PAGES

MISSING

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

NEW WESTMINSTER WATERWORKS CONSTRUCTION

DETAILED REVIEW OF DESIGNS, MATERIALS AND METHODS USED IN OBTAINING PURE WATER SUPPLY—LAYING 12-IN., 13-IN. AND 25-IN. STEEL WATER MAINS.

By JOHN WILLIAM BERNARD BLACKMAN, M.Can.Soc.C.E., M.Am.Soc.C.E.,
City and Water Engineer, New Westminster, B.C.

THE city of New Westminster is situated about fifteen miles from the mouth of the Fraser River, and twelve miles by road from the city of Vancouver. It is served by the Canadian Pacific Railway, the Great Northern Railway coming from the United States, the Canadian Northern Railway, and the Fraser Valley Electric Railway Co. It has also three interurban electric rail services to Vancouver. Other railways, such as the Chicago-Milwaukee, the Oregon-Washington, and the Northern Pacific Railway must pass through this city on their way to Vancouver. The rateable value of the city is $16,163,250.

As a fresh-water port, New Westminster stands second to none on the Pacific Coast. At the present time, without any harbor improvements, retaining walls, jetties or dredging, vessels up to 23 feet draught can clear the sandbar at the mouth of the Fraser. Dredging by the Dominion Government gives a channel of 30 feet at high tide. In anticipation of the opening of the Panama Canal the city has, with considerable foresight, completed a section of harbor improvements so as to take care of such shipping as may be required in the near future. It has recently spent $500,000 on these works.

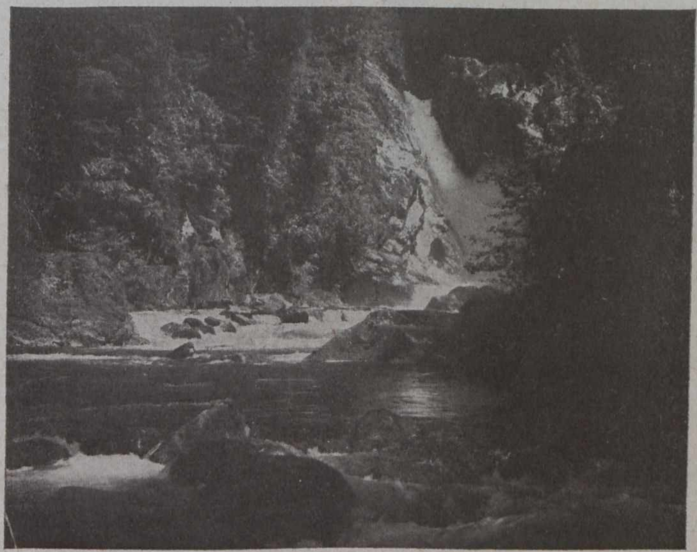


Fig. 1.—Coquitlam Falls, Head Lake.

The population, according to the last local census, was 17,000, with a suburban population of about 30,000.

In 1899 a 14-inch diameter pipe was laid from Lake Coquitlam to the city, delivering a minimum of 600,000 gallons per day.

Before proceeding further with the technical description of the water supply, it is desirable to give a brief résumé of the various interests and engineers concerned with other works, with which the writer came into contact in connection with the municipal water supply at Coquitlam Lake.

The city acquired the rights and charter of the Coquitlam Waterworks Co. in 1885, and was owner of the water shed round Coquitlam Lake, the land of the old intake works, all the water that it required for domestic purposes, and in addition 1,000 miner's inches* for any other purpose it required. Some ten years ago the Vancouver Electrical Power Co. acquired rights for 5,000 miner's inches, for their hydraulic power plant on the Burrard Inlet, and to obtain sufficient hydraulic energy to drive their water-wheels, drove a tunnel two miles in solid granite through the mountains to tap Lake Coquitlam. The Vancouver Power Co. is a subsidiary company of the British Columbia Electric Railway Co.; the latter company until recently supplied all the electric light and power for the electric railways of Vancouver, New Westminster and district. Owing to rapid development of this district the company found it necessary to increase their units, and at the same time acquired a further 5,000 miner's inches of water on Coquitlam Lake. They also obtained permission to build a dam to store the water for the increased hydraulic energy required.

In 1909 the company retained the services of the late James Dix Schuyler, M. Inst. C.E., M. Am. Soc. C.E., of Los Angeles, Cal., a well-known consulting engineer on water power and the construction of hydraulic fill dams. Upon Mr. Schuyler's recommendation, plans were drawn up for a dam to be constructed raising the lake from elevation 432 ft. above sea-level to elevation 503 ft. above sea-level. The dam was to occupy a position on the site of, and absorbing the old municipal waterworks intake, screen house, gate house, etc. The municipality strongly objected to this action, fearing that the purity of the water might be impaired, and that their rights at the lake were being taken away from them; they entered a strong protest, and commenced an action to restrain the company from proceeding with the works. In the first instance the provincial government of British Columbia had control of these water rights.

They retained Mr. A. O. Powell, M.Am.Soc.C.E., of Seattle, Wash., to make a report to them on the construction of the proposed hydraulic fill dam and the effect it would have on the water supply. During this time a case in the high courts between the Federal and Provincial governments was pending as to which government had control of the water rights. The case was decided in favor of the Federal government. The municipality's

*A British Columbia miner's inch is 1.68 cu. feet per minute.

case was then forwarded to Ottawa, and the Federal government instructed and retained Mr. John R. Freeman, of Providence, R.I., to advise the government and to see that the interests of the city were protected. Mr. Freeman advised the government that the water supply would be properly protected if the lake were cleared of all timber, living and dead, and all vegetable matter, etc., up to the height of the spillway of the proposed dam. He further advised that the Power Co. should construct at their own expense a tunnel on the east side of the dam in solid rock, and construct a water tower, some 1,000 ft. above the dam, to such plans as were to be approved by himself and the writer.

The work of clearing the site for the dam was started under Mr. Schuyler's régime. In 1911 Mr. G. R. G. Conway, M.Can.Soc.C.E., was appointed chief engineer to the Vancouver Power Co. and the construction of the dam, the clearing of the land, the driving of the tunnel to the city's new intake tower, and the building of the tower was completed under his supervision and direction.

Fig. 2.—Coquitlam Lake.

In 1909 the corporation of the city of New Westminster desired to increase their water supply and instructed the writer to proceed with the work of constructing a pipe line which would deliver not less than six million Imperial gallons per day.

The Lake.—Lake Coquitlam, named after the Coquitlam Indians, lies some fifteen miles in a northeasterly direction from New Westminster. (See Fig. 3.) It is about seven miles in length, varies from a quarter to half a mile in width, and has an area at its original level of about 2,328 acres. It is surrounded by high snow-capped mountains, on whose sides are the ravines within which are formed the glaciers assuring a constant supply, even during the most prolonged droughts. Many creeks and waterfalls discharge into the lake from the mountain sides, a type of which is shown on Fig. 1. The area drained by the lake is about 105 square miles. (See Figs. 2 and 3.)

Rainfall.—The average annual rainfall at the lake is 156 inches. Records have been kept for the last ten years by the Vancouver Power Co. The maximum rainfall recorded in one year is 180 inches. The average rainfall in New Westminster is 58 inches.

Run-off.—The co-efficient of run-off is estimated to be between 75 per cent. and 80 per cent.

Lake Levels.—The original surface elevation of the lake was 432 ft. above sea-level, and its greatest depth is 200 ft. below sea-level. The spillway elevation of the dam is 503 ft. above sea-level.

The Character of the Water.—Much has been written by eminent engineers and others during late years as to the value of a pure water supply, and standards of purity have been set up as typical of what is a pure water. Many of the largest cities of Europe and America are satisfied to-day with a supply, either filtered or otherwise, whose purity does not come anywhere near the standard. In the far west, in British Columbia, New Westminster holds the distinction of being favored with a water supply whose purity may be taken as a standard, and whose degree of purity is even better than that set, *viz.*: That not more than 100 bacteria shall be found in the 40 cubic

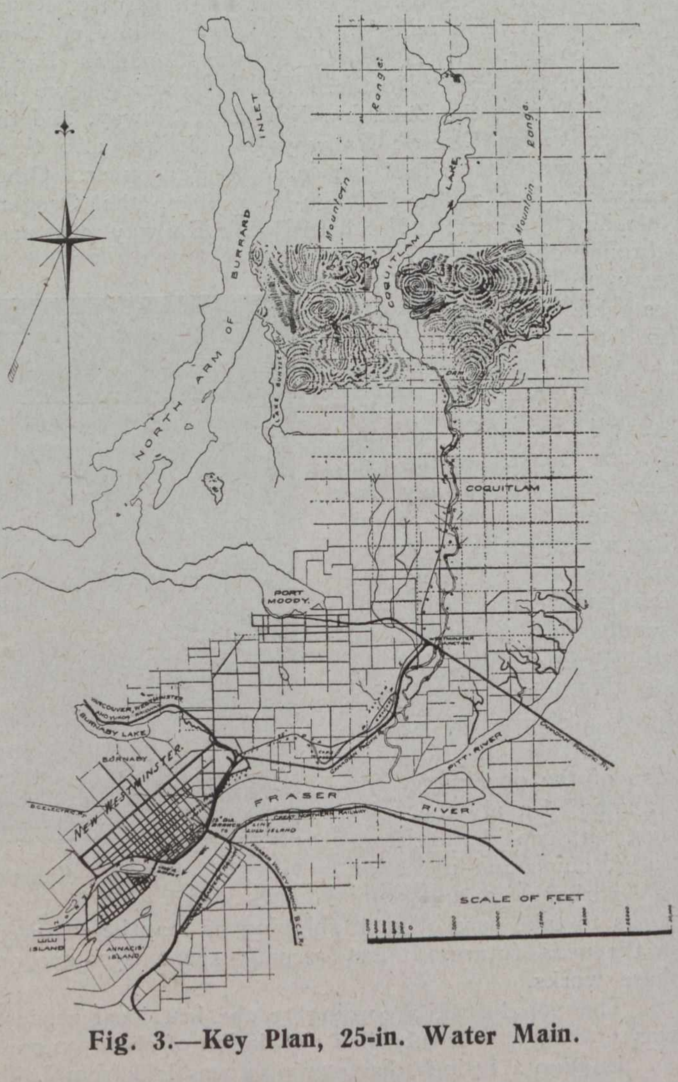


Fig. 3.—Key Plan, 25-in. Water Main.

centimeters of water sampled. The water in Lake Coquitlam has shown, in a series of examinations, no pathogenic organisms, and occasionally only 40 bacteria in the samples analyzed. The writer feels that he will not be contradicted in saying that no other natural surface water supply has been found equal to this, for its purity. The lake, as before mentioned, is surrounded by high mountains, averaging in height between 4,000 ft. and 5,000 ft., covered entirely by evergreen timber and undergrowth. Absolutely inaccessible from the outside world (except by one road constructed for the pipe line), it is thus free from any human contamination. The water is also free from color and turbidity (except during heavy autumn rains when slight turbidity is sometimes noticeable). The great depth of the lake, its coldness, the long period of sedimentation, and exposure to the light, assist in keeping this water in a continual state of purity.

Clearing.—The sides of the lake to be flooded by the construction of the dam (some 3,000 acres) were cleared

Fig. 4.—Falling Timber on the Banks of Coquitlam Lake. A Beautiful "Fall."

of all timber and underbrush, which was burned and disposed of. The swamp areas were surveyed by the writer and comprised some 255 acres; these areas were given special attention in clearing. The thoroughness with which this work was carried out is indicated by Fig. 4. The trees were eventually cut down level with the ground.

Fig. 5.—Foundation for Water Tower—4-ft. Pipe in Entrance of Tunnel. Note Solid Rock Foundation.

The clearing alone was an enormous task, and cost about $649,289.

Sanitary Precaution During Construction of Works.—The precautions taken to prevent the workmen from contaminating the water in the lake, or its banks, is worthy of mention and reflects credit on the officials of the Vancouver Power Co. Men working on the different gangs clearing, burning, etc., were taken to their work in large scows, by a tug, from the camps. In the vicinity of their work were placed movable closets covered with a light canvas screen, and containing a fairly large galvanized can. These cans were collected daily by boats, removed to an incinerator situated below the dam, and the contents burned. The cans were replaced daily. Notices were posted warning men that they would be instantly dismissed if found guilty of not using the closets when necessary. Two inspectors were in constant attendance and no difficulty was experienced

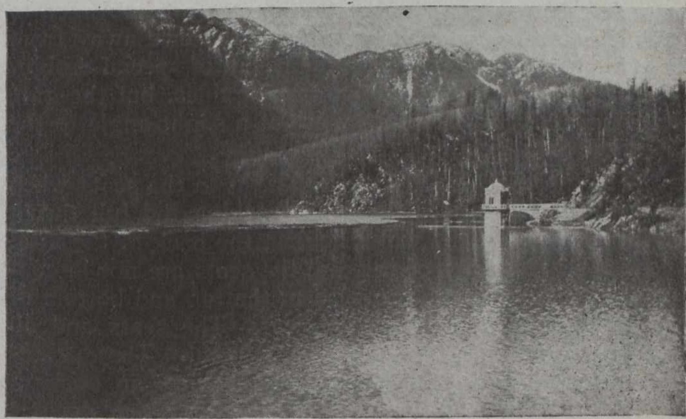


Fig. 6.—Water Tower with Lake Level Raised.

in getting the men to conform to this form of discipline. Weekly examinations of the water were made.

Watershed Reserved.—The Dominion Government have recently issued an order-in-council setting aside as a reservation a tract of land comprising the whole of the watershed of the lake, thus safeguarding the city's water supply from any possible pollution by any habitations, or lumbering operations. This action has been highly appreciated by the civic authorities.

The Water Tower and Approach Tunnel.—This work was carried out entirely by the Vancouver Power Co. It will be seen from the photographs and the plans (see Figs. 5. 6, 7 and 8) that the design is of no mean architectural outline, and that it harmonizes with the surroundings. This is a case in which the engineer has appreciated the desirability of the beautifying of engineering structures and carried it out with great success. The tower is a heavy concrete structure built on bedrock on the east side of the lake, about 1,000 ft. north of the dam. The level of the floor of the tower is 428 ft.,

Fig. 7.—Water Tower, Front View.

and the level of the entrance floor of the gate house is 518 ft. The tower is circular in section with an inside diameter of 18 ft. top and bottom. The walls are 4 ft. 6 ins. thick from the bottom to level 465 ft. and taper to 18 ins. at the top. A concrete arch bridge connects the tower with the shore.

There are four 40-inch square intake openings in the tower at levels 430 ft., 451 ft., 469 ft., and 487 ft. at angles of 60 degrees of each other. The openings are belled to the outside and covered with coarse racks 6 ft. square. Gates are secured over the openings on the inside of the tower and since these gates are subjected to back pressure only, tending to force the disc away from its seat, it was necessary to build them of special design. The cast steel disc slides in vertical guides, but the gate seat and the back of the gate are at a slight angle to the direction of travel.

The disc is therefore wedged tight to the seats when in the lowest position, the guides taking the full thrust of the pressure of the water against the back of the disc. In all other positions of the disc the seats are not in contact; hook wedges are provided at the top and bottom of the gates to hold against the seat. The seats and all wearing surface are lined with gun-metal. These gates are enclosed in a sheet steel box having an opening directly in front of the gate opening over which the fine screens are placed; these screens are made up in teak wood frames and are lowered into position by means of a hand winch placed on the operating floor.

The screen frames slide in channel guides secured to the tower walls by brackets and bolts.

