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The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

BRUSHWOOD AS A MEDIUM FOR SEWAGE FILTERS

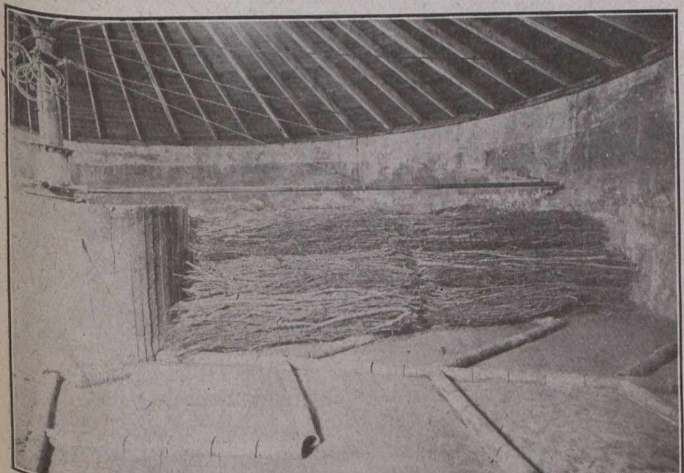
EXPERIMENTS AT NORTH TORONTO USING BRUSHWOOD AND SLAG AS FILTER MEDIA SHOW FORMER TO BE PARTICULARLY SUITABLE FOR INDUCING SLIMY GROWTH AND GIVING PROPER VENTILATION.

By **GEORGE PHELPS, A.M.Can.Soc.C.E.,**
Engineer in Charge of North Toronto Sewers and Disposal Works.

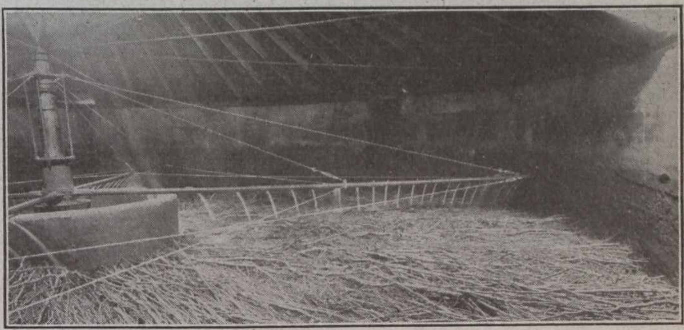
WITHIN the last two or three years, with the activated sludge process of sewage treatment coming so quickly to the front, engineers are beginning to look on the treatment of sewage by filtration as a somewhat slow process, and it seems probable that the filter will eventually be almost entirely discarded as new processes become perfected. In the meantime, filters are doing much good work, and any improvement in their efficiency is a step towards a solution of the sewage treatment problem. That there is room for considerable improvement in the character of medium ordinarily used is shown by the results obtained with an experimental filter, which has been in operation for 2½ years at the North Toronto sewage disposal works.

The sewage of that portion of the city, which was originally the town of North Toronto, is treated separately by disposal works, constructed before the annexation of this district to the city; it is a domestic sewage with practically no trade wastes, roof water being admitted to the sewers, but no other surface drainage.

It was found necessary in the early part of 1914 to clean out and refill some of the filters, and as an experiment, it was decided to use brushwood as a medium in one case, and for a second filter, screened, washed and graded slag, so that the two could be run under similar conditions and a fair comparison made between the results obtained. The depth of the medium in each case was 5 ft. 6 ins., both filters being 50 ft. in diameter, and roofed over. The distributors are of the Adams rotary type. Before reaching the filters, the sewage passes through a coarse screen, detritus tanks and sedimentation tanks, the retention period in the tanks averaging about three hours.



Brushwood Filter Under Construction.



Brushwood Filter in Operation.

The brushwood filter was started on June 3rd, 1914, at an average rate of flow of two million gallons per acre per day, and has been run continuously at varying rates up to the present time, with only a few short stoppages for alterations to the plant, the longest stop being for three days. There is a continuous and fairly constant flow to the filter, the maximum and minimum rate for any day being about 10% above and below the average.

After two months' working, the brushwood had become thickly coated with gray slime and a very satisfactory effluent was obtained, and from that time on, the flow to the filter has been periodically increased up to the present average rate of 7,250,000 gallons per acre per day. The following table shows the average daily rates from the time of starting the filter, *viz.*:—

June to August, 1914	2,000,000	gallons per acre
August to October, 1914	3,000,000	" "
October to November, 1914..	4,000,000	" "
November to December, 1914	4,500,000	" "
December to February, 1915.	5,000,000	" "
February to April, 1915	5,500,000	" "
April to September, 1915 ...	6,000,000	" "
September to July, 1916	6,500,000	" "
July to December, 1916	6,900,000	" "
December, 1916, to date	7,250,000	

The sewage passes through the filter at the present rate as freely as when it was first started. The coating of slime on the brushwood is in a condition of stability where it appears neither to increase nor diminish, and, as there is no sign of clogging, it is probable that the flow may yet be somewhat increased. The most noticeable change which took place was the shrinking of the brushwood, which in a few months settled down until the depth of medium was only about 4 ft. 6 ins. This shrinking apparently stopped after about 18 months working, and

Forming a Mattress.

the brushwood shows no signs as yet of rotting or breaking down.

The slag filter, which has been kept under observation alongside the brushwood, is filled with washed and screened steel slag, graded as follows:—

Bottom,	1 ft. 0 in.,	3-inch to 5-inch slag
Middle,	3 ft. 0 in.,	1½-inch to 3-inch slag
Top,	1 ft. 6 in.,	⅝-inch to 1½-inch slag

It was started at a rate of 1¼ million gallons per acre per day, and worked up to 2½ millions in 6 months; the rate was increased for a short time to 3 millions, but this resulted in clogging and ponding on the surface, and the rate had consequently to be reduced. The effluent from this filter has always been satisfactory, but its capacity is limited to about 2 million gallons per acre per day, the rate at which the sewage will pass through without clogging.

The effluent from both filters contains usually from .1 to .2 cubic centimetre of sediment per litre; this is a fine humus which is settled out by a half-hour retention in tanks; it is liable to increase with sudden rushes of storm water, but is easily got rid of.

Samples of sewage and effluents have been taken regularly five days in the week, until three months ago, since when samples have been taken on only two days in the week. These are always taken between 10 a.m. and 12 noon—about the time of maximum flow. Analyses are made in the laboratory of the Medical Health Department of the city, and the following tables give the average results obtained, *viz.*:—

January to December, 1915.

	Free amm.	Alb. amm.	Putrescibility.	Nitrates.
Tank effluent	12.63	2.83	32	
Brush filter effluent	10.70	1.52	95.7	
Slag filter effluent.	4.13	1.09	98.4	

December, 1915, to May, 1916.

	Free amm.	Alb. amm.	Putrescibility.	Nitrates.
Raw sewage	12.50	3.84	..	2.36
Tank effluent	11.45	3.06	32	2.50
Brush filter effluent	10.59	1.56	90	2.55
Slag filter effluent.	5.37	1.34	98	6.00

May to November, 1916.

	Free amm.	Alb. amm.	Putrescibility.	Nitrates.
Raw sewage	27.6	7.92	..	
Tank effluent	22.3	3.94	35	
Brush filter effluent	16.9	2.41	99.7	
Slag filter effluent.	11.4	2.20	100	

The methylene blue test is used for putrescibility, and value 100 equals stability for 10 days.

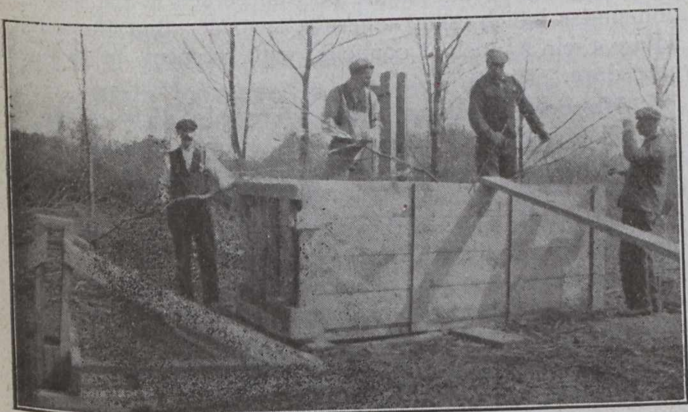
The filter effluents are settled for one-half hour before analysis.

Although the sewage is getting stronger in character, as shown by the average results for the last six-monthly period, the effluent from the brushwood filter is more stable than it previously has been, and the rate of flow at the same time is greater. This seems to indicate that the filter has not yet reached the limit of its capacity. The only tests for nitrates were taken during March and April, 1916. The average results given in the table go to show that nitrates are not formed in the brushwood as readily as in the slag filter, which is no doubt due to the rapidity with which the sewage passes through the brushwood. Unfortunately, this period included the time of the spring thaw, and the sewage was very much diluted. The filter was also taking considerably over 7,000,000 gallons per acre per day for practically the whole of the two months, so that further tests are necessary before a definite opinion can be formed on this point.

The accompanying photographs show the method of making and placing the brushwood mattresses in the filter, also the filter in operation and a section whilst under construction. The floor, as will be seen, is formed with a

Removing Mattress from Press.

slope each way to the under drains. The brushwood is placed in the filter in the form of mattresses of 2 cubic yards each. These were made by filling the brush into a wooden box of the required shape, and pressing it down with a follower on a long lever. The mattresses were wired up whilst under a pressure of about 80 lbs. per square foot, and after this was released the shape was retained and they were easily handled. Witch hazel was found to be the best material for making up, but almost any kind of brush is suitable, provided no dead wood is used. It requires to be cut in the fall or early spring when no leaves are on. The cost of cutting, bundling, hauling about half a mile and placing the brushwood in the filter was $1.20 per cubic yard, a figure much below that for which any ordinary medium could be obtained. The results have been so satisfactory that brushwood as a medium is being used generally at the North Toronto plants, when any filter needs refilling. The open nature



Putting Brushwood Into Press.

of the brush allows good aeration, and it is very efficient when working at a high rate of flow. The rotary distributor also seems well adapted for this type of filter. It gives a good distribution, does not require a great deal of attention and requires only about a foot of head for its operation.

For small installations, particularly where operating charges are of great importance, it may be a long time before the activated sludge process with the introduction of power that it entails, can compare favorably in cost of construction and maintenance with a plant consisting of sedimentation tanks and brushwood filters. Furthermore, an examination of the two processes will show that they are not so different in principle as at first sight they appear to be.

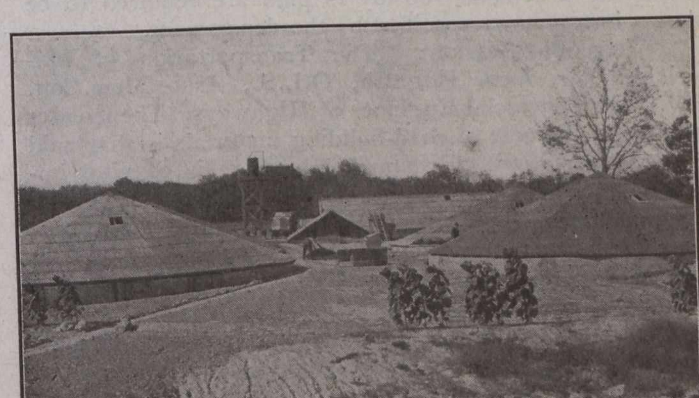
The activated sludge process by the mechanical aeration of sewage induces the growth of organisms on particles of sludge and by a mixing process brings these sludge particles into contact with all parts of the sewage, so accomplishing the process of oxidation and nitrification. The percolating filter accomplishes the same purpose by the reverse process, the organisms being stationary on the medium of the filter and the sewage brought into contact by trickling over the gelatinous substance in which they are contained.

Most recent methods of sewage disposal show that the three main conditions necessary for the effective purification of sewage are: Sufficient aeration, a suitable medium for the growth of nitrifying organisms, which must be brought into intimate contact with all parts of the sewage, and the maintenance of the sewage at a moderate temperature. In the activated sludge process the introduction of the necessary power and machinery for air compressing adds very much to the operating costs, and any process which would automatically maintain the required conditions would naturally recommend itself, provided that the results were satisfactory. The above experiment has shown that the brushwood filter maintains fairly well the conditions set out above, without the introduction of power. Constructed with a good system of underdrains and with a space between the walls of the filter and the brushwood mattresses, the air has very free circulation throughout. The brushwood does not get compacted or lose its spring but keeps quite open, and given proper ventilation, with the falling of a large volume of sewage through the filter, the air contained is constantly being changed.

Brushwood also shows itself to be particularly suitable as a medium for inducing the slimy growth characteristic of sewage filters. The thick coating of this slime over every particle of the brush is in marked contrast to anything that can be seen on a medium such as stone or slag. Regarding temperature, it should be noted that the sewage at the experimental plant does not fall below 40° Fahr. in the winter, and rises to a maximum of 58° Fahr. in the summer; and, as the tanks and filters are all covered, the effluent leaves the plant at about the same temperature as the sewage enters. The temperature of the air at 4 feet above the surface of the filter is noted every day and only occasionally in the coldest weather does it fall as low as 36° Fahr. The temperature of the filter medium can be taken as that of the sewage itself; that it, usually ranging between 40° and 50° Fahr., a favorable working temperature which has probably an important bearing on the efficiency of the filter.

To engineers constructing filters of this type, it is recommended that they be made at least 7 feet deep if possible, and made up to this depth again when the bed has been in work for 12 or 18 months, in which time it will have shrunk down considerably. Nothing has been added to the one described since it was started, not because it is inadvisable, but because it would break the continuity of the experiment. A deeper filter would give the sewage a longer time in contact with the medium and should give better nitrification. A 7-foot deep filter could probably be worked efficiently up to 8 or 9 million gallons per acre per day.

The writer is of the opinion that a brushwood filter would satisfactorily treat raw sewage after passing through a coarse screen and detritus tank, without a preliminary treatment in sedimentation tanks at something approaching the rate of working obtained in the above plant, provided that the effluent were passed through a suitable humus tank, and we hope to be able to continue the experiment along these lines. Such a filter



Filters at North Toronto Sewage Disposal Plant.

might be constructed on a coarse grating over a two-story tank having a deep sludge digestion chamber, free air space being allowed all round, under and above the filter, the sewage falling through the filter directly into the tank. After sewage has been aerated, the suspended solids quickly settle out, and a retention period of one-half hour in the tank should be sufficient to give an effluent fairly free of suspended matter. The sludge and humus would be collected in the same digestion chamber and might be drawn off under hydraulic head in the manner usual with two-story tanks.

