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The Canadian Engineer

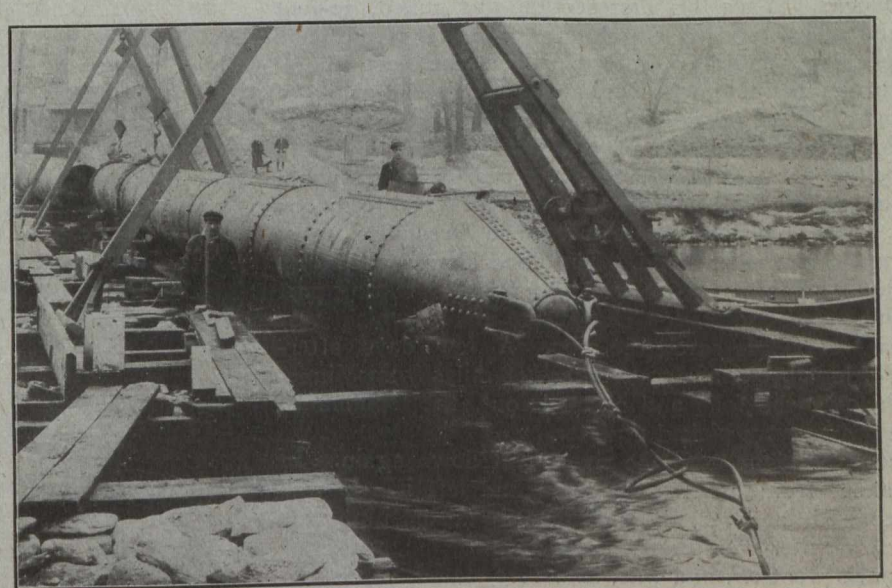
A weekly paper for Canadian civil engineers and contractors

Troubles in Constructing a 48-inch Submerged Main

Cost Details of Shafts and Tunnels—Steel Riveted Pipe Sections each 30 feet long—Description of Plant Used for Pulling Sections Into Place—Paper Read Before American Waterworks Convention Last Month at Richmond, Va.

By F. W. CAPPELIN,
City Engineer, Minneapolis, Minn.

THE distribution system required the crossing of the Mississippi River, just below the Falls of St. Anthony, with a 48-inch riveted steel pipe, ½-inch thick. The river at this point passes through a gorge some 900 feet between bluffs, which on the east side of the river reaches a height of about 100 feet above low water, and on the west side, 72 feet. On the east side there is 39 feet of sand and gravel to the Trenton lime rock; on the west side, about 11 feet from top of ground to lime rock, which is of same elevation on both sides of the river. This rock is 25 feet thick; separated from the underlaying St. Peter sandstone by 3 feet of shale. The St. Peter sand rock is some 800 feet thick. The river has cut through the rock, and the river bottom is filled with broken debris of lime rock and boulders at the deepest point (about 40 feet), then the sand rock.

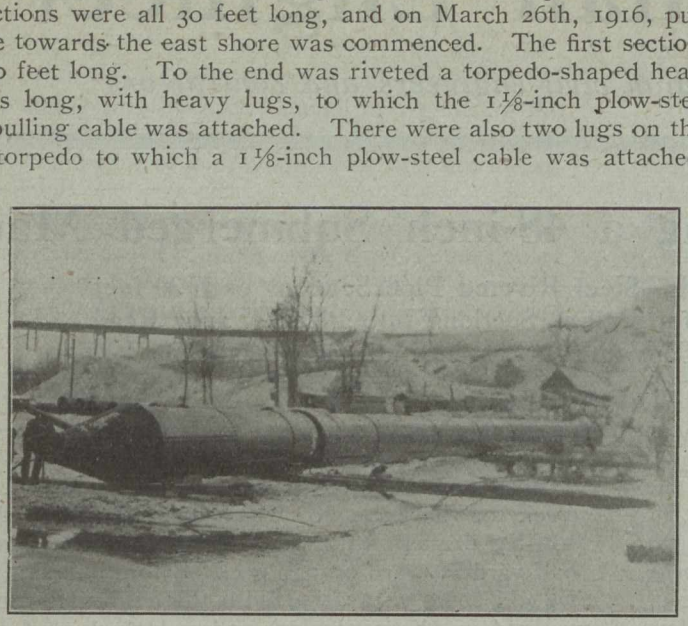


Showing Torpedo Head Just About to be Launched.

Eight-foot shafts were sunk on both sides of the river, and 8-foot by 7-foot tunnels extended from the shaft to the edges of the bluffs—340 feet long on the east side and 60 feet long on the west side—and trenches dug on shores as far as possible. This work was started January 3rd, 1916, and completed May 27th, 1916. As the current is very swift at all stages of water, it would be necessary to do the river work proper in extreme low water, which occurs from the end of December to the middle of March; mostly in below-zero weather. The problem was, how to excavate the trench in the material mentioned. Pile driving was impossible; water being too swift and shallow for a dredge (and no dredge to be had on the river here). It was then decided to build cribs 4 feet wide and 8 feet long, made of 10-inch by 12-inch timbers, with partly planked bottoms; each to be loaded with about two tons of rock. These cribs to be placed about 14 feet centres across the river, and 16 feet on centres up and down the stream. On these cribs across the river, 24-inch I-beams 28 feet long would be placed flatwise to form a running track for the excavator which consisted of an American stiff-leg derrick, with which we expected to handle one-half yard Howard orange peel. Before building the cribs we did some excavating with this rig on the low shore in land on the west side, and it looked as if we could handle the material that way all right, so we started the placing of the cribs with the derrick and run across the river in a short time, completing the runway from shore to shore.

The underframe of the derrick was fitted with grooved wheels which travelled on 40-lb. rails laid loose on the I-beams. The derrick was then sent back to the west end, and excavating operations continued with the orange peel, but as soon as we got into the river we found that the orange peel would not work satisfactorily at all and we changed the rig for excavating by attaching to the boom of the derrick a dipper stick placed about 20 feet from the end of the boom with a ¾-yard steam shovel dipper; the whole apparatus working in a crawfish fashion. The excavation with this machine commenced February 18th, 1916, and the ditch was finished March 17th, 1916. It was a very hard job. The material was exceedingly bad to handle; big pieces of ledge from earlier erosions were often encountered, and they had to be simply dragged out. Some 2,500 yards of this material was excavated and dumped on the down-stream side. All small material was immediately washed away by the current, leaving the heavier stuff in place. As we excavated towards the east side the cribs were removed. As we went along, I-beams were placed on the spoil bank, which were used as a track to carry the cribs, timbers and I-beams back to the west shore. These beams also formed the pathway between the excavator and the west side.

On March 21st, 1916, riveting of the 48-inch pipe was commenced. The sections were all 30 feet long, and on March 26th, 1916, pulling of the pipe towards the east shore was commenced. The first section pulled was 120 feet long. To the end was riveted a torpedo-shaped head 6 feet 7 inches long, with heavy lugs, to which the 1⅛-inch plow-steel iron-centre pulling cable was attached. There were also two lugs on the inside of the torpedo to which a 1⅛-inch plow-steel cable was attached. The



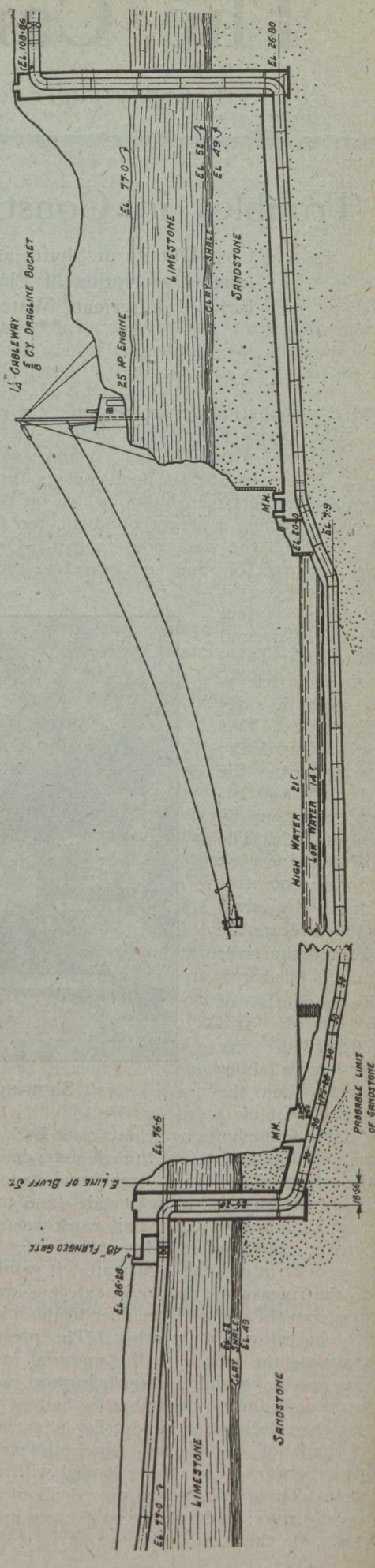
First Section Ready for Pulling.

pulling was done with a 25-h.p. Mundy engine, 125 pounds steam, and two triple sets of blocks. After this first section was pulled, 30-foot sections were added and pulled, and on March 30th, 486 feet of pipe had been pulled, and another day would have landed us on the east shore. This very day the ice broke in the upper river, about two weeks ahead of ordinary conditions, and a big ice gorge which had formed about 15 miles above the falls, broke and a tremendous flood of water came down; in fact, about 54,000 cubic feet per second, which is very nearly the maximum flood recorded on the upper Mississippi since 1860, when 60,000 to 65,000 cubic feet came down. We have a low-water record in December, 1910, for one day with 668 cubic feet per second. The flood simply picked up the pipe and laid it down stream on the flat west shore, only shearing part of the rivets in one joint about midways. The inside cable which was always anchored on the west shore saved the pipe. A few days afterwards, ten million feet of logs broke away at Anoka, 18 miles from Minneapolis, and came down over the falls and cleaned out the spoilbank, I-beams and all. The beams were picked up later.

Nothing further could be done until the river went down again. In July, the pipe was taken from where the flood had left it. It was straightened, joints repaired, and tested, and placed in position for handling again under low-water conditions. Meanwhile, the work of building shafts and tunnels went on, and was, as before stated, completed with lining May 27th, 1916. The shafts were lined with concrete, and the tunnels with 6-inch vitrified tiling.

The ditch was completely filled, of course, after the flood, with light material—sand and gravel, and smaller boulders—and it was decided that the surest and best way to excavate again would be with a drag-line excavating outfit, as follows: The track cable was started from a 14-in. x 14-in. x 48-ft. mast set up on the east shaft; elevation cable hitch about 116; the west end of cable being fastened to a bridle cable subject to pull up or down stream, with a set of ¾-inch double blocks at an elevation of about 31. Total span about 980 feet. The track cable was 1¼-inch plow-steel; the load line was ⅝-inch plow-steel, and the tension line was ¾-inch plow-steel. The engine was a Mundy 8¼ inches x 10 inches (25 h.p.) steam pressure 125 pounds. The bucket was a Sauerman ½-yard. A 20-h.p. engine was placed on the west side. We began setting up cable and engine on September 11th, 1916, and finished September 21st; and began drag-line excavation on the river proper October 16th, 1916, and finished January 20th, 1917.

The material was about as expected, but in the bottom of the trench we ran across large pieces of ledge that probably has been shifted into place during the early stages of the flood, and it became necessary to break these large debris by dynamite before the drag could handle them.

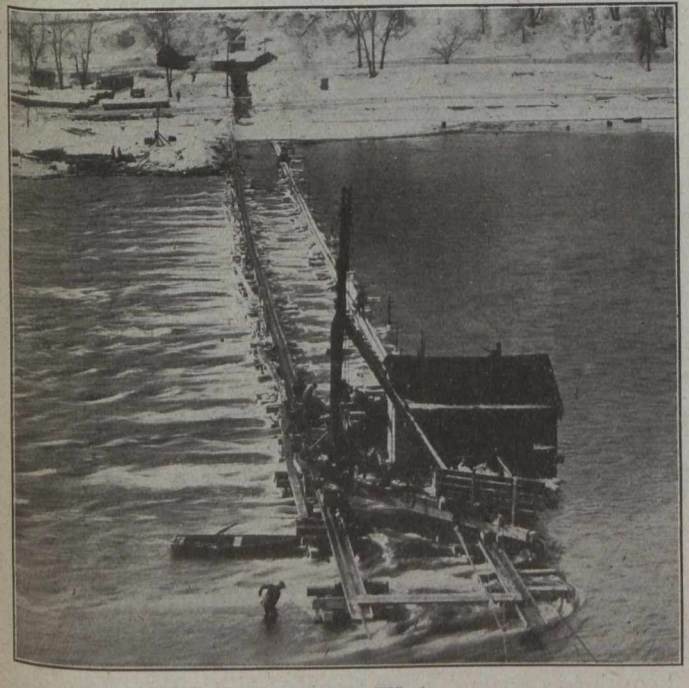


Profile Showing Elevations, Cableway Arrangement.

The drag-line bucket was dumped on staging placed right over the east side trench, and the material was slid down on the spoil bank made on the shore just below the pipe line.

On January 22nd, 1917, we began pulling the river sections of the pipe as before, and completed pulling on January 31st. The last pull was about 15 feet of a total length of pipe of 698 feet. As the pipe was pulled and sections added, water was let into the pipe on the west end, so as to keep it just about afloat above the bottom of the trench. The pipe was gradually lowered into place from the west end, and closed in and riveted up by February 9th, 1917. On the east end a coffer-dam had to be built over the pipe so as to cut off the torpedo head and put in the remaining pipe and make connections with the end of pipe at the mouth of the east tunnel. We had a lot of trouble unwatering the coffer, as we struck sand rock inside of the dam, and no puddle clay could be had—with extreme cold weather—20 below zero right along. However, the east end work was closed in on March 10th, 1917.

