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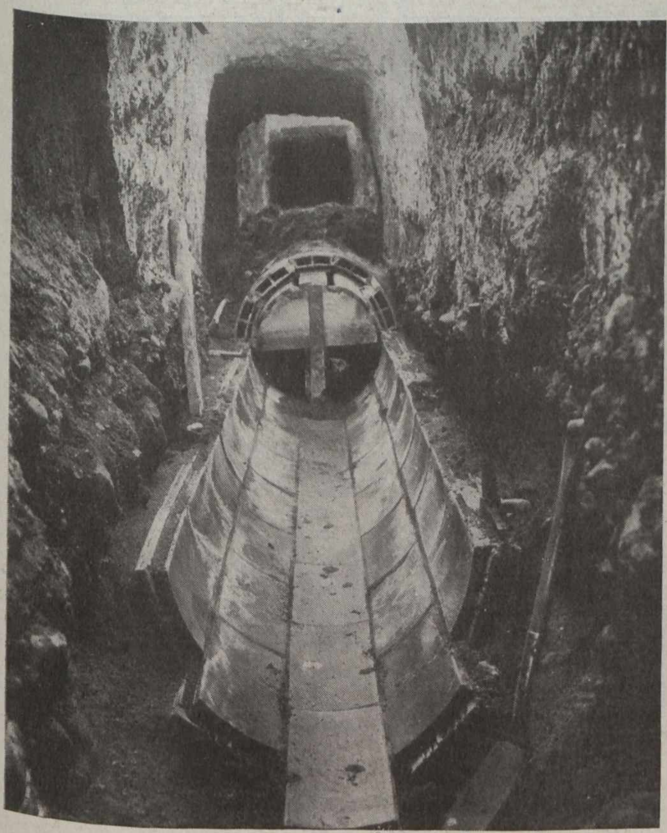
STORM SEWERS IN MOOSE JAW, SASK.

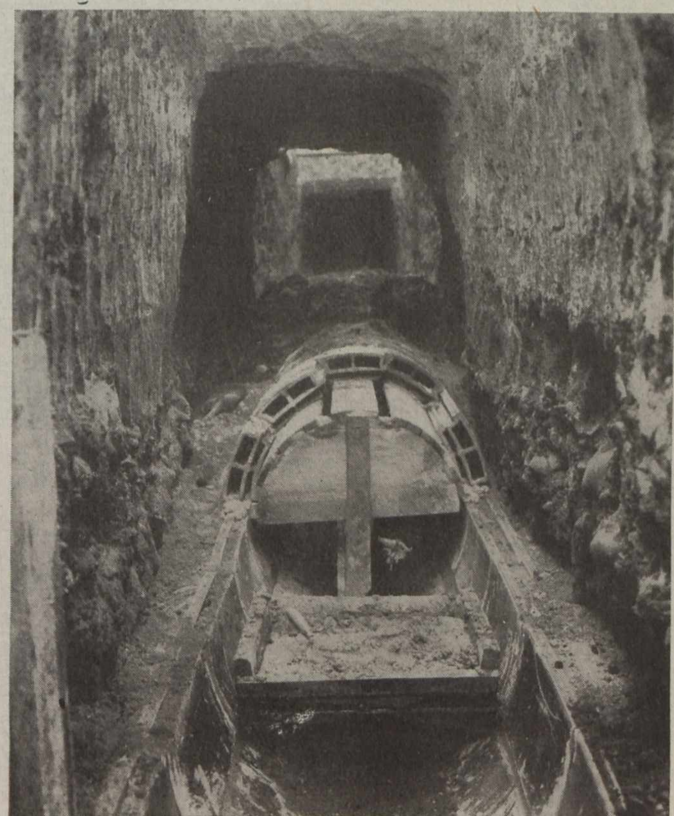
NOTES ON EXTENT OF SYSTEM, RECENT CONSTRUCTION, METHOD EMPLOYED AND COSTS—A WINTER UNDERTAKING TO PROVIDE LABOR FOR UNEMPLOYED.

By **GEO. D. MACKIE**, City Engineer-Commissioner.

THE city of Moose Jaw, like most of the other prairie cities, is drained on the separate system, and it is particularly necessary in Moose Jaw's case that every endeavor be made to prevent surface water reaching the sanitary sewers, as every gallon of sewage has to be pumped at the sewage disposal works before treatment.



Thirty-inch Segment Block Storm Sewer, Manitoba Street, Moose Jaw.



Thirty-inch Segment Block Storm Sewer, Manitoba Street, Moose Jaw.

With the rapid growth of the city during the last few years, entailing the construction of many miles of roads and streets, a large number of the natural water courses were destroyed, and as a consequence the necessity of constructing a system of storm sewers became absolutely necessary.

The city is intercepted by Thunder creek, which runs through it in an easterly direction and joins the Moose Jaw creek near the 11th Avenue subway. It is into these two creeks that the major portion of storm water discharges.

The first storm sewer was laid in 1906, but the construction of storm sewers did not keep pace with the city's growth, and, as a consequence, serious flooding took place every spring in the business section of the city due to the inadequate size of the storm sewers, or to the lack of them.

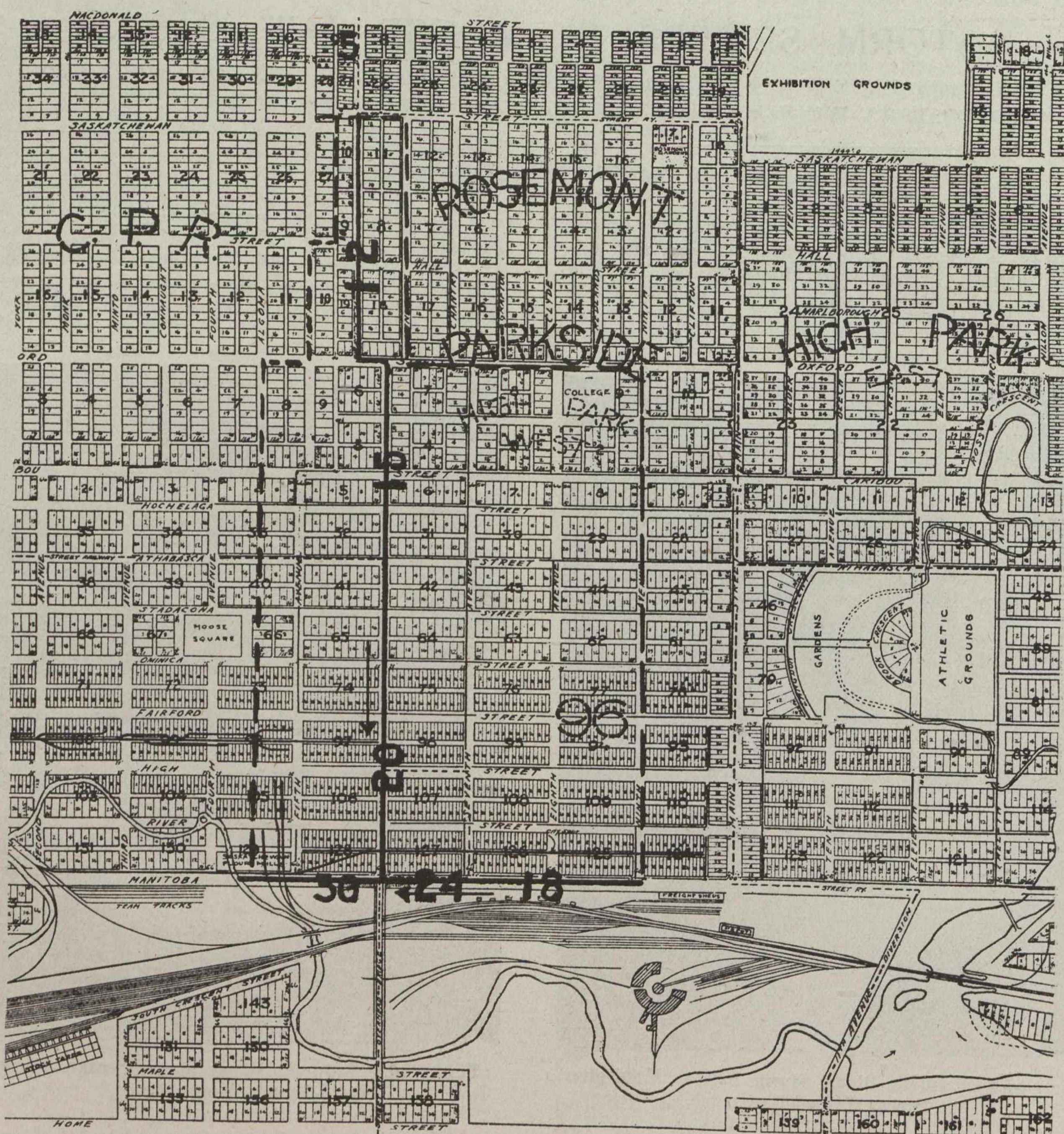
To partially remedy this state of affairs, the city authorized the construction of storm sewers to serve four different districts, and one of these sewers was constructed during the winter of 1914-15. This sewer is 7,744 feet long, and varies in diameter from 30 ins. to 12 ins., as shown on the accompanying plan. The area drained is enclosed by a broken line. The writer secured competitive prices for 24-in. and

30-in. pipes in tile, segment block and cement concrete, and the lowest prices received per foot were:

	Tile.	Segment block.	Concrete.
24-in.	$1.70	$1.80	$1.75
30-in.	3.32	2.30	2.60

Tile pipe was used for the 24-in. and segment for the 30-in. section. The tile pipe was supplied by the Redwing Sewer Pipe Company, and by the Alberta Clay Products block pipe can be laid at a cost of 1 cent per foot for each inch of diameter of pipe, and the writer believes this can be done under ordinary conditions, but as these pipes were laid in the winter, it required the services of two extra men tending fires, as in addition to heating the tile it was bedded in hot moist sand and covered with the same material to protect it from frost.

The accompanying views show the pipe as constructed in the ditch.



Section of City of Moose Jaw, Showing Route of New Storm Sewer, with Diameters of Various Sections Indicated.

Company, Medicine Hat, and the segment block by the American Sewer Pipe Company, Akron, Ohio. There are ten segment blocks to the ring in 2-ft. lengths weighing 230 pounds per lineal foot of pipe. The segment block was the first of its kind to be used in the city for sewer pipe, and was found perfectly satisfactory. The cost of laying the pipe is higher than for sewer tile of the same diameter, but this is more than offset by the difference in the first cost. The manufacturers claim that the segment

The construction of this sewer presented no difficulties. Table I. gives an itemized cost of the various portions of the work per foot compared with the estimated cost.

In addition to the pipe line itself, 1,219 lin. ft. of connecting drains between catch basins and manholes were constructed. This pipe line averaged 4½ ft. in depth, and was frozen to grade. As two connections on each street intersection had to be tunnelled beneath the street railway track, the cost (84.4 cents per lin. ft.) is relatively high. Twenty-nine manholes were built in the course of the work, averaging 267 ft. between centres. Four of these were of brick of irregular design, due to location and obstructions encountered; the remainder were of concrete of 1:3:5 mix, 3 ft. 6 in. inside diameter with a 9-in. wall. Forty-four catch basins were required, four being placed on each street intersection. These were of concrete, 2 ft. 6 in. inside diameter and a 9-in. wall. The benches of all manholes and the wearing surface of catch basins were given a finishing coat 1-in. thick 1 to 1 mix.

