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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

WATERWORKS RECONSTRUCTION AT HAMILTON, ONT.

NOTES ON GROWTH OF SYSTEM SINCE 1859 AND ON COMPLETE RENEWAL UNDERTAKEN IN 1912—PAPER READ LAST WEEK AT DAYTON (OHIO) CONVENTION OF AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.

By A. F. MACALLUM, C.E.,
City Engineer, Hamilton, Ont.

THE city of Hamilton, Ont., completed its first waterworks system in 1859, which system was developed gradually to meet the growth of the city until 1912, when it was found that the rapid growth of the city necessitated the complete renewal of the entire system. At this time there were in operation four steam pumps having a combined discharge of 13½ million Imperial gallons per 24 hours and three mains to the city, 18-in., 20-in. and 30-in. respectively. Two of these pumps and the 18-in. main were installed in 1859 and have been in continuous use since. These pumps of the vertical walking beam plunger type are to-day somewhat of a curiosity. The old pumps are still in commission, but used only in the event of interruption to the electrically driven turbine pumps installed during the reconstruction, and when the other two and newer steam pumps cannot meet the demand.

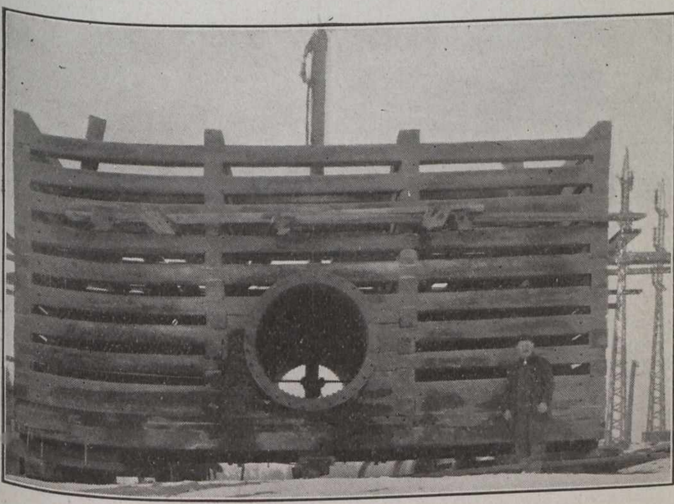

Fig. 1.—Timber Intake Crib Under Construction for Beach Pumping Station, Hamilton.

Hamilton lies at the westerly end of Lake Ontario, at its extremity of which a sand ridge cuts off the lake from the Burlington Bay, on the shores of which the city is situated. Owing to its location with respect to this sand ridge, through which a short canal is cut to the lake, combined with the fact that most of the sewage from the city is treated at disposal works before entering the bay, it has never been found necessary to treat the water taken by the intakes from Lake Ontario. This places the city in the unique position of being about the only city drawing its water supply from the lower Great Lakes without necessity of treatment.

In connection with the original installation, two intakes extended into the lake, one cast iron, 20 inches in diameter, at a distance of 1,000 feet, and the other a wooden box intake 3 feet square, at a distance of 300 feet, each having its inner end in a settling basin from which wooden conduits lead to the wells at the pumping station. It is interesting to note that one of these wooden conduits placed in 1859 was found to be in first-class condition after 55 years' service.

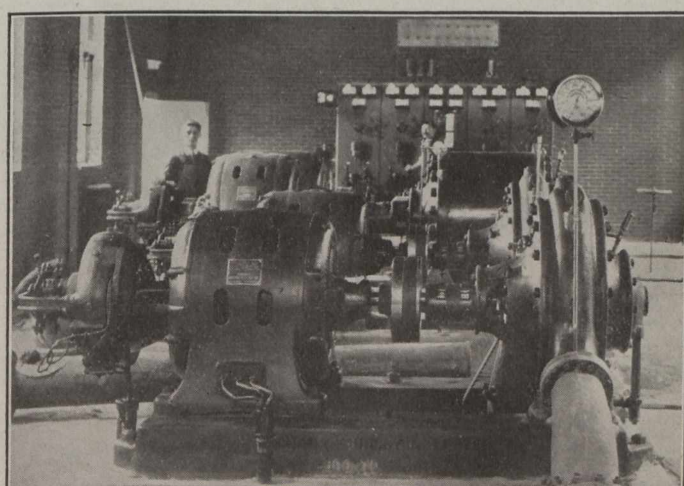

Fig. 2.—Interior View of Booster Installation at the Mountain Pumping Station.

It was decided to construct a new intake, 4 feet in diameter and 2,100 feet in length, which would bring it to a depth of 32 feet of water in the lake. This steel intake pipe, including intake piece, sluice valve and expansion joints, cost $20,520 delivered on the site and riveted in lengths approximately 140 feet, on the ends of which were flanged pieces. The price mentioned includes also the lead gaskets and bolts.

The accepted tender for laying this pipe was $35,000, which included the building and placing of the intake crib, and a concrete valve chamber and house at the settling basin end. As ice ridges formed out in the lake for a distance of about 1,000 feet and in some places 30 feet high, to protect the pipe it was necessary to lay the pipe in trench on the lake bottom so that when filled in again the pipe was covered. Concrete in bags was placed around the pipe for 300 feet from the shore line as an added precaution. Four piles were driven in the trench in such a position that when a 140-ft. section was floated into position two piles would be at each end of the section. Across the two piles at each end a sill was bolted at grade and the pipe lowered to rest upon these sills and held in position there by wooden blocks on either side. A cap was

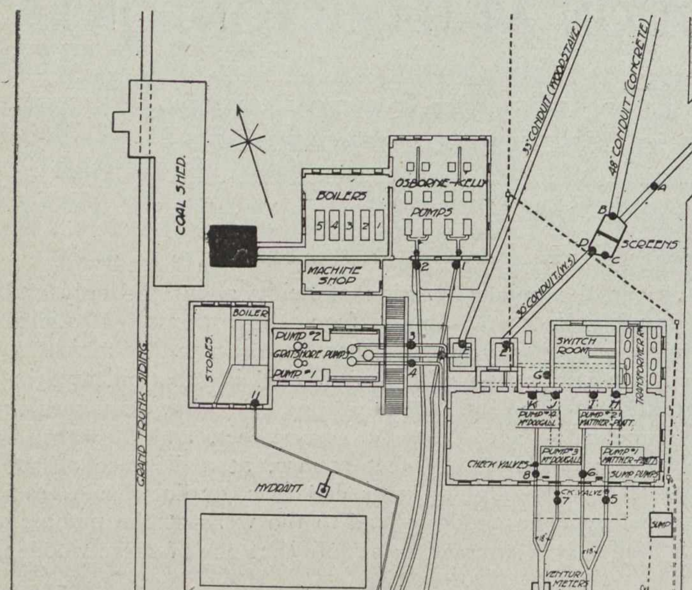

Fig. 3.—General Layout of the Beach Pumping Station and Mains, Hamilton.

bolted across the two piles over the pipe after the section had been bolted to the preceding section by the divers. Besides alignment, the object in driving these piles was twofold; first, for ease in joining up two sections clear of the sand, and secondly, to prevent as much as possible divers not bolting up the lower sections of the pipes because of difficulty of access. As there was practically little possibility of scour on account of the method of construction adopted, it was not considered necessary to space the piles closer. The above arrangement has proved quite satisfactory.

In an examination of the plans for intake cribs adopted by the cities on the Great Lakes it was found that the minimum size was 40 feet square and of sufficient height that the mouth of the intake facing upwards was at least 7 feet above the bed of the lake. This minimum size the writer did not consider necessary, but designed the intake crib to be 24 feet square, placing rip-rap around the outside, and this has since been found quite sufficient. No iron was exposed about the intake openings, but they were constructed with oak plank to prevent the formation of anchor ice. Fish screens were placed in the gate-valve house. A reinforced concrete conduit 4 feet in diameter and 2,000 feet long was constructed to the large well at the pumping station. This conduit, before reaching the pump well, passed through a screen chamber through which the two old wooden conduits also passed. At the intake and outlet of each conduit was placed a sluice valve so that any conduit could be cut off or either part of a conduit. Each of the turbine pumps feed from a small and separate well connected with the main well by a gate-valve cut-off. By this method any foot valve could be inspected and repaired if necessary without interfering with the water supply of the other pumps.

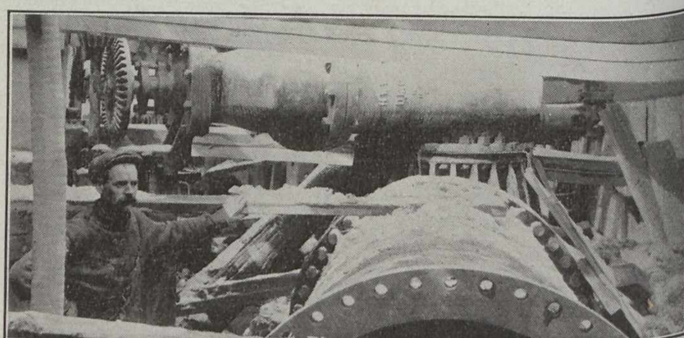

Fig. 4.—Installation of Header for the Beach Pumping Plant.

In the construction or reconstruction of any waterworks system the pumping plant is of paramount importance. What power used— steam, gas or electric— will depend principally upon the cost of these motive agencies delivered on the shaft.

Other considerations will be the capital cost of installation, including size of relative buildings and cost of operation with depreciation.

It should also be borne in mind that if the electric power be brought from a distance that it will be subject to interruptions and is consequently less reliable than the other agencies mentioned.

In Hamilton, on account of the low cost of electric power ($16.50) per annum it was decided to increase the number of electrically driven pumps to meet the future demands and the pumping station for the units already installed was enlarged. Two new electrically driven turbine pumps were installed, each of 6½ million Imperial gallons per 24 hours, or of the same capacity as two units already in operation. There is a steam plant also, having a capacity of 13½ million gallons per 24 hours, which is generally held in reserve to carry the peak load during periods of heavy consumption.

The subject of plunger pumps has been well covered in several text books, but the development of the centrifugal into its present efficiency is less known. This applies not only to the design and construction but also to its operation, and it is only comparatively recently that it has been efficiently applied to pumping problems. Almost any machine shop or foundry could build a centrifugal pump that would deliver more or less water against a certain head, but little attention was given to efficiency, accessibility or operation, everything being sacrificed to low first cost. Most pumping station centrifugal pumps are driven by electric motors and consequently the operating cost is a definite and known quantity. It then becomes a question of getting the maximum efficiency from the pump under the existing conditions.

A centrifugal or turbine pump has certain fixed characteristics. For instance, in a turbine pump operating at constant speed, as it will if driven by synchronous motors, the amount of water pumped increases with the drop of pressure in contradistinction from the piston pump, which always pumps the same quantity of water, no matter what the pressure.

If, then, a turbine pump is designed to deliver a quantity of water through a pipe or a piping system of certain diameters and length at its maximum efficiency and another turbine of exactly the same characteristics is started to pump through the same piping system the frictional head from the delivery piping will increase due to the increased quantity of water and consequent increased velocity of water through it with the result that the increased head will reduce the individual deliveries, so that the total deliveries from the pumps is equal to twice the delivery of the individual pump at the increased head, instead of twice that of the original pump if pumping by itself. If these two pumps are to work together most of the time the efficiency curve for each pump should be at its maximum over the variations in head between one and two pumps working.

If two turbine pumps deliver into piping system that decreases the individual delivery of each pump by more than 10% it will have the tendency to cause the delivery to swing from one pump to the other so that one pump will be delivering water and the other practically churning. This may be remedied by increasing the sizes of the impellers.

It is usual to keep the suction tubes of all pumps under 25 feet and most pumps have their suctions at not greater than 20 feet to minimize the possibility of air leakage.

It has been found in a number of cases with turbine pumps that the tips of the impellers wear very rapidly when the suction tube is greater than 12 feet. Less than this height there is little or no wear and the reason for this is probably due to imperfections in design of the turbine pump as built to-day, although some manufacturers guarantee over 80% efficiency.

The two-stage turbine pumps that the city of Hamilton installed at its main pumping station pumps to a head of 285 feet with an efficiency of 75% under full load. The tenders for two 6½ million gallons (Imperial) turbine pumps in place varied from $5,500 to $9,800. Extra impellers capable of lifting the water to 300 feet were included and the pumps had to be successfully operated for two weeks before acceptance.

Besides the main pumping station, there was built a booster station to replace steam and air-lift pumps and to carry the water to greater elevations than possible with the main pumping station without causing excessive pressures in the lower portion of the city. This station contains four turbine pumps each of one million Imperial gallons per 24 hours capacity. Two of these pumps raised the water about 80 feet above the level of the reservoir to which the main station pumps delivered the water and two pumps raised the water 280 feet above this level. Two-stage pumps only were necessary for the lower level below the mountain plateau, but six-stage pumps were required for the higher elevation. The problem at this station was to approximately determine the heads to which the pumps would generally work so as to get the greatest efficiency out of them. The pumps were directly connected to the mains fed from the main pumping station and about 75 feet below the level of the reservoir that the main station fed.

Besides the usual annual and daily fluctuations in head with the added effect of the draft of these pumps on the static head there was the difference in level of two reservoirs on the main system to be considered. One of

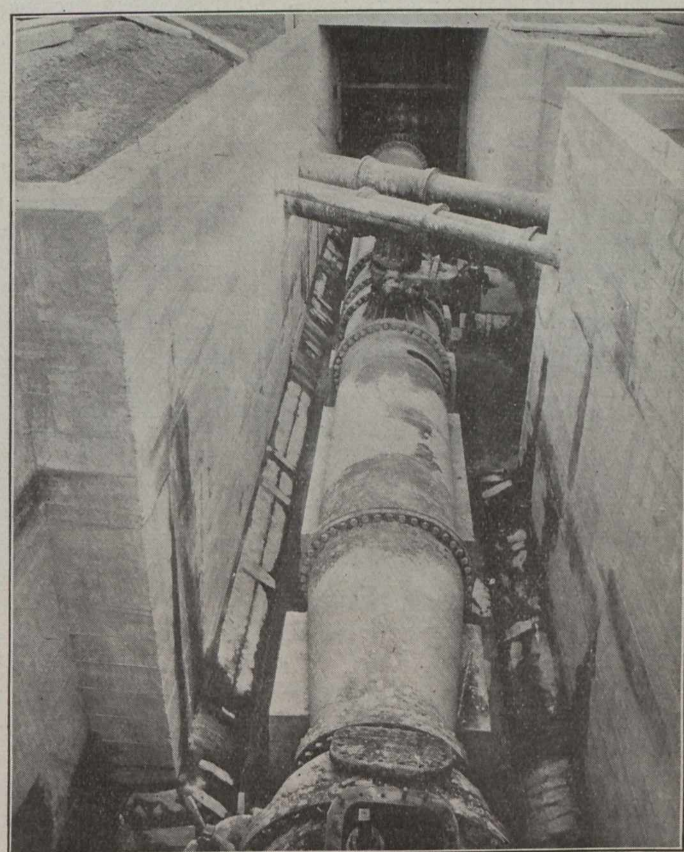

Fig. 5.—The 48-inch Header, Beach Pumping Station.

these reservoirs was only used in case of emergency or while cleaning or repairing the reservoir generally used, but as it was 60 feet lower in elevation and two miles distant across the city, and nearer the pumping station, it naturally produced considerable variation, and practically made the problem of obtaining maximum efficiency with turbine pumps under all working conditions indeterminate. The pumps, as built and operated, give a maximum efficiency of 60 per cent., although under certain conditions the specified efficiency of 75 per cent. is obtained.

Tenders for these four pumps in place varied from $6,000 to $6,800.

The main pumps are driven by 750-h.p. motors, the lower level pumps at the booster by 50-h.p. motors and the higher level by 130-h.p. motors. All these pumps run at 750 r.p.m.

As stated before, these were in commission from the main pumping station, three rising mains 30-in., 20-in. and 18-in. respectively being connected to the pumps in the usual haphazard way prevalent throughout many plants in this country. It was decided to build a fourth main 36 inches in diameter and about equal to the other three mains in discharging capacity. Although nearly two miles of this main had to be built to bring to the outskirts of the city along a pipe line already used by the other three mains, it was decided to take a slightly longer route away from this pipe line to avoid the danger of a bad blow-out, putting all the mains out of commission.

The connections from the pumps were carried to a header pipe 4 feet in diameter running at right angles and at a lower elevation than these connecting pipes.

