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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

BLOOR STREET VIADUCT CONSTRUCTION, TORONTO

PROGRESS MADE THIS YEAR ON THE TWO LARGE STEEL AND CONCRETE BRIDGES TO LINK BLOOR AND DANFORTH STREETS ACROSS THE DON AND ROSEDALE VALLEYS.

THE extent of progress made this year in the construction of the Bloor Street Viaduct, Toronto, has been such that all sections of the work are well up to schedule, and there is every indication that, with no serious intervention of handicap or delay, the work will be completed well within the stipulated time. No convenient thoroughfare at present exists to connect the new northeast section of the city with the central and business zones. This has been a serious drawback to the development of the former, pleasure and industrial traffic being alike obliged to proceed southward along the east bank of the Don valley to the Gerrard Street and Queen Street bridges, the former of which is old and likely to be replaced shortly, while the latter is nearly a mile south of the Bloor-Danforth route which the viaduct under construction will create.

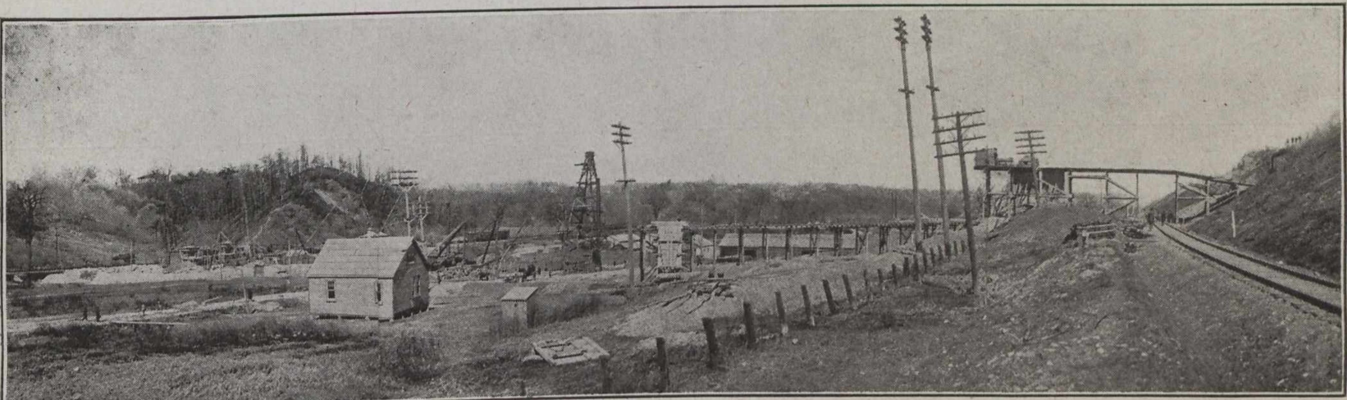

Fig. 1.—The Site of the Don Section in April, 1915. Sheet Piling is Being Driven for Pier Foundations.

Owing to the topography of the Don River valley the projected improvement was best effected by dividing the undertaking in three sections, the first being a bridge across the Don valley, through which run lines of Canadian Pacific, Canadian Northern and Grand Trunk railways, in addition to public thoroughfares and the river

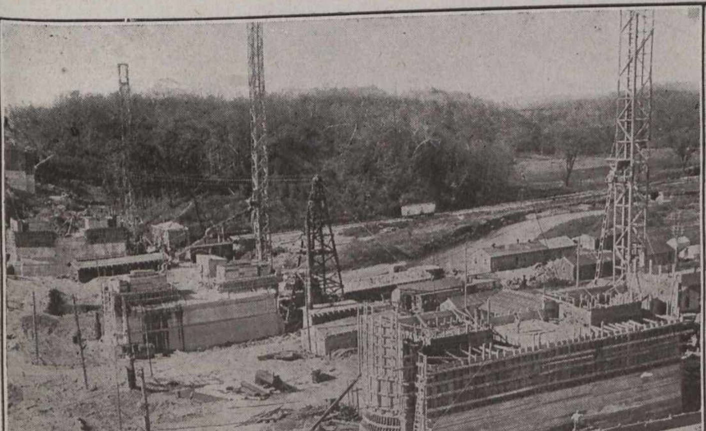

Fig. 2.—General View of the River Piers of the Don Section as They Appeared on October 18th, 1915.

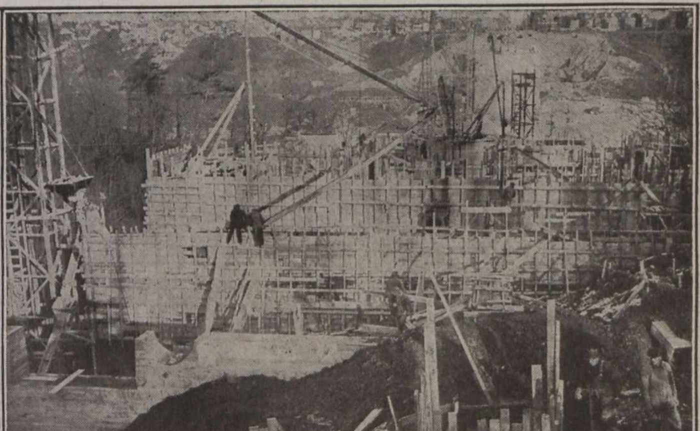

Fig. 3.—Looking East from the West Approach, Showing Form Work and Concreting Operations on Piers G and F.

itself. The second section effects a similar crossing of the Rosedale Ravine, which runs easterly along the southern border of a beautiful residential section, providing a well-wooded and parklike drive, and connecting with the Don valley at a point a short distance south of the proposed viaduct.

The third section of the undertaking, known as the Bloor Section, does not involve heavy construction work and comprises only an extensive fill with a paved extension of Bloor Street along the south bank of the ravine to join with the Rosedale Section in such a manner that, including the Parliament Street intersection, a junction is effected for east, west or southbound traffic.

The first or Don Section is, of course, the most extensive. A description of its general design appeared in *The Canadian Engineer* for October 29th, 1914. Briefly, it comprises a steel viaduct with reinforced concrete piers and approaches. The steel work includes five spans of three-hinged, four-ribbed arched construction. The bridge is 1,618 ft. long and attains a height of 130 ft. above the river. The river span itself is 281½ ft. in length and the adjoining spans are each 240 ft. long. On the outer sides of these are similar spans 158 ft. in length and there is, on the west approach, an additional 80-ft. span.

The progress of the work this year is clearly shown in the accompanying photographs, Fig. 1 of which illustrates the site during early spring operations. The contractors, Messrs. Quinlan and Robertson, with the greater portion of their plant installed, were at that time excavating to rock for the pier foundations. While considerable difficulty, due to infiltration of water, was experienced in one or two locations during excavation operations, the work proceeded satisfactorily and, in general, was sufficiently far advanced to permit the placing of considerable concrete with the advent of favorable spring weather. In Fig. 2 a general view is given showing the principal piers of the Don Section as they appeared two months ago. The view shows the concreting towers in the valley and illustrates well the compactness of the contractors' plant. The cableway, a tower of which is shown in the central portion of the view, was used to convey material exca-

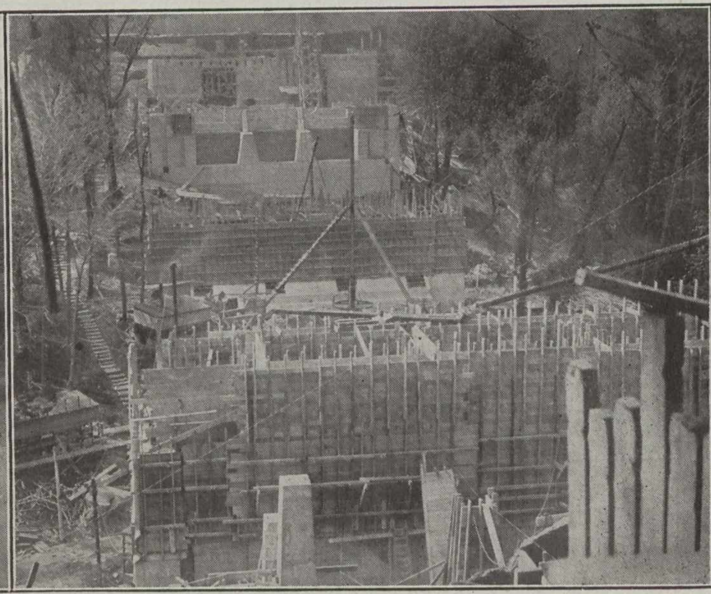

Fig. 4.—The Site of the Rosedale Section as it Appeared on April 8th and October 7th, Respectively.

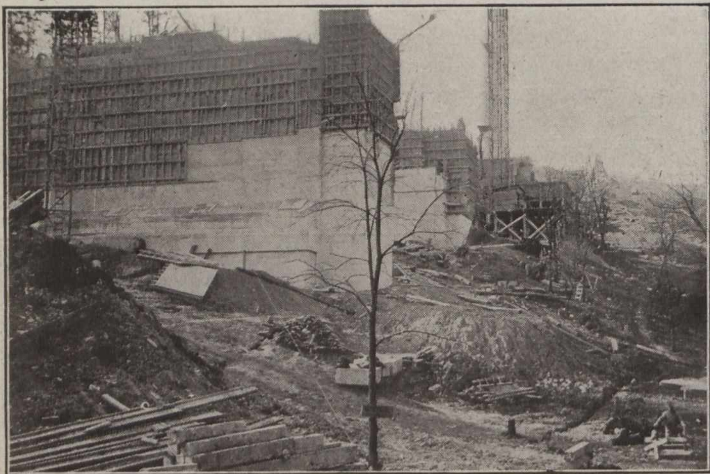

Fig. 5.—Form Work on Piers F and G—Don Section, Looking West.

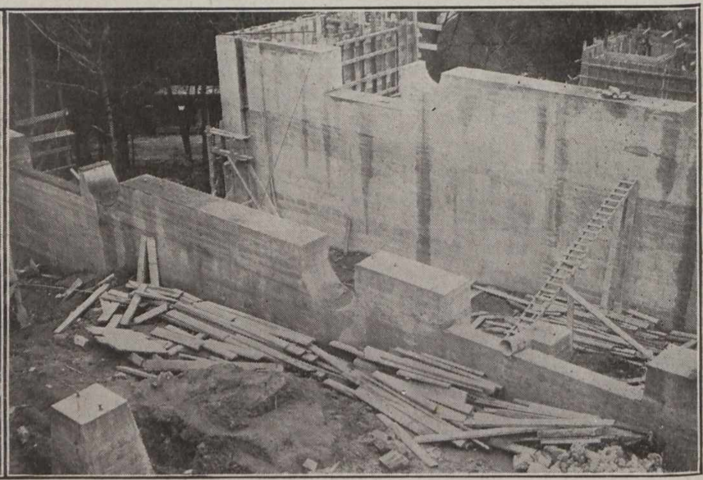

Fig. 6.—West Approach, Rosedale Section, Showing Provision for Future Lower Deck, Water Mains, Etc.

vated from the piers and approaches to the western bank for transportation to the Bloor Section. Fig. 3 is a view looking eastward, showing the form work and concreting operations on two piers near the west approach. It shows also a portion of one of the west approach cross-walls in which provision is shown for water mains and for the lower deck to be added in the future as the city's transportation scheme materializes. These western piers of the Don Section are shown to advantage in Fig. 5, where they have practically attained their height to base of steel.

Fig. 7 shows recent views of the east approach walls and of Pier A. In the left-hand illustration two of the interior walls are shown partly completed. The reader's attention is called to the height of the bank which gives a better idea than Fig. 1 or the illustrations of the piers, of the height which the bridge will attain.

The Rosedale Section is similar in general design to the Don Section, involving an equally pleasing combination of steel and concrete. Its design was outlined in *The Canadian Engineer* for December 17, 1914. This structure is about 600 ft. long and includes a 190-ft. span of three-hinged, four-ribbed arch construction, with a 64-ft. rise. There is another span of 80 ft. in its western portion corresponding in design to the 80-ft. span in the western portion of the Don Section. There is also a retaining wall 170 ft. in length extending from the west abutment of the bridge toward Sherbourne Street, its design conforming with the general design of the structure.

Rapid progress has been made on the Rosedale Section, as is evidenced by the illustrations shown in Fig. 4, one showing the site in April when the contractors were installing their plant, and the other a recent view with several of the piers completed and the others well under way. Fig. 6 is a view of the west approach cross-wall of this section. It clearly shows the provision made, as in the case of the Don Section, for the construction of a future lower deck, and for water mains, conduits, etc. The reader will remember that the present construction is based upon a design 86 ft. in width for both sections, this width providing two 20-ft. roadways, two 10-ft. sidewalks and two street car tracks at approximately 12-ft. centres. The floor system consists of concrete slabs supported on steel, and the provision made in the design for water mains, etc., and for the future underground railway system is below this deck.

On both sections concrete work has been advanced sufficiently far to permit the erection during the winter months of the steel superstructures. The concreting on the Rosedale Section is about 75 per cent. completed, and on the Don Section about 50 per cent. completed.

About one-third of the Bloor Station fill is already is place, and the work is progressing favorably. A portion of the material was supplied from excavation work for the piers and abutments of the Don and Rosedale Sections, and a portion of it is being received as free fill.

The contractors for the Don Section are Messrs. Quinlan and Robertson, the contract having been awarded to them by the city in December, 1914. Subsequently this firm awarded a sub-contract for steel to the Hamilton Bridge Works Company, Limited. The contract for the Rosedale Section was awarded in February to the Dominion Bridge Company, Limited, who, in turn, let a subcontract for excavation and concrete work to the Raymond Construction Company, Limited.

The bridge was designed by, and its construction is proceeding under the supervision of, the Railway and Bridge Section of the Department of Works, Toronto.

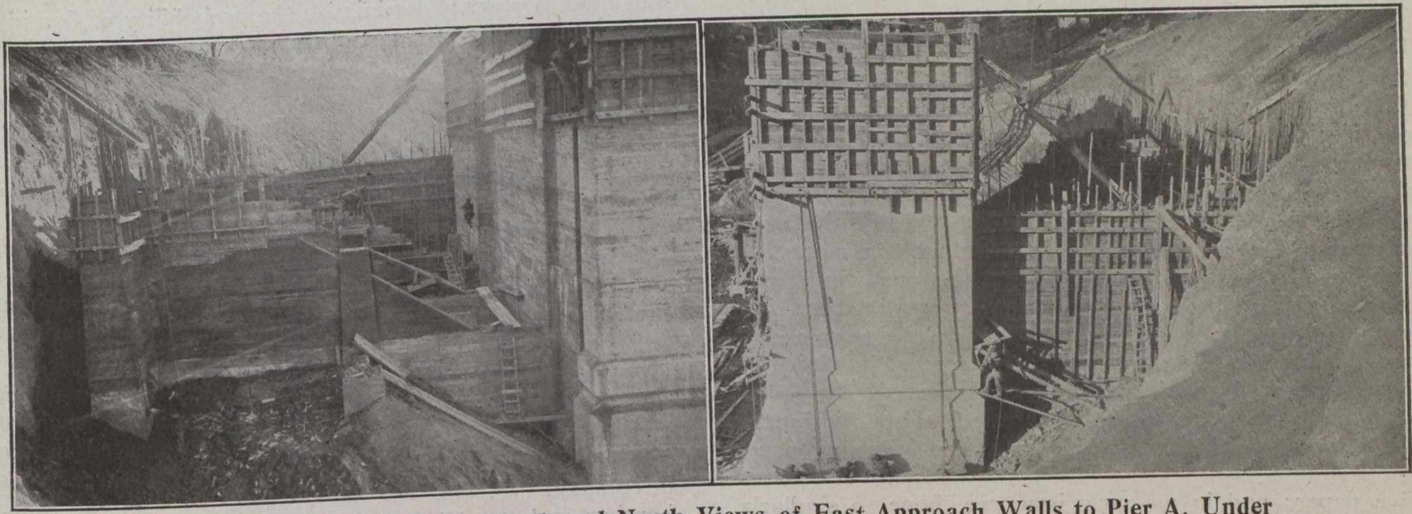

Fig. 7.—The Don Section—South and North Views of East Approach Walls to Pier A, Under Construction, November, 1915.

MONTHLY RAILWAY RETURNS.

The Grand Trunk Railway Company reports net earnings for October of $1,353,000, an increase of $309,000 over the previous year, or 29 per cent.

Net profits of the Canadian Pacific Railway for October were $6,579,434, an increase over last year of $3,258,106. Gross earnings were $13,443,214; working expenses, $6,863,780. For the four months ended October 31 the figures are: Gross earnings, $40,413,207; working expenses, $22,845,754; net profits, $17,567,453. In October, 1914, net profits were $3,321,328, and for the four months ended October 31, 1914, $14,820,980.