A secondary intake is provided situated entirely within the tower whereby water may be drawn off at any desired level. This intake consists of a steel stand-pipe 42 ins. in diameter built up in four separate sections having conical seats, on the upper and lower ends, each section seating on the next one below it, and the bottom section seating on a heavy cast iron elbow set in the tower floor. The intake pipe sections are guided between two 60-lb. steel rails placed on opposite sides of the pipe and fixed to the wall of the tower.

The lifting rods, 1½ ins. in diameter, are attached diametrically opposite near the top of each pipe section. This intake is operated by hand by means of a lifting gear which may be attached to any set of lifting rods. The approach channel to the tower, 20 ft. wide with slopes 1½ to 1 with sides rip-rapped, is cut from base of tower to deep water in the lake.

Tunnel Approach.—A tunnel 1,938 ft. in length, and terminating with a steel pipe 4 ft. 0 in. in diameter well below the dam, was driven almost entirely through solid rock to a valve house. A pressure-regulating apparatus is also installed at this point. The 25-in. and the 14-in. corporation mains are connected at this point with the

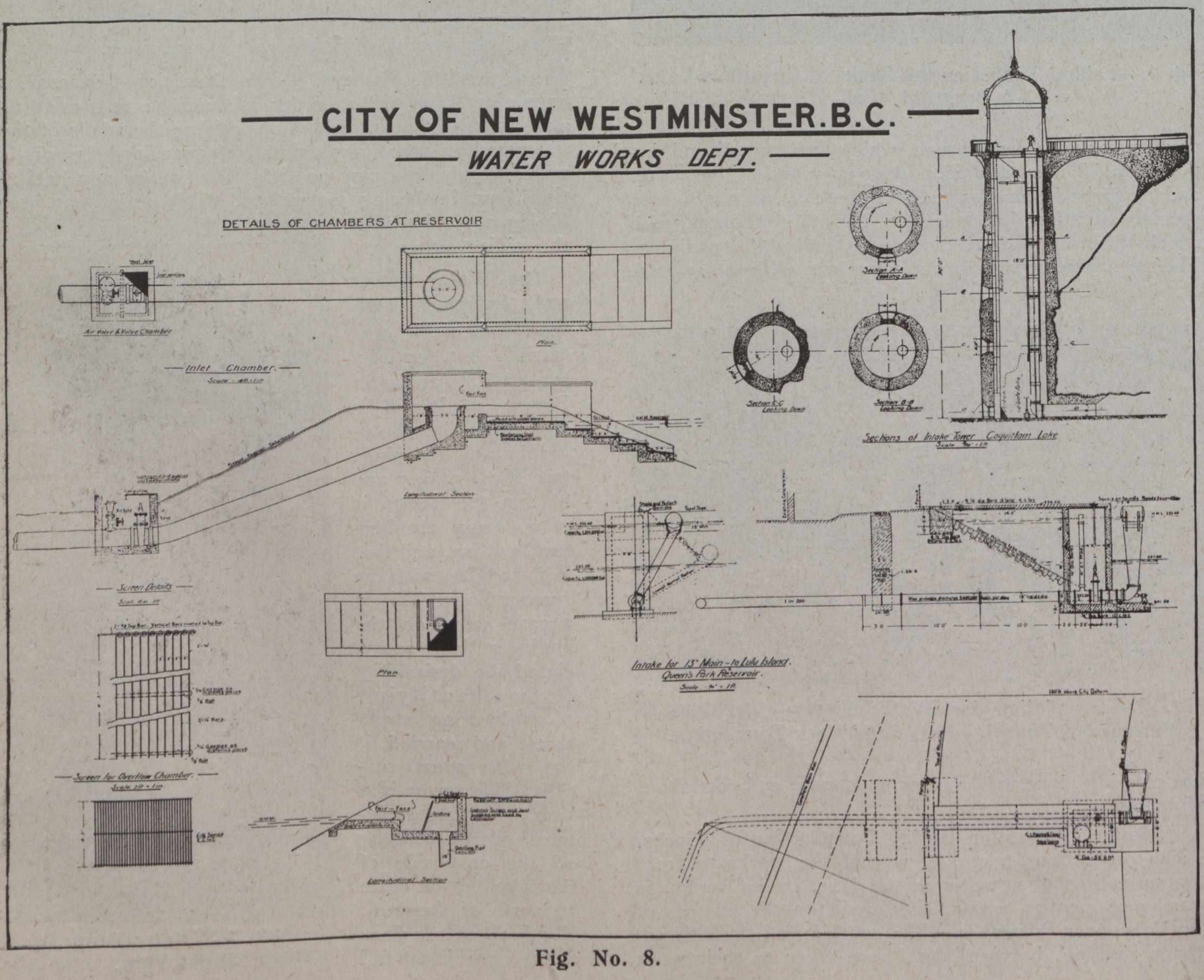


Fig. No. 8.

4-ft. o-in. pipe by a Y. Additional pipes can be taken from the 4-ft. o-in. pipe when required.

Location.—The location of the 25-in. pipe line for the first seven miles from the lake, follows the mountain side, parallel in most cases with the Coquitlam River, until Westminster Junction is reached. This line runs through a virgin British Columbia forest, composed mostly of large Douglas fir, cedar and hemlock. (See Fig. 9.

From Westminster Junction to Queen's Park Reservoir in the city limits, the line follows mainly the trunk road, except where it deviates on to its own right-of-way.

The Trenches.—The contract for laying and hauling the main was commenced in September, 1910. The work

Fig. 9.—Type of Country Through Which the Pipe was Laid.

was pursued all through the winter and was completed in January, 1912.

Digging the trenches was not done without much difficulty. For the first few miles the trenches were on a side hill, and considerable trouble was experienced with slides during the rainy reason, and during the thawing period after a heavy frost. Nests of large glacial boulders were frequently encountered; blasting operations had to be resorted to, and these were attended by an additional danger of the close proximity of a high-tension electric power line, at that time recently erected for the use of the Vancouver Power Co. in connection with their operations at the dam. Frequently a piece of rock flying from a boulder being blasted would cut a wire, cause the brush to catch on fire, stopping all work in the vicinity until repaired. The one and only narrow road or trail constructed for the laying of the pipe lines, was much used during the period of construction, as all the supplies for the 800 workmen at the dam had to be hauled over this road. A continual stream of four-horse and mule teams were hauling camp supplies and machinery all day. The contractors experienced considerable trouble in keeping this narrow mountain road open to traffic.

Hauling Pipes.—The pipes were manufactured in New Westminster, and as soon as they were ready were loaded on to flat railway cars and taken by rail to Westminster Junction, seven miles from New Westminster, where they were unloaded and hauled by road. Trolleys drawn by four horses were used to haul the pipes, the maximum haul being seven miles from this point.

Laying Pipes.—Special precaution had to be taken to see that no pipes were laid on the sharp edges of rock which had been blasted. Water in trenches gave considerable trouble and after the pipes were laid difficulty was experienced in preventing the pipes from floating. This was overcome by placing a layer of soft earth on the pipe and on top of this a layer of boulders. The pipe was laid giving minimum cover of 3 ft. o in. In deep ravines the pipe was carried across upon concrete piers. It will be noticed from the profile (see Fig. 10) that the line is exceedingly undulating, necessitating in some cases the use of vertical bends.

The Pipes.—It was decided to call for tenders for steel pipes of ¼ in. and 3/16 in. in thickness, and 24 ins. in diameter for a smooth pipe. It was found that a smooth pipe 24 ins. in diameter at lake level 442 ft. elevation would discharge 6,164,654 Imperial gallons per 24 hours; it was decided to adopt that diameter, and that riveted pipe, if quoted, should have such a diameter as would give a discharge equal to the 24-in. diameter smooth pipe. The lowest prices received for lap-welded pipes, 24 ins. in diameter, were as follows:—

Thickness of plate ¼ in. .... $2.83 per foot.
Thickness of plate 3/16 in. .... 2.74 per foot.

This gave the cost as $207,761 for 74,600 feet, which, with $13,428 for joints, made a total of $221,189.

The lowest price for double-riveted pipe, 25 ins. in diameter, was:—

Thickness of plate ¼ in. .... $2.67½ per foot.
Thickness of plate 3/16 in. .... 2.33½ per foot.

This gave the cost as $186,873 for the 74,600 feet which, with $17,804 for joints, made a total of $204,677 for 25-in. diameter pipe. This pipe gave an increased discharge of 205,346 gallons per day over the 24-in. smooth pipe. Although the writer was much opposed to the use of riveted pipe owing to the multitudinous rivet holes, the city decided that as a saving of $16,504 would be made and a slight increase in discharge would accrue, this tender should be accepted, provided the pipes were manufactured in the city.

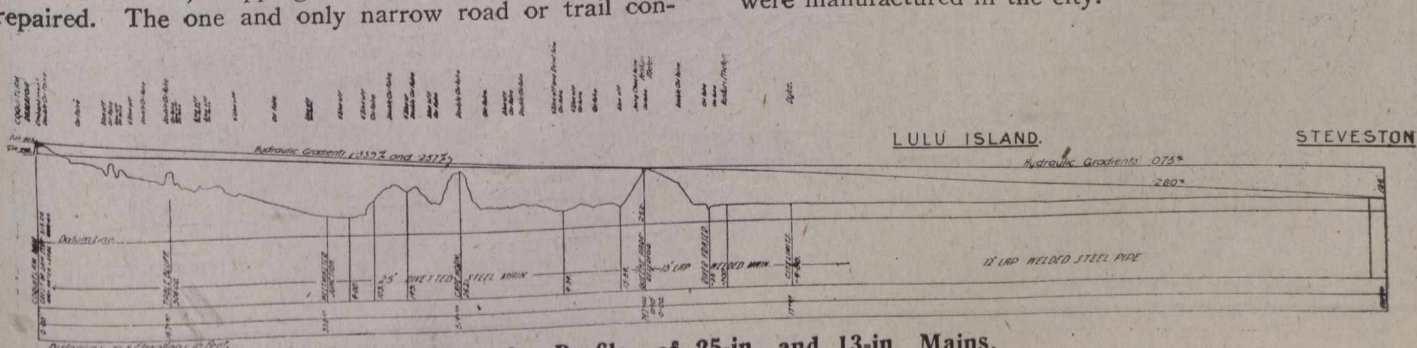


Fig. 10.—Profiles of 25-in. and 13-in. Mains.

The steel was specified to have a tensile strength of from 56,000 to 65,000 per square inch, the elastic limit not to be less than 31,000 lbs. per square inch, plates to double back to close contact by hammering, without showing signs of fracture or cracking, plates to be free from lamination, etc. See Fig. 11 for general details of riveting and joints, etc.

On page 419 is an extract from one of the test sheets.

Taking the joint efficiency of the 3/16-in. pipe at .656 (details of riveting are given in the detailed plans), the factor of safety with a free flow is 4.4 and for ¼-in. pipe with joint efficiency of .610 the factor of safety is 4.

This is taking the maximum head at the lake over spillway at 512 ft. Static head on the pipe is never likely to occur as the pipe can be controlled by the numerous sluice gates, 24 in number, and no occasion can ever arise when the full static head should be placed on the pipe. Allowance for water hammer was neglected.

From various sections taken from the 14-in. steel main which had been in service 19 years, no deterioration or corrosion was perceptible, owing to the remarkable purity of the water; therefore no allowance was made for this factor. From examination of the soil along the new pipe line and the old pipe line, no soil was discovered which would be detrimental to the pipe. Neglecting these elements the factors of safety are as follows:—

	Thickness of pipe. ¼ in.	3/16 in.
Tension	3.42	3.38
Shear in rivets	3.58	4.41
Bearing in rivets	3.65	3.81
Joints	4.00	4.4

It must be stated that at the time the pipe was designed, and the tenders were let, the question of raising the lake level by building the dam by the Power Co. was not decided; as the city was legally opposing their action, it was not justified in increasing the thickness of the pipe to meet this uncertainty, and admitting a legal defeat by making provision for the increased head; further, in case it should be considered that these factors of safety were not sufficient, a pressure regulator has been installed just below the dam to prevent increased pressure.

In the writer's opinion the factors of safety as given above are sufficient for this case and the full head can be given the pipe with a free flow without danger.

The pipes were manufactured in the city, a plant being installed for this purpose. After the plates were punched, rolled and the pipes riveted, an inspector who was permanently on the works, made a thorough inspection of every length and any loose or defective rivets were immediately cut out and replaced. The pipes were then caulked by pneumatic caulking tools.

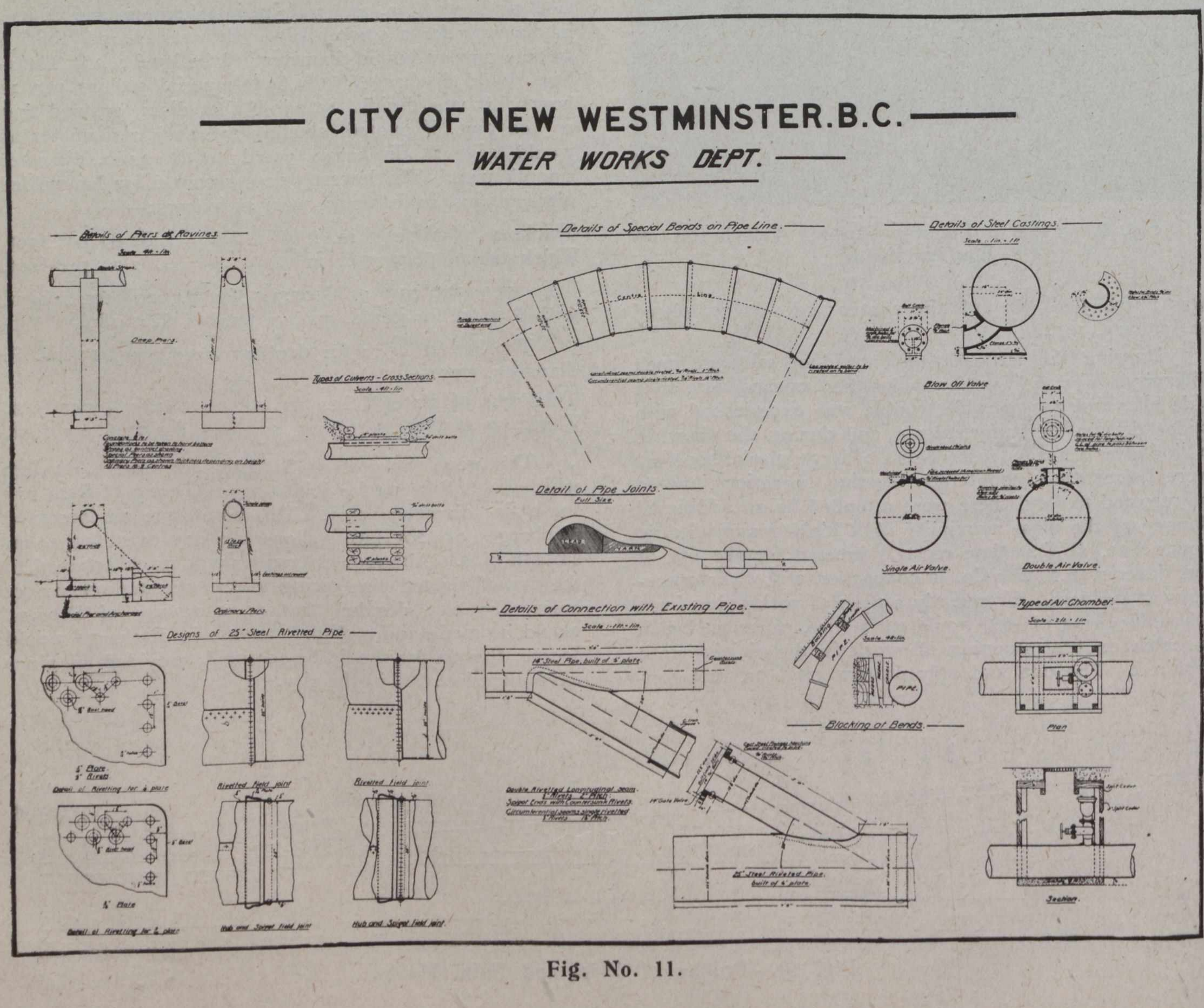


Fig. No. 11.