Between each of the old pipes and the header a gate valve was placed and as the new 36-inch main went off from the end of the header the whole arrangement proved very flexible in operation. On each of the mains was the usual check and gate valve besides the Venturi tube for measuring the discharge. Before laying the large main to the city and other mains throughout the city, tests were made to ascertain the relative efficiency and speed in making poured lead wool joints, also the relative efficiency of joints caulked by pneumatic hammers or by the usual hand method.

Fig. 6.—Sections of Beach Intake Pipe Before Placing.

It was found that with the pneumatic hammers between four and five joints could be caulked with a poured lead joint to one by using lead wool. This was due generally to the hammers becoming wedged in driving. It was also found that the compression in the caulking went deeper in the poured than in the wool joint with the consequent greater density.

Several alternate joints were caulked by the pneumatic hammers and by hand, and this section gradually put under pressure. It was found that every joint caulked by hand commenced to leak slightly at 110 pounds pressure but that the pneumatic caulked joints remained tight.

To carry the construction of these mains through quickly and efficiently by the city forces an air compressor with pneumatic caulking tools was purchased.

The city had a small steam shovel with a ½-yard dipper which did the excavating and also the lifting of the pipe into the trench. A 12-ton dinky engine with cars and track was also purchased and with this equipment (which also did the back-filling) as high as fifteen 36-inch pipe were laid in a day in a trench which had a variable depth but always sufficient to give a top covering over the pipe of 5½ feet. This large main was laid to grade with blow-offs every ½ mile to the city and having the usual gate and relief valves.

To compare the relative speed of hand and pneumatic caulking tests were made with the results shown in the following table:—

Size	Class	Depth of lead joint	Weight of lead used	Depth of yarn	No. of hand caulkers	No. of joints per day	No. of machine caulkers	No. of joints per day
36″	C.	3½″	121 lb.	1″	2	4	2	12
30″	C.	3″	90 lb.	1″	2	6	2	15

From this it will be seen that in the 36-inch pipe the machine men caulked three times as many joints as the hand men and 2½ times as many in the 30-inch pipe. Through many attending local conditions, as, for instance, the filling-in of old wooden bridges and building of concrete culverts which were charged to the cost of the mains to the city, no cost data is given, but a length of 2,157 feet of 24-inch mains in the city under normal conditions is given for depth from 7 to 9 feet with conditions causing the variation in cost of laying indicated. The average cost per foot was $1.86 for this size of pipe.

The length in feet of new mains in this reconstruction comprised: 36-inch, 12,900 ft.; 30-inch, 13,800 ft.; 24-inch, 6,000 ft.; 20-inch, 4,600 ft.; 18-inch, 2,500 ft.; and the total cost of this work, including intake, conduit, pumping stations and mains, was $750,000.

MUNICIPAL STREET RAILWAYS IN SASKATCHEWAN.

The cities of Regina, Saskatoon and Moose Jaw are all served by systems of municipal railways. In Regina there are 30.53 miles in operation, the system having commenced service in July, 1911. The system comprises 34 passenger cars, 30 freight cars, 2 sweepers and 1 motor haulage car. The cost of construction per mile has been substantially as follows: Single track, 60-lb., gravel, $17,950; single track, 80-lb., gravel, $38,000; double track, 80-lb., concreted and paved, $83,000. The cost of the railway has been $1,375,251, of which amount roadbed and tracks have cost $1,216,000 and electric line construction, including poles and wiring, the balance. Cars and other rolling stock are valued at $184,940.

The Saskatoon system commenced operation on January 1st, 1913. It comprises 16.28 miles of track, the cost of construction per mile having been $49,509. It has 18 passenger cars, 4 freight cars, 1 snow sweeper and 1 tower wagon. The roadbed and tracks have cost $365,255, the electric line construction $62,314, and the rolling stock $78,245.

The Moose Jaw Electric Railway Company, started in September, 1911, has approximately 11½ miles in operation, the average cost of construction having been $22,000 per mile. It has 19 passenger cars, 1 work car and one snow plough. Its power equipment includes one 1,500-h.p. and one 2,250-h.p. Diesel oil engine with direct connected generators.

The cost of railway is stated to be $218,351 for roadbed and tracks, and $35,848 for electric line construction, including poles and wiring.

These data are from the recently issued report of the Government Department of Railways of the Province of Saskatchewan.

When grouting the joints of sewer pipe the grout should be poured from one side until it flows around and begins to fill the opposite side, when the pouring should be finished from that side. This causes a wave action that insures close filling at the bottom of the joint.

THE WATER POWERS OF THE PRAIRIE PROVINCES.

ONE of the series of five monographs on the water powers of Canada, published by the Dominion Water Power Branch, especially to further the public interest in connection with the notable water power exhibit of the Dominion Government at the Panama Pacific Exposition, relates to Manitoba, Saskatchewan and Alberta, the prairie provinces, and is under the authorship of Percival H. Mitchell, E.E., consulting engineer, Toronto, one of the consulting engineers to the Water Power Branch.

To adequately review such a pamphlet which even in its rather extensive form has condensed its facts so as to be able to include mention of all the water powers of prominence throughout the prairie provinces, is almost impossible. The following is reproduced in parts verbatim but the full reading of this and the companion monographs on British Columbia, Ontario, Quebec and the Maritime Provinces, will well repay by the complete information available as to the magnitude of the water powers of Canada.

The Dominion of Canada has been most liberally endowed with a richness of natural resources possibly unrivalled in any country of the globe. The wealth of the land, the forest and the mine, has a world-wide reputation; the neighboring oceans, the lakes and the streams, for their transportation routes, their fisheries and their water powers are equally well known. The commerce and industry created by such a fund of resources has as one of its greatest elements of success the proximity of water powers to the power consuming market.

Within the provinces of the Dominion of Canada and excluding the Northwest Territories, practically all of the Yukon, and the northern and eastern portion of Quebec, it is estimated that 17,764,000 h.p. is available, this amount being inclusive, in the case of Niagara Falls, Fort Frances and the St. Mary's River at Sault Ste. Marie, of only the development permitted by international treaties, and further does not contemplate the full possibilities of storage for the improvement of capacities. The developed powers which are inclusive of all water powers whether for electrical production, pulp grinders, for milling or for the great many other uses, aggregate 1,711,188 h.p.

The prairie provinces are essentially agricultural. The settlement of the west has been fabulously rapid and the industrial development has far from kept pace with the agricultural requirements. The industrial era has dawned, however, and it is to be expected that in the near future the local consuming market will be to a great extent satisfied by local manufacturers.

The uses of electric power in an agricultural country are threefold: First, directly applied to the production, operation and marketing of the products and natural resources; second, for manufacturing purposes in the supplying of the market created by the people of such a country; and third, in the community life, the public utilities and transportation.

It is hard to predict the future of electric power under such conditions. The enormous strides of the last twenty years, in reality the period since the establishment of the first commercial electric transmission system, has developed established loads necessitating in the United States and Canada, alone, the development of water power plants aggregating nearly ten million horse-power, the last ten years more than doubling the first ten years in the rate of growth. The load curves showing the growth in power requirements from year to year in each of the large cities of Canada, show an increase from very small dimensions of from five to ten years ago to enormous demands, and at a rate of doubling in from one to three years, and with the curve of the load diagram indicating most vigorously similar increases in the years to come. While it is quite apparent that the greatest portion of these loads is consumed in the older districts of the Great West, the population and the quantity of output is, too, increasing very rapidly, adding a new factor of growth to the swelling power demand, the combined effect of which is readily borne out by the evidence of the respective records.

The water powers of Manitoba, Saskatchewan, Alberta, the Northwest Territories and the Yukon are under control of the Dominion Government. The Dominion Government water power policy, as administered by the Water Power Branch of the Department of the Interior, affords every reasonable protection to the public as to rentals, periodic revisions, control of rates, limited grants, etc., and at the same time fosters legitimate private enterprise to return reasonable profits. Regulations are in force affording all possible assistance to the development of water powers which have very reasonable assurance of economic utilization, and further, before the authorization to proceed with development is given, complete investigations are undertaken to prove the economic features of design, capacities and costs, and eventually supervision is carried out during construction. Proper government supervision and control of the construction and maintenance of all developments is the only safe method of intelligently initiating construction and maintaining an adequate system of river improvement for power purposes.

In the consideration of the water powers of Manitoba, Saskatchewan and Alberta, two river systems stand out pre-eminently, that of the Winnipeg River in Manitoba and the Bow in Alberta. The rapidly increasing utilization of these rivers for power purposes, the power plants at present contemplated for construction, and the value of the potential water powers not yet awarded, has required the immediate attention of the Dominion Government as to the possibilities in each case, and these demands have resulted in exhaustive investigations. The complete reports in these two instances have been embodied into the "Water Resources Papers" of the Water Power Branch of the Department of the Interior, under the title of "Bow River Power and Storage Investigations" and "Manitoba Water Powers," respectively.

The Winnipeg River is notably one of the most important power rivers on the continent, draining as it does an area of some 55,000 square miles into Lake Winnipeg. (The reader is referred to *The Canadian Engineer* for February 12, 1914, for a full description of the river's resources.) This great watershed comprises the Rainy Lake and Lake of the Woods and the English River, all inclusive of the immense circular area about 250 miles in diameter, lying immediately north-west of Lake Superior.

While the watershed of the Winnipeg River lies for the most part in the adjoining province of Ontario and across the boundary in the United States, the power possibilities of greater magnitude are included in the province of Manitoba. From the provincial boundary line to Lake Winnipeg, the Winnipeg River has a fall of 273 feet, the head waters of this portion of the river being at an elevation of 983 feet above the sea level, while Lake

Winnipeg is 710 feet above the sea level. Lake of the Woods is at an elevation of 1,060 feet, so that the fall to the provincial boundary is 77 feet. The fall of 710 feet from Lake Winnipeg to the sea level in Hudson Bay, combined with the immense flows from the tributary watersheds indicates the enormous potential water powers on the Nelson River.

The commercial value of the numerous water powers of the Winnipeg River are fully appreciated. The proximity to the city of Winnipeg, whose growth, in population, in wealth, in industry and in commerce, has been amazingly beyond the most optimistic predictions, has in itself provided a market of great magnitude now being served by two developed falls of this river. The rapid increase in power consumption has already exhausted the capacity of one power development, and has necessitated the other continually installing additional machinery, much in excess of the unit capacity originally contemplated. That the possible extent of market of the immediate future is fully anticipated by the keenest of power developing interests is most positively indicated by the fact that the Water Power Branch of the Department of the Interior of the Dominion Government has received numerous applications from capable and sound sources for the various undeveloped water powers; many of these overlap, many contemplate the combination of several successive falls by the concentration of their respective drops at one power site, and several are for individual falls.

The application for the respective power sites on the Winnipeg River are so varied and so conflicting, while at the same time supported by such reputable engineering advice that the government found it inadvisable to commit itself, with respect to any future developments on the river, until from an exhaustive survey and investigation could be constructed a proper basis of consideration which would determine the maximum possible advantageous utilization of the water power resources. This river study has advanced to the final stages and the full possibilities can only now be fully recognized.

After several years of work, by the government's engineers, the various power sites have been established; the proper combination of the small falls selected to conform to the most economic development; the most feasible scheme of utilization planned, and the general design proceeded with sufficiently to determine constructional costs on a reliable basis, and from these, the yearly cost of power deduced. The Department is therefore in a position to dictate a policy of power development which will ensure the full and maximum utilization of the river resources.

The Winnipeg River power sites are concisely shown in the following:—

Developed Power Sites on the Winnipeg River in Manitoba.

Site.	Distance from Winnipeg in miles.	Head	Horse Power Available. 24 hour power at 75% efficiency. 12,000 sec. ft.	20,000 sec. ft.	Turbine Installation. 12,000 sec. ft.	20,000 sec. ft.
Point du Bois (City of Winnipeg Municipal plant).	77	45	45,600	76,000 (119,500 using available pondage)	5-5,200 3-8,500	5-5,200 11-8,500
Lac du Bonnet Pinawa Channel (Winnipeg Electric Ry. plant).	65	39	28,200 (has steam auxiliary in Winnipeg		4-1,000 5-2,000	

Undeveloped Power Sites on the Winnipeg River in Manitoba.

Site.	Distance from Winnipeg in miles.	Head	Horse Power Available. 24 hour power at 75% efficiency. 12,000 sec. ft.	20,000 sec. ft.	Turbine Installation (Units considered). 12,000 sec. ft.	20,000 sec. ft.
Pine Falls	64	37	37,900	63,100	6-10,000	10-10,000
Du Bonnet Falls	64	56	57,300	95,500	9-10,000	14-10,000
McArthur Falls	62	18	18,400	37,000	11- 2,500	17- 2,500
Lower Seven Sisters	52	37	12,600	37,900		6-10,000
Upper " "	55	29	9 900	29,600		8- 6,000
Slave Falls	74	26	26,600	44.400	8- 5,000	13- 5,000
Total			162,700	301,200	217,500	555,500

Note:—The Upper and Lower Seven Sisters are located in the main channel on the Winnipeg River, paralleling the Pinawa, through which 8,000 second feet are assumed to be diverted for the operation of the Winnipeg Electric Railway Company's plant.

It will be noted that the Winnipeg municipal plant and the Winnipeg Electric Railway Company's plant are developed and aggregate a turbine capacity of 79,700 h.p. Further, it will be noted that capacities of all sites are given for flow of both 12,000 and 20,000 cubic feet of water per second, as representing respectively present conditions and future conditions after storage is established.

The two developed plants of the city of Winnipeg and of the Winnipeg Electric Railway are well known, but even their large capacities are quite insufficient for the loads of but a few years to come. The Du Bonnet site has already been leased to the Winnipeg River Power Company, who propose a large development of eight 11,500-kw. generators, an aggregate of 123,000 h.p., and transmitting to Winnipeg at 110,000 volts.

The Bow River rivals the Winnipeg in immediate importance, although its various power sites are smaller in capacity. The Bow has its source in the mountain lakes and streams and in the glaciers and snowfields of the Rocky Mountains. It drains an area of 3,138 square miles on the eastern slope of the mountains immediately west of the city of Calgary in the province of Alberta. The waterfalls are numerous as from the farthest of its headwaters, up in the mountains, 6,500 feet above the level of the sea, it falls 2,750 feet to Kananaskis Falls, where the Kananaskis River joins the Bow, and from Kananaskis Falls to Calgary, a distance of 55 miles, a further drop of 720 feet takes place. It is in this latter stretch that the most promising power sites exist and where the three Bow River developments at Eau Clair, Horseshoe Falls and Kananaskis Falls are situated. (The Eau Clair and Horseshoe Falls developments were described in *The Canadian Engineer* for December 17th, 1914. The Kananaskis Falls development in our issues of February 4th, 11th and 18th, 1915.)

Above Kananaskis Falls the entire drainage area of 1,710 square miles lies wholly within the Rocky Mountains National Park of Canada, and by the conserving and co-operating policy of the park's administration, the extensive storage possibilities are readily capable of full utilization, and already considerable storage has been created. The flow of the river, as in all mountain streams of this character, is subject to sudden variation and is greatly influenced by conditions of temperature. During the winter months the flow is held in check, but in the hot summer months of June and July the melting winter snows and the glaciers loose their floods which rush through the mountain gorges to the Bow, down the Bow to the Saskatchewan and to Lake Winnipeg, then down the Nelson to the sea. The summer floods are very great compared with the winter flow, a flood of 45,000 cubic feet per second being measured on the Bow River just above the confluence of the Kananaskis while a low-water flow of 500 cubic feet per second has been measured at the same point.

The rapidly increasing demand for power from the Bow River, and the necessity for providing adequate storage facilities for existing and contemplated plants on the river, rendered necessary the exhaustive investigation of the river's resources as to power capacities and regulation, and, at the same time, to enable the formation of a policy providing for the most advantageous realization of these sources in the best interests of present and prospective users both for power and irrigation. To meet these ends the Dominion Water Power Branch during the season of 1911, 1912 and 1913, instituted aggressive surveys and investigations into the power and storage possibilities of the river and watershed. These studies were compiled into a report which designates the suitable lakes and the possible improvement by their use, and further determined the feasible power sites, indicating the method of development to secure the most efficient results. The report has been published as "Water Resources Paper No. 2."

All feasible storage on the Bow River above Calgary is, fortunately, available for the whole water stretch of the river. The mean flow for the winter months has been 720 cubic feet per second, but by means of the storage that has been, and may be, created, it is anticipated that the mean flow can be increased to about 1,500 cubic feet per second. The effect of such storage upon the power output is to raise the winter mean output of 19,785 h.p., the aggregate of the six sites, to 48,175 h.p., and in addition a plant to be constructed on the Cascade River and supplied by water in transit from the Minnewanka storage lake would be capable of producing 1,165 h.p. The Minnewanka storage system is now complete and includes a dam at the head of the Cascade River.