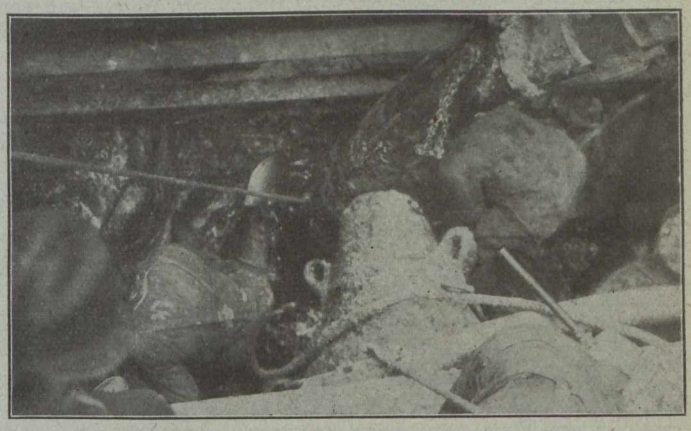
As soon as the pipe had been properly placed, we started to anchor same by placing very coarse fabricked bags filled with sand and cement, 1:4, around the pipe; *i.e.*, filling the entire trench in spots. Ten such anchors were placed, containing 18,000 sacks. The sand and cement was delivered on top of west bluff. The sand was heated and mixed with the cement (dry) in a small mixer and the sacks filled, then slid down a plank chute, wheeled to the river edge, then loaded on the drag-line bucket which we fitted with a small platform large enough to hold 12 bags. The east side engine would pull the bucket out over the pipe in the river and the west side engine pulled it back. As soon as the sacks had been thrown in place,



Looking West.

holes were punched in them by sharp-pointed rods to facilitate the wetting of the contents. The cement set up all right. This particular part of the work was finished March 3rd, 1917.

On March 21st, 1917, the entire work on the east side was finished, with coffer-dam removed, and with everything ready, the expected flood came, which took place April 4th, 1917. The ice gorge broke above Coon Rapids dam, about 14 miles above the falls, smashing some of the gates in the dam, and came very violently, but without doing us any harm, and we were lucky in getting through just in the nick of time. We still have high water, and it is impossible to tell if the ditch is completely filled or not. As soon as the river run secedes, we will



Unwatered Coffer-dam, Showing Torpedo Head.

empty the pipe and examine same for leaks before we turn on the city supply.

Detail Cost of Shafts and Tunnels.

Shafts.

Total vertical feet in east and west shafts, 149.7.

Material.	Amount.	Cost per vertical ft.
Coal for hoist	$ 150.00	$ 1.00
Crushed rock for concrete	237.75	1.58
Dynamite and caps	75.00	.50
Tools, etc.	125.00	.83
Cement for lining shafts	1,000.00	6.67
Use of hoisting machinery	171.45	1.15
Repairs and parts	50.00	.33
Lumber	200.00	1.34
Drilling 6-inch hole through rock for drainage	66.15	.44
Miscellaneous material	40.00	.27
Total	$2,115.35	$14.13
Labor.		
Supervision and foremen	$ 473.91	$ 3.16
Watchmen on engines	1,012.20	6.76
Excavating	1,370.89	9.16
Bracing	208.75	1.39
Sheathing	91.00	.61
Baling water	90.00	.61
Drilling	246.50	1.65
Blasting	34.25	.23
Building trestle	3.00	.02
Cribbing under shaft	5.00	.03
Concreting	286.69	1.92
Rigging up mixer	105.00	.70
Moving derrick	15.00	.10
Placing beams in shaft	76.10	.51
Backfilling	102.50	.68
Hauling materials	401.36	2.68
Total	$4,522.15	$30.21
Total cost labor and material	$6,637.50	$44.33

Tunnels.

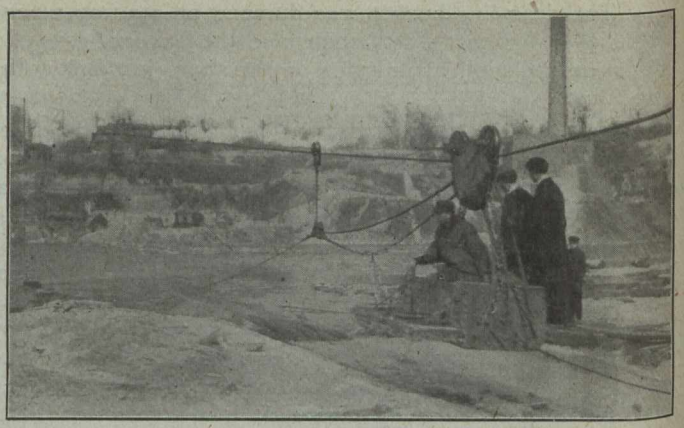
Total length east and west tunnels, 392.0 feet.

Material.		
Crushed rock	$ 174.24	$ .44
Dynamite and caps	75.00	.19
Wall tile for lining	724.66	1.84
Tools, etc.	125.00	.32
Cement	160.30	.41
Repairs	50.00	.12
Lumber	50.00	.12
Drain tile	42.14	.11
Power and lights	75.00	.19
Miscellaneous material	40.00	.10
Total	$1,516.34	$ 3.87
Labor.		
Supervision and foreman	$ 473.91	$ 1.21
Excavating	1,260.28	3.22
Drilling	104.00	.27
Blasting	84.75	.22
Bracing	229.13	.58
Laying tracks	142.20	.36
Excavating for drain tile	72.75	.19
Backfilling	375.63	.96
Laying drains	69.25	.18
Excavat'g for lining wall foundat'n	90.50	.23
Lining tunnel with tile, walls and arch	604.19	1.54
Concreting wall foundations	344.00	.88
Hauling materials	401.36	1.02
Total	$4,251.95	$10.84
Total cost, labor and material.	$5,768.29	$14.71

Detail Cost of River Crossing—48-inch Distribution Main.

Total length of crossing, 1,526 ft.; channel portion, 868 ft.; tunnel and shaft portions, 658 ft.

Material.	Amount.	Per ft. in Channel	Per ft. of Crossing.
1,523 ft. of 48″ x ½″ and 48″ x ⅜″ riveted steel pipe	$16,591.85	....	$10.87
48″ gate and air valves	1,537.69	....	1.01
Lead, cast iron pipe & specials	287.27	....	.19
Fittings & incidental supplies	204.55	....	.13
Bolts, pins, steel and iron	1,001.47	....	.65
Timber, blocking and lumber	2,041.64	....	1.33
Cement for bag anchorage and shore wall	800.16	.94	.52
Sand for above, and for filling trench and coffer-dam	647.34	.77	.42
Burlap bags for anchorage	1,021.31	1.19	.67
Paint and coating material	66.36	....	.04
Cable	371.00	....	.24
Electric power for lights and pumping	48.77	....	.03
Coal for engine and shanty use	1,184.94	....	.77
Oil, gasoline, candles, waste	742.26	....	.48
Dynamite and leads	383.14	.45	.25
Tools, rope, derrick repairs, etc.	1,001.33	....	.65
Transporting machinery	194.55	....	.12
Repairs and parts	387.23	....	.25
Miscellaneous material	139.83	....	.09
Total	$28,652.69	....	$18.77



Drag Line Bucket Used for Filling Concrete Over Pipe.

Labor.	Amount.	Per ft. in Channel.	Per ft. of Crossing.
Excavating and dumping dredged material	$ 2,215.79	....	$ 1.45
Timbering, sheathing, etc.	1,358.84	....	.89
Hauling pipe and specials	728.79	....	.48
Hauling supplies and equipm't	3,210.90	....	2.10
Rigging up engines, cable-ways, etc.	4,062.04	4.79	2.66
Foreman and supervision	2,888.45	....	1.89
Building cribs, etc.	1,598.21	1.88	1.05
Transporting and setting cribs	315.95	.37	.21
Dredging with shovel	2,416.09	2.84	1.58
Dredging with drag line	4,801.61	5.67	3.15
Watchmen on engines & camp	1,473.20	....	.97
Boiler work on steel pipe	4,193.53	....	2.75
Blacksmith, tool work and repairs	1,203.61	....	.79
Cutting pipe	287.88	....	.19
Scraping, cleaning, re-cleaning and painting pipe	481.31	....	.32
Setting 48-in. gate and expansion joints	121.50	....	....
Setting air valves	7.50	....	....
*Laying and erecting pipe in tunnel and shaft	898.68	....	.59
Anchor'g pipe with filled bags	1,490.86	2.20	.98
Unwatering coffer-dam	497.70	.59	.33
Concreting east shore	298.05	....	.20
Pulling pipe into channel	691.43	.82	.45
Moving materials	223.56	....	.15
Miscellaneous work	688.83	....	.45
Total	$36,154.31	....	$23.69
Total cost, labor and material	$64,807.00	....	$42.46

*Unit cost for laying and erecting pipe in tunnel and shaft was $1.37 per foot.

Detail Cost of 48-inch River Crossing, Pipe, Shafts and Tunnels.

Material and Labor.

Length of crossing, 1,526 feet; channel portion, 868 feet; tunnel and shaft portion, 658 feet.

Vertical feet of shafts, 149.7. Length of tunnels, 392.0 ft.

Total cost of pipe and crossing	$64,807.36
Total cost of shafts	6,637.50
Total cost of tunnels	5,768.29
Total	$77,213.15
Cost per foot of pipe in crossing	$50.60

The work was done entirely by the city's forces, as all work in Minneapolis is done by the day-labor system, and contracts are only let for material.

The pipe was furnished by the East Jersey Pipe Company.

Mr. J. A. Jensen, Assoc.M.Am.Soc.C.E., supervisor, was in direct charge.

ENGINEERS DISCUSS RAILWAY PROBLEM.

MEMBERS of the Saskatchewan Branch of the Canadian Society of Civil Engineers held a meeting Monday evening, May 21st, to discuss Canada's railway problem. L. A. Thornton, chairman of the Branch, who was the first speaker, said that the railway problem was, indeed, a big one, and, he might even say, a vital one for this country. The country could not jump at conclusions in a matter of such importance. Every aspect of it must be carefully studied to allow public opinion to express itself freely. The Canadian Society of Civil Engineers had always, and particularly since the beginning of the war, shown a keen interest in all the great questions of the day, and had given all possible assistance in the working out of the vital problems this country has had to face.

Mr. Thornton then referred to the great work accomplished by Mr. W. F. Tye, former chief engineer of the C.P.R., who had, in a paper that would be read to the meeting, explained what he thought was the best solution of the railway problem in Canada.

It must, however, not be forgotten, said Mr. Thornton, that after the war the people will have to bear many heavy burdens besides the financing of the railways, and even if the public were in favor of the government taking over the railways of the country, the people should be given every opportunity of studying the matter very closely so that they might know exactly where they were going.

O. W. Smith then read Mr. Tye's paper, remarking that Mr. Tye's work was one of which not only he himself, but all his colleagues and confreres, might very well be proud.

The "Regina Daily Post," in reporting the meeting, says:—

"H. S. Carpenter next read a paper on the same subject, prepared by Sir Thomas Tait, and which was published in full in *The Canadian Engineer*, of April 12th, 1917. He remarked that Sir Thomas Tait, contrary to the idea expressed by Mr. Tye, would have included the C.P.R. in the consolidation of the railways if such consolidation was to be the solution of the problem, as he considered it would be unfair to the C.P.R. to exclude it and force it to compete with a strongly consolidated railway organization.

"J. U. de Stein was then called upon to read a paper on the majority report of the Railway Enquiry Commission. E. J. W. Montgomery read the minority report of the commission.

"After Mr. Thornton had remarked that the many papers that had been read went to show the deep complexity of the question, and had pointed out that the matter should be given as much publicity as possible to allow the public to form a definite opinion on the whole matter, he declared the meeting open and invited everyone to express their views on the subject. After some of those present had differently commented on the suggestions contained in the various papers, the meeting concluded."

GRANITE BLOCK PAVEMENTS.*

By William H. Connell,
Engineering Executive, Day & Zimmerman, Philadelphia.

IN order to obtain the best results in granite block construction, the first step naturally is to determine upon the specification for the block itself. The American Society of Municipal Improvements have adopted the following specifications for a standard block, as being cut by the majority of the quarries in the United States:—

The blocks shall not be less than 3½ inches or more than 4½ inches wide on top, not less than 4¾ inches or more than 5¼ inches in depth and not less than 8 inches or more than 12 inches long. The blocks shall not show a variation of more than ⅜ inch on the head under a straight edge. They shall be so cut that they can be laid with joints not exceeding ½ inch in width.

The Borough of Manhattan, New York City, has adopted the following specifications:—

The block shall be not less than 6 inches or more than 10 inches long; not less than 3½ inches or more than 4½ inches wide, and not less than 4¾ inches or more than 5¼ inches deep. The contractor shall select a definite width for the blocks to be used on each city block within the limits of this contract and notify the engineer of such selection. All blocks shall be of the selected width with an allowable variation of ¼ inch either way from this width, but within the limits for width of blocks specified above. The blocks shall be approximately rectangular on top and sides and uniform in thickness. They shall be so cut that the joints between individual blocks when laid shall average not more than ⅜ inch. The head of the block shall have no depression greater than ¼ inch from a straight edge laid in any direction and parallel to the general surface of the block.

The city of Philadelphia has adopted a specification which is a mean between the specification adopted by the American Society of Municipal Improvements and the Borough of Manhattan.

Great care should be taken in the handling of the blocks to avoid chipping. Arrangement should be made to carefully unload the blocks from the boats or cars and immediately place them in the conveyances to haul them to the site of the work where the same care should be exercised in their unloading and handling. Rear-end dump vehicles should be used, as drop-bottom wagons unnecessarily damage the blocks. In all cases, the rehandling of blocks should be reduced to a minimum.

It probably appears to the ordinary layman as though there is no great necessity for requiring an inspector with any great ability in connection with laying granite block pavements and it is easily seen how one could hold such an opinion, as the blocks are cut at the quarry to conform to the specifications, and it is only necessary to lay the sand bed or cement mortar bed on a concrete foundation of the required thickness and pour the joints with either cement grout or a bituminous filler. This, of course, sounds very simple, but in order to obtain a first-class job it is absolutely necessary to be more than particular concerning a number of the essential details, without which a first-class pavement is out of the question.