Testing was done by cast-iron plates being placed in the ends of the pipes and these plates secured by rods passing on the outside of the pipe and connecting with each plate; these ends were then caulked and the hydraulic pressure applied. The tests showed a very small percentage of leaks. The pipes were then heated and placed in a bath of asphalt compound to a temperature of 300 degrees Fahr. After being drained, the pipes were stacked and placed on flat railway cars, ready for shipment. The pipes were made in 22-ft. and 30 ft. lengths. The joints were made by riveting on Stewarts and Lloyds patent joint. About 50 lbs. of lead was required for each joint. This was cast hot in the usual way in one pouring, but in very wet trenches lead wool was used.

Special bends were made up of riveted pipes for all curves. (See detailed drawing, Fig. 11.)

Sluice Valves and Air Valves.—Sluice valves or blow-off gates were placed in all depressions along the pipe line, and the place selected for these were small rivers, creeks and ravines, where a sudden discharge from the main could do no harm. They were twenty-four in number, composed of six 8-in. diameter, six 6-in. diameter and twelve 4-in. diameter. The valves were all attached to special cast-steel castings, which were riveted on to the main. (See Fig. 11.)

The larger control gates or valves which were 24 ins. in diameter with spur gearing, were placed as follows: One at the gate house below the dam, one seven miles from intake, and one near the reservoir at Queen's Park. Air valves were placed each side of the control gates or valves on the main pipe line, except at those close to the reservoirs, where only one was placed. All sluice valves were supplied by Glenfield and Kennedy, of Scotland. When the writer states that fifty-three air valves were placed on the 14 miles of main pipe line, readers can imagine that the line had many summits. The writer has searched much engineering literature but has found little that has been written on the rational methods for determining the size of air valves. As each summit presents a problem of its own, if one investigates it will be found that the sizes should vary at each summit. With a pipe line made of steel, whose strength to withstand external pressure is so much less than cast iron pipes, special attention should be given. The failure of steel pipe lines has shown that such pipes are not effective in resisting external pressures. For the benefit of junior engineers the functions of air valves are briefly stated below.

In order to prevent the formation of a vacuum sufficient to cause the collapse of any part of the main, air valves are placed at the highest points along the pipe line, and at either side of main control gates. These valves allow the air to enter the pipe when being emptied and allow the air to escape when being filled with water. A vacuum may be formed in the main as follows: By the sudden opening of a sluice valve in a depression (a blow-off valve). (2) By a sudden break of the main, especially if this should occur at a low elevation, causing a great rush of water from adjacent summits; this would draw the hydraulic grade below the pipe at these points. (3) By having blow-offs too large, causing one or more of the summits of the pipe line to be above the hydraulic gradient when the valve is fully opened. (4) By closing the intake valve or any other valve when a valve at a lower level is open.

Since water mains are never laid at any great depth, the external earth pressure is not great and the thickness of the pipe calculated to withstand the internal hydrostatic pressures is usually sufficient to withstand earth pressures for reasonable depths. This being the case, it will be found upon investigation that a relatively low vacuum

Report of Tests and Inspection of Plates.

MILL RECORD NOS.				CHEMICAL ANALYSES.				PHYSICAL TESTS					
Heat.	Pcs.	Description of Plate.	Weight lbs.	Car.	Phos.	Mang.	Sul.	Elastic limit sq. in.	Ultimate strength sq. in.	Per cent. Elong. in 8 in.	Per cent. Reduction.	Bending Test, &c.	Remarks
42,513	15	82½ × 68 × 10.2	6,100	.20	.019	.40	.031	36,490	62,200	27.5	53.4	O.K.	Cup.
44,503	10	82½ × 68 × 10.2	3,950	.19	.016	.38	.031	36,620	61,280	29.0	50.4	O.K.	Irreg.
47,556	5	82½ × 68 × 10.2	2,050	.18	.020	.47	.030	34,830	59,420	29.0	53.9	O.K.	½ Cup.
30,528	20	82½ × 68 × 10.2	7,900	.10	.028	.54	.030	35,850	63,280	28.0	49.9	O.K.	Irreg.
45,505	19	82½ × 68 × 10.2	7,540	—	—	—	—	—	—	—	—	—	—
42,513	29	82½ × 68 × 10.2	11,500	—	—	—	—	—	—	—	—	—	—
44,503	55	82½ × 68 × 10.2	21,655	—	—	—	—	—	—	—	—	—	—
30,528	20	82½ × 68 × 10.2	7,900	.19	.028	.54	—	—	—	—	—	—	—
44,503	46	82½ × 68 × 10.2	18,270	—	—	—	—	—	—	—	—	—	—
44,514	5	82½ × 68 × 10.2	2,050	.19	.014	.54	.033	37,470	58,750	28.7	58.0	O.K.	Irreg.
57,518	23	82½ × 68 × 10.2	9,150	—	—	—	—	—	—	—	—	—	—
58,512	24	82½ × 68 × 10.2	9,325	—	—	—	—	—	—	—	—	—	—
			107,000	Shipped 10/13/09. P.R.R. 279757.									
7,556	15	84 × 68 × 10.2	6,225	.17	.017	.52	.030	37,050	60,080	30.0	56.0	O.K.	Irreg.
6,544	53	84 × 68 × 10.2	22,830	.18	.020	.33	.031	35,990	59,380	31.2	55.9	O.K.	Irreg.
13,649	15	84 × 68 × 10.2	6,125	.19	.031	.57	.037	37,220	62,750	29.0	54.7	O.K.	Ang.
5,549	28	84 × 68 × 10.2	11,405	.19	.040	.43	.032	37,680	61,230	30.0	56.0	O.K.	Irreg.
5,549	24	84 × 68 × 10.2	10,270	—	—	—	—	—	—	—	—	—	—
6,544	27	84 × 68 × 10.2	11,580	—	—	—	—	—	—	—	—	—	—
5,549	38	84 × 68 × 10.2	16,925	—	—	—	—	—	—	—	—	—	—
			85,360	Shipped 10/13/09. P.R.R. 385793.									
7,559	21	84 × 68 × 10.2	8,615	.18	.035	.40	.043	37,670	58,410	29.0	58.5	O.K.	Ang.
18,549 } 7,559 }	47	84 × 68 × 10.2	19,230	.16	.018	.44	.034	36,890	58,440	28.7	53.3	O.K.	Irreg.
		Amt. For.	27,845										

may cause the collapse of a steel pipe. It is thus evident that careful attention must be given to the size of air valves. It is therefore necessary to calculate the velocity and volume of water that could be discharged by a possible rupture at every low point in the pipe line, so that the air valve or a cluster of them at the summits on each side of the supposed rupture may be large enough to admit a volume of air equal to the volume of water discharged. It must be borne in mind that one side of the line will probably have no water to run (except that which is in the pipe) whilst the other side will be supplying a certain amount from the source of supply. Nothing less than 4-in. air valves were used on this line, and where required clusters of 4-in. air valves were installed. These were supplied by Glenfield and Kennedy.

[NOTE.—The above article was originally prepared by the writer for the Journal of the Institution of Municipal and County Engineers of Great Britain, and was published in that journal earlier this year. It has been revised for publication in *The Canadian Engineer*.—AUTHOR.]

(To be concluded in an early issue.)

REPORT UPON MONTREAL AQUEDUCT.

Reporting upon the Montreal Aqueduct, a committee of Montreal engineers stated that the project will cost $10,000,000; that the sum of $5,200,000 has already been spent; and that the latter sum is regarded by the engineers as having been wasted. The city is warned that if the remainder of the money called for by the scheme is spent, it too will be wasted. They find that the city entered upon the work without making sufficient preliminary study. The engineers who made this report are a committee who were appointed by thirty-one engineers, all members of the Canadian Society of Civil Engineers, all citizens of Montreal and all ratepayers in Montreal. The report was presented free of any cost to the city, as a result of the offer which was made by the engineers after the Board of Control had refused to make an appropriation to pay for an independent report upon the project.

BRITISH COLUMBIA INSTITUTE OF CIVIL ENGINEERS.

A new local society of civil engineers has been formed in British Columbia under the name of "The British Columbia Institute of Civil Engineers." It has no connection with any other engineering society and is wholly provincial. It will include land surveyors, architects, draftsmen, etc., as well as civil engineers.

At the organization meeting the following officers were elected: Chairman, E. N. Horsey; secretary-treasurer, L. P. MacRae, Jr.Can.Soc.C.E.; under-secretary, F. M. Preston, A.M.Can.Soc.C.E.; council, Wm. M. Stokes, Jr.Can.Soc.C.E., J. H. Devey, A.M.Can.Soc.C.E., Mr. Noakes, A. K. Mitchell, A.M.Can.Soc.C.E., Mr. Lambert and Mr. Todd.

It is proposed to apply to the provincial legislature for a charter. Branches will be opened in Vancouver and other provincial centres. The present membership is forty-two, but the officers state that they expect to double this number within the next few months. A clause in the constitution says all members must be British subjects.

Among the avowed purposes of the new society is the intention to prevent the importation of civil engineers for any work in British Columbia when qualified engineers are available in the province; to secure employment of engineers in British Columbia in order of merit; to secure equitable remuneration for professional services; to assist members to obtain employment by recommending them to employers seeking the services of competent men; and to give professional advice and assistance to all members whenever desired, for the purpose of increasing the efficiency of the members.

CANADIAN SOCIETY OF CIVIL ENGINEERS, REGINA BRANCH MEETING.

Mr. J. N. de Stein, secretary-treasurer of the Canadian Society of Civil Engineers Regina Branch, kindly forwards the following report of a recent regular meeting of that branch:—

"The main discussion referred to the recent appointment of the 'Commission of Enquiry into Railways and Transportation,' and the action of this commission in choosing American engineers to organize their valuation work. In the first instance, the Dominion government was sharply criticized for appointing such a commission, which to a large extent will influence the whole financial future of Canada, and in which a number of important engineering questions will occur, without giving the engineering profession of the Dominion a representation on this commission.

"In the second place, the act of this commission in appointing alien engineers to such prominent positions was discussed, but no final decision was reached. This matter was left with the executive of our branch with power to prepare a resolution in this respect, and forward a copy of same to every member of the Federal Parliament for the province of Saskatchewan."

EDMONTON BRANCH MEETING.

Prof. John A. Allan, of the Department of Geology, University of Alberta, gave a very interesting paper on "Some Geological Problems of the Petroleum Resources of Alberta" at a regular meeting of the Canadian Society of Civil Engineers, Edmonton Branch, held November 15th. Prof. Allan gave a short historical sketch of the development of the petroleum industry, dealing with theories held by geologists as to sources. He remarked upon the various kinds of petroleum and dealt with the geological formation of Alberta in regard to petroleum resources. His lecture was fully illustrated by earth sections and maps.

ANNUAL EXCURSION, TORONTO BRANCH.

At least seventy-five members of the Canadian Society of Civil Engineers Toronto Branch accompanied City Engineer Geo. Powell, and Chief Engineer Wm. Storrie of the John ver Mehr Engineering Co., on the trip of inspection to Toronto's new mechanical filtration plant.

Mr. Wm. Gore, consulting engineer of the company, together with Mr. Powell, Mr. Storrie, Mr. King of the Cowlin Co., and others, explained the operation of the plant in detail. Every portion of the works was visited and trial runs of some of the units were witnessed.

The plant, which has been described in previous issues of *The Canadian Engineer*, was of great interest to the members of the society, who expressed their appreciation of the ingenuity of the many automatic features, and also of the substantial materials and high-grade workmanship utilized throughout by the Cowlin Co.

GRAVITY WATER SUPPLY SCHEME FOR CALGARY.

By George W. Craig,
City Engineer, Calgary, Alta.

(Continued from last week's issue.)

PROPOSED GRAVITY EXTENSION.

Elbow River Weir.—The location of the proposed new intake is approximately two miles upstream from the present intake. At this point the valley is 1,350 feet wide with a well-defined and wooded island in the centre of the valley dividing the river into a north and south channel, of which the south channel is only running during the higher flow stages of the river.

During the summer of 1915 three test holes located along the centre line of the proposed structure were drilled, showing alternate layers of clay, soft and hard sandstone overlaid with the usual river drift of gravel and boulders. Under the clay and sandstones is a glacial clay strata varying in thickness from 8 feet to 18 inches, followed by a hard sandstone strata, which was explored to depths from 3 to 6 feet without penetration.

In the drilling operations it was noticed that watertightness was found in the casing upon entering the clay strata, for which reason the upstream cut-off and the retaining wall has been sealed to this strata. As a further safeguard, the spillway section has been designed for uplift pressure assuming maximum at the heel, and zero at the toe, with drain holes provided at the latter point, and also through the downstream carpet.

The total length of the structure is 1,350 feet, consisting of 30 feet of intake and undersluice section, 360 feet of spillway section, and 960 feet of retaining wall with gravel backing.

The downstream face of the spillway section is that of a ogee curve conforming to the falling nappe of a discharge 6 feet over the crest, which is equal to a total discharge of 17,460 sec.-ft., which is nearly 30 per cent. in excess of the June flood in 1915.

A downstream carpet or apron has been provided, which is designed sufficiently wide to prevent any scour at the end of the structure. Although the writer is more in favor of a water cushion than an apron, some doubt was felt as to its suitability to meet winter conditions, as they exist in this part of the country.

The intake section consists chiefly of a forebay at the entrance to which provision has been made for racks and two sets of fine screens operated by a light hand-operated travelling crane, which pulls the screens up and carries them to the washing place where they can be played upon by means of a hose, which obtains its pressure from a tank on top of the cut bank. The tank is fed from a small hydraulic ram located in the basement of the intake house, where also room has been made for a furnace and coal storage, it being the intention to steam-heat the building during the winter time.

On the principal floor of the intake house is located a 30-inch Venturi meter, also a chlorinator.

At right angle to the entrance to the forebay, and incorporated in the spillway section is a 4-ft. 0-in. x 6-ft. 0-in. undersluice, the principal function of which is to remove all accumulation of silt, debris and ice particles, which would tend to block the racks and screens.

Suitable retaining walls along the cut bank in up and downstream directions form the north abutment of the spillway section.

The balance and the longest part of the structure is the 960 feet of dyke formed by a reinforced cantilever wall supporting a gravel backing.

The whole of the structure has been designed as a diversion weir, and not as a storage reservoir, the impounded storage to crest level being less than 100 acre-feet.

Expansion joints have been provided throughout the entire structure at 30-ft. intervals.

Pipe Line.—The extension of the present wood-stave pipe line consists chiefly of the building of 11,650 feet 30-inch wood-stave pipe, together with about 750 feet of 30-inch flanged steel pipe, which is used behind retaining walls and the river crossing, where it is particularly desirable to do away with any possibility of leakage.

In investigating the present pipe line it was found that for a distance of about two miles eastward from the old intake, it was necessary either to shift the bands to conform to the new spacing as required by the additional head, or just simply to double up on the bands. It was decided to adopt the latter method in view of the fact that trouble was anticipated in connection with removing the nuts and a subsequent rethreading of the bands.

Owing to the increase in head, approximately 70 feet, the discharge of the pipe line from the new intake has been increased by 5 million gallons, giving a total of 13 million gallons per 24 hours.

Five hundred and eighty feet of steel pipe is required for the pipe line from the connecting chamber to the inlet house of the proposed reservoir extension.