Table II. shows the cost per foot for manholes and catchbasins.

ginning of December and prosecuted to completion early in March of the following year. The temperature was below freezing at all times, falling as low as —40°. Unskilled relief labor was employed throughout, gangs changing each week. On an average each man secured one week's employment in three. An average of 57 men per day were employed throughout. The ground varied in nature from a heavy gumbo to grey clay carrying a stratum of heavy gravel. All the work was carried out under the supervision of the city engineering staff.

The contract price, based on summer conditions and skilled labor, was $25,008.89, while the cost to the city, under the most unfavorable climatic and labor conditions, was $26,795.63. This sum includes all clerical work, supervision, insurance of men, rentals of tools, and maintenance of the sewer for six months after the completion of the work.

Table 1.—Cost of Storm Sewers Per Foot.

Size of pipe	12-in.	15-in.	18-in.	20-in.	24-in.	30-in.
Material	Tile.	Tile.	Tile.	Tile.	Tile.	Seg. Block.
Length of section	1581 ft.	1509 ft.	1134 ft.	2086 ft.	635 ft.	797 ft.
Average depth	6.6 ft.	7.00 ft.	9.5 ft.	7.25 ft.	11.0 ft.	12.5 ft.
Nature of soil	Grey clay, 6 ft. frost	Clay and gravel, 7 ft. frost	Grey clay 5 ft. frost	Clay and gravel, 3 ft. frost	Clay and gumbo, 5 ft. frost.	Gumbo, 4 ft. frost
Yardage per lin. ft.	.65	.70	.90	.80	1.22	1.85
Cost per lin. ft. excavation	$ .65	$1.01	$1.03	$ .49	$1.34	$1.75
Backfill	$ .05	$ .07	$ .13	$ .13	$ .30	$ .40
Teaming, watching timekeeping, etc.	$ .14	$ .16	$ .16	$ .22	$ .22	$ .70
Pipe laying	$ .06	$ .06	$ .09	$ .12	$ .13	$ .52
Material	$ .60	$ .93	$1.19	$1.41	$2.01	$2.89
Total cost	$1.50	$2.23	$2.60	$2.37	$4.00	$6.26
Estimated cost	$2.00	$2.25	$3.00	$3.00	$4.00	$5.00

Table II.—Manholes and Catch Basins.

	No.	Vertical feet.	Total cost.	Unit cost.	Cost per vertical foot. With covers.	Without covers.
Manholes—Concrete	25	206	$1,710.37	$68.41	$8.30	$4.45
Brick	4	48	395.70	98.92	8.24	5.74
Catch Basins—Concrete	44	249	1,425.32	32.40	5.73	3.69

Materials—Sand, $1.80; gravel, $2.30; crushed stone, $3.30 per cubic yard. Cement, 75 cents per bag F.O.B. the job. Labor, 25 cents per hour.

The laying of storm sewers was let by contract in August, 1914, but owing to the outbreak of the European war at that time the contract was cancelled, and nothing further was done until the end of November, when, owing to the acuteness of the unemployed situation, the city council resolved to carry out the work themselves with unemployed labor. Construction was started in the beginning of December and prosecuted to completion early in March of the following year.

The writer doubts if there was 50 per cent. efficiency from the men employed in comparison with that of a regular laborer, as the men were recruited from all trades, and were entirely unfitted and unaccustomed to such work.

TRANSFERABLE LIFT SPAN FOR BRIDGE.

A lift span bridge with some unusual features is described in the Engineering Record for November 27th, 1915. Over the Arkansas River, at Pine Bluff, Ark., a bridge was recently completed in the design of which provision was made for a shifting river channel by using a lift span and five other truss spans of identical design to make possible the future transfer of the towers to lift any span desired. There is also to be noted the use of counterweight chains of special design instead of the usual wire cables, and the adoption of a folding cast-iron counterweight to control the balance of the lift span and chains. The bridge, which is a combined railway and highway structure, is approximately 3,010 feet long, with 1,610 feet of steel structure and 1,400 feet of timber trestle. The steel section consists of seven riveted spans, six of which are 239 feet 4 inches centre to centre of end pins and one 149 feet 7 inches long. The channel of the river is liable to shift at any time. At another bridge, a few miles below Pine Bluff, the channel shifted from one side of the river to the other, necessitating the construction of a new swing span, so that the bridge now has two swing spans. It was therefore considered desirable in this case to use a type of construction such that the movable span could be shifted to any part of the bridge in case of a change of location of the channel. The spans were accordingly made all alike and provided with all arrangements for attaching the lifting and control mechanisms to any one of the equal spans. The weight of the chains is balanced by disks of cast iron so arranged that they are picked up by the counterweight as it rises, thus adding to its weight to compensate for the otherwise unbalanced length of chain.

PRESENT SCOPE FOR PRACTICAL WORK IN IMPROVING CANADIAN CITIES.

THE objects and scope of the recently organized Civic Improvement League were presented to our readers in *The Canadian Engineer* for December 2nd, 1915. A conference of the League was held in Ottawa on January 20th, at which provincial and Dominion representatives were appointed as follows:

Provincial Representatives.—Ontario: Mr. G. Frank Beer, Toronto; Quebec: Hon. J. J. Guerin, President Montreal Civic Improvement League; Manitoba: Mr. W. Sanford Evans; Saskatchewan: Professor Oliver; Alberta: Commissioner Garden, Chairman Alberta Town Planning Association; British Columbia: Mr. G. R. G. Conway, M.Inst.C.E.; New Brunswick: Mr. W. F. Burditt, Chairman St. John Town Planning Commission; Nova Scotia: Mr. R. M. Hattie, Chairman Halifax Civic Improvement League; Prince Edward Island: Hon. J. A. Mathieson, Premier.

National Representatives.—Dr. J. W. Robertson, C.M.G., Mr. James White, Deputy Head, and Mr. Thomas Adams, Town Planning Adviser of the Commission of Conservation; Dr. P. H. Bryce, Hon. President of Canadian Public Health Association; Mr. J. S. Watters, President of Dominion Trades and Labor Congress; Mr. W. D. Lighthall, K.C., Secretary of the Union of Canadian Municipalities.

The chief paper presented at the latest conference was that by Mr. Thomas Adams, dealing with the present scope for practical work in improving civic conditions. Mr. Adams pointed out that between 1901 and 1911 there were created in four of the nine provinces of the Dominion an average of over 100 entirely new towns, thus illustrating the necessity for the foundations of a healthy civic structure. Concerning the scope for immediate action the paper dealt as follows:

Municipal Government and Finance and Unemployment.—The greatest need in connection with these matters is that a department of municipal affairs or a Local Government Board should be created in each province. That need arises from the fact that we require more uniformity in regard to measures which are necessary to secure (1) real and effective economies in the conduct of municipal business, (2) lower rates of interest on municipal borrowing, (3) greater efficiency in carrying out public undertakings, (4) proper auditing of municipal accounts, (5) prevention of fire and a consequent reduction in the cost of fire insurance, (6) proper control of labor difficulties during periods of slackness in employment with the least harmful results to the citizens affected during such periods, (7) enforcement of sanitary provisions, (8) avoidance of recurring mistakes in administration due to isolated local action, (9) reduction in cost of local improvement without lowering of standards of construction, (10) unifying the methods of valuing land for assessment, and other matters. We cannot overcome the defects of human nature in the personnel of councils, commissions or other bodies by legislation, but we can reduce the opportunities for bad management by setting up the right kind of machinery. At present we have a system of municipal government which is inherently bad because it lacks uniformity on the one hand and elasticity on the other hand, and to go on tinkering with it is to waste time and effort. We need a constructive policy which has for its final aim the substitution of a new system for that now in force. We need not begin by destruction or radical reform of our existing local government institutions, but we should aim at ultimately securing a final readjustment of our system so that it will attain even higher standards than those of the Mother Country where democratic local government is comparatively successful. As a beginning, we should recognize the need for apportionment of responsibility between the province and the local government unit—be it city, town or rural municipality—and make the first step in reform the setting up of a provincial department, with a cabinet minister at its head to give exclusive attention to affairs of local government. There are the beginnings of such a department in Alberta and Saskatchewan, but even in these provinces the question of giving them enlarged powers and wider scope requires consideration.

One of the most serious causes of bad sanitation is the absence of effective control over new developments just outside the boundaries of cities—in rural municipalities—and until we have a uniform sanitary standard for all urban growth whether within the city or just over its borders we will continue to have unhealthy conditions. With regard to the question of the fixing of values of land for purposes of assessment we have a position at present in many cities which contains all the elements of ultimate financial disaster unless we make an early attempt to regulate it. Bondholders frequently apply to government departments for statistics to enable them to judge of the soundness of investments in city bonds and they show a nervousness and lack of confidence in making these investments which is caused by our careless methods and is not justified by any lack of real stability in our institutions. That there is need for some stocktaking and re-appraisement of values is indicated by the fact that in more than one province we have an average assessment value per capita of nearly $1,800, as against about $550 in other provinces. In the largest cities and towns of Scotland the capital value of the assessed valuation is only $520 per capita, notwithstanding that vacant land is all assessed at agricultural rates, and every street along which buildings are erected has been constructed according to the best modern standards. An owner of land and improvements in a Scottish town can raise about four-fifths of this assessed valuation on mortgage, and the reader is asked to compare that with the proportion that could be raised of the assessed valuation of land in some of our cities.

The second suggestion under the head of municipal government is that we should ask the census department of the government to take up the question of municipal statistics. We have no satisfactory system of collecting statistics regarding municipal undertakings and finance. We collect many statistics without any apparent object in view, some of little real value because they are incomplete, and others useless because the reason for collecting them has ceased to exist. With our growing towns and steadily increasing municipal expenditure we urgently need a collection of municipal and vital statistics prepared with certain definite objects in view and we should draw the attention of the Dominion Government to this need and appoint a committee of expert municipal men to confer and make recommendations to the department concerned. Here the need for co-operation is between the (1) federal government, (2) the province, and (3) the city or town.

Town Planning, Housing and Public Health.—In regard to town planning, we have the excellent example of Nova Scotia, which has created a precedent for effective legislation dealing with this subject. The Commission of Conservation has issued a draft Act, which has been circulated among members of this conference. This draft slightly enlarges on the Nova Scotia Act, but does not differ from it in any of its material sense. Its purpose is to secure the proper regulation and control of the use and development of land for all kinds of building purposes; the term "town planning" very imperfectly indicates the comprehensive character and real significance of the measure. Its main provisions may be summarized as follows:

(1) It is considered desirable for the working of the Act that there should be a department of municipal affairs in each province, but this is not essential, as the duties may be assigned to another department. Under the department there should be a comptroller for each province, devoting himself specially to town planning. He should keep a plan of the whole province, showing the main arterial thoroughfares which, in the opinion of the highway commissioners or minister of highways, are desirable for purposes of main road communication. In each locality there has to be a local town planning board, consisting of three members of the council and two outside ratepayers, but, if desired, the work can be done by the local authority itself, and the draft altered accordingly to secure this. The local board would have the engineering officer or other qualified person as its executive officer.

(2) This gives certain powers and duties to the local board to approve all new development and to require plans and particulars of all sub-divisions and laying out of streets to be submitted in accordance with certain procedure. The Board may require that main thoroughfares shall be 100 feet wide. Agreements may be entered into with owners permitting streets to be of less width than 66 feet where land is given by such owners for streets wider than 66 feet. Arrangements may be made for adjusting and altering boundaries and effecting changes of land already sub-divided and local boards in adjoining areas require to co-operate in regard to sub-division affecting land near to their boundaries.

