(Paper No. 4111.)

“The Transportation Problem in Canada, and Montreal Harbour.”

By FREDERICK WILLIAM COWIE, B.A.Sc., M. Inst. C.E.

*Author's Reply to the Correspondence.*¹

The AUTHOR, replying to the Correspondence, observed that the The Author. interesting figures given by Mr. Reid Bell marked the beginning and extension of grain-growing in the American West. The progress of the shipping in the port of Montreal paralleled the rise in production. With 85 per cent. of the cultivable land in the Canadian North-West still to be settled upon and put under crop, the future of the country and of the port might be safely regarded as assured. With regard to the present-day winter phenomena on the river in front of Montreal, it had been found that the mighty St. Lawrence resented any effort towards controlling its natural characteristics, but that it lent its power to the achievement of measures of improvement carefully designed “for the use and convenience of man.” The thrusting and jamming of the ice in the strong current, and the resulting floods, were still spectacular for two or three days in April, but it had been found that an embankment composed of dredged material, mostly clay and boulders, was sufficiently yielding not to offer an appearance of resistance to ice-thrusts. A masonry wall and earthen dike also kept out the occasional abnormal floods. Other structures also required to be designed accordingly: cheap timber or concrete-pile wharves were out of the question, and in many places special protection was necessary to meet the natural physical conditions. The resistance of boulder clay, or of disintegrated shale compacted and mixed with boulders, to the action of strong currents might be exemplified by the permanence of the piers of the Victoria Bridge, designed by Robert Stephenson, just above the harbour. These piers were built in 1856 at a place where the river was nearly 2 miles wide. The depth of water ranged from 5 to 10 feet, and the current had a

¹ The Paper, with the Discussion and Correspondence upon it, was printed in vol. excviii.—SEC. INST. C.E.

[THE INST. C.E. VOL. CXCIX.]

The Author. velocity of 4 to 7 miles per hour. The shale rock upon which the piers were founded was distinctly susceptible of disintegration and erosion. As, however, the whole shale bed-rock was covered by a layer of 3 to 10 feet of boulder clay, it had remained for more than 50 years without the least sign of trouble at any of the twenty-six piers. It would therefore be of great interest to those connected with the present-day problems in Montreal to read the views expressed by Mr. Bell as to the difficulties that presented themselves to British engineers in designing works for Montreal in 1877.

The question of routes was probably the most important question relating to the economic development of Canada. In many cases it governed success or failure in keeping the transportation-tolls in Canada, the value of which was pointed out in the Paper. He had particularly left the question of routes, especially of the rival "Georgian Bay" or "St. Lawrence" canal routes, to be discussed by others. Either of these routes would be equally favourable to Montreal, and he considered it had not yet been sufficiently demonstrated which would give a distinct advantage over the other in economy, time of transport, length of season, or industrial success, owing to the location of its adjunct water-supplies. It was expected, however, that the New York State barge-canal would be opened for traffic 3 years hence. From Buffalo or Oswego navigation for barges of 12 feet draught would be opened to New York. The Erie Canal, from Buffalo to New York, as originally constructed and as enlarged, practically put the Canadian 6- and 9-foot St. Lawrence canals out of business, in order of construction. Would the 12-foot barge-canal when completed take away the traffic from the present successful 14-foot Canadian canals? The populous and rich American States, with their thriving ports, appreciated the value of transportation-tolls through their territory, and were making every effort to secure them. As early as 1837 Earl Durham, in his celebrated Report to the British Government, stated that the State of New York had created her own St. Lawrence from Buffalo via Albany, down the Hudson to the seaboard at New York, and thereby captured the trade which Canada had lost by neglecting to improve her waterways. This competition was probably the stimulant needed in Canada. The Canadian system, up to the present time, of canals, railways, and ports, was a credit to a new country of such vast distances and sparse population, and there were signs that there were far-seeing statesmen who realized that, cost what it might, the Canadian East and West routes were the economic necessities of Canada. The design and construction of these great transportation enterprises,

the demonstration of their commercial advantages, and the installation of such equipment as would meet and succeed against competition, was the happy function of the Canadian engineer, as it had been, and was, of the engineers of the great ports of the United Kingdom, where competition was becoming so keen from North Sea ports. The Author.