Three plants are now built on the Bow River. The Eau Clair development is within the limits of the city of Calgary and this had a capacity of 600 h.p., which is marketed under a city franchise.

The Horseshoe Falls plant is located about 50 miles west of Calgary at Horseshoe Falls, one of the very few concentrated falls on the river. This plant has installed two 3,750 and two 6,000 h.p. units operating on a 70-foot head and transmitting to Calgary.

The Kananaskis Falls plant is located immediately below the junction of the Kananaskis River with the Bow, about two miles above the Horseshoe Falls. The head created amounts to 70 feet, which, with the two present units, generates 11,600 h.p. This plant is in parallel with the Horseshoe Falls plant, both being owned by the Calgary Power Company.

In addition to the three plants above described the small plant at Lake Louise in connection with the Canadian Pacific Hotel at the mountain resort should not be omitted, notwithstanding its output of but 75 kw. (See *The Canadian Engineer*, December 17th, 1914.)

Four sites are available for economic development on the Bow. These are the Bow Fort site, for which a head of 66 feet operating three 4,400 h.p. units is considered the best development by the Dominion Water Power Branch engineers; the Mission, to utilize a head of 47 feet on three units of 3,500 h.p.; the Ghost site, also with three units of 3,500 h.p., on 50-foot head; and the Radnor site, with three 3,500 h.p. units at 44 feet head. All these four sites are located between the Horseshoe Falls and Calgary and are within short transmission distance to Calgary.

Further dealt with in considering the water powers of the Prairie Provinces are the North and South Saskatchewan Rivers which traverse the prairies and, while not having many favorable sites, include the La Colle Falls at Prince Albert and the Grand Rapids below the junction of the two rivers.

The Elbow River, one of the mountain headwaters of the South Saskatchewan, has one economical site capable of over 10,000 h.p. capacity and located but 33 miles from Calgary.

Flowing into Lake Winnipeg are numerous rivers, many of which include favorable power sites. Particularly these are the Fairford, Dauphin and the Waterhen; on the Little Saskatchewan, which flows into the Assiniboine River then into the Red and thence into Lake Winnipeg are the sites at Minnedosa and Brandon and on the Assiniboine is a site at Currie's Landing, near Brandon. On the east shore of the lake, the Rivers Manigotogan, the Bloodvein, the Pigeon, the Behrens, the Poplar, the Big Black and the Belanger are all under study from the power standpoint.

The Nelson River is very rich in water power and from the list of possible sites enumerated the aggregate for the minimum unregulated flow is over two and one-half million horse-power, while with the extensive regulation proposed for the headwater rivers this would be much increased.

The Churchill, lying even more northward than the Nelson, and flowing into Hudson Bay, promises many sites which the future will probably find playing an important role in Canadian industry.

The Athabaska, in Alberta, rises in the mountains and has occasional power sites, all of which require more or less expensive developments.

The Peace River, flowing through the 45,000,000 acres of arable land just recently made accessible for settlement, will no doubt rise to the demands for the electric power necessary in the many communities and industries bound to develop.

The Slave River drains Lake Athabaska into the Great Slave Lake and as there are some 16 miles of rapids in one stretch its investigation will no doubt reveal an excellent power site.

The MacKenzie River, flowing from the Great Slave Lake to the Arctic, is not as yet investigated from the power standpoint.

The resources of these provinces are extensive, the agricultural possibilities are famed throughout the world; the forestry products are astonishing in value, according to our conceptions of the Prairie Provinces; in coal, Alberta is the richest province in the Dominion, and in oil and gas, peat, bitumen, stone, cement and clay products, gold and iron, the real wealth is only beginning to be appreciated. The fur trade still maintains the activity of former days.

Irrigation is considered as a benefit, in general, to water power as the controlling dams and works necessary will usually offset any loss by water diversion.

The future of water power in the West requires no questioning as to its ultimate complete development. The new uses of electricity, bound to be evolved from time to time and quickly to be absorbed into the routine requirements of ordinary life, combined with the present rapidly growing power loads, will, within the period of one or two generations hence, demand the utilization of practically all the available water powers of the country.

As possibly affecting the west most vitally, the problem of chemically fertilizing of soil must demand serious attention. The great natural fertility of the prairie is dependent upon a wonderful but gradually exhausting store of plant foods, and the agriculturists have neglected the replenishing to maintain the original or necessary supply. In some parts of the West artificial fertilizing is a need of the present, and in the near future the demand will be universal. Nature replenishes the earth by the decaying of the plants which have absorbed the nourishment, by animal manures, by bacterial action and by the electrical discharges of the air.

Nitrogen is the greatest essential in the replenishing of the soil; the atmosphere contains an unlimited supply, three-quarters of the weight of the air being nitrogen, but not in a form available for the soil. Above each square mile of land, it is estimated, there are 20,000,000 tons of nitrogen. As a result of electric action in the air about 100,000,000 tons of combined nitrogen are restored annually by Nature to the soil of our planet, present in the form of nitric acid and nitrates in descending rain. By properly applied electrical discharges in the presence of air, this process can be duplicated and nitric acid and nitrates produced in commerical form. The locality of the manufacture of such a necessary commodity is, from the standpoint of transportation, nearest to the point of use, and the distribution of the atmosphere is universal; in the Prairie Provinces the proximity of the great water powers adjacent to this coming market is most notable.

The 200,000,000 acres of arable land within the provinces, when all placed under cultivation, will possibly consume on an average more than 100 pounds of nitrates to the acre when extensive fertilization is resorted to. To-day the efficiency of electrical production of nitrates is low, but possibly five tons per horse-power-year would be beyond the highest efficiency to be obtained in the future. The power required to meet such a yearly demand would have to be two million horse-power. The figures are staggering, but with time as an element and with Canadian wheat as a staple, in an ever-widening market such conditions must come to pass.

By electro-metallurgy the iron ores of Lake Winnipeg will assume a commercial value, and the future market of the West for iron and steel will find considerable locally manufactured. Iron pigs and steel ingots from iron ore, produced by the electric furnace, are now an accomplished commercial fact.

Electrification of trunk lines is a matter for time to bring about; conditions in the West, on the prairies and in the mountains, are ideal for this transformation.

Distribution of electricity in the rural districts may become a reality of the near future, while hydro-electric distribution has been studied in Manitoba on a very extensive scale, embracing the greater portion of the southerly part of the province, the wide distribution necessary in supplying the rural remote districts, and the intermittent and comparatively small power demand now to be obtained does not at present justify its development. In the adjoining province of Ontario, however, a notable publicly owned system* has been established, and besides transmitting power to towns and cities throughout a great area over a network of over 2,000 miles of circuits, this system is now extending its lines so as to include many of the rural districts, with the expectation that the load to be procured will eventually justify the extension to include the whole area traversed by the system.

In conclusion, Mr. Mitchell states that it is not out of the way to predict that the Prairie Provinces will be served with transmission lines joining the eastern, northern and western powers, augmented by steam-driven plants at the coal mines and serving the transcontinental railways, the municipalities, the rural population, electro-chemical works, electro-metallurgical works and wide-spread industries, and that the power necessities, even with the millions of horse-power now available in the rivers, in the near future will demand the greatest of conservation, regulation and efficiency of development at all these respective sites.

*The Hydro-Electric Power Commission of Ontario.

RAILWAY DEVELOPMENT IN SASKATCHEWAN.

The following table from the annual report for the year ended April 30th, 1915, of the Department of Railways of Saskatchewan, shows concisely the history of railway development in the province since its inception:

	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.
C.P.R.	1,090.10	1,181.40	1,235.85	1,528.84	1,650.39	1,819.14	2,080.18	2,271.38	2,479.34	2,762.75
C.N.R.	461.87	604.28	854.51	1,004.78	1,143.91	1,383.60	1,683.27	1,750.19	2,087.63	2,099.32
G.T.P.R.	.....	.....	154.08	260.67	465.15	531.75	635.75	873.09	1,087.56	1,118.51
Total	1,551.97	1,785.68	2,244.44	2,794.29	3,259.45	3,734.49	4,399.20	4,894.66	5,654.53	5,980.58

The table shows that in ten years the railway mileage has been almost quadrupled. Compared with the mileages constructed in other provinces during the past six years, as given in the report for the year ending June, 1914, of the Department of Railways at Ottawa, the development in Saskatchewan is even more striking.

Province.	Total operating mileage.	Mileage Increases. 1909	1910	1911	1912	1913	1914
Saskatchewan	5,089	550	301	189	633	897	438
Ontario . . .	9,255	296	1	92	224	454	255
Quebec . . .	4,043	89	132	87	1	103	57
Manitoba. . .	4,057	94	16	245	54	473	82
Alberta . . .	2,544	...	167	6	403	315	332
British Col. .	1,978	63	36	10	13	96	27

There has been an expansion throughout the province as a result of this railway development that is of considerable interest. The following figures show the increase in towns and cities and in grain production during the past decade:

	1905.	1914.
Cities	3	7
Towns	16	72
Villages	63	296
Rural municipalities	2	297
Elevators	307	1,465
Grain production	46,612,136	243,513,384

OVERHEAD ELECTROLYSIS AND PORCELAIN STRAIN INSULATORS.

A paper by S. L. Foster in the Proceedings of the American Institute of Electrical Engineers for August, 1915, observes that there is a slight leakage of current from trolley wires to earth through insulated supports on all overhead construction, which, if not checked, permits a flow of current which gives rise to electrical separation of water into oxygen and hydrogen. The oxygen liberated acts vigorously upon the adjacent metal parts, which in time become badly corroded. This electrolytic action also seems to remove the galvanizing from live metal parts before attacking the iron. A partial remedy for this rusting of live galvanized wire is painting.

This electrolytic effect is also seen to take place over strain insulators when the creepage distance is insufficient. This indicates that a creepage distance proportional to the conditions met must be secured to stop the flow of current around the outside of the insulators. The author concludes that under fog conditions the insulator surface exposed for creepage is insufficient in our present standard devices.

Another form of overhead electrolytic action noticed in electric railway work is caused by the use of dissimilar metals in contact. Sulphuric acid and other fumes in the air and ozone from a nearby ocean are supposed to be the electrolytes that set up a local battery action at these points of contact. The logical remedy for this trouble is to use similar metal in contact.

Sandstone Varieties.—According to the U.S. Geological Survey, the products of rock decomposition may be reconsolidated either by great pressure or by the injection of cementing materials, or by both. Thus sands are formed into sandstones, clays become shales, and calcareous deposits yield limestone. Aside from their cementing materials, sandstones differ in composition exactly as did the sands of which they are composed. Sandstone may be nearly pure quartz, or quartz and feldspar, or quartz, feldspar, and mica, and it may vary in texture from the fine to the coarse. Some sandstone is so coarse that it will hold six quarts of water to the cubic foot, and underground deposits of such sandstone form excellent reservoirs, which may yield a never-failing supply of water. An arkose sandstone from the quicksilver region of California, made up of granitic detritus, was found to contain quartz, orthoclase, oligoclase, biotite, muscovite, hornblende, titanite, rutile, tourmaline, and apatite. In short, all the rock-forming minerals which can in any way survive the destruction or grinding up of a rock may be found in sands, and therefore in sandstones.

Stream Gauging and Hydraulic Science.—In the great advance which applied science has made in the last generation a prominent member of the vanguard has been the stream gauger—the measurer of the volume of flowing water. His rapid progress is even more notable when it is considered that his work was born hardly a generation ago. In 1889, the United States Geological Survey began investigation of the water resources of the country, and so little work of that kind had previously been done that the beginners felt that they were entering an entirely new field of research. Owing very largely to contributions of the engineers of the United States Geological Survey, stream gauging has developed empirically and scientifically until it comprises a field of classified knowledge which well entitles it to a dignified place among the sciences. As a science it is a subclassification of that longer recognized and more inclusive science of hydraulics. Knowledge of it is required in practically all branches of engineering, and it is being taught as a regular course in many of the leading scientific schools. The relation of stream gauging to the science of hydraulics, stream gauging as a science, and the probable future developments are discussed briefly in a report by C. H. Pierce and R. W. Davenport, recently issued by the Geological Survey as Water-supply Paper 375-C.

In regard to future developments the authors say: "It seems probable also that in the future the results of accurate stream gauging will be utilized in connection with problems in meteorology and physiography. Although the determination of better coefficients for use in the accepted hydraulic formulas and the deduction of new laws not heretofore expressed may be confidently expected, it should also be remembered that the results of stream gauging have already been applied to the measurements of rainfall on a large scale and to problems involving no less complicated features than the determination of effects of deforestation on the navigability of interstate streams."

PHOSPHATE IN WESTERN CANADA.

The discovery of phosphate deposits near Banff, Alta., referred to in *The Canadian Engineer* for September 16th, 1915, is of high importance in the opinion of the engineers of the Commission of Conservation. Western Canada, being a farming country far removed from the hitherto discovered deposits of phosphate in Canada, which are confined to the Ottawa district, will naturally look to the commercial development of these deposits in its endeavor to maintain soil fertility and to increase its yield. Supplies of phosphate at a low price will naturally have a very important bearing upon the agricultural industry in the prairie provinces. The following example, quoted from "Conservation," illustrates the amount of high-grade phosphate rock which it would be necessary to add to the land annually as fertilizer to replace the phosphoric acid removed from the soil by the crops in the three provinces. In 1913 there were 16,726,400 acres under cultivation in these provinces and the depletion per acre annually is equivalent to the phosphoric acid contained in 60 pounds of high-grade phosphate rock. At this rate, 501,800 tons of high-grade phosphate rock would be required each year simply to offset the depletion of the land already under cultivation in Manitoba, Saskatchewan and Alberta.

An order has been placed by the Canadian Brake Shoe Company, Limited, Sherbrooke, Que., for the installation of a Snyder electric furnace for the melting of steel. This furnace will melt and refine cold material and will deliver 24 tons per day of 24 hours. The steel will be used for the manufacture of shell steel for the British Government. The company has been operating a steel foundry for many years, using electric furnaces exclusively for melting. It now has six furnaces of the three-electrode type in operation.

In no one particular has road building grown more rapidly than in the use of bituminous oils in the treatment of road surfaces, their popularity being due to the fact that they water proof the surface and at the same time serve as a binder to retain the material on the roadway. That such treatment will go a long way toward making a road suitable for use every day in the year is conceded a fact by everyone, and the best of it is that oiling treatment is equally good for macadam, gravel or dirt surfaces. This opens a very large field for the use of this material and nothing seems to be more definitely assured in the road building line than the continued and increasing use of road oils in country districts.

CHARTS FOR SPECIFIC SPEED AND DIAMETER OF HYDRAULIC TURBINES

By R. L. HEARN, B.A.Sc.

THE following charts are offered in hope that they may be found convenient and useful, as well as saving much time and labor in investigating the various characteristics of hydraulic turbines. The charts are plotted according to the principles outlined in Pedler's "Construction of Graphical Charts."

Charts No. 1 and No. 2 are plotted for the solution of the formula for specific speed $N_s = \frac{N\sqrt{H.P.}}{H^{5/4}}$, where *$N_s$ is the specific speed or type characteristic, that is the speed in r.p.m. which would be attained by a runner if it were reduced in all dimensions to such an extent as to develop 1 *H.P.* under 1 ft. head; *N* is the r.p.m. of runner; *H.P.* is the horse-power per runner; and *H* the effective head in feet on turbine.

In Chart No. 1 the scales are plotted in such a manner that when N_s and *H* are assumed constant any number of combinations of *N* and *H.P.* can be obtained simply by swinging a straight edge about the point of intersection of a line joining the assumed values of N_s and *H* and the support. Thus avoiding the necessity of referring back to the values of N_s and *H*.

Example: Assuming $N_s = 14.9$ and $H = 360$ as remaining constant, find values of *H.P.* when $N = 780$, 900, etc. Join 14.9 on scale of N_s with 360 on scale of *H* and let the point of intersection of this line with the support be denoted by *A*. Join 780 on scale of *N* with *A* on support and produce to cut scale of *H.P.* Read 900 for value of *H.P.* Now, to obtain value of *H.P.* when $N = 900$ all that is necessary is to join 900 on scale of *N* with *A* on support and produce to cut scale of *H.P.* Read 674 for value of *H.P.* Similarly any number of combinations of *N* and *H.P.* can be obtained without referring back to the values of N_s and *H*.