(3) Town planning schemes or by-laws may be prepared for the general object of securing proper sanitary and hygienic conditions, amenity and convenience in connection with the lay-out of land. What is meant here by a set of by-laws is practically a partial town-planning scheme. Such partial schemes are compulsory and are adaptable for rural areas and small towns. The more comprehensive scheme is most suitable for large cities, and is optional. In other respects this part of the Act follows in general principle the successful British Act of 1909. Schemes and by-laws would deal with building lines, width of streets, limiting number of separate family dwelling houses to the acre, prescribing the area of any lot which can be built upon, prescribing the setting aside of areas for residential, manufacturing and other purposes, prohibiting noxious trades and structures injurious to amenity, etc.

Powers of individuals to defeat the work of a board or to indulge in speculation in expectation of improvements being carried out will be reduced to a minimum. The provincial department may prepare a scheme or by-laws if the local board fails to do so and there is strong enough local representation in favor of it being done. The local authority must provide enough money to meet the reasonable requirements of a local board to prepare a scheme or by-laws but has the option to refuse funds to carry out the provisions of either. It is necessary to give the local authority power to approve or disapprove large expenditures in executing the scheme, but it is equally necessary for the effective working of the Act that the local board should be provided with the limited amount to prepare its scheme or set of by-laws.

This is the briefest possible summary of the draft Act which will require careful study to master its details. The need for such an Act is apparent; our present method of developing land is discredited; we are creating new slum conditions in our suburban areas which are as bad as those in old centres, although they are less necessary because they are capable of being controlled by regulation; unhealthy and feverish speculation in land is the result of unbridled license in carrying out its development. Therefore, I urge that this conference should consider the desirability of recommending the provincial governments to pass legislation along the lines of the Act framed by the Commission of Conservation at the earliest moment.

The housing question requires consideration, but it is difficult to deal with it in the form of a general recommendation. The Commission of Conservation is undertaking a special study with a view to making recommendations for new legislation to the provincial governments. The writer's view is that it is desirable to suspend judgment on the housing question until this report is complete, but that the Dominion council of the league, when formed, should be asked to appoint a special committee to collect statistics and information regarding housing conditions in the different provinces.

Public health is a matter which is being well taken care of in most of the provinces. Our machinery to deal with this is fairly up-to-date. There is need, however, for more accurate and more comprehensive statistics on public health matters and something might be done to-day to indicate the strength of this need.

Immigration and Development After the War.—With regard to immigration we have a question on which experience is the best guide. It is intimately connected with our civic problems and requires consideration from the point of view of the municipality as well as that of the Dominion and province. Whether or not we should pass a resolution suggesting methods and principles which should be adopted in making a more careful selection of immigrants, and whether or not it is possible to devise a method which will encourage a greater amount of settlement in agricultural areas is a matter we should discuss.

To support the passing of town-planning legislation and the setting up of departments of municipal affairs will be one of the most effective steps to secure safeguards for civic development after the war. There is need, however, for having a constructive policy in regard to future settlement of agricultural land, particularly in connection with the return of soldiers and possible immigration of the future. We want to urge a policy which will enable us to have (1) less length of roads in rural areas, but better and more conveniently planned roads; (2) more accessibility between good areas of land and means of transportation; (3) co-operation and facilities for education and social intercourse; (4) facilities and assistance in creating rural industries in small towns and villages and the other things which are necessary in combination to secure the successful settlement of land. These things are not beyond our reach, but they require us to pay the price demanded *ab initio*, in nearly every successful enterprise. Painstaking investigation must be made, carefully prepared schemes thought out; and when our studies are completed and sound schemes prepared it will probably then be found essential for government support to be given to start the schemes, both in the form of some financial credit and in the form of administrative energy. Some definite recommendation might be made by this conference which may influence the provincial governments to deal with the problem, and be a help to the Commission of Conservation and the Economic and Development Commission in studying and recommending action in the future.

Maps.—There are other matters of importance to be considered. For instance, the writer agrees with Mr. Nelles, of the Geodetic Survey Department, that we must have better maps of our Canadian towns and cities* be-

*See "The Mapping of Canadian Cities," by Douglas H. Nelles, in *The Canadian Engineer* for Jan. 6, and Jan. 13, 1916.

fore we can get the best results in planning and improving our cities and towns, also that if these maps are to be economically prepared we must look for help in their preparation to the federal and provincial governments. Let us urge the importance of this matter on the attention of the authorities concerned. There are the questions connected with child welfare, more scientific methods of distributing public charity, the question of dealing with the feeble minded, of promoting the right kind of technical education to suit our needs and others of a cognate kind.

We must be careful not to dissipate our energies over too wide a field, although we can do much by organization to so arrange and allot our work that we can include every civic activity within the scope of our organization by delegating the work to special committees.

There is need for an International Institute similar to the Agricultural Institute at Rome, to collect municipal statistics all over the world and place them at the disposal of all cities and towns. The writer hopes that the Civic Improvement League will inaugurate a movement to secure the establishment of such an institute.

VICTORIA INNER HARBOR IMPROVEMENTS.

The 9th annual report of the Inner Harbor Association summarizes the vast amount of improvement work that has been done during the past year or is now in progress in connection with the harbor scheme. The report is, in part, as follows:—

In the upper harbor, or basin, a large portion of the bottom has now been dredged to 20 feet deep at low water. The large rock about the middle of the basin will be removed after the works are completed in the lower harbor.

The channel leading to the inner harbor is now considerably wider than formerly and forms an improvement that will be greatly appreciated by all steamships frequenting the port. The Dominion Government dredges and rock drills are engaged continuously, day and night, in deepening and widening this channel on the northern side, and the operations will be continued until the water is deep enough and wide enough to accommodate without danger ships of much larger capacity than those at present using the inner harbor.

The lower harbor generally, where dredging can be done, is now 20 feet deep at low water. The rock on the western side of the entrance (off Behrens Island) has been removed; the rocks off Shoal Point, on the eastern side of the channel, have been cut back about 200 feet, thus widening the channel considerably and straightening out a very difficult turn. This is being further widened as opportunity offers.

The northern side of the channel, between Songhees Point and Pelly Island, and eastwards to Behrens Island, is gradually being straightened, in accordance with the original scheme. The southern side of Pelly Island, and the immense mass of rock contiguous, is gradually being removed, and by the end of March will be fairly straightened out to line, widening the channel about 120 feet. The removal of Songhees Rock (west of Songhees Point at the eastern approach to the northwest passage) will shortly be undertaken, and a commencement of the removal of the material (mostly packed clay) forming the bottom of the proposed northwest passage, will be made, giving a navigable channel 300 feet wide, free from rock. This work will be proceeded with during the intervals when the dredges are not engaged in the removal of the rock broken up by the drilling plant. The work to the north of Pelly Island may be looked upon as preliminary to the eventual removal of the whole of the rock in that locality.

The Narrows between Songhees and Laurel Point have been widened about 75 feet by the removal of rock, etc., at the northern side.

To the southeast of Songhees Point the rocks have been cut back to 16 and 20 feet deep at low water. It is proposed to remove the remainder of the triangle to the railway bridge as the work proceeds inwards. All movable material has been dredged from the eastern side of this triangle and the channel, as far as the railway bridge, has been widened about 150 feet.

The general trend of the works of improvement in the inner harbor has been the gradual removal of all impediments to navigation south of a line drawn westward from Songhees Point to Pelly Island, produced westward towards Behrens Island, as laid down on our original plan and this system has been steadily pursued.

The rock blasted by the drilling plant, or broken up by the Lobnitz, is immediately removed by one of the dredges in close attendance upon these machines, and the bottom kept clear, as far as circumstances permit.

The total amount of rock, clay, gravel and sand removed from the bottom of the harbor during the year 1915 has been approximately 420,000 cubic yards, of which total about 36,000 yards were rock blasted out by the drilling plant or broken up by the Lobnitz rock-breaker. The total outlay on these works during the year has been about $230,000.

The above refers, as stated, to the inner harbor work, and does not cover the extensive work under way on the outer harbor, docks and breakwater. An important part of the latter work completed during the year is the formation of a turning basin, some 21,000 superficial feet in area, dredged to 30 feet at low water, for the manoeuvring of ocean vessels leaving port.

About two-thirds of the length of the breakwater is now above high-water level and the structure is meeting all expectations in securing quiet water under the most stormy circumstances, not only at the new piers under construction, but also preventing the breaking of heavy seas over Rithet's southern wharf. The work on the two piers is making rapid progress. Already nine of the 3,000-ton caissons are in place. At present the work on the piers is all under water and it will be another year before they assume visible shape and proportions.

The total outlay to date on the breakwater has been about $1,400,000 and on the new piers about $740,000.

MEAN SEA LEVEL FOR RAILWAY PROFILES.

General Order No. 157 of the Board of Railway Commissioners for Canada requires that on and after February 1st, 1916, all profiles submitted by railway companies subject to the jurisdiction of the Board, which commence at, terminate at or intersect with any of the lines listed in "Altitudes in Canada," edited by James White, assistant to the chairman and deputy head of the Commission of Conservation, shall be based upon mean sea level as provided in that publication. This includes those which touch tide water and are not listed in "Altitudes in Canada." The Canadian Pacific, Canadian Northern, Grand Trunk Pacific and Grand Trunk Railway Companies have all consented to the proposal.

The annual meeting of the Manitoba Good Roads Association will be held on February 14th.

WATER POWERS IN THE PORCUPINE AREA OF NORTHERN ONTARIO.

OF interest in connection with the increased mining activity in the Porcupine gold area is a consideration of its water power resources. In *The Canadian Engineer* for December 16, 1915, the subject was discussed in an abstract from the 1914 report of Mr. Thos. W. Gibson, Deputy Minister of Mines for Ontario. The following notes are from the Ontario Bureau of Mines' report on the Porcupine gold area, which contains an appendix prepared by W. R. Rogers, topographer of the Bureau, and dealing with the subject of water powers within the area.

Mr. Rogers states that during early mining operations in Northern Ontario, steam power from wood fuel is used in the preliminary working of prospects, but that, as development proceeds, timber in the immediate neighborhood is soon exhausted, and then either coal or hydro-electric energy must be resorted to for power purposes.

All the hydro-electric power furnished the Porcupine camp comes from two plants situated on the Mattagami River, a tributary of the Moose flowing into James Bay. The location of the power plants with respect to the mining area is indicated on the accompanying sketch map. Both of these were formerly independent plants, but now are controlled and operated by the Northern Canada Power Company, Limited. The two plants are provided with interswitching facilities, so that they work continually in parallel. The new company has expended a great deal of money in new construction, replacements, and betterments, so as to guarantee to power users continuous and satisfactory service.

The first development was that at Sandy Falls, six miles northwest of Timmins, which is the terminus of the Porcupine branch of the Timiskaming and Northern Ontario Railway. Power was available from this development in June, 1911, and a saw mill operated on the east bank of the Mattagami River before the mines were ready to use electric energy—a unique experience in a new mining camp.

Two units are installed in the power house with a total capacity of 2,500 h.p. It is the intention to install other units, doubling the capacity. The effective head is 35 feet. During the summer of 1913 extensive improvements to the plant were undertaken. The timber dam is now replaced by a concrete structure, from which water is carried to the power house by a 9-foot wood stave and an 8-foot steel penstock.

A continuous record of the flow of the river has not been kept, but several measurements have been made during low-water periods in different years and meter records are as follows:—

January 20, 1910	1,654 cubic feet per second
March, 1910	517 cubic feet per second
March 25, 1912	633 cubic feet per second
March 25-26, 1914	500 cubic feet per second

A meter record taken July 4, 1911, at Cypress Falls, some miles down the river, gave a discharge of 3,351 cubic feet per second. Here the drainage area is estimated at 4,500 square miles, whereas at Sandy Falls it is only 2,500 square miles. Reducing the reading on this basis would give a flow of 1,862 cubic feet per second at Sandy Falls on the above mentioned date.