The standard practice to-day specifies either a 1-inch sand cushion or 1-inch 1:4 cement-sand cushion laid dry. A number of the larger cities are rather inclining to the cement-sand cushion in preference to the ordinary sand

*Abstracted from paper read before the Fourth Canadian and International Good Roads Congress.

cushion as it is felt that weaknesses are less apt to develop due to shifting of the sand cushion. The Borough of Manhattan, New York City, the city of Baltimore, the city of Philadelphia and a number of other localities have recently adopted the cement-sand cushion.

The standard practice with reference to the grout for the joints calls for a 1:1 cement grout mixture. There have been a number of experiments in recent years with a mixture of bituminous material and sand for fillers. These experiments were undoubtedly carried on more extensively in the Borough of Manhattan, New York City, than any other place and to a somewhat limited extent in the city of Philadelphia and other cities.

These fillers consist of different mixtures, ranging from 30 to 40 per cent. of sand mixed with bituminous material—either tar, asphalt or asphalt and tar mixed. In Baltimore, they have obtained very good results with an asphalt filler used in the following method: They pour hot asphalt to a depth of 1 inch, about 1 inch depth of hot gravel, and repour and refill with hot asphalt and hot gravel alternately until the joints are flush. I am informed that this usually takes approximately four pourings. After the joints are filled, the hot asphalt is squeegeed over the entire surface of the blocks and hot gravel is then thrown over this before traffic is allowed on the pavement. This gives an asphalt surface of about ⅛ of an inch on top of the granite block, giving the street the appearance of a sheet asphalt pavement.

The best results in granite block construction are undoubtedly obtained with the cement grout filler, and it would seem to be good practice in every instance to make arrangements to close the street the additional seven to ten days and construct the pavements with grout fillers. Of course, there are some streets that it is practically impossible to keep the traffic off for this length of time, and in such cases it will be necessary to use the bituminous filler, but there are a number of instances where bituminous filler is used, where the traffic conditions have been such that the street could be closed for a long enough time to use the cement grout filler.

The old method in using cement grout filler was to fill the joints for a certain depth with pea gravel and then pour the cement grout filler. It has been found, however, that better results are obtained by eliminating the gravel entirely and filling the whole joint with the 1:1 mixture, and this method is used exclusively in a number of cities. There has been considerable discussion relative to the best means for mixing the grout. Of course, just as good grout can be mixed by hand as by machine, provided it is given the proper attention, but more uniform results will be obtained by adopting the machine-mixing method, as this eliminates the human element which often is not properly controlled.

The cement grout, of course, must be kept thoroughly agitated until it is poured into the joint, and the blocks should be thoroughly sprinkled before the filler is placed in the joints.

All of these essential details which, carried out to the letter of the law, go to make up a good pavement, appear to be so simple that in many cases the inspector and the workman are more or less lax, the result of which will show in the construction immediately after it is completed or within the next few years. A good job can only be obtained by strict attention to these apparently trivial but very essential details in the construction. The pay of inspectors on highway work usually ranges from $3.50 to $6 per day, and most engineers with experience will bear out the statement that a thoroughly capable inspector, judged by the standard of the average highway inspectors, is worth $10 per day to the community. A great many of the failures in paving construction are due, not always to dishonest inspection but careless inspection, and it would seem as though this branch of the service has not been given the consideration it should, and if it is necessary to pay $10 per day to obtain the right kind of inspectors, it would be far better to do so than to lose more than the increase in salary through poor work as obtained through careless inspection.

Of course, it is perfectly obvious that in order to lay good pavements we must eliminate all possible conditions that are liable to result in failure. In doing this, we must also take into consideration the human element and provide for methods of construction that will, as far as possible, eliminate the personal equation entering into the construction; or, in other words, we should not depend any more than is absolutely necessary, in such an essential matter as this, on perfect workmanship.

Some question has been raised relative to the tests for granite block. Some cities specify that the blocks should come from certain definite quarries, or from a quarry that will be acceptable to the engineer. There should be a more definite method in stipulating just what the requirements should be than to leave it up to the personal judgment of the engineer. After making an inspection trip of the different quarries and an investigation of stone laid by those quarries, it has been determined to make the test for the Philadelphia specifications as follows:—

Compressive Strength.—The granite shall have a compressive strength of 16,500 pounds per square inch, except when unusually heavy traffic conditions are to be encountered, in which case the compressive strength shall be 20,000 pounds per square inch. It is understood, however, that a strength of only 16,500 pounds will be required unless definitely stated otherwise in the proposal. The toughness shall be not less than 11, as determined by the method employed by the United States Department of Agriculture.

However, it might be stated that these requirements are not entirely satisfactory. Very extensive studies and tests are being made in Philadelphia at the present time to determine upon new standard tests that will insure satisfactory results. Of course, it must be borne in mind that on streets such as West Street in New York, where you have an enormous amount of heavy steel-tired trucking, that it is desirable to use the hardest granite that can be secured, but at the same time not be so hard that it will be brittle and chip, and on such a street it might be desirable to raise the crushing strength to at least 30,000 pounds. However, the New Hampshire and southern granites that test from 15,500 upward are entirely satisfactory for probably 95 per cent. of streets where it is desirable to use a granite block pavement. The Worcester, Mass., pavements, which have been in service upwards of 15 years, and have had practically no money spent on them for repairs, are the softer granites and they have proven entirely satisfactory on heavy traffic streets.

A very important matter in the construction of granite block pavements is the proper ramming of block. Where the specifications do not state the number of rammers that shall be employed to follow up the work of a definite number of pavers you will invariably find that the ramming of the block is neglected and that the contractor will employ just enough rammers to slightly ram each block. Of course, the pay for rammers is about $3.50 per day, and the fewer the contractor has to employ the cheaper the

work can be performed, so that instead of stating that the blocks must be thoroughly rammed, it is most important to state the relative number of pavers and rammers that shall be employed, as is stated in the following quotation from the Philadelphia specifications:—

Number of Rammers to be Operated.—On all granite block pavement construction the number of rammers to be operated shall be in the proportion of 1 rammer to every 2 pavers.

SOME GENERAL PRINCIPLES OF PHYSICAL VALUATION.*

By Geo. F. Swain, LL.D.,
Professor of Civil Engineering, Harvard University.

THE word "value" is one of the most uncertain in the dictionary of economics, and several distinct meanings are given in treatises on that subject. An object of little or no intrinsic value may have value for its possessor, but none for any one else; that is to say, its value may be entirely sentimental, and it would fetch nothing in the market. Again, an object of great intrinsic value, measured by its cost or by the cost of reproducing it, may have no value whatever in the market, because it possesses no sentimental value or no earning power; or again, an article or a property of little intrinsic value, measured by its cost or the cost of reproducing it, may have great value in the market because it has great earning power.

By the word "value" the economist usually means value in exchange; that is to say, the price which the article or property would bring as between a willing seller but one who is not forced to sell, and a willing buyer but one who is not forced to buy.

There is no sentiment about a commercial property like a railroad. The real value of such a property is measured by its earning power and by nothing else. No matter how costly or how inexpensive it may have been originally, its value in exchange will be measured by its earning power. Prospective earning power, perhaps under altered conditions, must of course be considered. Some properties, therefore, have a so-called "strategic" value, because, while they may earn nothing by themselves, they may be combined with other properties in a way to produce or enhance earnings.

If property is valued for the purposes of sale to a new owner, earning power, with the explanation above given, will therefore be the proper basis, taking account, in other words, of the uncertainties and potentialities of the future. This, however, would not be a physical value; that is to say, the value might include a large sum to represent location, good-will, patent rights or other elements which cost little or nothing, but which produce earning power.

In the case of a public utility corporation, a valuation is generally made either for the purpose of regulating capital, or for serving as a basis of rates to be charged, or for condemnation, or for purposes of taxation. For purposes of taxation or condemnation, earning power may be fairly taken into account. For purposes of fixing rates, which are themselves sources of earnings, it would clearly be reasoning in a circle to base the value upon earning power; for purposes of capitalization, earning power has clearly no direct or necessary connection; in these cases, it is the physical value of the property which is to be determined; that is to say, the value of the various physical elements which go to make up the property.

To determine this physical value there are two, and only two, available bases:—

(1) The original cost, or original cost less depreciation, according to circumstances;

(2) The cost of reproducing the property at or about the time the valuation is made, or, the cost of reproduction new less depreciation, according to circumstances.

These two bases are entirely distinct, and should be kept so throughout the valuation; whichever basis is adopted, it must not be confused, with reference to any of the elements of value, with the other basis, otherwise, confusion will result, and the conclusion arrived at will be unintelligible. If the original cost is to be found, it must be found without the slightest reference to what any part of the property would cost if reproduced at the time the valuation is made. If the cost of reproduction is to be found, it must be found entirely without reference to what any part of the property cost originally. The result will then be either the original cost, or the cost of reproduction new, and this result can be used intelligently and with due regard to circumstances, and as to whether it is a fair measure of value. Much of the confusion with regard to the subject of valuation has arisen from combining these two methods.

The valuation of a property is generally for the purpose of ascertaining what the courts have termed "the present value" or "fair present value." Just what the present value, or the fair present value may be, is not easy to state, and probably cannot be stated. The courts, however, have frequently stated what it is not. They have again and again laid down the principle that it is not original cost. In some instances they have stated that it is not the cost of the reproduction new, but it is generally admitted, I think, that both the original cost and cost of reproduction new, and also the depreciation, depending upon circumstances, are all elements which may affect the judgment as to the "fair value."

If the problem of the Railway Inquiry Commission were to determine the first cost of the properties which we have considered, this would have been a problem for accountants and not for engineers, except, perhaps, for some engineering advice on certain pertinent matters. The properties in question, namely, the Canadian Northern System and the Grand Trunk Pacific, have, for the most part, been constructed within a comparatively few years. To determine their cost would be purely a bookkeeping proposition, to be performed by expert accountants, with the aid of sworn statements, affidavits, vouchers, etc. Some of the lines of the Canadian Northern, however, are old lines which have been taken over into the system within recent years. I do not know what records are available, but it is very possible that to determine the original cost of these properties would be impracticable.

I have assumed, therefore, and I think it is clearly evident from the above brief discussion, that the problem assigned to me, that of making an approximate physical valuation of these properties, must necessarily be that of ascertaining the cost of reproduction new of these properties, and not the first cost. In other words, it is desired to ascertain what present investment in money may fairly be said to be represented by the physical properties concerned. If certain elements of value which originally cost little or nothing, like some of the real estate, have appreciated in value; the enhanced or present

*From report to the Royal Commission to Inquire into Railways and Transportation in Canada.

value is to be ascertained. If this was not the object, my valuation, as above stated would be unnecessary.

With the exception of the land, however, and those lines of the Canadian Northern System which are old lines recently incorporated into the system, in other words for the portions of the lines considered which have been built within recent years, the cost of reproduction and the original cost should nearly coincide. The land values themselves should probably not differ greatly, except in the large cities, where in some cases, land costing little originally has now become very valuable, so that its first cost and its cost of reproduction would be very different. In the case of the older roads recently bought and incorporated in the Canadian Northern System, the cost of these properties to the Canadian Northern Company might differ greatly, both from the original cost of the properties and from their cost of reproduction new at the present time. They may have been bought at very high or at very low prices, as compared either with first cost or cost of reproduction.

These principles were briefly discussed with the Commission before the beginning of the work. The problem, therefore, to be performed by the force under my direction, was to ascertain the cost of reproduction new of the properties in question at the present time. By the phrase "at the present time" is not to be understood the present moment, in view of the inflated prices for materials and labor which have come about as a result of the war; but rather, the fair cost of reproduction new, assuming that the properties were to be reproduced at fair average prices prevailing during a brief period of years just before the war.

LAKE OF THE WOODS REPORT.

The members of the International Joint Commission, when at Detroit recently, signed the report on the Lake of the Woods levels, and it is expected that this report will be delivered to the Canadian and United States governments this week. The two officers of the commission are now engaged in getting into shape some material supplementary to the report. It is probable that the report will be made public at an early date by the two governments. It is understood that accompanying it will be nine volumes, three of which are the consulting engineers' reports and maps and the remainder consisting of testimony and arguments.

That the United States Steel Corporation has appropriated up to date about $9,000,000 for building the company's Canadian plant at Ojibway, Ontario, is a statement made by Judge E. H. Gary, chairman of the company, to *The Canadian Engineer*. The construction on foundations, docks, etc., has been commenced.

The Manitoba government has established a purchasing department. Everything required by any of the departments will be requisitioned and put through the purchasing department. The head of the new department is Mr. E. A. Gilroy, former auditor of purchases, and he will be known as the government's purchasing agent. Mr. H. Hurd will be the assistant purchasing agent.

The British government is taking more ships from the Pacific routes and the Empress vessels of the Canadian Pacific Railway may be diverted. The ships being taken off the Pacific are being used for the greater part on the North Atlantic to carry foodstuffs and munitions to Britain, France and Italy. Some may be used during the open shipping season at Archangel, Northern Russia.

TAKING TRAINS TO THE TRENCHES.

DOUGLAS S. ROBERTSON, special correspondent at the front for the Toronto "Evening Telegram," has written an interesting account for that paper of the construction and operation of narrow-gauge railroads behind the fighting lines in France. He says that where the guns are roaring Canadian railway building is proceeding with all the push and go it ever exhibited on the western prairie. But the engineers and contractors have stars on their sleeves, and the men are all in khaki.

Canadian railway battalions are now handling the greater part of the railway construction behind the British front. Of the five assistant directors of light railways, no less than three are Canadians. Shells are delivered by rail right to the guns; rifle ammunition is hauled within a stone's throw of the firing-line; food and materials of all kinds are readily despatched to wherever needed; wounded are carried quickly to the base; and troops are shifted to and fro. Motor transport behind the lines has cost some fifty cents per ton per mile, says Mr. Robertson, whereas by railway the cost is about one cent, and, although the motor transport serves its useful purpose, the railway is more reliable.