In Chart No. 2 the scales are plotted in such a manner that when *H* and *H.P.* are assumed constant, any number of combinations of N_s and *N* can be obtained in a similar manner as in Chart No. 1. The example for Chart No. 1 can be applied to Chart No. 2 by changing N_s and *H* to *H.P.* and *H*, *N* and *H.P.* to N_s and *N*.

Chart No. 3 is plotted for the solution of the formula for diameter of turbine runner, $D = \frac{1840\,\phi\sqrt{H}}{N}$.

Where D = diameter of runner in inches, ϕ = ratio of peripheral velocity to spouting velocity, H = effective head in feet on turbine, N = *r.p.m.* of runner and 1840 = constant.

Example: Assume $H = 360$, $\phi = .83$, $N = 780$, find *D*. Join 360 on scale of *H* with .83 on scale of ϕ and mark point of intersection with support. Join 780 on scale of *N* with point on support and produce to cut scale of *D*. Read 37.2 inches as value of *D*. Any number of combinations of *N* and *D* can be obtained without referring back to the values of *H* and ϕ in a similar manner as in Chart No. 1.

* Characteristics of Modern Hydraulic Turbines, by Chester W. Larner, Esq., Trans. Am. Soc. C.E., Vol. LXVI., page 306.
* Hydraulic Turbines, by R. L. Daugherty; page 98-106.

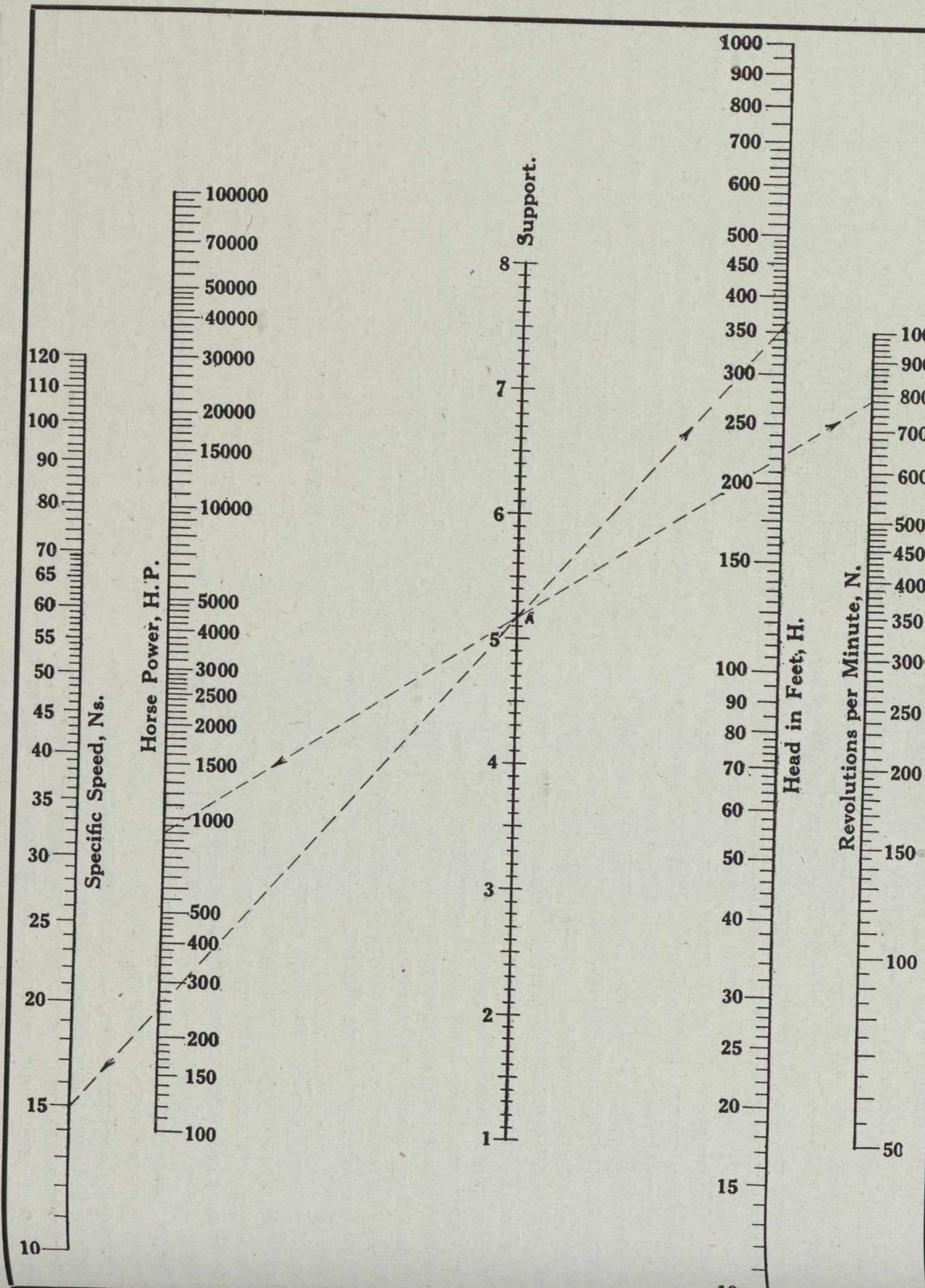

Chart I.—Specific Speed of Hydraulic Turbines.

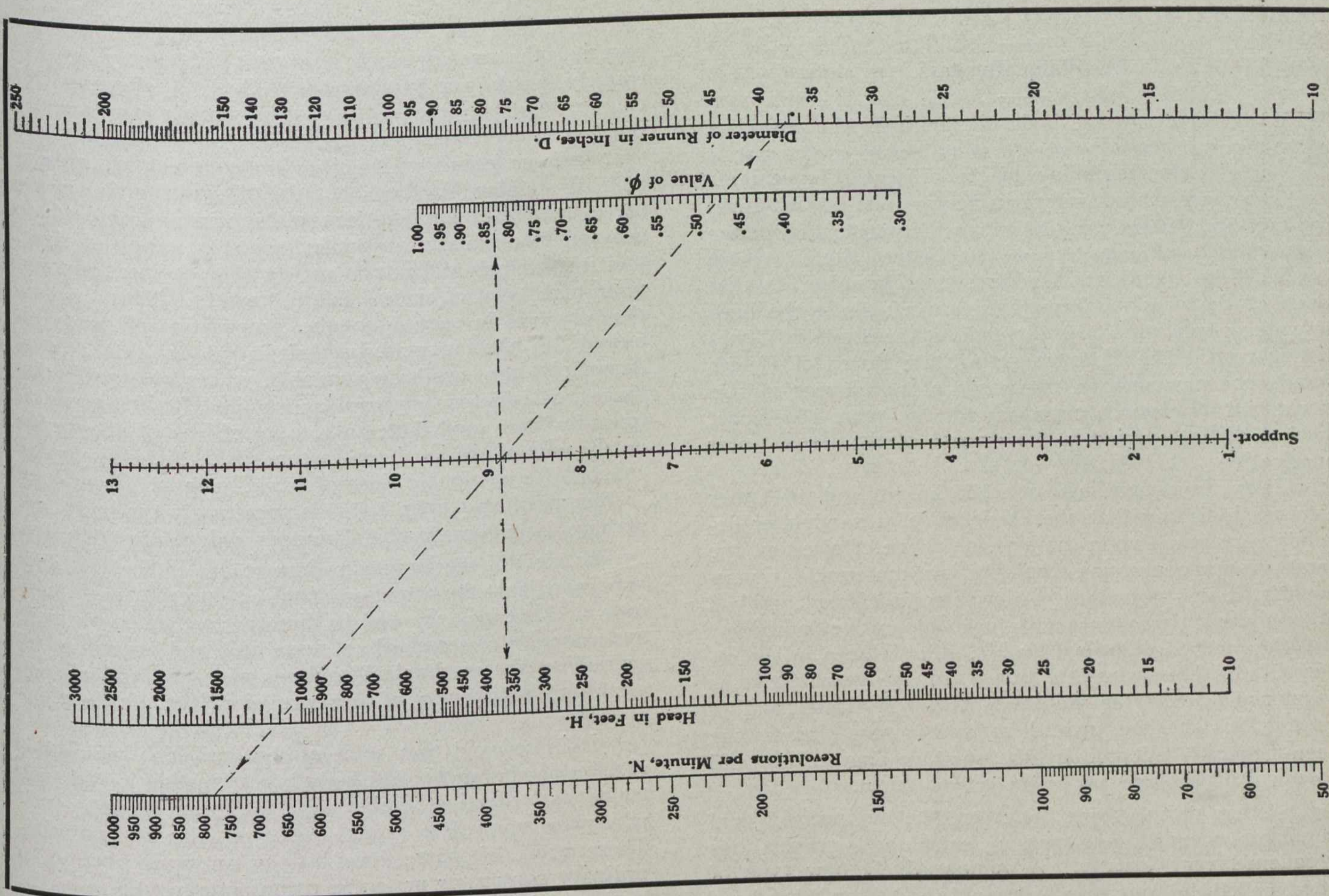

Chart III.—Diameter of Runner.

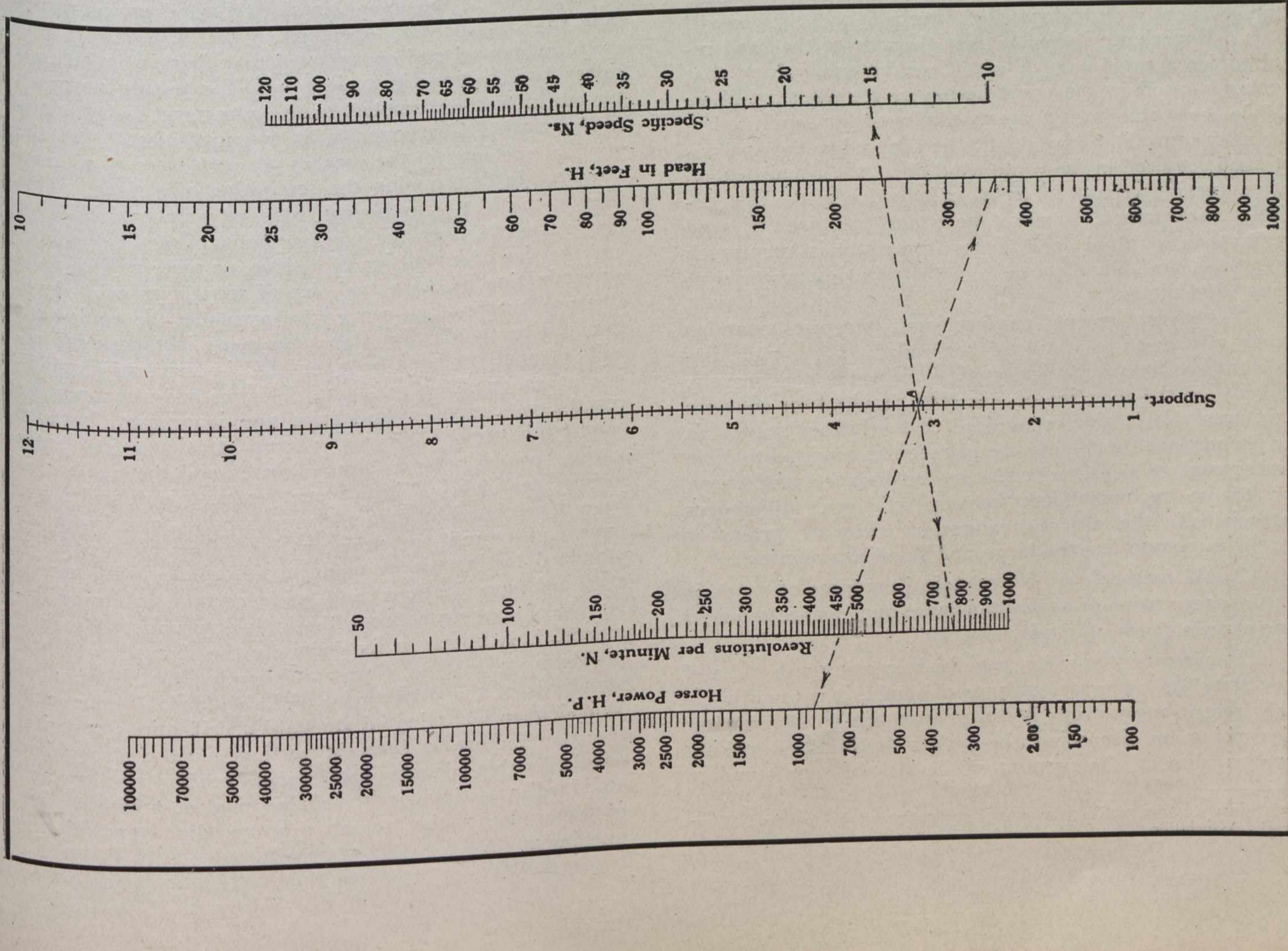

Chart II.—Specific Speed of Hydraulic Turbines.

MECHANICAL ANALYSES OF SANDS.*

By Philip Burgess.

TO the sanitary and hydraulic engineer the period of 1890 to 1895 is of great importance, because it marks the beginning of the present very remarkable growth of water purification plants. English, or slow sand, filters are adapted to the purification of the comparatively clear waters of the Eastern States, where this work received its first important impulse, so that much of the original investigation work along the lines of water purification was directed to the study of filters of this type. The Massachusetts State Board of Health stands conspicuously in the position of pioneer in this work, and its reports, especially for the years 1890-1892, mark a distinct period in the growth of the art of water purification.

Early investigations of this board and of other workers indicated that the efficiency of a sand filter depends very much upon the size, or range of sizes, of the sand grains composing the filtering material. Consequently, it was necessary to devise some efficient method of analyzing the filter sands for comparative purposes, and the method described by Mr. Allen Hazen in the report of the Massachusetts Board for the year 1892 was developed to meet the requirements which existed at that time. This method proved so satisfactory that it has been generally adopted by the sanitary engineering and chemical professions up to the present time.

Within recent years, however, the engineering field requiring accurate analyses of sands and gravels has broadened very greatly. A comparatively new type of filter, called the American or "rapid sand filter," has been developed and has been found to meet the average requirements in the United States, outside of the Eastern States, more efficiently than does the English, or "slow sand" filter. Experience indicates that the size of the sand required for a rapid sand filter differs materially from that generally used in the construction of a slow sand filter. While the methods of analysis employed for sand used in the slow sand filter may readily be adapted to the analysis of sand required in the rapid sand filter, the usual method of expressing results in terms of effective size is not entirely satisfactory, because the range of sizes of sand permitted in rapid sand filters frequently is very much less than is commonly used in the filtering material of slow sand filters.

Moreover, recent engineering literature contains many references to a still further and, perhaps, more important use for mechanical analysis of sands and gravels, namely, in the selection of materials required for concrete mixtures. It is now recognized that arbitrary standards or proportions for mixing the aggregates required to form waterproof or dense concrete are no longer satisfactory, or to be recommended, because of local differences especially in the size and ranges of sizes of grains or particles composing the large and small aggregates.

A still further use of mechanical analyses of sands is in the preparation of asphalt mixtures such as are required for certain types of street pavements.

In view of the very rapidly increasing use of, and necessity for, accurate analyses of sands, it is remarkable that recent engineering literature contains so little matter describing or discussing the proper methods of making such analyses. On account of the lack of such standard methods, it is not surprising to note that specifications covering the use of such materials frequently are extremely weak and ambiguous. Such weaknesses, of course, tend to increase the cost of work and frequently result in a very unsatisfactory quality of material.

Another feature of the situation, to which the present lack of standard methods of analysis contributes, is the fact that the manufacturers of apparatus required to separate materials into specified sizes, or range of sizes, find it extremely difficult to satisfy the specifications and requirements of engineers in this respect. This is particularly true in regard to the preparation of sands required for filtering material. It is seldom that a local community does not have available, within reasonable distances, satisfactory material as required for the preparation of a filter sand, but, on account of lack of knowledge on the part of the local contractors, or of the engineers in charge of a particular piece of work, such local sands are seldom used and filter sand is nearly always imported, perhaps from considerable distances and at large expense.

In view of the increasing importance in the matter it is believed that the attention of the engineering profession may at this time very well be directed to the development and adoption of standards of apparatus and procedure required for the mechanical analyses of sands and also to securing a uniformity of terms required for specifications of materials.