From the available records it will be seen that 500 cubic feet per second may be assumed at the extreme low-water natural discharge. This is equivalent to only 1,600 h.p., while the total capacity of the present installation is 2,500 h.p. Consequently controlled storage must be resorted to for increasing the minimum flow. This is now provided for above Wawaitin Falls.

The other power house, situated at Wawaitin Falls, is distant 11 miles southwest of the town of Timmins. This plant was not ready to supply power until the autumn of 1912. From the dam at the foot of Kenogamisee Lake, an expansion of the Mattagami River, there is an open canal 1,200 feet long from which water is led through two 9-foot wood stave penstocks, each 1,500 feet in length, to a surge tank, 40 feet in diameter, on the crest of the hill overlooking the power house. From the surge tank two 8-foot steel penstocks, each 1,300 feet long, lead to the power house. The operating head is 125 feet. At present two units are installed with a total capacity of 7,000 h.p. Canal and head works, however, are arranged so that the power house can be extended and two more units added, thereby doubling the capacity.

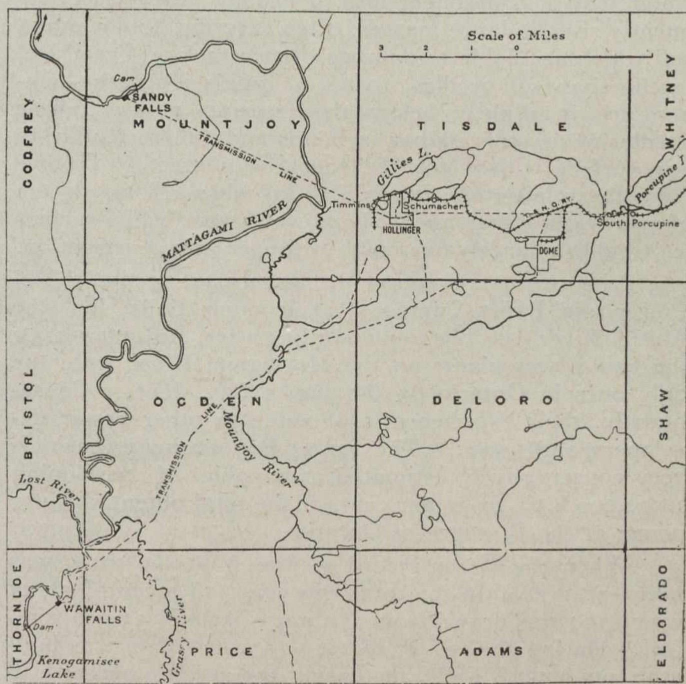


Fig. 1.—Showing Location of Power Plants on the Mattagami River at Wawaitin and Sandy Falls, also Transmission Lines to the Porcupine Mines

Meter records available at this point under natural flow are as follows:—

March, 1910	366 cubic feet per second
July 15, 1911	792 cubic feet per second
March 16-30, 1913 ....195 to	240 cubic feet per second
March 25-26, 1914	354 cubic feet per second

The Cypress Fall record for July 4, 1911, corrected for a drainage area of 1,000 square miles instead of 4,500, would give a natural flow of 745 cubic feet per second. This record corresponds closely with that for July 15, 1911. Assuming 200 cubic feet per second as the minimum natural flow, the horse-power resulting would be only 30 per cent. of the present capacity of the power plant, hence the necessity for storage.

From the records, it would appear that a run-off coefficient of 0.2 cubic feet per second per square mile of drainage area may be taken as representing the minimum flow of the Mattagami River under natural conditions.

Storage.—High-water periods in Northern Ontario are at the time of the spring break-up, and to a much less extent during the late autumn, when rains are usually fairly abundant. February and March have been the months when water becomes scanty, particularly in those winters when the usual thaws did not occur. How to provide for low-water periods without reliance upon auxiliary steam plants is a problem that can be solved only when abundant storage is possible. The experience of the power plants on the Mattagami River has very definitely established this fact.

Pondage may be considered as the close-at-hand storage of water immediately available for use in the turbines. It is a necessary precaution in Ontario water powers in order to provide against ice troubles as well as to meet local fluctuations in power needs during the day. Three distinct types of ice are met with: surface or sheet, anchor, and frazil. The first, in addition to restricting the area of the channels, is liable to cause jams in the spring, cutting off the water supply or raising the tail water with a consequent loss of head. Anchor ice frequently rises in large masses, often carrying boulders and soil which are liable to damage the ice racks. Frazil ice, in the shape of needles, forms in rapids when the temperature is slightly below the freezing point. These needles or crystals gather in lumps and adhere readily to any surface with which they come in contact. Trouble from these latter sources is avoided when a long stretch of still water exists above the power house, while surface ice trouble is largely overcome by proper dam construction.

Prior to the erection of the large plant of the Abitibi Power and Paper Company, at Iroquois Falls, on the Abitibi River (see *The Canadian Engineer*, July 1st, 1915), the two power plants on the Mattagami River were the only ones in Ontario on the James Bay slope. Consequently, their experience is of value to other power developers and users. The James Bay drainage basin is very conservatively estimated as capable of developing 1,500,000 h.p., or 30 per cent. of the total potential water power of the Province of Ontario.

When the meter record of March 25-26, 1914, was taken at Wawaitin the total flow was 518 second-feet, of which 164 was drawn from a storage basin of 33,000 acre-feet. During the winter of 1914-15 a new dam was built at Kenogamisee Falls, increasing the storage capacity to 100,000 acre-feet. This reservoir should be ample to supplement the flow at low-water periods. Kenogamisee Lake, the original reservoir, is shallow, and the water available is considerably lessened in late winter by a two-foot covering of ice.

Floods and Forests in Relation to Storage.—Floods are reduced in magnitude and stream flow rendered more constant where the drainage basin at headwaters is forested. For the most part, Northern Ontario is a forested area, but, where such is not the case, reforesting, particularly at the sources of streams, as an aid to reliance upon storage reservoirs, seems a necessary precaution of the future in order to prevent disastrous floods, and to equalize as much as possible the stream flow throughout the year. Floods may do little damage at present except to power installations, so the ideal conditions will not receive much attention until some future time when a shortage of power makes their consideration urgent.

Sometimes the topography of drainage areas precludes the possibility of providing large storage reservoirs. In Northern Ontario, water storage above the natural high-water mark on streams and lakes is not desirable, as it results in killing the timber along the banks and shores, giving the country a most desolate and deserted appearance. The concensus of opinion favors storage at or near the sources of streams, thereby preventing a combination of conditions which usually occasion disastrous floods in the areas adjacent to the lower stretches of the river.

In the particular case of the Mattagami River, the present storage not only helps the power plants already in operation, but will improve the conditions for future developments farther down the river. At eight different points down stream where surveys have been made, the farthest of which is only 75 miles north of the Transcontinental Railway, it is possible to develop a total of 149,235 h.p. under natural conditions. In this estimate the coefficient used for minimum low-water discharge is 0.3 c.f.s. per square mile of drainage area. Records at Sandy and Wawaitin Falls indicate that 0.2 is the proper coefficient. This would reduce the estimate of undeveloped energy on the Mattagami River to 100,000 h.p. Storage facilities, with the exception of those already mentioned in connection with the Wawaitin development, are very meagre, and consequently the river cannot be described as well-regulated in its natural condition.

Power Storage.—In his statistical review, referred to above, T. W. Gibson points out some of the power difficulties that have been experienced, and refers briefly to the auxiliary steam plants that have been provided by the larger mines to meet emergencies resulting from electric power shortage.

During the winter of 1911-12, owing to extreme low water, there was a shortage of power for operating the Porcupine mines, but since that date the Wawaitin Falls development has been completed and the Sandy Falls plant improved and enlarged. Despite this increase of capacity there was again a decided shortage of water during the winter of 1914-15 that was not relieved until the second week in April, 1915, thereby seriously interrupting the work of the mines and curtailing the gold production.

In the Porcupine camp, provision has been made, to the extent of about 2,500 h.p., to meet periods of power interruption. This is notably the case at the Hollinger mine, where two new compressors, driven by synchronous motors, have been arranged so that they can be turned into steam engines and the motors used as electric generators supplying current for general use around the mine and mill or for driving other compressors.

Power Costs.—In the Cobalt silver camp where the Northern Ontario Light and Power Company operates, and also at Porcupine, where the Northern Canada Power Company supplies electric energy, a flat rate of $50 per horse-power per annum has obtained until recently. Many of the contracts are expiring and the power companies are proposing to introduce new schedules with a sliding scale of rates depending on the amount of power consumed and the load factor. In some cases the new rates work out at a higher figure than the old. The largest consumer in the Cobalt camp is the Dominion Reduction Company, which requires over 500 h.p. for operating its plant. The Dome and Hollinger mines are the largest consumers in the Porcupine camp. At the present time the former uses about 2,000 and the latter 3,500 electrical horse-power.

CHANGE OF NAME.

The International Acheson Graphite Company of Niagara Falls, N.Y., has changed its name, and hereafter will be known as Acheson Graphite Company.

Some tests of the weight of freshly cut woods have just been made by the Laurentide Company, of Grand Mere, P.Q. They show that brown ash weighs 50.26 pounds per cubic foot, yellow birch 64.40 pounds, white birch 55.62 pounds, elm 71.31 pounds, and sugar maple 73.36 pounds.

CONSTRUCTION NEWS

WATER, SEWAGE AND REFUSE.

Chatham, Ont.—A 2-inch water main will be laid to supply the new sugar factory site for construction purposes. About 1,500 feet of pipe will be required. W. G. Merritt, City Clerk.

▲—**Collingwood, Ont.**—Tenders will be received by Hugh A. Currie, Chairman of the Collingwood Water and Light Commission, up to 8 p.m., on Wednesday, March 1st, for the following works:—(1) Steel water tower. (2) Foundation for steel water tower. (3) Pumping machinery, comprising one motor-driven unit of 800 imperial gallons capacity. (4) Pump well and connections. Plans and specifications may be seen at the office of Chipman & Power, Engineers, 204 Mail Building, Toronto, or at the Water and Light Office, Collingwood.

Niagara-on-the-Lake, Ont.—An 8-inch tile sewer will likely be constructed on Prideaux St.

Ottawa, Ont.—The city council intends to undertake the following works as local improvements: A 9-inch tile pipe sewer in Bullman St., from Parkdale Ave. to the west limit of Lot No. 894 Bullman St. North, at an estimated cost of $1,460.85; a 12-inch tile pipe sewer in Scott St., from Pinehurst Ave. to the west limit Lot No. 891 Scott St. South. Estimated cost, $3,238.40. Norman H. H. Lett, City Clerk.

Stratford, Ont.—The board of works recommended the construction of a sewer on Nelson Street, from Walnut Street to lot 246; also improved storm drainage on Mornington Street, from Waterloo Street to James Street, and from the intersection of Birmingham and Youngs Street to the Erie Creek. A. B. Manson, City Engineer.

+—**Toronto, Ont.**—Contracts for sewer construction, awarded by the board of control, were as follows: Cawthra Ave., Lloyd Ave. to C.P.R., to R. C. HARRIS, Commissioner of Works, at $4,074; Connolly St., Laughton Ave. to Campbell Ave., to W. E. TAYLOR, at $1,198.

Toronto, Ont.—The Provincial Board of Health has approved of sewer extensions at St. Catharines.

Winnipeg, Man.—Estimates of the cost of nine-inch and 18-inch sewer accommodation for the military in the exhibition grounds will be submitted to the board of control by W. P. Brereton, City Engineer.