There are four standard culverts on the 30-inch extension and a river crossing with retaining walls which carries the pipe line round a projecting cut-bank, and under a backwater immediately above the present intake.

Connecting Chamber.—At a point 570 feet west from the westerly end of the proposed reservoir extension is at present located a reducing piece (30-ins. to 20-in.). It is proposed to remove this special and build in its stead a connecting chamber from which will issue the 20-inch steel pipe leading to the reservoir extension. The chamber will be provided with a flash-board control, which will enable the operator to cut in or out on the 20-inch or the 26-inch pipe line. This arrangement will therefore allow for the following combinations:—

1. To operate present and proposed reservoir jointly.
2. To cut out proposed reservoir, as for cleaning purposes, and still draw from the present reservoir.
3. To cut out both reservoirs, and feed direct into distribution system.

Now to deal briefly with the question of sedimentation and turbidity, for which the reservoirs have been especially designed:—

We have samples drawn from the city hall main representing water from both Bow and Elbow Rivers during the turbid period of July, 1916.

Expressed in percent. of total solids:—

Precipitation after 1 hour sedimentation..	57 per cent.
Precipitation after 2 hours sedimentation..	64 per cent.
Precipitation after 3 hours sedimentation..	68.3 per cent.

Leaving after 24 hours a slight opalescence, which should not be offensive, particularly if it is considered that the period of turbidity under the very worst conditions, probably does not aggregate three months during the year.

It is possible to further precipitate chemically, and the design admits of an installation for the purpose; it is, however, hoped that this will not be necessary, although I have allowed in my estimate a figure to cover it.

The proposed extension has a capacity of 16 million gallons. In passing through this reservoir the velocity is cut down from the initial velocity at point of inlet to 1 foot per 102 seconds at the regulating chamber, or, in other words, it will take the supply approximately 24 hours to pass through the reservoir at a very small velocity, admitting of as complete a precipitation of solids as can well be secured short of using a filtration plant.

Sedimentation Reservoir.—The paving consists of concrete slabs 5 inches thick resting on a gravel cushion 6 inches thick. A further function, in addition to watertightness, which this part of the work has to perform is that of protecting the slopes from wave and ice action, so as not to increase the turbidity of the water.

At the westerly end of the reservoir is located the inlet house, with the necessary retaining walls. The house is built with a water cushion, and the outlet of the pipe submerged in order to extinguish the velocity as much as possible before it passes into the reservoir.

Division Retaining Wall and Regulating Chamber.—The division between the present reservoir and the sedimentation reservoir is formed by means of a retaining wall, in which is incorporated the regulating chamber, a water-tight cut-off being formed by means of sheet-piling driven under the toe of the wall. This retaining wall represents a considerable expenditure, and its construction was only decided upon, in view of the extremely unstable condition in which the present earth dam is.

The regulating chamber contains a movable baffle which enables the water to be drawn out of the sedimentation basin from either top or bottom, depending on the time of the year.

Provision by means of two sluice gates has been made for the utilization of the sedimentation basin as a reservoir in case of emergency. Under normal conditions, however, the water, after passing the baffle, will drop over a weir into another chamber from which it passes through a pipe under the embankment into the present reservoir.

The weir, besides measuring the quantity by means of a Simplex weir meter, enables the water to receive some aeration. Complete drainage of the retaining wall has been arranged for by means of drain pipes which are connected up with an existing cast-iron drain leading back to the present outlet.

Under this section should be mentioned the steps taken to tighten the present reservoir.

Considering the nature of the material found in test holes dug in the sedimentation reservoir, and from observations of the existing earth dam forming the westerly boundary of the present reservoir, the writer is of the opinion that the principal leakage takes place through the easterly and westerly end of the reservoir, or through the artificially constructed earth dams. It has, of course, been impossible to unwater the present reservoir, but assuming that the leakage really does take place as indicated above, the design allows for driving sheet-piling along the toes of these earth dams, and tightening the slabs by means of a layer of gunite reinforced with expanded metal.

Alterations to Present Outlet.—The most important alteration to the present outlet is that of providing a more adequate control, which has been accomplished by providing bigger sluice gates, by cutting the suction from pump house No. 3 direct in on the reservoir, and besides the present 16-inch outlet providing a new 30-inch outlet.

The combined discharge of the new outlet is figured for the peak load of consumption or about 38 per cent. in excess of the gravity supply.

Besides minor alterations to the house, provision has been made for an overflow connecting up with an existing 24-inch sewer with an automatic overflow to empty in to the Elbow River. The present bridge from the embankment, which is in a state of collapse, will be removed, and a reinforced concrete bridge constructed in its place.

Cost.—Following is a summary of estimated costs:—

Elbow River weir	$100,065.59
Right-of-way	5,000.00
Pipe line	78,660.40
River crossing	13,543.77
Connecting chamber	1,107.67
Sedimentation reservoir	21,798.11
Lining sedimentation reservoir	15,652.50
Division retaining wall, etc.	27,786.06
Alteration to present outlet	1,793.38
Lining present reservoir	14,646.00
	$280,053.48
Add 15 per cent. for engineering contingencies	42,008.01
Total for gravity extension scheme	$322,061.49
To this must be added for new mains and alterations to existing mains between reservoir and city	57,000.00
	$379,061.49

Annual Charges.—Following are the estimated annual charges:—

*Depreciation	$ 5,962.08
Sinking fund, 30 years on $323,000 @ 4%	5,759.12
Interest on debentures, 30 yrs., $323,000 @ 5%	16,150.00
Total annual charge on gravity extension scheme	$27,871.20
Annual charge on $57,000 (mains)	5,291.31
Total	$33,162.51

*At 2% for all items excepting pipe line 2½%, river crossing 2½%, and right-of-way nil.

Should a coagulant prove necessary, which is not believed to be probable, a further sum should be added to the annual charges as follows:—

Sinking fund on capital expenditure of $1,500, 30 years @ 4%	$ 10.70
Interest on debentures on $1,500 @ 5%	75.00
	$ 85.70
Operation, ⅛ grain of coagulant on 12 million gallons per annum, 78,214 lbs. @ 4c.	3,128.56
Additional per annum if coagulant be used	$3,214.26

Examining the annual charges against pump house No. 2 as they were for the years 1915 and 1916, and comparing them with a reasonable annual stand-by charge, which would be required in order to maintain pump house for emergency purposes:—

Average of 1915 and 1916 expenditures	$37,979.50
Cost of keeping plant as stand-by	7,436.00
Annual saving	$30,543.50

Therefore, we have:—

Annual charges for proposed gravity extension	$33,162.51
Annual saving on pump house No. 2	30,543.50
Net annual expense	$2,619.01

This shows that if the construction of the proposed gravity extension is carried out without coagulation, the charge for service will be only about $2,620 in excess of the present annual charges. Should coagulation be adopted this would bring the excess over present charges to about $5,750.

[NOTE—The alternative scheme—including filtration—will be outlined in our next issue.—EDITOR.]

REGULATING SIGNS ON HIGHWAYS.

The Ontario Department of Highways intends to prevent further mutilation of provincial roads by sign and billboard advertising, and the first steps in this direction have been taken by the Toronto-Hamilton Highway Commission with the approval of the Deputy Minister, Mr. W. A. McLean. The commission has called attention to a section of the act which makes it illegal to place a sign within one-quarter of a mile of the highway without the approval of the commission. Before that approval is obtained the sign owner will have to pay a substantial fee to the commission and the revenue from these fees will be used for the maintenance of the highway.

U. OF T. MEN NOW WITH CONSTRUCTION BATTALION

AFTER spending one month in Witley Camp, England, Canada's No. 1 Construction Battalion received an urgent call to start work in France, where they are now engaged in assisting the movement of troops, in bridge building, highway construction, etc. A large number of well-known Canadian engineers and contractors are with this battalion. The above photograph is of a number of University of Toronto men who are connected therewith.

From left to right the men in the photograph are: Lieut. L. B. Allan, S.P.S., 1911; Capt. (Dr.) C. P. Fenwick, 1916; Capt. E. P. Muntz, S.P.S., 1914; Lieut. G. D. Fleming, 1915; Capt. W. Mons, S.P.S., 1899; Capt. (Chaplain) E. F. Church, Victoria, 1916; Sergeant-Major T. R. Loudon, S.P.S., 1905; Capt. J. B. Heron, S.P.S., 1904; Lieut. E. H. Jupp, S.P.S., 1915; Pte. J. Nichol, S.P.S., 1917; Corp. W. J. Peart, S.P.S., 1913; Lieut. R. E. Lindsay, S.P.S., 1914.

The ranks of the battalion were considerably depleted by an exacting final medical examination and by temporary suspension for dental treatment, but were brought to strength by the acquisition of selected construction men drafted from the 127th York Rangers.

The battalion arrived in England about September 23rd, 1916. Their initial training was received last summer at Valcartier Camp, where they had the honor of holding premier place in the review held by the Duke of Connaught. Toronto citizens will remember the big sign which was suspended across the street at 189 Queen Street West, just in front of Toronto's now famous drill ground, University Avenue—a sign which brought many a Toronto recruit for this battalion.

The fortunes of No. 1 Construction Battalion will be closely watched by hundreds of engineers and contractors throughout Canada, and there is no doubt but that they will give a good account of themselves.

ENGINEERS LOSE SUIT AGAINST CONTRACTOR.

The interpretation of a contract for the construction of sewers in the municipality of Laval des Rapids formed the subject of a judgment rendered last week by Justice Lafontaine in the Superior Court of Quebec Province.

Seraphin Ouimet, Royal Lesage and Leon Desroches, civil engineers, took action against Andre Bray, contractor for the construction of the sewers, claiming $2,429, of which sum $1,650 was asked as a penalty for an alleged delay of 165 days in the completion of the work, the balance of $779 being for damages suffered through the said delay in the execution of the contract.

One of the clauses in the contract stipulated that for each day of delay there should be a penalty imposed of $30, of which amount $10 a day should be payable to the engineers who prepared the plans. It was to recover that penalty that the plaintiffs brought the present action.

The defendant on his side sued the municipality of Laval des Rapids to guarantee him the amount claimed by plaintiffs in the event judgment was given against him. In reply to the principal claim he said there was no contract between the plaintiffs and himself and consequently they could have no legal claim against him. The delays complained of were caused by the municipal authorities themselves and for that reason they on their side could not recover any penalties.

Mr. Justice Lafontaine maintained the defence on the ground that there was no lien de droit between plaintiffs and defendant. "The town," his Lordship said, "does not seem to have any claim against the contractor, and it would be singular if the plaintiffs, who are only employees of the town, could have a greater right than their masters. Under Article 1028 of the Civil Code the contract could not legally stipulate any penalty in favor of the plaintiffs. Any arrangements that may have been made between the plaintiffs and the town can in no way bind the defendant."

The principal action against the contractor was therefore dismissed, and the town was condemned to pay the costs of the action.

STREET CLEANING AND HEALTH.

At the convention of the Society of Street Cleaning and Refuse Disposal of the United States and Canada, held in New York City, October 9th to 13th, 1916, a paper, entitled "Health and Sanitation," dealt in interesting manner with the effect that scientific street cleaning has upon public health. The author was Mr. G. H. Hanna, of the Tiffin Wagon Co., Tiffin, Ohio, who is first vice-president of the society. Mr. Hanna was for sixteen years superintendent of streets of Cleveland, Ohio, and is well qualified to discuss street cleaning methods. Following is a brief abstract of some portions of Mr. Hanna's paper:—

Street cleaning and the disposal of city wastes have represented stumbling-blocks in the path of municipal progress for a majority of cities, and great credit attaches to the few on this continent who, through their fortunate or unfortunate contact with these problems, have been able to bring about the degree of progress which the past few years have witnessed.

I need not cite any dry statistics to convince this audience that city budget makers have too frequently designated the street cleaning department as a near relative of Kelly's goat, and have pruned its appropriation to the verge of criminality. I say criminality, because to impair the health of a city is criminal.

The cleanliness of a community is a pretty accurate barometer of its health. I am not a physician, and am not capable of adding anything to the controversy about the extent to which disease germs are transmitted by dust. I understand, in a general way, that there is less tendency to-day than there was a few years ago to attribute infection to dust-borne germs, although I think no one has gone so far as to deny that germ diseases in some instances are transmitted in dust. Further than this, I never heard of anyone claiming that dust was a benefit to health, or cleanliness a menace; and, leaving health out of the question, nobody wants filthy streets or dusty premises. Call it a mere sentiment if you will, but it is a sentiment that distinguishes the civilized man from his cave-dwelling ancestors.

And in relation to street cleaning cost, I want to point out that the most economical place in whcih to perform the street cleaning function is in the street. The same filth must be combatted somewhere, perhaps where it originates, perhaps where it is blown after lying neglected on the pavement. I recall a rhyme which appeared some years ago in an Ohio paper:—

"We have a cheap and novel way
To clean a city street.
The summer sun beats down all day;
The breezes fan it as they play
And blow the dust off neat.
The refuse of two thoroughfares
Is on our bric-a-brac and chairs
And in the food we eat."

Some plead for street cleaning funds as a justifiable luxury. I contend for them as a means of saving money in the performance of what must be performed by some means in any event.

I will not undertake a complete review of the various methods of street cleaning, most of which have their place in relation to the kind of pavement, traffic conditions, cost of labor, etc., which vary with the locality. My own experience as commissioner of street cleaning in Cleveland led emphatically to the conclusion that flushing, under favorable conditions, was the cheapest and most effectual method of cleaning that could be devised. I collected statistics for some time as to the cost of cleaning various pavements by this method, and made some interesting discoveries, both as to the variation of cost on different surfaces and the relation of this variation in cost to the other charges that are customarily considered in choosing paving material.

The use of the flusher on a given street may vary from twice a week to a daily flushing, proportioned to the traffic. I would supplement flushing with a white-wing patrol system, in which the city is divided into sections with a suitable force of men assigned to each section. Every street should receive at least a daily visit from a man with a hand-sweeper and a pushcart. Flushing saves the time and energies of the sweeper, permitting him to work chiefly in the gutters. Where the traffic is light, the entire accumulation of refuse can be removed in his handcart, but for medium and heavily travelled streets, his function will be merely to sweep the accumulated refuse into piles along the curb, which a dump-wagon will collect. The administrative test of a good street cleaning superintendent lies in routing his flushers, his sweepers and his wagons to get the maximum result with the minimum effort and to avoid delays between the collection and removal of the wastes.

The handling of street wastes, garbage and other refuse materials is the ensuing problem. My own strong preference is for the early incineration of all such materials. A city with ideal equipment and organization should incinerate its wastes daily. To be sure, certain exponents of thrift tell us that there are valuable substances contained in these wastes which can be extracted to the profit of the community. I have not yet been convinced that the pittance which communities realize from the sale of wastes afford a sufficient offset to the dangers entailed in handling these wastes for profit. Reduction means delay and much handling. Admitting that men can be hired to do this kind of work, I still think it is a kind of work which they should not be encouraged to do. The continual exposure to infection on the part of a few men means the continual exposure of the entire community to the danger of an epidemic. The plagues of Europe are not such distant history that we can afford to ignore the possibility of just such disasters in America.

We all remember a few years ago, when garbage contracts in smaller municipalities were customarily taken by hog-raisers, who undertook to convert municipal garbage, collected at a profit, into pork, which could be sold for another profit. It was only when state veterinarians were compelled to kill thousands of diseased hogs and condemn other thousands of carcasses that the unprofitableness of this kind of profit became apparent. I think it is a fair type of the risks run by any community which fails to recognize in these substances just what they are: dangerous poisons, which are to be handled as little, and destroyed as quickly, as possible.