The Canadian Northern Railway's October return is as follows:—

	1915.	1914.		Increase.
Gross earnings	$3,678,500	$2,578,300	+	$1,100,200
Expenses	2,421,500	1,859,100	+	562,400
Net earnings	1,257,000	719,200	+	537,800
Mileage in operation ..	7,260	6,866	+	394

At the second annual convention of the City Managers' Association, held in Dayton, O., in November, Mr. M. H. Hardin, vice-president of the association, said, in part: "The elimination of political influence in administrative affairs can best be effected by appointment. I do not mean that a trained or skilled man cannot be elected to a municipal position but, that trained men in most every line are usually so much in demand that they are too busy to aspire to political positions."

POWER DEVELOPMENT AT CEDARS RAPIDS, QUEBEC.

As announced in these columns some time ago the Canadian Society of Civil Engineers, recognizing the extent and importance of the large development near Montreal of the Cedars Rapids Manufacturing and Power Company, arranged to have the subject dealt with in three papers, each dealing with a separate division of the work, by engineers connected with the development.

The first paper was presented on November 4th by Mr. Henry Holgate, M. Can. Soc. C.E., consulting engineer, Montreal. It had to do with the history and legal phases involved in the organization and the early stages of the work.

The second paper was presented by Mr. Julian C. Smith, M. Can. Soc. C.E., general manager of the Cedars Rapids Manufacturing and Power Company. It treated of the general hydraulic design, hydraulic machinery, auxiliary equipment and some phases of the construction work. This paper was presented on November 18th.

The third paper of the series was presented on December 2nd by Mr. R. M. Wilson, M. Can. Soc. C.E., chief engineer and general superintendent, Montreal Light, Heat and Power Company. It dealt with the electrical design and construction of the plant, electrical testing and the operation of the plant during the past year.

This large hydraulic development, one of the most extensive in Canada, has been dealt with in numerous articles that have appeared during the past two years in *The Canadian Engineer.* Many interesting and important details, previously unrecorded in the engineering press, have been brought to light, however, in the three papers referred to above. In our issue of November 18th we referred to some features of that division of the subject treated by Mr. Holgate; the following paragraphs have been extracted from Mr. Smith's exhaustive paper; and in an early issue we hope to similarly refer to the phase of the work dealt with by Mr. Wilson at the meeting on December 2nd.

According to Mr. Smith, the engineering problem involved was to design a plant which would utilize the 56,000 cu. ft. per sec. (which the company had acquired the right to use) from the St. Lawrence, with its total head of 32 ft., without affecting the navigation of the river, and to keep the cost of the development within such limits as would provide for a commercially successful future. An important finding in the early stages of investigation was that relating to the freedom of the tailrace level of the proposed plant from ice troubles in the river, and the design proceeded on the assumption that both the tailrace level and the headrace level fluctuated approximately the same amount, leaving the head acting on the plant approximately constant at all seasons.

The paper describes first the general scheme of development and the construction of the dyke and canal. The velocity of the water in the canal was chosen as 3 ft. per second for normal water conditions, for the final development of 160,000 h.p. Owing to a variation of velocity and to a fluctuation in the river above the power-house amounting to 6 ft., the south bank of the canal was constructed so that under worst conditions of high water and high wind waves would not overtop the embankment, high winds being apt to prevail in the locality at certain seasons of the year. The effect of waves was given careful consideration in the design of the plant. This is a rather unusual element in power plant design.

The velocity of the canal, stated above to be 3 ft. per second under normal conditions, increased, during low water and with ice coating, to 4 ft. per second, and creating a problem in which the canal had to be considered as an open channel in the summer and a closed conduit in the winter.

The probable effect of sudden load changes on the water level was also studied and provided for.

The south bank of the canal rests on solid rock throughout the lower section and has a concrete core wall, except at the upper end. The total excavation for the first development of 100,000 h.p. included 1,800,000 cu. yds. of earth and 650,000 cu. yds. of rock, this material being used in the sides of the canal.

The velocity of the river being high, about 7 or 8 ft. per second, and that of the water entering the canal comparatively low, about 2 ft. per second, a series of cribs was constructed to deflect the main current farther out into the river and minimize the probability of floating material entering the canal. Further precaution against ice involved two sets of openings through the south bank, each consisting of 17 openings, each of which has a free span of 15 ft. These are closed with stop-logs, which may be adjusted at will to provide an overflow of about 2 ft., creating a high surface velocity, which will remove the ice, assisted by properly located booms.

The power-house, which is really a dam at the end of the canal, will ultimately be 1,200 ft. long, but at present is approximately 700 ft. Openings are provided here also for the removal of ice and other material that may collect in the canal.

The substructure as now constructed has ten units, each of about 10,800 h.p., and three exciters, each of 1,500 h.p. An interesting study was presented in the selection of type of thrust bearing from the three types in common use, viz., the oil pressure bearing, the roller bearing and the Kingsbury bearing. The paper enters into a review of the advantages and disadvantages of each type, a study of which led to a decision in favor of the Kingsbury bearing, and a further decision to place the thrust bearing on the top of the machine in order to make it more accessible, and also to reduce the thickness of concrete required under the machine. A thrust bearing between the water-wheel and the generator would have necessitated a tunnel passage for accessibility. The design finally adopted involved cast-iron brackets to carry the thrust bearing on the generator, which provided a construction of satisfactory rigidity and little variation.

The paper deals also with the construction of the power-house superstructure, the features of which have already been fully covered in these columns. It will be remembered that the unit method of construction was used.

Proceeding onward to a discussion of the hydraulic equipment, Mr. Smith describes the governors, racks and gate hoists. The racks are specially rolled sections, made up of bars 2¾ in. deep by 5/16 in. thick and spaced 3 5/16 in. c. to c. They are made in two sections, upper and lower, and are located in slots in the concrete, providing easy removal, although the water may be over 35 ft. deep in front of them. Owing to this depth the facilities provided for cleaning the lower parts of the racks consisted of an emergency set of gates by means of which the entire inside water system, including racks and gates, can be completely unwatered.

Each unit has three openings, about 13 ft. in width, each of which is provided with two gates, upper and lower, the combined height of which is 27 ft. There are, therefore, six gates for each unit. Two different schemes were adopted for their manipulation. The bottom gates descend by their own weight and are raised by motor-driven drums. The upper gates are provided with screw hoists. A reinforced concrete beam, located about half-way down in the entrance to the wheel chamber, supports these upper gates. It requires a 15 h.p. motor to operate the three lower gates and a 30 h.p. motor to operate the three upper gates.

The exciter turbines are provided with two gates, operated by a screw hoist similar to that used by the main units.

Studies of friction between gates and guides were very carefully conducted and the efficiency of the hoists exhaustively studied.

Mr. Smith devotes some space to the factors governing the selection of the vertical type of unit in place of the horizontal, observing that he had previously been an advocate of the horizontal unit on account of the various difficulties with the thrust bearings and the operating experiences of many in connection with the vertical unit. The horizontal unit has the advantage of being very much more accessible, both as regards water-wheel and generator, while in the case of serious repairs, the vertical machine must be almost entirely dismantled.

In the Cedars development it was decided to limit the number of units to eighteen. If the horizontal machine had been adopted, these units, of over 10,000 h.p. each, would have necessarily required at least four runners. The diameter of the single runner at its widest point is nearly 18 in., and it is evident, states Mr. Smith, that a single runner cannot be turned up on edge and used in a plant, the total head acting being only 30 ft. A very exhaustive study was made of this four-runner design, and the results were so much in favor of the single runner that the vertical type was adopted.

The main unit consists of a single runner vertical wheel supported on a thrust bearing carried on the top of the generator. The shaft is held in line by one babbitted guide bearing immediately below the thrust bearings and one lignum vitæ water-lubricated bearing just above the wheel. The speed of operation is 55.6 revolutions per minute.

The shaft is a solid forging, with a coupling at the lower end, where it is bolted to the water-wheel runner. It is 32 ft. long, 25 in. diam. and 24 in. diam. at the lower and upper guide bearings, respectively, and 27 in. diam. in the hub of the generator.

A unique feature is the provision of a cast-iron speed-ring, located just outside the movable guide vanes to provide support and to guide the water in the proper direction.

These movable guide vanes control the amount of water admitted to the wheel. They are operated by two trunk piston operating engines connected to the operating ring at points 180 degrees apart.

The runner is the largest in dimensions yet constructed, being 17 ft. 7 in. in diam. The total weight of the revolving system is 550,000 pounds. This weight is carried down through the bridge on top of the generator and through the generator frame itself to the cast-iron pit liners, which, in turn, transmit this load to the speed-ring and the speed-ring carries it to the concrete foundations of the power house.

On account of the characteristics of the thrust bearing and in order to save time in shutting down each unit, a system of grates, operated by compressed air, was installed. There are six break-screws of hard rock maple, each with a face of 225 sq. in., pressed against the lower edge of the specially designed generator rim. Compressed air at 90 pounds pressure brings the revolving mass to rest in less than five minutes.

The power-house is served by two cranes of 150 tons each, among the largest in Canada, each with an auxiliary hoist of 10 tons. The span is 61 ft. 3 in. and the lift 49 ft. Each crane is operated by four 3-phase, 60-cycle, 220-volt motors. A 30-ton crane operates in the gate-house with 32 ft. span and 40 ft. lift.

The governor system supplied by the I. P. Morris Co. is the open system, consisting of pumps applying pressure direct into mains, which convey the pressure to the governor engines and governor control apparatus. The discharge from the apparatus flows back into an open tank. In this extensive Cedars system considerations of water hammer had to be gone into carefully, the medium used in the governor being water. A unique feature of the system outside of the large sizes of pumps, which are six-stage centrifugal, with a maximum pressure of 250 pounds and a capacity of 1,100 U.S. gallons per minute, is the use of a reinforced concrete flume lined with copper extending the whole length of the power-house and acting as a storage for water for the governors.

One special feature of the entire arrangement of the power-house is that all auxiliary apparatus is on practically the same level as the main units, and no machinery vital to the operation of the plant operates in lower levels, tunnels or inaccessible places. The exciter machine, motor generator sets, pumps and other auxiliaries are all under the eye of the men in charge of the main units.

The lubricating system is an extensive one. The thrust bearings of each main unit require 15 gallons per minute and that of each exciter unit five gallons per minute. The guide bearings of the main and exciter units require 3 gallons and 1 gallon per minute, respectively. Sufficient storage is supplied to operate the plant for 30 minutes in the event of the stoppage of the electrically-operated centrifugal pumps, which bring back the oil to the filters, from which it flows by gravity through storage tanks to the different thrust bearings and guide bearings.

Mr. Smith's paper concludes with a brief summary of construction. The first work started in June, 1912. Power-house excavation started in the spring of 1913. The first concrete was placed in August, 1913, and the power-house was completed in October, 1914. The canal was flooded on October 29th, 1914, and in December the entire plant was turned over for operating.

The American Well Works Co., of Aurora, Ill., are establishing a branch at Chatham, Ont., having purchased the factory formerly occupied by the Defiance Engine Co. They intend to add to the buildings and equipment of this concern at once, and will begin operations at an early date. They will start with a force of about 60 men and will manufacture various lines of pumps, making a specialty of deep-well pumps. Their sales agents are R. H. Buchanan and Co., of Montreal; Gorman, Clancey and Grindley, Limited, Edmonton and Calgary; and the British Columbia Equipment Co., of Vancouver.

SOME PRINCIPLES GOVERNING THE DESIGN AND THE OPERATION OF IRRIGATION SYSTEMS.*

By Sam G. Porter, B.A., B.S., M.Can.Soc.C.E.
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An irrigation system, like any other machine, must be designed to meet the requirements of efficient operation. A machine may be perfect mechanically, and built of the best material to be had, yet be worthless as a working unit because it does not fulfil the practical requirements of operation. This analogy is not sufficiently recognized by many who are responsible for the design and the operation of irrigation plants. It is not the purpose of this paper to present a complete discussion of the principles of design and construction of irrigation systems, but to emphasize one or two important features which do not usually receive sufficient consideration.

The design of many irrigation canals is based on the theory that the required carrying capacity of the canal depends solely on: (1) The area to be irrigated; (2) the duty of water, or the quantity to be supplied per acre each season; (3) the length of the irrigation season, or length of period required to mature the crop irrigated.

*From the report for 1914 of the Department of the Interior, on Irrigation.

These three factors, together with a proper allowance for losses, determine the total quantity of water required per season, but they do not, by any means, determine the necessary rate of delivery or carrying capacity of the canal. As a matter of fact, this latter requirement is practically independent of the second and third factors, as stated above. In other words, it may easily happen that a canal serving a certain area which requires 1.5 acre-feet per acre per season may need to be fully as large as another canal serving an equal area, which requires 3.0 acre-feet per acre per season. The reason for this will, I trust, be made clear by the discussion which follows.

It is the practice in India and Egypt to express the second factor, on duty of water, in the number of acres which a flow of 1 cubic foot per second will serve, while the third factor, or length of period of flow, is called the "base" of the duty. Usually the "base" is the period required to mature the crop. It is sometimes used, however, in a more restricted sense to apply to the period of maximum demand, called by Buckley the "period of pressure." Likewise Parker uses the term in both ways, to express the length of the irrigation season, and also as "the interval between successive waterings." In American practice, duty was formerly expressed in acres served per second-foot, often without defining the length of period of flow. This, of course, was very indefinite. Now it is usually expressed in depth of water applied, or in acre-feet per acre per season, and the maximum demand

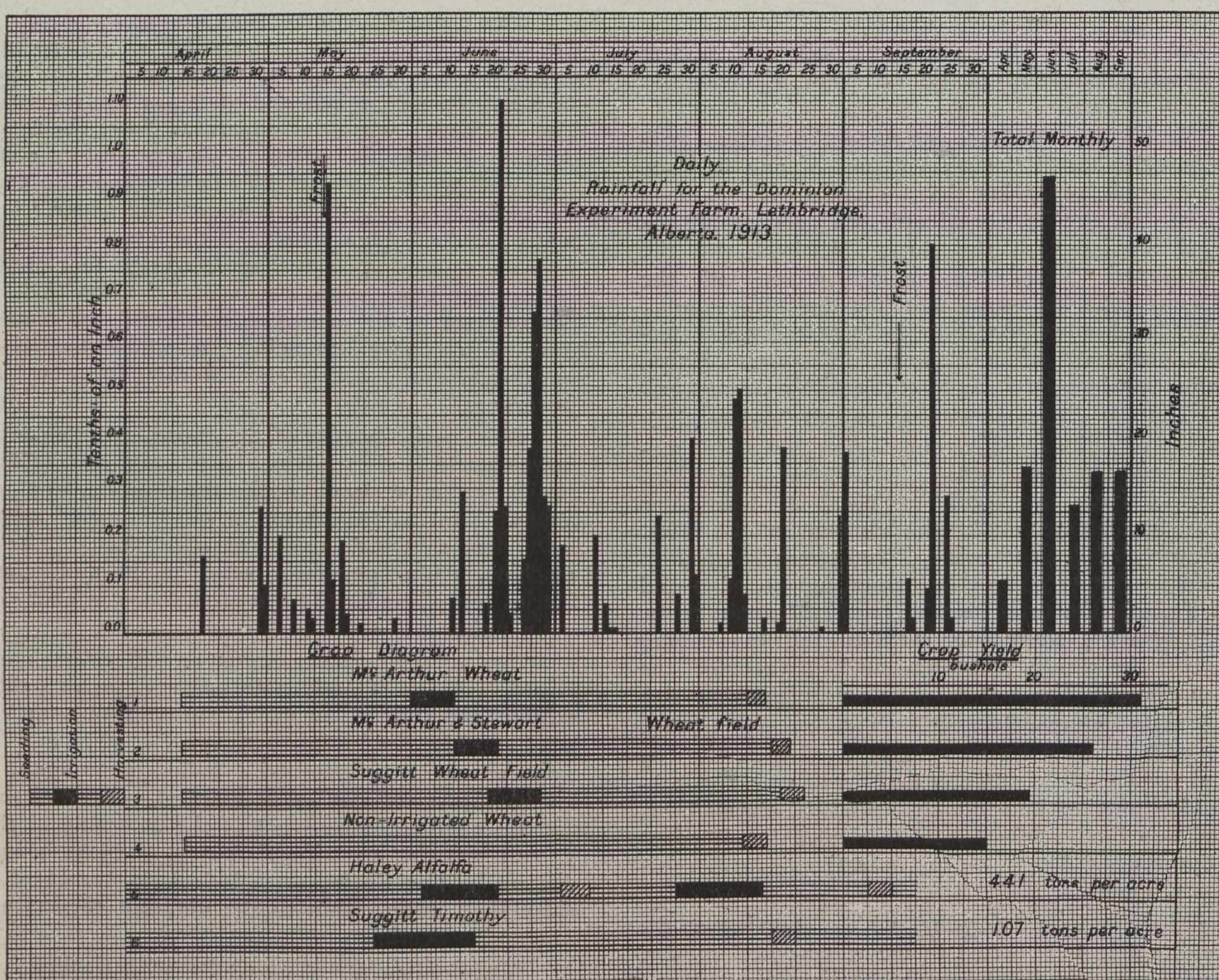


Diagram Showing Effect of Rainfall and Irrigation on Crop Yield.

as a certain depth applied in one month, or a certain percentage of the full season's duty in one month.