Winnipeg, Man.—Plans are being prepared for the construction of watermains to the proposed Institute for the Deaf and Blind.

Winnipeg, Man.—The Jefferson Ave. Joint Sewer Committee has given orders that the sewer must be built to the west side of the C.P.R. Winnipeg Beach line by March 15.

LIGHT, HEAT AND POWER.

Amherstburg, Ont.—A new street lighting system will be installed at a cost of $2,582. G. E. Pulford, Clerk.

Dereham Tp., Ont.—The township council proposes to install light and power systems. Alex. Bell, Mount Elgin, Ont., Clerk.

East Williams Tp., Ont.—Estimates on the construction of a hydro-electric line from Granton to Arkona will be secured by the township council. W. McCallum, Nairn, Ont., Clerk.

Galt, Ont.—The city will purchase an electric motor for the pumping station. Jos. McCartney, City Clerk.

Hamilton, Ont.—Tenders will be received up to 5 p.m. on Monday, February 21st, for the removal and re-erection of existing pumps, motors and electrical equipment at the Gage Ave. sewage pumping station. Plans and specifications may be seen at the office of A. F. Macallum, City Engineer, City Hall.

London, Ont.—The Canadian Pacific Railway Telephone Co., Montreal, proposes to run a new copper line between London and Toronto.

McGillivray Tp., Ont.—Estimates are being prepared by the Hydro Commission on the cost of a line through McGillivray from Lucan to Grand Bend. J. D. Drummond, Ailsa Craig, Clerk.

New Toronto, Ont.—Tenders will be received up to 4 p.m. on Friday, February 18th, for the supply of a 500-gallon turbine pump together with motor. Engineers, James, Loudon & Hertzberg, Excelsior Life Building, Toronto.

Niagara Falls, Ont.—The Ontario Power Company will spend $3,000,000 to build a third pipeline and install new units to increase by one-third the amount of power the company at present can generate. The work will require two years to complete.

▲—**Ottawa, Ont.**—Tenders will be received up to 12 o'clock noon, March 1st, for the construction of a pumping station and electric sub-station on Lemieux Island; the manufacture, delivery and installation of main piping, valves and specials; heating and plumbing, all for the above station. Plans and specifications may be seen at the office of the Engineer, John B. McRae, 310 Booth Building, Ottawa.

+—**Ottawa, Ont.**—The following contracts have been awarded by the city council: Supply of one motor, SHEPHERD & CAMERON, Queen St.; two pumps, MUSSENS, LIMITED, Montreal; boiler, OTTAWA BOILER & STEEL WORKS, 135 Broad St.

+—**St. Thomas, Ont.**—The local hydro-electric commission awarded the contract for two 750 k.v.a. transformers to the CANADIAN GENERAL ELECTRIC COMPANY, LIMITED, of Toronto, for $6,650.

Tisdale Tp., Ont.—The township council will purchase a fire pump estimated to cost about $5,000. W. H. Wilson, South Porcupine, Ont., Clerk.

BRIDGES, ROADS AND STREETS.

Edmonton, Alta.—Mr. J. D. McArthur, of Winnipeg, President of the Edmonton, Dunvegan and British Columbia Railway, states that plans are being prepared for a large steel bridge over Peace River at Peace River Crossing. Estimated cost, $750,000.

Frontenac County, Ont.—The good roads committee was authorized by the county council to appoint a commission to act in conjunction with a commission to be appointed by the Lieutenant-Governor in Council to lay out and designate a suburban area of county roads adjacent to the city of Kingston.

Hamilton, Ont.—Plans for the bridge over the Valley Inn, to be used in connection with the entrance of the Toronto-Hamilton highway to the city, will shortly be considered by the board of control. It is estimated that the bridge will cost $250,000.

Merritton, Ont.—The town council is considering the laying of pavement on a portion of Merritt St. F. Rutherford, 24 Queen St., St. Catharines, Engineer.

Montreal, Que.—Tenders will be received by the Board of Commissioners, City Hall, up to noon, Thursday, February 24th, for the supply and delivery of refined asphalt. Specifications may be obtained at the office of the Superintendent of Purchases and Sales, and all necessary information will be given at the office of Paul E. Mercier, City Engineer.

West Toronto, Ont.—The Good Roads Commission has recommended that Dundas Street, from Runnymede Road to Lambton Hill, be paved with asphalt. Estimated cost, $12,000.

York County, Ont.—The county council passed a by-law to borrow $78,000 to finance the York road system until the June session of the council, when debentures will be issued. Of the total $12,000 is for maintenance, $35,000 for construction, and the balance to meet liabilities already incurred.

York County, Ont.—York county council has decided to construct 210 miles of highways at a cost of between $700,000 and $800,000. E. A. James, 57 Adelaide St. E., Engineer.

FACTORIES AND LARGE BUILDINGS.

+—**Arnprior, Ont.**—Contract awarded by the Department of Militia and Defence, Ottawa, to MAURICE SULLIVAN, of this town, for the erection of a drill hall.

Buckingham, Que.—The Alexandra Hotel, recently destroyed by fire, will be rebuilt at once. Estimated cost, $20,000. J. A. Bernardin, Owner.

Cottam, Ont.—The Imperial Bank proposes to establish a branch here. W. A. Clark, Essex, Ont., Manager.

Davidson, Sask.—The Bank of British North America was destroyed by fire recently. Loss, $4,000.

Ditton, Que.—The School Board is considering the erection of three schools, estimated to cost $4,400. Secretary, Tancrede Halle, Ditton.

Edmonton, Alta.—The three-story plant of the Emery Manufacturing Company was destroyed by fire last week. The loss is $100,000.

Haileybury, Ont.—The hotel owned by Otto Knapp has been entirely destroyed by fire. Loss, $90,000, insurance $62,000. Owner will probably rebuild in the spring.

Hamilton, Ont.—As a result of a conference between the board of control and the hospital board, it was decided to erect a nurses' home in connection with the Mountain Hospital at a cost of $30,000. S. H. Kent, City Clerk.

+—**Hamilton, Ont.**—Contract awarded to DAWSON & WEST for repairs to the building on Catharine Street North, of Kent, Garvin & Co. Estimated cost, $2,800.

Hamilton, Ont.—The Grand Trunk Railway Co., Montreal, will erect a new station on North Ferguson Ave., to replace the old structure at the Corner of King Street and Ferguson Avenue.

+—**Hespeler, Ont.**—A. B. Jardine & Company's plant, destroyed by fire last week, will be rebuilt. The contract for the carpenter work has been let to PRESTIEN & BARTLES, and for the masonry work to GRILL BROS.

Loco, B.C.—The Imperial Oil Company, Limited, 404 Abbott Street, Vancouver, contemplates the erection of an office building and club house, at an estimated cost of $18,000. Tenders will be called later.

London, Ont.—Plans are being prepared for enlarging the plant of the Parnell Steam Baking Company, and installing new machinery. Estimated cost, $50,000. E. Parnell, Manager.

Moncton, N.B.—Tenders will be received by George Morton, Secretary, School Trustees, McQuade P.O., Moncton, N.B., up to February 17th, for the construction of a schoolhouse. Plans and specifications may be seen at the Times Office, Moncton, or on application to Jas. McQuade, McQuade P.O.

Montreal, Que.—According to a statement made by J. H. Rainville, M.P., a large factory will likely be built here for the manufacture of cutlery.

Oakville, Ont.—Wallace, Chapman & Marshall will establish a factory here for the manufacture of boxes, etc.

Ontario.—Votes by the Dominion Government for public buildings in Ontario, mostly revotes or to complete buildings already begun, include the following:—Barrie, drill hall, $15,000; Berlin, public building, $50,000; Brantford, new drill hall, $75,000; Brussels, public building, $22,500; Burford, public building, $10,000; Burk's Falls, public building, $20,000; Campbellford, public building, $16,000; Cannington, public building, $8,000; Cobourg, new public building, $25,000; Copper Cliff, public building, $15,000; Cornwall, public improvements, $3,000; Dunnville, public building, $20,000; Durham, public building, $24,000; Elmira, public building, $5,000; Exeter, public building, $15,000; Forest, public building, $20,000; Fort Frances, public building, $25,000; Fort William, customs house and examining warehouse, $15,000; Fort William, drill hall, $30,000; Galt, drill hall, $6,000; Georgetown, public building, $20,000; Gore Bay, public building, $5,000; Gravenhurst, public building, $20,000; Hamilton, 7 public buildings, enlargements and improvements, $47,000; Hamilton, Postal Station "B," $35,000; Hespeler, public building, $22,000; Huntsville, public building, $20,000; Ingersoll, drill hall, $25,000; Kenora, drill hall, $20,000; Kingston, R.M.C., covered drill hall, $15,000; Kingston, ordnance stores building, $10,000; Kingsville, public buildings, $20,000; Lindsay, public building improvements, $7,000; Listowel, drill hall, $3,000; London, armory, to enlarge site, $50,000; London, postoffice, $95,000; London, Customs House improvements, $7,000; Meaford, public building, $10,000; Millbrook, public building, $20,000; Milverton, public building, $5,000; Morrisburg, public building, $20,000; Napanee, drill hall, $10,000; New Liskeard, public building, $20,000; New Hamburg, public building, $10,000; Oakville, public building, $5,000; Orangeville, public building, alterations, additions, etc., $9,000; Ottawa, departmental buildings, fittings, etc., $50,000; Ottawa, Customs building, $530,000; Ottawa, new drill hall, $50,000; Ottawa, Parliament buildings, improvements, $30,000; Owen Sound, drill hall, $25,000; Palmerston, public building, $19,000; Parry Sound, public building, $20,000; Pembroke, drill hall, $4,000; Penetanguishene, public building, $7,000; Perth, public building, $25,000; Peterborough, new public building, $47,000; Petrolea, public building, improvements, etc., $2,000; Picton, postoffice addition, etc., $11,000; Port Stanley, public building, $5,000; Sault Ste. Marie, drill hall, $25,000; Southampton, public building, $20,000; Stratford, public building, alterations, and improvements, $20,000; Sturgeon Falls, public building, $7,000; St. Catharines, public building, repairs to roof, etc., $3,000; Sydenham, public building, $5,000; Walkerville, public building, $5,000; Wallaceburg, public building, $25,000; Watford, public building, $20,000; West Lorne, public building, $20,000; Weston, public building, $10,000; Wiarton, public building, $19,000; Windsor, drill hall, extension, $25,000.

Ottawa, Ont.—Fire completely destroyed the manufacturing establishment of the Grant, Holden and Graham Co., Limited, on Albert St., recently. Estimated loss, $20,000.

Prince Rupert, B.C.—Plans are being made by T. M. Michaels and F. J. Burling, for the construction of a woodworking plant in this city. A sawmill will also be erected in the early spring at Port Simpson, B.C.

Regina, Sask.—Plans are being prepared for a four-room school.

Richelieu Village, Que.—The erection of a school is contemplated by the School Board. Estimated cost, $3,000. Secretary, J. C. Bashaw.

Smith's Falls, Ont.—The Elgin Ward School was totally destroyed by fire last week.

St. John's, Nfld.—W. F. Coaker, of St. John's, contemplates the establishment of a shipbuilding plant at Catalina, Nfld.

Stratford, Ont.—A. J. Bates, of the McConkey-Bates Co., proposes to build a factory for the manufacture of corrugated iron.

Sydney, N.S.—The Knights of Columbus contemplate the erection of a building estimated to cost between $20,000 and $30,000.

+—**Toronto, Ont.**—Contract awarded to the DOMINION BRIDGE CO. for alterations to the premises of the Standard Sanitary Mfg. Co., 55 Richmond St. E. Estimated cost, $1,000.