The principle of treatment of sewage in sedimentation tanks followed by percolating filters has been criticized on the ground that, during its passage through the sewers aerobic bacteria are developed in the sewage and the process which is started there is reversed in the sedimentation tanks where anaerobic bacteria are developed, to be reversed again in passing through the filters, which is a distinctly aerobic process. The part played by aerobic bacteria in the sewers is open to question, but there is no doubt that the treatment of sewage by filtration after it has passed through sedimentation tanks is a change over from the anaerobic to the aerobic process. A method which would eliminate the first sedimentation tank as here suggested would not be open to this objection, and the removal of what is apparently a check in the process might help towards the attainment of good results.

The brushwood filter described, which has been a decided success, is virtually the outcome of previous experiments with a lath filter originated by Lieut.-Col. G. G. Nasmith, C.M.G. The writer has been in charge of the construction and operation of the filter under Mr. W. R. Worthington, of the sewer section, Department of Works, Toronto, of which Mr. R. C. Harris is the commissioner.

ANNUAL CONFERENCE OF COUNTY ROAD SUPERINTENDENTS OF ONTARIO.

The programme for the next annual conference of county road superintendents of Ontario, the sessions of which will be held in the Parliament Buildings, Toronto, is as follows:—

Tuesday, March 27.—Morning Session: "Departmental Requirements Regarding Annual Returns," Mr. W. Huber, Assoc.Mem.Can.Soc.C.E. Records and annual statements of expenditures on highways towards which the provincial subsidy is paid are required to be shown in a manner specified by the department.

Afternoon Session: "The Transportation of Materials," Mr. Geo. Hogarth, O.L.S., Assoc.Mem.Can. Soc.C.E., Provincial Engineer of Highways. The greater portion of the cost of road-building materials is that paid for transportation. Economical haulage is of vital importance in the reduction of the cost of roads. "Maintaining Earth and Clay Roads," Mr. A. A. Smith. The keeping of unimproved portions of the county road systems in a passable condition is of as great importance as the maintenance of roads after construction.

Wednesday, March 28.—Morning Session: "Highway Bridges," Mr. Geo. Hogarth, O.L.S., Assoc.Mem. Can.Soc.C.E. The department has prepared standard plans and specifications for steel and concrete bridges, which are available for the use of county road superintendents and engineers. "Culverts," Mr. Arthur Sedgwick. There are a number of types of culverts, each being best adapted to certain conditions.

Afternoon Session: "Dust Preventatives and Bituminous Binders," Mr. G. C. Parker, B.A.Sc., Assoc. Mem.Can.Soc.C.E. Dust on a metalled road indicates wear, and its prevention by the use of bituminous materials, properly chosen, results in greater comfort to users of the highways as well as a reduction of maintenance costs. "Important Details in Oiling and Tarring," Mr. W. Huber, Assoc.Mem.Can.Soc,C.E. Expenditure for good materials is wasted if care is not exercised in the preparation of the road surface and the methods of application.

Thursday, March 29.—Morning Session: "The Highways Laws of Ontario," Mr. W. A. McLean, Member Can.Soc.C.E., Deputy Minister of Highways. County road superintendents should be well versed in the legislation under which they operate, in order that they may advise their municipal councils with respect to proper procedure.

Afternoon Session: "Increasing the Safety of Highways," Mr. W. H. Losee, B.Sc. Many accidents could be avoided by the elimination of level railroad crossings or, where that is impossible, the removal of obstacles obstructing the view of those using the roads. "Repairing Gravel and Stone Roads," Mr. R. M. Smith, B.Sc. A thorough system of caring for gravel and stone roads should be adopted immediately following their construction.

Friday, March 30.—Morning Session: "Reducing Construction Costs by Increased Efficiency," Mr. W. Huber, Assoc.Mem.Can.Soc.C.E. Approximately one-half of the cost of a highway is that of labor. The elimination of wasted time and energy is the first step towards lowering the cost of construction.

Afternoon Session: "Roads Foundations and Drains," Mr. R. C. Muir, A.M.Inst.C.E., Assoc.Mem.Can.Soc. C.E. The bearing power of a subgrade depends on the efficiency of the drainage system. The subjects of foundations and drainage are closely allied. "Concrete Roads," Mr. H. S. Van Scoyoc, chief engineer, Toronto-Hamilton Highway Commission. When used in a road surface, concrete is subjected to severe conditions. It is essential, therefore, that only the best materials be used and careful methods of construction be followed.

AMERICAN CONCRETE PIPE ASSOCIATION.

The annual convention of the American Concrete Pipe Association will be held in the Auditorium Hotel, Chicago, on February 12, 13 and 14, 1917.

Among the papers which will be read are the following: "Supporting Strength of Drain Tile in Ditches," by W. J. Schlick, drainage engineer, Iowa State College; "New Drain Tile Specifications of the American Society for Testing Materials," by George P. Diekmann, chief chemist, Northwestern States Portland Cement Co., Mason City, Iowa; "Concrete for Sanitary Sewers," by M. W. Loving, Universal Portland Cement Co.; "Aggregates for Sewer Pipe and Drain Tile," by Prof. Duff A. Abrams, Lewis Institute, Chicago, Ill.

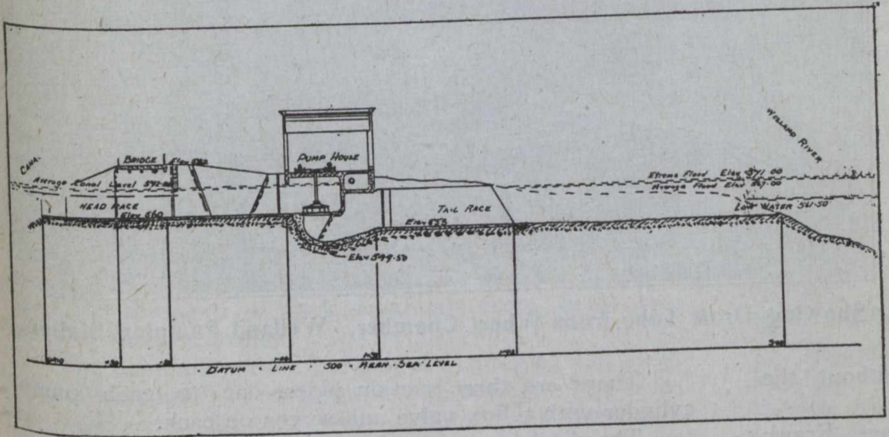
ROLLING STOCK FOR FRENCH RAILWAYS.

According to a French contemporary, the Germans have carried away some 55,000 railway vehicles from France, and in order to make good the shortage orders for new stock have been placed in America and Spain by the Government. The first batch of 5,000 vehicles was ordered at the beginning of 1915, and 3,400 of these are already in service. About 7,000 are being erected in the railway companies' workshops and 200 by private firms, who received the parts and are making the bodywork. Orders have been placed with French firms when they were ready to accept them.

WATERWORKS DEVELOPMENTS, WELLAND, ONTARIO.

By D. T. Black, Town Engineer.

THE commencement of the construction of the large stone aqueduct at Welland, Ont., still in use on the present canal, brought contractors, tradesmen and a large number of laborers to the then quiet county town. The temporary increase in population caused a moderate building boom, introduced new life and a desire amongst the citizens to possess some local improvements employed at that time in other towns.



General Section. New Pumping Station, Welland.

The council of 1887 was a very energetic one, and in the council minutes, three items of importance are recorded; the construction of the first sewer; the erection of several electric arc lamps to replace the old coal oil street lights, and the passing of a by-law by the people for the installation of a water supply.

The first Welland water supply was completed in 1888, and consisted of supply pipe, filter, pumping station, distribution mains, hydrants and some fire hose, at a cost of $48,000.

The filter and pumping station are situated about one-quarter of a mile west from the present canal, and on the south side of the river. The source of supply was from the Welland Canal by means of a 12-inch pipe. The power was water from the government raceway, which passed the site chosen for the pumping station. The tailrace discharged to the river close by.

The supply pipe fed the filter and had a by-pass pipe direct to the pumps. The filter measured 50 feet by 36 feet wide, and the filtering material was sand and graded gravel. The filtered water was collected into a well under pumps.

The pumps consisted of two sets of three plunger pumps each, and received power from two turbine wheels, one for each set of pumps. The headrace water was drawn from the raceway and had wooden racks and a set of stop-logs. The average head of water measured from surface in raceway to surface of river was 9 feet. The turbine wheel gates were controlled from the pump-house. Each set of pumps was alike in design, and were erected by Wm. Kennedy & Sons. One set was rated at a quarter million gallons each plunger, or a total of three-quarters of a million gallons; the other set was rated at a half million gallons each plunger, or one and one-half million gallons each. The power from the wheels was transmitted by steel shafts and gearing and both sets could be operated in conjunction with each other by means of a slip-bolt coupling on the main gear shaft. The pumps were supplied with air vessels, gauges, etc. Three years later, a 50-h.p. engine, fed from two tubular boilers, was erected to assist the pumps when water was low or when frazil ice interfered with the wheels. The wheels and pumps are still used at odd times, but the engine has been out of use for some time past. This plant did good service until 1912, when the new station was completed.

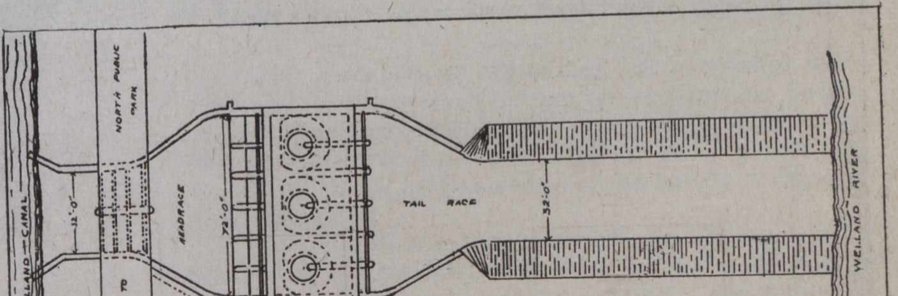
Mr. Wm. Kennedy, Jr., Montreal, designed the new pumping station, and the entire construction was carried through by the town engineer.

The new station is situated on what is known as the Island, a narrow strip of land near the centre of the town, and north of the aqueduct. This strip of land is bounded on the west by the Welland Canal, which supplies the water power and is the source of supply. The east boundary is the Welland River, into which the tailrace water flows. The total cost of the building, machinery and new water mains was $75,000.

The most interesting part of the construction was the concrete foundations and substructure, intricate in design to obtain the maximum power from the head obtainable.

The foundations, walls and floors were 1:3:5 concrete in mass formation, and where reduced in thickness were 1:2:4 reinforced with steel rods. The pump-house floors were 1:2:4 reinforced concrete.

The substructure consisted of penstocks, three wheel chambers and wheel pits. The intake works consisted of two channels each 16 feet wide, 85 feet long, having a bridge roof 20 feet wide. Each channel from bridge floor to channel floor is 22 feet, and has an average depth of 12 feet of water. Each channel is provided with a set of stop-logs and stop-log lifts. The headrace is 72 feet at its widest part. The penstocks are provided with steel



General Plan of New Pumping Station, Welland.

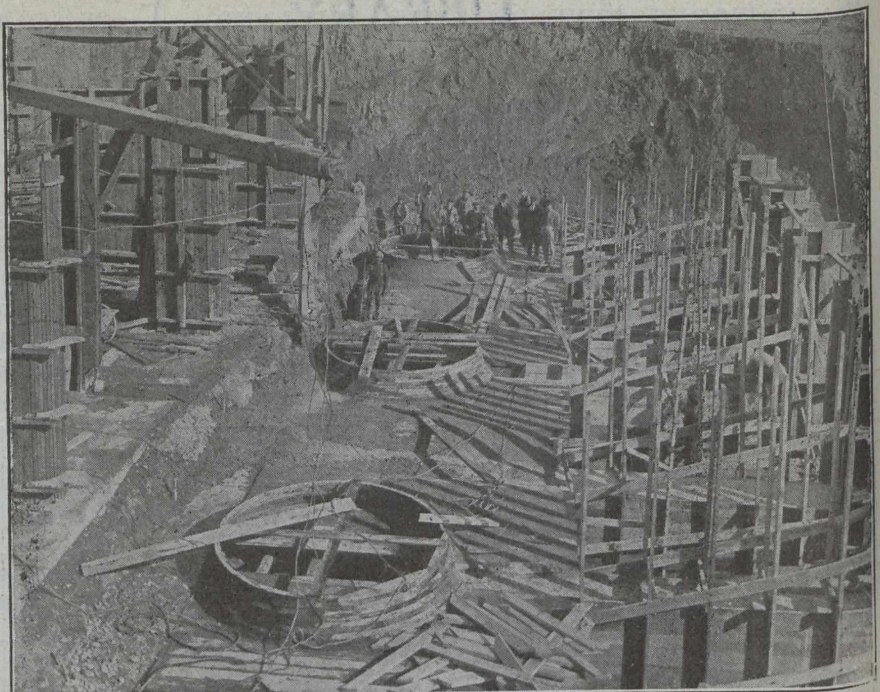
racks and stop-logs. The three wheel chambers are each 22 feet in diameter, and are entirely separate, one for each pumping unit. Stop-logs are provided for emergency between wheel pits and tailrace. The tailrace, also built in concrete, is 135 feet long and 32 feet wide.

The turbine wheel installed for the first unit was manufactured by the Jens Orten-Boving & Co., London. It is rated at 250 brake horse-power, measures about 10 feet in diameter, and under 8 feet head of water, measured from headrace water surface to tailrace water surface, when the wheel is running at 28 revolutions per minute, has ample capacity to work the pumps continuously when they are discharging three million Imperial gallons of water daily against a pressure of 120 lbs. per square inch in the air vessel.

The water-wheel runner and shaft are supported entirely by a bearing on the top of the wheel case, thus doing away with the necessity of cross-arms and foot steps beneath the runner. The hand-operated water-wheel gate moving apparatus has a graduated indicator showing the percentage of total gate opening and the number of square inches the gates are open.

There are three horizontal single-acting, outside packed plunger pumps; the bed plates of which are connected together; placed around the top of the turbine shaft at angles of 120 degrees each between the pumps. The pump plungers are driven by three connecting rods, directly connected to one crank on top of the 8⅝ inches diameter turbine shaft. Securing the advantages of three throw plunger pumps without the friction losses of gears and cost of up-keep.