It appears that the London press is favorable to the English Channel tunnel project and that Premier Asquith, who recently received a deputation regarding it, is also in sympathy with the idea. Late in August it was announced in Paris that France had taken all the necessary steps to enter into negotiations with England for the joint construction of the tunnel. Plans were outlined by M. Sartiaux, chief engineer of the Nord Railway Company, who stated that the tunnel would cost £16,000,000. It is stated that the English Tunnel Company controls the right to construct tubes, and that the capital is subscribed and the initial boring well under way.

ENGINEERS CONDEMN MONTREAL AQUEDUCT SCHEME

REPORT BY SPECIAL COMMITTEE OF MONTREAL CONSULTING ENGINEERS FULLY CONFIRMS INVESTIGATION PREVIOUSLY MADE BY THE CANADIAN ENGINEER AND ADVISES CITY TO ABANDON PRESENT PROJECT.

THE MONTREAL AQUEDUCT will cost at least $10,600,000, without allowing for steam auxiliary plant, parking, contingencies (estimated at $620,000), or the Cook claim of $900,000 damages.

The total annual saving to the city by immediately abandoning the present project and purchasing 7,000 h.p. would be at least $262,000.

These are the salient features of a thorough report made by seven of Montreal's leading engineers, all estimates being based upon official figures supplied to them by the civic authorities. The report fully substantiates the article printed in *The Canadian Engineer* in the November 11th, 1915, issue, which was written after proper investigation by this journal, and which was read to the Montreal waterworks superintendent before publication, and concurred in by him so far as the figures and estimates contained therein were concerned.

Following is the letter of transmittal which accompanied the engineers' report:—

"Montreal, November 20th, 1916. To His Worship the Mayor and the Members of the Board of Commissioners of the City of Montreal, L. N. Senecal, Esq., Secretary; and to His Worship the Mayor and the Members of the City Council of the City of Montreal, the Honorable L. O. David, City Clerk.

"Gentlemen,—The Ratepaying Engineers of the City of Montreal who submitted a memorandum to the Board of Commissioners and City Council on April 20th, 1916, appointed a Committee to study and draft a report on the works now under construction and contemplated for enlarging the water supply aqueduct and developing hydro-electric power for the use of the municipality. The report of the Committee was submitted at a special meeting, duly called for the purpose of receiving and considering it, of which meeting Mr. Phelps Johnson was elected Chairman and Mr. H. M. MacKay, Secretary.

"The report was fully discussed at this meeting, unanimously approved by the said Ratepaying Engineers, and the Committee was instructed to have it forwarded to the Board of Commissioners and to the City Council. I am directed to say that the discussion of the report showed that the Committee had reached their conclusions only after long study and careful calculations, verified from all available data, and that the signatories of the original memorandum concurred in the conclusions of the Committee.

"I am also directed to advise you that the Committee consisted of Mr. W. F. Tye, Chairman; Sir John Kennedy; Mr. Ernest Marceau; Mr. R. A. Ross; Mr. J. A. Jamieson; Mr. Arthur Surveyer; and Mr. Walter J. Francis, Secretary. These gentlemen, independent consulting engineers, were requested to undertake the work as being specially qualified by reason of their ability, experience and high professional standing, to deal authoritatively with the matter.

"The Ratepaying Engineers feel that they cannot too strongly express their appreciation of the disinterested zeal for the best interests of the City, which influenced the members of the Committee to undertake the very large amount of work required by the analysis of the data presented to and collected by them and the preparation of the accompanying report. They cannot too strongly urge upon the City the absolute necessity of giving immediate consideration to and of acting upon the conclusions embodied in the report.

"Respectfully submitted. H. M. MacKAY, Secretary of the Meeting."

The report of the Committee is appended to the above letter. Following is the text, in full, of this report:—

"Montreal, November 13th, 1916. To His Worship the Mayor and the Members of the Board of Commissioners of the City of Montreal, L. N. Senecal, Esq., Secretary; and to His Worship the Mayor and the Members of the City Council of the City of Montreal, the Honorable L. O. David, City Clerk.

"Gentlemen,—In accordance with the arrangements made on June 22nd, 1916, when a delegation of the ratepaying engineers appeared by invitation before the Aldermen, and in response to the requests contained in two official letters dated October 16th, 1916, from Mr. Commissioner Ross asking that further studies be undertaken and report made thereon, we have prepared our report, free of cost to the City, in connection with various aspects of the enlargement of the aqueduct.

"We now have the honor to submit herewith the conclusions reached after having studied the project, gone over the works in progress and reviewed all the documents and data placed at our disposal.

HISTORICAL.

"Since the middle of the nineteenth century Montreal has been supplied with water from an open aqueduct five miles in length, which brought water from the Lachine Rapids to a pumping station where water wheels pumped the water to the City. Ice troubles in winter caused such serious power shortages that steam power was gradually substituted for hydraulic power for pumping. The City's requirements for power kept on increasing, and in 1905, Mr. Georges Janin, then Superintendent of the Waterworks, proposed that the aqueduct be enlarged to produce 5,000 horse-power in summer and 2,000 horse-power in winter, so that the steam pumping plant might be done away with and the pumping done by hydraulic power. Great economy was claimed for the project, since known as 'Enlargement No. 1'. To provide water for the City while the hydraulic power plant was being built, a closed reinforced concrete conduit was constructed alongside the aqueduct. This was completed in 1909, and the work on Enlargement No. 1 was thereupon commenced. While this was being carried out Mr. Janin proposed that Enlargement No. 1 be further increased to provide 10,000 horse-power. His proposal was accepted and part of the work was put under contract in July, 1913. This is known as 'Enlargement No. 2' and is now under construction. The claims made for the economy of the first enlargement were more strongly repeated for the second.

"In connection with Enlargement No. 2, on September 1st, 1916, the City Engineer reported that 58% of the excavation and 20% of the retaining walls had been completed by the contractors. The only work performed, so far, has been in the headrace. The tailrace, which also forms a part of the Cook Construction Company's contract, has not been touched, nor have the following important component parts of the complete installation:—entrance breakwater, headgates, several bridges, fencing, power house, and dredging in the river.

"In December, 1913, an accident to the conduit occurred, as a consequence of which the City engaged Messrs. Lea, Jamieson and Heckle to investigate the break. These gentlemen found such a condition apparent that they recommended to the City that the whole project be carefully studied. Previous to this it had been pointed out in 1913 in the public press that the proposed power development was apparently much less economical than the City's estimate would lead one to believe. This Mr. Janin strenuously denied. The recommendation of Messrs. Lea, Jamieson and Heckle not having been acted upon, the Canadian Society of Civil Engineers in July, 1915, made strong representations to the City urging that a full investigation of the project be made. This recommendation was not accepted, and in October, 1915, it was again vigorously placed before the City. On November 11th, 1915, *The Canadian Engineer* published a comprehensive article on the subject, and concluded by fully endorsing the request that the project as a whole be thoroughly investigated and reported upon.

"None of these recommendations having been acted upon, thirty-one independent ratepaying engineers of Montreal signed a memorandum to the City in April, 1916, urging that an engineering commission be appointed to report on the cost of the works and to advise to what extent, if at all, the project might to advantage be modified.

"By request, a delegation of these engineers, appeared before the Board of Commissioners on May 12th, 1916, and discussed the question after explaining their position as ratepayers and engineers. Again, on June 22nd, 1916, following the publication of many articles in the press, a delegation of the ratepaying engineers accompanied by official representatives of various public bodies, appeared before the Aldermen and Commissioners, when it was proposed by some of the aldermen that the ratepaying engineers should make a report free of cost to the City. The delegation reported to the ratepaying engineers, who assented to the proposal and named a committee to carry out the investigation, the result of which is summed up in the following conclusions.

CONCLUSIONS.

"1. The capacity of the original aqueduct was sufficient for three times the present population served, if used for water supply only, and not for hydraulic power.

"2. The cost of the construction of a filtration plant was the only further capital expenditure necessary to make the water from the original aqueduct ideal both for domestic and industrial use.

"All surface waters in the neighborhood of Montreal require filtration. With filtration the water from the original aqueduct would be superior to any other water available for Montreal's use. Filtered Ottawa River water is equal to filtered St. Lawrence River water in purity, and is superior to it in softness, and for washing and boiler purposes.

"3. With the exception of the filtration plant and the pumping equipment, all expenditures in connection with the present project are chargeable to power development.

"No changes in the original aqueduct were required, either for an increased quantity, or an improved quality, so that the work done and contemplated must be considered as a project to obtain more power. The whole cost except that of the filtration plant and the pumping equipment must therefore be charged to power development. The various reports of Mr. Janin, the official history of the Montreal Waterworks compiled by Mr. F. Clifford Smith, and clause 1 of the specifications under which the Cook Construction Company is working show that is was so regarded.

"4. The power project cannot be regarded as an essential part of a general improvement scheme, because boulevards, parkways, permanent bridges and so forth were just as applicable to the original aqueduct as they are to the present development.

"The district through which the aqueduct passes could have been opened up, driveways along the original aqueduct constructed and suitable bridges built from time to time as found necessary or desirable, for a sum insignificant in comparison with the cost of the present project. The boulevards were an afterthought in connection with the 1910 report of Mr. Janin, and were considered by him simply as an adjunct to his power plans, and as a means of obtaining land at no cost.

"5. The present project has never been properly studied or reported upon as a whole.

"Neither Mr. Janin's project of 1905, nor its subsequent enlargement proposed in November, 1910, now being carried out, were ever properly studied as a whole, nor has it ever as a whole been reported on by any engineer. No complete plans and estimates have ever been made of such essential parts of the project as the river intake, the power house, or the necessary outlet works in the river below the tailrace.

"The generating of electrical energy by water power, and its transmission, has within the past twenty years completely revolutionized the aspect of power utilization, so that any report made twenty years ago is of no present value regardless of the eminence of authors.

"In 1907, Messrs. Marceau and Kennedy when reporting on Enlargement No. 1 were not given the necessary information to permit them to pass upon the economics of the project. Their report was specifically stated by them to be an interim one only, and it did not deal in any way with any cost except that of the closed conduit.

"In July, 1910, Messrs. Hering & Fuller, in their report on 'An Improved Water Supply for the City of Montreal,' referred to the aqueduct power project, but they did not compare the relative annual costs of power developed and power purchased. The only comparison made was with the cost of power as previously produced by the City, and in this comparison essential figures were omitted. We are entirely unable to agree with their endorsation of the project as being a 'sound, practical, business proposition on its own merits' because no project of power development can be so considered which does not assure as economical a supply as could otherwise be obtained.

"Neither of these two reports referred to the proposed 10,000 horse-power development, but only to the less extravagant first enlargement designed for 5,000 horse-power in summer and 2,000 horse-power in winter.

"In 1914, Messrs. Lea, Jamieson and Heckle reported only on the break in the conduit, and they properly advised the careful study of the project as a whole.

"6. The project as designed would not safely develop under the best conditions more than 7,000 horse-power at any time of the year, and the average output would be actually much less than this.

"The headrace has a capacity of about 14,000 horse-power in summer only, which would reduce to an average of about 7,000 horse-power in winter even assuming that no frazil troubles be experienced. The tailrace as designed is not capable of safely passing the flow required for more than about 6,000 horse-power even during the summer months, and the output may only reach 7,000 horse-power for a few weeks. If it were attempted to pass a greater volume, the velocity would be such that the bottom would be eroded, the retaining walls undermined, and much other damage done.

"7. Serious operating troubles due to frazil and other ice are inevitable. These will greatly reduce the maximum output below 7,000 horse-power and may cause complete stoppage of the plant during a more or less protracted period every winter.

"No practical design of the headworks will avail to keep out the frazil which consists of particles of ice intimately mixed with and carried in suspension by the water.

"In Mr. Janin's 1907 report it is clearly shown that serious ice troubles occurred every year, and that the winter power was often not more than 20% of the summer power. In Mr. Smith's official history it is stated that ice blockings in the aqueduct, frazil, and various difficulties in the tailrace necessitated the substitution of steam pumping for hydraulic pumping.

"The 10,000 horse-power plant of the Lachine Rapids Hydraulic Power Company, situated in the same rapids and less than two miles away from the aqueduct intake, is practically closed down for three or four months every year. The conditions at the intake of this plant are similar to those at the proposed aqueduct plant, while the possibilities for removing frazil and other ice are much superior to those at the aqueduct where no means whatever are provided for this purpose.

"8. The minimum capital cost of the project as designed will be $10,600,000. This cost is exclusive of the filtration works or any pumping plant or steam auxiliary plant, or the Cook Construction Company's claims of over $900,000, or an allowance for parking, or the usual allowance for contingencies.

"This estimate of cost is from official figures supplied by the City. We have used no figures of our own, except interest from the present date to completion, which future interest figures were not furnished by the City. This cost does not include the filtration works nor any pumping plant, nor steam auxiliary plant, nor the Cook Construction Company's claims, nor an allowance for parking, nor the usual allowance for contingencies, and these have not been considered by us in any discussion of cost.

"This estimate does not contain any figures whatever for necessary dredging in the St. Lawrence below the outlet of the tailrace, as apparently this feature of the development has not been considered, studied or estimated by the City. The soundings given in the Georgian Bay Canal plans show that this dredging would extend for nearly half a mile. No figures for contingencies, excepting on the power house, are included in this estimate, as no such figures were furnished by the City. Were we making an estimate for a private corporation we would have added at least $620,000 for this item. Mr. Mercier's report of June 16th, 1915, shows that it had been found necessary to re-design the concrete retaining walls, at an estimated increased cost of $675,000, an addition of nearly 50%. The first estimate of the total development amounted to $4,975,000, which has now grown to a minimum of $10,600,000. Knowing these facts and believing that the City figures are even now in many other respects for from complete, we are convinced this huge sum will be exceeded by millions of dollars.

"The money cost of this project could have purchased and have developed any one of a number of powers within easy transmission distance of Montreal and each having a capacity of at least 100,000 horse-power.

"9. Radical changes in design at greatly increased cost would be necessary to even approximate the capacity of the power development as claimed by the City.

"10. The minimum capital cost based on the maximum safe capacity of the plant as designed will be $1,515 per horse-power.

"The excessive cost of this development will be appreciated by reference to the following paragraph from *The Canadian Engineer* of November 11th, 1915: 'Power Rates in Montreal.—Nowhere on the American continent is power being developed cheaper than around Montreal. The new Laurentide development of 125,000 h.p. is being paid for by a $6,500,000 bond issue, or $52 per horse-power. Cedars cost $90 per horse-power, and when ultimate development has been completed, this will be reduced, it is said, to $75. Shawinigan cost considerably less than $100, and the latest development there cost only $50 per horse-power. It is said that the average cost of all the developments within a transmission radius of Montreal is not much over $100 per horse-power, and the average throughout Canada, $125 per horse-power.'

"11. The minimum fixed charges and operating expenses for the power plant will amount to $757,000 per annum.

"In the above estimate interest is figured at 5%, a lower rate than Montreal now has to pay, sinking fund at 1%, and depreciation on the parts affected at the usual rates.

"12. The minimum fixed charges and operating expenses of the power plant will be $108 per horse-power per annum.

"This abnormally high operating cost may be appreciated by a reference to the following extract from *The Canadian Engineer* of the before-mentioned date: 'The cheap developments near Montreal make a low rate for power possible. The Aluminum Company of America is said on good authority to have contracted for power at $12 per horse-power per annum from Cedars, and to have been given other inducements at that. The Montreal Water & Power Company is said to have a $20 rate for 20-hour power in the winter months and $24 for 24-hour power in the summer. The City itself at present has a $20 rate for 20-hour power and a $30 rate for 24-hour power. And no steam standby would likely be necessary for the City if they contracted for the 10,000 h.p. from one of the power companies, on account of the way the various Montreal plants are tied together for emergencies, and on account of the splendid steam standby that the Montreal Light, Heat & Power Company are now constructing.'