Toronto, Ont.—The factory of the Hamilton Carburetter Company on Queen Street will be enlarged.

Toronto, Ont.—The Board of Education is considering the construction of an Industrial Farm School to consist of buildings each capable of accommodating fifty inmates. Estimated cost, between $25,000 and $50,000 each.

Vancouver, B.C.—Mr. Alex. Pantages, of Seattle, has announced that work will start shortly on the erection of a theatre on Hastings St., estimated to cost $250,000.

+—**Vancouver, B.C.**—The work of constructing a $60,000 addition to the plant of the American Can Co., Railway St., will be carried out by the DOMINION CONSTRUCTION COMPANY.

West Garafraxa Tp., Ont.—The trustees of School Sections Nos. 4 and 10 are considering the erection of schools. Secretaries, W. J. Philip, R.R. No. 3, Arthur, Ont., and J. A. Spence, R.R. No. 3, Arthur, Ont.

Woodstock, Ont.—The Standard Wire Fence & Tube Company will erect a new warehouse, estimated to cost $1,000.

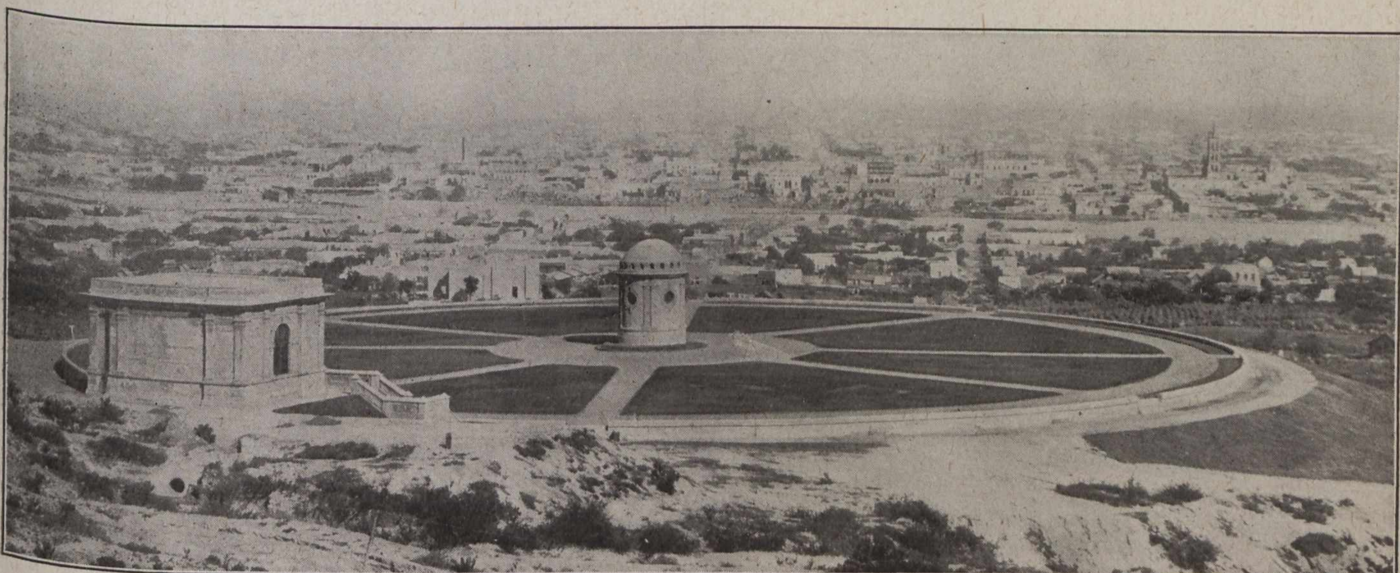
ADDITIONAL CONSTRUCTION NEWS
will be found on page 48.

THE ENGINEER AND STANDARDS OF BEAUTY.*

By G. R. G. Conway, M.Can.Soc.C.E.,
Consulting Engineer, Toronto.

THE work of the engineer touches every phase of our national and civic life, and the influence of engineering structures upon the community life of the people is of great national importance. In new countries we cannot expect in the early pioneer days that much consideration will be given to the finer details of designing. To open up great tracts of unpeopled territory, railways must be built as rapidly and as cheaply as possible, and there is always a fitness and simplicity in the temporary structures that are erected with the available local materials that appeal to us with pleasure because in this pioneer stage there is no time for the consideration of how such structures will look. To create electrical energy, waterfalls and rivers must be harnessed, and to accomplish this economically dams of the cheapest materials are thrown across streams and rivers for storage purposes. To develop highways, bridges must be built, and these, too, in the early days consist of a few logs cut down on the site and secured after the primitive fashion of the pioneer in all ages. As the new country develops, however, and this is true all over the American continent, wealth is created on the foundations laid by the sturdy pioneers of our race, and the small structural works have grown into gigantic engineering enterprises serving, it may be, millions of people, and because of such service daily influencing their comfort and well-being. The engineer is then brought face to face with the idea of permanence in his structures, and in the interests of economical administration it is necessary for him so to design his structures that the annual cost of maintenance is reduced to a minimum. The temporary trestles and bridges of the early railroads are replaced by steel, masonry, concrete or earthen structures. Old timber crib dams make way for permanent structures of concrete or earth work. Simple timber railway stations become massive structures of brick or stone, and so on throughout the whole range of the engineer's province, the new structures taking the place of the old bear most emphatically the stamp of permanence. If, then, we are building structures that are to last for generations, is it not worth while to design them so that the Canadians of future generations, looking back upon the great works being carried out to-day, and the greater works which we anticipate to-morrow, will admire and appreciate the early work of the 20th century as we admire and appreciate the great works executed at the beginning of the 19th century in Great Britain and France? Or, to go further back, as we ourselves admire the work of the Romans—that wonderful race, great in art, great in science, and famous for immortal laws, who "builded better than they knew," and who, with true and noble colonizing instincts, scattered over two continents wonderful engineering works that we can marvel at even if we cannot emulate them.

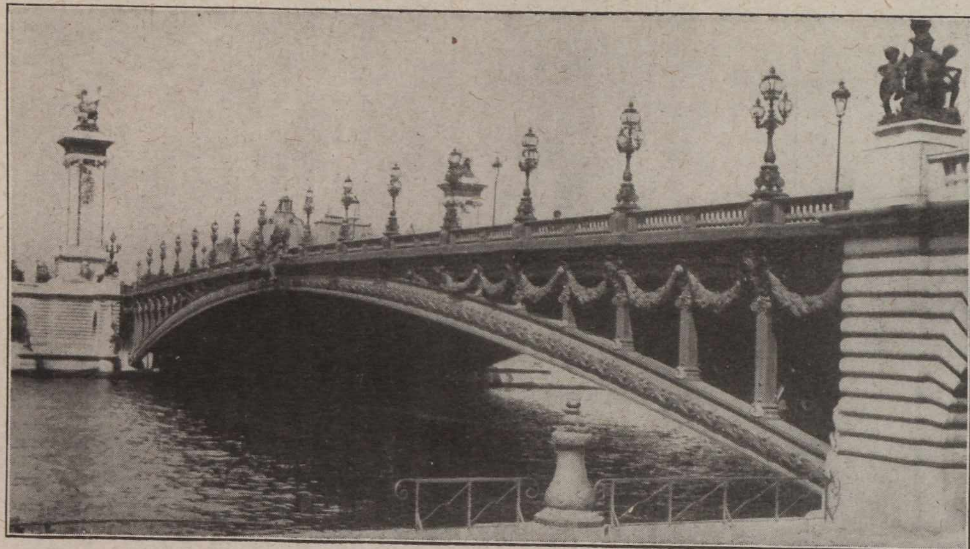
The standards of beauty are enlarged with the growth of knowledge. Many of the works of the ancients are of great beauty and will always remain beautiful, but beauty and the appreciation of beauty are inherent in ourselves. The creation of beautiful structures can only be attained by a full and true knowledge of the kind of materials used, and by certain subtle distinctions born of integrity of purpose and refinement in handling those materials. Ruskin's well-known aphorism, in which he defines architecture as "the art which so disposes and adorns the edifices raised by man, for whatsoever uses, that the sight of them may contribute to his mental health, power and pleasure," has a meaning for us as engineers.



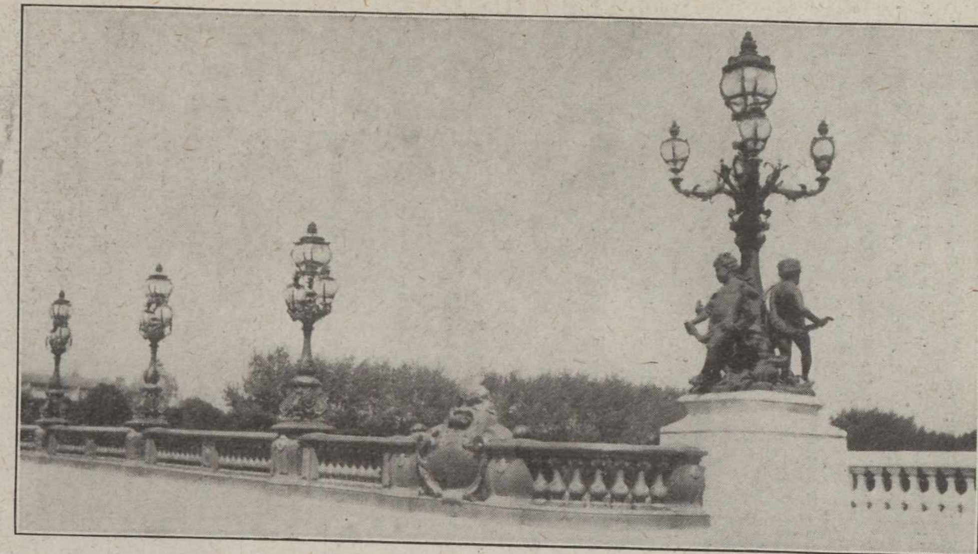
Service Reservoir, Monterey, Mexico, Showing a Simple Architectural Treatment of Valve Houses and Layout of Roof in Grass Plots.

This is an age of specialization. That, of course, is an idle platitude, for no man can say to-day, as Lord Bacon said, "I will take all knowledge to be my province." Even the most versatile engineer can attempt to master but one branch of his profession. In our own Society we have among those directing the "great sources of power in Nature for the use and convenience of man," engineers engaged in bridge design, railroads, canals, hydraulics, water supply, and sewerage; electrical, mining, municipal mechanical, and chemical engineers, but in olden days the sister professions of engineering and architecture were practised in many cases by the same individual. Roman engineers, designers of the Claudian Aqueduct and the Pont du Gard, produced great engineering works which are among the finest architectural remains of that great

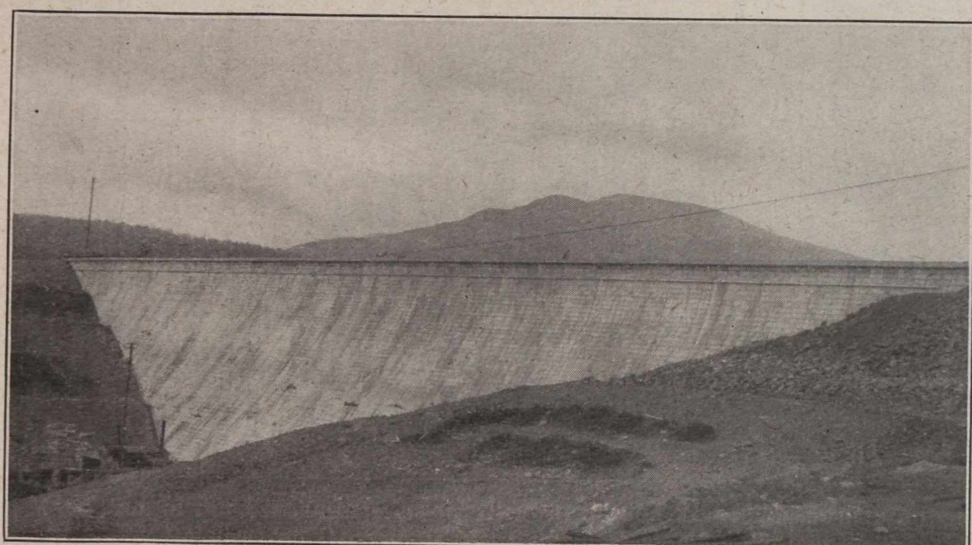
*From an illustrated address before the Ottawa Branch of the Canadian Society of Civil Engineers, January 21st, 1916.