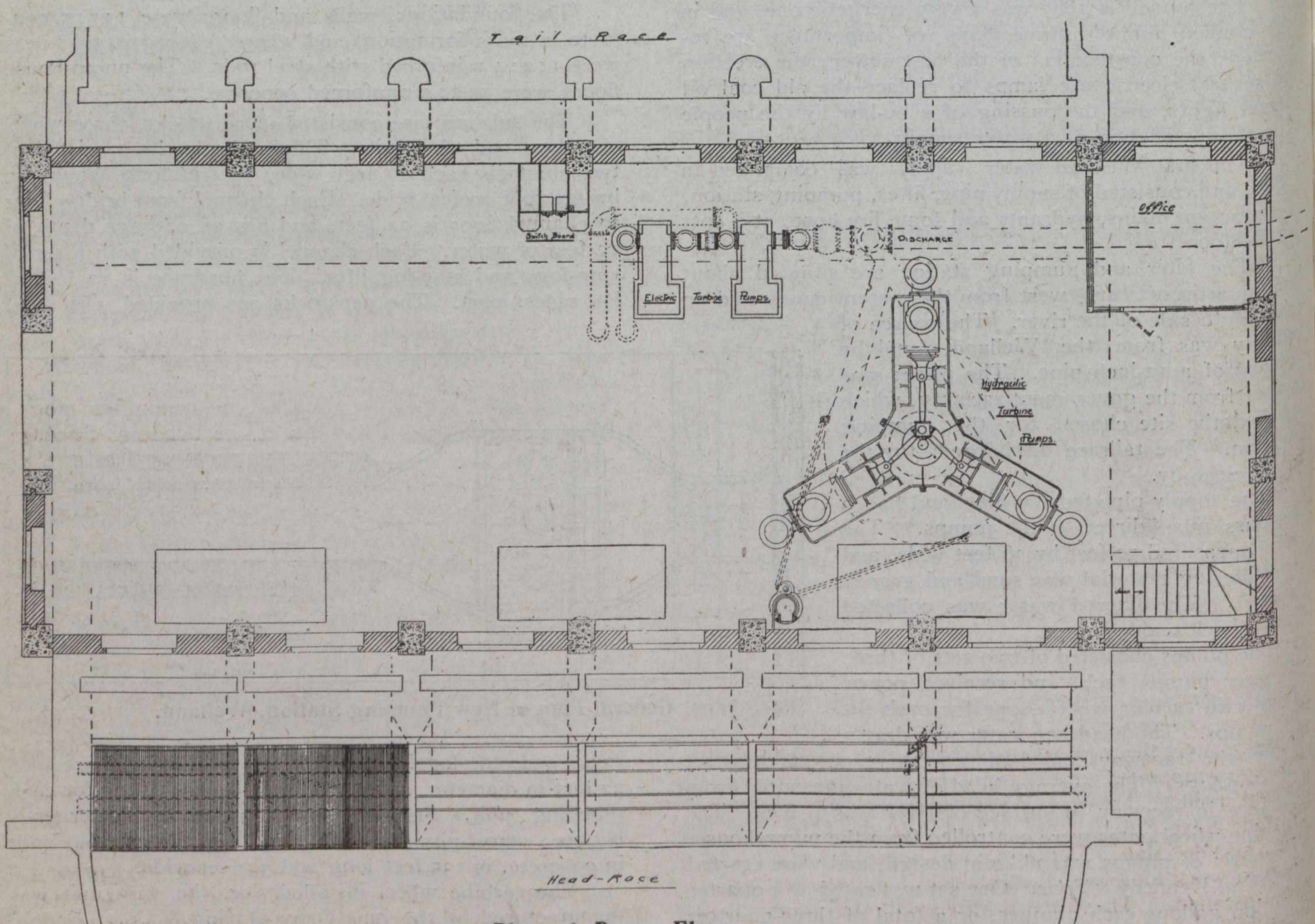
The pumps were manufactured by Messrs. Frank Pearn Co., Limited, Manchester, England.



Showing Draft Tube from Wheel Chamber, Welland Pumping Station.

There are three suction pipes, one to each pump cylinder with reflux valve and screen on each.

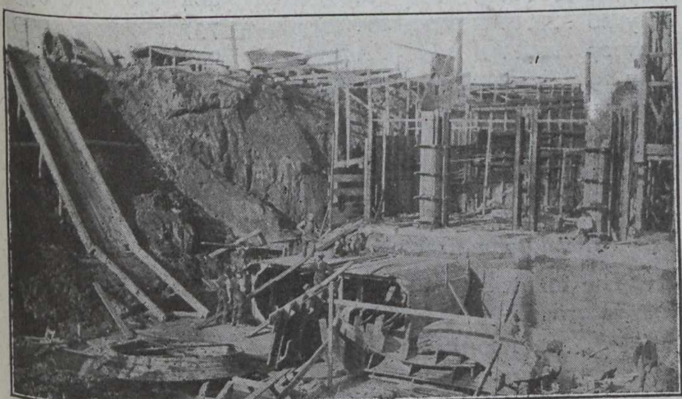
The discharge pipes from the three pumps are connected to one pipe with an air vessel at the junction.



Plan of Pump Floor.

These pipes have a stop valve between the air vessel and main discharge pipe to the town main.

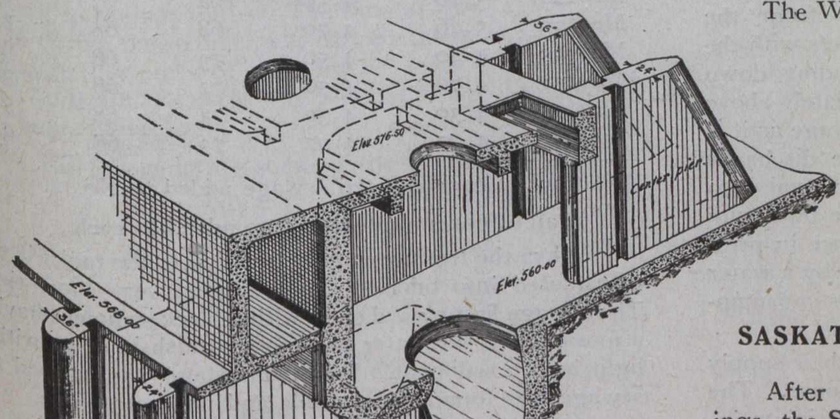
The pumps are fitted with glass water gauges, pressure gauges, revolution counter, etc. The whole forms one complete unit, with provisions for two other



Showing Wheel-Pit Forms, Welland Pumping Station.

units, so arranged to work separately from, or in conjunction with each other.

The pumping station building measures 93 feet long, 38 feet wide and 23 feet from floor to ceiling. The walls are faced externally with No. 1 Milton brick, internally with white enamelled brick 6 feet above the floor and light buff brick to ceiling. The roof is flat of double construction, with air space. The outer roof is constructed



Perspective Sketch Through Substructure Section. Taken Immediately in Front of New Pier.

of timber covered with 3-ply Brantford roofing felt and tar and gravel; the inner roof is 6 inches thick of reinforced concrete, supported on heavy I-beams, and smoothly finished inside. The windows are 11 ft. 6 ins. by 4 ft. 6 ins., and have Finestra steel sashes; the window sills are grey marble slabs. A 10-ton hand-operated travelling crane to work longitudinally the length of the building was installed. The office is fitted with telephone, fire alarm bell and loud pump pressure alarm bell. The station was completed early in 1912. In 1914 the Turbine Equipment Co., Limited, Toronto, were given the contract to erect two additional electrically driven centrifugal pumps to relieve the water power pumps during trouble with frazil ice, and assist the pressure at other times. This installation consists of two separate pumps to work separately or in conjunction with each other and also in conjunction with water power pumps.

The pumps are De Laval, single-stage, double-action centrifugal, and are rated to deliver 2½ million gallons each in 24 hours, at a speed of 1,890 revolutions per minute, against a pressure of 70 lbs. and when working in series against a pressure of 110 lbs. Each pump and motor is mounted on one box bed and connected with a forged steel shaft and flexible coupling. The impellers are of the enclosed double-suction type of the non-overloading design and each as well as the protecting rings are made of government bronze. The suction pipes have a suction head of 15 feet and receive supply from the wheel chamber for No. 2 unit. The discharge pipes are connected together, and fitted with a complete set of valves for separate control; the necessary pressure gauges, etc., complete.

The motors are spiral cage, Canadian Crocker-Wheeler, 125 brake horse-power each, 2,200 volts, 60-cycle, 3-phase, 1,890 r.p.m. with switch-board complete.

The total water mains laid up to 1916 within the corporation limits was 25¾ miles, from 4-inch diameter to 16-inch diameter, with an extra 1½ miles outside the town limits. During 1916, 731,174,560 Imperial gallons were pumped. This large quantity is accounted for by the heavy consumption in the steel plants, which chiefly form Welland's industries.

The Welland Water Commission was formed in 1908, and took control of the waterworks which previously was managed by a committee of the town council. Since the formation of the commission Mr. Robert Cooper has been returned continuously as the chairman, and is deeply interested in the development of the system. The superintendent is Mr. F. D. Milo.

SASKATCHEWAN DIVISION, CAN. SOC. C. E.

After a number of organizing and committee meetings, the Saskatchewan Division of the Canadian Society of Civil Engineers was formed at a meeting held in the city commissioner's office at Regina, January 30th, the branch to include every member of the society residing in Saskatchewan.

A list of officers was presented by the nominating committee, to be submitted by letter ballot, which will be voted upon at the next regular meeting. The following are the nominations: For chairman, L. A. Thornton, Regina; vice-chairman, G. D. Mackie, Moose Jaw; executive committee, H. S. Carpenter and E. G. Montgomery, Regina, T. C. MacNabb, Moose Jaw, Prof. A. R. Greig and C. J. Yorath, Saskatoon; secretary-treasurer, J. N. deStein, Regina.

Besides the regular meetings, a large summer meeting will be held alternately in the various centres of the province, for this year Saskatoon having been chosen.

An advisory Board will be nominated to represent each branch of the engineering profession in the province. This board will give professional advice to members requiring such and will also report to the council in all matters where the standing of the profession is involved.

NOTES ON EXPERIMENTS WITH ACTIVATED SLUDGE PROCESS AT REGINA.

By J. Russell Ellis, Acting City Engineer.

THE reasons for instituting the experiments were as follows: (1) To establish the practicability of the process under our local conditions; (2) to obtain data which could be applied in the design of a large scale plant if it should be considered feasible to proceed to this extent.

In May, 1915, the work was started by erecting two galvanized iron cylindrical tanks each 4 ft. 6 ins. in diameter by 5 ft. 10 ins. high in the city power house. The capacity of each tank when filled is 92.72 cu. ft., or 577.8 Imperial gallons. A small pump, an air compressor and an air tank were secured. Experimental tank No. 1 was filled up as follows:—

A 1-in. galvanized iron pipe leads from the compressed air tank to the tank No. 1, but before entering this branches into three ½-in. pipes. One of these branches is carried down inside the tank and across the bottom to a dead end. The other two are carried down one side of the tank, across the bottom, up the other side and back across at the top, being connected to form complete circuits. At the bottom of the tanks the pipes are perforated and covered over with canvas, as shown in the drawing. In the 1-in. air supply pipe a ⅜-in. orifice is inserted, the difference in pressure on the two sides of which is measured by the connected water gauge, and from the gauge readings the consumption of air is readily calculated.

In tank No. 2 the pump draws sewage from the bottom of the tank through a pipe which connects with the tank, and discharges it through a pipe leading down through the top of the tank and ending immediately above a galvanized iron cone, which disperses the sewage as it is discharged. An air injector is formed in the discharge pipe just above the tank by reducing the sectional area of the pipe and connecting this section of the pipe with an air orifice of ⅜ in. diameter. The difference in pressure on the two sides of this orifice is indicated by a water gauge connected to the orifice pipe and the air consumption is calculated from the gauge readings.

Sewage is supplied to both tanks through a supply pipe connected to a force main in the pump-house. The effluent is siphoned from the tanks through a siphon installed in each tank, as indicated on the plan.

Tank No. 1 was placed in operation on May 18th and tank No. 2 May 20th, 1915. After a short period of operation, chemical tests revealed results as follows:—

	Free Ammonia Raw Sewage	Free Ammonia Tank 1	Free Ammonia Tank 2	Albuminoid Ammonia Raw Sewage	Albuminoid Ammonia Tank 1	Albuminoid Ammonia Tank 2	Nitrites Raw Sewage	Nitrites Tank 1	Nitrites Tank 2	Nitrates Raw Sewage	Nitrates Tank 1	Nitrates Tank 2	Oxygen Consumed Tank 1	Oxygen Consumed Tank 2
May 22-26	....	7.69	6.50	....	2.84	1.026	....	0.990	0.495	....	0.485	0.980	....	....
May 31 ...	1.009	....	....	16.03	....	....	....	....	....	0.23	4.32	8.98	....	....
June 1	....	....	....	....	trace	trace	....	....	....	....	6.72	8.98	0.75	0.80
June 7	....	....	....	....	....	....	....	....	....	....	8.20	8.98	....	....

All quantities are given in parts per 100,000.

In addition to these tests the chemist made several observations to determine the relative amount of mineral salts by measuring the electrical conductivity of the sewage. The average conductivity of the city water as previously determined was stated to be 0.0000406 (not absolute measure). The observations on the sewage showed the following results:—

	Raw sewage.	Tank No. 1.	Tank No. 2.
May 17	0.0000432	.....	.....
May 22	435	0.0000460	0.0000509
May 24	...	464	659
May 26	...	737	903
May 27	...	940	1186
May 29	...	1160	1334
May 31	...	1165	1250
June 1	...	1249	1255

The difference in the results from the two tanks is due to the continued circulation of the sewage in tank No. 2 developing greater heat than the other tank.

The following data in connection with the operation was recorded:—

	Quantity of air in cu. ft. per min. Tank 1.	Tank 2.	Air.	Temperatures, in degrees Fahr. Tank 1.	Tank 2.
May 18 ..	3.96	....	55	48	..
May 19 ..	3.60	....	56	52	..
May 20 ..	4.40	....	66	55	58
May 21 ..	4.40	5.08	66	57	76
*May 22 ..	4.47	5.08	69	60	84
May 23 ..	5.18	5.76	72	60	90
May 24 ..	5.08	5.08	70	61	92
†May 25 ..	4.30	2.72	69	67	87
†May 26 ..	4.90	4.07	62	67	83
†May 27 ..	4.90	4.50	67	67	87
May 28 ..	5.26	4.50	64	67	87
May 29 ..	5.26	4.70	68	68	87
May 30 ..	4.40	4.50	73	68	86
†May 31 ..	4.70	4.30	72	68	87
June 1 ...	4.30	4.30	74	68	87
June 2 ...	4.07	4.07	73	68	85

*Pail of concentrated sewage added to No. 2.

†Pail of concentrated sewage added to each.