The observations of Mr. Farrer Cochrane, on the extensive development of commercial navigation on the Great Lakes during a season of 7 months, were of special value. This water-borne commerce had been admitted to be the cheapest transportation in the world, and its success was the best reply to Dr. Corthell's remarks as to the "great drawback involved by 4 to 5 months of ice-bound navigation to any water route and any harbour in Canada." Dr. Corthell's comparison of what would happen to the northern ports of Great Britain in favour of Southampton was very unfairly drawn. The Canadian transportation problem, as Dr. Corthell, with his eminent professional record, knew, must have always with it the disadvantage of the northerly winter—the disadvantage or drawback which Duluth, Chicago and Buffalo must always share: those cities had grown great and rich and generous, due to their economic situations on the Great Lakes, which were closed when Montreal Harbour was closed, and also to the invigorating climate of the north. It was quite true that not all of the farmers who emigrated from the United States to the Canadian West, as referred to in the Paper, remained. He might cite one concrete example, of a man who went from Texas to Brandon with a capital of 20,000 dollars, bought a well-stocked farm 1 square mile in area, repaid his investment with the proceeds of 3 years' wheat-crops averaging 23 bushels to the acre—not a remarkable yield—then sold his farm for double what he gave for it, and was now living on the Pacific coast and sending his sons to the eastern universities.

He desired to express his appreciation of the encouraging observations of Mr. Hamer. The New Zealand problems were being dealt with in a most satisfactory manner. Skilful authorities on the development of ports had visited the United States and Canada to obtain information which had been gained at great cost, in money and experience, in those countries during the last century. The solution of these special problems would certainly pay.

The name and reputation of Professor Luiggi were well known in Canada, and the Author wished to record here his appreciation of the methods and facilities adopted for the storage and handling of grain, as shown him at Genoa by the courtesy of the gifted

The Author. engineer, Mr. Biondi. This installation, due in a great measure to Professor Luiggi, was found by the Author to be excellent as to design, extent, and economy.

Mr. Mowat's exceptional experience rendered his remarks very valuable. Mr. Mowat was in error, however, in his statement that, in addition to the tariff charges, the Montreal Harbour Commissioners levied a general rate on goods, and also dues on the registered net tonnage on vessels. The only charge on goods, in the case of grain, was the wharfage charge of 3 cents per ton. Vessels in the port of Montreal had the advantage of being charged no port tonnage-dues. In the Author's opinion, great economy would result to harbours and districts if special charges were levied in the case of small parcels, while giving bulk cargoes the advantage of cheaper rates. The general consumer would directly reap the benefit. The Montreal Harbour Commissioners had, in this manner, gone so far as to revolutionize conditions when they were discovered to be non-competitive. Two excellent grain-elevators, much more modern and better than anything at present in the port of London, were taken down in Montreal in 1911, only because elevators of later design could handle grain cheaper and were subject to lower insurance rates. London, with a population equal to that of all Canada, might have only one port, but the Author was informed that when the new installations at Manchester and Hull were completed, those ports would be able to handle grain economically and manufacture it for consumption in London.

The observations by Mr. Seurot gave many of the considerations requiring study in designing Montreal Harbour, so as to give the necessary safe accommodation for ships, without attempting to restrain by force the natural characteristics of the St. Lawrence. Unfortunately, full details of the physical conditions necessitating special designs could not be given in the Paper. For instance, improvements farther up, or the placing of a dam above Victoria Bridge, would, in the Author's opinion, be impracticable and unwise. The bed of the river was now a natural dam at the very place suggested. An additional dam would still leave the river flowing down the present steep slope from Victoria Bridge to Longueil. As designed, the undeveloped channel south of St. Helen's Island would, when completed, give a more uniform and flatter slope, and the current would be trained into the main river below Isle Ronde to meet navigation requirements.