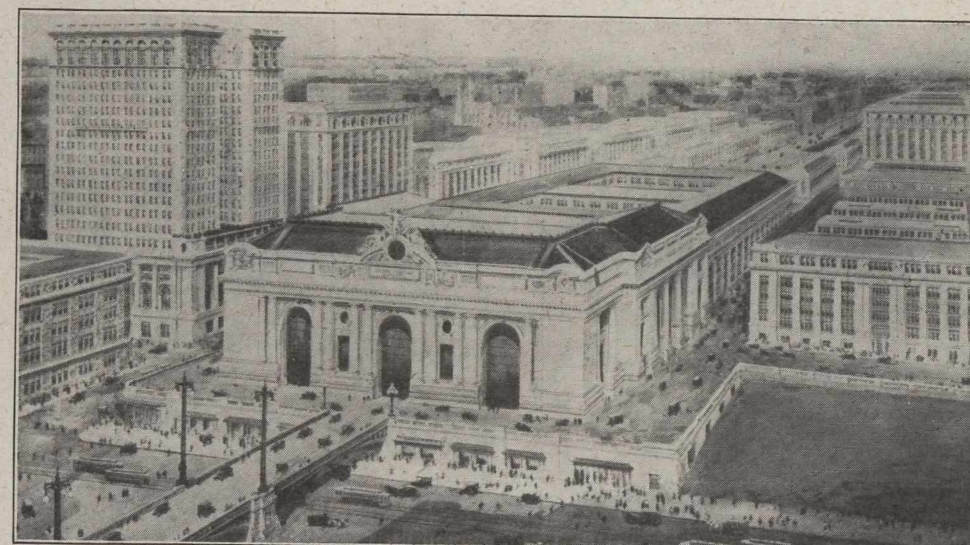
Example of the Collaboration of Engineers, Architects and Sculptors, Pont Alexandre, Paris.



Detail of Parapets on the Pont Alexandre, Illustrated in the Opposite View.



Main Dam of the Ashokan Reservoir, Brown, Station, N.Y. A Structure that Requires no Ornaments but Care in Designing Parapet.



Grand Central Railway Station, New York. Example of Collaboration of Engineer and Architect.

race, and in the Renaissance period were not such artists as Michael Angelo, Leonard da Vinci, and Palladio great both in architecture and engineering? In mediaeval ages, bridges, churches, cathedrals and dwelling houses were designed under the supervision of the priests and clergy, but during the 16th and 17th centuries these supervisors of craftsmen became more interested in doctrinal controversies and so both architectural and engineering problems passed from their control, and the new profession of the civil engineer arose with such pioneers as Brindley, Smeaton, Telford, and Rennie.

With the development of steam and all the discoveries of modern science and engineering, the separation of the two professions became wider, but I think to-day there is a new spirit that is drawing them together again. The question, then, of the aesthetic treatment of engineering structures is to-day more fully appreciated by an enlarging circle, and it is one in which the engineer needs and desires the co-operation of the architect. This co-operation of the engineer and architect will have the effect of stimulating a healthy public interest in the need for great engineering structures being made as beautiful as possible. It has been said by a well-known engineer that if two designs are submitted to a board of directors, the one beautiful and the other ugly, the directors will always choose the ugly one, but this is untrue to-day, and many great corporations are setting a worthy example in encouraging the co-operation of the engineer and the architect.

Why should not even the humblest railway station be a beautiful object? We no longer believe in Ruskin's fierce denunciation of railway stations, and in these days of constant travel the comfort and beauty of well designed railway terminals are a delight to travelling man. Why cannot we have beautiful designs for the buildings and chimneys of steam power plants, for a water tower, for all our bridges, for service reservoirs, and valve houses? We should, though, in every case, let these structures speak for themselves and express by their design their meaning, stating plainly, without pretension, what they represent. We do not want a railway terminal to look like a temple for the worship of Minerva, nor a steam plant chimney to resemble Cleopatra's needle.

Probably most of the discussion upon this subject has arisen in connection with the design of bridges, and the writer has noted with pleasure recently the influential engineering press stimulating thought in this direction. Let us, therefore, examine first the evolutionary changes in bridge design by referring to some old and modern types of bridges. The earliest method of crossing a river was, perhaps, by stepping stones, by logs thrown across the stream or, where the span was wide, by a bridge of boats. It is, though, outside the scope of this paper to discuss the origin of the several types upon which all modern bridges are designed. Many beautiful bridges have been designed in wood. We have records of some of the earliest that combined great ingenuity with beauty, and to-day in Switzerland and Japan are many notable examples.

For two thousand years the engineer has been able to make masonry bridges beautiful, and although his opportunities in Canada for constructing such bridges are few, a study of the older designs is of great assistance in dealing with reinforced concrete structures which are in our country taking the place of the cut stone structures of Europe.

In the Pont du Gard, built by Agrippa, the son-in-law of Augustus, in 19 B.C., there is a grand combination produced by the form and proportion of the arches, and the varied effect of dressed and undressed masonry. In this structure, as well as in the Claudian Aqueduct, and the aqueduct at Tarragona, in Spain, the engineering skill is remarkable, proving that the Romans were highly skilled in mechanics and hydraulics. In these structures we see the harmony of science and art, twin sisters who should never be separated, and the result stands to-day a triumph of fine building.

In the bridge of Augustus, at Rimini, the piers are very massive, equal in thickness to one-half of the arch openings. There still remain traces of decoration on the key stones, and the ruined cornice indicates that the bridge was one of great beauty. Judging from its massive proportions, it is probable that over the piers were elaborate architectural details combined with noble statuary. Structurally it is excellent engineering, and even now, after the lapse of nearly 2,000 years, can be seen the fine workmanship of the old masons.

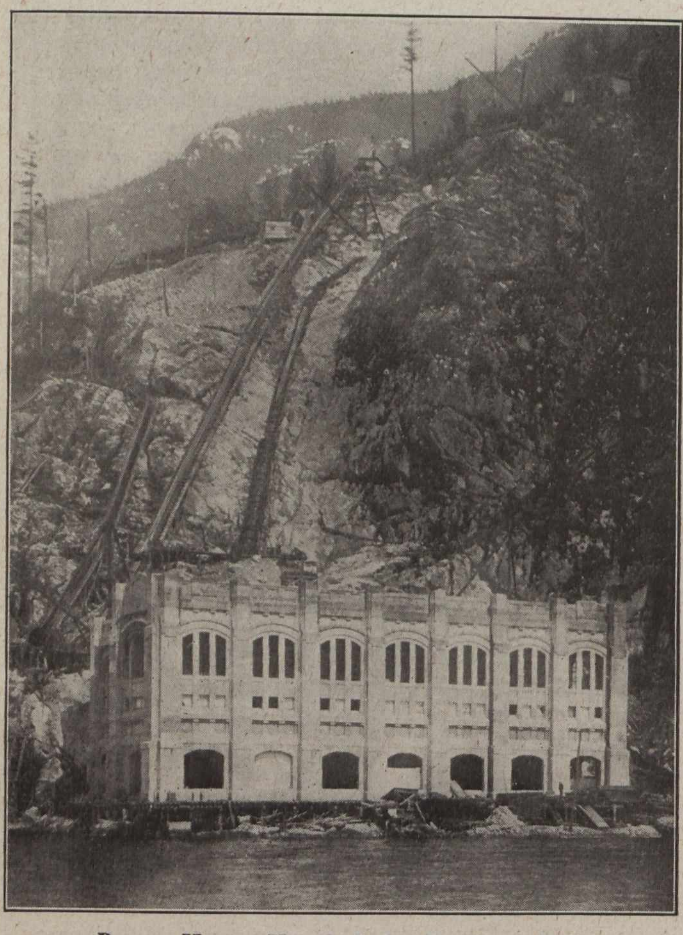
In the Renaissance period in Italy we could select many types for illustration of beautiful bridges which were erected by architects and engineers. One of the best-known, and one which well repays careful study, is Bartholomew Ammanàti's famous bridge, which was rebuilt in 1566-1569, called the Pont della Trinata, over the Arno, at Florence. Ammanati's genius as an architect and sculptor is well known, and in this bridge we find careful study given to the engineering details that go to make up a successful structure. There are three spans, the centre 90 ft. 10 ins., and the two side spans 87 ft. 7 ins. The arches are two parabolic curves meeting at a centre with a slight angle which is obscured by an ornamental escutcheon. The arch ring is very heavily moulded, and the spandril panelled, a method which requires very careful treatment to prevent the scale of the design being lost.

During mediaeval times many beautiful bridges were built in Great Britain which are standing to-day more beautiful than ever with the "golden stain of time" upon them. The Bridge of Dee is an excellent example. Of particular worthiness of note is the treatment of the under side of the arch by ribbing so as to economize material and produce at the same time delightful effects of light and shade. It might be suggested that a similar treatment is possible in an economical design of a reinforced concrete bridge.

[Mr. Conway similarly called attention to the early masonry bridges of France, and to the London, Waterloo, Aberdeen and Grosvenor masonry bridges of Great Britain. Over 40 lantern views of bridges were shown, the selection bringing out in an able manner the aesthetic features of each. As lack of space forbids the presentation here of these illustrations, portions of Mr. Conway's discussion relating specially to certain examples are necessarily omitted.—Editor.]

Iron and Steel Structures.—It is when we come to consider the modern development of bridge building, and the introduction of iron and steel, that the aesthetic problems assume a different character from those of simple masonry structures. The development of the use of iron and steel in bridge building has been, to use Herbert Spencer's line of progress in organic evolution, "from simplicity to complexity of structure, and from obscure complexity to a defined simplicity of function." It is this simplicity of function which is the prevailing note of all well-designed steel structures. Michael Angelo maintained that to an architect a knowledge of anatomy was essential. Can we not also say that to those who examine iron and steel structures from the purely aesthetic viewpoint a knowledge of the anatomy of a bridge is necessary, and an understanding of the relationship and the functions of all its separate parts? Metal bridges include the majority of all long-spanned arches. The longest single masonry span in existence is 295 feet, and bridges of reinforced concrete have already been constructed with spans up to 325 feet. The longest single steel span, as you all know, is that of the Quebec bridge, which is 1,800 feet. In such structures, therefore, the addition of ornament would be entirely false and foreign to the fundamental principle of their design, and its application, if done at all, could only be carried out consistently by a great increase of weight and sacrifice of economy.

The standard of aesthetic criticism to be adopted must depend, therefore, upon whether the most suitable application of the material used has been made, and when it is possible to select an optional design the choice must lie with the most beautiful outline consistent with economy.



Power House No. 2, Lake Buntzen, B.C.