"13. Twenty-four-hour power can readily be purchased in the open market at a figure not exceeding $25 per horse-power per annum, and twenty-hour power suitable for pumping for not more than $20.

"At any time during the last fifteen years, it has been practicable to purchase on the open market sufficient power for all municipal purposes at a small fraction of the cost of the power expected to be produced from the present development. Or a modern steam plant could have been installed, or the present steam plant remodelled, which would have provided power at a much less cost per horse-power per annum than that of the present aqueduct development.

"14. The yearly cost of purchasing the 7,000 horse-power, which is the maximum amount of power that the project might develop, would not exceed $150,000.

"The figure of 7,000 horse-power is used for comparative purposes only. The average output of the plant as designed would be less than this figure.

"Mr. Janin in his report of November 3rd, 1910, estimates at 3,000 h.p. the energy necessary to pump fifty million gallons of water per day. Montreal's average consumption is not very much above this now, and on this basis 4,000 h.p. would be a conservative estimate of the maximum power required for pumping. This could be purchased for a sum not to exceed $90,000 a year.

"Present lighting contracts will prevent any power being used by the City for lighting for some years to come. Moreover, Superintendent Parent in his report dated September 12th, 1916, upon the municipalization of the City's lighting system, showed that the capital cost to the City would be $1,680,000, and the yearly loss, with power at a cost of $15 per horse-power per annum, would be for each 6.6 ampere lamp, $5, and for each 4.4 ampere lamp, $10. The use of aqueduct power at $108 per horse-power per annum would enormously increase these unfavorable figures.

"15. As compared with the purchase of power, this project, if and when completed, would involve a loss of at least $600,000 per annum.

"The yearly deficit in the finances in the City of Montreal is growing at an alarming rate, and Montreal cannot afford to throw away one dollar.

"16. The present project should never have been started, and we are firmly of the opinion that all thought of completing it, along the present lines, should be abandoned.

"The chief physical features which make the aqueduct project impossible of economic development and operation are the low available head, the great length and cost of headrace and tailrace canals and the location of the intake in swift water where frazil ice cannot be prevented.

CONDITIONS TO BE MET IF THE PROJECT BE ABANDONED.

"17. If all work were to be stopped at once, the total capital cost to the City would be about $5,200,000, which includes an allowance of $300,000 for boulevards, bridges, fencing and cleaning up, but no allowance for the claims of the Cook Construction Company.

"In view of the arrangements made with many of the adjoining land-holders, it will be necessary to grade the boulevards if work be stopped, but there is no necessity of conforming to the high banks and level grades deemed advisable when waste banks were a necessity.

"Bridges will also be necessary, but these need not be single spans as contemplated for the aqueduct.

"A small amount of general cleaning up will also be required.

"The stoppage of the work would not interfere in any way with the operation of the filtration plant.

"The claim for damages of over $900,000 filed by the Cook Construction Company against the City having been left out of the estimate of total capital cost is also omitted here. The amount, if any, which may be awarded in settlement of this claim would of course increase the capital cost of $10,600,000, if the work were completed, or the sum of $5,200,000, if the work be stopped now. In each case it would appear in the fixed charges for an amount equal to 6 per cent. of the sum awarded.

"18. The annual fixed charges on this amount of $5,200,000 will be $345,000.

"19. The total yearly cost of 7,000 horse-power purchased, plus the fixed charges on $5,200,000, would be $495,000.

"The present needs for pumping are not more than 4,000 h.p. and on this basis the total yearly cost would be reduced to $435,000.

"20. The total capital cost which will be saved by abandoning the present project will be a minimum of $5,400,000.

"This amount of saving is exclusive of any dredging in the St. Lawrence, any allowance for contingencies or any of the probable increases in cost due to inaccuracies or discrepancies in the City's figures. The interest alone on this amount, without taking into consideration sinking fund, operating expenses or depreciation will amount to $270,000 a year, while power for the City's present pumping requirements can be purchased for $90,000 a year, and on the same basis for a sum not exceeding $150,000 a year in 1930.

"21. The total annual saving to the City by immediately abandoning the present project and purchasing 7,000 horse-power would be a minimum of $262,000.

"The present needs for pumping are not more than 4,000 horse-power and on this basis the total yearly saving would be $312,000.

"22. By judicious adaptation of the existing conditions, a limited return may be derived from the expenditures already incurred.

"We desire to extend our thanks to the City Commissioners, the Chief Engineer of the City, the Superintendent of the Waterworks, and to the City's engineering staff, for the courtesies extended to us and for the voluminous data which they have placed at our disposal. We trust that the conclusions now reached may be received in the spirit in which they are submitted, namely, the best interests of the City.

"We have the honor to be, gentlemen,

"The Committee of the Ratepaying Engineers: W. F. Tye, Chairman; John Kennedy; Ernest Marceau; J. A. Jamieson; R. A. Ross; Arthur Surveyer; Walter J. Francis, Secretary.

"Read and approved at a meeting of the Ratepaying Engineers, held in Montreal on the 13th of November, 1916. Phelps Johnson, Chairman of Meeting; H. M. MacKay, Secretary of Meeting."

Exports of tungsten ore from Japan in 1915 were 85 tons to the United States, 214 tons to France, and 110 tons to the United Kingdom, or 409 tons in all. Estimated shipments to July 20th, 1916, are placed at 480 tons, most of it going to the United States. The tungsten output of Japan is reported as 25 to 40 tons of ore per month from the Kiwada mine, 10 to 11 tons per month from the Takitori mine, and 75 tons per month from several small mines. Those in Corea produce between 50 and 60 tons per month. Attempts were made to obtain tungsten from Siam, but the ore contained large percentages of tin, greatly reducing the value.

A USEFUL TYPE OF CRIBWORK.

By A. E. Eastman, A.M.Can.Soc.C.E., Cardinal, Ont.

CRIBWORK in some form has been in use ever since the beginning of engineering, and will continue to be used, because in certain classes of work substitutes will be difficult or impossible to find.

Types of cribwork are many, ranging from the cribs made of round logs, notched sufficiently to prevent movement and give a good bearing, which were used in bridge construction in the days of early settlement, to the immense cribs used in the foundations of the Quebec Bridge and other structures, and to the concrete cribs used at Port Weller on the new Welland Ship Canal.

The writer wishes to give to the readers of *The Canadian Engineer* a general idea of a type of crib which has given much satisfaction, and, while the dimensions and description given herein refer to one particular crib, variations in dimensions and form can easily be made to suit such circumstances as may occur, and with equal satisfaction.

After the crib-seat had been excavated, soundings were taken from a float mooring into the required position every two feet along the front, back and ends, and also along the line of the longitudinal ties.

These soundings were plotted and the bottom of the crib built to conform to the crib-seat as found.

Ways had been prepared for the building of the crib, and the cribs were built up about fourteen to sixteen courses before launching. They were then built up afloat to the required height, in this case about sixteen feet.

This crib was 40 ft. long, 16 ft. wide on the top, and 18 ft. wide on the bottom, this difference in width being made up by a batter four feet high. The general details are shown on the accompanying plan.

The material used was 4 in. by 12 in. plank, the cross ties and ends being pine and the remainder mixed timber of good quality. Ten-inch wire nails, weighing four to the pound, were used to fasten the planks, and an average of about eighty were used in each course.

The front face was built solid, each longitudinal course being made up of not more than three planks, and filling pieces were cut to fill exactly the spaces between the ties. The back was left open, that is, no filling pieces were required between the ties; the back longitudinal courses were the same as in the front face, not more than three planks, but each butt was supported and overlaid by a 4 in. by 12 in. block, not less than three feet long.

The longitudinal ties were three in each course, of lengths shown on the plan. The ends were open, except from the bottom to the top of the batter between the longitudinal ties and the face sticks, where filling pieces were required. Similar filling pieces were used in each row of ties as well as the ends. In all cases where filling pieces were called for they were required to fill the space completely.

Floors were placed in four pockets only, as the plan shows. These floors were to carry ballast as an aid in sinking the cribs.

After the cribs had been built up to the necessary height they were towed into position for sinking. The floored pockets were filled with stone until the cribs were almost awash. A deck of loose plank was laid over the unfloored pockets and skips of stone placed on this deck to complete the sinking. These skips were handled from a floating derrick and found very convenient, for if the crib moved off line, raising one or two skips were usually sufficient to lighten it enough to make it easy to bring the crib to line again. Before starting to sink each crib (after the first one) two pieces of 4 in. by 12 in. plank were spiked on one end of the crib on the face, with one end projecting by the end of the crib. This projecting end was kept against the face of the last crib sunk, thus insuring that end being in line, and it was necessary to have a transit point on the other end of the crib only.

After the crib had been sunk the floored pockets were well filled before the skips were removed, then filling all pockets was continued.

As mentioned before, this description is of a certain crib built by the writer, but changes might be made to suit conditions. For instance, in this crib the batter was on the face of the crib, but if a plumb face were required from top to bottom, the batter could be omitted, or even built on the back of the crib, where the larger base and weight of backfill on the batter would increase the stability of the crib.

Several advantages of this type of crib may be pointed out, as follows:—

(*a*) Four in. by 12 in. plank will in many localities be easier to purchase and be cheaper than larger sized timber, such as 12 in. by 12 in.

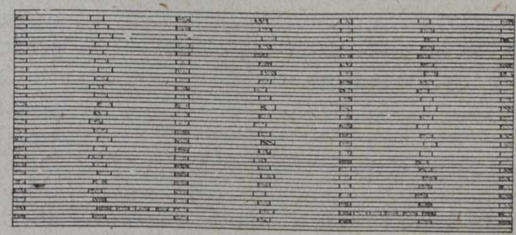
(*b*) Ease in handling this size of timber.

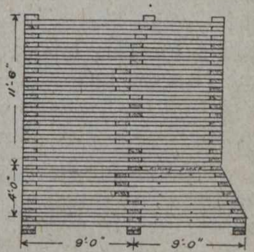
(*c*) Unskilled labor can, under an ordinary foreman, build this crib, there being no dovetails or other joints to make. If the cross-ties be bought the required length, the main items are cutting filling pieces and driving the spikes.

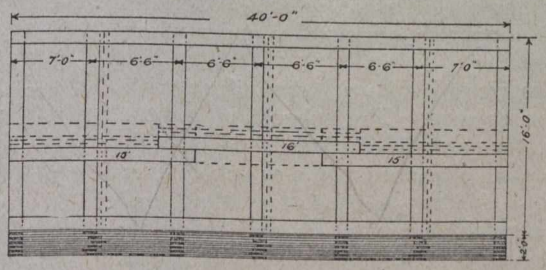
(*d*) Rapidity in construction (often a matter of importance), as two men can carry any plank used.

(*e*) Small openings between courses permit of the use of small stone for filling, which in many localities is a consideration; and with care in building, earth may be used for filling where stone is particularly hard to get.

(*f*) No boring necessary, as in the case where driftbolts are used to fasten crib timbers; a saving in time and labor.







Details of Cribs.

(*g*) Cribs of special shape can be built as easily as the regular rectangular form.

Other advantages may occur to readers.

Who originated, and when, this type of crib the writer does not know, but it has been used by Mr. J. L. Weller, engineer-in-charge of the Welland Ship Canal, on the present Welland Canal, and also by Mr. C. D. Sargent, superintending engineer of the Ontario-St. Lawrence canals, under whose directions the crib described above was built.

SEEKS $30,000,000 FOR RESEARCH WORK.

President Butler of Columbia University, New York City, is asking the trustees of the university for $30,000,000 increase of the university's endowment to provide for expansion of Columbia's research activities. One of the projects contemplated is a national industrial research laboratory to which manufacturers throughout the United States may bring their problems for solution. Plans for this laboratory, to be erected on the shore of the Hudson near the university, have been worked out by a committee headed by the dean of the engineering schools of the university. In his report Dr. Butler says:—

"The European war has served at least one good purpose in arousing our industrial managers and our public men from their long sleep of indifference to scientific inquiry and to scientific progress. It has now been heavily borne in upon them that what some American industries waste would support a principality under wiser and keener administration.

"The future of American industry is bound up with the future of American science. The schools of mines, engineering and chemistry, already distinguished in high degree and now upon that advanced plane which invites only the highest type of student and releases time and energy for genuine research, are anxious and ready to undertake with great energy some of those specific tasks which will aid American industry to improve the products, to decrease its wastage, to co-ordinate its processes, and to multiply its resources for dealing satisfactorily with the many-sided human problems which industrial relationships and industrial enterprise of necessity involve.

"The testing and experimental laboratories which are needed in such an undertaking must be placed at the point where transportation, both by rail and by water, is easy and cheap, and where there may be ready access on the part not only of those who conduct the investigations and those who are being trained in methods of research, but also on the part of those who represent or are engaged in the industries whose problems are, at any given moment, the subject of inquiry. It is within the mark to say that a capital sum of $6,000,000 for equipment and endowment is needed in order to deal promptly and satisfactorily with this great group of problems. Every dollar put into such an enterprise would be returned to American industry many times over in the course of a very few years."

The example set by President Butler will be stimulating to those who have been active in Canadian research work.

Railroad construction contracts, totalling 28,000 miles in Russia and China, are pending, and even that amount is said to represent only a small part of the future development in this respect. A conservative estimate places the railroad construction in Asiatic China and Russia at from 60,000 to 70,000 miles in the next decade.

REDUCTION OF HIGHWAY GRADES.*

By Jules Duchastel de Montrouge, M.Can.Soc.C.E.,
City Engineer, Outremont, P.Q.

PEOPLE are generally very quick to protest against any increase in freight rates charged by railways, and generally always find them high, but they always fail to grasp the importance of the saving they can make by having good roads. In the past 80 years, freight rates have been decreased nearly 90 per cent., but taken as a whole, the reduction of cost of highway transportation has been nil.

The question of grades is a very important economic one. It is quite true that in cities, towns and villages, it is practically impossible in most cases to modify any bad grades, on account of the damages that might be caused to the bordering property holders and the heavy costs they are sure to claim through the courts; but in town planning or in the opening of new city districts, the question of grades should be looked into carefully and settled according to well-established engineering rules.

It has been established that a horse of, say, 1,200 pounds will, by exerting a force equal to one-tenth of his weight, draw a load of 2,000 pounds on a level road; on the same road but on a 5 per cent. grade, with the same force against his collar, he will draw 1,000 pounds, and on a 7 per cent. grade, only 750 pounds. What is true in connection with the horse-drawn traffic, is at least equally true in the case of the mechanically drawn traffic.

Another important feature of this question of grades, is the fact that steep grades are more detrimental to haulage on improved roads than on unimproved ones, and this is due to the fact that the tractive resistance on improved roads being low, the grade effect will be proportionately greater in the first case than in the second.

Steep grades are slippery and dangerous in cold weather, hard to maintain, and their surfaces are easily washed away in stormy weather.

Steep grades generally come about in urban municipalities on account of the desire of land speculators to lay out their roads and streets along lines parallel to straight boundary lines, trying in this manner to get out of the subdivision every available square foot of land. We have some very sad examples of these poorly laid-out streets in some of the most beautiful districts in the Island of Montreal, and unfortunately, this state of affairs cannot be remedied, on account of the huge sums it would require. What is more pleasing than curved roadways, ascending slopes of a gentle grade? One sees fine examples of what I mean in the Rosedale district of Toronto, along West Crescent Heights in Westmount, or Cote St. Catherine Road in Outremont.

There should be a law in this province establishing the maximum grade of roadways and streets, as there is a law fixing the width of streets.