As already pointed out, the total quantity required for the season does not determine the required rate of delivery, for it does not take into consideration the fluctuating character of the water requirements. The demands through the season are never, under any circumstances, uniform. To state the quantity required per month, rather than per season, is better, but even the arbitrary division into months may not always meet the conditions imposed. The base should be that period, of whatever length, within which important crops under the system must receive an irrigation, or, this being delayed, will suffer in consequences. The length of the period will be influenced by the climatic conditions and the nature of the crops. In Egypt, for instance, the principal crop is cotton, and it has been determined that it requires an irrigation once in eighteen days. The base in that case should be eighteen days and the capacity of the system determined on that requirement.

The question arises, will this principle apply to conditions in Southern Alberta? The climatic conditions of a short season, but long days of bright sunshine, produce a short, intense growing season which necessitates the crop being urged through the growing stage without opportunity for a set-back, otherwise either the yield will be materially reduced or the date of maturity will be too far prolonged, or both. Hence the maximum demands are concentrated within a very short period.

Not to be provided with a reasonable irrigation within that period will mean practical failure, or at least dry-land returns to most crops. It may be called the critical period, and its length should be the "base" used in computing the required rate of delivery. Probably a fair statement of its length as applied to average conditions in Southern Alberta is fifteen days.

A chart appearing elsewhere in this report entitled "Diagram showing the effect of rainfall and irrigation on crop yield" under the report of the Duty of Water investigations presents a very striking illustration of the above argument. It will be noted that the McArthur wheat, irrigated at the proper time, produced 31 bushels per acre, the McArthur and Stewart wheat irrigated nine days later fell off 15 per cent. in yield, and the Suggitt wheat irrigated sixteen days later fell off 37 per cent. It is also worthy of note that a delay in applying the irrigation likewise delayed the date of maturity of the crop.

In arriving at the conclusion that fifteen days, or thereabouts, is the length of the critical period and is to be used as the base in our computation, it does not necessarily follow that all the land under the system must be provided with an irrigation within that time. Two important factors need to be considered in that connection: first, what is termed the "irrigation factor," or the percentage of the entire irrigable area which is likely to be irrigated during any one season; and second, the percentage of the area which is in crops whose water requirements are of an exacting, non-drought-resisting nature. It is essential that crops of this class, in which may be included grains, garden produce, sugar beets, etc., be provided with water promptly when needed. On the other hand, such crops as alfalfa, while requiring a greater total amount of water during the season, are less exacting in their demands, and can suffer a delay with less permanent injury. It will then serve his own interest, no less than the efficiency of the system as a whole, for the irrigator to plan to water his forage crops as much as possible before and after the critical period during which all the water supply, and perhaps more, is required to save the more perishable crops. It is evident that the greater the proportional area in one crop of an exacting nature, the greater the allowance necessary for increased capacity during periods of pressure.

Ordinarily the irrigation factor will not exceed 80 per cent. For illustration let it be assumed that 75 per cent. is a fair figure. Then, with 25 per cent. of the land idle, and, say, 25 per cent. in crops whose requirements are of the less urgent nature, 50 per cent. must be watered during the critical period.

The depth which will be required for one irrigation will, under ordinary practice, vary from 0.3 feet to 0.8 feet, and will average 0.5 feet.

On the above assumed basis, the system should be designed to deliver 0.5 feet depth to 50 per cent. of the irrigable area in a period of fifteen days. This is equivalent to 0.25 acre-feet per acre in fifteen days, or 0.0167 acre-feet per acre per day, equal to 0.0083 second-feet per acre, or a net capacity of one second-foot for each 120 acres. Frequently only one irrigation will be applied in this climate on certain crops; but just as great a capacity, if not greater, is required to deliver that one irrigation at the proper time as for three or four irrigations, extended over the entire season, because the major part of the land will want it at one and the same time.

The above serves to emphasize the importance of a proper diversification of crops, in order that the water requirements may be more evenly distributed. It also emphasizes the importance of reservoirs for storing water during periods of low demands for use during periods of pressure.

The old system of constant flow delivery has given place almost universally to the more practical rotation system. But in adopting the rotation method of delivery instead of the constant flow, the extreme should be avoided. That is, the rotation period must not be made too long. This point has been brought out in discussing the capacity to be provided for in designing the system. It may be presented from a partially different point of view. What is meant by going to the extreme in rotation is giving each farmer enough water to thoroughly irrigate his entire irrigable area in one short run. It is better to divide it into two or three runs, so that he will always have at least a small quantity at his disposal within a short period rather than the whole quantity at once, and being compelled to wait correspondingly longer between runs. In other words, he can come nearer meeting the agricultural requirements with a flow two days out of each ten, or three out of each fifteen, than if he has one run of six days in each thirty. It is in every way fairer to the water user, for if he receives a run only once in thirty days, and must take it in his turn, it may come either before or after the time he most needs it. On the other hand, his neighbor's turn comes just at the period of greatest need and produces much greater benefit. Such an arrangement works an injustice.

It is much easier to plan a system of distribution where the rainfall is negligible. Rainfall introduces complications. Where the irrigator is of an optimistic disposition, and likewise strongly disposed to avoid unnecessary labor, he is likely to postpone his irrigation to the last possible moment, on the prospect of a providential rain making it unnecessary. The hoped-for rain does not come, the farmer is thrown behind in his work, the water demands become congested, the irrigation system is overtaxed, and the crops suffer by the consequent delay.

Engineering design and operation management are of primary importance, but for ultimate success they must be supplemented by the co-operation of the water users themselves, who must exercise foresight and skill in their own methods. Results are the measure of success. A loss of five dollars an acre more or less, in crop returns, either by not being able to deliver the water at the time it will do the most good, or by not properly handling it when it is delivered, is sufficient evidence that the machine is not properly doing its work.

THE MINERAL PRODUCTION OF ONTARIO IN 1914.

According to the report for 1914 of Mr. Thos. W. Gibson, Deputy Minister of Mines for the Province of Ontario, the production of minerals in 1914 was less in value than for 1913 by $6,936,352, or 13 per cent. The falling off is considerable, yet the causes are not far to seek. Early in 1914 it became evident that a business depression was setting in, which in any event would have led to a lessened output of certain of the mineral products, notably pig iron and all materials of construction such as bricks, cement, etc. Other articles on the list would also have suffered from the same cause. In addition, it is recognized that the silver mines of Cobalt have passed their zenith, and in any circumstances—except possibly the occurrence of a very high price for silver—the output of silver would have been less than in 1913.

But all these causes were gathered up and given additional weight by the outbreak of hostilities in Europe. Silver mining was temporarily paralyzed, and the Canadian Copper Company shut down four of its six nickel-copper furnaces. Capital was frightened, and money could not be borrowed to carry on going concerns, to say nothing of opening up new enterprises. Prices of products dropped, and the cost of supplies went up. Some kinds, indeed, could not be had at all, or only in insufficient quantity. For a short time uncertainty prevailed, but ere long it became apparent that overseas commerce could still be conducted, although owing to the diversion of many passenger and merchant vessels, with some irregularity and at greater expense. By lowering the price of silver, which fell to 49 cents per ounce before the close of the year, the effect of the war was undoubtedly to lessen the activity of companies at Cobalt, some of whom preferred to allow their ore to remain in the mine rather than produce and market the metal at its reduced value. Nickel mining recovered from the shock caused by the outbreak of the war, and in November the Canadian Copper Company increased the number of their furnaces in blast to four; early in 1915 the whole six were again in operation, and the company was preparing to build a seventh. The Mond Nickel Company, on the other hand, whose matte is exported to Wales for refining, having got their new works at Coniston into going order, pushed production to the utmost limits. On the whole, considering the tremendous nature of the conflict and the unprecedented disturbances in finance and commerce to which it has given and is still giving rise, it must be admitted that the mining industry of Ontario has stood the strain very well. The wonder is, not that the diminution in the output was so great, but that it was not much greater.

The following table summarizes the mineral output for the year:—

Product.	Quantity.	Value.
Metallic:		
Gold, ounces	268,942	$ 5,529,767
Silver, ounces	25,217,994	12,795,214
Copper, tons	14,453	2,081,332
Nickel, tons	22,760	5,109,088
Iron ore, tons	240,059	531,379
Pig iron, tons	556,112	7,041,079
Cobalt ore, tons	97	27,743
Cobalt oxide, lbs.	643,891	518,736
Nickel oxide, lbs.	303,752	27,716
Cobalt and nickel oxides, lbs.	113,843	45,189
		$33,707,243
Less Ontario iron ore (163,779 tons) smelted into pig iron	....	361,952
Total metallic production..	....	$33,345,291
Non-metallic:		
Arsenic, refined, lbs.	4,059,868	$ 116,624
Brick, common, No.	294,400,000	2,336,207
Tile, drain, No.	14,710,000	277,530
Brick, paving, etc., No.	11,639,000	237,440
Brick, pressed, No.	61,934,000	656,944
Stone, building, etc.	....	1,088,862
Calcium carbide, tons	2,381	142,883
Cement, Portland, bbls.	2,665,650	2,931,190
Corundum, tons	548	65,730
Feldspar, tons	18,062	55,686
Graphite, refined, tons	1,363	87,167
Gypsum, crude, tons	43,183	58,800
Gypsum products, tons	31,117	162,375
Iron pyrites, tons	107,258	264,722
Lime, bushels	2,075,228	333,407
Mica, tons	349	40,402
Natural gas, million cu. ft.	14,063	2,346,687
Peat, tons	600	2,100
Petroleum, Imp. gals.	7,437,356	337,867
Phosphate of lime, tons	450	3,150
Pottery	....	25,720
Quartz, tons	52,947	82,544
Salt, tons	104,774	498,383
Sand and gravel, cu. yds.	359,100	151,909
Talc, crude, tons	1,269	3,807
Talc products, tons	8,866	70,776
Sewer pipe	....	571,756
T'l non-metallic production	....	$12,950,668
Add metallic	....	33,345,291
Total	....	$46,295,959

COBALT ORE SHIPMENTS.

The following are the shipments of ore, in pounds, from Cobalt Station for the week ended November 26th, 1915:—

Buffalo Mines, 60,681; Penn Canadian Mines, 70,725; La Rose Mines, 87,195; Mining Corporation of Canada (Cobalt Lake Mines), 184,573; Mining Corporation of Canada (Townsite City Mine), 159,631; Peterson Lake Silver Mining Company, 129,892; O'Brien Mines, 147,536; McKinley-Darragh-Savage Mines, 241,472; Dominion Reduction Company, 176,000. Total, 1,257,705 pounds, or 628.8 tons.

New Liskeard—

Casey Cobalt Mine, 84,620 pounds.

The total shipments since January 1st, 1915, are now 28,508,204 pounds, or 14,254.1 tons.

FIELD FOR HIGHWAY ENGINEERS

By F. A. Churchill,
With the Dunn Wire-Cut-Lug Brick Co., Conneaut, Ohio.

DESIGNING and constructing street pavements and highways has become a specialized branch of engineering. Road improvement as an adjunct to agricultural and commercial development is now so far recognized as a necessity that modern road building is limited only by ability to finance the movement. No settled section is now deaf to the appeals of reason and self-interest. Yet great as has been the mileage of road improvement during the past decade, the surface of possibility has been no more than scratched.

There are in the United States, for instance, approximately 2,200,000 miles of established highways, of which only 240,000 miles have been improved, and of these many are in need of reconstruction.

As knowledge of the fundamental principles of construction extends, a vast field for highway engineering opens. Indeed, the demand for really competent, up-to-date highway engineers already exceeds the supply.

Our colleges and universities are seeking to fulfil their obligations to the public and to the students by offering courses in Highway Engineering. This is a laudable undertaking, and it is laying the ground work for a future usefulness that will be of immense value. Some of these schools of highway engineering are in an experimental stage—tentative ventures, the success of which is yet to be demonstrated. Other schools have taken up the problem seriously and with evident determination to succeed.

There is a difference of opinion regarding the practical value of the training given in some of these schools, but that is a matter which will work itself out in time. The gratifying fact is that our higher institutions of learning realize the need for trained highway engineers and are trying to fill the gap in educational opportunities.

It is, perhaps, inevitable that theoretical highway engineering, taught by theoretical highway engineers, is preponderant in some of the schools. It is unquestionably true in many instances that graduates leave these schools with little practical knowledge of highway construction, although they are well grounded in the theory. The average new graduate can hardly be regarded as an expert, qualified to take entire charge of important work. Experience is needed. The same is true in any profession. Nor is it extensive work alone which is important. Every highway or street is important to the public, and anything less than the best engineering is a wrong committed at the cost of the community paying for the service.

Young highway engineers need experience under capable chiefs. Young engineers acquire in the schools a knowledge of fundamental principles, and they are taught the technique of designing; but the construction of a pavement involves matters of detail which the schools do not teach and which, in many instances, the schools can not teach. In a vital sense, each pavement is a distinct problem. Local conditions of soil, topography and traffic modify general specifications, and require the adaptation of methods to suit peculiar exigencies.

The highway engineer learns by experience that the success of his work often depends largely upon strict and correct attention to what appear to be minor details. It is only through the medium of experience that the highway engineer learns why apparently trivial details are of the highest importance.

That highway construction is rapidly becoming a test of engineering ability is a truth which ought to be emphasized. The public is becoming so far sophisticated in such matters as to be able to make a fairly just apportionment of blame. The engineer in charge is blamed for the shortcomings of the contractor if the latter follows the former's designs, specifications and orders.

In other words, where the engineer is responsible for the design and has absolute jurisdiction over the manner in which the contract is executed, he is held to accountability for results. Exception to this rule is noted in case higher authorities, either public officials or property owners, select a type of pavement unsuited to the particular location for which it is chosen.

A fundamental, and enormously expensive, weakness in our system of road improvement is in allowing incompetent persons to determine the kind of roadway to be constructed. Only a competent engineer can estimate the volume, kind and weight of traffic that a highway may be called upon to bear in future years. Only a trained and well-informed engineer knows what kind of road surfacing and constructional methods ought to be adopted in order to ensure a roadway which, with proper maintenance, will endure until after the construction bonds have been retired.

The engineer should stand between the taxpayers and their ignorance, prejudices, errors of judgment and politics. Unfortunately the engineer sometimes can do no more than proffer advice. When he cannot select the type of pavement to be constructed, even the best engineer cannot be held responsible for results.

Nevertheless, the engineer who is loyal to his convictions and to the public is gradually coming into his own. The people are beginning to heed the advice of engineers who are known to be honest, fearless and capable.

In Europe, the engineer decides all highway questions. If a road is to be improved, the authorized engineer determines the kind and width of improvement, the grades and where the road shall go. That is one reason why Europe has an intelligently designed system of good roads. Another reason is found in the fact that contracting usually is an hereditary business descending from father to son, generation succeeding generation. Contractors, therefore, have pride in their work and they are loyal to the traditions of their families. The third reason is that government supervision supervises.

The best highway engineers know that the final word in highway construction has not been spoken. There remains something to be learned. This fact gives an incentive to ambitious men to engage in highway engineering. The field for development is unlimited.

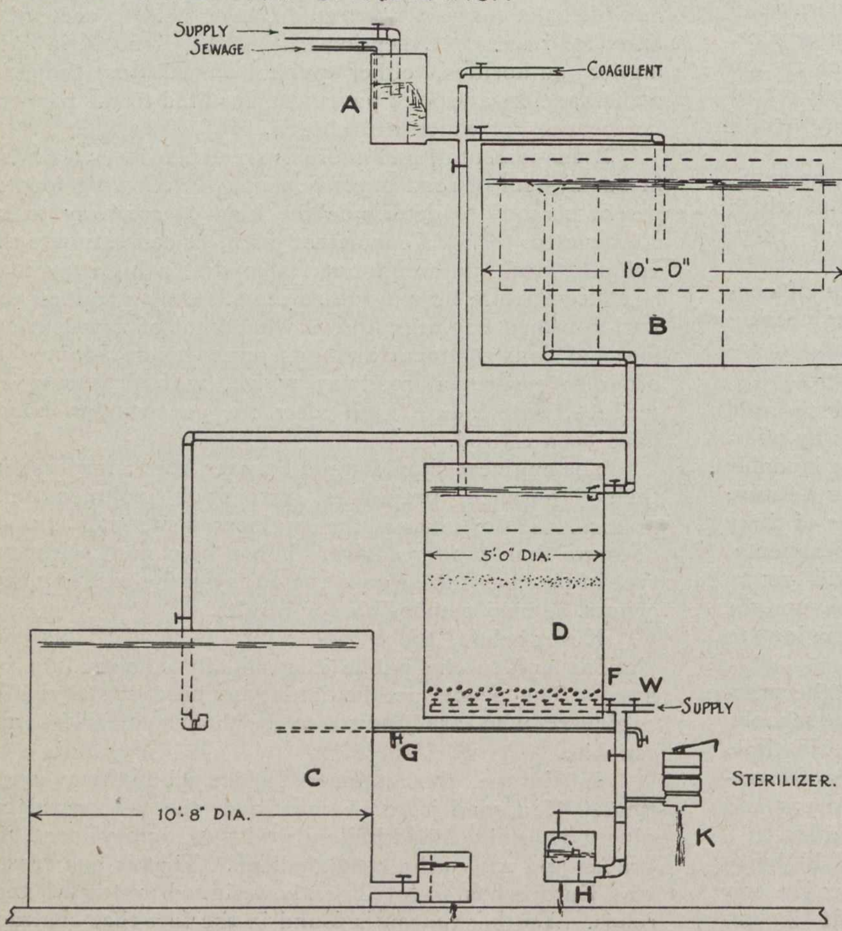
EXTENSIVE ROAD SYSTEM PROJECTED FOR NORTH YORK COUNTY, ONT.

