	Per Cent.	Feet.	Feet.	Degrees.	Per Cent.	Per Cent.
Prince George-Prince Rupert.....	467	...	758	758	100.0	100	12,049	6,942	21,419	100	100
Prince George-Vancouver..	517 (C.N.R. 209)	33	1,670	1,703 (C.N.R. 314)	222.5	160	14,936	11,127	47,262	127	127
Prince George-Squamish.....	428.5	151	2,112	2,263	288.6	180	14,821	12,614	52.798	115	125
Vanderhoof-Prince Rupert.....	398	...	620	620	100.0	100	10,781	5,427	18,539	100	100
Vanderhoof-Vancouver	586 (C.N.R., G.T.P. 278)	33	1,808	1,841 (C.N.R., G.T.P. 452)	294.3	211	16,204	12,642	50,142	167	167
Vanderhoof-Squamish.....	497.5 (G.T.P.69)	151	2,250	(2,401 G.T.P. 138)	375.0	246	16,089	14,129	55,678	152	262

SUMMATION OF COMPARATIVE OPERATING EXPENSES ON VARIOUS LINES.

Point to Point.	Maintenance of Way.	Maintenance of Equipment.	Train Wages.	Fuel.	Other Items.	Total.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Prinee George-Prince Rupert	25.00	25.00	9.00	12.50	28.50	100.0
Prince George-Vancouver	31.75	31.75	20.00	20.00	28.50	132.0
Prince George-Squamish.....	28.75	31.25	26.00	22.50	28.50	137.0
Vanderhoof-Prince Rupert.....	25.00	25.00	9 00	12.50	28.50	100.0
Vanderhoof-Vancouver.....	41.75	41.75	26.50	26.40	28.50	164.9
Vanderhoof-Squamish	38.00	40.50	33.75	30.75	28.50	171.5