Finally, the question of relocation of a roadway to shorten its length, or to avoid sharp turns or steep grades is also an important economic problem. As a rule, this can only be accomplished in newly developed districts on account of the heavy expense entailed. There are cases where straight roads passing over hilly districts have been relocated clear around the hills without little if any additional length, as the length of the vertical curve passing over the hills was just about the same as the length of the horizontal curve of the newly located road.

*Abstract of article in the Calgary News-Telegram.

DISINFECTION AND OTHER PROGRESS IN MUNICIPAL WATER SUPPLIES.

THE Committee on Water Supplies of the Sanitary Engineering Section of the American Public Health Association has made a report reviewing some lines of progress in municipal water supplies. The committee consists of F. F. Longley, New York, chairman; Geo. G. Earl, New Orleans, La.; Ed. E. Wall, St. Louis, Mo.; G. D. Haskins, Lawrence, Kan.; F. D. West, Philadelphia, Pa.; and Joseph Race, city bacteriologist, Ottawa, Canada. The following is a brief extract of their report:—

Disinfection.—A few years ago the disinfection of domestic water supplies was resorted to principally in those cases where the water was known to be highly polluted, and then only as an extreme measure. Its value, as measured by the several factors of bacterial efficiency, convenience and low cost, soon became so apparent that the use of the common disinfecting agents, hypochlorite and liquid chlorine, spread rapidly to places where it was only occasionally necessary as an emergency measure. In time it will, no doubt, become a useful and necessary adjunct to all waterworks systems for the purpose of producing a refinement in the quality of the water that will insure as far as possible the elimination of all pollution causing water-borne diseases.

The principal change in the situation regarding disinfection of water supplies has arisen to a large extent out of the great increase in price of chemicals resulting from the European war. The price of hypochlorite of calcium, which was the principal agent used in water disinfection up to two years ago, has gone up abnormally high. For a period of a month the price was more than ten times, and for a period of six months the price was more than five times as high as it was before the European war began. On the other hand, liquid chlorine has hardly exceeded twice its normal price.

This has been reflected in a striking way in the increase in number of liquid chlorine installations for the purpose of disinfection of water supplies. The following table gives the best information available regarding this point.

Liquid Chlorine Plants.

Period.	Total number of plants installed during each period.	Total number in service.
Prior to Jan. 1, 1914	46	46
Jan. 1, 1914, to July 1, 1914	29	75
July 1, 1914, to Jan. 1, 1915	51	126
Jan. 1, 1915, to July 1, 1915	94	220
July 1, 1915, to Jan. 1, 1916	132	352
Jan. 1, 1916, to July 1, 1916	201	553
July 1, 1916, to Sept. 1, 1916	77	630

These installations represent an average total volume treated by this method at the present time of nearly 4,300 million gallons per day. No corresponding information regarding the increase in number of hypochlorite plants is available for the purpose of comparison, but from a general knowledge of the field of disinfection, it may safely be stated that the increase in number of such plants has been small compared with liquid chlorine. Further, it is known that numerous hypochlorite plants have been discontinued on account of high cost, and liquid chlorine equipments substituted in their place.

Attempts are being made to find out more about the factors that control the efficiency of disinfection, with a view to introducing, if possible, additional factors to improve that efficiency. One experimenter, Mr. Joseph Race, of Ottawa, who reviewed some of the results of his experiments in the September 28th, 1916, issue of *The Canadian Engineer*, points out that for the treatment of highly colored waters or waters high in organic matter, ammonium hypochlorite gives a markedly greater efficient than does calcium hypochlorite. He applies this in a practical way by mixing ammonia with the hypochlorite solution immediately before it is applied to the water supply. The economy of this treatment as against a larger dose of hypochlorite alone would depend, of course, upon the relative cost of the two chemicals. In the present market his experiments indicate a saving by the use of ammonia with a smaller quantity of hypochlorite. It appears likely that experience might indicate other advantages, such for instance, as less likelihood of objectionable tastes and odors.

Cost of Chemicals.—Aluminum sulphate showed a slight rise of about 10 or 12 per cent. within a week or so after the outbreak of the war. The price then remained steady until about a year later, when it began to rise. This occurred at about the same time as the rise in price of sulphuric acid, which occurred as a result of the great industrial activity fostered by the war. The price of aluminum sulphate in the New York market then rose to something over four cents per pound, from which price it has not yet receded on current quotations.

Soda ash, like aluminum sulphate, responded to the pressure of increasing industrial activity towards the end of 1915, and increased to five or six times its normal price. The increase in the price of this chemical affects only a few waterworks plants. Lime, also used in water softening plants, has not been influenced by these factors, as its price is fixed almost entirely by purely local considerations.

Physical Chemistry.—Still another direction in which new ideas are developing in connection with the treatment of water supplies is in the application of the principles of physical chemistry to the problems of decolorization and clarification. The colloidal character of coloring matter may be considered as established. The colloidal character of the fine turbidity of many of our southern and western waters has long been recognized. Too little is commonly known about the nature of colloids and the laws governing their actions. Knowledge regarding this is, however, becoming more and more accessible and efforts are being made to apply these principles to problems of water purification. As it becomes more clearly recognized that profound actions hinge upon obscure factors such as the concentration of ions of one sign or the other, or the electro static charges upon the colloidal particles that produce the color effect in water, and as the advance guard of scientists connected with our public health and water supply questions succeeds in devising means for the convenient measurement of these concentrations, interesting and epoch-making developments may be expected in the direction of decolorization and clarification of waters.

Generally speaking, the universities are better provided than any one else with the facilities and the time for investigations along this line. The committee considers it proper to suggest their active co-operation in the study of obscure problems of this nature.

Meters as a Sanitary Measure.—Sanitarians who are looking toward improved quality and reliability of the public water supply may at first blush think the question of the use or non-use of meters of or the form of meter rate is very much outside of their province. The practical fact is that a city may be able to afford to maintain a supply of one amount with every possible safeguard, but altogether unable to do so for double that amount. Thus, if waste of water is not checked, conditions may arise which contribute to an inferior quality of the supply and sometimes failure of adequate pressure to provide proper sanitary facilities or to afford safe fire protection. Again, even if the entire system is metered and pressure and quality are maintained, the meter rate between the large and small consumer is sometimes so framed that the small consumer pays an inequitable rate in comparison with the large consumer and this may tend to an objectionable restriction of consumption.

Our larger cities are spending enormous amounts of money to procure more and more water, and sometimes almost before their latest extensions and improvements are completed, they are facing other and larger expenditures and still further increases in capacity with apparent per capita consumptions which in many cases are ridiculously high. The water ratepayers and taxpayers have somehow to meet these ever-increasing costs, and if due to waste, the consumption is vastly greater than the necessities warrant, they are paying just that much more than they need to pay on account of this waste.

Meters will materially decrease water consumption by preventing waste. High quality, and satisfactory and reliable pressure and reserve capacity are easier to secure with moderate consumption, and these things are certainly more to be prized than excessive amounts of waste water. Still, because of this common waste, pressure, reserve capacity and quality have frequently to be sacrificed, and the taxpayers and water ratepayers are often paying a great deal more for a poor and unreliable unmetered service than they would have to pay for a very good metered service.

Usually when the suggestion is made that they should pay less as a whole for a better service by metering their supply, there is a general protest. This arises out of prejudice and ignorance, and the fear of restricting a water consumption is too prominent in the minds of many who look at this question from a purely sanitary viewpoint, since they forget that reasonable restriction as to quantity is extremely important to the far more vital questions of maintaining the necessary pressure and quality.

It is the belief of the committee that the elimination of useless waste of water would in many cities greatly decrease and delay vast expenditure in increased capacity and would leave funds for much-needed improvements in quality and reliability of service. Further, that the general adoption of meters can reach this result, and that meter rates and methods of raising the necessary revenue, in which each beneficiary of any portion of the waterworks service pays for the benefits which he receives in proportion to his participation therein, form the most acceptable basis upon which people will adopt the universal meter system.

Since 1906 the Alaska Road Commission has constructed 901 miles of wagon roads, 557 miles of winter sled-roads, and 2,216 miles of trails. The average cost of construction of the wagon roads has been $3,000 per mile; of the sled-roads, $325 per mile, and of the trails, $100 per mile. The practical value of this road construction is shown by the fact that the cost of transporting freight over the Government-built and maintained roads in 1912 was $1,243,735, while it is estimated that without these roads the cost of this work would have been $3,385,412 a saving in one year of $2,141,677, or approximately the total amount spent by the Federal Government in the construction of the entire road and trail system of the Territory.

STREET TRAFFIC PROBLEMS.*

By Nelson Peter Lewis,

Chief Engineer, Board of Estimate and Apportionment, New York City.

AMONG the most difficult problems presented to road builders and road planners is that of street traffic. The increase in the volume of this traffic has been almost sensational during recent years, especially since the use of the motor vehicle became general. While this increase is quite obvious in all cities, the statistics in street traffic in London are unusually complete, and the reports of the London traffic branch of the Board of Trade bring out some remarkable facts. The number of horse-drawn cabs licensed by the metropolitan police decreased from 11,404 in 1903 to 2,385 in 1912, while during the same period the number of motor cabs increased from one to 7,969. During the same period the motor omnibuses increased from 13 to 2,908, while the 3,623 horse-drawn omnibuses in 1903 have entirely disappeared. Some remarkable statistics are given as to the number of vehicles passing certain points at certain hours and during the day, but the surprising feature of these statistics is that the total number of vehicles licensed in 1912, including tramway cars, was actually 203 less than in 1903. No better illustration is afforded of the enormous increase in the service rendered by motor vehicles owing to their higher speed and greater flexibility.

On certain streets of all busy cities the number of vehicles is so great and the resulting congestion is so serious that students of this problem have become much alarmed and are discussing the need of more effective traffic regulation. The easiest solution of this problem appears, however, to be the better diffusion or distribution of traffic, and this can in no way be more effectively brought about than by a better and more uniform standard of improvement of the roadways of both urban and rural highways.

Why is it that so many drivers of vehicles tend to use the same street when many different possible routes could be followed? Undoubtedly the chief reason is that they wish to use the streets that are best paved. In the case of the motor vehicle a slight detour with corresponding increase of distance is of little consequence and time will actually be saved by the avoidance of traffic congestion, but those who are riding, especially for pleasure, prefer to follow the streets that are most attractive, those on which the abutting property has been improved to a higher degree and in a little more sightly manner. When our streets shall have become uniformly well paved and when the property along them shall have been improved according to better standard—not necessarily with palatial homes, but with good taste—when tree planting is taken up more seriously and when the space not needed for roadways and foot paths is devoted to grass plots or planted with shrubbery, those with whom time is not the important element, will follow these streets, now given over wholly to the delivery wagons of the milkman, the grocer and the butcher, and appreciable progress will have been made in the solution of the traffic problem.

There is, however, a very serious problem which has grown out of the use of motor vehicles, namely, the increasing weight, the increasing wheel loads and the increasing size of these vehicles. The motor or the tractor

*Address at annual meeting American Road Builders' Association, November, 1916.

can overcome grades with heavy loads which were impossible to the horse-drawn vehicle, and highway officials responsible for the maintenance of our city streets and of the country highways leading out of them are greatly concerned at the damage inflicted upon road surfaces by these loads. The only effective remedy appears to be the enactment of drastic ordinances and laws which will absolutely prohibit the use of vehicles having more than a specified load per inch width of tire, and that load should probably be less for steel tires than for rubber tires.

The width and length of such vehicles is a matter of serious concern, especially on city streets. Where roadways have been designed to accommodate a certain number of lines of traffic and the number of lines is reduced through an increase in the width of the vehicles, the capacity of the roadway is reduced in still greater proportion, and if this increase in width is allowed to proceed, very costly street widenings will become necessary. In this case, also, it would appear to be necessary to prohibit absolutely the use on our highways of vehicles having more than a certain specified width.

Fortunately, the tendency of the manufacturers of motor trucks appears to be in the direction of more moderate loads. Of 221 manufacturers producing commercial vehicles at the beginning of the present year, 133 confined themselves to those of less than three tons capacity. Of the 88 manufacturers offering trucks of more than three tons capacity, twelve appear to have increased this capacity in their models for this year, only two of these increases being the six tons, while six have decreased the capacity of their trucks, one from four to three and one-half tons, three from five to three and one-half tons, one from six to four tons, and one from seven and one-half to five tons. Of twelve newcomers in the field, only one offers a truck with a capacity of six tons and two of five tons, while the rest provide for smaller loads.

While the imposition of an absolute limit upon wheel loads and upon the dimensions of vehicles seems necessary to preserve our highways, both in the city and country, the development of the motor vehicle appears on the whole to present no problems to highway officials, especially problems relating to street congestion, which will not solve themselves with the more general improvement of our streets and roadways and with the adoption of a higher standard of real estate development which will make the subsidiary highways more attractive to those using motor vehicles.

HIGH-TENSION TRANSMISSION LINES AND STEEL TOWERS.*

By Lesslie R. Thomson, B.A.Sc.,
Dominion Bridge Co., Montreal.

THE truest economy in transmission line design may only be attained by a close co-operation between the electrical and structural engineers after a careful weighing of all the various conditions that affect the whole project. The following few notes are prepared from the point of view of the structural engineer who may be called into consultation when a transmission line is under consideration. The first part treats in a general way of the basic conditions that govern a design, and of the criteria on which the economy should be judged; the second part outlines present practice, touching certain details and recommending various structural requirements.

General Characteristics.—When electrical power is to be developed and then carried over any considerable distance, the necessary transmission line becomes one of the most important items in the estimated cost of the whole installation. It will be admitted that the aim should be, not to so design the line that the original investment is a minimum, but rather to so lay out the whole scheme that, consistent with satisfactory operation, the annual outlay is reduced to the smallest possible dimensions. Before going further it would be well to note at this point that the term "satisfactory operation" is a very difficult one to either define or equate to a definite financial basis, but an attempt will be made, however, to reduce it to tangible terms.

The *annual cost* of a line may be assumed to divide itself roughly under the following heads:—

(I.) Interest on the original capital investment.

(II.) Depreciation.

(III.) Operating costs, *e.g.*, engineering services, repairs, patrolling and (*a*) any premiums on accident or interruption liability insurance, or (*b*) the annual equivalent of any monetary damages due to interruptions to service (unless covered by policies under iii.-a).

(I.) (II.) and (III.) are not isolated or independent channels of expenditure, but are related one to the other; and will consequently overlap to a certain extent. It is desirable to touch briefly on this interdependence. In the past it was often considered that if the capital investment was reduced to a minimum, the line would then be the most economical one possible. This is now felt to be only partly true, for a cheaply constructed line with frequent interruptions and accidents, with perhaps heavy damages, may prove in the long run to be far more costly than a well-designed line involving a larger capital outlay. The problem thus resolves itself into preparing a design on which the sum of (I.), (II.) and (III.) is a minimum.

Capital.—It will be readily seen that items (I.) and (II.) will contribute a fairly important part of the total annual cost, and consequently, any attempt to reduce the capital investment will result in the reduction of both the interest and depreciation charges. The following list comprises the various heads under which the capital expenditure is distributed: (*a*) Wires and splices. (*b*) Towers or poles. (*c*) Insulators. (*d*) Guy wires. (*e*) Right-of-way complete, or (*f*) Land for towers with right of passage for overhead wires. (*g*) Foundations. (*h*) Erection including the delivery of towers. (*j*) Engineering services.

The cost of all the foregoing will vary, of course, with every change in the layout of the line. The minimum clearance of wires from the earth, all the electrical characteristics, such as voltage, number of circuits, number of phases, power per circuit, sizes and types of insulators, etc., and the average span length, will all affect the total capital cost. But for purposes of discussion, from the point of view of this paper, it may be assumed that all electrical features have been fixed together with the minimum clearance of wires from ground. This leaves span length as a remaining variable whose changes will affect the capital cost.