Twisting and twining in sinuous curves, the light railways reach out to all parts of the battlefield. Every spur is constructed with double loops, so that should shell fire or other mishap destroy one loop, the alternative loop may be used. So numerous are these light lines, and so well planned, that traffic can never be altogether held up under any conceivable circumstance of mishap. They fairly gridiron the country back of the lines.

Stopping at a safe distance in the rear, the standard gauge lines unload their tonnage at the various ammunition dumps, whence it is moved to the trenches and the guns as required. The locomotives are largely steam-driven 17-ton Baldwins. The cars for the most part are like small editions of the Gondola coal cars. They measure 17½ ft. long by 5 ft. wide and are equipped with hand-brakes. These cars have a capacity of 2½ tons. By virtue of collapsible sides they can be transformed into flat cars. The railways are largely operated by despatchers, who use the telephone system.

Grades are fairly easy on these light roads. There is no rise greater than 1½ per cent., and no sharper curve than 20 per cent. There are some large cuts and fills. Broken stone and brick are used extensively for ballast, as a firm roadbed is necessary when moving heavy loads of shells. Many of the ties are cut in the woods of France by Canadian forestry battalions.

Although the light lines are built and maintained by Canadians, they are largely operated by British, Australian and New Zealand troops, enlisted specially for such work. Each repair train carries an electric generator, driven by a gasoline engine. These repair trains consist of a considerable assortment of machines, such as shapers, lathes, metal saws, drills, grinders, etc., all electrically driven.

"Tamping ties and driving spikes," says Mr. Robertson, "running transits and taking levels, the laboring and the professional sides of railroading, may be prosaic enough occupations at home, but here they are not only useful in the highest degree, but also they are fraught with no small portion of the soldier's risk. Every bullet has its billet and every shell its destiny. And not a few Canadians made the great sacrifice when helping to win the war with railroads."

MONTREAL AQUEDUCT REPORT

Steam Plant Would Have Been Better Than Enlargement—Report by Messrs. Vautelet, S. Laurent and McRae

(Continued from last week's issue.)

IN the case of abandoning the power development, there is no land available for boulevards and the aqueduct is used only to bring water to the pump-house of Atwater Avenue.

We have, however, included the cost of finishing the south wall to the rock cut to correspond to the north wall ($43,300) to allow of the completion of the aqueduct at some future time, if it is ever deemed advantageous.

We have also included an arbitrary amount of $279,575, being 15 per cent. of the cost of the uncompleted part of the contract. This amount may be increased or decreased in the final settlement with the contractor.

We have included, as we have done in all cases, the interest until the completion of the work, although the city is not allowed to charge interest to capital account. In this case it amounts to $1,072,948. We have estimated the cost of abandoning the work at $5,895,000.

Scheme 1.

Present city scheme, but with mean velocity in headrace limited to 1.5 feet per second.

From the preceding considerations in studying the power obtainable, as based on the present plans, under winter and summer conditions, leaving out the question of frazil, we have assumed the mean velocity at 1.5 feet per second (1.02 miles per hour) in the headrace, on account of the nature of the earth bottom.

As it is intended to provide a substantial paving for the bottom of the tailrace, a velocity of 8 feet per second (5½ miles per hour) will not be excessive, and we have adopted this figure as the maximum mean velocity in the tailrace.

It is assumed that in winter there will be an ice covering of two feet in the headrace, though it is possible that during excessively cold winters, a slightly greater thickness of ice may form.

In the tailrace, on account of velocities being higher than 3.5 feet per second (2.4 miles per hour) there will be no ice covering in winter.

This power has been calculated for normal conditions, winter and summer respectively. Floods and frazil will cause unfavorable conditions from time to time, probably every year, either on account of loss of head or decreased flow, and it is to be distinctly understood that at such times the power stated will be considerably reduced. The only remedy against floods and frazil troubles is an auxiliary steam plant which must form a necessary adjunct to the water power scheme under consideration.

We find that for the limiting velocity of 1.5 feet per second (1.02 miles per hour) in the headrace, and under other conditions mentioned above, the power available, as based on the lowest winter month, and the lowest summer month average gauge readings respectively, at both entrance and outlet gauges, is as follows:—

Winter	7,445 h.p.	5,600 e.h.p.
Summer	11,900 h.p.	8,900 e.h.p.

The headrace is the controlling factor in both cases; that is, the tailrace, as designed and paved all through, is large enough to pass all the flow of the headrace, with velocities well under the limit of 8 feet per second as fixed. In fact, the highest velocity produced in the tailrace under this scheme will not be over 6.2 feet per second.

We have assumed that the summer power of 11,900 h.p. will be available for 7 months, so that during the 5 winter months the power of 7,445 h.p. will be available, say, for 2.6 months, and that there will be no water power available for the balance of the 2.4 winter months, pumping during the periods of deficiencies being done by the auxiliary steam plant.

We have shown before that the city will, in the near future, need to pump a daily average of 100 million Imperial gallons of water for domestic supply. The power required for pumping this quantity of water will be 8,570 h.p.

In this scheme there is no paving provided for the headrace and as paving will certainly be required in a good many places, the velocity could then be increased. If this were done, Scheme 1 would practically become Scheme 2.

The filtration plant at its present capacity of 50,000,000 Imperial gallons per day when placed in operation will require 2,960 h.p. for pumping and for electric heating, as at present installed. When it is increased to a daily capacity of 100 million gallons, the power required for both pumping and heating will be 3,270 horse-power. The filtration plant could be heated by exhaust steam from the auxiliary plant at a greatly reduced cost, as compared with electrical heating.

With this change in the heating system the filtration plant will require 1,910 h.p. for pumping when the capacity is increased to 100 million gallons per day. The plant under Scheme 1 must then produce power as follows:—

Needed for pumping 100 M. I. G. per day...	8,570 h.p.
Needed for elec. current for filtration per day	1,910 h.p.
Total	10,480 h.p.

During the summer period, say, for 7 months, the water power development will take care alone of the above requirements. During the winter period the development will require the help of a steam auxiliary, and our estimate for the scheme to meet all conditions is given below:

	Total cost.	Operation cost.
Actual needs	$8,537,000	$590,000
Future needs	9,177,000	679,000

The amounts charged for interest are, in the first case $1,200,744, and in the second case $1,231,234. This project includes the cost of land for boulevards and the cost of Lasalle Bridge.

Scheme 2.

Winter power, 13,000 h.p.; summer power, 24,500 h.p.

In Scheme 2 we have considered possible improvements to the present scheme, and have studied the conditions which will give a maximum practical hydraulic development for the city. This scheme is based on the following assumption and alterations to the present scheme:—

The headrace remains the same, excepting that the earth sections are paved with concrete and the sides of the rock cut below the gravity walls given a straight and smooth concrete facing instead of the irregular concrete finish called for by the specifications.

The paving we have considered is the same as specified in paragraph 38, page 8 of the specifications for contract No. 2.

The surface ice in winter is assumed to be two feet thick.

The tailrace is radically changed. It is widened from 113.85 feet to 172 feet; the bottom is paved with concrete one foot thick, and the grade altered from 4 feet to 2.5 feet in 2,900 feet, the bottom at the outlet remaining at elevation 2.00 above datum.

Under these conditions we estimate that the scheme is capable of the following power development: Winter, 13,000 h.p. (This power is subject to decrease or interruption on account of frazil or anchor ice. It is based on the lowest average winter month for 19 years (1895 to 1914); velocity in headrace, 2.82 feet per second); summer, 24,500 h.p. (Based on the lowest average summer month in two years, which is the only period of time for which we have any gauge records).

The maximum mean velocity in headrace is limited to 3.25 feet per second. The velocity in tailrace is limited to 8 feet per second.

We have estimated for a development of 13,000 h.p. winter and summer, which will be used as follows:—

Needed for pumping 100 M.I.G. per day....	8,570 h.p.
Needed for elec. current for filtration per day	1,910 h.p.
Total needed	10,480 h.p.
Excess power	2,520 h.p.
Total	13,000 h.p.

As in the case of Scheme 1, this hydraulic development must be supplemented by an auxiliary steam plant to provide power during times of ice and frazil troubles.

It is also assumed that the 13,000 h.p. above mentioned will be available for seven summer months. During the five winter months we have assumed that on the average there will be a decrease in hydraulic power equivalent to a complete shut-down of 2.4 months each year; during that time power will have to be furnished by the auxiliary steam plant.

Additional power over the 13,000 h.p. may be produced during the summer only, at a cost of $5.06 per h.p. or $6.74 per e.h.p. It has no market value.

We have not taken it into account in our calculations, except by providing foundations for a future extension to the power house, should it be decided later to utilize this additional summer power.

Thirteen thousand horse-power will pump a yearly average of 124,000,000 gallons per day, but in that case the summer average will be 142,000,000 gallons per day, and the auxiliary steam plant shall have to be used during the summer.

If instead of developing 13,000 h.p., 2,000 h.p. are developed in addition, out of the additional 11,500 h.p., then the summer average of 142,000,000 can be pumped by hydraulic power and the cost of operation on the h.p. basis will be reduced from $56.90 to $50.35.

Part of the balance of 9,500 h.p. may also be used to pump large quantities of water during the summer only, to provide water for fountains, parks etc., and to clean the streets. This water can be pumped at a cost of $3.20 per million gallons.

Another part of the balance might also be used for refrigeration of cold storage warehouses or to manufacture cheap ice. We have estimated from accurate data that the capital cost required for an ice manufacturing plant of a capacity of 300 tons per day, during seven months, if located at Atwater Avenue, would be $337,000. This amount might be diminished by about $60,000, if the buildings of the present pump-house (which would then have been moved near the filters) were used for the ice plant and as a garage for the motor trucks used in its transportation. This plant would manufacture ice from filtered water, at a cost of 54c. per ton. We have estimated that the cost of delivery at different central places, such as the bath houses of the city, would be about 45c. per ton, so that the cost of ice delivered (not distributed) would be about $1 per ton. One ton would provide 100 blocks of 20 lbs. of ice at a cost of 1c. per block.

We have calculated the cost of developing 13,000 h.p. summer and winter, as follows:—

Total cost	$10,609,000
Cost of operation	740,000
Amount charged for interest	1,299,398

Scheme No. 3.

Summer power	9,500 h.p.
Winter power	5,000 h.p.

Scheme No. 3 provides for enlarging the headrace with sloping banks without boulevards; the tailrace is the same as provided for in Scheme No. 1.

We limit the mean velocity in the headrace to 1.5 ft. per second. Two feet of surface ice will form in winter.

The lowest average summer month in two years is November, 1908, when the power produced would have been 9,500 h.p. The headrace is the controlling factor, and the velocity in the tailrace is 4.1 ft. per second.

The lowest winter month is March, 1912, when the power produced would have been 5,000 h.p., with headrace as controlling factor.

That part of the headrace situated in the rock section, 6,000 ft. in length, will be practically as shown on present plans, except that on the south side the bank will be sloping above the lodge instead of being supported by gravity walls as on the north side, where they are built.

In the east earth section, for a length of 14,000 ft., the banks slope 2 to 1. Between stations 140 and 128, the width at bottom will be 130 ft. Between stations 128 and 44, the width at the bottom will be 91 ft.; this section will govern. Between stations 44 and 0, the width at the bottom will be 122 ft. We have estimated the cost of Scheme No. 3 as follows:—

	Actual needs.	Future needs.
Total cost	$7,515,000	$8,205,000
Cost of operation	504,000	648,000
Interest charged	1,152,076	1,184,924

In this scheme there is no land for boulevards; the walls are built only in the western earth section, and the tailrace is built only large enough for the production of 9,500 h.p. It could be increased in capacity at some future time, as per Scheme No. 2, but in that case the tailrace would have to be enlarged and the walls demolished, and new bridges required for Wellington and Buffalo.

Cost of Pumping by Steam. (Scheme No. 4.)

In this scheme there are no boulevards. To pump 100 million Imperial gallons per day, we calculated, first, the cost of adding two new DeLaval pumps and new boilers to the existing plant.

The existing plant has been lately valued by Supt. Lesage at $674,000. With additions, its total value would be $1,032,696, and the cost of operation $494,924 per annum. We have also estimated the cost of an entirely new plant, consisting of six DeLaval units of the same capacity, with new boilers, buildings, etc.

The capital cost is $769,240, and the operating cost is $369,744 per annum.

There is, therefore, a difference in favor of the new plant of $125,180 per annum, and, even if we add 5 per cent. of $674,000 to cover the dead loss of the old plant, the difference will still be $91,480 per annum in favor of a new plant.

This difference would, in reality, be much larger, owing to the necessity of remodelling the old plant, and to the difficulty of supplying water to the city during the remodelling.

When the work is completed it is planned to have the water flow by gravity from the filtration plant to the steam pumps, increasing the suction by about 12 feet. If the steam plant is not to be altogether discarded it will have to be remodelled to suit the new conditions and considerable piping shall have to be done.

The best location for the steam pumps would be near the filtration plant, as that plant could be heated by exhaust steam, instead of electricity as it is now.

The current used for heating by electricity is paid by Tariff I. of the city. When the addition to the new plant is made (and this should be done at once) the cost of heating would be at actual rates, at least $25,000 per annum. This amount would be saved each year by using exhaust steam. Large quantities of steam will be available for heating, if required, at no extra cost.

We have estimated the cost of pumping by steam as follows:—

	Capital cost.	Cost of production.	Interest charged.
Actual needs	$6,434,000	$546,000	$1,098,590
Future needs	6,703,000	712,000	1,111,411

The plant we have estimated on, which employs DeLaval pumps, hand-fired boilers and cheap fuel, as designed by Supt. Lesage, gives excellent results, but the cost of labor, which is, in this case, an important item, might be diminished by the use of mechanical stokers. In that case we have estimated the saving at $24,000 per annum, and the increase in capital cost at $56,000. As the saving would be the same for all schemes, except Scheme 5, we have left it out of our calculations.