It is believed that some of the confusion which has resulted in the matter has been from the adoption of such terms as "effective size" and "uniformity coefficient" which are applied to sands used for filtering material. These terms, of course, have little or no significance to an ordinary contractor or to the manufacturer who is in the business of screening and sizing sands and gravels.

Moreover, a further confusion has arisen from the endeavor to use the actual sizes of the sand grains rather than the sizes of the openings in the screens. It was early recognized and appreciated that there may be considerable variations in a sieve used for testing purposes in respect to the diameters of the wires and the spacings of the mesh. Consequently it was considered that the nominal spacings of the meshes per inch were of no consequence in determining the separation of a sieve. This view of the matter, of course, required a determination of the relation between the average diameter of the openings and the size of separation of a sieve, or more properly the determination of the actual size of separation of a sieve. Because but few engineers have available the equipment required to standardize sieves, in many instances the results of analyses have been reported in terms of numbers of meshes, or wires, per inch. This method of expressing results, of course, is indefinite and inaccurate, because wire cloth used in the manufacture of sieves frequently varies both as regards sizes of wires and the number of meshes per inch. Within recent years, this difficulty has been appreciated by manufacturers who in some instances have endeavored to clear up the matter by producing standard testing sieves made in accordance with recent standard specifications and with certain arbitrary intervals of spacing between the individual units. By such means, it is hoped to fix definitely the diameter of the openings in testing sieves. Recently, the Bureau of standards of the department of Labor and Commerce at Washington has adopted standard specifications covering the manufacture of certain testing sieves; also, when solicited, this department stands ready to rate and standardize testing sieves at a nominal cost with a view of determining the actual average diameters of the openings.

*From a paper read at the annual convention of the American Waterworks Association.

The writer believes that the engineering profession should adopt a standard method and standard apparatus for making mechanical analyses of sands and gravels. It is believed also that simplicity and accuracy in reporting the results would be obtained by revising the methods commonly used at present to report such analyses. Possibly that feature which would tend most to clear up the situation would be to change the standard of measurement from the size of sand grains to the size of opening in a sieve. In view of the fact that testing sieves can now be obtained which are composed of wires of uniform sizes and of accurate spacings, in both directions, it follows that such sieves will, within reasonable accuracy, contain openings of a certain definite size. Testing sieves which do not come within such requirements as are contained in the specifications of the Bureau of Standards should be rejected.

One of the difficulties to be encountered in such a change of standard would be to compare previous analysis with present or future requirements and conditions. Some years ago, while at Philadelphia, the writer made a great many tests to determine the sizes of separation of two nests of sieves; also to determine the relation between such sizes of separations and the diameters of openings in the screens. The average ratio of size of separation to size of opening was found to be 1.10 and was a constant within the limits of accuracy which can commonly be secured in making a mechanical analysis of sand.

Some of the finer sieves examined contained twilled cloth and not directly woven cloth. The average ratio of the size of separation of the twilled cloth to the average diameter of the openings was found to be 1.18. This comparatively large ratio of separation to diameter of opening in such sieves has been stated to be one reason why there is no constant relation between the diameter of opening and the separation of a sieve. As a matter of fact, however, no difficulty need be encountered in obtaining directly woven wire cloth even for the fine sieves, so that a nest of sieves may readily be obtained with a practically constant ratio of sizes of openings to sizes of separations throughout.

In determining the relation between the separations and openings in the sieves at Philadelphia, there were counted over one-quarter million sand grains and the work extended over a period of two months. The sieves were rated and rerated until the curves of analyses obtained by examinations of the same sample of material by the two sets of sieves coincided throughout their entire length. Great care was taken, also, to secure accurate measurements of the diameters of the wires and of the number of meshes per inch in both directions, from several parts of the area of the cloth.

In Table I. are shown ratings of different nests of sieves with which the speaker has from time to time been familiar. The table serves to illustrate some of the reasons why it is believed that the subject of standard apparatus and standard methods for analysis of sands and gravels is of great importance to the engineering profession at this time.

Attention is drawn also to the marked differences in engineering specifications and requirements for the preparation of sands used for filtration purposes. Frequently such specifications are limited to an expression of the maximum and minimum effective size and maximum and minimum uniformity coefficient.

These terms mean nothing to the ordinary contractor who must furnish the material. It is obvious that the whole question of obtaining satisfactory material would be very much simplified if the specifications would read that a satisfactory sand would be one which contains not more or not less than certain specified quantities as separated by certain standard sieves. Such standard sieves would be available for the contractor, or manufacturer of the material, as well as for the engineer in charge of the work who, under present circumstances and conditions, has the matter almost entirely in his own hands. This is true in regard to specifications for sand required not only for filtering material but also for any other purpose.

Table I.—Sizes of Separation of Representative Testing Sieves for Sand Analysis.

Meshes per inch.	Sizes of Separations in Millimeters. A-1	A-2	B	C	D	E
4 ...	....	....	....	5.6	....	5.7
10 ...	2.00	2.00	2.19	2.15	....	2.09
14 ...	....	....	....	1.45	1.45	....
18 ...	1.04	1.05	1.07	....	....	....
24 ...	0.79	0.81	0.81	....	0.86	0.78
30 ...	0.58	0.60	0.61	0.57	0.58	0.57
40 ...	0.45	0.46	0.48	0.46	0.40	0.45
50 ...	0.31	0.33	0.34	0.37	0.30	0.34
60 ...	0.24	0.30	0.30	0.23	0.27	0.29
80 ...	0.187	0.197	0.190	0.195	0.195	0.193
100 ...	0.153	0.161	0.168	0.160	0.150	0.156
140 ...	0.121	0.117	0.126	0.115	0.120	.....
200 ...	0.085	0.087	0.104	.....	.....	.....

It is significant that the difficulties of the present situation are appreciated by some of the manufacturers of screens and testing sieves who have, in some cases, in their trade publications, gone into a discussion of testing sieves rather thoroughly with a view of meeting the demands of the engineering profession. Special reference is made to catalogue A entitled "Testing Sieves," published by a manufacturer of Cleveland, Ohio. This company has placed on the market a set of testing sieves, the finest of which conforms to the No. 200 sieve described in the standard specifications of the Bureau of Standards at Washington, D.C. The intervals between the wires, or the diameters of the openings in the sieves, increase in a certain definite ratio, namely, the square root of 2, or 1.414. This ratio has certain obvious advantages because it permits the selection of sieves which give accurate ratios of separations of 1.1414, 2, or 4 to 1. These sieves are described in Table II.

Table II.—Standard Testing Sieves.

Mesh (No. per inch).	Diam. of wire (inch).	Opening (inch).	Opening (millimeter).
	0.149	1.050	26.67
	0.135	0.742	18.85
	0.105	0.525	13.33
	0.092	0.371	9.423
3	0.070	0.263	6.680
4	0.065	0.185	4.699
6	0.036	0.131	3.327
8	0.032	0.093	2.362
10	0.035	0.065	1.651
14	0.025	0.046	1.168
20	0.0172	0.0328	0.833
28	0.0125	0.0232	0.589
35	0.0122	0.0164	0.417
48	0.0092	0.0116	0.295
65	0.0072	0.0082	0.208
100	0.0042	0.0058	0.147
150	0.0026	0.0041	0.104
200	0.0021	0.0029	0.074

It is believed that the adoption of a standard nest of sieves along these lines by the engineering profession would help very materially in securing uniformity in the expression of results of mechanical analyses of sands.

It is, also, believed that there would be a great advantage in simplicity of expression of results of analysis or in the form of specifications covering the preparation of filter sands to the effect that 10 per cent. of the sand passes, or shall pass, a standard sieve No. 35, or a standard sieve having an opening of 0.417 mm. diameter, as compared with the usual statement that a sand has, or shall have, an "effective size" of 0.46 mm. Moreover, the term "effective size" has no significance whatever outside of its application to a filter sand and of itself alone the term is of doubtful value as applied to sands such as are frequently used for rapid sand filters. The range of sizes is believed to be much more significant.

If contractors and waterworks superintendents understood more about the matter, frequently it would be possible to construct and maintain filtration plants at much less expense than is now required. The matter of obtaining satisfactory filtering material frequently is extremely simple, but has been made difficult by the methods of analysis commonly employed, and by the requirements as to size described in engineering specifications. There is no probability that the engineering profession as a whole will adopt the terms now used in the mechanical analyses of filter sands for the analyses of sands and gravels used for other purposes such as proportioning concrete, paving mixtures, etc., so that uniformity and standardization of the results of such analyses can be obtained only by a revision of present methods.

TORONTO-OSHAWA ROAD.

A report has been prepared by Mr. W. A. McLean, Provincial Engineer of Highways for Ontario, on the proposed 26-mile Toronto-Oshawa road. Mr. McLean recommends an 18-ft. macadam road with 4-ft. gravel shoulders on either side. A maximum grade of 6 per cent. is recommended, this work costing about $128,000. For about 6½ miles eastward from Toronto the Kingston Road, which is the only right-of-way to be considered, is in fair condition, and only requires surfacing; estimated to cost $26,000. The macadamizing of the remaining 19½ miles will cost in the neighborhood of $156,000, bringing the total estimated cost to $310,000 for the 26 miles.

The apportionment of the cost has not been definitely settled. A meeting at Whitby on October 14, brought the municipalities much nearer an agreement, however, and there should be little difficulty in this regard. The Provincial Government grant of $4,000 a mile would account for $104,000; Toronto, 30 per cent., or $93,000; townships, at $2,300 a mile, $65,000; Whitby and Oshawa, about $17,000; frontage tax, about $20,000.

The report was referred to the councils of each of the municipalities for their consideration before the committee can make further headway.

The Arrowrock Dam across the Boise River just above Boise, Idaho, the highest dam in the world, was officially dedicated a few weeks ago. This dam, which is on the Boise project of the United States Reclamation Service, is 348.5 ft. above bedrock and about 250 ft. above the river bed. It is arched in plan to a 662-ft. radius and a 1,060-ft. length. The section is the normal gravity type. About 530,000 cu. yds. of cyclopean concrete was used in the construction.

ANALYTICAL METHODS IN SEWAGE TREATMENT.

THE sanitary section of the American Public Health Association presented a report at its meeting in Rochester, N.Y., last month advising the adoption of certain tests for determining the efficiency and sufficiency of sewage treatment and for operating control. These tests, recommended in 1914, were referred to in *The Canadian Engineer* for December 31st, 1914, page 803, particularly those relating to suspended matter in sewage and avidity for oxygen. The following observations, from the latest report of the committee, reaffirm the advisability of the use of these and other tests in all laboratories connected with the operation of sewage treatment.

The volume of sewage in America which must be taken care of is increasing rapidly each year. This is attributed to the natural growth of cities and towns, and is also due to the general demand for complete sewerage facilities throughout the country, which requires the installation of new sewer systems and the extension of existing ones. These conditions add steadily increasing loads upon the watercourses, while their ability to receive the sewage does not increase and in some cases actually decreases; consequently, the pollution of watercourses is becoming more evident, and in many instances has gone beyond safe limits.

The continued increase of urban population throughout the country compels the municipalities to depend for the most part upon the large surface streams for sources of water supply. Certain pathogenic bacteria contained in sewage—notably those causing typhoid fever and certain forms of dysentery—are capable of surviving for considerable periods in water, and even after being transported for many miles by stream may produce disease if again taken into the human system.

The people at large are waking up to the importance of maintaining our rivers and streams in a reasonably clean condition, so that they may serve as proper sources of water supply and be useful for both industrial and pleasure purposes. To conserve these natural advantages sewage treatment works are being constructed all over the country, and these in the aggregate represent the investment of large sums of money.

It is therefore surprising to learn how few sewage works in America are under competent supervision and provided with laboratory facilities; in fact, only a few of the larger plants receive such attention.

In the case of water purification plants, the public in general demands that the works shall be operated with skill and that the product delivered to the consumer shall be the best that can be obtained with the available facilities. This is only natural, as a deterioration in quality, even though it be for only a short period, is apt to have a direct and deleterious effect on the health of the community. On the other hand, inefficient or careless operation of sewage treatment works does not, as a rule, give rise to a storm of protest unless the error is so great that it is apparent to the most casual observer.

One of the reasons for this lack of interest on the part of the public is that in many cases sewage treatment works are installed for the good of the commonwealth, and the citizens of the town do not personally realize the resulting benefits. Another reason lies in the fact that sewage works are frequently objectionable and untidy; this is due to the lack of appropriation of sufficient funds for maintenance, and sometimes to carelessness.

With modern processes and proper operation it is possible to reduce objectionable sights and odors to such a point that only a prejudiced visitor will be dissatisfied. A reasonable amount of money spent in laying out flower beds, shrubbery and trees, and in taking care of the grass walks will be more than returned in the added interest in the plant by its operators and by the citizens.

The committee calls the attention of designing engineers to the importance of including the sodding or seeding of slopes and planting of trees and shrubs in the contracts for the construction of sewage treatment works, for new works are too often left in a very unsightly condition with respect to landscape embellishments.

Municipalities frequently employ expert engineers to study local conditions and to design sewage treatment works, but when such works are put in service their operation is entrusted to an untrained employee, transferred from some other branch of the service, who is totally lacking in knowledge of the complex forces which must be controlled in order to produce the results which the designers intended, and for which the funds were invested.

This is poor business policy; a municipality or private owner would not attempt to operate a power plant or other installation involving complicated machinery without the services of trained engineers, because they know it would not be economical to do so.

Where sewage treatment works are of sufficient size to warrant it, laboratory control will allow improvements in methods of operation whereby failures may be averted, and the capacity of the plant maintained to an extent which will more than pay for the small expense involved.

In the case of a small works the expense of an individual laboratory will usually be prohibitive. However, if there are several such plants in the same neighborhood it may be possible to obtain the services of an expert operator, provided with a laboratory, to look after all of them, and the expense, divided among the several communities, would be very small. It is recommended that designing engineers call the attention of their clients to the necessity and economy of such operating control.

As the great majority of sewage treatment works in America are small and frequently widely separated, it is apparent that the needed expert supervision cannot be obtained locally, and that efficiency of operation can only be obtained through some central authority.

In several states the legislators have empowered the state boards of health with authority to control the pollution of watercourses, and their approval is required before sewerage works can be constructed.

The state board of health, in its uniform relation to all the municipalities of the state, and with similar boards in adjacent states, is in a position to perform such a service to better advantage than any other body now existent in the usual organization of the various state governments of the country. The problem is not for the national government, as the operation of sewage treatment works requires oversight by individuals familiar with local needs, characteristics and possibilities, and stationed within a few hours travel of the local works, in order to be of service in case of emergencies which require immediate attention or advice. On the other hand, except in scattered cases, the unit of the county appears to be too small.

In municipalities where sewage treatment is entrusted to competent expert employees, and where this work has the strong moral and financial support of the citizens, the exercise of state authority and supervision is but little needed; but in such cases the co-operation of state and municipal officials is of mutual advantage.

For the state boards of health to act intelligently they should know the methods of operation and results accomplished in all the sewage treatment works in the state. They would then be able to act as clearing-houses, applying to one works the information obtained from several others operating under similar conditions. Such information must, of course, be applied to any particular works by one who is thoroughly conversant with local conditions and able to distinguish the peculiarities and differences involved. The operation of each works is a purely individual matter. Blindly copying, without due analysis of the local conditions, is generally fatal.

This would in no way encroach upon the province of the private or consulting engineer; on the contrary, it would be to his advantage.

The state is interested in seeing that the existing works accomplish the best results possible, and the separate communities are naturally anxious that the works shall meet the requirements at the minimum expense for operation, additions and renewals.

To obtain these data, information is required on the following:—

(1) The purpose of the works—*i.e.*, are they primarily intended to protect sources of water supplies, or to prevent the creation of nuisance?

(2) The construction of the works—*i.e.*, the details of each process which influence operating methods rather than the stability of the structure.

(3) The quantity and character of the sewage to be treated.

(4) The methods of operation and results accomplished.

The data concerning the construction of the works should be obtained either through plans submitted for approval supplemented by record plans after the works are constructed, or, in cases where the board is not yet clothed with such authority, by means of inspection and measurement. Any changes from the original contract drawings or alterations after the plant is in service should be especially noted, as these may be vital information in connection with operating policies.

It is presumed that in those states where the law does not require approval of sewerage works before construction, the number of plants is small, and hence there should be no difficulty in obtaining the needed data.

The records of operation and results accomplished should be furnished the state by the town or owner upon blank forms prepared by the town officials or the owner in conjunction with the state officials.