In order to link up the good roads system of the Ontario counties of Simcoe and South York, it is proposed to proceed with road improvement in North York to the extent of about $500,000. This will involve the construction of about 100 miles of unimproved road in addition to an appropriation of $68,000 for bridges and culverts. According to Mr. E. A. James, engineer to the York County Highway Commission, the system will provide for four through roads between Lake Ontario and Lake Simcoe, in addition to the improvement of the existing cross-roads. It will link up the six market towns of Schomberg, Aurora, New Market, Sutton, Mount Albert and Stouffville.

ULTRA-VIOLET RAY STERILIZATION OF WATER.

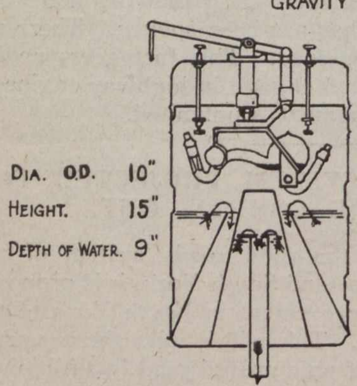
SOME interesting investigations into the efficiency of the ultra-violet ray method of water sterilization were carried out last year under the direction of Capt. F. A. Dallyn, C.E., provincial sanitary engineer of the Ontario Board of Health. The tests were performed by Mr. N. F. Parkinson, M.A.Sc., now on active service with the 13th Battery, C.F.A., Second Contingent. His report covers almost an entire year's investigations and brings out many advantages possessed by the ultra-violet ray method, as well as some difficulties encountered. An account of the work appears in the report, for the year 1914, of the Board of Health of Ontario. The following is a summary of the first part of the work, which divided itself into an investigation of (1) efficiency as considered from the standpoint of thorough disinfection, and (2) approximate estimate of cost. The latter will be referred to in a subsequent article.

ULTRA VIOLET RAY STERILIZATION



FIG·1·

GENERAL ARRANGEMENT OF 110 VOLT INSTALLATION
Showing Method of obtaining Supply from
GRAVITY MECHANICAL FILTER and SEWAGE POLLUTED TAP WATER



110 VOLT APPARATUS
being the
B_2 TYPE OF STERILIZER
MNFD BY
THE R.U.V. CO. INC. OF NEW YORK

FIG·2

Prefactory to a discussion of these questions, however, the following more general remarks are presented.

Production and Efficiency of the Ultra-Violet Rays.—It has long been recognized that light from certain sources is active as a germicide. The germicidal action of light rays has occupied for a considerable period a very prominent place in the deliberations of scientists and sanitarians, especially in the case of sunlight. Messrs. Downes and Blunt, Duclaux and others have demonstrated that solar light is capable of killing bacteria and certain fungal growths, and that this action is due to the ultra-violet portion of the spectrum, that is, to those waves recognized by their chemical activity rather than by their power of producing heat or light, (a photographic plate, exposed in the solar spectrum beyond the point where the visible blue-violet light appears, is rapidly sensitized). The bactericidal power of sunlight is greatly limited for the reason that its ultra-violet radiations do not reach the earth in sufficient quantity. The atmosphere absorbs ultra-violet rays; glass behaves in a similar manner.

Research has shown that certain artificial light sources produce these radiations to a large degree. This is particularly true in the case of the mercury-vapor lamp, the rays from which, as seen in Table I., are of such wave length as to give the light powerful germicidal action. This table, and some accompanying information, is quoted from an article by Dr. Jules Courmont, Professor of Hygiene, Faculty of Medicine, Lyons, in the "Revue Generale des Sciences Pures et Appliquees," Paris, April 30th, 1911.

Table I.

	Wave length.
Spectrum of Welsbach light.	
Upper limit of infra red	600.0μ
Solar spectrum.	
Upper limit of infra red	300.0
Upper limit of visible red ...	0.761
Upper limit of ultra-violet ...	0.397
Lower limit of solar spectrum	0.295
Upper limit of bactericidal ultra-violet	0.28
Metallic spectra.	
Inferior limit of mercury spectrum	0.2225μ
Limit of metallic ultra-violet..	0.12

The wave lengths of light rays are usually measured in units which have received the designation of "angstroms" (A. units). The angstrom unit is equal to 0.000,000,000,1 meters. Table I. gives the wave length of a few different places in the spectrum. For convenient tabulation the unit μ is used equal to 1/1,000 millimeter or equal to 10,000 angstrom units.

The upper limit of the very bactericidal ultra-violet is a wave length of 0.28μ. It is seen that the lower limit of the solar spectrum shows a ray length of 0.295μ, and this just approaches the length required for maximum bactericidal activity.

Ultra-violet radiations of solar origin, of length smaller than 0.295μ are entirely absorbed by the atmosphere and hence do not reach us. In order to obtain light which is truly bactericidal (of wave length less than 0.28μ), we must have recourse to artificial means.

The quartz mercury-vapor lamp is the most powerful of these. Luminescent mercury-vapor is very rich in ultra-violet light. Its ultra-violet spectrum reaches from 0.3650 to 0.2225μ. Quartz is transparent to all light of greater wave length than 0.15μ and to all the rays of the spectrum given out by the luminous mercury-vapor.

The ultra-violet rays of smaller wave length than 0.28μ and especially bactericidal; those between 0.28μ and 0.2225μ from the quartz mercury-vapor lamp are very destructive to all living cells, and dangerous to any one handling the lamp without proper precautions.

The spectra of sunlight and of quartz mercury-vapor lamp with wave lengths noted are compared in Fig. 5. Here is shown graphically, what Prof. Courmont states in his article, the overlapping of the quartz lamp spectrum into the field of bactericidal activity, while that of the sun, due to its passage through the atmosphere, stops before this point of maximum activity is reached.

Some work has already been done concerning the efficiency of the rays in the killing of bacteria, with pure culture of different forms, using a small 66-volt lamp, burning 3.5 amperes. Dr. M. Von Recklinghausen, at Sorbonne University, gives the result in graphic form (Fig. 6) showing a comparison of the resistance of different types of bacteria to the rays.

In the progress of the work carried out by Mr. Parkinson pure cultures of the different bacteria were not experimented with; a comparison between ordinary water bacteria and those growing at body temperature was, however, carefully made. The exposure was either in the ordinary commercial types of apparatus or by means of a quartz tube of dimensions and form as shown in Fig. 7. In the bulb of this tube the water containing the organisms was inserted by means of a pipette, care being taken not to wet the sides of the tube in doing so. Then the bulb was immersed in the tank until it was in the plane of the lamp, and at a predetermined distance. The screen was then removed from between the bulb and the lamp and the exposure timed carefully, the screen was then replaced and the bulb removed, the water being examined in the usual manner.

Results obtained in this way point out the fact that the sterilizing action is largely accounted for in the first close contact that occurs. Thus in five minutes' exposure at a distance of 22 inches from the light the action is not as great as in two minutes at 9 inches from the light, while it takes three minutes at this latter distance to sterilize the water. However, when the water is exposed

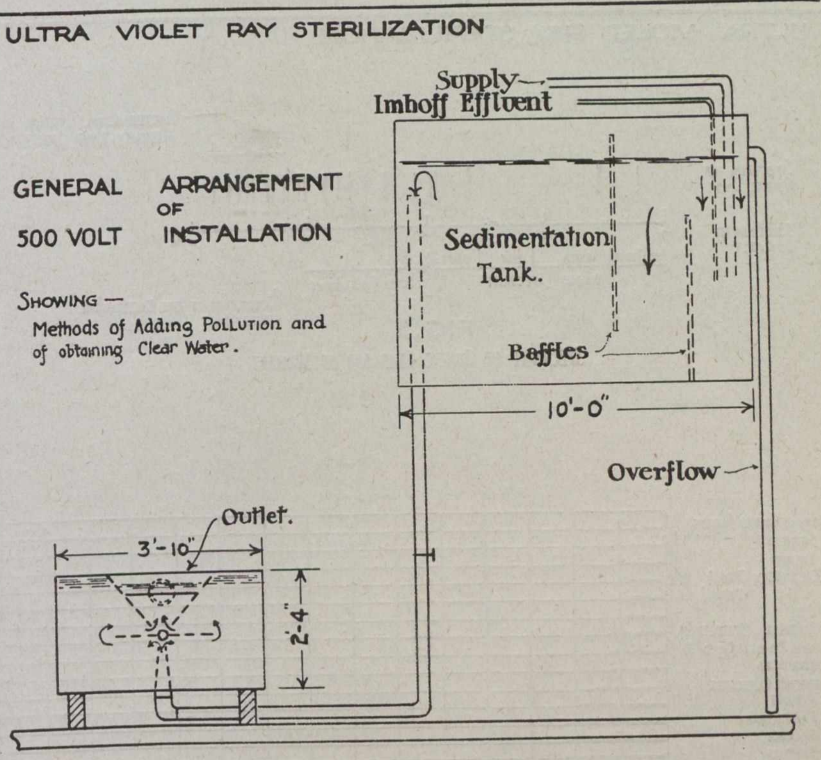


FIG. 3

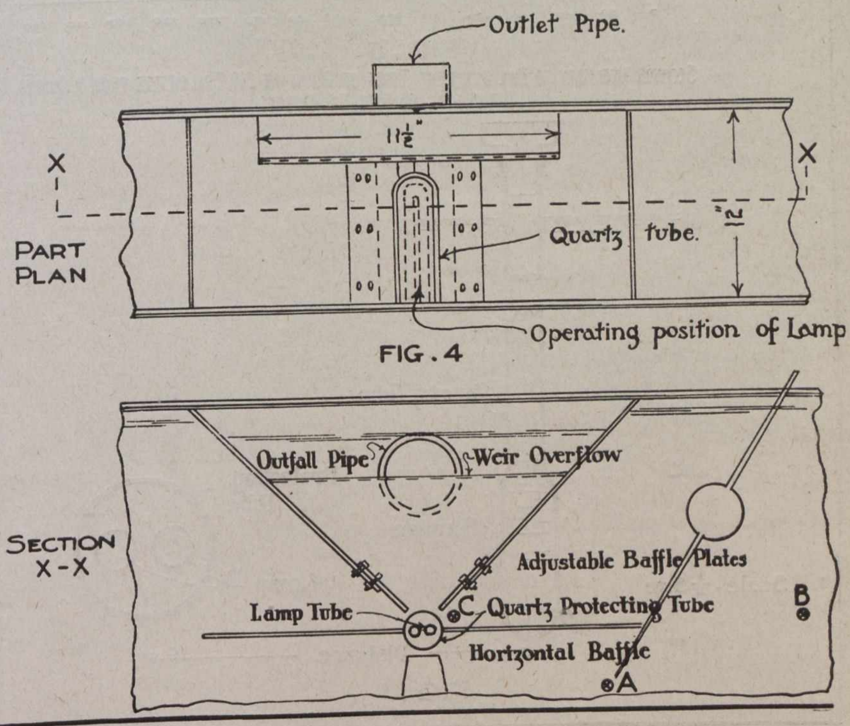


FIG. 4

as close to the lamp as possible, that is the sample tube touching the protection tube and creating a film of water about ⅜ inch in thickness next it, the sterilizing action is completed in a very small fraction of a minute and if the water were exposed in a thin film, the sterilization would be practically instantaneous.

In the consideration of the first question it included the determination of the efficiency of two different types of mercury-vapor lamps used for the production of the ultra-violet rays. The lamps were of the mercury-vapor type, and were supplied by the R. U. V. Co., of New York. The arrangement of the smaller lamp (B 2, Fig. 1) lent itself admirably to use in determining the relative effect of turbidity and different water conditions upon the bactericidal efficiency of the lamp. The following waters were treated, having in mind the desirability of determining to what extent the efficiency of the system would be impaired by conditions often met with in a raw water supply.

ULTRA VIOLET RAY STERILIZATION

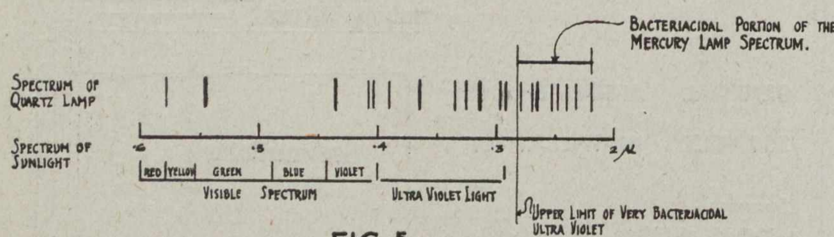


FIG. 5

SPECTRUM OF QUARTZ LAMP AND OF SUNLIGHT

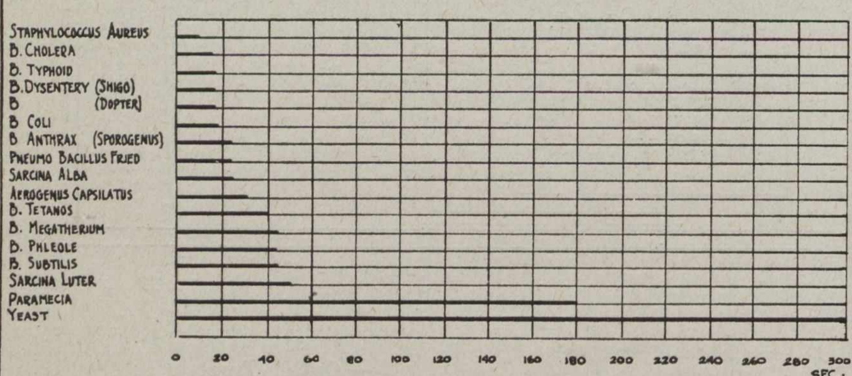


FIG. 6

SECONDS NECESSARY TO KILL DIFFERENT TYPES OF GERMS AT 200 MILLIMETERS FROM A QUARTZ LAMP BURNING AT 66 VOLTS 3.5 AMPERES

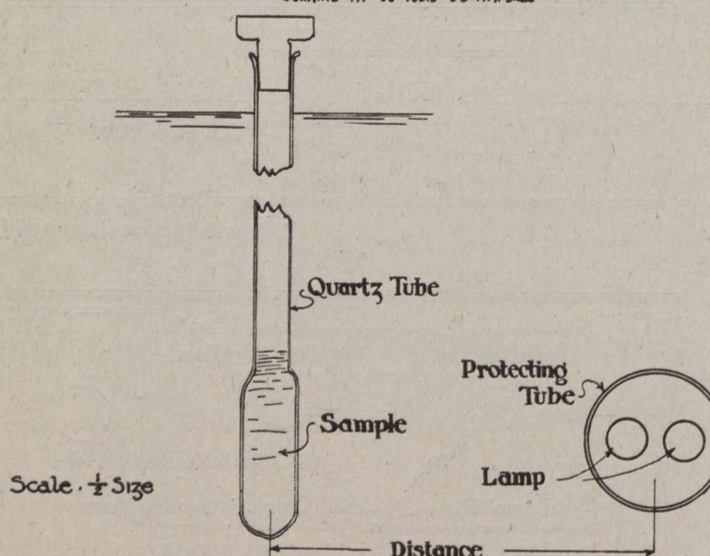


FIG. 7

(1) The effluent from a mechanical filter free from turbidity and all gross particles, and with varying bacterial counts, depending on the rate at which the filter was run and the abuse it was subjected to.

(2) Sewage-infected tap water, having gross particles present in varying amounts, and with a turbidity of five parts per million (American Public Health Standard).

(3) Sewage-infected tap water, having gross particles in suspension, and with clayey turbidity added as follows: (*a*) 20 parts per million; (*b*) 20-25 parts per million; (*c*) 30-50 parts per million.