When the fresh sewage was added to the tanks it was transmuted into odorless matters in a very short time. The sewage first turned clear with a black sediment having a mossy odor, and later became brownish in color with a light brown sediment. When this stage was reached the sewage was found to be stable and non-putrescible.

After the foregoing series of tests the experimental plant was transferred to the sewage disposal works, and re-erected in the pump-house there. It was then operated by the regular attendants, the tanks being filled and drawn during cycles of about six hours. This was continued for several months, and the results appeared to be highly satisfactory.

Near the end of the year it became necessary to re-arrange the apparatus, and change the motor driving the pump and air compressor. After this lapse the tanks were cleaned out and the experiments started again. Beginning January 12, 1916, operation was begun on a twelve-hour cycle; *i.e.*, ten hours for aeration, and two hours for settling, drawing and filling. It was planned to gradually reduce this time as the sludge deposit increased until the minimum period required for obtaining the desired purification was found. The air pressures, volumes of sewage treated, temperatures of sewage before and after each filling and the room temperature were recorded. During January and February the room temperature ranged from 38 degrees to 46 degrees, the temperature of the fresh sewage entering the tanks from 46 degrees to 50 degrees and the temperature after aeration from 40 degrees to 47 degrees, showing an average loss of 7 degrees in tank No. 1 and 6.3 degrees in tank No. 2 during the aeration period.

The tanks were operated continuously from January 12th to February 15th, being then closed down till February 20th for repairs to pump and motor. Tank No. 1 was in operation from February 20th to March 2nd, and tank No. 2 from February 20th to February 25th. Both tanks were operated from March 13th to April 24th, from April 27th to May 5th and from May 13th to June 5th. The idle periods were due to the adjustments and repairs required to the apparatus. The time of the staff during the summer was entirely taken up with the press of the summer work. On April 5th the cycle was reduced from 12 hours to 10 hours.

The following are some of the results noted:—

	Percentage of sludge.	
	Tank 1.	Tank 2.
March 2	8.6%	3.9%
March 10	8.5%	...
March 31	13.8%	10.5%

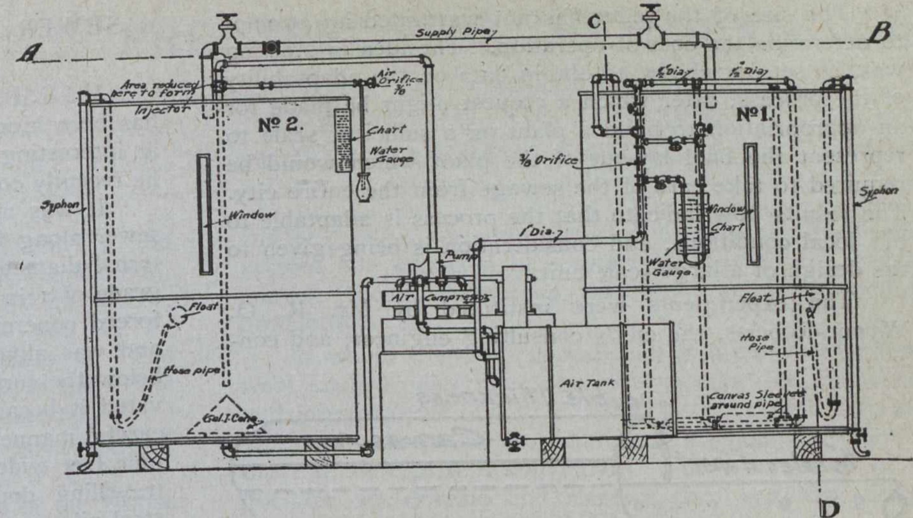
Chemical Tests.

Raw Sewage.

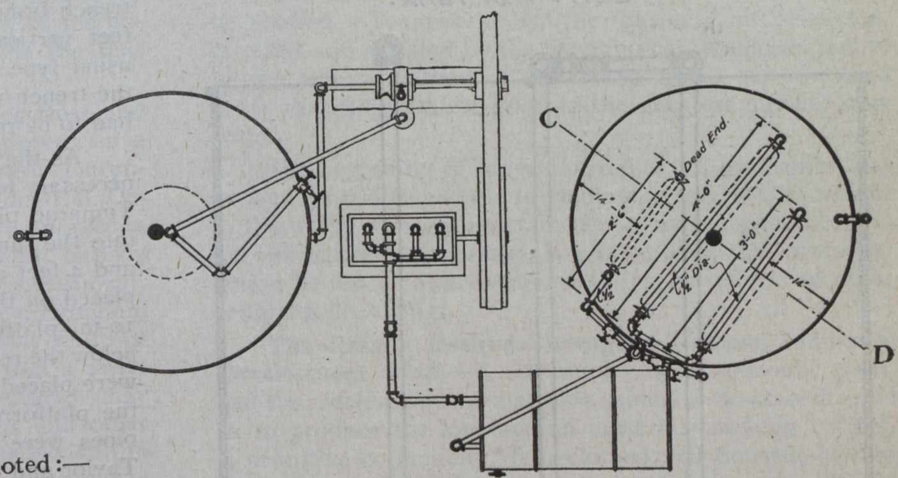
	Oxygen absorbed, in pts. per 100,000.	Nitrites, in parts per 100,000.	Nitrates, in parts per 100,000.
February 5	3.0	none	none
February 7	2.4	none	none
February 10	3.5	none	no test
February 11	3.0	none	no test
March 29	3.7	none	none
April 4	3.0	none	0.7

Effluent from Tank No. 1.

	Oxygen absorbed, in pts. per 100,000.	Nitrites, in parts per 100,000.	Nitrates, in parts per 100,000.
February 5	1.1	.1	.3
February 7	1.1	.3	.4
February 10	1.2	.3	no test
February 11	1.2	.1	no test
March 29	2.0	0.5	0.5
April 4	1.2	0.8	0.5



Elevation.



Section at A.B.

Effluent from Tank No. 2.

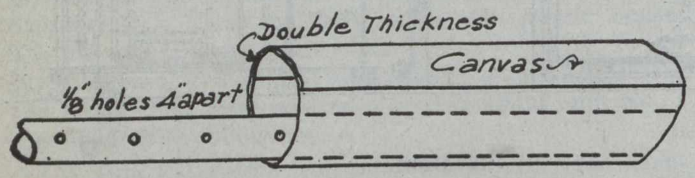
	Oxygen absorbed, in pts. per 100,000.	Nitrites, in parts per 100,000.	Nitrates, in parts per 100,000.
February 5	1.3	.1	.5
February 7	1.2	.3	.3
February 10	1.2	.2	no test
February 11	1.3	.2	no test
March 29	1.5	.7	.8
April 4	1.5	.8	.8

Relative Stability, in Days.

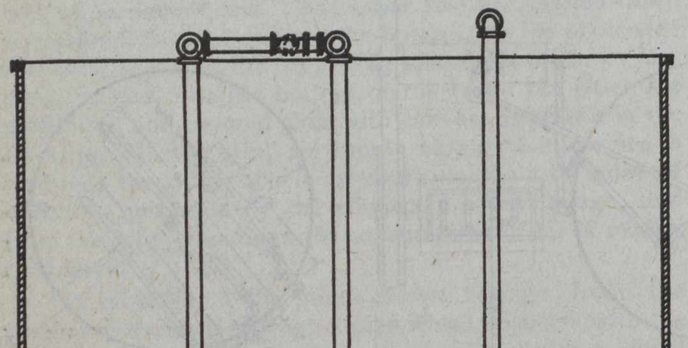
	Tank No. 1.	Tank No. 2.
February 5	4	3.9
February 12	10	3.2
February 29	5.3	...
March 2	3.3	...
March 14	1.9	2.0
March 15	5.0	2.7
April 1	...	1.7
April 17	2.6	2.6
April 18	2.8	2.8

The size of the plant has not warranted an attempt to determine the cost of operation. The idea in starting was, as set out above, to obtain data on the adaptability of the process, after which a request might be made for an appropriation to build a plant on a sufficient scale to represent the final lay-out of the plant which would be required to take care of the sewage from the entire city. The results now indicate that the process is adaptable to our local conditions, and consideration is being given to the design of a large scale unit.

The experiments were instituted by Mr. R. O. Wynne-Roberts, the city's consulting engineer, and conducted by him up to June 1st, 1915. Mr. Wynne-Roberts was assisted by Messrs. Andrews and Cruikshanks, chemists. During June and July, 1915, the work was in charge of Mr. F. McArthur, city engineer, and since August 1st, 1915, has been handled by Mr. J. Russell Ellis, acting city engineer, assisted by Mr. D. A. R. McCannel, assistant sewerage engineer.



Detail of Pipe & Canvas Cover at Bottom of Tank.



Section at C.D.

The expenditure of the Dominion Public Works Department during the fiscal year 1915-16 amounted to $19,539,298, a decrease of about ten millions compared with 1914-15.

SEWER CONSTRUCTION IN QUICKSAND.

Mr. R. H. Parsons, the city engineer of Peterborough, has been kind enough to furnish information concerning an interesting bit of sewer construction in wet sand, which he recently completed.

It was necessary to lay about 7,100 lineal feet of sewer along King, George and Park Streets, having internal diameters of 33, 30 and 24 inches with a general grade of 1 in 1,200. The two larger pipe were reinforced concrete tile pipe. The ground was nearly level and was almost entirely sand, with water at eight feet below the surface. Immediately the wet sand was excavated it became quick and required to be handled in a careful manner. The trench in the dry ground was about nine feet wide, with a rail laid on either side to carry a travelling double pile-driver. Lackawanna interlocking steel piles 12 feet long were driven into the sand on each side of the open trench, leaving about 6 feet clearance between. These were held in place as the wet sand was removed by hand, by 3-in. x 12-in. elm walings and screw-trench braces placed every 4 or 5 feet horizontally and 4 feet vertically. The dry trench was shored up by the usual type of waling and struts. The average depth of the trench was about 15 feet, consequently the quicksand had to be removed to a depth of about 8 feet.

As the quicksand would not carry any weight it was necessary to adopt a special method of sewer construction. Tamarac piles 4 to 5½ inches in diameter were driven into the sand 4 to 10 feet, and 6 feet apart longitudinally and 4 feet apart transversed. Caps 2 ins. x 10 ins. were placed on the parallel row of piles and on the caps 2-in. x 10-in. platform lumber. The platform was a few inches below the required invert level of the sewer. Rough boards were placed on either side of the trench and on these and the platform was placed 1 : 2½ : 5 concrete. The sewer pipes were cast in moulds on the surface by Messrs. Taylor and Hall and the concrete was composed of 1 : 2 : 3, reinforced with triangular mesh 4 ins. x 4 ins.—half a pound of metal to the square foot placed in position to take up tensile stresses. These pipes were 3 feet long.

The reinforced concrete pipe were carefully set on the concrete in the required position and the space between the external sides and the trench boards filled in with concrete with a splayed finish. The exposed parts of the joints were grouted with cement and covered with a layer of rich mortar.

Pile-driving was a slow work as it took as many as 150 blows of the hammer to cause the pile to sink 12 feet. Water jet and steam jet were tried to facilitate the driving but they were found of little use. The cost of labor and fuel for pile-driving amounted to an average of about 55 cents per lineal foot forward, whilst the excavation, piling, drawing piles, laying the pipes and refilling, cost about $6 per foot run. The total cost of the work, including everything, amounted to about $12.61 per foot run.

The pile-driving was done by a pair of hammers operated on a double derrick and from a compound drum, so that there was no changing from side to side. The derrick straddled the trench and ran on rails. The equipment for extracting the piles consisted of a rolled steel joist resting on a frame on each side of the trench and on the joist there was placed a 10-ton chain block which could be moved from side to side as required.

Pumping had to be carried on by means of a 3-inch centrifugal pump driven by a 10-h.p. electric motor. Power lines were attached to temporary poles set along the route.

NATIONAL INDUSTRIAL PREPAREDNESS MEMORANDUM

TEXT OF A DEVELOPMENT PLAN CALLING FOR THE FORMATION OF A PERMANENT CONSULTING BOARD—SUBMITTED TO THE GOVERNMENT VOLUNTARILY BY FIVE PROMINENT CANADIAN ENGINEERS

SIR CHARLES ROSS, M.Am.Soc.Mech.E., and head of the Ross Rifle Co.; Prof. C. H. McLeod, secretary of the Canadian Society of Civil Engineers; and R. A. Ross, Walter J. Francis and H. R. Safford, councillors of the Canadian Society of Civil Engineers, voluntarily forwarded, last April, to the Prime Minister a memorandum on industrial preparedness.

Acknowledgment of the memorandum was received, but nothing further was heard concerning it until Sir Wilfrid Laurier requested that it be tabled in the House last week, along with other communications from the Canadian Society of Civil Engineers or members thereof. Now that the document has been "brought down" publicly, *The Canadian Engineer* feels at liberty to publish it, as it will undoubtedly interest all members of the engineering profession in Canada. Following is the text of the letter of transmissal:—

"Acting on the suggestions of Sir Charles Ross and subsequent discussions, the undersigned engineers have the honor to transmit for your consideration a memorandum of their views regarding a National Industrial Development Plan for the Dominion. While we appreciate that this highly important matter has, no doubt, already received much careful consideration by the Government, nevertheless we sincerely trust that this memorandum may prove of service to you, and that you may find our suggestions acceptable. We submit them from a sense of patriotic duty and because we believe that Canada may well follow the example of the United States and other countries in calling upon engineers and scientists to render assistance, not only in these critical times, but in those which will succeed the war."

The accompanying memorandum was as follows:—

The Necessity for a National Industrial Development Plan.—The history of any community or country is a record of the cycles of dynastic, economic or industrial change, the period of change in each instance being marked by a pause in the established order of progress.

The Dominion of Canada in common with the rest of the civilized world is at this time experiencing an interruption in its course of rapid development. Her position today may be likened to that of an industrial enterprise which has been financed and made ready to operate, and which has reached the time when dividends must be earned upon the expended capital before further capital is obtainable for increasing the equipment. In such a case prudent foresight dictates the taking of stock and the organizing of the enterprises along lines which will ensure co-operation among the different departments with a view to the largest possible production.

In this country the Government, through its various activities, has taken stock to some extent of our land, forest and mineral resources, and has in a degree also interested itself in investigations of the manufacture of certain products, such as steel and paper.

The curtailment of imports and the increasing demands resulting from the present war has compelled Canada to depend upon and to develop a number of her own resources. Zinc, for example, heretofore largely produced abroad, is now being smelted in this country, and magnesite, formerly imported, is now being mined, utilized and exported in considerable quantities. Phosphates, recently discovered, may later be added to our productions.