It is practically impossible to recommend a standard form of report blank to cover all the many types of apparatus used in sewage treatment. If, however, the report form for each works in a state is prepared to meet the local needs, it can still contain essential data so recorded that reports of operation of similar types of apparatus in different works will be in identical form for comparison.

In preparing such forms it should be borne in mind that the small works are generally operated by employees lacking a technical education, and therefore clearness and simplicity should be obtained by having as much as possible printed, leaving only figures to be filled in.

The reports should be printed on sheets either 8½ in. by 11 in., or of such size as to conveniently be folded to

8½ in. by 11 in., so as to facilitate filing in standard letter files. It would be desirable to have the sheets made up in the form of pads, so that the operator by placing carbon paper beneath the top sheet could obtain a copy.

The record sheets should be signed by the operator and mailed at monthly intervals to the office of the Board of Health.

It is again desired to call attention to the importance of recording essential data. In the majority of sewage treatment works no provision is made to obtain a record of the rate of flow to the plant, even though such information is vital to proper operation. The committee strongly recommends that engineers in designing new works provide means for easy measurement of the flow, and that measuring devices be installed in existing works not now so equipped.

When the record forms are printed, blank spaces should be left at convenient places where it may be desired to put figures resulting from computations by the state authorities.

For example, if the operator reports that sludge was placed on drying bed "D" to a depth of 7 in., the state official, knowing from the records the area of the bed, can compute the number of cubic yards of sludge, which he would enter in the blank space mentioned.

If this system of obtaining data were to be put in force, in a short time the state officials would be in possession of a fund of information which could be used in advising operators of sewage works, and this would not only aid the local communities, but also the commonwealth.

When sewage works are operated without producing nuisance, and at a reasonable expense, the objection on the part of communities to being compelled to instal works will diminish, for the fear of failure will be lessened.

It would be of further advantage if the Boards of Health would use the information so gathered to prepare pamphlets, written in clear, popular style, to call to the attention of town officials the need for and value of sewage treatment not only as a local matter, but in its broader effect upon the commonwealth.

NEW ULTRA-VIOLET RAY DEVICE.

A novel addition to existing apparatus for the ultra-violet ray sterilization of drinking water was recently described by Mr. Billon-Daguerre before the Académie des Sciences, Paris. By his arrangement the water is made to flow in a thin sheet across a cone of intense radiation just before it is drawn off for use. The outlet pipe is T-shaped and of transparent quartz. It is provided with a slot adjacent to a mercury vapor lamp, and the thin film of water flowing through the slot gets full benefit of the ultra-violet action. In larger apparatus there are two slots in the outlet pipe and two corresponding lamps. This equipment can sterilize 2,500 gallons per hour.

As a test of its efficiency, the apparatus was supplied with water containing cultures of bacillus coli, cholera and tuberculosis germs. It was perfectly sterilized at the rate of 2,200 gallons per hour, with a power consumption of 440 watts. It is stated that after 3,000 hours' continuous operation there was no appreciable reduction in the germicidal efficiency of the lamps, and no calcareous or other deposits had formed on either the lamps or the outlet pipe, no doubt owing to the scouring effect of the rapid water flow.

THE HYDRAULIC JUMP, IN OPEN-CHANNEL FLOW AT HIGH VELOCITY.

A PAPER to be read by Karl R. Kennison, before the American Society of Civil Engineers on November 3rd, presents an analysis of the hydraulics of the turbulent discharge below a spillway dam, where the so-called "jump" frequently occurs. A knowledge of the hydraulic principles involved should enable destructive high velocities and turbulence to be avoided, or intelligently provided for, in the design of flumes, dam foundations, etc.

The interesting feature of the paper is that in every open channel, except at controlling sections where the discharge is a maximum, there is, in addition to the existing water level, another level at which the same quantity of water might be flowing, under the same head. These two alternative stages should be recognized in the design of all structures for controlling the flow of water. The hydraulic jump is merely the turbulent passing between these two stages.

We quote from Mr. Kennison's paper as follows:—

When water is discharged into a flume through a contracted gateway and under a considerable head, it sometimes continues to move in a thin sheet at a high velocity along the bottom of the flume for several hundred feet. Then it suddenly becomes turbulent and forms what is called a "hydraulic jump," the surface level down stream from this point being much higher than that of the approaching high-velocity discharge; or, when water flows over an ogee dam and out on a smooth apron it sometimes continues in a thin sheet, having a surface level far below the normal level of the river a little farther down stream, until it suddenly changes into a tumbling mass, rising to the normal river level by this back roll or hydraulic jump.

This phenomenon sometimes becomes of great practical importance, and has been investigated mathematically by the writer because of its interest in connection with the design of two important dams under widely different conditions and different parts of the country. In one of these cases it was desirable that the back roll or hydraulic jump should not be pushed far down stream from the foot of the ogee, off from a concrete apron which protected a clay river bed from scour; in the other case it was desirable that the back roll or hydraulic jump, with its violent surges, should not be pushed down stream so far as to interfere with the draft-tube exits of the power house.

The problem does not appear to have received proper attention in the textbooks. No exhaustive mathematical analysis is attempted here, but merely an explanation of the peculiar conditions of flow which make the jump possible. The conclusions are as follows:

In the case of water flowing in an open channel on a steep gradient there are certain controlling sections which throttle the flow and determine the quantity of the discharge, that is, certain points where, for the given head and channel depth, the discharge is a maximum. If the contraction which causes this throttling of the flow is sufficiently gradual—for example, a submerged dam with smooth gradual approach and get-away—it can be shown that the depth of water at this point is theoretically two-thirds of the total head measured from the channel bottom or dam crest up to the hydraulic gradient, and the discharge per foot of length, therefore, should be $3.09\ H^{3/2}$.

At other points than at the controlling sections, however, the depth of water is not necessarily determined by the quantity discharged and the available head, but also by the channel conditions; because, for a given quantity of water flowing and a given head or elevation of hydraulic gradient, there are two possible surface-water levels which we will call alternative stages. The upper stage is the normal level in an ordinary stream, and for very low velocities is practically coincident with the hydraulic gradient. The lower stage is that ordinarily taken by water discharged at high velocity from an orifice or below a spillway dam. This is the more unstable of the two levels, due to the friction of high velocity on the channel bed. In other words, it can be shown that in any open channel, except at controlling sections such as just referred to, there is, in addition to the existing water level, another level at which the same quantity of water might be flowing with equal steadiness and under the same head or elevation of hydraulic gradient.

As these two definite alternative stages are the only possible ones under the existing head for smooth undisturbed flow, the stream must stand at one of these two levels, that is, water flowing in a smooth channel of uniform section must continue to flow at its existing stage, whichever one that happens to be, until, either due to a change in the channel bed or after sufficient loss of head in friction, it encounters a controlling section where the two alternative stages merge into one, and the depth is two-thirds of the total head. Below this controlling section the two possible stages again separate. At such a point as this the water level may change, without disturbance or interruption of the steady flow, from upper to lower stage, or from lower to upper stage, or may continue at the same stage. For example, the water behind a spillway dam is approaching at the upper stage and just below the dam it flows away at the lower stage, the change occurring smoothly over the dam where the two stages were merged into one. On the other hand, if the dam is submerged by back-water almost as high as the up-stream pool, the surface may simply dip down locally at the dam where the depth is two-thirds of the head. In this case the upper alternative stage is maintained throughout, below as well as above the dam. It can also be shown that under certain circumstances the flow over a dam may theoretically be reversed, the dam facing down stream, and the water apparently running up hill—simply a case of passing from the lower to the upper stage smoothly, over a gradual controlling section where the depth is equal to two-thirds of the head.

In such phenomena the presence of the controlling section tends to eliminate any disturbance in passing from one level to the other, so that the existence of the two alternative stages is not noticed; but water flowing at the lower high-velocity stage and suddenly encountering obstructions which tend to destroy its velocity may rise suddenly, and with considerable disturbance and eddying, to the more stable upper low-velocity stage, and this phenomenon is the so-called "hydraulic jump," occasionally observed in open channels, and a common occurrence below spillway dams. It is merely the passing between the two alternative stages.

In this phenomenon the only energy loss is that due to the accompanying disturbance and eddying, the jump proper merely transferring kinetic into potential energy. Ordinarily, however, this hydraulic jump occurring below a spillway dam is accompanied by such violent disturbance and eddying that the total surplus energy in the water may be destroyed in this way. The jump proper, or the passing from lower to upper stage, does not involve energy losses, except incidentally, and it is doubtful if the ordinary formula for loss by "sudden expansion" applies in this case.

The author proceeds to establish a mathematical basis for the above conclusions, as indicated in the relation between depth, head and discharge, and maximum discharge at controlling section. He gives numerous examples of the two "alternative stages" and of the hydraulic jump. The destructive high velocity below spillway dams is also considered. He points out that the destructive energy due to the drop over a spillway dam is a definite, fixed quantity, regardless of the presence or absence of any hydraulic jump. The only destruction of this energy (conversion into heat) in the hydraulic jump is that due to the accompanying eddies and disturbances, and is measured by the drop in hydraulic gradient. If this drop is large, as over a high spillway dam, the disturbance is equally large, and unavoidable. The Bassano dam of the Canadian Pacific Railway Irrigation Project, is equipped, after the recommendation of Mr. John R. Freeman, with two staggered rows of "baffle-piers," shaped like snow-plows, pointed up stream, and designed to split up the high-velocity sheet of water before it can strike the bed of the stream, and throw one jet against another* so that the energy will be absorbed as much as possible by eddies within the body of the down-stream pool, and not by tearing the foundations. These baffle-piers, backed up by a water-cushion, give assurance that the jump will start at the toe of the dam. They themselves are not designed to destroy the energy by impact, but merely to start the necessary eddies, which act in the water-cushion below the baffle-piers and complete the hydraulic jump.

The paper calls attention to the existence of the two alternative stages in open-channel flow, and to their practical importance, in many cases, when the flow is at high velocity; it is also intended to identify the hydraulic jump as the passage from the lower to the upper stage. Below a spillway dam, it often happens that these two stages are so far apart that the jump cannot occur between them, until a considerable distance down stream and after enough energy has been destroyed in friction to bring the two stages near together.

*See page 423, *The Canadian Engineer*, for September 30, 1915.

NEW UNIVERSITY BUILDING, EDMONTON.

An important and singularly artistic unit has been added to the buildings of the Alberta University in Edmonton by the completion of the main administrative block. This building, officially declared open on Wednesday, October 6th, 1915, is to be devoted entirely to teaching and administration. The structure is a three-story one, built of brick, elaborately adorned with classical trimmings of Indiana limestone. It was designed by Messrs. Nobbs and Hyde, architects, Montreal, and was erected by Messrs. George W. Fuller and Co., Limited, of New York and Winnipeg, the cost being slightly over $600,000. Mr. Cecil Scott Burgess, A.R.I.B.A., Professor of Architecture in the university, acted as resident architect.

The university campus covers 258 acres, with a frontage on the River Saskatchewan of 2,100 feet, and an elevation above the river valley of 200 feet. A complete plan has been developed for its beautification, and for the arrangement upon a definite system of all future university buildings. This scheme is the work of several eminent Canadian architects and designers.

WINNIPEG-SHOAL LAKE AQUEDUCT CONSTRUCTION.

THE progress made this season on the construction of the Shoal Lake Aqueduct for the Greater Winnipeg Water District has been very gratifying. The percentage required by contracts for completion this year is 18 per cent. This comprises about 16 miles of aqueduct, and it was recently stated by Mr. S. H. Reynolds, chairman of the District, that by November 1st practically 16 miles of the aqueduct would be finished. As the construction of the aqueduct proper began only last spring, there has evidently been good progress made despite some unfavorable weather conditions.

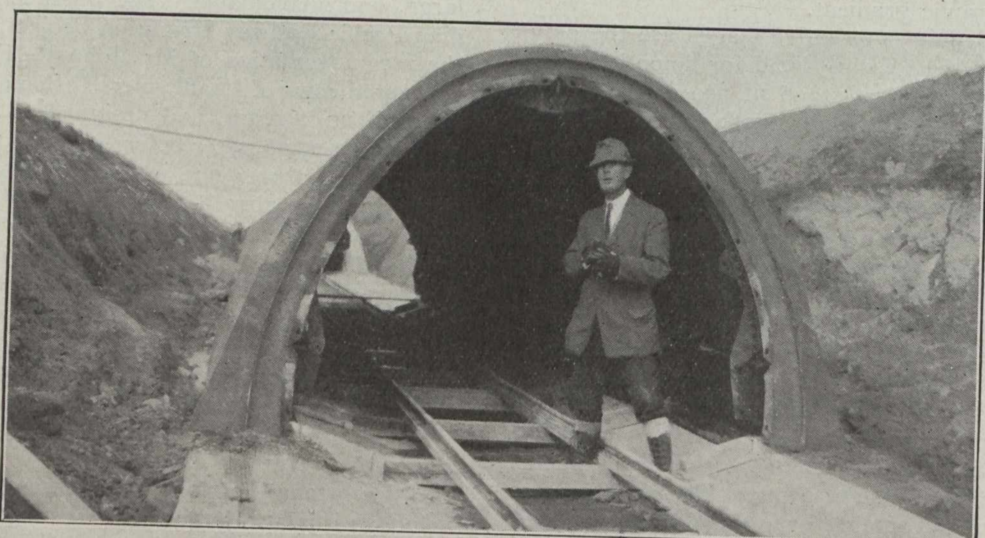

Fig. 1. Section of Open-flow Aqueduct.

Fig. 2.—Reinforced Section Under Brokenhead River.

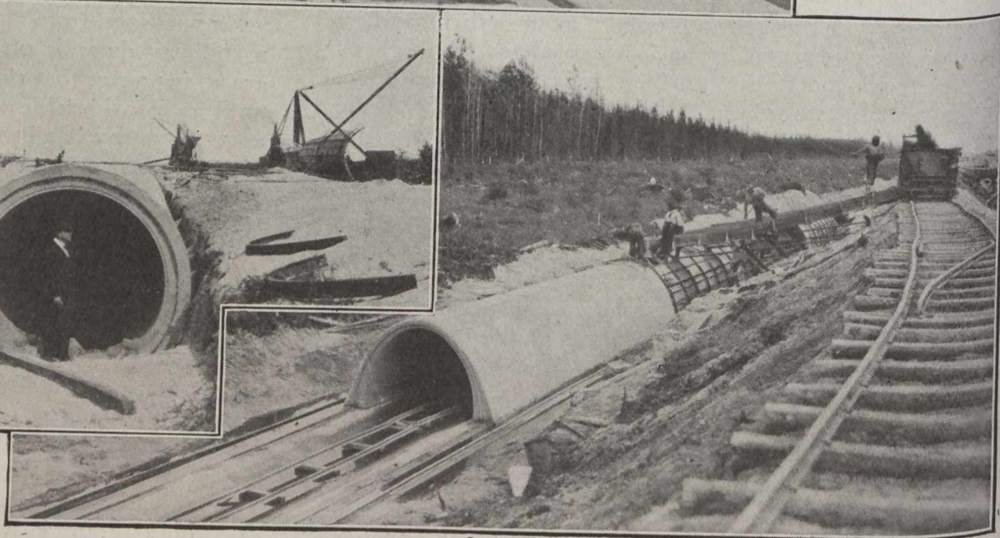

Fig. 3. Concreting Closure Arch Between Alternate Sections.

The whole project has been fully described in *The Canadian Engineer*. Our issues of September 11th, 1913, and October 23rd, 1913, outlined the scheme in full and summarized the engineers' report on the suitability and availability of Shoal Lake water supply. The undertaking comprises over 100 miles of permanently constructed railway from Winnipeg to Shoal Lake, a diversion dyke and channel to bar Falcon River from the mouth of the intake in Indian Bay, about 85 miles of cut-and-cover aqueduct leading to Transcona, where a large reservoir is to be constructed when future requirements warrant it, 9.8 miles of 60-inch steel pipe to the Red River in Winnipeg, a tunnel beneath the river, and 2.3 miles of 48-inch cast-iron pipe to McPhillips Street reservoir. It is a gravity system throughout, with a difference of elevation of 294 feet.

Preliminary work in 1913 involved an immense amount of survey and topography work through practically undeveloped country for almost the entire length of the proposed line, in addition to soundings at Indian Bay and test borings along the line. In 1914 the line was cleared, the railway built, and the Falcon River diversion dyke and channel partly constructed. These works were separately described in our issue of April 29th, 1915.