The effect of span length on capital cost is a little difficult to predict with any certainty, but various characteristics undoubtedly influence it, and these characteristics will be examined. Reverting now to the list

*Abstract of paper presented to the Canadian Society of Civil Engineers, at Montreal, November 16th, 1916.

of headings under which capital expenditure may be distributed, it will be noticed that the cost of certain of them will be practically unaffected by any change in span length. These items are (*a*), (*d*) and (*j*). The cost of wires and splices may be assumed to be independent of span length, for most transmission cables are strong enough in any event to carry their loads over comparatively long spans while the increase in cable length—due to larger sags—may be neglected. Similarly the cost of guy wires (*d*) and of engineering services may be regarded as being independent of span length.

The items now remaining are those whose costs vary with the changes in the span length. If short spans are to be used there will be a large number of light towers, or perhaps poles, with consequently heavy costs for insulators, and possibly for erection. On the other hand, the right-of-way will be less expensive than were longer spans desired. This will be easily appreciated when one considers the fact that long spans necessitate increased distances centre to centre of conductors at cross-arms, and also large sags in the cables which, in heavy winds, must have wide arcs of swing. These facts naturally require for the line wider limits, and consequently a more expensive right-of-way, in order that the cables shall at all times and under all circumstances remain within the limits of the property or passage right acquired.

As the spans increase in length the towers become, of course, heavier, but there are naturally fewer of them to the mile and it must be borne in mind that the cost of insulators varies directly with the number of towers. Pole lines usually have spans of 150 ft. to 300 ft. long while tower lines have spans of from 300 ft. to 2,500 ft., depending on the judgment of the engineer.

In flat country, a succession of equal spans with as few horizontal angles as possible will give the most economical arrangement. In mountainous country the high points along the lines should be selected for the tower sites, and very little effort should be made to keep all spans of equal length. For sake of repairs, shipping, storage of spare parts, etc., all towers should be made alike unless some exceptional circumstances should demand a few special towers.

By selecting high points for the towers in rough country, a considerable saving may often be effected owing to the fact that the conductors will in general be above the trees, and consequently the necessity for a large amount of expensive clearing on the right-of-way is obviated. Also tower sites in mountainous country should not be placed in the path of possible snow or land slides, while towers placed near rivers that are liable to overflow their banks should be protected by cribs or piling.

The cost of foundations will naturally increase as the number of towers increases, and will, in general, be cheapest per mile when long spans are selected. The cost of erection will, within certain limits, vary directly as the number of towers. The question of lightning also enters into the discussion to a small extent. It has been found to be practically true that lightning most frequently discharges through one of the pin insulators to the tower rather than travel along the line to a lightning arrester provided for the purpose. Consequently the fewer towers and insulators with, however, the same number of lightning arresters per mile, the less likelihood of damage by lightning.

A somewhat theoretical solution of a portion of the problem of span length has been given by D. R. Scholes in a communication presented to the American Institute of Electrical Engineers, Vol. xxvi., part 2, in which he has determined the effect of varying span lengths on the cost per 1,000 ft. of the line. Mr. Scholes has considered in this presentation the cost of towers, of insulators and of foundations. In the first part of his paper he showed that for a 500-ft. span, a tower having a ratio of base to height of about ¼ is the most economical.

Using throughout his subsequent calculations, a tower of this proportion he deduced by means of a derived formula the varying weights of towers necessary for spans of from 200 ft. to 1,000 ft, and plotted the cost of these on a base of span length in feet, and with ordinates of cost in dollars per 1,000 ft. of line.

Plotting on the same scale the cost of insulators, and the cost of foundations, the sum of these three quantities was plotted and a curve drawn. The result showed 425 ft. as the most economical span (considering towers, insulators and foundations only) giving 12½ towers to the mile.

In weighing this result certain related facts must be carefully considered: (i) On the shorter span, *i.e.*, from 150 ft. to 300 ft., a tower is not nearly so economical as a pole, for two reasons:—

(*a*) Pole lines with short spans only need a comparatively narrow right-of-way, owing to two facts, firstly, the pole bases are perhaps only 2 ft. 6 ins. or 3 ft. 0 in. wide (instead of 10 ft. or 11 ft.), and secondly, the vertical arrangement of the wires permits short cross-arms, and small centre to centre distance for outside conductors.

(*b*) The actual cost of a pole for short spans is less than a tower because of the fact that tower sections for light loads cannot be reduced beyond a certain amount, say, 3/16 in., and hence this steel is not working satisfactorily.

(ii) On the longer spans no allowance has been made for increased cost of right-of-way or possible decreased cost of erection.

To briefly summarize the foregoing factors may not be inappropriate. By short spans are meant those from 150 ft. to 300 ft., while by long spans are meant those from 300 ft. to 2,500 ft. or thereabouts. For reasons already outlined, structural steel poles* are the more economical for short spans and without further comment will be assumed to be used. The advantages of short spans with poles are as follows:—

Short cross-arms and small bases permit narrow rights-of-way; frequent supports for conductors by reducing sags and hence swings, enable lines to have a narrow right-of-way. (One of the two-circuit lines of the Provincial Light and Power Co. has a right-of-way of only seven (7) feet); steel in poles is likely to be economically used; and riveting on poles is done in the shop, which is superior to the field bolting necessary for towers.

The disadvantages are higher costs for steel supports and insulators per mile. It will have been recognized by this time that great emphasis has been laid upon the cost of right-of-way and the saving that may be effected by reducing its width. The importance of this can hardly be over-estimated, especially in regions where land is expensive. It will generally be found that in modern transmission lines entering cities or towns, the saving in cost of right-of-way more than compensates for any increased cost of insulators or poles.

*The technical difference between a pole and a tower will be discussed in a subsequent portion of this article.

(Continued in the next issue.)

Editorial

CANADIAN FUELS.

In view of the shortage and price of imported coal, it seems an opportune moment to direct attention once more to the advantages and desirability of using our own fuel, thereby not only being independent of external sources of supply, but also providing more employment for our own people.

Canada possesses fuels ranging in quality from peat to semi-anthracite; and thanks to the researches made by the Mines Department at Ottawa, by the Saskatchewan Government and by certain private concerns, we have acquired valuable information as to their uses for various purposes. Peat has received considerable attention from the Mines Branch, and with the knowledge that it is used as fuel in other countries, it is somewhat surprising that peat has not been more largely utilized in Canada.

We have large tracts of peat awaiting economic development. This fuel involves a certain amount of treatment before it is useful. For example, the high percentage of entrained moisture must be reduced and the carbonaceous constituent must be compressed into a saleable briquet or other form. Peat is used in certain parts of Ireland as fuel for gas producers and is believed to be giving satisfactory results.

The next grade of fuel is lignite, of which there are said to be about twenty billion tons in the western provinces, practically all neglected with the exception of several small mines near Estevan and some larger ones in Alberta. Lignite is an ideal fuel for gas producers, as has often been proved by the Dominion and U.S. government authorities, yet the quantity consumed is exceedingly small in comparison with the requirements of the country. Mr. R. O. Wynne-Roberts, in his report (1912) on lignite in Saskatchewan, advocated the gasifying of lignite and the utilization of the gas under steam boilers and for gas engine power, the latter to be used for constant loads and the former for varying loads owing to greater flexibility.

It is interesting to note that in the development of power in Great Britain at the present time, the gasification of inferior coal and the use of the gas as fuel is being carried out,—with success, it is claimed.

Some grades of coal are not easily saleable owing to their size. Banff coal, for example, breaks up when mined, and much of it has to be briquetted. Banff briquettes are well known in the west and are used to a great extent. There is another way in which such grades of coal can be used, namely, as pulverized fuel. A battery of Bettington boilers is installed at Cape Breton which is heated by burning pulverized coal, and the results are reported to be good. What is believed to be the first large installation for burning pulverized coal under a complete battery of stationary steam boilers has been in operation since August 1st, 1916, at the shops of the Missouri, Kansas & Texas Railroad, at Parsons, Kan. According to the "Iron Age," there are eight 250 h.p. water-tube boilers; evaporation was obtained of 10.7 lbs. of water (from and at 212° Fahr.) per pound of combustible, with 16 per cent. carbon dioxide in the chimneys.

JOINTS IN CONCRETE ROADS.

"On account of the trouble that has been experienced in getting the joints truly vertical and in keeping the slabs from rising, numerous highway engineers in the United States have even reached the point where they are beginning to recommend the construction of concrete pavements without any joints, feeling that the trouble which may result from transverse cracks can be more readily taken care of than the trouble which may result from raised slabs."

The above quotation is from an editorial in *The Canadian Engineer*, September 21st, 1916, issue. Some further light upon this particular problem is afforded by a letter to the editor of Engineering Record, of New York, written by Mr. A. N. Johnson, a very well-known consulting highway engineer of Chicago. Mr. Johnson says:—

"The question of the width of joints has been discussed by a number of engineers, some of whom have expressed to me the opinion that they should be wider, especially on work done late in the season. My own opinion in the matter, however, is that the information now at hand is not sufficient to justify any conclusions at this time. The action of pavements where joints are built depends not only on the width of joints, but also on their spacing, and many factors must be considered.

"The Illinois Highway Department this past year has constructed a number of stretches of roads without joints. The question to be answered is whether in the long run there is less expense and no greater inconvenience to traffic by leaving out the joints, thus avoiding their first cost of construction and their subsequent maintenance as compared with the maintenance expense that may be incurred on roads where joints have been placed.

"These matters undoubtedly will be considered by the road committee of the American Concrete Institute, as well as by the sub-committee on tests for roads of the American Society for Testing Materials."

LETTER TO THE EDITOR.

Moving Pictures of Canada's Resources.

Sir,—In company with other members of the staff of this bureau, I have just completed a four months tour of Canada, travelling over all transcontinental lines from ocean to ocean and with teams and pack animals to the remotest parts of the Dominion. My purpose was a general survey of all conditions.

We were amazed at the wonderful undeveloped natural resources of the country and the untold opportunities afforded on all sides for home-making and safe investment.

This bureau is engaged in university work; in research in all directions; it is composed of all of the principal state universities and colleges in the United States; and it is without capital stock, and is not for profit.

It shows in motion pictures how everything is made and the sources of all raw material and to audiences admitted free.

The bureau would welcome an opportunity to extend its work throughout Canada. It would be glad to display in all of its foreign and domestic circuits films showing the natural resources, commercial and industrial life of the Dominion without expense, to stimulate investment in Canadian securities.

Also, to display in all the high school auditoriums in Canada to adult audiences at night, admitted free, films of industry and travel from all parts of the world for comparison, and general public instruction, and to enable the home-coming disabled soldiers to discover some line of endeavor best suited to his enfeebled condition.

All foreign films accepted by the bureau may be entered duty free.

FRANCIS HOLLEY,
Director, Bureau of Commercial Economics.

Washington, D.C., November 10th, 1916.

PERSONAL.

HERBERT GATES REID has been appointed assistant superintendent of rolling stock, Canadian Government Railways, Transcona, Man.

W. VALQUET, engineer of the Dominion Public Works Department at Ottawa, has been on a tour of inspection of public works in Western Canada.

H. E. BEASLEY, general superintendent of the Esquimault & Nanaimo Railway, Victoria, B.C., spent a few weeks in Toronto and vicinity recently, visiting relatives.

R. R. KNIGHT, city engineer of Fort William, Ont., has obtained a commission as lieutenant in the Royal Canadian Engineers, and will shortly leave for France on active service.

H. W. BASSETT, superintendent of the contracting firm of Grant Smith & MacDonnell, Vancouver, B.C., was badly injured in a motor accident recently, but is reported to be doing well.

LIONEL L. GISBORNE, formerly assistant waterworks engineer at Ottawa, has been appointed manager of the Toronto office of the General Supply Co., of Canada, 38 Toronto Street.

P. A. McFARLANE, formerly district superintendent of the Bell Telephone Company, Toronto, has been transferred to Montreal with the title of commercial engineer, a new position created by the company.

MACAULAY POPE, formerly manager of appliance department, Toronto Hydro-Electric System, has severed his connection with that system and has accepted a position with the Imperial Oil Company of Canada.

ROWLAND KIND, graduate of the Michigan School of Mines, has accepted the appointment of general superintendent of the mine and mill of the Highland Mining and Development Co., near Ashcroft, B.C.

Hon. F. COCHRANE, Minister of Railways and Canals, Ottawa, was recently presented with an oil portrait of himself, by a number of friends in Cobalt, Haileybury and New Liskeard, Ont., at Haileybury.

R. J. LECKY, A.M.Can.Soc.C.E., of Regina, Sask., has been appointed recruiting officer for the "Canadian Engineers," covering military district No. 12. He has also been appointed as resident engineer for the same military district.

Lieut. J. D. McBEATH, A.M.Can.Soc.C.E., formerly assistant city engineer of Moncton, N.B., has been placed in charge of the recruiting office for the Canadian Engineers' Training Depot recently opened at St. John, New Brunswick.

F. H. HOPKINS & CO., Montreal, have opened an office in the Mail Building, Toronto. Associated with them in the office will be the Toronto branch of the Dominion Wire Rope Co., Limited, of which Mr. Hopkins is vice-president. Mr. C. V. Osborn, formerly manager of the St. Catharines office, will be manager of the Toronto office.

W. R. DAVIDSON, superintendent of the Grand Trunk Railway at London, Ont., has been promoted and will take charge of the Detroit division of the company. CHARLES FORRESTER, superintendent at Stratford, will succeed Mr. Davidson.

R. J. DURLEY, Ma.E., of Montreal, has taken over the unfinished Canadian work previously handled by the Montreal office of the firm of MacMullen, Riley & Durley, which was recently dissolved and reorganized as MacMullen, Riley & Angus. Mr. Durley will also continue his consulting practice.

J. K. SCAMMELL, C.E., a consulting engineer of St. John, N.B., has volunteered for overseas service. During his absence his business is being carried on by a graduate engineer who is prevented from joining the colors by physical unfitness.

H. E. RICE, of the Dominion Steel Corporation, Sydney, N.S., has been promoted to the position of assistant general superintendent, and GEORGE D. MACDOUGALL, formerly mechanical superintendent of the steel works, has been appointed chief engineer.

R. G. S. ANTHONY, formerly superintendent for the Cherry Creek Gold and other mining companies, has joined the staff of the Consolidated Mining and Smelting Company, Limited, at Trail, B.C., where he holds the position of assistant superintendent on the zinc plant.

Major R. W. BROCK, formerly director of the Geological Survey, Deputy Minister of Mines, and dean of the Engineering School of the University of British Columbia, has organized the Western Universities Overseas Battalion, of which he is second officer in command.

Lieut.Col. FREDERICK F. CLARKE, who left Toronto last August in command of the 127th (York Rangers) Battalion, is reported to be ill in England. Lieut.-Col. Clarke is a surveyor by profession, and was in the service of the Canadian Northern Railway.

CYRUS CARROL, D.L.S., M.Can.Soc.C.E., of Regina, Sask., one of the pioneer surveyors of the North-West Territories, who recently celebrated his 82nd birthday, has resigned from the service of the government of the province of Saskatchewan (public works department) and has moved to Hamilton, Ont.

A. R. ROBERTS, B.Sc., F.C.S., of Toronto, has been appointed Canadian sales agent for the Cement-Gun Co., Inc., of Allentown, Pa. The guns are now being made in Canada. Mr. Roberts, who is an engineer and a chemist, having graduated from Cambridge University and then from Zurich in a post-graduate course, has an office in the Traders Bank Building, Toronto.

J. M. NELSON, formerly with the Algoma Steel Co., Sault Ste. Marie, Ont., has been appointed superin-