It would therefore appear that if a concerted effort were made to determine our requirements for domestic and foreign trade and to investigate the results from an economic standpoint, the country as a whole and our industrial enterprises individually would be placed in a position to develop and increase their activities along logical lines within the limits of known resources.

A knowledge of the mere existence of raw materials is insufficient. It is essential that their character, best uses and final fabrication into marketable products should be studied. Teamwork by the business interests, led, directed and assisted by the Government, would appear to be the proper method of systematizing all our forces in order that the greatest good to the greatest number may result.

The beginning of a cycle of industrial production has arrived, and if Canada is to increase her industrial weight in the world or even maintain her relative importance and her normal rate of increase, it is imperative that concerted action be taken towards co-ordinating her efforts as other countries are doing.

The Results Desired Through a National Industrial Development Plan.—A community is an economic unit, and the mechanisms of that unit should be so co-ordinated as to produce the largest and most far-reaching results. A primitive community, fed, clothed and housed, having no further necessities is an agricultural state only. Rapid increase of population and urban concentration demand the creation and development of new mechanisms to provide food, clothing and habitations. Industrial enterprises must be created to support the population. Means of communication and transportation must also be established for the handling of either raw or manufactured products among the various groups and between the point of production and the transportation outlets of the country. There will, therefore, immediately spring up a demand for products other than bare necessities. As everything is derived from the earth, two questions arise, the first being whether or not the additional products can be obtained economically from the resources of the country, and the second whether or not these additional products may be economically turned into finished products within the country. The correct answers to these questions demand close study on the part of the most scientifically trained minds.

At the present time the industrial enterprises of the country are working individually, each towards its own end, without being mobilized for efficient production from a national standpoint. It is obvious that systematic co-operation of the various enterprises will result in benefit to the country as a whole.

We are of the opinion that information regarding the resources of the country and the results of the study of the economics of the industrial situation should be made and rendered available to the public. If this were done, present undertakings would benefit and many new enterprises would spring up with a reasonable prospect of success. The Government is the only organization which can properly co-ordinate, instruct and give direction to the activities of the country. If furnished with properly ascertained facts and with co-ordinated Government guidance, no industry, whether established or newly formed, can fail to benefit itself and the whole community.

To be more specific, we mention a number of points which will doubtless arise for consideration in the working out of a national development plan.

(*a*) The gathering of statistics of the products of the country as regards both quality and quantity, the conditions of production or growth, the cost of production and the cost of marketing.

(*b*) An investigation as to the possibility of the economic production of any article of commercial importance not now manufactured, mined or grown in Canada.

(*c*) The most profitable methods of manufacture or growth of present or future products, and the increase of output. This involves provision for research, trade schools, and the intimate personal training of the farming community by means of model farms and otherwise.

(*d*) Complete information regarding the most advantageous markets, a point which involves full study of the problems of transportation.

The results which should flow from this work are,—

(1) More complete utilization of the national resources of the country,

(2) The general introduction of more scientific and commercially profitable methods of production,

(3) An increase in production by reason of the improved methods and widened fields of operation, and

(4) A reduction in cost to the consumer through the elimination of unnecessary handling and improvement in transportation.

A Suggested Method of Procedure to Obtain the Necessary Information for the Establishment of a Policy.—It is a well-established fact that the material development of modern civilization is in the hands of the engineer and the chemist.

The necessity for a national industrial development plan and the results desired therefrom have been fully recognized by other nations. It is needless at the present time to refer to the fact that Germany recognized the need very early, and had long since begun to reap the results the German Government desired. The economic and military preparedness of Germany has indicated to the rest of the world not only the advisability but the absolute necessity of scientific handling of the economic resources and forces of the community.

Spurred on by recent events, Great Britain, France and the United States of America have each in its own way seriously taken up the subject,—one of the most important of the present day. The war over, competition will be unprecedented. With Europe impoverished as a result of the struggle her immediate need will be employment for the industrial population in order not only to prevent starvation in the industrial ranks, but as far as possible to regain the lost wealth and to recover the lost trade.

Although affected favorably rather than otherwise by the present situation, the United States recognizes the above facts and realizes that future competition is something which may only be met by the most thorough preparation. The Americans have therefore taken up the question of national preparedness and have appointed what is known as the Naval Consulting Board, consisting of representatives nominated by the great engineering and scientific bodies of the United States, namely,—American Society of Civil Engineers, American Institute of Electrical Engineers, The American Society of Mechanical Engineers, American Institute of Mining Engineers, American Chemical Society, American Electrochemical Society, American Mathematical Society, American Aeronautical Society, The Investors' Guild, The American Society of Automobile Engineers and American Society of Aeronautic Engineers.

Originally the Naval Consulting Board was intended to act in an advisory capacity with regard to naval affairs only, but its activities have since its organization been extended to include the investigation of the industrial resources of the country with a view to advising on a national policy therefor. It is interesting to note that practically the first recommendation made by this body was for the establishing of a national laboratory devoted to the solving of problems in chemistry, metallurgy, aeronautics, electricity and kindred subjects, and the placing of the information so obtained at the disposal of the community.

The recommendation for a national laboratory was made notwithstanding the fact that the Bureau of Standards of the United States, already established about fifteen years and quite broad in its field of action, has been doing excellent work and rendering valuable service to all classes of the community. In making the recommendation the Naval Consulting Board doubtless had in mind the development of equipment especially suited to the requirements of the army and the navy on such a scale as would demonstrate results before attempting commercial manufacture. By this course all new developments in guns, aeroplane engines and the like may be thoroughly tried out before the placing of large contracts by the Government.

The organization of the Naval Consulting Board has placed the scientific and technical talent of the country at the disposal of the United States without cost for professional service.

The French Republic has organized a civilian board similar to the United States Naval Consulting Board and has raised it to the dignity of a ministry (Le Ministere des Inventions). Great Britain has also enlisted the services of a board of civilian scientists and technologists with a view to the utmost development of the nation's industries for the prosecution of the war.

In view of the action of the United States, France and Great Britain, we are not suggesting a new or untried principle. This is further confirmed by the bibliography attached hereto. If engineering may be turned to the advantage of the country, we conceive it to be our duty to respectfully suggest that an invitation to co-operate be extended to the engineering and scientific societies in order that they may be in a position to render an official service to the Dominion.

The Government of the United States in appointing the Naval Consulting Board, selected engineers who have wide knowledge of engineering economics, thereby admitting that many of the problems of the industrial community are both scientific and economic in their nature. It was recognized also that the Government of the United States itself could not meet a situation of this kind through its own bureaux since they are lacking in that contact with commercial conditions which is the essence of the case. Further, no mobilization of industrial organizations could be expected from the interested business enterprises acting apart from the Government. In other words, it was recognized that between the Government and industry there was required a body commanding the respect of both and recognized as authoritative by reason not only of its scientific attainments but also by reason of its disinterestedness. Under these conditions the Government of the United States naturally turned to the engineering and scientific societies as being the only group from which could be expected the necessary technical and economic knowledge coupled with freedom from the rivalries of the commercial world.

We are therefore encouraged to express the opinion that the Canadian Government cannot do better than address the engineering and scientific societies of Canada, inviting them to appoint from their number representatives whose advice would be at all times available to the Government. We feel sure that the engineers and scientists in Canada have as much public spirit as their professional brethren in the United States, and that a properly authorized consulting board of engineers would draw to itself the best talent in the country, and that without remuneration.

Following this idea, we venture to express the view that the necessities of the immediate present at least might be met by selecting representatives of the civil, mechanical, electrical, mining and chemical engineers.

There is in Canada one engineering organization, namely, the Canadian Society of Civil Engineers, which embraces all branches of engineering and may be taken to correspond largely to the five great scientific bodies from which the Government of the United States selected the great part of its Naval Consulting Board. There are in addition two other organizations of less magnitude and which include in their membership a number who are also members of the Canadian Society of Civil Engineers. These two are The Canadian Mining Institute and The Society of Chemical Industry. The Royal Society of Canada may also be considered a scientific society, but the great majority of its members are devoted to philosophy and literature. The accompanying chart indicates the number of fully qualified technical men in each of the organizations named.

In order that our view may be either confirmed or modified, we beg to suggest that the Government call prominent members of the industrial, engineering and scientific communities into its counsel and question them as to the necessities of the case and the best methods of procedure.

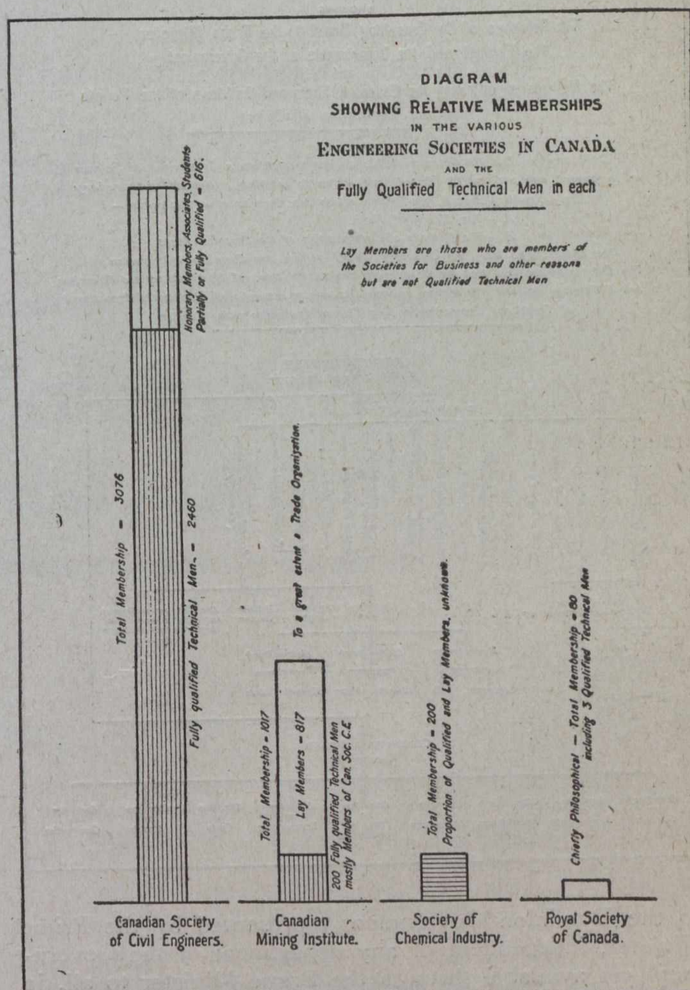
The Formation of a Permanent Consulting Board.—Assuming that the results of the investigation made along the suggested lines have been favorably considered by the Government and found acceptable in a broad way to all parties, it becomes pertinent to indicate the possible organization and power of such a body.

The introduction of a consulting board into the mechanism of government should not result in any upsetting or changing of the present Government organizations. On the contrary, the Consulting Board should be supplementary to and independent of the executive and be free to act either in the interest of any individual department of the Government or in the interest of the Government as regards its general policy in relation to industrial development.

Possibly the Government may later consider it advisable to establish a "Ministry of Industrial Development" or a "Ministry of Science," but if so this does not in any way affect the principle of the present suggestion. We have attached hereto a diagram indicating our ideas of the function of the permanent Consulting Board and its relation to the Prime Minister.

We trust we may be pardoned for suggesting that the personnel of the Permanent Consulting Board should be free from political, individual or trade bias. The members should be in a position to deal with the technical matters presented to it in the same disinterested spirit as that with which the Bench acts, and in the suggestion referred to above this feature has been carefully kept in mind.

Assuming, then, the concurrence of the engineering and the scientific bodies above referred to, we would suggest that the Consulting Board be composed of two representatives in civil engineering, two representatives in mechanical and electrical engineering, two representatives



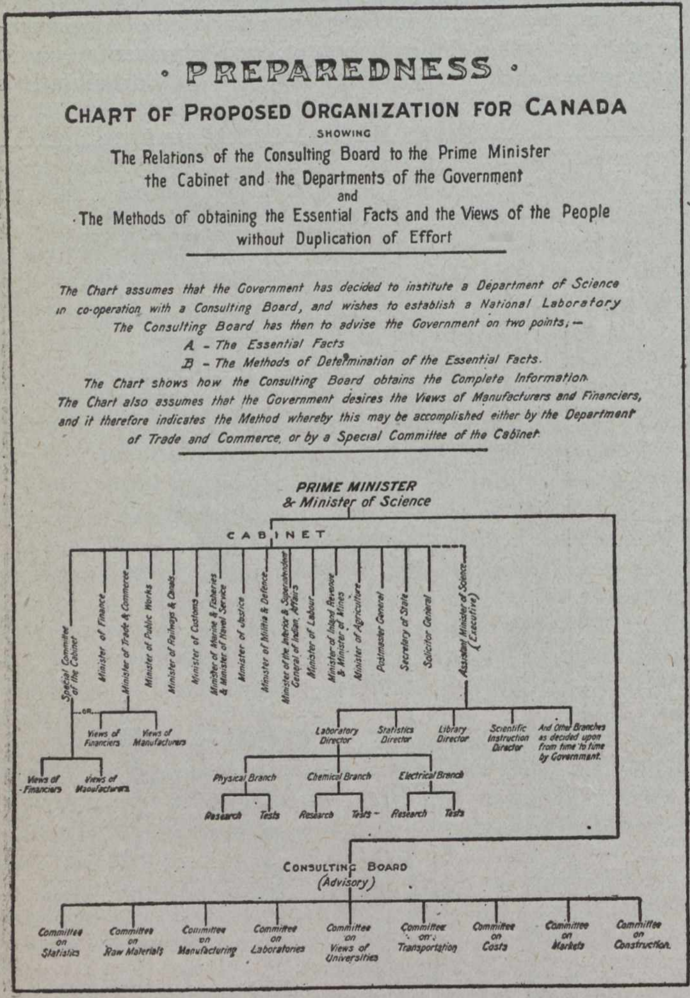
in mining and metallurgical engineering, and two representatives in chemical engineering, all nominated by their respective societies to act each during the pleasure of the Government or of the nominating bodies. Further, we would suggest that the recall of any member be at the option of either the Government or the Society, replacement, however, to be always at the discretion of the Society.

The official headquarters would presumably be at Ottawa in an office provided by the Government, together with a well-paid and highly competent engineering secretary.

The operations of the Board will require a certain amount of detail work, usually performed by subordinates. We believe that the Consulting Board should be authorized to appoint the necessary subordinates to carry out details.

If it be found desirable to make a census or investigation of the industries of the country the Board might call upon non-paid technical assistants from the branches of the societies in the different Provinces, following the course pursued by the Naval Consulting Board of the United States in investigating the industrial resources of each State.