The greater part of the present season's operations have related to the aqueduct itself, several sections of which are illustrated in the accompanying views. For the most part it is of solid concrete. Fig. 1 shows a section of open-flow aqueduct in a trench of moderate depth, with the end bulkheads and the outside forms removed. Owing to considerable variation in gradient the cross-section varies accordingly, ranging, in fact, from a section 10 feet wide and 9 feet in height (used at the deep summit cut, near Indian Bay) to one 5 feet wide and 5 feet high, where there is a maximum gradient. The invert is constructed first, and upon it a series of alternate 45-foot sections of the arch are poured and followed later by the closure sections of similar length. As shown in Fig. 1, a track is laid upon the invert and through the arch. Upon it a car transports the inner forms and places them in their new positions. Projecting from the end face of the section shown in Fig. 1 may be noted half a 6-inch strip of No. 20 gauge copper water-stop. This strip extends the full length of the joint. The important purpose which it serves in case of contraction in the concrete, and the unique details of its form and adjustment are described in *The Canadian Engineer* for June 10th, 1915.

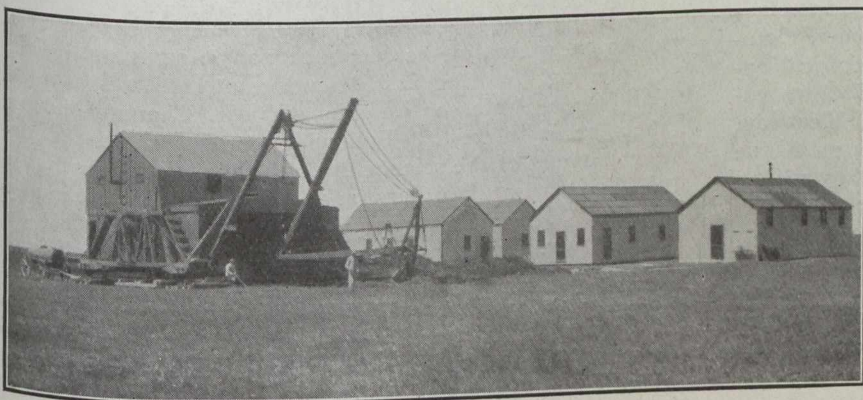

Fig. 4.—Gasoline-operated Walking Dredge Engaged in Trench Excavation.

In Fig. 3 the process is shown of pouring concrete into a closure arch through wooden chutes from the steel dump-cars operated upon a dinky track built upon the spoil bank alongside the trench. This method of distributing and pouring concrete is in use upon contracts Nos. 32, 33 and 34, which are being executed jointly by the Northern Construction Company and the Carter-Halls-Aldinger Company. The character of the country and the condition of the trench is typical of all work upon this construction east of the Brokenhead River, Mile 40.

Besides the Red River crossing (to be accomplished by rock tunnel), there are the Falcon, Birch, Whitemouth and Brokenhead Rivers, under each of which the aqueduct is depressed, converted to circular section and reinforced with steel. At these points it is provided, also, with blow-offs and waste weirs. Fig. 2 is a view of the west end of the reinforced section passing under the Brokenhead River and across a 3-mile depression adjacent thereto. Concrete at that point in the line is 1 foot thick and reinforced. The pipe is 7 ft. 6 in. in diameter.

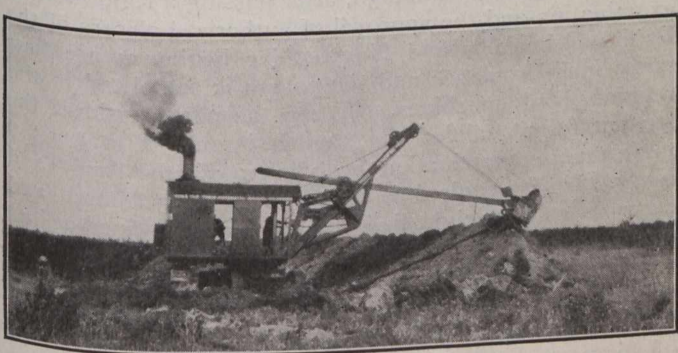

Fig. 5.—Thew Shovel Excavating in Heavy Soil.

Figs. 4, 5 and 6 show the three types of plant applied to the opening of the aqueduct trench. Fig. 4 is a walking dredge, operated by gasoline power, excavating in the trench in the prairie at Mile 24. This is on Contract 30, Camp No. 2, of the work being carried out by the Tremblay McDiarmid Company. Fig. 5 shows a Thew shovel mounted upon a truck excavating in firm soil at Mile 43 on work being carried out by Thos. Kelly & Sons under Contract 31. These contractors have three such shovels at work—two of them at this point and one at Mile 33. Fig. 6 shows the largest of six Bucyrus drag-line machines operated by the Northern Construction Company and Carter-Halls-Aldinger Company on Contracts 32, 33 and 34. The machine excavating has a two-yard bucket, as it operates in a rather deep cut. The other five machines are equipped with buckets of one yard capacity. All of these machines are working upon swamp-covered soil and operate upon sectional platforms.

According to the report of Mr. W. G. Chace, chief engineer, to whom we are indebted for the accompanying views, approximately 8 miles of the aqueduct had been completed on September 25th. The crossing of the Whitemouth River, which is similar in depressed and reinforced section to the Brokenhead crossing, was about 90 per cent. completed at that time.

While little concrete work will be done after November 1st, other phases of the work will be vigorously proceeded with during the winter, particularly rock work. In addition, a contract has just been let to Henderson & Snider to make test borings where the aqueduct will cross the Red River at Winnipeg. It is expected that this work will occupy three months.

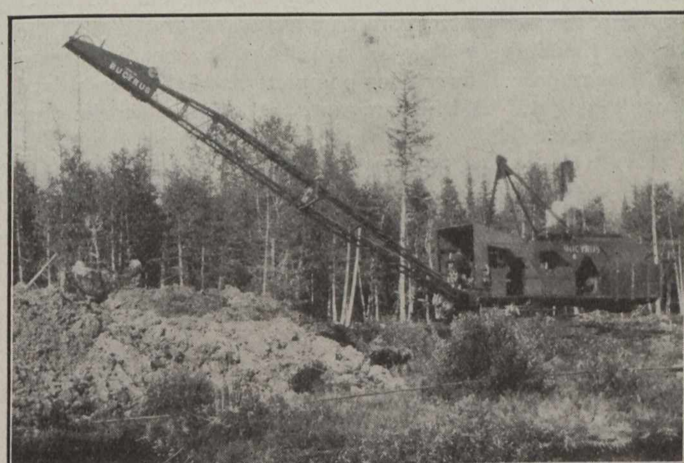

Fig. 6.—A Bucyrus Drag-line Excavator at Work on a Deep Cut.

Sanitary engineers are following with great interest the progress of the activated-sludge method of sewage treatment. At Houston, Tex., according to Mr. E. E. Sands, the City Engineer, they have one large activated-sludge tank in operation, and also have a small tank about 12 in. square and 8 ft. deep, with a glass front and a small filtros plate in the bottom of tank. They have been operating the large tank (14,000 gallons) but a few days and have only accumulated 5 per cent. of sludge so far, but find that at a certain time of the day the sewage carries a considerable amount of solid matter, so they are able to build up the sludge quite rapidly, and they expect within the next three or four weeks to have the tank running at a normal condition.

CANADIAN SOCIETY OF CIVIL ENGINEERS, OCTOBER 7th MEETING.

Interesting discussion followed the paper on Stave Falls power development which was presented before the Canadian Society of Civil Engineers at Montreal, October 7th, by R. F. Hayward, general manager of the Western Canada Power Co., Limited. A summary of Mr. Hayward's paper appeared in *The Canadian Engineer*, October 7th issue. R. A. Ross, consulting and electrical engineer, Montreal, spoke concerning the difficulties encountered in the Stave Falls work, and Mr. J. C. Kennedy, consulting engineer, Montreal, who had charge of the preliminary work done by the Stave Lake Power Co., told of some of the storage problems encountered.

Walter J. Francis, who presided at the meeting, stated that the papers presented to the Canadian Society of Civil Engineers regarding water power developments, were greatly increasing in number, in interest and in value. In looking through the records of the Society, he found that Mr. R. A. Ross had said in 1898 that electrical engineers were beginning to think over long distance electrical transmission; that in 1894 no such plants had been constructed, but that by 1898 a few plants had been built, and that more would undoubtedly follow. In view of the developments undertaken in every portion of Canada, it is remarkable what rapid strides this branch of engineering has made, when one recalls that the subject was discussed in the above manner so recently as only seventeen years ago.

Mr. Hayward, in reply to a question, stated that the cost of the Stave Falls plant would be $72 per h.p. when the four units will have been completed and the dam raised to full height. Of this amount, the storage works cost $25 per h.p.

Only two units are installed now. The power house will be extended and two more will be added. The third unit will likely be installed this season, but the fourth unit will probably not be installed for some months yet.

The third turbine is in Customs at Vancouver, and the fourth has been constructed but has not yet been shipped from the Escher-Wyss works in Switzerland.

The plates for the third and fourth penstocks are in Vancouver. These plates were brought from Scotland and laid down in Vancouver at a cost of 2 cents per pound. The structural iron work for the extension of the power house is on the ground at the plant.

Mr. Hayward stated that rapid advances had been made during the past few years in water turbine design and construction. The horizontal double runner turbines which they have at Stave Falls, although built only a few years ago, have an efficiency of only 83%, but at the time these were constructed that was considered excellent. The vertical single runner turbines at Cedars Rapids, however, have an efficiency of 90%, which represents so great a saving as compared with the turbines at Stave Falls, that the latter may some day have to be modified.

Regular Meeting, October 14th, 1915.

For nearly two hours Mr. J. A. D. McCurdy, the aviator, held the rapt attention of a very large and appreciative audience at the headquarters of the Canadian Society of Civil Engineers, 176 Mansfield Street, Montreal, at a meeting of the General Section on the evening of the 14th instant. In introducing the speaker, Mr. Walter J. Francis, who presided, said that the thrills of satisfaction which the United States and particularly Canada felt when Mr. McCurdy made his famous flight from Florida to Havana in 1911 were no greater than the thrills of satisfaction which now exist in Mr. McCurdy's success in the training of aviators at Toronto for service with the Allies, mentioning the fact that already fifty-three of Mr. McCurdy's graduates have crossed the ocean, and all have been accepted.

In opening his address, Mr. McCurdy gave a brief historical sketch of the efforts of man to navigate the air, concluding that the first scientific interest was aroused only when Professor Langley and Mr. Chanute showed their great interest. Following on, he traced the dedevelopment of the science through the preliminary flights of the Wright Brothers and the efforts of Alexander Graham Bell, which resulted in an association that included Mr. Baldwin, Mr. Curtiss, Lieutenant Selfridge and Mr. McCurdy. After describing in a general way the machine used in the Havana flight of 1911 with a lifting capacity of 140 pounds, Mr. McCurdy went on to describe the biplanes now being built by the Curtiss Aeroplanes and Motors, Limited, for Great Britain. These biplanes weigh about three tons and have a lifting capacity of over 2,000 pounds. They can fly at 86 miles an hour and are capable of rising to a height of 4,000 feet in 9 minutes. Provision is, of course, made for gun mounting, wireless and all the latest devices. The most recent engines are of the fixed base, 8-cylinder, 5-in. x 7-in., water-cooled, V-type with a capacity of 170 h.p. each. Two such engines are fitted in each machine. These engines have largely replaced the well-known revolving cylinder, air-cooled, Gnome type of engine where power in excess of 80 h.p. is desired, owing to the difficulties in cooling large Gnome engines. Attempts have been made to place two Gnome engines side by side on the same shaft giving a maximum of 160 h.p., but the newer type is simpler and more powerful. An interesting fact is that the engines now in use weigh less than four pounds per horse-power of capacity, which is a most remarkable development in engine construction.

In concluding, Mr. McCurdy expressed the view that on the conclusion of the war the hydroplane, owing to its speed and convenience, would become popular as a pleasure and sporting craft. The school of flying at Toronto, now about to be moved to Bermuda for the winter season, is the largest school of aviation in the world. It is equipped with nine machines in charge of seven pilots. Three hundred students are now enrolled. Candidates must be British born and are accepted between the ages of 18 and 30, after passing a rigid medical examination and the approval of authorized officers of the British Admiralty and Navy. The beginners are first taken in hydroplanes and the course is completed in the regular land machines. When the pilot considers the student fully qualified the student is subject to a rigid performance examination by officers of the Army and Navy. He is required to take a machine by himself and describe a figure eight five times around two fixed points on the ground, at the conclusion of which he must alight within 150 feet of a predetermined point. He is then required to immediately repeat this performance. Next he is called upon to rise to a height of at least 350 feet, shut off his power and glide to the earth, alighting at a point within full view of the observers. It is interesting to note Mr. McCurdy's statement that no accidents have occurred at the school. Mr. McCurdy prophesied that one of the results of the war would be the giving to Canada of an efficient corps of trained fliers such as will be possessed by no other country.

Editorial

SAVERS OF TIME AND MONEY.

That technical journals save engineers much time and many journeys was shown in the remarks made two weeks ago before the Canadian Society of Civil Engineers at Montreal by R. F. Hayward, chief engineer and general manager of the Western Canada Power Company. Mr. Hayward had travelled nearly 3,000 miles to be able to discuss with other engineers the difficulties and interesting problems he had encountered in the construction of the magnificent power plant at Stave Falls, B.C.

In reply to a vote of thanks for his having travelled so far, Mr. Hayward stated that there were practically no technical libraries in the West, and that the engineers of the West frequently longed for advice from their fellow engineers, and that he personally had found that a 3,000-mile journey for the sake of five minutes' conversation with another engineer, had paid for itself over and over again.

If it were not for the medium which technical journals afford for interchange of ideas and knowledge by widely separated engineers, a very large proportion of the engineers would have to take a great many more such journeys than are now required.

TOWN PLANNING.

The term "town planning" has been interpreted in different ways. Some associate the phrase with the beautification of towns and cities by laying out picturesque boulevards, pretty gardens, fine parks, impressive civic centres, and so on. All these things add materially to the aesthetic appearance of a city, but there are other interpretations of town planning, namely, the economic considerations in providing for the future in the matter of health, homes, traffic, etc.

Germany, not long ago, was held up as a model nation in this and other respects. German examples of town planning were advertised abroad; volumes were written to show that Germany was much ahead of English-speaking countries in these matters. In many respects, Germany has led the way. She had formulated laws and organized the work of town planning before the other nations were cognizant of the importance of the movement. Incidentally, the awakening of the English-speaking nations was largely due to the work of a humble British author named Ebenezer Howard. It must, of course, be acknowledged that there was already a considerable measure of static enthusiasm for this movement, and doubtless Howard's effort helped to convert it into dynamic force, which has done much in Britain to effect changes in the few years since the publishing of his book.

It is interesting to learn that the British conception of town planning has done more for the people than has been the result of work in Germany. The "Town Planning Review" recently referred to the following convincing facts:

There are, on an average, five persons per house in Manchester and eight per house in London, but in Berlin there are 77 per house, and in some houses there are 250 families in occupation. The number of inhabitants per square kilometer (or two-fifths of a square mile) is 32,000 in Berlin and 15,000 in London.

The number of deaths of persons between 15 and 25 years of age is 30 per cent. less in London than in Berlin. London has 50 per cent. less tuberculosis than Berlin. The manhood of Berlin cannot be endowed with a magnificent stamina when 33 per cent. of the men in that city were declared unfit for the army. The idea of town planning in Germany seems to be the provision of fine open spaces by the removal of some buildings and increasing the height of others. The effect of this has been, as in New York, the enhancement of the price of land. Landowners have speculated on the health, comfort and happiness of the people, to their own advantage. Thus we see that Germany does not, after all, afford us the inspiring example that was claimed for her.

The Commission of Conservation is contemplating the organization of a conference of town planning societies, etc., to discuss various subjects of importance. Mr. Thomas Adams has already shown that he belongs more to the practical school of town planning than to the aesthetical school; or, better still, he measures aestheticism and practical advantages of town planning by the dollar. We want art and health, beauty and comfort, pleasure and business, city lungs and city homes, fine gardens and ideal dwellings. If we have to declare for artistic buildings or for robust health, then we unhesitatingly stand for the latter. If we have to choose between parks and homes, the latter must always win, for the city, after all, should be established on homes.