The D.F. apparatus (Fig. 3) had a capacity of 3,000 to 7,000 gallons per hour. It was found impossible to get filtered water to supply this apparatus owing to the capacity and arrangement of the filters at the Experimental Station. Fortunately for the city of Toronto, water was usually of very good quality. The bacterial count of this water at the tap was so low that addition of pollution was necessary for the purpose of these experiments, as in the case of waters 2 and 3 treated in the B2 apparatus. Turbidities up to 30 parts per million were encountered at times, partly owing to the sewage added and partly from the condition of the tap water from storms affecting the turbidity of the lake water. On account of the sedimentation provided, no gross particles of any size reached the apparatus. The presence of minute air bubbles in the sterilizing tank did not seem to affect the efficiency to any great extent.

Apparatus.—The two forms of apparatus employed in this work are illustrated in Figs. 1, 2, 3 and 4, the form of the separate lamps being shown in detail in Figs. 2 and 8.

The 110-volt lamp (B2 type) is of different form from the 500-volt lamp. When in operating position the lamp is suspended over the surface of the water. The water is passed through a cylindrical tank with baffles so arranged as to give two close contacts between the water and the rays of the lamp. The mercury arc burns from one end of the tube to the other, and since the lamp is suspended above the surface less than one-half of the rays are downward. This causes the loss of over 50 per cent. of the emanations of the lamp. (The ultra-violet rays cannot be reflected like ordinary light rays.) The tank was 12 inches in diameter and 14 inches deep, the depth of the water being about 9 inches. The water is exposed to the rays during all the time it is in the tank.

According to experiments, the effective penetration of the ray is greater than the depth in this tank.

The 500-volt lamp used with the larger apparatus is of altogether different form from that employed in the smaller outfit. This lamp is surrounded by water and all the rays are utilized in sterilization. A sketch of the lamp itself is shown in Fig. 8, the method of generating the rays being the same as in the smaller type, namely, by means of the mercury-vapor arc, which is carried the length of the "U" tube. The sterilizer apparatus consisted of a metal tank arranged as shown. The water is brought into close contact with the rays on two occasions.

Both these types are for gravity installations, that is, they discharge the water by an overflow and not under pressure. The use of the pistol lamp (Fig. 8), however, makes it possible to construct pressure apparatus very easily. This apparatus may be placed either on the suction or discharge side of pump or in a water supply pipe line, and it does not necessitate a repumping or the provision of an extra pump well in a municipal plant. Two of these types of pressure apparatus are shown, one being a unit which is adapted for municipal use (Fig. 10), while the other, E. type (Fig. 9) is used extensively for boat supplies, public buildings, swimming pools, etc.

The gravity apparatus offers certain disadvantages for industrial or domestic purposes which are overcome to a great extent in the pressure type. That is to say, with the former type a storage tank must be used and the discharge from the apparatus must be at a sufficient height to deliver by gravity to the taps, otherwise repumping is necessary.

A particularly objectionable feature in the B2 apparatus exists in the case of water having small amounts of oil and other substances of low specific gravity in suspension. These substances come out of suspension and float on the surface of the water in the apparatus, and are held there by the baffle arrangement. The action of the rays is considerably interfered with by this screen.

In the type in which the lamp is suspended above the water there is a lack of economy. This form of apparatus is used where the supply of water required is small and a cost of 6 to 10 cents per day is negligible. (The apparatus is equivalent to a ¾ h.p. dynamo) and should be operated only off a power line.

In the case of the 500-volt apparatus the baffles were all movable and some work was done to determine the functions of the various parts, for instance, the opening between the baffles and lamp was changed or the horizontal baffles were removed entirely. These results may be of interest and are here given. Ten samples of the inflowing and outflowing water were taken under each separate set of conditions and the averages of the results are given in Table II.

The method employed was to take samples first with the baffles all in place, and at a rate of 3,000 gals. per hour; that is, the horizontal baffles were untouched, while the upper inclined opening (the bottom one was not capable of adjustment) between the baffles and the lamp was varied from ¼ inch to the maximum of 2½ inches, ten samples being taken under each set of conditions. The contacts were two in number, one between the riser pipe and the lamp of ½ inch, and the other ¼ to 2½ inches, as stated. The horizontal baffles were then entirely removed and the water run through at the same rate, and with similar changes in the inclined baffle opening.

The results obtained did not show the variation expected. It was supposed that the baffles were essential in the ordinary work of sterilization; that is to say, that by means of them the water was held in contact with the rays for a time in order that the action might be prolonged. However, the results given, together with the

ULTRA VIOLET RAY STERILIZATION

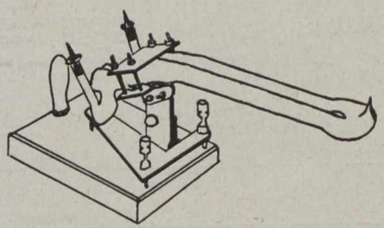


FIG. 8

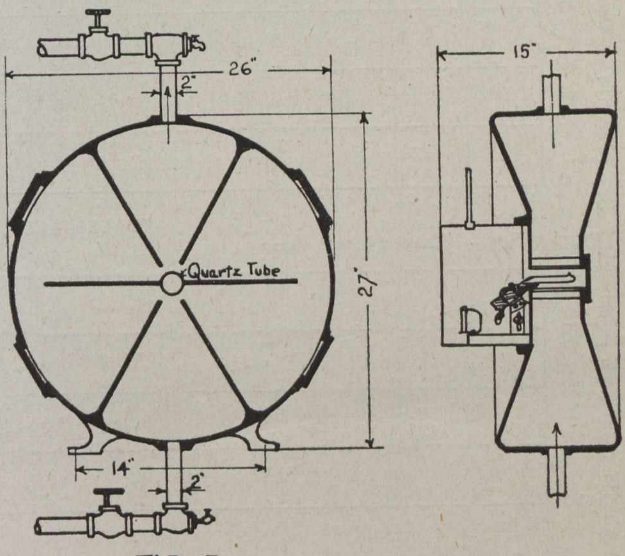


FIG. 9

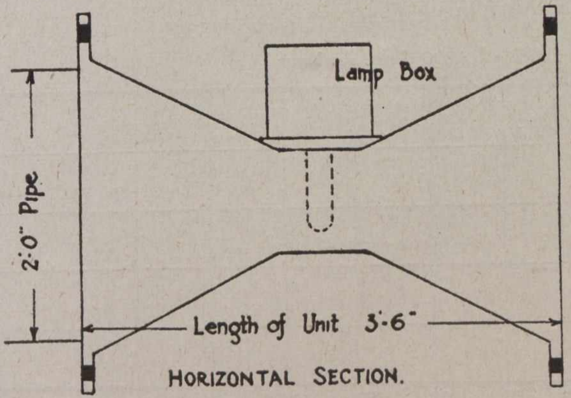


FIG. 10

general observations given above, demonstrate that the initial exposure on leaving the riser is responsible for the most of the sterilization taking place, the presence of the baffles and the second exposure being simply a means of procuring a safety factor in the operation of the lamp.

The treatment of turbid waters is now brought to our attention. With baffles adjusted unfavorably as regards the treatment of water of this character the removal of bacteria was exceptionally high, being well over 99 per cent. with turbidity of 20. With turbidity of 30 and a direct path between the initial and final exposure, that is to say with the horizontal baffles entirely removed, the removal was 97.5 per cent. and 98.4 per cent. as regards the bacteria growing at temperatures of 18-22 degrees C. and 37.5 degrees C. respectively.

The action as regards coli was not ascertained, due to the fact that the pollution of the water was greater than expected and the dilutions used did not define the limits. The bacterial count of sewage varies greatly from day to day, being affected by drainage conditions, and with apparatus arranged for a constant dilution it is difficult to judge as to the colon content of the treated water at any given time.

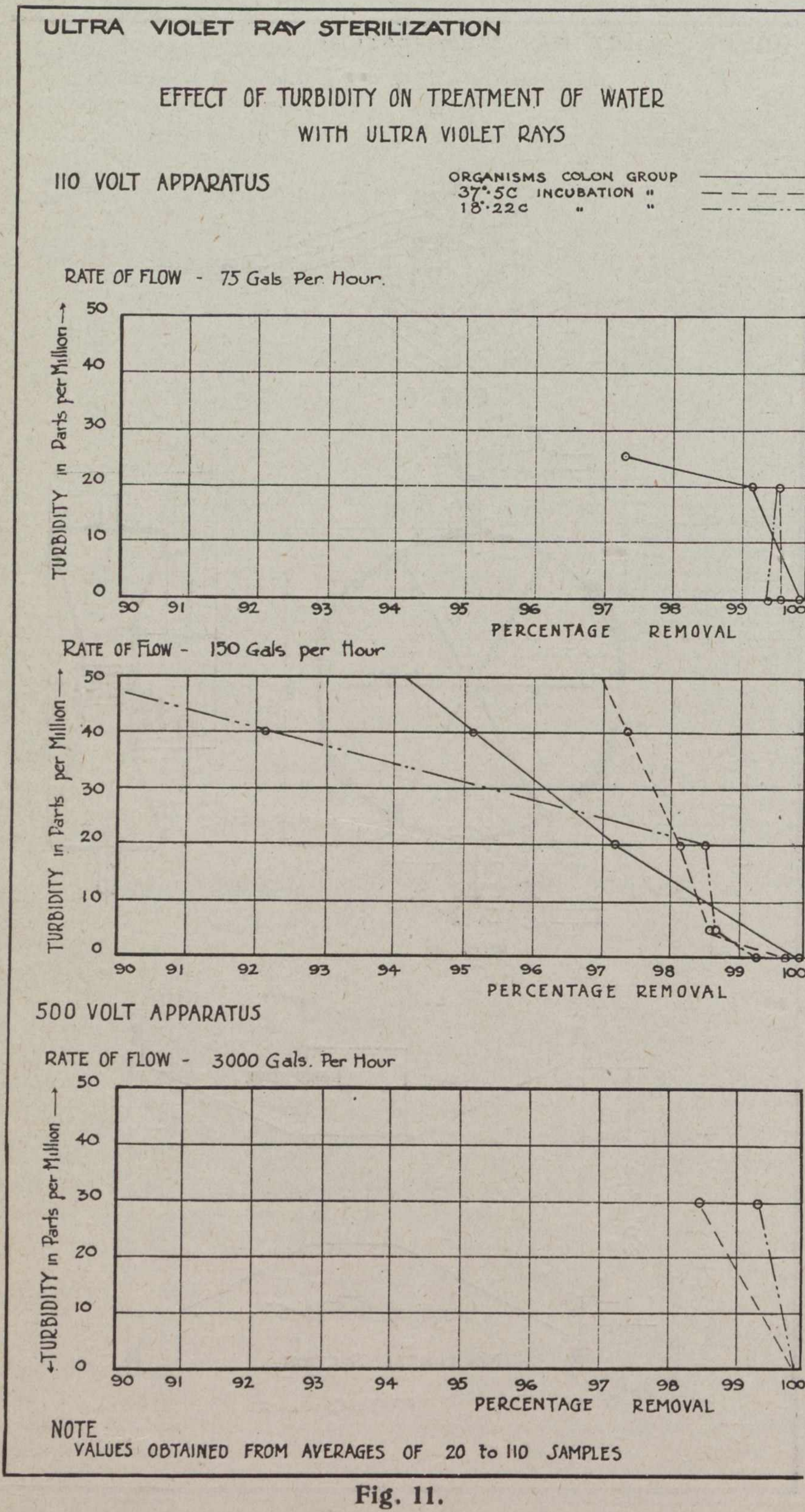


Fig. 11.

Following this work, other experiments were undertaken to determine the progress of sterilization in the tank itself. The samples, withdrawn through pipettes (Fig. 4) from the three different points marked A, B and C, were taken at the same time. By comparison of the counts from different sampling points with that from the influent the progress of the sterilizing action throughout the course of the water in the tank is followed.

The results (Table III.) show once more that most of the sterilization takes place on the first contact of the water with the rays; sample point A shows a reduction in count of 94 per cent. while the increase due to the action of the rays during the passage of the water from the lamp to the side of the tank, back again and past the lamp a second time is accountable for another 3.2 per cent., making a total reduction of 97.2 per cent. from influent to effluent.

As regards the operation of the lamps, the small one or B2 apparatus is first considered. Very few difficulties were encountered with this lamp after it was put in running order. Duplicate lamps were sent with the apparatus, which were both broken in transit, and both were repaired by Mr. Menzen, of the Department of Physics, University of Toronto; these lamps afterwards operated constantly. The lamp burns with a resistance on a 110-volt line and requires 75 volts across the terminals. On one occasion when the water was turned off and the lamp left burning it overheated and the composition protection on the top of seals burnt off, resulting in an expansion of the mercury in the terminals. The mercury which evaporated condensed on the surface of the water in the form of a white powder. Attention was drawn to this the next day by a dropping off in the sterilization due to the presence of this shield between the light and the water. The lamp did not go out.

The operation of the 500-volt lamp gave some trouble and this is of interest as regards supervision of installations. The power for the lamp was taken from a 500-volt direct-current line, which also supplied power for the pump used for lifting sewage. The voltage on the power line was very unsteady and varied from 450 to 560 volts. On holidays it was low, the supply being cut down on account of low requirements of other customers on the line. During the night this happened to a certain extent, as well as at noon time when the factories partly shut down their machines, a sudden jump occurring early in the morning and at 1 o'clock noon. The lamp, owing to the resistance through which it is operated, burns at 375 volts across the terminals and remains lighted with considerable reduction (10 per cent.) of voltage. A sudden change of voltage of such magnitude as encountered here, or the supply of over 375 volts, breaks the arc. Frequently on Monday mornings the lamp was found out, the watt-meter indicating that the interruptions had occurred between 6.30 a.m. and 7.00 a.m. These abnormal conditions should be controlled in all installations. It is inadvisable to have other machines on the same inside line. Machines occasionally get out of order and a fuse will blow out, resulting in an interruption of the current. The lamps do not light up automatically, and consequently falling off in disinfection must result.

In most municipal plants, auxiliary lines or storage batteries can be installed, and the unit will consist of several lamps burning at all times, the water passing each lamp in succession. In such an installation the behavior

Table II.—Adjustment of Baffles.

Opening in the inclined baffles.	Turbidity. P.P.M.	Voltage.	Percentage bacterial removal. 18-22° C. count.	37.5° C. count.
December 24—Horizontal Baffles in Place				
1/4 inch	1	350	99.84	98.7
1/2 "	1	350	99.3	99.2
1 "	1	350	99.8	99.67
1 1/2 "	1	350	99.8	99.7
2 1/2 "	1	350	99.84	99.72
December 26—Horizontal Baffles Removed.				
1/4 "	30	350	97.5	98.5
1/2 "	20	350	97.5	98.4
3/4 "	1	350	99.6	99.9
1 "	20	350	98.7	99.0
1 1/2 "	30	350	98.5	98.6
2 "	20	350	99.4	99.4

of one lamp or the going out of a lamp will not affect materially the disinfection going on. Such plants can always be operated under a factor of safety. Overdosing with ultra-violet rays has no such effect as overdosing with chloride of lime, which causes an increase in the objectionable taste and odor.

As regards the tank used in the experimental D.F. apparatus, the water came in through a riser pipe, bent to an oval shape, the water discharging against the cylindrical quartz protection tube. It was found a very difficult matter to regulate the flow so as to have an equal velocity through the apparatus on both sides. The riser was made of sheet metal, and irregular in shape. The bottom of the tank being made of thin flexible metal, the centering of the riser was unsteady on account of a springing action. A slight deviation threw the majority of the water to either side of the lamp, thus introducing a possible loss of efficiency. A better arrangement is to introduce the influent through a pipe at the side or bottom and past fixed baffles, similar to the exit.

The ventilation of the lamp box on the same apparatus introduced some new trouble. The location of the apparatus was in a particularly dusty part of the plant and the method of ventilation of the lamp box allowed the dust to be carried in. It then circulated into the quartz protection tube carried by the current of air due to the difference in temperature between the lamp itself and the tube. The dust deposited on to the inside surface and in time became dense enough to interfere materially with the action of the rays. Attention was drawn to the accumulation of dust by the decrease in sterilizing power of the lamp. The tube was then removed and cleaned out; at the same time it was found that the tube had been cracked, but whether by a knock administered during the many changes of baffle plates, or whether by temperature extremes, is not known. The tube was replaced after the crack had been repaired and from time to time a piece of absorbent cotton was used to wipe out any dust that had collected there. The only way to guard against this trouble would seem to be the separation of the resistance and the lamp box proper. That is to say, that if the source of most of the heat were removed so much ventilation would not be required and the possibility of dust getting in and interfering with the operation would not be so great. Also, a fine metal screen might be provided over any ventilation openings in the lamp box.

Table III.—Progress of Sterilization in "D.F." Tank.