With regard to Mr. Ommanney's remarks, it was a grave question for the Harbour Authorities whether it was necessary or economically justifiable to provide for the peak load of a steamship company

instead of for sufficient to accommodate a fairly high average. The The Author. Harbour Commissioners designed accommodation on the basis of one ship per double-story transit-shed per week. If, according to the exigencies of navigation, a ship arrived later than the schedule time, and therefore reached a shed in which was stored most of the outward cargo, and was expected to unload and re-load in time to sail according to the advertised sailing-date, it might not be the fault of the Port Authorities if the shed was too small. Where the port-revenues were as low as at Montreal, the Commissioners could not be expected to provide the wider sheds suggested by Mr. Ommanney, which might remain idle for a week, and then be large enough to accommodate the following week's congested traffic. As to Mr. Ommanney's statement that the practice of elevating teams one and two at a time to the upper story of the sheds was analogous to bringing the "mountain to Mohammed," the Author considered that the analogy rather failed in argument, in view of a season's record of traffic by these freight-hoists. No. 2 single-team hoist, operated by the Canadian Pacific Railway Company, carried in one season, of less than 200 days, 13,549 teams, which, allowing for load one way and an average of 4 tons to the load (many of the loads being 7 tons), would give a total in one season of 54,196 tons of freight, at a total cost, including power, operation, interest, and depreciation, of \$2,600, or approximately 5 cents per ton. No. 3 double-team freight hoist, of newer type, carried 17,269 teams, which, on the same basis, would give 69,076 tons of freight, at a cost of \$2,100, or about 3 cents per ton. So successful were these hoists that in 1914 the trade demanded two more, which were now completed. With regard to details of harbour-construction in Montreal, very little attention was given in the Paper to this subject, with the exception of grain-handling and elevators. The timber crib cost in Montreal 8 cents (*4d.*) per cubic foot, or \$2.16 per cubic yard. Mass concrete would cost, in similar positions, \$8.00 per cubic yard, or nearly four times as much. It was probable that the opening of the Panama Canal would result in cheapening timber from the vast forest-areas of British Columbia by 25 per cent., and possibly 33 per cent. The crib sub-structure was particularly adapted to the River St. Lawrence conditions—fresh water, a compact river-bed, strong currents, and ice. It lent itself to very rapid construction, and in Montreal, up to the present time, had been exceedingly satisfactory. In the United Kingdom, however, concrete work was done for one-half the Montreal rate, and crib-construction could not be recommended. It would be seen from the Appendix that

The Author. the rates for labour, and also the costs of several of the chief materials, were very much higher in Canada than in the United Kingdom. Mass concrete work in Montreal, in jobs of 10,000 cubic yards, with a mixture of 1 : 2½ : 5, would cost—

Labour	\$ 1.96
Lumber	0.01
Cement	2.34
Sand	0.45
Stone	1.89
Machines and supplies	0.49
Organization (10 per cent.)	0.71
	<hr/>
	\$7.85

As requested, he gave some prices in connection with elevator-construction in Montreal :—

Piling . Southern pine piles, 9 inches in diameter at the small end	
Driven Average length over 20 feet	
	\$
Material	0.31
Labour	0.17
	<hr/>
	\$0.48 per lineal foot.

Reinforced-Concrete Work: Elevator-Construction.

Concrete slab, 1 : 3 : 5, 11,000 cubic yards—

Forms	\$ 0.09
Concrete	0.19
Steel	0.04
	<hr/>
	\$0.32 per cubic foot,
	or
	\$8.64 per cubic yard.

Columns and walls, 1 : 3 : 5, 3,000 cubic yards—

Forms	\$ 0.26
Concrete	0.19
Steel	0.05
	<hr/>
	\$0.50 per cubic foot,
	or
	\$13.50 per cubic yard.