Function of the Consulting Board.—The function of the Consulting Board is outlined in the diagram already referred to. Briefly, it should act as consulting engineers



to the Dominion Government represented by the Prime Minister, independent of any department of the Government yet available through the Prime Minister to all, in precisely the same way that the general manager of a large corporation has consulting engineers at his call, not on his staff but available to take up, independently of the working organization, all such technical or economic problems as he may desire to have solved.

The Creation and Maintenance of a Department of Investigation, Research or Reference.—If the Consulting Board be constituted along the lines we have suggested it will probably recommend that the Government establish a national testing and investigating laboratory for technical tests, investigation, research, reference or experiment. Such a laboratory would do for the Government precisely what any laboratory department does for a large manufacturing company,—namely, investigate the materials supplies, the processes employed in producing finished products and the economics of the production as related to technical matters.

[NOTE:—The above memorandum was accompanied by an exhaustive and valuable bibliography.—EDITOR.]

ACCURACY OF STREAM FLOW RECORDS.

By K. H. Smith, A.M.Can.Soc.C.E.
Resident Engineer, Dominion Water Power Branch, Halifax.

DURING the course of his regular work the writer found it necessary to compile stream flow records of a number of streams in Nova Scotia for which a limited number of measurements were available upon which to base rating tables. When additional measurements were obtained, these records were revised and in several cases the additional measurements were sufficient to establish fairly satisfactory rating curves.

An attempt has been made in the accompanying table to show the preliminary and revised records in such a way that they may readily be compared. It is believed that these results are of interest to those engaged in hydrometric work and particularly to engineers who are obliged to make preliminary estimates of water supply in districts where stream flow records for a reasonable length of time are not available. In fact, it is thought possible that more satisfactory results may be obtained from approximate rating curves and gauge heights for limited periods than from studies of rainfall alone. In most cases evidences of high-water mark may readily be found and referred to the gauge height, while frequently, as well, evidence of average low water may be secured, which average for cases where storage is contemplated is more useful than a record of an individual minimum flow.

It is obviously impossible to present in tabular form all the conditions affecting the accuracy of the results obtained. The number of measurements are given in each case and their range, though the accuracy of the results depends not only on the number and total range of the measurements, but also on their distribution. The general conditions at the gauging station, such as average velocity, nature of the channel, banks and control are also contributing factors. For more complete information in regard to each of the stations listed, the reader is referred to a report of the Nova Scotia Water Power Commission to be issued shortly. It may be assumed, however, that fairly good conditions obtain at each of the stations given.

It should be noted that possibly part of the differences obtained in the revised records may be due merely to revision rather than to additional available data. Moreover, in the case of small streams such as Archibald Brook and Fall River, the difference between the preliminary and revised records, when expressed as a percentage of flow, is somewhat out of proportion to the importance of the actual difference.

It is, of course, to be understood that carefully determined cross-sections were obtained at each station and that these sections extending above high-water mark are considered essential in defining approximate rating curves. Various methods for extending rating curves are discussed by Messrs. Hoyt and Grover in their book on "River Discharge" and need not be mentioned here. However, the writer wishes merely to state that for his own work, he has obtained the most satisfactory results from plotting on ordinary cross-section paper the measured discharge as a function of $A \sqrt{d}$. Where A is the area of the section and d is the mean depth. This is one of the methods described in "River Discharge." In the case of the St. Croix River, one of those listed herewith, a measured discharge of 1,064 second-feet was obtained at

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July-December, 1916

EXPLANATORY NOTE

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Figures in parentheses refer to length of article; e.g., (2) means two columns.

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a gauge height for which 1,010 second-feet had been computed by the method indicated from seven previous measurements, the largest of which gave only 174 second-feet. That is, the difference between the computed and measured discharge was only 5 per cent. of the measured discharge, the maximum error generally assumed for individual current meter measurements.

While it is intended primarily merely to present this data as representing actual results obtained, several points might be noted:

(1) The average flow obtained from the preliminary records is in every case within a very small percentage of the revised results. This is true even in the case of Fall River, where only two measurements were available for the preliminary computations.

(2) The records of minimum flow as obtainable in the preliminary computations are generally more largely in error than the records of maximum flow. Naturally, irregularities of the stream bed have greater effect on the distribution and direction of the current at periods of low flow. However, the revised records of minimum flow are in most cases more accurate than the revised estimates of maximum flow, and the errors of the preliminary records of maximum flow may ultimately be slightly greater than they appear at present.

(3) In general, the preliminary computations of maximum flow for the period are within a small percentage of the revised results. Greater differences may develop when further measurements for higher water stages are secured, though high-water measurements already obtained and used in obtaining the revised results, as for example, in the case of the St. Croix River seem to indicate a comparatively small error in the preliminary computations.

(4) After a reasonable number of well-distributed measurements have been obtained at a station where permanent conditions obtain, the increase in accuracy for additional measurements is small. For example, 10 measurements on the Indian River gave results identical with the results obtained for 13 measurements, except in the case of the minimum flow, where there is a small difference.

Table Showing Comparative Results for Computations of Flow of Certain Streams in Nova Scotia.

River.	Basis of Preliminary Records.	Basis of Revised Records.	Period in Days.	Preliminary Records. Max. Sec.-ft.	Min. Sec.-ft.	Mean Sec.-ft.	Revised Records. Max. Sec.-ft.	Min. Sec.-ft.	Mean Sec.-ft.	Differences. Per cent. of Revised Records Max.	Min.	Mean.
Archib'd Brook	5 measurements, 47 sec.-feet to 135 sec.-ft.	9 measurements, 3.4 sec.-feet to 135 sec.-ft.	152	707	8	75	560	7	72	26	14	4
Fall River ...	2 measurements, 64 sec.-ft. and 93 sec.-ft.	6 measurements, from 1 sec.-ft. to 93 sec.-ft.	121	135	14	60	135	10	58	0	40	3
Gaspereau ..	9 measurements, 55 sec.-feet to 375 sec.-ft.	12 measurements, 26 sec.-feet to 1,536 sec.-ft.	317	3,396	46	385	2,975	41	382	14	12	0.8
Indian	10 measurements, 77 sec.-feet to 1,597 sec.-ft.	13 measurements, 5 sec.-feet to 1,597 sec.-ft.	327	1,597	47	173	1,597	45	173	0	4.4	0
Lahave	4 measurements, 184 sec.-feet to 2,982 sec.-ft.	5 measurements, 184 sec.-feet to 2,982 sec.-ft.	202	4,313	197	1,134	4,388	184	1,125	1.7	7	0.8
Medway	3 measurements, 246 sec.-feet to 3,084 sec.-ft.	4 measurements, 246 sec.-feet to 3,084 sec.-ft.	226	3,232	186	1,473	3,232	176	1,426	0	5.7	3.3
Northeast ..	9 measurements, 33 sec.-feet to 382 sec.-ft.	13 measurements, 17 sec.-feet to 382 sec.-ft.	327	391	18	89	387	21	90	1	14.3	1.1
Philip	5 measurements, 134 sec.-feet to 531 sec.-ft.	6 measurements, 58 sec.-feet to 531 sec.-ft.	273	3,694	72	316	3,780	56	308	2.3	29	2.6
St. Croix	7 measurements, 61 sec.-feet to 174 sec.-ft.	10 measurements, 6 sec.-feet to 1,065 sec.-ft.	316	1,010	20	206	1,064	33	205	5	40	0.5
St. Marys ...	5 measurements, 412 sec.-feet to 4,370 sec.-ft.	9 measurements, 49 sec.-feet to 4,370 sec.-ft.	245	13,800	219	1,405	13,730	116	1,352	0.05	89	4

USE OF GAS AT THE FRONT.*

By W. B. Campbell.

THE Germans first used gas a year ago last spring. There was a feeling of horror, but there was also the impression that the Germans were very ingenious people to bring out this scheme. They are not!

If you read the Sunday papers, and I guess most everyone reads them at times, you will notice that it is quite a common habit for the writers to concoct wild stories of all kinds of inventions, especially inventions for killing people in warfare. The first mention that was made in those papers of the "tanks" showed a machine about 200 feet high. Well, the Germans' use of gas was somewhat along the line of these stories. It is not a new idea at all.

Perhaps the first time gas was actually used was the "stink bombs" of the Chinese. They were not poisonous but were intended to annoy the enemy as a cover for something more effective.

A popular story is that a great secret is locked up in the Tower of London, which, if the British government would only consent to use it, would wipe out all enemies wherever they are, but that the government is too humane to do that! The basis of that story, and it has a basis, is that about seventy years ago the use of chlorine as a weapon of warfare was actually proposed. It was Lord Dundonald, I think, who suggested it at that time, and the suggestion was turned down. The fact that gas could be used was quite well known. It was sufficiently well known to be taken up at one of the Hague conferences and they decided against it. However, the Germans did not mind that,—merely a scrap of paper.

As gas is used at the front to-day there are two forms of it, liable to confuse people when reading the newspapers. There is what is known as cloud gas, the poisonous kind, sent up in cylinders and released and sent across in the form of a cloud. Then there is what is known as shell gas, which is sent across in shells and released on the breaking of those shells. The cloud gas is the most important and the most deadly. It may seem a fairly convenient weapon, but if you will consider the gases that it is possible to use and the properties necessary to make them usable at all, you will see that it is not such an easy thing. First, as to the properties; the gas must be heavy; it must be at least twice as heavy as air. If not, it will diffuse too readily and be thinned out by the time it gets to the enemy trenches and be of very little use. The gas must be compressible to a liquid, so as to be transported, in cylinders, in bulk. It must not be a liquid of such a high boiling point that it will boil off with rapidity. It must be poisonous,—the more so the better.

Some of the gases ordinarily considered poisonous are not nearly poisonous enough to be used in this way. The arsine, AsH_3, that compound of hydrogen and arsenic, which has a specific gravity of 2.7. This makes it plenty heavy enough. It can be liquefied. It has a convenient boiling point, but at 1/10 of 1% it takes about two hours exposure to kill. Then there is sulphur dioxide. That is more poisonous than most people think. It has a fairly convenient specific gravity; its boiling point is 10 degrees below zero Centigrade. In comparing the toxicity of these gases there are two terms used—the minimum effective concentration, that is the least concentration which will kill a man or knock him out in five minutes, and the maximum bearable concentration, that is the most that can be stood without danger for one hour. Sulphur dioxide has a minimum effective concentration of .05%, so it is a rather poisonous gas.

Some of the other gases that might be thought of are nitric oxide, boiling point of 26 deg. Cent., fairly heavy, and about as poisonous as sulphur dioxide. The high boiling point stops its use as cloud gas and it is not sufficiently poisonous to make it useful for shell gas.

Another one is hydrogen sulphide. That has a low boiling point but it is a little bit too light to use as a cloud gas, and it is only about half as poisonous as sulphide dioxide.

To come down to the ones really effective, first there is chlorine. That is the one the Germans used in the first gas attack. It has a boiling point of 36 deg. below zero Cent. It is two and a half times as heavy as air. It is very convenient. It can be liquefied and put into cylinders. It boils off rapidly and its minimum effective concentration is .01%, five times as poisonous as sulphur dioxide. The maximum concentration is about half of that.

Prussic acid is only three times as poisonous as chlorine. Another gas the Germans are making considerable use of is phosegene. That is not an ideal gas. It is twice as poisonous as chlorine, but it takes twice as long to kill. Another thing against it is that it has a boiling point of 8 degrees Cent. That is higher than the temperature you encounter on a fairly cold day in winter weather over there. There are a good many days when that gas would not come out of the cylinder at all. It is used mixed with chlorine. It is effective because it has serious after-effects on a man's heart. A man will get a small amount of it into his system, so small an amount that he will not think he has been gassed at all, but maybe two or three hours later he will be filling sand bags or doing some other work around the trenches and his heart will go back on him and he will drop exhausted or dead. The first time this gas was used the after-effects on the heart were not looked for and there was one party of men who had been slightly gassed but their officers did not consider them badly affected. They were sent to march out to the dressing station. None of them reached the dressing station. Now men have instructions that after being exposed to gas, they are not to move out of the trenches or do any more work than absolutely necessary for twenty-four hours. During that time the effect of the gas will wear off.

As to the quantity used, this is rather surprising. The effective concentration of chlorine is .01%, one part in ten thousand. Of course it is necessary in calculating the concentration for an attack to prepare to use more than that amount. Say you are figuring on using ten times that amount (the Germans in one attack sent over gas strong enough so that the men had to use helmets ten miles back of the line), that is, a concentration of 1/10 of 1%, a wind of ten miles per hour (that is just a moderate breeze) and a cloud eight feet high at the enemy's trenches, if you figure that out you will get about 22,000 cubic feet of air passing over each yard of trench per minute, and this must be loaded up with chlorine. That requires about 22 cubic feet of chlorine, or 4¾ pounds, per minute per yard of trench. That does not sound much, but when you figure it by the mile, the way gas attacks are made, it mounts up.

*Paper read before the Canadian Society of Civil Engineers, Montreal, January 11, 1917.

An attack for fifteen minutes means fifty tons of chlorine per mile of front. Chlorine is taken up to the trenches in cylinders each containing sixty-five pounds of the liquid. The cast-iron cylinder weighs roughly about 65 pounds more; that means one hundred tons of material to be carried up to the trenches to make an attack of fifteen minutes. The cylinders are clumsy things; they must be carried up at night so that the enemy cannot see them; they must be brought up along a communication trench probably half a mile long with a crook in it at every ten yards or so, and one of those cylinders are required to every yard of trench. It takes four men to a cylinder; two men carrying and two to relieve them every hundred yards or so.

The only preparation for an attack of this kind on our front was intended to cover a small raid. When this gas was to be brought up, the command was given that in carrying these cylinders nobody was to mention the word gas or cylinders, because sound travels pretty well and the trenches are not very far apart. You can imagine the delights of lugging around cylinders weighing about 130 pounds, and all done in the dark. Before that, we were all anxious to make a gas attack, but this experience cured all such desire.

Besides carrying up these cylinders there were other preliminary preparations. The cylinders were to be placed in the ground. We had to set boxes each holding four cylinders. That is so that the gas would be well protected from shell fire. That was all done a long time ahead. As a matter of fact, now practically the whole line from one end to the other is equipped with boxes in the fire step so that gas can be brought up and delivered from any point on short notice. Well, supposing you have made that preparation, you have arranged with the divisions on either side to have a smoke attack for perhaps two or three miles, the artillery has its orders and everything is to break out on a certain signal, about one o'clock in the morning. One o'clock in the morning comes and the the wind dies or turns around another way, and the affair is called off for another night, when the same thing happens again, and after about a week of that sort of performance, the objective of that raid is no longer there, or probably the Germans know you have gas and you lug the cylinders out again.