	Average Bacterial Count			Percentage Removal			
Sample Point	18-22° C. Count	37.5° C. Count	*Colon Fermentation	18-22° C. Count	37.5° C. Count	Colon Fermentation	Average Removal
Influent	730	200	1,230	....	....	....	....
A	50	17.4	31	93.2	91.3	97.5	94.0
B	49.5	12.7	29	93.4	93.6	97.6	94.8
C	23	4.2	29	96.9	97.9	97.6	98.1
Effluent	26	16.4	20	96.4	96.8	98.4	97.2

*B. coli per 100 cc. presumptive test.

Character of Water Treated.—The source and method of addition of pollution, and the nature of the solids (organic, inorganic or colloidal) thus introduced into the water, are all important points which affect the interpretation of the results, and in order to have all information in connection therewith thoroughly understood the case of each installation is taken up separately.

The accompanying diagram (Fig. 1) shows the arrangement of the B2 apparatus in the system. The tap water and the Imhoff effluent were mixed in the overflow tank A, the quantities being regulated by the valves on the sewage and water pipes, a constant head being kept on the overflow. A mixture of the two enters the coagulating tank B. The storage was two hours. This tank, in turn, overflowed to C and D, D being the mechanical filter while C is a slow sand filter to which the mixture was also supplied. The discharge of the mechanical filter was regulated by a float valve keeping a constant head over a standard adjustable orifice. The sterilizer was supplied from a pipe inserted in the effluent pipe of the filter, and was arranged so that it could also be supplied from the raw water in tank C, or with tap water directly from the main by opening valve W and closing valve F to the filter.

Other points marked on the diagram indicate points from which the samples were taken. Thus, when filtered water was being treated, the influent sample from the filter was obtained by immersing a sterile bottle attached to a piece of copper wire into the water and allowing it to fill. The filter effluent, or water going into the sterilizer, was sampled at H by holding a sterile bottle under the stream, the effluent from the sterilizer being sampled similarly at K. When treating tap water, the influent sample was obtained at H as before, an excess of water being allowed to escape here.

Tap water, when used with sewage and turbidity added, passed through tank C, which was converted into a mixing tank, the added turbidity being well stirred into the water by means of a paddle, and the sample taken through a tap placed in the line at C, as shown.

The turbidity consisted of a hard, blue clay, free from organic matter. This was pulverized in a mortar and well rubbed up into a smooth paste with a small quantity of water before addition to the tank.

The sewage of Imhoff effluent used for the pollution of the water was a characteristic type of Toronto city sewage. The storage in the Imhoff tank was not more than 20 minutes, and as the sewage is pumped directly from a flowing sewer to the tank, it was in a fresh condition when used.

Summary.—A summary with conclusions arising out of these experiments is now given in order to keep the information under different headings, and in a more accessible form. The manufacturers of the apparatus, the R.U.V. Co., of New York, do not advise the apparatus for use with unfiltered water, requiring a filter effluent or water with zero turbidity and free from suspended matters. Generally speaking, if the apparatus were limited in this manner, by being incapable of treating slightly turbid waters, the use of it for water sterilization would be very much restricted. All filter units are liable to break down, and at such a time as when several units are out of commission at once and only part of the supply is filtered, the emergency or follow-up treatment must be capable of handling the error, otherwise the system as a whole does not give a safe supply nor meet with the sanitary requirements of a municipality.

Many municipalities, especially those situated on the Great Lakes, have a water supply which is at most times clear, but which on occasion may be subjected to light turbidity due to storm conditions on the lake. The probability of pollution at these times increases, and when a chemical disinfectant is used, great difficulty is experienced in obtaining proper dosage without objectionable taste. Filtration in such a municipality could not be dispensed with unless there were a system of water protection which would be satisfactory in its action during this time of abnormal water conditions. In view of these facts extensive work was done with the R.U.V. apparatus in order to determine the effect of turbidity upon per cent. bacterial removal.

The proportion of work done with filter effluent was small compared with the work done with waters carrying some slight turbidity. There were a few samples taken with the 110-volt installation, when a clear filter effluent alone was used. For the most part, the tap water was fairly clear, but owing to the sewage added, it was to a certain extent clouded. The turbidity of this class of water in the results with the 500-volt lamp, is under 1 part per million. At times it was slightly over this, but never more than two, unless stated. No filter effluent was supplied to the 500-volt apparatus, the supply available not being sufficient for its capacity.

The graphs on Fig. 11 show the effect of turbidity on water treated by the ultra-violet ray up to turbidity (according to the American Public Standard) of fifty parts per million, the color at the same time being 21. Mr. Geo. C. Whipple states in his figures relative to the Aesthetic Deficiency of Water that when these conditions are encountered, about 55 per cent. of the consumers will object to the quality of the water and that some means has to be adopted to improve the appearance. The ultra-violet ray treatment showed up very satisfactorily for these turbidities. In the small apparatus water with turbidity of 50 was treated, with a consequent reduction of 97.4 per cent. in the 37.5° C. count, and 95.2 per cent. in the Colon. In the large apparatus water with turbidity of 30 was reduced in bacterial count by 94.9 per cent., 91.3 per cent. and 99.46 per cent. in the 18-22° C. count, 37.50° C. count and colon fermentation respectively. It is, therefore, apparent that irregularities in the action of filter plants by a secondary treatment with U.V.R., (some such additional protection being a recognized necessity for all filter plants handling seriously polluted waters) can be well taken care of; also slight irregularities in the condition of raw water supplies can be handled directly by U.V.R. without preliminary filtration.

MUNICIPAL IMPROVEMENTS IN MOOSE JAW, SASKATCHEWAN.

The report is in hand of the City Commissioners of Moose Jaw, Sask., for the ten months ended October 31st, 1915. It is interesting in that it shows continued progress in municipal affairs accompanied by greater economies in each department, without material sacrifice in the efficiency of utilities or serious curtailment of necessary works. The Commission consists of Messrs. James Pascoe, mayor; George D. Mackie, who is also city engineer, and W. F. Heal.

The report shows that, in general, controllable expenditures have been reduced 17 per cent. over 1914, practically every department showing a reduction in running expenses. The city engineer's department effected a creditable saving of 47 per cent. The work of this department is roughly divided into three groups, *viz.*, the board of works, sewers and sewage disposal and waterworks. The first involves street maintenance and cleaning and maintenance of storm sewers. During the year the overhead bridge at Eighth Avenue was completed, its construction having been commenced about the end of 1914. The total expenditure upon it has been $97,375, of which the city paid about one-third.

There are twelve miles of graded streets without curb and gutter, 24 miles with curb and gutter and about five miles of pavements in the city. This year the only road building carried out was about 2,000 lineal feet of road 30 ft. wide, connecting two parks, in addition to a small amount of pavement repair.

The city has now 7.2 miles of storm sewers, of which 1½ miles were constructed this year. A storm sewer, the main portion of which varies in diameter from 24 to 30 inches, was built to relieve the business section of the city west of Main Street. The work was done by day labor, which, including material, cost $28,928.

There are 28½ miles of wood walks in Moose Jaw, about 900 ft. having been added this year.

The total amount expended on pavement repairs in 1914 amounted to only $201.

Early in the year a slight shortage of water supply was met by the Snowdy Springs storage. In 1914 the city engineer had recommended an increase of water supply, but the financial stringency made it impossible at that time. The Snowdy Springs supply contains much suspended matter, but apart from this it is a good supply for domestic purposes. To rectify the defect, a battery of two filters with a capacity of 500,000 gallons per day are now being installed by the Roberts Filter Co. at a total cost of about $8,000. The installation will be put into operation before the close of the year.

The city derived about 95 per cent. of its supply this year from the Sandy Creek supply. The average daily consumption has been reduced by 15 per cent., now amounting to about 706,000 gallons per day. The number of consumers increased by 3 per cent. The expenditure of operating the waterworks plant was reduced by 33 per cent. over 1914.

The city's water supply is pumped from Caron, Sask., by kerosene engine power at a cost of $26.57 per million gallons, and is pumped again at Rosedale by electrical power at a cost of $30.29 per million gallons; hence the cost is about 5½ cents per thousand gallons, excluding interest, depreciation of machinery and water mains, etc. Repairs to the steel main from Caron cost $44 per mile, and to the wood pipe line from Snowdy Springs $122 per mile. Repairs to the cast iron mains in the distribution system cost $11.76 per mile.

The total length of sanitary sewers in the city is 37 miles, of which 1 2/5 miles were laid this year, the extension being an 18-inch intercepting sewer laid by day labor at an average depth of 18 ft. and costing $33,893. Considerable difficulty was experienced owing to underground water requiring the operation of two electrically driven pumps day and night for over six weeks. In jointing the sewer to affect watertightness, a composition of asphalt and cement was used. Special care was exercised to prevent the infiltration of ground water into the sewer, the discharge of which must be taken care of at the sewage disposal works.

In the sewage disposal plant, work was in progress all year in connection with the modernizing of sedimentation tanks, installation of traveling distributors over the filter beds, etc., improvements which will be completed before the close of the year. The sludge from the sedimentation tanks is deodorized with chloride of lime before being placed in the sludge beds. The sewage is analyzed by assistant engineers, one day a week being set aside for the purpose. The plant cost $8,788 for operation, being a saving of 28 per cent. over 1914 and 61 per cent. over 1913. The cost of pumping the sewage at the sewage disposal works amounted to $28.37 per million gallons.

The municipally operated power house had an increase of 7.42 per cent. in output over 1914, with a decrease in operating charges, inclusive of fixed charges, of 11 per cent. Owing to the reduction of rates which took effect in July, 1914, the net revenue for the ten months was 14.7 per cent. below the corresponding period of last year. The total revenue for the ten months was $124,440. The operating charges were $119,391. The fuel bill itself was reduced 27 per cent., while the controllable operating expenditures were reduced 21.9 per cent. The cost of production at the power house switchboard was 3.668 cents per kw.-hour, as compared with 4.441 cents per kw.-hour in 1914. The number of consumers shows an increase of 4.8 per cent. The only new work carried out in this department during the year involved the installation of an economizer and an induced draught plant.

The report covers also questions of refuse removal and destruction, health and relief, parks and boulevards, fire department, street lighting, building department, employment bureau and finance.

According to the returns made to the Ontario Bureau of Mines for the nine months ended September 30th, 1915, the nickel mines at Sudbury are being worked to the maximum capacity, and the production of nickel for the nine months nearly equals the largest previous output for a full year. Over 75 per cent. of the output is made by the Canadian Copper Company, but the operations of the Mond Company are now more extensive than formerly and its output has correspondingly increased. The yield of copper was also much greater than in the corresponding period of 1914 and nearly equalled the total output of that year.

RURAL HIGHWAYS.*

By L. W. Page,
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THE fundamental problems which confront an engineer in dealing with public road improvement are concerned with determining, first, which roads should be improved; second, what types of improvement should be employed; and, third, what methods of construction and maintenance are most efficient. To solve these problems intelligently requires skill in handling questions of economics in addition to engineering ability. In other words, the highway engineer should be able to determine what to build and where to build it, as well as how the building is to be done, and he should bear in mind that as much waste is likely to result from improving the wrong roads or employing wrong types of improvement as from using faulty materials or methods in making the improvements. It seems well to consider briefly, therefore, the extent to which determinations of each character may be rationalized.

The only reasonable basis for determining which of perhaps a great number of public roads in a community should be improved, or the order in which improvements should take place, is public convenience. In order to make each improvement add the maximum amount to the convenience of the public, however, it is necessary that the engineer who plans the improvements must have a comprehensive understanding of the economic and social relationship which exists between different parts of the community under consideration and also the effect which different roads, if improved, would have in making this relationship more advantageous.

In order to gain a comprehensive understanding of this kind it is usually necessary for the engineer to prepare a plan showing the various highways in proper relation to each other, and showing also how population and industries are distributed. The amount and character of traffic using each important road, or which would use an improved road having the same location, may be estimated by means of traffic counts or otherwise, and should be shown on the plan.

With such a plan before him, it is practicable for an engineer to lay out an intelligent system of improved highways which would accommodate the entire community, and to assign relative weights to each unit of the system according to its importance. This system would serve as a model toward the development of which all road improvement work should be directed, but which might be readily modified to meet the exigencies arising as the system developed.

The proper type of improvement for any particular road ordinarily depends for the most part on purely economic considerations. That is, the type selected should ordinarily be shown to have a net economic advantage over any other type which might be selected. The economic efficiency of improved roads is affected by a number of factors, some of which are usually more or less indeterminate, but an intelligent evaluation of these factors evidently forms a much more satisfactory basis for making comparisons than would be formed by any set of arbitrary assumptions. Attempting to compare types of improved roads without first evaluating the factors which affect their economic efficiency is in fact very much like attempting to estimate volumes of solids without first

*From a paper presented at the International Engineering Congress, San Francisco, Cal., September 20-25, 1915.

estimating their linear dimensions, and is almost as indefensible.

The principal factors which affect the economic efficiency of an improved road and upon which economic comparisons should be based are: First, cost of construction; second, cost of maintenance; third, amount and character of traffic; and fourth, the average unit cost of hauling before and after the improvement is made. If these factors are all intelligently considered for each of the types of any ordinary road, it is apparent that the most economical type in theory may be readily selected.

The first factor, cost of construction, can usually be satisfactorily estimated for any particular road, when the conditions which affect the availability of materials, the character of labor, the prevailing gradients, etc., are understood. These conditions should all be indicated on the model system plan, where such a plan is employed, and should be sufficiently complete to obviate all probability of large errors in preparing the estimates.

The second factor, cost of maintenance, is dependent on the character of material used, the volume and character of traffic, and the climatic and topographic conditions which affect the road under consideration. This array of variables, especially when it is considered that traffic conditions are constantly changing, makes the cost of maintenance appear at first glance almost indeterminate. For most types of road improvement, however, the effect of these variables can be estimated within reasonably close limits from the data already available, and the Office of Public Roads is now working in co-operation with State highway departments and other interested persons in an effort to make these data more nearly complete. It is hoped that within a short time the information which is being collected can be so reduced and correlated that the cost of maintaining any particular type of improved road, under any given set of ordinary conditions, can be estimated with a very satisfactory degree of accuracy.

The third factor, amount and character of traffic, has its principal importance, from an economic viewpoint, in the effect which it has on the cost of maintenance. Every road should, of course, be designed to further the convenience of traffic and the comfort of travelers, but almost any type of improved road, when properly constructed and maintained, will meet this requirement. Traffic data are usually collected by means of counts, but the estimates upon which economic comparisons are based must frequently be modified from what the counts would indicate in order to allow for the changes which are likely to result from the improvement itself and from other probable economic changes in the community.

The fourth factor, average unit cost of hauling before and after the improvement, varies very slightly for different types of improved roads, provided that they are all equally well maintained. The real economic justification for improving any road hinges on this matter of reduction in the cost of hauling, however, and it, therefore, deserves the most careful consideration. If the unit cost of hauling before and after the improvement, and the total volume of traffic using the road are known, the total annual saving resulting from the improvement can evidently be estimated; and, if the improvement is to be justified economically, this total annual saving must be sufficient, after all costs for maintenance and repairs are deducted, to pay a reasonable interest on the original investment. To determine what type of improvement will return the largest net rate of interest on the original investment is the sole purpose of making an economic investigation.

Road improvements may, of course, sometimes be justified by other than purely economic considerations, as, for example, when a wealthy community constructs a highly improved road simply to increase the pleasure of travel, they need no further justification than that they are willing to pay for it. Such improvements, however, are to be classed as luxuries and the community adopting them should so understand. A more frequent example of poor economy, but perhaps good politics, is the "Through Highway" connecting large centres of population. While such highways undoubtedly serve an economic function, one of their principal purposes in most cases is to accommodate pleasure traffic originating and ending in the cities. This class of traffic, of course, deserves consideration and must be accommodated in some way, but in making economic investigations, the engineer should be very careful to show to what extent the matter of caring for pleasure traffic is allowed to influence his plans, and should also show, as far as possible, just how this influence will affect the cost of the improvement.

If a model system of highways has been previously worked out, and the importance of each unit in the system has been properly weighted, it is apparent that the investigation for determining the proper type of improvement to employ on each road will be greatly simplified. It is also apparent that the more comprehensive this system can be made within reasonable limits, the less will be the duplication of work required and the greater will be the possibility of securing satisfactory results through efficient organization. The state is, therefore, much better circumstanced for planning and supervising road improvement work than are any of its political subdivisions. This is evidently true, even though the officials controlling road work in the subdivisions are as honest and intelligent as those composing the state organization.

There are now 42 states out of the total of 48 which have established highway departments of one kind or another and the organizations under which these departments operate are being constantly revised and improved. This shows that the public is awaking to the advantages to be gained by having all highway work done under a scientific and comprehensive organization. There is also unquestionably a growing public demand for quantitative assurance that every dollar levied for the purpose of highway improvement is being spent to the best possible advantage, and in order for the engineer to meet this demand, he must be in a position to analyze the factors which affect the economic efficiency of improved roads and reduce his findings to a more or less quantitative rational basis. The general method of procedure necessary in order to accomplish this has already been outlined.