Bin girders, bottoms and hoppers, 1 : 3 : 5, 2,000 cubic yards—

Forms	\$ 0.34
Concrete	0.33
Steel	0.28
	<hr/>
	\$0.95 per cubic foot,
	or
	\$25.65 per cubic yard.

Reinforced-Concrete Work : Elevator-Construction—continued.

Bin-walls, 1 : 2 : 4, 12,000 cubic yards—

	\$
Forms	0.18
Concrete	0.20
Steel	0.12
	<hr/>
	\$0.50 per cubic foot
	or
	<hr/>
	\$13.50 per cubic yard.

Concrete in cupola, 1 : 2 : 4, quantity 3,600 cubic yards
(poured in winter, protected and heated : framing,
columns, walls, stairways, etc.)—

	\$
Forms	2.01
Concrete	1.41
Steel	0.32
	<hr/>
	\$3.74 per cubic foot,
	or
	<hr/>
	\$100.00 per cubic yard.

The purpose of the Paper was to demonstrate that the transportation problem was one of the most important questions touching the present and future prosperity of Canada, and that Montreal Harbour, properly developed and equipped, was the key to competitive success. The value to the Canadian and British people of retaining the transportation of Canadian products within the borders of the Empire was too great to be easily realized. The simple statement of the results in estimated dollars and cents, or in pounds, shillings and pence, did not carry conviction. It was an "engineer's estimate" which looked doubtful, if not absurd. In the Paper, 18 cents per bushel was given as the average loss to Canadian and British transportation and selling organizations if the Canadian grain was diverted, at the Canadian twin ports, to American routes. The money was not lost—it went to enterprising American neighbours and competitive European steamship-lines, ports, manufacturers. In Canada every endeavour was being made to retain the share of tolls on Canadian products while on the Continent of North America. There was also the portion in Europe to be taken care of. In the Paper he had not dared to enter into this latter phase of the question, which was essentially the problem to be considered by home authorities and engineers. After an inspection and close study of Continental and British ports, ending in May, 1914, however, he begged to place before the British members of The

The Author. Institution a grave warning. In Canada there was the competition of a great and powerful neighbour, one State of which was willing to spend 130 or 150 million dollars in an attempt to obtain the transportation of the Western products through the State and Port of New York. Would the thrifty people of that State have assumed that obligation if the splendid system of railways, which, according to Dr. Corthell, had for many years practically put the old Erie Canal out of business, were able to hold their own in competition with the Canadian route via the port of Montreal? Montreal was not a large city, although its growth in recent years was worthy of close study by industrial organizations. The port had been developed, against trying odds, by earnest and far-sighted Montreal business men, aided by the Government of Canada. Yet in the last 10 years the Montreal Harbour Commissioners had dared to expend £1,000,000 in one branch of port business, namely, facilities for the storage and handling of grain. In 1913, and again in 1914, with quantities of grain aggregating 60 to 80 million bushels handled in the port, the facilities paid their way handsomely and were filled to their utmost limit, working under the following tariff of charges:—

1. Working out, elevating, weighing, storage in large cool bins for 20 days, weighing, airing and delivery into ocean steamships at their regular berths (0·4d.)	0·8 cent per bushel
2. Tonnage dues on either lake or ocean vessel	None
3. Wharfage on grain (1½d.)	3 cents per ton

The district and port of London had been for centuries the manufacturing and distributing centre in Europe for the products of all parts of the world. It was entitled to that place by its situation, financial position, and population, and by the excellence of its port. The present imports of grain into the United Kingdom in a month were about equal to the exports from Montreal in a year. Surely a large share of this quantity of 600 million bushels imported through the various ports per annum should pass through the port of London. Could it, according to the present charges of the Port Authority? These, according to the published tariff for grain in bulk, were:—

1. Working out from ships; landing rate, storage for 14 days; delivery to vessel at elevator not at regular berth	2·8 cents per bushel
2. Tonnage dues on ship, additional	..
3. Wharfage on grain, additional	..