Cost of Pumping by Electricity. (Scheme 5.)

In this case we have used for the cost of electric current the rate of $30 per e.h.p., according to the present contract with the Montreal Light, Heat and Power Co.

At the request of Commissioner E. W. Villeneuve we wrote to the companies supplying electric power in Montreal, and enclosed Mr. Villeneuve's letter, asking at what rate the companies would be prepared to supply the city with power per day of 24 hours for a period of 25 years.

We received two letters from the Montreal Light, Heat and Power Co., advising they would be prepared to undertake the street lighting of Montreal at the present prices for a period of 40 years from date, and also quoting tentatively for 3-phase alternating current, 11,000 volts, delivered at the city pumping plant, Atwater Avenue, $25 per annum per h.p. (probably e.h.p.) of maximum demand on the basis of a 20-year contract, and $24.50 per annum per h.p. (probably e.h.p.) of a maximum demand on the basis of a 40-year contract. This for 24 hours' service.

The current which is now furnished to the city for 24 hours' service is of two kinds:—

1. A current of 2,200 volts in units of 400 e.h.p. or more at a cost of $30 per annum.

2. A current of 2,200 volts in units of from 100 to 399 e.h.p. at $35 per annum.

Current at 11,000 volts would have to be stepped down for use, and to the price of $25 would be added the operation cost of transformation and electric losses.

The average pumpage at Atwater Avenue is at the rate of 54,000,000 Imperial gallons per day. On account of the insufficient reservoir capacity the output varies from 73,000,000 maximum to 45,000,000 minimum. This variation greatly increases the cost of power for operating.

When the city buys power from a company for pumping the company must be ready to deliver it for the peak load at any time, and very properly charges for the said peak load all year long at $30 per e.h.p. For instance, at the McTavish pump a test was made, showing that the pump, working at full capacity for two hours, was pumping at the rate of 5,760,000 gallons per day, and used 523.5 e.h.p. The city paid $15,660 for power used at McTavish Street in 1915, or for 522 e.h.p. at the rate of $30 per annum. During that year the average daily pumping was 4,620,000 gallons, which requires about 420 e.h.p. The cost of this average power is, therefore, $37.35 per e.h.p., or an increase of about 25 per cent.

At Papineau Avenue, where the nominal rate is $20 per e.h.p. per annum, the cost of power actually used was $27.72, or an increase of 38 per cent., the difference between the percentages of increase being due to the respective efficiencies of the pumps.

In the absence of complete details of the terms on which electric power would be supplied for this service we have based our estimates on the following:—

First—Buying power at $30 per e.h.p., maximum demand.

Second—Buying power at $25 per e.h.p., maximum demand.

(As per terms of present contract.)

	Total Cost.		Cost of Operation.	
	Actual.	Future.	Actual.	Future.
	$	$	$	$
Scheme 5 at $30 per h.p.	6,102,000	6,268,000	565,000	712,000
Scheme 5 at $25 per h.p.	6,102,000	6,268,000	529,000	656,000

The amounts charged for interest are:—

	Actual.	Future.
Scheme 5	$1,082,524	$1,090,191

It is recommended that at least two power transmission lines be installed to the pump-house in case of purchase of power. The present steam plant and its emergency intake is a further insurance against any serious interruption of your service.

We must point out that the maximum pumping occurs only during four months of summer, during which

time the companies have an excess of power, whereas in winter the maximum is very seldom above the average for the whole year, and it could easily be arranged never to exceed it. The power companies might possibly be ready to grant better terms to the city if the facts were better understood.

Electric Lighting.

We have seen that in case the filtration plant is heated by exhaust steam the power needed in the near future by the city will be as follows:—

Pumping at Atwater Avenue	8,570	
Filtration plant	1,910	
		10,480
Lighting		4,330
Total		14,810 h.p.

None of the schemes we have considered gives enough power for lighting. The only question before us, therefore, was to find out whether it would be cheaper for the city to buy power and do its own lighting, or have the lighting done by contract as at present.

We have estimated for the near future on 3,000 lamps of 6.6 ampères and 2,000 lamps of 4 ampères, as per Mr. Parent's report to you, dated Setpember 12th, 1916, assuming wires underground for a distance of 25 miles of streets and aerial distribution for 425 miles of streets.

We estimated that for the city to do its own lighting would require a capital cost of $1,670,000, and the cost of operation, not including the cost of current, would be $286,000 per annum, and that the cost of lighting by contract at present prices would be $365,000 per annum. This would leave a difference available for current of $79,000 per annum, or $18.24 per h.p., or $24.32 per e.h.p. at Atwater Avenue.

We must remark, however, that the price of current is a small item of the cost of lighting, but that the place where the current is delivered has great importance on this item, so that if the current could be bought by the city at $25 per e.h.p., delivered at sub-stations, the cost of doing the lighting and buying current and the cost of having the lighting done by contract would be equal.

It must be noted that should the city take over the lighting it will no doubt have to erect some 18,000 extra poles. This should be guarded against, and it is suggested that all the aerial systems be placed under the control of the commission now in charge of the underground work. There is no doubt that in that case the cost of lighting would be materially lessened.

We have seen that Scheme 2 has 2,520 h.p. available, and that there will be 25 miles of street with wires underground. The city pays for the lamp-posts, the cables laid in place, and pays also the rent of the conduits where the cables are laid. When the price of copper has become normal, the city might undertake that part of its lighting. For the time being it would be more advantageous for the city to continue to have the lighting done by contract, as at present, leaving the consideration for doing its own lighting for some future time, in case it could produce electric current at a lower price than it could be bought, and when the price of copper would have become normal again.

The amount of interest for each scheme shown in the following table must be deducted from the total cost of each scheme, as the city is not allowed to charge interest to capital account, but must charge it to current expenditure.

Financial Statement.

Loans authorized:		
Issued	$6,701,000	
To be issued	3,799,000	
		$10,500,000
Estimated discount		319,000
		$10,181,000
Less filtration works	$1,894,490	
" pumps	72,137	
		1,966,628
Amounts available for aqueduct		$ 8,214,371
Amortized at end of 1916		274,608

Interest Charges.

	Actual needs.	Future needs.
Work abandoned	$1,072,948	$1,072,948
Scheme 1	1,200,744	1,231,234
" 2	.....	1,299,398
" 3	1,152,076	1,184,924
" 4	1,098,590	1,111,411
" 5	1,082,524	1,090,191

Amounts Chargeable to Capital Account.

Work abandoned	$4,821,898	$4,821,898
Scheme 1	7,335,880	7,945,675
" 2	.....	9,308,752
" 3	6,341,728	7,019,290
" 4	5,334,723	5,591,137
" 5	5,019,150	5,177,077

Yearly Expenditure and Revenue of the Aqueduct.

Year.	Cost of operation and maintenance.	Ordinary revenue.
1904	$ 200,772	$ 836,537
1905	226,990	911,520
1906	237,939	972,586
1907	291,942	1,027,179
1908	288,178	941,611
1909	272,496	984,432
1910	391,676	1,051,047
1911	454,897	1,168,209
1912	663,769	1,328,029
1913	811,464	1,626,147
1914	1,036,375	1,414,192
1915	1,195,309	1,374,793

The cost of operation, maintenance, etc., does not include the interest on the invested capital nor any provision for amortizing or depreciation.

Remarks on Costs and Conclusions.

It must be clearly understood that we have estimated the cost of the different schemes on condition that they be executed with despatch, in a businesslike way and without undue delays.

We have found that the cost of putting the canal in proper shape if the work were discontinued is $5,894,846, of which $1,072,948 represents interest. We had, therefore, to charge $294,742.30, being the interest at 5 per cent. per annum on the said cost, to the cost of pumping by steam or of buying electric current (Schemes 4 and 5).

On account of fluctuating rates and prices, it is impossible at present to make an estimate of cost which would hold good for any length of time. This must not be forgotten in comparing estimates made as early as 1905 with those made now.

Total Cost and Cost of Operation for All Schemes.

(Power given in h.p.)

	Power development. Potential hydraulic power. Summer.	Potential hydraulic power. Winter.	Pumping and electric power. Summer.	Pumping and electric power. Winter.	Heating. Winter.	Total cost. Actual.	Total cost. Future.	Cost of operation. Actual.	Cost of operation. Future.
Schemes:									
I. Present plan	11,900	7,445	10,500	10,500	Heating by exhaust steam.	$8,537,000	$ 9,177,000	$590,000	$679,000
II. Maximum power available	24,500	13,000	13,000	13,000		.....	10,609,000	.....	740,000
III. Minimum power available	9,500	5,000	10,500	10,500		7,515,000	8,205,000	504,000	648,000
IV. Pumping by steam	Nil	Nil	10,500	10,500		6,434,000	6,703,000	546,000	712,000
V. Buying electric current—									
$30 per h.p.	"	"	10,500	10,500	1,400	6,102,000	6,268,000	565,000	712,000
$25 per h.p.	"	"	10,500	10,500	1,400	6,102,000	6,268,000	529,000	656,000

The estimates referred to at the beginning of our report show a close agreement with our own, although calculated for different assumptions of the quantity of power obtainable from the canal, and for different methods of utilizing said power.

Our estimates do not include the cost of the filtration plant already built, nor of its proposed additions and operation, but include the cost of the power needed, and the cost of heating. We have not included either the cost of the main suction and discharge pipes beyond the pump-house; the cost of some of the bridges (as explained before) nor of the claims of the Cook Company. These costs would be the same for all schemes.

As for boulevards, which are provided for only in schemes 1 and 2, we have included the cost of land, fences and ditches, and whatever grading must be done by the contractor, and nothing else.

In this report five schemes are considered. The figures used are taken from works lately executed, with a percentage added to cover normal increase in cost of labor and materials.

The tables all indicate "present needs" and "future needs." We would direct your attention to the figures for "future needs" only, as such will be justified by the time the plant is ready for operation.

Cost of Schemes—(H.P. Basis).

	Total cost.	Capital cost.	Cost of operation.
Scheme 1	$874	$756.66	$64.66
" 2	816	716.06	56.90
" 3	782	668.50	61.71
" 4	639	522.48	67.81
" 5—			
Electric current at $30.	597	493.05	67.81
Electric current at $25.	597	493.05	62.47
Work abandoned	562	459.22	28.07

We will now consider the schemes as described.

Present Scheme (Scheme 1).

This scheme is the one to which exception has been taken, and we agree that it should not be proceeded with as outlined. It could not have developed the expected power.

Maximum Hydraulic Development (Scheme 2).

This scheme shows the cheapest cost of operation per h.p. It is described at length in the body of the report, and considered in our recommendations.

Minimum Hydraulic Development (Scheme 3).

This scheme is inferior to Scheme 2, and need not be considered. It gives less hydraulic power, and the auxiliary steam plant being worked to a much larger extent, the possible increases in the price of coal will affect the cost of operation to a greater degree.

Pumping by Steam (Scheme 4).

This scheme considers finishing the aqueduct simply as a channel to carry water to the pumps, which are operated directly by steam. The high cost of operation is due to the charges against it of money already spent on the aqueduct extensions. Had the old aqueduct been left as it was, simply as a supply to the steam pumps, a steam pumping plant would have been a most attractive proposition.

Buying Power (Scheme 5).

There are two subdivisions to this scheme, figured on electric power supplied at $30 and $25 per e.h.p., on the same basis as power is now purchased for pumping purposes.

Here, as in the case of scheme 4, the cost of operation is charged with the amount already spent on the aqueduct extensions. To this is added such expenditure as may be required to put the channel in condition to carry the water supply to the pumps. This scheme is again referred to in our recommendations.

From our examination we considered that it will be necessary to pave certain sections of the bottom between the walls, as a precaution against their sliding or turning over, due to the unstable nature of the ground. We have provided for such paving in our estimates.

Power for Lighting.

There is not sufficient hydro-electric power in sight at present to justify your considering the taking over of the city lighting. This question has been treated at length in the body of the report.

Filters.

The filters, as designed and now nearing completion, have a rated capacity of 50,000,000 Imperial gallons per day. We understand that plans are under way for a further extension to 100,000,000 Imperial gallons per day output, with possible future extension to 150,000,000 Imperial gallons. The present records show a maximum pumpage of over 70,000,000 Imperial gallons. This means that the filters have not sufficient capacity to meet the present demand.

(Concluded on page 488.)

Absence of Regulation Helped Create Railroad Problem

Says Minority Report of A. H. Smith of Railway Inquiry Commission—"The Scrap Heap is Frequently the Most Economical Disposition Available for Inefficient Plant and Machinery"—Status and Usefulness of the Three Transcontinental Railway Systems

A LENGTHY summary of the majority report of the Railway Inquiry Commission, and a part of the minority report have already appeared in these columns. Mr. A. H. Smith introduces his report by discussing the general problem of transportation in Canada. He says:—

For a proper understanding of the problem, a knowledge is necessary of the history of railway development in Canada, especially as affected by the public policy, which has found expression in governmental acts.

Canada early recognized that its growth depended upon the construction of railways. The large productive areas of the country could be served only in a limited way by its splendid system of waterways.

Even before the eastern provinces became united into the Dominion of Canada, the Grand Trunk had become an important railway line, serving the people both of Canada and the United States. The Intercolonial, as is well known, was constructed out of public funds, and largely for the purpose of bringing more closely together, commercially and politically, two more or less separated sections of the Dominion. Long in advance of its justification upon a commercial basis, an all-Canadian transcontinental line was projected by the Government and completed with extensive public aid by a private company as the Canadian Pacific.

Because of the great distances which separate parts of Canada's producing territories from the consumers' markets, development of the country's resources depended upon railway building, while cheap transportation was necessary to enable the people to compete with other producers. The people of Canada, therefore, gave such aid as was necessary to procure for themselves railway lines that would bring the country's resources into use and keep themselves in touch with the outer world.