Then, the gas shells are another proposition. I do not know whether the Allies are using gas shells or not. They were not when I left last summer, but they may have started since. These are not very effective. The Germans used two kinds. The most effective are what are known as tear shells. They contain a gas which is not poisonous in the quantities used, but it irritates the eyes and gives the same feeling as would peeling onions. Protection against this is afforded by means of goggles which exclude all the air, and that is plenty of protection. If the gas is very strong the irritation may be sufficient to affect the nose and throat and even cause vomiting. It is not poisonous, however, and the effects are only temporary. As soon as one gets to fresh air the trouble is all gone. The other kind of shells used by the Germans are poisonous. They have very much the same effect as phosegene. The poisonous effect of these shells is not very great, though, because it is difficult to get sufficient concentration. When one of those shells breaks they have to follow it with another shell pretty quickly to get any effect, so, though the Germans used those quite plentifully around our trenches, nobody was gassed.

When the gas was first used at Ypres in April, 1915, our men had no protection whatever against it. They did not get the worst of it at that time, but the French troops were completely cleaned out on two miles of front. Evidently the German general staff had no idea how effective the gas was going to be because they made no preparation to follow it up the way they might have done. Immediately after that attack protection began to be devised. The women of England made over a million respirators, of a kind, in three days on an appeal from Lord Kitchener. They were crude, of course; simply a small pad stuffed with cotton, with a piece of elastic to hold it over the mouth. This was supposed to protect the mouth and nose. The pad was soaked in a solution of sodium carbonate, but it was difficult to breathe through. Immediately following those was a type which covered the nose better. It was soaked in a solution of hypo and sodium carbonate, and if carefully put on was quite effective against chlorine. Shortly after that the first helmet type of respirator was produced. It was simply a bag of flannel with a similar solution plus glycerine. It was not a good respirator in many ways. The men breathed in and out in a small space all the time and the doctors said they would smother. But that was not the case. They got enough fresh air but it was not very comfortable. That combination of chemicals is perfectly good against chlorine.

But about July, 1915, word was brought that the Germans were preparing phosegene to be used against us, so some protection had to be devised. A new respirator was brought out which was an improvement on the former one. The chemicals used on the pad were costic soda and carbolic acid. It was effective against chlorine and to some extent against phosegene. The helmet was much more comfortable than the other, but the protection was far from perfect. It would not protect against the amount of phosegene that could be used in summer weather, but it was the best that could be had at that time. However, the Germans did not use the phosegene until December, 1915. It was rather cold and these helmets furnished perfect protection against the amount used at that attack. Something better was being worked on all the time that this helmet was being used, and last spring a helmet was issued that was protection against phosegene and a whole assortment of gases. It had one defect, namely, that it generated a certain amount of formaldehyde which was very irritating on the eyes, so much so that men were likely to get the idea that they were being gassed when they were not, so that they would take off their helmets and try to put on others, many casualties then occurring. However, the men were warned against this.

Later on, a helmet with rubber sponge goggles was brought out. This was designed to protect the eyes against this formaldehyde, also to protect them from the gas from tear shells. These helmets look very heavy but the men soon get to feel quite at home in them. I have some helmets used by the Germans, and the chemicals used in one are charcoal and potassium carbonate. The chemical protection is perfectly good but there are a lot of other faults in their respirator. The weight of the box drags the helmet down and it does not fit properly, so the gas gets into the man's nose and mouth. There are other helmets made by the Germans which I have examined, but they all have some defects, and on the whole we have better protection against gas than the Germans have. Since last June the British have worked up this feature of warfare so perfectly that now we are making more gas attacks and better ones than the Germans are making, and I think the Germans are very sorry they ever started the use of gas.

REPORT OF SUB-COMMITTEE D, AMERICAN WOOD-PRESERVERS' ASSOCIATION.

The following abstracts are taken from the report of the above committee, which was submitted at the annual meeting of the association held in New York January 23-25, inclusive.

A number of sub-committees were appointed to work under the main committee. Sub-committee D was instructed to present all information available concerning the use of water-gas tar and oil for treating paving blocks, and, if in their judgment it is warranted, a tentative specification for such oil.

This sub-committee reported in part as follows:—

It was found upon investigation that there are in existence many thousands of square yards of wood-paving that, judging from the chemical analysis of the original oil now in the blocks, had been originally treated either wholly or in greater part with water-gas tar. In view, however, of the specifications and other conditions connected with the treatment and laying of many of these blocks, it did not seem advisable to include them in this report.

We have, however, submitted for your consideration the location, yardage, character of treatment, oil used, present condition, traffic conditions, and in some cases a photograph of a considerable number of streets that are paved with wood blocks that were treated with refined water-gas tar.

With the exception of two cases which are noted, your sub-committee by its personal knowledge is assured that the oil used was refined water-gas tar of the grade represented by the analysis and that the quantity injected per cubic foot was found from the block manufacturers' records to agree with the specifications.

In passing judgment on the serviceability of a material for use in treating paving blocks, your sub-committee feels that there are four features to be considered: (1) Waterproofing value of the material; (2) its preservative value as against decay; (3) permanency of the oil in the blocks; (4) ease and completeness of penetration; (5) its freedom from bleeding.

The waterproofing value of water-gas tar has been quite generally recognized.

As regards the preservative value of the material against decay, your sub-committee would report that it was unable to find any instance of decay in any of the blocks inspected by it, nor was any such decay reported from any of the uninspected work. Since a number of these streets have been in service for over eight years, your sub-committee feels justified in assuming that this feature of the requirements of a proper preservative has been amply fulfilled.

With regard to bleeding, your sub-committee would call particular attention to the fact that, from its inspections, and from the inquiries it made of those having the pavements in charge, there was an entire absence of any complaint from bleeding, not only as to the older pavements, but also on those of very recent construction.

Your sub-committee is convinced, therefore, that as a result of the fulfilment of the foregoing requirements, and in view of the uniformly successful results that were obtained, as evidenced by the examples cited in this report, the refined water-gas tar has demonstrated its value and usefulness as a preservative for wood-paving block.

It therefore recommends to the committee that refined water-gas tar be recognized as a suitable and satisfactory wood-block preservative, and that the following specifications be submitted to the association for adoption, as a standard specification for this class of material:

Refined Water-Gas Tar for Paving Blocks.—The preservative shall be a refined water-gas tar. It shall comply with the following requirements:

1. It shall contain not more than 3% of water.

2. It shall contain not more than 2% of matter insoluble in benzol and chloroform.

3. The specific gravity of the preservative at 38°/15.5° C. shall not be less than 1.110, nor more than 1.140.

4. The distillates, based on water-free oil, shall be within the following limits: Up to 210° C., not more than 5%; up to 235° C., not more than 15%; up to 315° C., not more than 40%; up to 355° C., not less than 25%.

5. The specific gravity of the total distillate below 355° C. shall not be less than 0.99, nor more than 1.02 at 38°/15.5° C.

6. The foregoing tests shall be made in accordance with the standard methods of the American Wood-Preservers' Association.

REGINA BRANCH OF CANADIAN SOCIETY OF CIVIL ENGINEERS TO WIDEN ITS SCOPE.

The members of the Canadian Society of Civil Engineers resident in Saskatchewan have unanimously decided to extend the scope of the Regina branch of the society so as to include all members of the engineering profession in Saskatchewan and have decided to change the name of the Regina branch to that of Saskatchewan branch.

A meeting for organization was recently held at Regina when the following gentlemen were elected: Chairman, L. A. Thornton, Regina; secretary pro tem, J. N. De Stein, Regina. A nominating and organization committee of five were also elected, composed as follows: L. A. Thornton and H. S. Carpenter, of Regina; G. D. Mackie, of Moosejaw; C. J. Yorath, of Saskatoon, and R. W. Ross, of Melville. This committee will convene in the near future when further organization and the general policy of the branch will be decided upon after sanction of the council of the parent society has been obtained.

A despatch from London, England, states that application will be made to the Treasury for permission to raise capital necessary to complete the irrigation of 500,000 acres of land in the Medicine Hat, Alberta, district, owned by the Southern Alberta Land Company, Canadian Wheatlands, Limited, and the Alberta Land Company. Sir William Plender is receiver for the Southern Alberta Land Company, and among others assisting in the new effort are mentioned Sir Frank Grist, Sir Robert Nivison and A. J. McMillan, who spent several months in Ottawa last summer negotiating with the Canadian Government respecting these interests. The development of land in this territory involves an expensive irrigation scheme requiring a large amount of capital. Over $5,000,000 has already been spent in construction operations, but the war prevented the raising of additional money to complete the irrigation canal system. Since the outbreak of the war efforts have been made to have the Government take over the project or to interest the Canadian Pacific Railway in the scheme in the hope that the big transportation company might go forward with the work along the same lines as its own project in the same part of the country. However, with the recent improvement in the financial situation, it is evident that an effort will be made to secure capital in England, and the present plan is to raise an additional £1,000,000 if the consent of the Treasury can be secured.

CANADA'S RAILWAY PROBLEM AND ITS SOLUTION.

By William Francis Tye, C.E.,
Formerly Chief Engineer, Canadian Pacific Railway Co.

(Continued from last week's issue.)

Before it is possible to arrive at the cure, one must understand what are the reasons which have caused the trouble.

Canada may be compared with the Siamese Twins,—two bodies, the east and the west, commercially united by a narrow ligature—the railways. The long stretch of country extending from about Sudbury to near Winnipeg, a distance of nearly 1,000 miles, is practically barren as far as local traffic is concerned, and a big drag on the earnings. Each of the two bodies—the east and the west—is very large in size, and, as yet, sparsely settled. So the railways in each body have a somewhat thin traffic local to that body, and in addition, the transcontinental lines have a through traffic from one to the other, which must be carried across nearly 1,000 miles of practically unproductive territory.

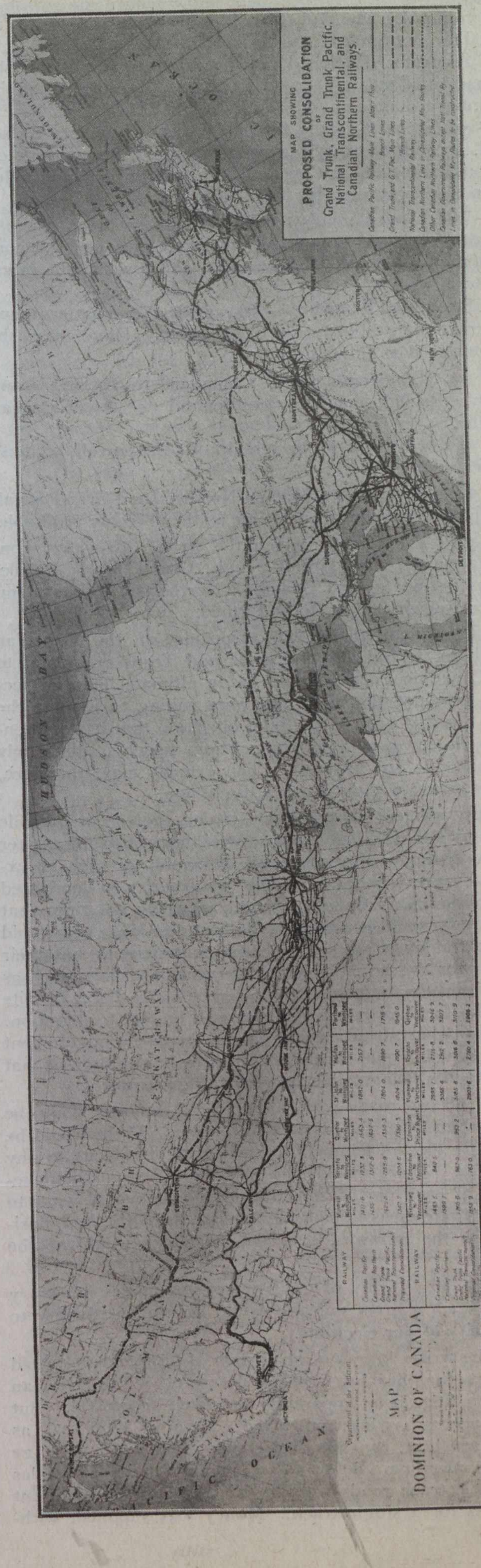
It is thus necessary that any railway connecting the two bodies have an extensive system in each, not only in order to get its fair share of the traffic, in each of the two bodies, but also to gather traffic in one to carry to the other, to enable it to pay the cost of operation on the long unproductive stretch through Northern Ontario.

The Grand Trunk, which is entirely local to the east, has always been moderately successful. It has been expensively constructed and financed. It has been controlled from London, a point too far away for effective control. It has had no opportunity to take part in Canada's greatest development which has gone on in the west, and has, therefore, been only moderately successful.

The Grand Trunk Pacific and the Transcontinental, which really form one system, have been built without any regard to the principles which underlie the economics of railway location and construction. The first essential for any railway is that it get traffic, as without traffic it cannot live, no matter how cheaply or inexpensively it be built, and this cannot be had without an extensive system of feeders. These two roads spent large sums in building main lines far in advance of their present requirements, and very little on feeders or branch lines. The result is 3,550 miles of very expensive main lines, and only 1,200 miles of branch line feeders—fixed charges equal to gross earnings, and a cost on each road of about $200 to do $100 worth of business.

The Canadian Northern was built, first as a western road, and while it remained a purely western road, was very successful, but it, too, caught the mania for a through transcontinental railway. It, too, built a long, expensive line across the unproductive country between Montreal, Toronto and Winnipeg, without, at the same time, building an adequate system of feeders and terminals in the east with which to gather traffic for the west, and to support the long, unproductive mileage in Northern Ontario.

The Canadian Pacific, on the contrary, was developed along the proper lines. It built its main line as cheaply as possible, used the funds which it saved by this class of construction rather than the expensive construction indulged in by the Transcontinental and Grand Trunk Pacific Railways, in building a system of feeders in the west and in the east. In this way it had the maximum of traffic and the minimum of fixed charges, instead of the



Map Showing Proposed Consolidation of Grand Trunk, Grand Trunk Pacific, National Transcontinental and Canadian Northern Railways.

minimum of traffic and the maximum of fixed charges, as the Transcontinental and Grand Trunk Pacific have.

As traffic developed and conditions warranted, the Canadian Pacific Railway improved its lines, thereby making a double saving of: first, the interest on the excessive first cost during the many years of meagre traffic, and, second, the very much lesser cost of doing work on a constructed line rather than in a wilderness many miles from a railway or other transportation.