He had not had a satisfactory answer as to the reason for this The Author. high tariff, as, after inquiries, he was of opinion that land sites of equal comparative suitability could be obtained at London docks at no greater cost than in Montreal. Construction-costs, both for concrete granaries and for working-machinery, were much lower in London than in Montreal. Wages for operating were at least one-third cheaper in London. The only cheaper feature in Montreal was the cost of power. Would not a special comprehensive system for bulk handling in British ports, similar to that at Montreal, be worth considering? The steamship transportation, the port business, the manufacturing of the products, the mercantile profits, and the delivery to home and foreign markets would be the prize. The only reasons for the present conditions advanced in the Discussion and Correspondence, and in conference with the efficient staff of the Port of London Authority, were the following:—

- (1) The fact that grain was received in small parcels and must be handled and delivered in the same, at greater cost.
- (2) The custom requiring grain to be delivered in bags.

Would either of these customs continue if grain in bulk could be taken out of ships, stored for 20 days, and delivered in good condition as desired over conveyers to conveniently located manufacturers at a saving of 2 cents per bushel (2 per cent. of the value), and, in addition, the manufactured product conveniently located for cheap reshipment to home or Continental markets? To mills situated at inland points the grain could be cheaply delivered in bulk in self-dumping box cars of American type.

He referred British members of The Institution to statistics of imports of grain products through Continental ports such as Hamburg, Rotterdam, Antwerp, and Genoa, all having transportation routes to the great manufacturing district in Central Europe, to the increases in their trade by leaps and bounds during the past few years, to the comparative port tariffs, and to the new manufacturing installations situated in and adjoining these ports; also to the cheap means of transportation of the grain to inland points for storage and manufacture. British shipping, ports, manufactures, and mercantile interests had lost a large share of this, and the interest of Canadian members was that this new development incidentally favoured the American route and the port of New York. Only within the past few years had any considerable quantity of Canadian grain been shipped abroad to any but British ports. In 1913, however, one-third of the exports through the port of Montreal was shipped to Continental ports, while undoubtedly

The Author.

COMPARATIVE COST OF DELIVERY OF GRAIN IN BULK AS AGAINST GRAIN IN BAGS. ¹	
Grain in Bulk—	
Elevator charge for loading 8,000 bushels of grain at}	\$
\$2 per 1,000 bushels ² }	16.00
Grain in Bags—	
Bagging and sewing 8,000 bushels in 2-bushel bags at}	\$
1½ cent per bushel }	120.00
Cost of bags, 4,000 at 6½ cents each. }	265.00
Loading 4,000 bags into steamer as follows—	
400 bags to the hour (one gang):	
Eight men, 10 hours each—80 hours at}	24.00
30 cents }	
One foreman, 10 hours at 45 cents	4.50
	<u>413.50</u>
Difference ³	\$397.50

even larger proportions of the Canadian grain shipped through American ports were destined for foreign manufacturers. He had been proud to inspect the magnificently designed and constructed ports of the United Kingdom, and to note their splendid organizations and the integrity visible everywhere in their principles and methods. He deferentially suggested that the lessons which Canadians had learned in their struggle for national and professional existence would be worthy of study by the engineers, manufacturers, and authorities having in their charge British commercial houses and ports; and, personally, he would consider it an honour to welcome them to Montreal, and attempt to return the cordial welcome he had received from the authorities of the various ports in the United Kingdom, and from fellow-members of The Institution.

¹ Sir Thomas R. Price: "Report on The Storage and Handling of Grain," Union of South Africa. 1911.

² The charge at Montreal Harbour is 0.3 cent per bushel (= \$24 for 8,000 bushels).—F. W. C.

³ Nearly 5 cents per bushel.—F. W. C.