Cheap transportation depends upon careful investment and efficient management. In the usual case, these are most likely to be found where private initiative and proper incentive to effort are employed. So far, Canada, for the most part, has pursued the policy of leaving to private enterprise the management of the transportation machinery. The Intercolonial, which has been under governmental control since its beginning, is an exception. But this line, I am informed, usually pays nothing to the government as a return upon money invested in the property. On the contrary, it has frequently called upon the government for aid in meeting expenses of operation. The investment in this line is large, some authorities placing it as high as $348,000,000, including loss of interest. Evidently its rates are too low or its expenses are too high, but the use of this line, at the rates enforced, is regarded in some quarters as a right of the people in the maritime provinces. If the Canadian people have ever made an agreement, or adopted a policy which may be construed as creating that right, the contention may be correct; it is, at any rate, within the power of government to grant such a privilege. The fact is referred to merely to point out in connection with what I shall say later that a railroad may be built either as a commercial enterprise and for ordinary commercial purposes, or as a public undertaking and for other purposes, which are within the proper scope of government. The two should not be confused. But it should be kept in mind that when government builds and operates a railway which does not pay its way, including proper maintenance and interest upon investment, taxation is relied upon to support transportation upon that line. The burden is shifted from the user to the general public, but the processes by which this is done are often so complex as to obscure the facts, and actual costs are not ascertainable.

Completed by Company.

The Canadian Pacific affords a later example of the internal development policy of the government. That road had its beginning in a transcontinental project that was proposed to be carried out directly by the government. At an early date, and it seems to me wisely, that purpose was altered; it was decided to have the road completed by a private company. But the undertaking was large, the population sparse, the prospect of profit remote, so that the government not only turned over to the company the uncompleted road upon which it had expended a large sum, but it also extended to the company generous aid in the shape of land grants, cash subsidies, guarantees, and loans. It is true that value was given to the land grants largely through the building of the road and the opening of the territory to settlement. The important point here is that the Canadian Pacific owes its later and continued success, not only to the skill and enterprise of its builders and managers, but to the fact that through liberal direct aid, it was able to begin business with a small charge against its earnings on account of borrowed capital. Thus favorably started, the company was able to devote its energies and surplus income to the development of the road and the country.

A new transportation problem arose with the settlement of the prairie provinces, where the land is devoted chiefly to raising grain and live stock. Owing to the long hauls that intervene between the producer and consuming markets, freight charges absorbed a considerable part of the proceeds. The Great Lakes afforded the least expensive route to the east and tidewater. But these lakes are open only part of the year, and navigation closes before the season's crops can be moved from the lake ports. With the filling up of the country and consequent increase in production, came a general demand for additional means of transportation. While land speculation probably had no little influence, the farmer felt the effect of inadequate facilities, and any project that promised relief appears to have found approval among citizens who were able, through their legislators, to bring public aid to the development of these enterprises. Railroads, therefore, were not only actively in demand, but railroad builders were popular and had little or no difficulty in obtaining public support for proposed new lines.

What Made the C.P.R.

The Canadian Pacific stood as an example of success to be repeated by newer railways. Unfortunately, too little attention appears to have been given to the underlying facts which actually made that road what it was. Experienced men apparently believed that a second Canadian Pacific might be had if they could but lay a transcontinental road, build great hotels, passenger terminals, and operate ocean steamers. These things were only the outward evidence and not the cause of Canadian Pacific's prosperity. It may even be that they contributed little to the strength of that company's financial condition, if due account be taken of all the costs, investment as well as operating, involved in carrying on such enterprises.

In May, 1903, a Royal Commission of Transportation, of which Sir William Van Horne was chairman, was appointed "to consider questions affecting transportation of Canadian products to the markets of the world through and by Canadian ports, with a view of placing the Canadian producer in a position to compete, and compete successfully, through all Canadian ports with the producers and exporters of other countries." The report of this commission is interesting. It clearly reflects the effect of the outlook which great opportunities and a land boom had upon the minds of the people. All kinds of transportation projects were recommended. For instance, the Grand Trunk Pacific was to be extended to Moncton the Intercolonial was to be extended to Georgian Bay, etc. New canals were to be built, and old ones widened and deepened. This commission also recommended a bounty for Canadian-built ships, toll-exempt canals, additional waterways to be opened at public expense, and the acquisition of water terminal lands out of public funds. In other words, it was clearly the intent that transportation should be stimulated by subsidies from the public treasury.

It would now seem that there could not have been in sight enough traffic to justify the extensive development here recommended. However, many of the things proposed in this report have been done, and other ambitious schemes not here mentioned have since been brought out. The point in mind is that without making a specific declaration of the fact, as far as I know, Canada's policy for years appears to have

been to promote the public welfare by means of building or aiding in the building of transportation lines throughout the Dominion.

It is unfortunate that Canada did not have a policy of regulation in this period which could have prevented needless duplication of lines and facilities. Competing lines have been built where effective regulation could have saved a large part of the investment, while completely satisfying every reasonable and proper need for service. Instead of co-ordination and conservation under government supervision, railways were permitted to duplicate plant in fields not yet productive enough to support the one; the government, on the other hand, was, in one way or another, aiding both projects, if it had not indeed itself promoted either or both projects. Very naturally, it has not and could not have obtained the benefit which should have followed a correct programme of government aid. The policy of government aid makes the need for regulation of railway building more necessary even than where private capital is depended upon, for in the latter case the proposal must at least have a promise of commercial success before capital can be induced to come in and give it support. To the absence of such regulation must be charged responsibility for no small part of the railway problem of to-day.

Effect of Policy.

We may well inquire here as to the effect of this policy upon the three principal systems. The Grand Trunk Railway Company, feeling no doubt that its own traffic field had been invaded by the government-aided Canadian Pacific, desired in turn to enter the promising western territory. Accordingly, it proposed to build a line from North Bay to the Pacific Coast. Public aid was required and granted in a way to ensure the building of the road. If any serious thought was given to co-ordinating existing or proposed roads, and to utilizing them for the public good, it did not find public expression in any constructive way. The Grand Trunk Railway Company evidently felt confident in the success of its plans, for it pledged its own credit in aid of the extension, and entered into contracts which it now finds quite beyond its ability to carry out.

Canadian Northern interests, directed by Mackenzie, Mann & Company, who since an early date had been operating local lines in Manitoba, seized the opportunity afforded them for expansion and rapidly extended their rails throughout the prairie region. The records show that the Canadian Northern had a large mileage on the prairies before the projection of the Grand Trunk Pacific; so that when the extension plans of the Grand Trunk became a part of the national policy, as they did become, the Canadian Northern was added to the number of those who wanted to own a transcontinental system and one as fully complete and self-contained as was that of the Canadian Pacific. Hence, we find two new companies, both built largely upon public credit, striving for first place in a field which, as for transcontinental transportation, or even as for connecting Eastern and Western Canada, was already occupied. Besides having the Great Lakes waterway, there could have been barely enough business to support one additional line, and that only by the exercise of economy in operation and prudence in investment.

Created a Boom.

The Canadian Pacific, enjoying splendid credit, with adequate powers and resources, and keenly alive to the possibilities of losing business to competitors challenging its supremacy everywhere, then entered the contest by undertaking to build new lines in an effort to protect its sources of revenues.

The stimulation felt throughout the country by the influx of settlers and by the importation of so much new capital not only created a boom, but it quite naturally affected prices for labor and materials, sending these soaring; the increased prices in turn contributed largely to the higher costs which are now reflected in the construction accounts of the new roads.

This brings us fairly to a recognition of the fact that while the policy of public aid to railways had originally been founded on the urgent need for transportation to open up a new country, to develop its resources, and to unify Canada commercially and politically, it was carried far beyond the limits warranted by the original exigency. It appears to me that the responsibility is as much the government's as the private companies'. Without enabling legislation and the extension of government credit from which all received their essential support, the companies could not have expanded and overbuilt.

This policy, in so far as it aimed at the development of Canada, appeals to me as sound, and fully justified in its inception, but it needed to be supplemented by some form of supervision that would have insured to the people the benefits of that policy without the losses that have followed the effort to assist development indiscriminately.

The situation must be faced as it exists. It is not possible to undo what has been done, the money which has been spent cannot be recalled. The immediate and obvious thing to do is to adopt a constructive and discriminating programme, first, for correcting the conditions which necessitate continuing loss and waste, even where that would require the abandonment of useless property, and, second, for controlling new construction. The scrap heap is frequently the most economical disposition available for inefficient plant and machinery.

Mr. Smith then deals with the status and usefulness of the three transcontinental railway systems, and says:—

The Canadian Pacific Railway is essentially self-contained and self-sustaining. I agree with my colleagues as to its financially strong position. It has world-wide commercial strength. As a result of the aid and privileges extended by government, together with the prudence and progressiveness of its managemnet, which has extended its field of activity over nearly all Canada, and through its steamship lines and commercial organizations throughout a large part of the world, it is a success.

Is Efficiently Operated

The Canadian Pacific is well built, well maintained and has adequate terminals and equipment. It is efficiently operated. It is somewhat at a disadvantage in crossing the mountains, and elsewhere it has gradients that, compared with more recently built lines, do not make for as good train-load and operating efficiency. It is assumed that the Canadian Pacific will make improvements as the need for them arises, for it is fully able to do so.

Accorded reasonable treatment, that company will continue, I am sure, to give good service, and I believe the best interests of Canada will be served by continuing the present status of the Canadian Pacific. The introduction of government railway competition, which might have no regard for investment or cost of operation, would be unfair and, in the end, would react disastrously upon the Canadian people. The regulating power affords to the people of Canada adequate protection in the matter of rates and services, and such power should likewise protect the company.

Grand Trunk System.

The fortunes of the Grand Trunk Railway Company are bound up with the Grand Trunk Pacific. It stands as guarantor for large sums of money invested in the railway, and has advanced millions from its own resources in an effort to develop the western line and its subsidiary properties. The Grand Trunk Pacific Development Company has absorbed many millions of Grand Trunk capital without definite prospect of return, and to the Grand Trunk Pacific Branch Lines Company large construction advances have been made. Not only is the Grand Trunk committed for many millions, but the government has directly invested large sums of money in this property and guarantees other large sums, the total of which exceeds $127,000,000.

The Grand Trunk Pacific was located on a scale that would do credit to any single-track line. There is not enough business to justify such an outlay, and the prospect for business which will warrant the cost seems quite remote. For long distances, sections of this line parallel one or more other lines.

The part of the Grand Trunk Pacific lying between the Rocky Mountains and the Pacific coast is in a country which appears to have abundant natural resources. In time, these may be developed to the advantage of this road.

The port of Prince Rupert is suited for a large ocean traffic, which is non-existent. The development of Alaskan trade seems to present the most immediate possibility for this port and railway.

The road west of Winnipeg has some disadvantages on account of expensive trestles and instability of enbankments. It has good grades, but inadequate terminals at important places. It has sufficient equipment but lacks feeders.

From the Rocky Mountains to Winnipeg, the presence of parallel road arises a question as to whether the Grand Trunk Pacific line is not the best adapted by location and physical

condition to handle the trunk-line traffic. If it is not the best, then the disposition of this part of the road, with its branches, naturally depends upon its usefulness as a road serving local interests.

From Winnipeg east to North Bay and Port Arthur, the Transcontinental and Grand Trunk Pacific railroads together can give efficient service as a connecting link between the railways of Eastern and Western Canada. This road also affords a good line for traffic moving via the Great Lakes. In fact, it is probably the best route of any for hauling bulk commodities at low costs.

Government Morally Bound.

Officers of the Grand Trunk Railway Company claim that the government is morally bound to relieve the company of the Grand Trunk Pacific, because the government is responsible for the failure of the project, having permitted a rival company to enter the field. The rival line, however, has been constructed at a lower cost per mile, and manages to get enough traffic to pay its operating expenses and a large part of its fixed charges, which cannot be said of the Grand Trunk's system west of North Bay. I feel that I am not called upon to discuss the merits of the Grand Trunk's claim against the government. I have no doubt the government has observed at least the letter of its contract.

Standing alone, with efficient operating conditions imposed there is no reason, within my knowledge, why the Grand Trunk Railway proper should not become a profitable operation. It occupies a good territory, reaching some of the best traffic centres in the United States and Canada, and has American connections that ought to contribute to its welfare. The company needs terminal improvements in cities and modern equipment, especially locomotives. The need for equipment is pressing, and should be met.

Canadian Northern System.

The lines of the Canadian Northern, particularly in the prairie provinces, appear to be advantageously located in view of traffic conditions. Inspection of the property brings out the fact that this road was built with proper regard for economy, and the creation of a permanent public service utility.

In some instances, the system has extended its lines where it should have obtained a traffic interchange agreement or the joint use of facilities instead, at least until the traffic had grown enough to justify further expansion. A public policy intended to develop and serve the country as a whole, at the lowest cost, would have enforced arrangements which would have obviated the needless duplication of facilities.

The line from Yellowhead pass to Vancouver, in part at least, may be unnecessary, but it is there by the joint action of government and the company. The character and capacity of this line through the Fraser River canyon, where it is alongside the Canadian Pacific for about 200 miles, would suggest that no more money should be spent for double-tracking or revising grades on either of the railroads for years to come. From Yellowhead pass to Edmonton, the proximity of the Grand Trunk Pacific places two lines where one affords abundant capacity.

Appears to Have Been Unwise.

The invasion of the east by the Canadian Northern now appears to have been unwise, but condemnation thereof must be tempered with a knowledge of the conditions which forced this extension. There was a public demand for railroads. All Canada was enthusiastic over the prospects of a rapid growth in wealth and population. Railroads were on a competitive basis, and the public stood ready to back any new railroad enterprise, since that meant a rival carrier, and, incidentally, a new business in construction. There was no regulation which enforced co-operation among rival lines. The Canadian Northern, seeking to expand and become a profit earner, quite naturally desired to get all the traffic it could, and to hold all it got for as long a haul as possible. As a result, it undertook to do what appeared to be necessary under the conditions then existing—that is, to extend its line to both oceans.