Construction.—The customary methods of constructing and maintaining the various types of improved roads are generally well understood by the engineering profession, or at least by those members of the profession who have been sufficiently interested to follow the discussions concerning highway work which are constantly appearing in engineering literature. Most of the types now in use have been developed through extensive experience, and while slight modifications in the present methods of construction will very likely continue to take place, it does not seem at all probable that there will be any very radical changes in type in the near future. It is true that a number of so-called new types of improved roads and new processes of construction have been recently developed and patented, but I think it unnecessary to consider them here.

The principal types of improved roads are earth, sand-clay, gravel, macadam, bituminous macadam, Portland cement concrete and brick. A complete discussion of any one of these types would take up as much space as it is purposed to occupy with this entire paper, and would probably present, furthermore, only a very small amount of matter at all new to the members of this congress. It seems best, therefore, to touch only on those features of construction concerning which there has been more or less difference of opinion among engineers, and to express such opinions regarding these features as the experience of the Office of Public Roads would appear to justify.

It should be borne in mind, however, that no typical sections could be made sufficiently general to meet all conditions, and still be of value. Special cases will frequently arise which must be given individual consideration, if the best results are to be obtained.

The amount of crown which should be given the cross-section of an improved road, for example, is a matter of very great importance and one which has been much discussed. The two factors which have had most influence in determining this detail are: first, the desirability of draining water off to the sides as quickly as possible after it falls on the road, and second, the desirability of keeping the cross-section as flat as practicable in order that traffic may not be unduly encouraged to use only the centre of the roadway. The character of the road surface determines which of these factors should be given most consideration.

Another much discussed point relates to whether the subgrade for brick and concrete roads should be given a flat or crowned cross-section. The Office of Public Roads at present recommends the flat cross-section, especially for concrete pavements, where the width does not exceed about 20 feet. This recommendation is based, for the most part, on the fact that fewer longitudinal cracks have been observed in pavements having flat subgrade cross-sections than where the subgrade is crowned, and the use of such flat cross-sections adds comparatively little to the cost of the narrower concrete pavements, in which longitudinal cracks are most objectionable.

Defective foundations can be corrected in a number of ways. Surface drainage is, of course, the first consideration, and when properly planned, is ordinarily adequate. Some combinations of soil and topographic conditions, however, render effective surface drainage impracticable, and in such cases, one of three methods of foundation treatment will usually be found satisfactory. The Telford base is especially adapted to soils which, even when well drained, are more or less unstable; the V-drain to localities where field stones may be cheaply obtained, and the side ditches to all locations where the soil is inclined to be springy or hard to drain.

Some of the other questions concerning which opinions differ are: What are the proper sizes of stone for the different courses of macadam roads, what methods of bituminous treatment are most satisfactory under given conditions, what kinds of coarse aggregate are best for concrete pavements, whether Portland cement grout or bituminous cement should be used for filling the joints in brick pavements, and whether brick pavements should be provided with expansion joints both laterally and longitudinally, or only longitudinally. The present attitude of the Office of Public Roads concerning these and other similar points has already been expressed in its published bulletins and specifications, and they are mentioned here only in order that the attention of engineers may be called to the need for collecting and assembling data bearing on the efficiency of different detail methods of construction.

Maintenance.—No paper on the subject of "Rural Highways" would be complete without discussing at least to some extent, the important question of road maintenance. Scientific care in planning and constructing public roads cannot possibly obviate the necessity for maintaining them, though it can no doubt greatly assist in meeting this necessity by causing it to be fully recognized and its importance properly appreciated.

The work of maintaining public roads is necessarily more routine in character than other classes of road improvement work, and would, therefore, seem to be more susceptible to advantage from standardization of methods. In the United States, however, there are discouragingly few localities in which any attempt at systematic maintenance has been made, and these are to be found only in states having strongly centralized control. In many of the states which have well organized highway departments and even those in which state aid for construction is an established policy, all road maintenance work is still being done or left undone under the supervision of the county, township or other local administrations. Judging by the annual reports of the various state road officials, however, it seems that they are practically all agreed that this arrangement is not satisfactory and are accordingly seeking to have the laws or appropriations under which they operate so changed that the work of maintaining the state-aid roads will be done under state supervision. This change has already been made in a number of states, and so far as is known, an immediate improvement has resulted.

In conclusion, it seems fitting to pay some tribute of appreciation to the efforts of highway engineers and other public road officials throughout the country who, notwithstanding the arduous nature of their prescribed duties, are always ready to co-operate in collecting and disseminating information relating to road improvement work which might be of value to other communities, and who almost uniformly show even a broader-minded disposition in their willingness to profit by the experience of others whenever the opportunity is afforded them.

NOVEMBER MUNICIPAL BOND SALES

The municipal bond sales in Canada for November, as compiled by *The Monetary Times*, amounted to $2,265,892, compared with $1,245,874 for October and $622,049 for the corresponding period of last year.

Comparing the record of November, 1914, with that of the month just ended, the bond sales are as below:—

	1914.	1915.
Canada	$622,049	$2,265,892
United States	170,200	1,000,000
	$792,249	$3,265,892

This month total sales are more than four times the November sales of last year and reflect the improved state of financial affairs in Canada generally, apart altogether from the absorption of the fifty million domestic war loan and the bond offerings of provincial governments. A Montreal issue of $1,000,000 was sold to United States investors.

The following are the particulars of the November municipal bond sales in Canada by provinces:—

Ontario	$1,152,342
Manitoba	620,000
Quebec	328,000
Alberta	101,500
Saskatchewan	59,950
British Columbia	3,100
	$2,264,892

REPAIRING PAVEMENT CUTS IN OTTAWA.

DURING the past three years considerable attention has been given to the method of making repairs to pavements in Ottawa where cuts have been made. Repairs up to three years ago were done in a haphazard manner, the general result being the gradual settling of the packed-in earth, the concrete, of course, going with it, as shown in Fig. 1.

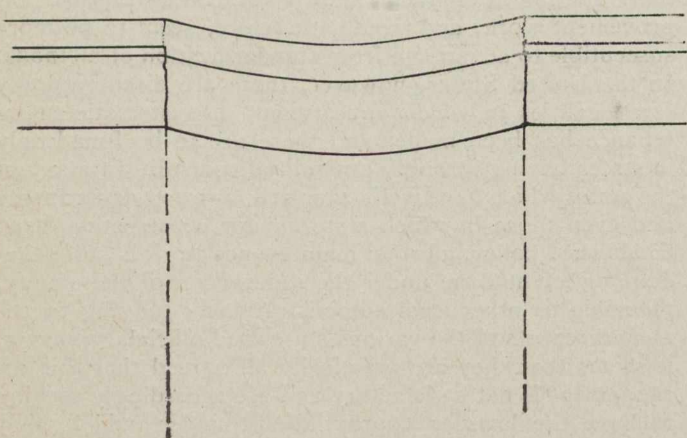

Fig. 1.

The present method of repairing cuts in pavements is shown by Fig. 2. The trench is first of all well packed by means of a tamping machine; then excavation is made to a depth of 4 inches below the old concrete. The sides of the old concrete being then slightly bevelled, as shown. Three-quarter-inch square iron bars are then placed directly below the old concrete at 12-inch centres and the new concrete is afterwards placed and packed. The concrete is allowed to set for three days, then an asphalt cushion is pounded down and the asphalt wearing surface 2 ins. thick is laid and compressed by an 8-ton roller. Great care is

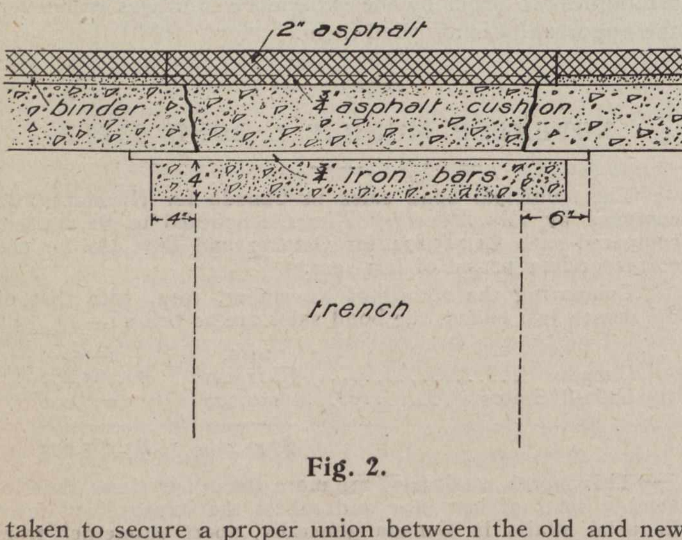

Fig. 2.

taken to secure a proper union between the old and new wearing surfaces. The edges are evenly cut away and cleaned up before the new top is put down. The practice of painting the edges with hot asphalt cement has been done away with, as, if too much asphalt-cement be used that portion of the pavement will be too rich in bitumen, and will consequently be much softer than the rest. Smoothing irons are used to even up the joints, care being taken to see that they are not too hot, else they will burn the mixture.

In Ottawa a "Pavement Cut Book" is kept, where permits are given for the cutting of pavements. Thus, when a pavement is opened for the installing of gas, water or sewer, a record is available, and the cut is fixed up immediately the underground work is completed, thereby eliminating any fear of deterioration of the asphalt around the cut to any great extent.

The method of repairing the pavement cuts mentioned above costs a little more than formerly but this is more than off-set by the good condition of the city streets.

MANITOBA BRANCH CANADIAN SOCIETY OF CIVIL ENGINEERS.

The programme for 1915-16 of the Manitoba Branch of the Canadian Society of Civil Engineers has been received. There is an exceedingly good list of papers by prominent Canadian engineers of the Middle West. In the general section the following papers have already been read this year by the authors on the dates noted:—

September 9th—Steam Power Plants at Divisional Points on the G.T.P. Railway. H. Lorimer.

October 14th—Something About Projectiles. T. R. Deacon.

November 4th—Righting of the Transcona Elevator. Frank Lee.

December 2nd—Grade Separation in the City of Winnipeg. W. P. Brereton.

The papers already read this fall before the electrical section are as follows:—

October 13th—Electric Signal System as a Factor in Fire Protection. Fred. A. Cambridge.

November 10th—Wireless Telephony. J. M. F. Wilson.

December 8th—Application of Curves, Charts and Graphs to the Analysis of Engineering Problems. F. H. Martin.

The following is the balance of the programme:—

(1) General Section. January 6th—Studies for, and Experiments with, Mixtures for Winnipeg Concrete Aqueduct. W. G. Chace and D. L. McLean.

February 3rd—Movable Bridges. E. Brydone-Jack.

March 2nd—Some Features of the Design and Location of the Aqueduct for the Gravity Water Supply for the Greater Winnipeg Water District. W. G. Chace and M. V. Sauer.

April 6th—Prairie Stream Discharge. M. C. Hendry.

May 4th—C.P.R. Terminal Layout at Transcona. Frank Lee.

(2) Electrical Section. January 12th—Telephone Transmission, Construction and Distribution of Cable Plant. H. E. Brockwell.

February 9th—Applications of Synchronous Condensers for Line Regulations. F. H. Farmer and E. V. Caton.

March 8th—A Modern Fire and Police Signal System. Fred. A. Cambridge.

April 12th—Mercury Arc Under Atmospheric Pressure. J. W. Dorsey.

May 10th—Public Utility Development. H. Hartwell.

(3) Mechanical Section. December 20th—Reinforced Concrete, Advantages in Construction Work.

January 17th—The Evolution of the Locomotive.

February 21st—Oxy-Acetylene Welding.

March 20th—Modern Application of Compressed Air.

April 19th—Refrigeration.

May 17th—Accident Prevention.

Editorial

WHILE ENGINEERING PICKS UP—"HAVE A CAN DO."

It has been such a long pull since the beginning of that depression—which was old enough to speak for itself before a single shot was fired in Belgium, and which, until smothered in Canadian khaki, threatened to create a relentless wail of unemployment throughout the length and breadth of the land. How many engineers managed to weather the slump without an occasional, or at least a single, instance of being mired in that frame of mind commonly known as "down in the dumps"? The coveted call for engineers that, once upon a time, developed into a still-hunt and bickerings over increased salaries, gave place to another call which our engineers have answered just as manfully, and with no questions asked. The engineer is a happy man when he is busy. After the decline in business activity, and before the call for Canadians, in that period when the maze of depression shut out the horizon of engineering application and the latter showed signs of being overcome with a lethargy of indefinite duration, the engineer was not happy. When the "breaks" fade behind financial depression, and a fickle future refuses to gesture at the most enticing forecast, there is the uncomfortable foreboding of rust on the vernier and a warp in the slide-rule.

Although the engineers of Canada have responded in such large numbers to the Empire's call, there are many still who, owing to responsibilities and army regulations, must remain at home to serve. For both the brighter prospects of 1916, though a bit distant, must create incentive and inspiration. Exercise for a little longer of the noble attribute of patience is advice that falls on well-proven ground.

One of our Western engineers sends us some inspiring lines that will not be found amiss by young or old. He assures us that now, as never before, every Canadian engineer must have a "can do."

"The youth who has entered the technical institute, the young man who has entered the university, the rodman, instrumentman, assistant engineer, the chief of the office—each must have for his motto, 'I can and will do.'

" 'Yesterday is past; to-morrow's a mystery; to-day is here! make the best use of it' is a motto which should serve a useful purpose.

"This war, with its frightful list of casualties, may be with us for a long time yet, for we know full well that the real fighting will start when Joffre and French invade the German provinces and the steam roller of the Russian army sets to work to assist in grinding the domineering, hateful Prussian militarism into dust.

"To those who have not yet volunteered, to those who are still doing their duty as civilians, each has a further special call upon him, the war first—after that, the work which is to hand. To those members of our engineering societies who are apt to become neglectful, due to the cares of business and advancing years, 'have a can do' and for another year or so, let it be your solid determination to put in a prompt attendance at each regular meeting and so help on the good work of your society. Don't delay, but 'have a can do' and do it now."

NEW USES FOR COBALT METAL.

In the silver refineries of Ontario last year 913,778 pounds of cobalt oxide were produced. Until the outbreak of war, trade in cobalt was good with England and the continent of Europe. There is now little prospect of a revival of the demand for cobalt on a large scale until war gives place to peace. The chief use of cobalt has been in the form of oxide for the production of cobalt blue and in the manufacture of porcelain, enamelled ware, etc. Experiments are being made with cobalt with a view to its use as a substitute for nickel in the plating of metallic objects, and it may find employment in the making of alloys, notably of steel.

The metal cobalt resembles nickel in almost all its properties. Its density, malleability, ductility, hardness, tensile strength, and electrical properties are, so far as they are known, very similar to those of nickel. These properties of nickel make it of remarkable industrial value in the composition of a great variety of alloys. Of these may be mentioned the high-grade steels, where toughness and hardness are desired; for automobile parts, steel tubes, gun steel, cranks and crank-shafts, boiler-plates, tires, connecting-rods and axles; the nickel-iron wires such as invar and platinite, with low temperature coefficients of electrical resistance and of expansion respectively; and the variety of important nickel alloys with non-corrosive properties, for coins, boat propellers, etc. It would be surprising if cobalt could not be advantageously substituted for nickel to produce a better grade of some of the above products. As these are high-grade products, where superior qualities are desired, a high cost, within certain limits, would not be prohibitive. Hence, if research leads to the substitution of cobalt for nickel, even in the case of one of these products, a market for the metal cobalt at a reasonable price would be assured, and large sums of money would be annually added to the returns from Canadian natural resources.

Mr. T. W. Gibson, Deputy Minister of Mines, Ontario, has a suggestion which deserves consideration. The five-cent piece is the least desirable of our Canadian silver coins, mainly because of its smallness in size and the consequent difficulty in handling it, and especially of distinguishing it from the 10-cent piece without close ocular examination. Why should it not be replaced by a coin made of pure cobalt, intermediate in size between the 10-cent piece and the 25-cent piece? asks Mr. Gibson. Such a coin would have many advantages. It would be readily distinguishable from all other coins. It would be attractive in color, pure cobalt being similar in appearance to pure nickel, but somewhat more silvery, and tarnishing slowly, if at all. Being very hard, it would be difficult to counterfeit. Lastly, the chief source of cobalt being for the present in Canada, a cobalt coin would be distinctively Canadian, and its introduction would strike a chord to which the national consciousness would readily respond. The coin could be called a "cobalt," just as the United States 5-cent piece of copper-nickel alloy is called a "nickel." By comparison, however, a pure cobalt coin would be greatly superior in appearance and every other respect to the so-called "nickel," which contains only 25 per cent. of that metal.