The Intercolonial's troubles have been those inherent in all government management—excessive cost of construction, expensive management, and low freight rates.
* * * * *

Suggested Remedies.—To remedy these matters many different suggestions have been made. These may be summarized as follows:—

1st. Transferring the Canadian Northern, Grand Trunk Pacific and Transcontinental to the Canadian Pacific.

2nd. Government ownership of some, or all, of these railways.

3rd. Aiding the Canadian Northern and Grand Trunk Pacific Railways until such time as they become profitable.

4th. The remedy which the writer advocates, consolidation of the Grand Trunk, Grand Trunk Pacific, Transcontinental and Canadian Northern in one system, under a new company to be formed.

The first of these, *viz.*, disposing of the Canadian Northern, Grand Trunk Pacific and Transcontinental to the Canadian Pacific, might be an ultimate financial success, provided that company were willing to assume the risk, but it is open to the fatal objection that it would entirely do away with all competition, which is absolutely necessary in any business. This remedy may, therefore, be dismissed without further discussion.

Government Ownership.—It does not seem possible that any one who has given serious thought to the matter can be in favor of government ownership of such an extensive system, more especially in a country so dominated by politics as is Canada. One can easily imagine what the result would be: before the first election a cry would go up for lower rates, which the politicians to suit their needs would grant. This would result in deficits such as have been so common on the Intercolonial. These deficits and the fixed charges would have to be met by taxation. The Canadian Pacific would have to meet the government rates, which would surely result in the bankruptcy of that road, or its being taken over by the government.

If all the roads were nationalized the cost would be far too much for the country to finance. There would be an entire lack of competition, which is disastrous to any business. There would be a lack of continuous management, as each party as it attained power would want to reward its own politicians by giving them the best positions on the railways, and the best men would not be selected.

The large army of government appointees necessary to run such a great mileage would be a grave danger to the purity of our elections.

The writer knows of no system of government-owned railways that has been really successful. The German railways have been apparently the most successful. But their success has been much more apparent than real, as they have been run not as a commercial, but as a huge military machine. Before the war many hundreds of miles of double track roads were in existence, with insufficient business for a single track. Money was supplied, without stint, to keep them in first-class military shape, all of which gave them an appearance of prosperity and good management, while, in reality, they were not so economically managed as the English roads.

Government Management in Canada.—Our experience of government-managed railways in Canada has not been such as to justify us in such a gigantic addition to our public responsibilities. We have now five government-owned roads in Canada, and not one of them has earned interest on its cost, and only one (the Temiskaming & Northern Ontario Railway) has earned its operating expenses. * * *

A short examination of the Transcontinental and the Intercolonial Railways is illuminating.

Construction of the Transcontinental.—The Transcontinental was built by a commission without experience in the construction or operation of railways.

The Stanton-Gutelius Commission appointed to investigate its construction, shows that its cost to 1914, exclusive of any rolling stock, amounted to $99,500 per mile. At the same time this road was being constructed, the Canadian Northern Railway Company built a parallel road for exactly the same purpose, *viz.*, to connect the eastern and western systems. The road is in every respect as efficient an instrument of transportation as is the Transcontinental, and its cost certainly did not exceed $50,000 per mile.

The Quebec bridge is a link in the Transcontinental System. With the necessary approaches it has cost $40,000,000 and was decided on and built without any consideration as to its economic value.

Train ferries, which could have been built for a small fraction of its cost, would have served every purpose for many years to come, and would have taken the traffic directly through Quebec, much to that city's advantage. Until a few years ago similar ferries handled all the traffic from the west into New York, and all the traffic across the Detroit and St. Clair Rivers. They are to-day handling all the traffic into San Francisco except that from the south.

It is quite safe to say if the Transcontinental Railway, including the crossing of the St. Lawrence River, had been built by the Canadian Pacific Railway Company, its cost would have been at least $100,000,000 less than as built by the Dominion Government.

(To be continued.)

TORONTO BRANCH, CAN. SOC. C. E.

The Toronto branch of the Canadian Society of Civil Engineers will hold its regular monthly meeting in the Chemistry and Mining Building of the University of Toronto, on Tuesday, February 13th, at 8 p.m. Dr. A. P. Coleman will deliver a lecture on "Labrador Revisited." Dr. Coleman has made two trips to the wilds of Labrador and has secured many beautiful slides. As this meeting will be of general interest, the executive of the branch extends a cordial invitation to the members to bring their lady friends.

The membership lists of the Toronto branch are being revised and the secretary will be pleased to hear from any member of the Canadian Society of Civil Engineers residing in Toronto who has not been getting notices of the branch meetings.

Editorial

INDUSTRIAL PREPAREDNESS MEMORANDUM.

The memorandum on National Industrial Preparedness, which is printed on another page of this issue, evidently reflects much thought and labor. In solving the big problems that Canada must face after the war, the co-operation of the country's engineers will be urgently needed. The voluntary efforts of these five engineers in attempting to pave the way for the solution of some of the problems, should be emulated by more members of the profession.

WATER POWERS OF MANITOBA, ALBERTA AND SASKATCHEWAN.

The Commission of Conservation has just published a 334-page report on the water powers of Manitoba, Saskatchewan and Alberta. It is a compendium of all available data respecting this great natural resource and will form a valuable book of reference. To complete the information, Mr. Leo Denis, hydro-electric engineer to the Commission, made reconnaisance surveys in the less settled portions of Manitoba, Saskatchewan and Alberta. In southern Manitoba, the Commission, following its announced policy of avoiding duplication of effort, requested Mr. J. B. Challies, superintendent of the Water Power Branch, Department of the Interior, to contribute chapters regarding this portion of the area covered. Mr. Challies, whose name appears as joint author, also contributed the chapter on the Bow River above Calgary.

Incorporated in the report are also all available data procurable from reports by the Irrigation Branch, the Geological Survey of Canada and the United States Geological Survey.

Mr. Denis has added a considerable amount of new material (having examined personally the waters to the east of Lake Winnipeg, and the Nelson, Hayes, Upper Churchill, Athabaska, Peace and other rivers), and, what is perhaps more important, has correlated the whole information in such manner that it can be used for reference readily, the information being given in very condensed form. The facts are set forth in uniform style for every stream, in each case beginning with the head waters and drainage areas and giving the data regarding the various power sites in the order in which they occur, following the river down stream.

This style is similar to that followed in the volume, "Water Powers of Canada," which was published by the Commission in 1911, in which the subject was treated in a fairly complete manner in regard to the eastern provinces, the information covering the powers of the prairie provinces being admittedly very incomplete.

Following the policy enunciated in 1911, the Commission will, when the report by Mr. Arthur White on the British Columbia water powers is published, leave this field of investigation to the administrative branches of the public service. The Commission's object is to investigate, advise and inform. When its investigations have aroused the desired interest, its activities are directed to other fields. The "Water Powers of Canada," the volume under review, and the "British Columbia Water Powers," when published, will give in very handy form and in uniform style a thorough, condensed summary of the various water powers in Canada.

The information given is not so voluminous nor in so much detail as might be required by engineers proposing actual developments, but the circulation of these books will undoubtedly do much to interest Canadians and others in the development of these powers, and more complete information can then be secured by interested persons either from the Commission of Conservation or directly from the various departments more intimately connected with the administration of the water powers of the country, such as the Ontario Hydro-Electric Power Commission, the Nova Scotia Water Power Commission, the Quebec Streams Commission, the water power and irrigation branches of the Department of the Interior, etc.

The report is illustrated by sixty-three photographs and diagrams, besides two large maps, and has seven valuable appendices giving table of water powers on the Saskatchewan River and tributaries and streams flowing into Lake Winnipeg; tables of estimated flow and theoretical horse-power on streams where complete data on flow are not available; table showing descents on streams where lack of information prevents estimating flow; utilized water powers in the Yukon; monthly precipitation in prairie provinces; water power legislation; and bibliography.

In connection with these appendices it is interesting to note that the total available theoretical power, assuming most suitable conditions of regulated flow, amounts to no less than 865,000 h.p. on the Saskatchewan River and tributaries and streams flowing into Lake Winnipeg. Of this, only 109,000 h.p. has been developed. The estimated available theoretical power (May to November) on streams in the Prairie Provinces where complete data on flow are not available, totals about 5,500,000 h.p., of which approximately 240,000 h.p. is not favorable for development. (Naturally, this does not intimate, by any means, that all of the remainder can be developed economically.) Even this tremendous figure does not include streams where lack of information prevents estimating the flow. The utilized water powers in the Yukon are two in number, the power now being developed totaling 12,700 h.p.

The main portion of the report is divided into eighteen chapters, as follows:—

Winnipeg River; Red and Assiniboine Rivers; Western Tributaries of Lake Winnipeg; Eastern Tributaries of Lake Winnipeg; Nelson River and Tributaries and Hayes River; Saskatchewan River; North Saskatchewan River and Tributaries; South Saskatchewan River and Tributaries except Bow River; Milk River; Bow River below Calgary; Bow River above Calgary; Athabaska River and Tributaries; Eastern Tributaries of Lake Athabaska; Peace River; Slave River and Tributaries of Mackenzie River; Churchill River and Tributaries; Yukon River and Tributaries; Coppermine, Hood, Dubawnt, Ferguson and Kazan Rivers.

Mr. James White, Mr. Arthur White, Mr. Denis, Mr. Challies and the many other engineers who have had a hand in the preparation of these three volumes on Canada's water powers, are to be congratulated on the efficient manner in which this general survey of Canada's water power resources has been carried to completion.

PERSONAL.

W. ELLIS has been appointed chairman of the Hydro-Electric Power Commission of Hamilton, Ont.

GEORGE BURY, vice-president of the C.P.R., will leave Montreal shortly for Russia, to take control of the operations of the Russian railways.

Lieut. E. V. DEVERALL, of Toronto, a graduate of the School of Practical Science, 1915, has been given a commission with the 10th Royal Engineers of the Imperial Army. Lieut. Deverall was employed by the Dominion Bridge Co., Limited, before he enlisted.

ALAN SULLIVAN, secretary-treasurer of the Canadian Electrical Association, has completed arrangements by which he becomes the Canadian associate of Moses, Pope & Messer, consulting engineers of New York City. Mr. Sullivan will retain his official connection with the Electrical Association.

A. L. SMITH, formerly superintendent of the C.P.R. at London, Ont., who has been with that company for twenty-five years, has resigned to accept the presidency and general managership of the Algoma Eastern Railway. He will be succeeded by W. R. TANSLEY, formerly assistant superintendent.

N. R. NORMAN, who resigned his position as sales representative at Fredericton, N.B., for the Northern Electric Co., to enlist for foreign service in the Imperial Aviation Corps, and who is now in London, has been succeeded by CHARLES N. NISBET, for several years superintendent of the Sussex Electric Light Co.

PAUL J. MYLER has been appointed president of the Canadian Westinghouse Co., Hamilton, Ont. For a long time Mr. Myler was vice-president and general manager, but relinquished the duties of general manager some time ago. F. A. MERRICK has been appointed vice-president and general manager, and H. H. WESTINGHOUSE, the former president of the company, has been appointed to the position of chairman of the board, a new position which has been created.

Brigadier-General F. O. W. LOOMIS, proprietor of the firm of D. G. Loomis & Sons, general contractors, Montreal, who went to the front with the First Canadian Contingent, in command of the 13th Battalion (Royal Highlanders of Canada), and who for the past six months has been in France in command of the 2nd Canadian Brigade, has been awarded the D.S.O., and has also been made an officer of the Legion of Honor (France), and has been mentioned in despatches.

OBITUARY.

Sergt. HENRY SANDFIELD MacLEAN was killed in action in France on January 17th. He enlisted with the 88th Fusiliers of Victoria, B.C. He was the youngest brother of John S. MacLean, of the Canadian General Electric Co., Toronto, and son of the late Alexander MacLean, of Ottawa, formerly Canadian Trade Commissioner to Japan.

FRANK GILBERT, at one time a member of the firm of Gilbert Brothers, engineers and contractors, Montreal, died at Westmount on January 23rd at the age of 70. The firm did considerable work in the development of the Montreal harbor.

Major EDMUND HAZEN DRURY, assistant director of engineer services for Canada, died suddenly on January 31st at his residence in the Sifton Apartments, Ottawa, Ont. Major Drury, who was fifty-seven years of age, was born at St. John, N.B., and was a graduate of the Royal Military College, Kingston. He spent four years in Mexico with the Mexican Light and Power Co. He was in the original Hudson Bay Railway survey for the government and later was appointed chief engineer for the Chilean Longitudinal Railway, Chili, South America. Since the war he had occupied the important position on the headquarters staff of the Militia Department, now made vacant by his death. He was a member of the Canadian and American Societies of Civil Engineers.

ENGINEERS' CLUB OF TORONTO, ANNUAL

At the annual meeting of the Engineers' Club of Toronto, held on Thursday evening, February 1st, the following five directors were elected to serve for a term of three years: Messrs. C. H. Heys, W. A. Bucke, T. S. Young, Arthur Hewitt and T. D. LeMay.

JOINT COMMITTEE OF TECHNICAL ORGANIZATIONS, ONTARIO BRANCH.

The Ontario branch of the Joint Committee of Technical Organizations has recently sent out a circular letter outlining the work contemplated. The main lines along which the committee is at present working are as follow:

1. Co-operation with one or more of the following organizations: (a) The recently appointed Advisory Council on Industrial and Scientific Research; (b) Imperial Munitions Board; (c) National Service Commission; (d) The Canadian Engineers and other sections of the Department of Militia and Defence; (e) other government departments and commissions directly or indirectly connected with war work, such as the soldiers' aid committees.

2. Making preparations with a view to obtaining a comprehensive census of technical men with details of their qualifications, so that accurate information may be promptly available as to those most suited to render advice and assistance in different branches of technical war work.

Census cards necessary for the securing and classification of information covering the qualifications of the members of the various technical societies affiliated with the movement are now being prepared and will in the near future be forwarded to every member.

SOUTHWESTERN CONCRETE ASSOCIATION. Annual meeting and concrete show, Convention Hall, Kansas City, Mo., February 19-24, 1917. Chairman, Show Committee, Chas. A. Stevenson, 1433 West 10th Street, Kansas City, Mo.

IOWA ENGINEERING SOCIETY. Annual meeting, February 21-23. Secretary, J. H. Dunlap, Iowa City.

AMERICAN INSTITUTE OF MINING ENGINEERS. Meeting in New York City, February 19-22. Secretary, Bradley Stoughton, 29 W. 39th Street, New York City.

WISCONSIN ENGINEERING SOCIETY. Madison, Wis., February 15-16. Secretary, L. S. Smith, 939 University Avenue, Madison, Wis.

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION. Annual meeting in Indianapolis February 14-15. Secretary, W. F. King, Indianapolis, Ind.