An inspection of this company's property shows that generally it is of a type of construction well suited to its needs, and that the builders have installed it at a cost which, by comparison, seems small. Nowhere was there evidence of waste in the construction work itself. It is true that the company had some construction under way, or planned, that appeared wasteful because unnecessary, but this is due, I understand, to the unregulated competitive system, or to bargains with public authorities.

The building of expensive terminals in cities already supplied with adequate facilities affords an example of duplication for which the public must eventually pay. However, in the absence of restraint and regulation by consistent public authority, it is difficult to determine how the company could have avoided this.

The precarious financial situation of the Canadian Northern is due, in part, to its uncompleted condition, and to the fact that needed capital cannot be obtained on its own resources, especially during the period when capital is so greatly in demand by powerful governments. This system is not at present able to earn all of its fixed charges. As important parts of the system have but recently emerged from the construction period, it would be truly remarkable if it were able to do so. It does earn a very large proportion of such charges, and probably could earn all of them but for the burden of eastern extensions and duplications that have been placed upon it. Practically all commercial enterprises, and particularly railroads, must go through a development period.

The Canadian Northern is short of equipment. With the return to normal conditions, and provided with the capital necessary for equipment and for additional local facilities, this road can, in my judgment, work its way out in a reasonable time.

CANADA'S COMMISSION OF CONSERVATION.

The following reference to the work of the Commission of Conservation appears in the fifth interim report of the Dominions Royal Commission:—

"From an examination of the work carried on by the commission, it would appear that its activities in the domain of lands, minerals, forests, fisheries and waterpowers connect with, and may possibly duplicate, work which is actually done, or which could be more suitably carried on, by the departments of the Federal and Provincial governments charged with the administration and development of these great natural resources, and maintaining for this purpose experienced and expert staffs. The council for industrial and scientific research which has lately been constituted for Canada, on the lines of that in the United Kingdom, will also necessarily devote much of its attention to the tabulation, examination, and testing of the resources of the Dominion in the way of raw materials with a view to their development and utilization in industrial processes.

"It would appear, therefore, that an excellent opportunity is afforded for a co-ordination between the functions of the commission of conservation and other existing departments which would promote both economy and efficiency, and tend to more methodical application of energy.

"We would refer to one point connected with the work of the commission of conservation which deserves special notice. No visitor to the Dominion and to Western Canada in particular, could fail to admire the spacious walks and broad streets of the towns and cities, or to note that these have been laid out not only to meet present needs but with a wide outlook for future development. It is interesting, therefore, to find that the town planning committee of the commission is paying special attention to the details of housing accommodation and conditions, as well as to the principles of scientific town planning, and that its advice is being sought to a greater extent than the present staff can satisfy."

WAR TAXATION ANNOUNCEMENT.

In an official statement issued last week, Sir Thomas White, finance minister, said that the liability to taxation under the Business Profits War Tax Act ceases at the end of the present year and that the proposed increased taxation applies only to the last annual accounting period of the three accounting periods to which the act of last year applies. In other words, the increased taxation will affect only annual accounting periods, which end after December 31st last. For example, if a company's accounting period ends on May 31st of this year, the company will pay the increased tax in respect of its fiscal year commencing June 1st, 1916, and ending May 31st, 1917, and it will not be liable upon its profits earned after May 31st, 1917. The new tax, therefore, cannot apply to new companies about to establish themselves in Canada.

TRAFFIC THROUGH CANADA'S CANALS

Traffic through the canals of Canada in 1916 showed an increase of 8,384,688 tons. The total volume was 23,583,491 tons, though, as pointed out by Mr. J. L. Payne, comptroller of statistics, this tonnage includes duplication. It represents the business through all the canals and the same cargo often passes through two or three separate canal systems. After eliminating all duplication the net tonnage is given as 21,011,905 tons. The distribution of gross traffic in tons was as follows: Sault Ste. Marie, 16,813,649; Welland, 2,544,964; St. Lawrence, 3,368,064; Chambly, 398,977; St. Peter's, 9,629; Murray, 46,680; Ottawa, 237,651; Rideau, 105,430; Trent, 45,000; St. Andrew's, 13,438.

The traffic as analysed is as follows:—

	Tons.
Agricultural products	5,178,806
Animal products	11,342
Manufactured products	834,266
Forest products	1,388,873
Mine products	16,170,204

The total volume of Canadian wheat moved through the canals of Canada and the United States at Sault Ste. Marie in 1916 was 185,003,667 bushels. Of this quantity, 82,807,342 bushels passed through the Canadian canal. Larger accommodation on the American side of the St. Mary's River probably accounts for the preference given that channel.

The growth since 1895 in the volume of Canadian wheat annually carried through the Canadian canal at Sault Ste. Marie is seen from these figures: 1895, 1,087,800 bushels; 1900, 5,573,267 bushels; 1910, 51,774,833 bushels; 1913, 101,066,133 bushels; 1916, 82,807,342 bushels.

The comparison of 1915 and 1916 is as follows:—

Through the	1915. Bushels.	1916. Bushels.
Canadian canal	48,727,911	82,807,342
American canal	121,389,950	102,196,325
Total	170,117,861	185,003,667

Canadian wheat moved in the form of flour must also be brought into the account. The total quantity brought down in 1916 was 3,805,384 barrels, as compared with 2,215,098 barrels in 1915. At 4½ bushels to the barrel, this would represent 17,124,228 bushels of wheat.

The total volume of waterborne wheat in 1916 would thus be made up as follows:—

	Bushels.
Through the Canadian canal	82,807,342
Through the American canal	102,196,325
In the form of flour	17,124,228
Total	202,127,895

The distribution of Canadian wheat, moved through the Canadian and American canals at Sault Ste. Marie from Port Arthur-Fort William in 1916, was as follows:—

To Montreal, 1,233,982 bushels; to Georgian Bay ports, 46,406,749 bushels; to other Canadian ports, 28,029,847 bushels; to Buffalo, 106,349,943 bushels; total, 182,020,521 bushels.

To account for all the Canadian wheat shipped eastward by water in 1916 there must be added the quantity passed through Duluth in bond. The complete statement would therefore be as follows:—

From Port Arthur-Fort William and Duluth, to Montreal, 1,686,482 bushels; to Georgian Bay ports, 48,007,361 bushels; to other Canadian ports, 28,029,847 bushels; to Buffalo, 107,279,977 bushels; total, 185,003,667 bushels.

"The people of British Columbia should realize the importance of turning out vessels and steamers as fast as they can be completed," said Mr. J. J. Coughlan, of the firm of John Coughlan and Sons, in a recent interview regarding the shipbuilding programme on the Pacific Coast. "Our first boat," he said, "is well under way and will take to the water in November at the present rate of construction. We are laying the keel for the second vessel at the present time, and next week we will lay the keel for the third vessel. The second vessel will be launched in December and the third in February of next year. We are now contemplating clearing away space for a fourth keel."

SHIPBUILDERS BUSY IN NOVA SCOTIA

We have developed Nova Scotia's great coal industry. Following that its iron industry has attained international importance. So once again the opportunity presents itself of playing a part in transporting the commerce of the world. Added to this a great emergency confronts the empire. "Ships! Ships! Ships!" is the cry. This is the editorial comment in a timely shipbuilding number of the Halifax Morning Chronicle, which furnishes data regarding the shipbuilding industry of that province.

On the Atlantic Coast there are 51 wooden vessels of a total tonnage of 16,316 under construction, of which 46 are being built in Nova Scotia. Every shipyard in the province is being worked to capacity. At Lunenburg, La Havre, Liverpool and Shelburne, attention is being mostly devoted to fishing and coasting vessels. On the French Shore, St. Mary's Bay, at Annapolis, at Parrsboro, Fox River, Port Greville, Spencer's Island, Advocate Harbor, at Hantsport and Noel, and other points, there are under construction tern schooners for the deep sea trade, varying in size from 200 to 500 tons, and there are tern schooners under construction at Liverpool and Shelburne.

At Meteghan, St. Mary's Bay, a tern schooner has been started. At Little Brook one is almost completed. There is one soon to be launched at Grosses Coques, where two more are to be started, and there are two at Belliveau's Cove. At Parrsboro there is under construction a schooner of about 600 tons, at Fox River a schooner of about 460 tons, at Port Greville a schooner of about 350 tons and another of about 200 tons. At Spencer's Island a 430-ton schooner, at Advocate Harbor a 460-ton schooner, at Hantsport a 350-ton schooner, and several large schooners at Annapolis.

The Nova Scotia Steel and Coal Company's first steel vessel which is 260 ft. in length, and has a carrying capacity of 1,900 tons is nearing completion at the Trenton shipyards. The keel has been laid for a second boat which is about 260 ft. overall, and has a deadweight capacity of about 2,400 tons, propelled by triple expansion engines. These engines will be built complete at this plant. The steam will be furnished by two Scotch boilers 11 ft. diameter and 10 ft. 9 in. long, with a working pressure of 185 lbs. per square inch. The boilers are being built by the John Inglis Company, Limited, Toronto.

Mr. Wallace Downey, a Nova Scotian, of the Downey Shipbuilding Corporation, New York, says that unnecessary costs in shipbuilding and ship operation, resulting from endless variety, is probably about 20 per cent. in excess of what the building and operating costs of the world's shipping would be if types and sizes were standardized and specialized for certain trades and uses. Twenty per cent. upon the cost of the world's shipbuilding and operation would, of course, aggregate hundreds of millions annually.

This is an unnecessary overhead charge on water transportation. He believes the cost of shipbuilding can be reduced at least 20 per cent. by standardization, and I believe the cost of operating ships can be reduced from 10 to 20 per cent. by standardization and specialization.

BURNS CEMENT-GUN CONSTRUCTION CO.

L. P. Burns, of Toronto, formerly a well-known railroad contractor, has organized the Burns Cement-Gun Construction Co., with head office in the Bank of Hamilton Building, Toronto. The company will specialize on Gunite construction.

They are now completing self-contained outfits mounted on motor trucks, the engine and compressor being arranged on a trailer, with the gun and materials on the truck itself. These portable outfits will have great facility in reaching work in any portion of Ontario.

Garages and other building work will be handled, but special attention will be given to the construction of concrete walls, floors, etc., for reservoirs, filtration plants, sewage disposal plants and other engineering work such as the coating of steel penstocks, tanks, etc. The company expects to develop as a specialty the lining of steel ships with Gunite instead of hand-placed cement mortar.

"HYDRO" ACQUIRES ONTARIO POWER CO.

Sir Adam Beck announced last week that the Hydro-Electric Power Commission of Ontario had acquired the assets and rights of the Ontario Power Co. The commission pays eight million dollars in its own debentures for the ten million dollars outstanding stock of the company, and assumes the company's bond liability of $14,669,000. The company is to receive the current assets and assume the current liabilities.

The deal involves no cash outlay by the province. The company's book valuation is $26,900,694, and the total revenue for 1916 from the sale of power was $2,396,277. The net income for the year was $1,501,353. The bond interest was $767,118, so that the net earnings of the company were $734,235. F. A. Gaby, chief engineer of the commission, estimates an annual surplus of $201,009 after paying the interest on the Hydro bonds, but without allowing for depreciation.

A portion or all of the water now used by the Ontario Power Co. will probably be diverted through Chippewa Creek and used in connection with the Queenston Heights development of the Hydro Commission. The Hydro's new plant will be capable of developing 27 electrical h.p. per second foot, whereas only 16 h.p. is developed by the Ontario Power Co. at the present time, and from 12 to 13 h.p. by the Canadian, Niagara and Electric Development companies. The Hydro Commission will have a 315 ft. gross head and a net head of 303 ft., and Hydro officials state that their calculations are conservatively estimated on a basis of 84 per cent. turbine efficiency and 93 per cent. generator efficiency.

The ultimate capacity of the Queenston plant is expected to be about one million horse-power, and to develop this Sir Adam Beck will have to buy out the two remaining Canadian power companies, so as to get the whole of the Canadian allotment of 36,000 cubic ft. per second, or else the Canadian government will have to induce the United States to make an agreement whereby Canada will be allowed to divert more water from the falls. There has been considerable agitation in the United States for a further diversion on that side of the boundary, and it is probable that within the next four or five years a new treaty will be entered into, permitting greater diversion both in the United States and Canada.

The Hydro Commission is spending fifteen million dollars on the Chippewa scheme, which will no doubt absorb the Ontario Power Co.'s system in the course of time. It is figured that the Ontario Power Co.'s plant will pay for itself in fifteen years by the "scrapping" process; that is, by applying to surplus the revenue ordinarily apportioned to depreciation.

Sir Adam Beck considers the Ontario Power Co. the most efficient power concern on the Canadian side of the Niagara River, as this plant is said to suffer less interruption from ice troubles than the other plants. Moreover, it has a franchise capacity of 180,000 h.p., and by means of an additional conduit (and enlargement of the franchise) its capacity can be increased to 240,000 h.p. The Electrical Development Co.'s plant has a capacity of 125,000 h.p., and that of the Canadian Niagara Co. has 100,000 h.p. capacity.

Of the 36,000 second feet permissible diversion from the falls, the Ontario Power Co. is entitled to 11,180, the Canadian Niagara Co. to 8,820, and the Electrical Development Co. to 9,390, leaving a surplus of 6,610 which will be used for the Chippewa scheme. By using the Ontario Power Co.'s water, the Chippewa scheme will now have a supply of 17,790 second feet, by means of which it is expected to develop at least 480,000 h.p.

In connection with the transfer of the property, Sir Adam Beck succeeded in modifying the company's contract with the Niagara, Lockwood and Ontario Co., by means of which the Ontario Power Co. was bound to deliver about 60,000 h.p. until the year 2010. An arrangement has been made to terminate this contract in 1950, so that 60,000 h.p. additional will be available for Canadian use sixty years sooner than would have otherwise been the case, assuming that the export of power would not have been prohibited anyway by the Dominion Government before that time.