UTILIZATION OF WATER POWER FOR MINING AND INDUSTRIAL PURPOSES IN ONTARIO.*

SITUATED as all the principal mining camps of Ontario are, in rocky areas well supplied with rivers and lakes, they are able to take advantage of cheaply developed water power within convenient distance for transmission to mines and works. The harnessing of water powers for mining and other industrial purposes has gone on with much rapidity in Northern Ontario. The silver mines and mills of Cobalt are operated by electric energy derived from falls on the Montreal and Matabitchuan rivers; power for Gowganda is developed on the Montreal, and further utilization of that stream is now being undertaken; the Mattagami River at Wawaitin and Sandy Falls furnishes current for operating the mines and stamp mills at Porcupine; energy is transmitted from the Blanche River at Charlton to the Tough-Oakes mine at Kirkland Lake, and a power source in Marter township on another branch of the same stream is about to be developed to supply further requirements of the camp; Iroquois, Twin and Couchiching Falls on the Abitibi are now operating the machinery of the Abitibi Pulp and Paper Company; and the Sturgeon at Sturgeon Falls, the Spanish at Espanola, the St. Mary at Sault Ste. Marie, the Wabigoon at Dryden, the Rainy at Fort Frances, perform a similar function for the pulp and paper plants at these places. In the Sudbury region, the Canadian Copper Company obtain their power from the Spanish River at Turbine and have large projects for further developments on that river; and the Mond Nickel Company draw upon the energy developed by falls on the Wanapitei in Dryden and Secord townships, on the Vermilion at Wabigeshek, and the Spanish at Nairn. The Michipicoten at High, and the Magpie at Steep Hill, falls supply power to the iron mines of that district. The Winnipeg River where it leaves Lake of the Woods, is utilized in grinding wheat on a large scale at Keewatin and for municipal and industrial purposes at Kenora, and the tumbling rapids of the St. Mary where it empties out of Lake Superior suffice for a variety of industrials at Sault Ste. Marie. In eastern Ontario, water power from the Trent operates the silver refinery at Deloro, from Deer Lake the gold mine at Cordova, and from the Madawaska the graphite mine and mill at Whitefish Lake. At Ottawa and Gananoque, Peterborough and many other places, water power on a considerable scale has long been in use for operating machinery, providing light, etc. It is unnecessary to mention the Falls of Niagara and the vast scheme for distributing throughout southwestern Ontario the benefits of cheap power so successfully carried out by the Hydro-Electric Commission of Ontario; or the developments at De Cew Falls, or on the Grand, Saugeen, Severn and numerous other streams in the older parts of the province, since the uses to which the power is applied belong more to manufacturing and agriculture than to the mining industry. In probably every case, the cost of power has been reduced by at least 50 per cent. of its expense when derived from burning wood or coal, and the development has been a boon to mining in the province.

But water power has its disadvantages as well as its advantages. Chief of these is the liability to serious diminution because of insufficient rainfall. The annual precipitation of moisture in southern Ontario is about 32 inches, but is considerably less in the northern parts of the province, varying according to district. In some years, of course, the precipitation is much heavier, and in some much smaller. The excess is simply allowed to run off, and so is of no significance to the user of water power; but there is no way to supply a deficiency. Ample storage capacity assists to equalize the flow, but reservoirs cannot create water, or hold it unless it flows into them. The season of 1914 was unusually dry, and in consequence during the low-water period, which occurs in January, February and March, the water powers upon which the mines and plants of Cobalt, Porcupine, Sudbury and elsewhere depend were unequal to the occasion. The situation in the early part of 1914 was much the same, but the beginning of 1915 faced an accumulated deficit, and a system of shutting down mills and works in rotation had to be put into effect. The result was, of course, to lessen production, to what extent the statistics for the output of 1915 will no doubt reveal. It would seem that the effect is likely to be prolonged into the year, for the light snowfall of winter disappeared with few or no accompanying rains, and the present prospect is not promising for a good supply of power in 1915. One result will be that resort will be had to auxiliary steam plants, and where they have been retained, their aid will undoubtedly be welcomed. In making provision for the operation of machinery, prudence counsels a reserve of motive power. Thus, in constructing a central compressed air plant at the Hollinger gold mine to serve present and future requirements, sufficient boiler capacity was installed for use in case of failure of the supply of electricity developed from water power. The style of compressor selected had the advantage of being reversible; that is, the machines may be used as steam engines, and their motors for generating electric power.

By an amendment to the Rivers and Streams Act the Legislature last session considerably modified the law regarding the use of rivers for the dual purpose of floating sawlogs and generating power. Formerly, the lumberman was practically in full control, the statute granting him the right to use the river at freshet seasons for driving his logs to market. So long as there was no other use for the water, no harm was done, but as shown above the development of water power on the streams of eastern, northern and northwestern Ontario during the last few years has been very rapid. The power user naturally wished to conserve as much of the freshet flows as possible, so that his turbines might continue to turn during the inevitable season of low water. If compelled to shut down, mines, pulp mills and other industries depending upon him for power were obliged to follow suit.

Both lumbering and water power development are important, and the situation required regulation. What the Legislature did was in effect to place authority in the Minister of Lands, Forests and Mines to deal with emergencies as they arose, and to exercise control over the levels of any stream where conflicting interests required action to be taken. The amendments will be found in 5 Geo. V., chapter 15 (Rivers and Streams Act, 1915).

*From the 1914 report of Mr. Thos. W. Gibson, Deputy Minister of Mines for the Province of Ontario.

NOVEMBER SALES OF TELEPHONE BONDS IN THE PROVINCE OF SASKATCHEWAN.

During November there were sold $101,100 Saskatchewan rural telephone companies' bonds: Bright, $3,000; Rose Bank, $4,500; Sinnett, $2,500; Fillmore, $2,000; Iola, $7,200; Patience Lake, $7,000; Togo, $11,000; West Beverley, $2,000; Collingwood, $4,200; Lampman, North, $1,200; Bonnie View, $5,000; Paswegin, $1,000; Silton, North West, $3,500; Manor, $6,000; Fairy Hill, $1,000; Naisberry, $1,500; Bridgeford, $6,000; Wawota, $2,500; Alida, $20,000; Rock Haven, $7,000; Claire, $3,000.

COAST TO COAST

London, Ont.—Paving work for 1915 has been completed, making an addition of about five miles to the improved streets of the city.

Saskatoon, Sask.—Last week the Canadian Northern Railway opened up an additional 35 miles of track between Elrose and Eston.

Calgary, Alta.—The outlay for public work this year has been $497,345, as compared with $1,326,561 in 1914. In 1913 the expenditure was $2,025,941.

Port Alma, Ont.—A large gas vein, producing about 2,000,000 ft. of natural gas per day, was struck along the shore of Lake Erie by the Glenwood Natural Gas Co.

Fredericton, N.B.—The Fredericton-Gagetown section of the St. John Valley Railway has been completed, which means that the railway is now complete from Centreville to Gagetown.

Peace River Crossing, Alta.—Steel on the Central Canada Railway reached a point 7 miles from Peace River Crossing several weeks ago, and it is expected that the line will be completed by the middle of December.

Roger's Pass, B.C.—According to an official estimate, the two fast approaching headings of the Roger's Pass tunnel, pioneer bore, will meet on December 19th. It is expected now that the tunnel will be ready for operation next July.

Le Pas, Man.—Steel on the Hudson Bay Railway is still being laid, and a weekly train service is now in operation over the first 242 miles of the line. The bridge over the Nelson River at Manitou Rapids will be finished early in February.

Montreal, Que.—The city proposes to spend over $1,000,000 this winter in the construction of sewers. Of this, $109,000 will be spent in the eastern division; $295,100 in the western division, and $747,353 in the northern division.

Ottawa, Ont.—By a vote of the city council last week, it was decided not to appoint a commissioner of works at the present time. The names of several prominent engineers and others were under consideration, and the proposal was defeated by a vote of 10 to 11.

Toronto, Ont.—According to the report for November of Dr. C. J. Hastings, M.O.H., the filtration plant at the Island removed 99.1 per cent. of the bacteria from the filtered water. B. coli. were found in the water three times during the month, out of 163 examinations.

Victoria, B.C.—The piers for the large Dominion Government telescope to be erected on Little Saanich Mountain are under construction. One of them is 44 ft. in height above floor level of the observatory. The foundation is a structure of monolith concrete weighing about 800 tons.

Oakville, Ont.—A 7-mile stretch between Oakville and Clarksons of the Toronto-Hamilton Highway was opened for traffic last week, and the event was suitably commemorated in conjunction with that of officially putting into service a new lighting system on the main street of Oakville.

New Toronto, Ont.—The new water supply system is to be placed in operation this week. In addition to the needs of the municipality itself, the Grand Trunk Railway and the village of Mimico are customers, the former to the extent of 300,000 gallons per day and the latter 500,000 gallons per day.

Edmonton, Alta.—Nickel deposits are now being developed on the shores of Athabasca Lake and there are indications of considerable wealth in the Northern Athabasca country in nickel and copper ores. Mr. J. D. Piche states that the best claims discovered to date are near Fond du Lac, from which ore can be transported by boat to Fort McMurray, the northern terminus of the Alberta and Great Waterways Railway.

Vancouver, B.C.—Track has now been laid on the Pacific Great Eastern Railway within eight miles of Clinton, 67 miles north of Lillooet, the present terminus of the new line, and the section to the next objective point is expected to be completed and ready for traffic before Christmas Day. The company plans to extend service as soon as the track has been linked up with Clinton. The distance from Squamish to Clinton is 166 miles.

Edmonton, Alta.—According to Ralph H. Douglas, Provincial Railway Engineer, about 80 miles of continuous grade has been completed on the Oliver-St. Paul line. On the Peace River branch of the C.N.R. the track to San Guido on the Pembina River has been reballasted and steel has been laid for several miles beyond the Pembina Bridge. On the line southeast from Camrose, towards the Battle River, some 22 miles of steel have been recently laid.

Ottawa, Ont.—Details of the route of the Ottawa South intercepting sewer have been decided upon and it has also been decided to construct it by day labor. The work has been divided into three sections, the expenditure totalling about $310,000. Mr. F. C. Askwith, acting city engineer, will proceed with the first section as soon as authority has been granted by the Provincial Board of Health, and arrangements made with the C.N.R. for an easement through their property.

Vancouver, B.C.—The Canadian Northern Railway has let a contract for one of two large car ferries for service between Vancouver and Patricia Bay on Vancouver Island. The ferry will be 310 ft. long with a 52-ft. beam and a depth of 20 ft. It will carry 25 cars in addition to its passenger accommodation. The Davis Shipbuilding and Repairing Co., of Levis, Quebec, were the successful tenderers. Work will be commenced at once and the contract calls for delivery next July. The cost is estimated at $400,000.

Toronto, Ont.—It was announced last week by Hon. Robert Rogers, Minister of Public Works, that the difficulty which arose during the summer in regard to the Toronto Harbor construction works has been settled finally. The Canadian Stewart Company has undertaken to make good the defective construction by a sub-contract disclosed upon examination by the government engineers, and the work will proceed without further hitch. The restoration of the imperfect construction will be done without cost to the government.

Victoria, B.C.—The Imperial Oil Co. has now completed the installation of its tanks at McLaughlin Point, and the construction of the wharf, which is about 150 feet in length, is now progressing. Several cribs have been placed by the contractors, The Taylor Engineering Works of Vancouver. An extensive system of piping is also to be laid between the wharf and the tanks, and the pumping equipment is still to be installed. Warehouses, stables, etc., are being built by the Dominion Construction Co. The storage is for refined product, the crude oil being brought from Peru to Ioco, where the new refinery is situated. The storage plant is expected to be in operation by April next.

PERSONAL.

Capt. J. S. FITZGERALD has been appointed second sanitary officer with rank as Major to assist in the work of camp inspection and sanitation.

C. E. FOWLER, M.Am.Soc.C.E., gave an address on bridges and foundations at a recent meeting of the Vancouver Branch of the Canadian Society of Civil Engineers.

G. A. STOKES has been appointed terminal superintendent for the Grand Trunk Railway at Port Huron, Mich. Mr. Stokes was formerly connected with the G.T.R. terminals in Toronto.

Col. Dr. G. G. NASMITH, director of laboratories in the health department of the city of Toronto, who has been with the Canadian contingents in France for the past year, has returned on leave of absence to assist the city in matters pertaining to the sewage disposal plant and the new filtration plant.

SAUL DUSHMAN, Ph.D. (Tor.), formerly instructor in electrochemistry, University of Toronto, and now of the engineering research laboratories of the General Electric Co., Schenectady, New York., delivered an address in Toronto on December 9th on the subject of "Science in Industrial Research." The meeting was held under the joint auspices of the Bureau of Scientific and Industrial Research of the Royal Canadian Institute and the Canadian Manufacturers' Association.

OBITUARY.

The death was announced in Winnipeg on December 9th of Mr. D. A. Low, superintendent of waterworks at Prince Albert, Sask. The deceased was 46 years of age.

An old and respected resident of Fredericton, N.B., in the person of Mr. John M. Taylor, formerly chief engineer of the city waterworks, passed away recently at the age of 84.

The death occurred recently of Mr. Edwin M. Smith, vice-president of the Western Dry Dock and Shipbuilding Co., of Port Arthur. The deceased was also president of the American Shipbuilding Co., Cleveland, and the Buffalo Dry Dock Co., of Buffalo.

Following an unsuccessful operation, Mr. Thomas R. Burpe, formerly connected with the Department of the Interior at Ottawa, died in Toronto recently at the age of 67. In his early life the deceased was private secretary to Sir Sandford Fleming during the construction of the Canadian Pacific Railway. For 15 years prior to 1897 he was Deputy Commissioner of Crown Lands at Winnipeg.

The death occurred on December 6th of Mr. William A. Conner, vice-president of the Standard Underground Cable Co. of Canada, Limited, Hamilton, Ont. The deceased, who was a resident of Plainfield, N.J., has been a director of the above company for the past ten years and first vice-president since 1909. He planned and constructed the Hamilton works in addition to similar plants at Pittsburgh, Pa., Perth Amboy, N.J., and Oakland, Cal. He began his business career in 1876 in the oil refining business at Pittsburgh, where he later attained the position of assistant manager of the Standard Oil Co. The deceased was in his 57th year.

LAND SURVEYORS ON ACTIVE SERVICE.

In *The Canadian Engineer* for November 18th, 1915, it was stated that 69 qualified British Columbia land surveyors are serving in the trenches. We are informed, however, that the number at present in service with His Majesty's forces is 85, and that enlistment of B.C.L.S. men is still in progress. When one considers that there are some 250 authorized land surveyors in the province, a large proportion of whom are over the age limit, an enlistment of 33 per cent. of the total represents a very large percentage of available men. Few professional bodies in Canadian, if any, hold the record for enlistment that the British Columbia land surveyors have earned.

ANNUAL MEETING, CANADIAN SOCIETY OF CIVIL ENGINEERS.

Professor C. H. McLeod, Secretary of the Canadian Society of Civil Engineers, announces that the annual meeting of the Society will be held in Montreal on the 25th, 26th and 27th January, 1916.

It is hoped that the usual arrangements for free return passage will be granted by the Eastern Canadian Passenger Association and the Western lines.

A notice giving the programme in detail will be issued on or about January 1st, next.

CALGARY BRANCH CANADIAN SOCIETY OF CIVIL ENGINEERS.

At the annual meeting of the Calgary Branch of the Canadian Society of Civil Engineers, held on the 4th instant, the following officers were elected for the ensuing year: Chairman, William Pearce; secretary-treasurer, Sam G. Porter; executive committee, H. Sidenius, A. S. Dawson and P. J. Jennings; auditors, J. S. Tempest and S. K. Pearce.

The Branch plans to have a regular programme of luncheons with prominent members of the profession and others for speakers, during the coming year.

COMING MEETINGS.

INTERNATIONAL ROAD CONGRESS.—To be held at Worcester, Mass., December 14, 15, 16 and 17, 1915. General Secretary, Herbert N. Davison, Chamber of Commerce, Worcester, Mass.

AMERICAN FORESTRY ASSOCIATION.—Annual meeting to be held at Boston, Mass., January 17th and 18th, 1916. Secretary, P. S. Ridsdale, Washington, D.C.

CANADIAN NATIONAL CLAY PRODUCTS ASSOCIATION.—Fourteenth annual convention to be held at Toronto January 18th to 20th, 1916. Secretary, G. C. Keith, 32 Colborne Street, Toronto.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—The Thirtieth Annual Meeting to be held in Montreal, January 25, 26 and 27, 1916. Secretary, Prof. C. H. McLeod, 176 Mansfield Street, Montreal.

AMERICAN CONCRETE PIPE ASSOCIATION.—Annual Convention to be held in Chicago, February 17 and 18, 1916. Secretary, E. S. Hanson, 538 S. Clark Street, Chicago, Ill.