There is a temptation to proclaim for a city that it possesses magnificent parks and boulevards and to be purblind to filthy slums, contaminated water and neglected thoroughfares. There are cities on this continent that boast of their natural beauties and are willing to spend millions on schemes which will enhance such conditions, while the real important questions of life and death to the community are inadequately considered. This is not the true meaning of town planning. It means the development of the city in a rational way, each requirement being satisfied, each section of the community receiving attention, each civic service organized and each department administered as far as the resources of the city permits, and without undue discrimination. If the proposed conference, under the direction of Mr. Thomas Adams, will help to bring the people to a better appreciation of the real function of town planning then the Commission of Conservation will have achieved something which will be of inestimable value to Canada, for scores of cities in this Dominion are in the early process of development, and errors which have been committed by older cities should now be avoided in a large measure, so that true economy can be attained in all branches of city life.

At the recent International Engineering Congress held at the Panama Exposition, Mr. Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment, New York City, made an "appeal to the engineer to take a broader part in the development of the city than merely making the surveys and carrying out the ideas of others."

Town planning belongs more to the province of the engineer than to any other profession, because it involves surveys, contouring, street works, drainage, water mains, railways, water fronts, lighting, bridges, etc. The embellishments, again, are the work of the architects, landscape specialists and the artists. The fundamental necessaries of a city are the arteries of its constitution, which give it life, and should be planned by engineers after careful consideration of the local circumstances. The architects and landscape specialists will add on the completion and finishing touches.

Mr. Nelson P. Lewis' concluding remark was: "If the engineer does not assume the task and show his capacity for it, he will have no one but himself to blame if others take it away from him." Canadian engineers have not yet shown much enthusiasm in this connection; up to the present the principal advocates for town planning are members of other professions.

LABOR TROUBLES AND SHELL PRODUCTION.

It seems as if German sympathizers were still making use of the United States labor unions to impede the production of war munitions in Canada and the United States. The latest development is a strike of the machinists' union in the chief machine-tool-producing centres of the United States. About ten of the largest factories for the production of these tools are situated in Cincinnati, and the machinists of that city are on strike. Cleveland, which is another important centre of this industry, is experiencing the same trouble. In the New England States, from which ten or twelve million dollars' worth of machine tools for munition work have been obtained recently, approximately three thousand men have been on strike for five or six weeks.

The Canadian Machinery Corporation has been working 22½ hours a day for the past year, and it is stated that they have sufficient orders to keep them busy at the same rate until next June or July; but their capacity, and that of The John Bertram & Sons Company, and other firms manufacturing similar lines in Canada, are said to be entirely insufficient to meet the demands without importation from the United States.

As it therefore appears unlikely that many Canadian factories will be able in the near future to increase their equipment, it is highly reassuring to note the statement made last week by Col. Frederick Nicholls, that Canada is now turning out shells at the rate of 5,200,000 per annum, but that the country has sufficient capacity to produce over 50,000,000 shells per annum.

INSTRUCTION IN THE OXY-ACETYLENE PROCESS.

At the Montreal Technical School a new night course of instruction has been established with a view to furnishing proper training in the oxy-acetylene welding and cutting process. While not a part of the regular courses, as it is in Europe and in a number of engineering schools in the United States, the study is regarded a very useful one and is well patronized.

Elementary instruction began on October 8th, a series of ten lessons, taught in English and French, with practical instruction in a workshop equipped with individual benches. An advanced course is scheduled to begin in January. L'Air Liquide Society of Montreal is bringing the course to the attention of employers and employees.

COAST TO COAST

Vancouver, B.C.—Capilano Creek has been diverted at points where it had eroded its banks and endangered water pipes and crib work along the roadway.

Prince Rupert, B.C.—A new 16-ft. plank roadway is being constructed and re-decking of several existing roadways is under way, at an expenditure of about $15,000.

Victoria, B.C.—The Board of Trade has been considering the establishment of a copper refinery in the province, and a report from its mining committee will be forthcoming at an early date.

South Vancouver, B.C.—Sewer construction will shortly be completed for the season, and the system connected up with the trunk sewers of the Vancouver and District Joint Sewerage and Drainage Board.

Winnipeg, Man.—The Manitoba Good Roads Association awarded the first prize in its 1915 split-log drag competition to the municipality of Rosser in the earth class, and to the East Kildonan road in the gravel class.

New Westminster, B.C.—Tunnelling and pipe laying for the new trunk sewer has been practically completed, and the sewer outfall will be finished in a few days. The paving of Fifth Street and Sixth Avenue has also been finished.

Edmonton, Alta.—An offer for the supply of gas to the city at the rate of 25 cents per thousand feet has been made by J. A. D. McArthur, with whom are associated Messrs. J. G. G. Kerry, O. M. Biggar and Dr. J. K. McLennan.

Vancouver, B.C.—The Dominion government wharf will be completed in a few weeks. Several dredges operating near the Second Narrows are providing material for filling, about 60,000 yards of which will entirely complete the work.

Stratford, Ont.—A start will be made this fall on the new main sewer. The concrete tile for it, including 6,160 ft. of 36-inch, and 5,084 ft. of 48-inch concrete pipe has been completed by the contractors, Messrs. Brennan & Hollingsworth, of Hamilton.

Vancouver, B.C.—The Connaught Bridge, which was destroyed by fire last spring, will be opened for traffic in a few days. A temporary wooden span has been placed across the broken section, and a single track car line across it is now ready for operation.

Orangeville, Ont.—It is stated that the Hydro-Electric Power Commission of Ontario has purchased the dam and power development at Horning's Mills of the Pine River Light and Power Company, to be used as an auxiliary power system.

Kirkland Lake, Ont.—Mining operations, which were temporarily discontinued at the Tough-Oakes mine owing to shortage of power, will be resumed shortly. The company is now building a hydro-electric power plant on the northeast arm of the Blanche River.

Edmonton, Alta.—Steel will be laid this year on the Edmonton, Dunvegan and British Columbia Railway to a point on the south bank of the Peace River opposite Dunvegan. Steel on the Canada Central Railway has already reached Peace River Crossing.

Montreal, Que.—A party of 520 skilled workmen left last week for Russia to engage in railway construction. Mr. H. B. Ferguson, of Pauling & Company, an English contracting firm, organized the party with the assistance of the Deakin Construction Company, Montreal.

Vancouver, B.C.—The reclamation of an area of about 42 acres, known as the Granville Street tide flats, has been commenced. More applications for factory sites have been received for the new area to be created than can be taken care of when the work is completed.

Montreal, Que.—The city's expenditure on public works in 1915 has amounted to $5,398,000. Paving operations, which have been rather evenly spread over the 31 wards, have involved an outlay of $2,890,000. The sidewalk expenditure has been $677,000, and the cost of sewers $1,500,000.

Ottawa, Ont.—The Dominion Government is preparing plans and regulations for the working of the rich deposits of phosphate of lime in the Rocky Mountains, recently referred to in these columns. In the meantime no work is permitted on existing claims, and no new applications are being accepted.

Prince George, B.C.—Grading has been practically completed on the Pacific Great Eastern Railway from Vancouver, and steel is being laid this fall from Clinton to Squamish, a distance of 167 miles. Construction is well advanced on the bridges and regular trains will probably be put into service between Squamish and Clinton before the close of the year.

West Vancouver, B.C.—The water supply scheme will be proceeded with at once, providing for the installation of a 230,000-gallon reservoir of reinforced concrete with a 6-inch intake, and a settling tank. The contract was awarded recently to M. P. Cotton, the price being $90,000. The new scheme will require about 18 miles of 6-inch wooden pipe. The contract provides for completion next spring.

Port Nelson, Man.—About 1,000 men are engaged on the harbor work. Three large dredges are deepening and straightening the channel, and extending the harbor basin. Wharves have been built this year and considerable progress made on the railway terminals. It is expected that the harbor facilities will be completed by the time the first train over the entire line reaches Port Nelson. This is expected to occur next September. Practically the whole line has been graded and over 200 miles of steel laid. Track-laying has been somewhat delayed this season, however, owing to a number of sink holes.

Vancouver, B.C.—As already mentioned in these columns, the city engineer has been investigating the pollution of water supply and the general conservation of water on the Capilano and Seymour water sheds. In his interim report recently presented to the city council, Mr. Fellowes points out that only four months ago the Brittania Mining and Smelting Company applied for the right to use 5,400,000 gallons per day, and this, if granted, would mean the discharge of this amount of water into Seymour Creek, causing serious pollution. He protests against the granting of this concession.

UNIVERSITY OF BRITISH COLUMBIA.

The newest Canadian university opened its doors as an educational institution on October 1st in the city of Vancouver. On its teaching staff are some very familiar names. The president is Dr. F. F. Westbrook, and registrar, Mr. C. E. Robinson. Mr. Reginald W. Brock is Dean of the College of Applied Science. In the Department of Geology and Mineralogy, Mr. Brock is professor and Dr. D. D. Cairnes assistant professor. In the Department of Mining and Metallurgy, Mr. J. Moncrieff Turnbull is professor. In the Department of Chemistry, Dr. Douglas McIntosh is professor and head of the department, and Dr. E. H. Archibald is assistant professor. In the Department of Civil Engineering, Mr. H. K. Dutcher is assistant professor. In the Department of Mechanical Engineering, Mr. I. Killam is assistant professor, and Mr. F. C. G. Wood, lecturer.

Two new temporary buildings have been completed for the departments of Geology and Mineralogy, and alterations have been made in the building formerly used by McGill College for the use of the Science department devoted to Physics and Chemistry. The library, administration offices and lecture rooms will be in another new building. These arrangements are temporary, pending the erection of the university buildings according to plans fully considered and adopted, but deferred during the war on account of financial considerations.

NEW CANADIAN MEMBERS, N.E.W.W.A.

Recent elections to membership in the New England Water Works Association included in its lists the names of the following Canadian Engineers:—

R. L. Dobbin, superintendent of waterworks, Peterborough, Ont.

H. Hymmen, superintendent of waterworks, Berlin, Ont.

B. G. Michel, municipal engineer, Carleton Place, Ont.

William Perry, consulting hydraulic engineer, Montreal, Que.

Col. H. N. Ruttan, consulting engineer, Winnipeg, Man.

Arthur Surveyer, consulting engineer, Montreal, Que.

OTTAWA BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting of the Ottawa Branch of the Canadian Society of Civil Engineers was held on Thursday, October 14th, in the chambers of the Conservation Commission, with an unusually representative attendance of engineers.

The retiring chairman of the branch, Mr. A. St. Laurent, assistant deputy minister of public works, presided and read an interesting paper on various harbor improvements throughout the Dominion. Mr. A. B. Lambe, the able secretary-treasurer of the society for the past two years, submitted a report on the general affairs of the branch. The retiring officers of the branch are Messrs. A. St. Laurent, A. B. Lambe, W. J. Dick, and M. F. Cochrane. The results of the election of officers for the coming year were as follows: Mr. John Murphy, chairman; Mr. J. B. Challies, secretary-treasurer; Messrs. Gordon Gale, A. T. Philips, R. De B. Córriveau, Alex. Gray, W. S. Lawson, managing committee.

The Ottawa Branch of the Canadian Society of Civil Engineers is one of the most flourishing of the many branches of this important society. Despite the fact that a very large proportion of its membership is with the Canadian expeditionary forces, the past year of the branch has been a very successful one. With the energetic and well-known enthusiasm of the members of the new executive, it is confidently expected that the coming year will also be as satisfactory.

CANADIAN SOCIETY OF CIVIL ENGINEERS—PROGRAMME OF WINTER MEETINGS.

Preliminary announcement was made at the October 7th meeting of the Canadian Society of Civil Engineers at Montreal, regarding the proposed programme for the year. The committee on meetings has certainly arranged a most interesting and valuable programme, and in many respects it is probably one of the best that the Society has ever had. A paper on the Cedars Rapids power plant will be presented by Julian C. Smith, manager of the Cedars Rapids Manufacturing and Power Co.; Henry Holgate, consulting engineer; and R. M. Wilson, chief engineer of the Montreal Light, Heat and Power Co. A paper on the Mount Royal Tunnel will be presented by Stephen P. Brown, chief engineer of the Mount Royal Tunnel and Terminal Co.; A. F. Stewart, chief engineer of construction for Mackenzie, Mann & Co.; and W. C. Lancaster, electrical engineer of the tunnel company.

C. M. Morssen, president of the Atlas Construction Co., Montreal, will read a paper on the world's largest reinforced concrete construction. Eugene W. Stern, of New York City, is preparing a paper somewhat along the line of the "Wielder of the Weapon," presented last year by Prof. Haultain. The legal aspects of the engineering profession will be discussed by Geo. H. Montgomery, K.C., of Montreal.

Western work will be well represented in three most interesting papers. A. D. Creer, chief engineer of the Vancouver and Districts Joint Sewerage Board, will read a paper on the Greater Vancouver Sewerage Scheme. The new Winnipeg water supply will be covered by W. G. Chace, chief engineer, and James H. Fuertes, consulting engineer, of the Greater Winnipeg Water District. John G. Sullivan, chief engineer of western lines of the Canadian Pacific Railway Co., will read a paper on the Roger's Pass Tunnel. Interesting papers on street railway electrolysis and a large gas plant will be read, besides which there will be two meetings which will not be open to the public, at which certain engineering features relating to the war will be discussed.

The committee on meetings consists of the chairman, Walter J. Francis, of Montreal; the officers of the various sections of the Society, and the chairman of each branch.

SOME NOTABLE MILITARY PROMOTIONS.

Our readers will be pleased to learn of the following promotions among our engineer-soldiers at the front. :—

Lieut.-Col. C. H. Mitchell, who was placed in command of the intelligence section of a Canadian army division last fall, and later in charge of both the intelligence and operating departments of that division, has recently received the command of the intelligence and operating departments of the entire corps. This is the highest appointment, exclusive of rank, held by a Canadian officer in the Canadian forces at the front.

Capt. T. C. Irving, Jr., who was in command of the 2nd Field Company, Canadian Engineers, at Valcartier, and second in command since the company left Salisbury for active service, has received a well-earned promotion to the rank of major, with command of the 2nd Field Company.

Lieut. N. R. Robertson has been promoted to a captaincy succeeding Major Irving as second in command of the 2nd Field Company.

PERSONAL.

JAMES DUNN has been appointed sanitary inspector for the village of New Toronto.

W. B. STEWART, of Lytton, B.C., has been appointed deputy mining reporter for the Ashcroft mining division.

F. L. McPHERSON, municipal engineer, West Vancouver, has resigned, and has attached himself to the Fifth Garrison Battalion at Victoria.

W. A. MARTIN, late assistant general manager of the Toronto Electric Light Company, has been appointed general manager of the Jefferson Glass Company, Toronto.

H. V. DARDIER and a party of engineers of the Vickers-Maxim Company, of London and Liverpool, are investigating nickel deposits in the neighborhood of Fond du Lac.

A. H. EAGER, shop superintendent at Winnipeg for the Canadian Northern Railway Co., has been elected president of the Western Canada Railway Club. Mr. Louis Kon has been re-elected secretary.

E. S. M. MACNAB, engineer of car lighting for the Canadian Pacific Railway, addressed a meeting of the Canadian Railway Club on October 12th, his subject being "Electric Lighting of Railway Cars."

J. A. D McCURDY, B.A.Sc., director of the Curtiss Aeroplanes and Motors, Limited, and now associated with the Curtiss School of Aviation at Toronto, addressed a general meeting of the Canadian Society of Civil Engineers in Montreal on October 14th, the subject being aviation. Mr. McCurdy's paper was illustrated by lantern slides.

OBITUARY.

It has been announced that G. E. Revell, B.A.Sc., of the First Field Company, Canadian Engineers, was killed in action last June. Mr. Revell, who went to France with the First Canadian Contingent, was a mining engineer residing in Nelson, B.C., prior to enlistment. He graduated from the School of Practical Science, Toronto, in 1899, and was an associate member of the Canadian Society of Civil Engineers.

The death occurred in Toronto last week of Mr. Silas James, many years ago superintendent of roads for York County, and formerly a prominent land surveyor.

The announcement has been made of the death in Flanders of Major A. V. Roy, of the 22nd Canadian Regiment. The deceased was a civil engineer, born in Montreal and for ten years one of the city's harbor commissioners. He represented the province of Quebec at the World's Fair at Chicago in 1903, and had been connected with many important engineering works in Canada and Northern Africa.

COMING MEETINGS.

NATIONAL MUNICIPAL LEAGUE.—Annual convention to be held at Dayton, Ohio, November 17th to 19th. Secretary, Clinton Rogers Woodruff, 705 North American Building, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Annual meeting to be held at New York December 7th to 10th. Secretary, Calvin W. Rice, 29 W. 39th Street, New York.