Construction work on the Chippewa Creek scheme is going ahead as fast as the equipment is arriving on the ground. One steam shovel and a gang of one hundred men are now at work under Superintendent Angel.

The Hydro Commission is now selling about 146,000 h.p. in the Niagara District alone, of which 100,000 h.p., is being secured from the Ontario Power Co., and 46,000 h.p. from the Canadian Niagara Co. It is expected that by November 1st, 1917, the requirements of the Niagara district will have reached 190,000 h.p. This is exclusive of the 60,000 h.p. now being sold to Canadian customers by the Ontario Power Company. Immediately upon taking over the latter concern, the Hydro's Niagara load really became 206,000 h.p.

These figures are exclusive of the requirements in the territory covered by the Hydro's other districts, viz., Severn, Wasdell's, St. Lawrence, Eugenia, Ottawa, Port Arthur, Muskoka, Central, and Northern.

Twenty cities, thirty-four towns, one hundred and twenty villages and seven townships of Ontario are embraced in the Hydro-Electric System. The System represents a public expenditure of $69,350,000, not including the $15,000,000 for the Chippewa scheme, and not including the Ontario Power deal.

MONTREAL AQUEDUCT REPORT.

(Continued from page 483.)

Under ordinary conditions, and with the figures now before us, we would have no hesitation in recommending the adoption of Scheme 2, with provision for boulevards, as its cost of operation per h.p. per year is the lowest. But under the circumstances which have allowed of the contractor being able to proffer a claim of $1,469,338.17 on a contract of $3,012,562, on which work to the amount of $1,148,731.38 had been completed at the end of 1916, the question is different. We must also take into account the fact that the contractor has to be reckoned with for any changes or additions to the present plan. We would, therefore, recommend:—

1st. That the south wall of the aqueduct be at once extended to the rock section and that the west earth section be completed with paving where needed, as this should be done for all schemes.

2nd. That no work be done on the rock section nor on the east earth section until the final scheme is decided upon. This also applies to the tailrace.

3rd. That you immediately ask the several companies furnishing electric power in the city for firm bids of power. Carefully worked out specifications should be furnished to the power companies setting forth the exact conditions of the service required.

Prices should be, at the same time, obtained from the contractor for all changes, and additions to the present contract.

As soon as this is done (and it could be done in a couple of weeks) you shall be able to come to a decision with full knowledge of the costs of operation of all schemes.

As all our figures will be in the hands of your chief engineer, he will be able to place before you the exact cost of each scheme.

In the meantime, studies should be started and designs made for the proposed electric motor-driven pumping station. This station should be designed to pump the output of the proposed new filter plant, which is to be 100,000,000 Imperial gallons per day. Provision should also be made for future extensions. The equipment of this station will be the same whether you generate your own electric power, or buy it. The plans for the steam standby station should also be put in hand. We have suggested that the new pumping plant be located on the south side of the aqueduct near the filters. This should provide a most convenient location for all piping connections. It also facilitates the connection of the steam standby to the heating system that is proposed for the filters.

No addition or alterations to the present steam pumping plant should be made.

The plans for the hydro-electric station may be delayed until you have to come to a decision regarding the source of power.

We would also recommend:—

4th. That the lands required be secured at once, so as to prevent further delays to the work.

5th. That the addition to the filtration works at a cost of $900,000, as estimated on page 85 in the annual report of 1915, be proceeded with.

Mr. Thomas J. Dillon has been appointed general manager of Canada Foundries and Forgings, Limited. Mr. Dillon has had jurisdiction over the western plants at Welland, Ont., the Canada Forgings and Billings and Spencer. This now extends to the James Smart Manufacturing plant at Brockville. Mr. Dillon is also a director of the company.

Editorials

THE RAILWAY PROBLEM.

What is the government doing in regard to the railway problem? The two reports presented by the Railway Inquiry Commission were brought down some weeks ago, but apparently no steps have yet been taken to relieve the situation. Both the majority and the minority reports agree that something must be done. Both suggest radical changes; and the commissioners are unanimous in stating that more equipment is needed.

It is sincerely to be hoped that the freight situation of last winter will not be duplicated—or worse—this coming winter. More freight cars, more coal cars and more engines appear to be an immediate requirement, regardless of what is done or left undone in reorganization of the Grand Trunk and Canadian Northern.

When the railroad report was first made, parliament was urged to give sufficient consideration to it, that the right course might be taken at this juncture.

There is no doubt that to make further mistakes in the railroad policy would prove extremely costly to the country. The greatest caution should be exercised before deciding to amalgamate under one management 25,000 miles of railway lines which, in respect of mileage and territory served, have no parallel; to acquire the control of their stocks; to operate the roads; to assume responsibility for the interest on their debts,—and all this during a period of world-wide unsettlement of business conditions.

But careful consideration by parliament does not mean pigeon-holing by the government. Thorough investigation and extensive parliamentary debate are necessary to the settlement of this question. If the proper time is to be given to the subject in parliament, the government should introduce a formal measure, which would precipitate the debate, soon enough for some definite and thorough-going action to be taken before another winter catches any of our railroads without the necessary equipment to meet the conditions experienced in this climate.

MR. ACWORTH'S VIEWS.

Members of parliament will no doubt attach the greatest importance to the fact that Mr. Acworth's views have coincided with those of Sir Henry Drayton. Prior to Mr. Acworth's appointment on the Canadian Railway Inquiry Commission, he said:—

"A careful study of the evidence has convinced me that in the long run state control ends in keeping down the best to the level of the worst, and that, taking them all for all, the private railway companies of England and the United States have served the public better than the government railways of the Continent, or of our Australian colonies, and, which is still more to the point, are likely to serve it better in the future."

Yet holding that opinion, Mr. Acworth joined Sir Henry Drayton in a proposal practically to nationalize the railways and to operate them by a permanent commission.

Sir Henry Drayton, in his recent Toronto address, drew attention to the fact that Mr. Acworth is familiar with company management and finance, being a director of the Underground Railway of London, which controls the greater part of the transportation facilities, both street and underground, including the omnibuses, in and around the metropolis. He is a recognized authority on railway economics, he has written leading text books on the subject, and in the opinion of the practical railroad managers of America his knowledge and standing is such that he was engaged by them to give evidence last month in their behalf before the Congressional Committee on Transportation at Washington, in regard to the evils of political railway management.

The politicians at Ottawa may not like the references to politics and political management in either the majority or minority reports of the commission. There is sure to be extensive debate upon the whole subject, and the earlier the debate is started, the sooner a decision will be reached; and the sooner the situation is taken in hand and a solution found for it, the better will it be for all classes of the public, including even the owners and operators of the railroads themselves.

THE TYE AND TAIT REPORTS.

Before the appearance of the report of the Railway Inquiry Commission, the problem had been unofficially discussed in two pamphlets, both of which were published in full in *The Canadian Engineer* at the time they were issued. The author of one was Mr. W. F. Tye, for many years chief engineer of the Canadian Pacific Railway; the author of the second, Sir Thos. Tait, at one time a prominent administrative officer of the C.P.R., and for seven years chairman of the Victorian (Australian) Railway Commission, and since 1911 president of the Fredericton and Grand Lake Railway & Coal Co., which built in New Brunswick a railway that has been leased to the Canadian Pacific.

The influence of both of these private reports on the majority report of the Railway Inquiry Commission is marked. Many of the suggestions made have obviously been incorporated in the report of the commission.

This influence, brought to bear by private reports from two engineers, and reflected in the report made by a lawyer and a financial economist, is further evidence that commissions dealing with engineering subjects should include engineers. In all questions dealing with efficiency or management, engineers—by virtue of their training—can bring valuable help. When these questions deal with subjects so directly in the engineering field as transportation, it should be a first corollary of the government that engineers should be included in the make-up of the commissions.

Mr. Tye's work and Sir Thos. Tait's work should not be forgotten. We have no desire to pile cabinet timber at Sir Robert Borden's doorstep, but may we say that if the majority report of the Railway Inquiry Commission be adopted, the government will have no difficulty in finding at least two of the three able railway commissioners who will be needed on the Board of Trustees?

PERSONALS.

GRAHAM AIRDRIE BELL, Department of Railways, Ottawa, was included among those mentioned in the King's birthday honors. He was gazetted a Companion of the Order of St. Michael and St. George.

R. T. BELL, formerly division engineer on the National Transcontinental Railway, and latterly superintendent of the Toronto-Hamilton Highway and superintendent of road construction at Camp Borden, has received a commission as captain of the 23rd Draft Reinforcements for Canadian Railroad Troops. Capt. Bell has opened a recruiting office at 16 Temperance Street, Toronto, and he is permitted to recruit in the district from Port Arthur to Cochrane, and also in the city of Toronto.

H. VICTOR BRAYLEY, A.M.Can.Soc.C.E., has resumed his connection with Gunn, Richards, Limited, of Montreal and New York, and will be joint Canadian manager with T. Max Fyshe, A.M.Can.Soc.C.E. Mr. Brayley resigned from Gunn, Richards, Limited, a couple years ago in order to carry out some special production engineering work for Sir Mortimer B. Davis.

W. R. BURGE, who recently resigned as Toronto manager of the Jenckes Machine Co., is now a member of the Ontario sales organization of the Canadian Allis-Chalmers, Limited, Toronto.

GEORGE J. BURY, Montreal, vice-president of the C.P.R., was among the Canadians included in the list of King's birthday honors, having been made a knight.

P. F. CAVERHILL, chief provincial forester of New Brunswick, has resigned and will return to British Columbia.

ERNEST A. CLEVELAND, M.Can.Soc.C.E., DONALD CAMERON, M.Can.Soc.C.E., and STUART S. McDIARMID, B.Sc., who have conducted a consulting engineering office at Vancouver for several years under the firm name of Cleveland & Cameron, have dissolved partnership. Mr. Cleveland is continuing business at the same office, 1001 Rogers Building; Mr. Cameron has entered practice on his own account in the same building; and Mr. McDiarmid has a commission in an overseas draft of the Forestry Battalion.

WILLIAM H. CONNELL, for about five years chief of the Bureau of Highways and Street Cleaning of the Department of Public Works of Philadelphia, Pa., has tendered his resignation, effective May 31. He is to become connected with the firm of Day & Zimmerman, 611 Chestnut Street, Philadelphia, as engineering executive.

C. A. HAYES has been appointed general manager of the Government Railways east of the St. Lawrence River, with headquarters at Moncton, N.B., in succession to F. E. Gutelius, and E. P. BRADY has been appointed general manager of Government Railways west of the St. Lawrence, with headquarters at Cochrane, Ont. W. A. COWAN has been appointed assistant to Mr. Brady.

Major W. G. MACKENDRICK, president of the Warren Bituminous Paving Co. of Ontario, Limited, Toronto, who has been in France for about a year and a half building roads, first for the Canadian Corps and then as deputy assistant director of roads and in charge of all roads in the Fifth Army, has been promoted to be assistant director of roads and given the rank of lieutenant-colonel.

JAMES O. MEADOWS, A.M.Can.Soc.C.E., who was joint author, with Mr. Frank H. Pitcher, of the article on the Montreal Water & Power Co.'s chlorine cell installation, published last week in *The Canadian Engineer*, was incorrectly described in connection with that article as being the chief chemist of the Montreal Water & Power Co. Mr. Meadows is the company's sanitary engineer.

Lieut.-Col. C. H. MITCHELL, M.Can.Soc.C.E., member of the consulting engineering firm of C. H. and P. H. Mitchell, Toronto, was among those honored by the King in the birthday list. He was made a Companion of the Order of St. Michael and St. George.

WILLIAM RODGER, who has been chief draughtsman with the Jenckes Machine Co., of Sherbrooke, Que., for the past eighteen months, has accepted a position as construction engineer with Fraser, Brace & Co., of Montreal, contracting engineers.

OBITUARIES

ANTOINE BALZOLA, president and secretary-treasurer of the Niagara-Spanish Aerial Car Tramway over the Whirlpool, died of heart failure at Niagara Falls, Ont. Mr. Balzola's home was in Spain. He was the chief promoter of the novel enterprise at the Whirlpool.

Capt. W. J. EAGAN, of Cobden, Ont., was killed in action about ten days ago. Capt. Eagan was a member of the firm of Shea & Eagan, railway contractors, who executed contracts on the National Transcontinental and Canadian Northern Railroads, as well as in connection with the double-tracking of the C.P.R.

THOMAS KENNEDY, who for more than fifty years was prominently identified with Messrs. Glenfield & Kennedy, of Kilmarnock, Scotland, died April 20th in his 79th year. For a long period Mr. Kennedy was managing director of the company but had lived in retirement for the past four years. Previous to entering the firm of Glenfield & Kennedy he followed the sea as a marine engineer and assisted in the laying of the first Atlantic cable. Much of the success which has attended the Glenfield & Kennedy Company is due in large measure to his exceptional skill, his rare organizing powers and his devotion to duty. Mr. Kennedy was a member of the Institution of Mechanical Engineers and the Institute of Engineers and Shipbuilders.

ADOLPHE RODRIGUE PINSONAULT, a well-known railway engineer, of Montreal, died May 24th in his 69th year. Mr. Pinsonault was engineer of the Intercolonial Railway between River du Loup and Truro, N.S. Later he was attached to the engineering staff which laid out the line of the C.P.R. around the north shore of Lake Superior.

MALCOLM J. ROBINSON, formerly minister of public works for Saskatchewan, died suddenly on May 26th in the Queen's Hotel, Toronto. Mr. Robinson graduated from the School of Practical Science, Toronto, in 1895, and had spent practically all his life since that time in Western Canada.

G. A. STEWART, who died recently at Victoria, B.C., assisted in the construction of the first railway built in Canada, and was later assistant engineer of the Northern Railway from 1852 to 1854. He practised his profession at Port Hope from then until 1865, and was chief engineer of the Midland Railway from 1868 to 1877. In 1886, Mr. Stewart was appointed to make topographical surveys of the Rocky Mountain National Park, Banff, Alberta, and was in charge there for eleven years.