The sweeping condemnation of all iron and steel structures that has sometimes been made by artists and architects is due to a false and unfair appeal to standards which, however true they may be when applied to masonry bridges, cannot be applied to structures which have forms and functions of an entirely different nature.

The first consideration, therefore, in designing all engineering structures after the questions of strength and stability have been satisfied, is that the form of the structure should be determined essentially by the material of which it is composed, and should not copy in some strange, fantastic form in some of its details the design of older forms of architectural ornament.

In a discussion which took place some sixteen or seventeen years ago at the Institution of Civil Engineers, Professor Pite said that as a practical designer he would like earnestly and heartily to press home the fact that artistic simplicity would be achieved by disassociating from the mind all architectural phrasology, all architectural ornament, all architectural traditions, such fantasies as the curve and compound curve lines of beauty, and by aiming in metal bridge building at exactly the same beauty of workmanship, beauty of economy of material, beauty of accomplishment that please the mind in any form of mechanical effort. In that way engineers would keep clear of the changing whims of artistic fashion, keep clear in metal of the traditions of an architectural art of stone, of the traditions of an architectural art in wood, and work out in iron with its different qualities and stresses an aesthetic style based on the absolute scientific necessities of engineering practice which would, without doubt, afford infinite satisfaction to generations to come.

The earliest attempt to build an iron bridge was made at Lyons in 1755. The arches were actually cast, but the attempt was abandoned as too costly, and the real introducers of iron in bridge building were two ironmasters, Reynolds and Derby, who designed the bridge in Coalbrookdale. In this bridge there is a curious treatment of metal work which the early designers, under the influence of mediaeval bridges, adopted. At a later date, at the beginning of the 19th century, when Rennie and Telford were making use of the new material for longer span bridges than they had hitherto adopted, and where the metal bridge was combined with masonry abutments, careful attention was given to the architectural treatment of the masonry portion of the work.

In such bridges as the Garabit viaduct in the south of France, Niagara Falls bridge, Brooklyn Suspension bridge, and the bridge over the Zambesi River, the most exacting demands are satisfied. These bridges please the eye because of their sense of fitness to the site and the work they have to perform.

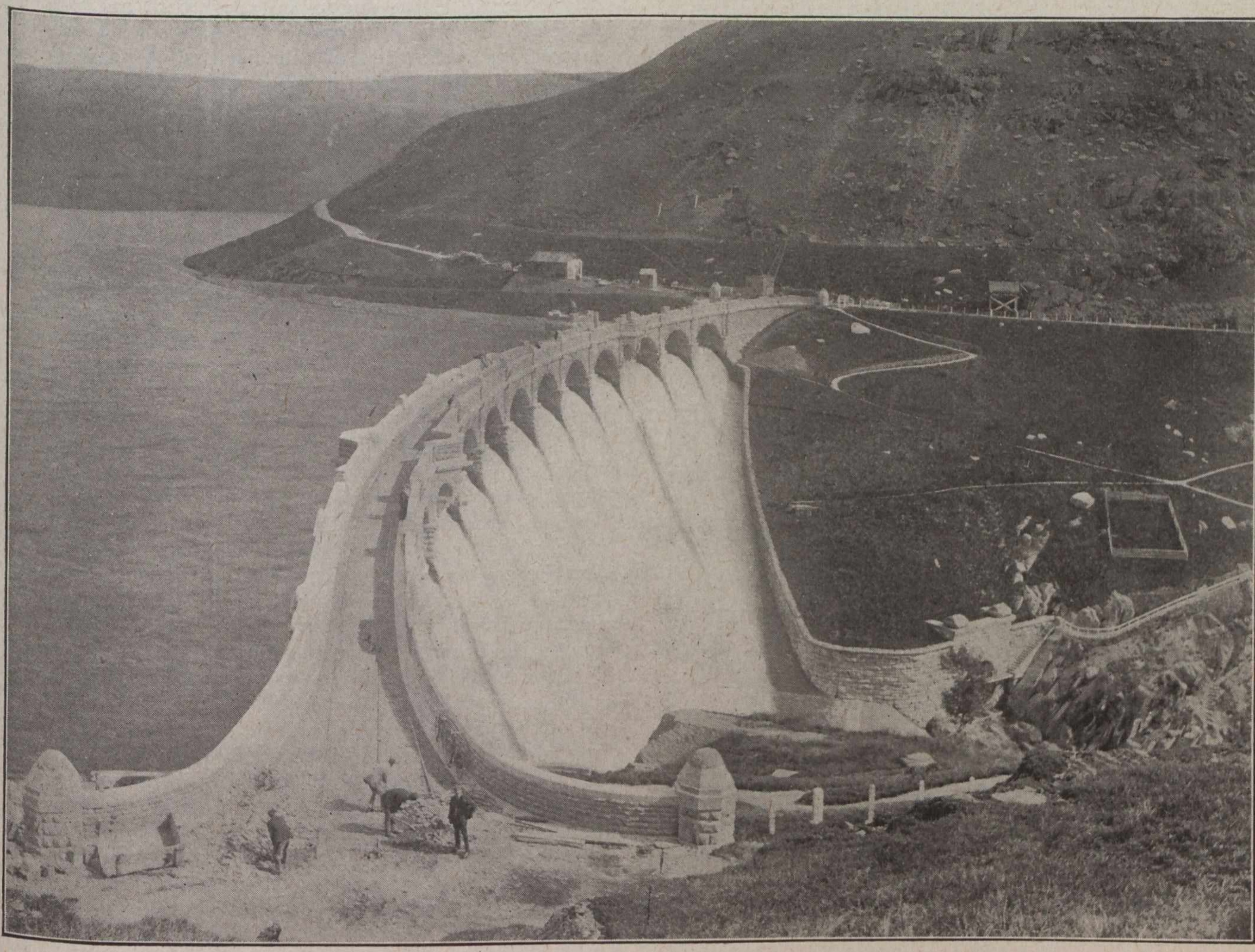
Probably the cantilever bridge has been, more than any other form, subjected to severe criticism from the aesthetic point of view. The famous Forth bridge, which perhaps represents the highest expression of engineering skill yet reached, roused a storm of aesthetic criticism, which was to be expected against a structure few people could understand. William Morris, a man for whom many of us have the greatest admiration, and one who spent his life successfully in striving to make the England he loved so well a more beautiful place than he found it, went down to Edinburgh when the bridge was completed and said there never would be an architecture in iron, every improvement in machinery being uglier and uglier, until they reached the supremest specimen of all ugliness—the Forth bridge.

The next evening at the Edinburgh Philosophical Society, Sir Benjamin Baker appeared on the scene and replied that he expressed a doubt if Mr. Morris had the faintest knowledge of the duties which the great structure had to perform, and he could not judge of the impression it made upon the minds of those who, having that knowledge, could appreciate the direction of the lines of stress and the fitness of the several members to resist the forces. Probably Mr. Morris would judge the beauty of the design from the same standpoint whether for a bridge a mile long or for a silver chimney ornament. It was impossible for anyone to pronounce authoritatively on the beauty of an object without knowing its functions. The simple columns of the Parthenon were beautiful where they stood, but had they taken one and bored a hole through its axis and used it as the funnel of an Atlantic liner, it would, to his mind, cease to be beautiful, but, of course, Mr. Morris could think otherwise. He had been asked why the under side of the bridge had not been made a true arc instead of polygonal in form, and his reply was that to have made it so would have materialized a falsehood. The Forth bridge was not an arch and it said so for itself. No one would admire bent columns on an architectural facade, or a beam tricked out to look like an arch, but that was really what the suggestion of his artistic friends amounted to, though they did not see it, being ignorant of the principles on which the Forth bridge was constructed. The object had been to so arrange the leading lines of the structure as to convey an idea of strength and stability. This in such a structure seemed to be at once the truest and highest art. We must admit that the engineer was right. On the other hand, the view of another artist, Alfred Waterhouse, R.A., is interesting. Writing to Sir John Fowler after the bridge was completed, he said: "The simple directness of purpose with which it does its work is splendid, and invests your vast monument with a kind of beauty of its own, differing though it certainly does from all other beautiful things I have seen."

In the design of the Tower bridge there is a great departure from those principles which Sir Benjamin Baker advocated when discussing the design of the Forth bridge. The site of this bridge, in close proximity to the Tower of London, influenced its design, and although the claim has been made that this bridge expresses perfectly the collaboration of the architect and engineer, one feels that the Gothic masonry is entirely out of place. The combination of Gothic architecture with a steel structure destroys the sense of fitness and robs the bridge of true beauty by giving it an architectural character of a by-gone age when such bridges could not have been erected.

In many simple bridges constructed in Canada to-day to open highways in inaccessible places, a note of simplicity has often been successfully struck. As an example of this the suspension bridge over the Bulkley River at Hagwillgate, B.C., with the simple treatment of the suspension piers is entirely satisfactory.

An example of the most perfect collaboration of the architect and engineer appears, in the writer's opinion, in the Pont Alexandre bridge at Paris (illustrated on another page). This is a three-hinge steel arch, and the whole structure is one of the most beautiful that has been built at any time. It is the work of two engineers, two architects, and two sculptors, working in collaboration.



Example of a Masonry Structure where Careful Attention Has Been Given to the Architectural Details of the Design. Craig Goch Dam for Birmingham Water Supply.

During recent years there has been a marked advance in the design of reinforced concrete structures, and the pages of the engineering press fully illustrate many notable designs that appeal to us by their simplicity. Among those that are notable is the Langwise Viaduct,* carrying the Churarosa Railway in Switzerland; the Walnut Lane bridge, Philadelphia, and a score of others.

Dams.—In the construction of dams for the storage of water for city water supplies, power purposes, and irri-

*See *The Canadian Engineer* for October 14th, 1915.

gation works, many opportunities occur for the collaboration of architect and engineer. When the drawings were being prepared in the office of James Mansergh for those wonderful dams in the Elan Valley for the supply of water for Birmingham, Mr. Mansergh asked Professor Pite and Sir Alfred East, the one an architect, the other an artist, to study the site and make suggestions to him upon their architectural treatment. The result is magnificent, and no one who has seen those works since their completion can fail to be impressed with the beautiful designs and their fitness with the surroundings. In this case, and also in the case of the Vyrnwy Dam for the storage of water for Liverpool, the utilitarian work of the engineer has created a beauty spot accessible to tourists. The large works recently carried out by the Irrigation and Reclamation Departments of the United States include a number of great dams which, together with the work of the Boards

Intake Tower, Coquitlam Lake, New Westminster Waterworks, B.C.

of Water Supply for New York City and Boston, set examples that can with advantage be followed in many other places. With many dams, such as the simple reinforced concrete type, no attempt at architectural decoration beyond perhaps a carefully designed parapet is required. In the Bassano dam,† which is a very massive structure, it is to be regretted that the gate-houses have been designed in the domestic half-timbered style—a style which seems singularly out of place when forming an integral part of what is a magnificent concrete structure. The influence of the architect is not always satisfactory, even when his collaboration is sought by the engineer. As an illustration of this, the reader is reminded of the building of the Assouan Dam in Egypt, and of some remarks made by Sir Benjamin Baker, the engineer, to the effect that after the drawings of the dam had been completed they had been turned over to an architectural department, and the architect, having returned from Egypt saturated with Egyptian temples, had covered the design with details of Egyptian architecture. Sir Benjamin Baker told the contractors who were tendering upon the work to take no notice of the architectural ornament as he did not want the dam to imitate a temple built four or five thousand years before. When the dam was in progress, tourists of all professions—artists, architects, and engineers—all of whom had been dosed with Egyptian temples themselves and had their ideas of how a great dam built across the Nile should look—visited the works. Sir Benjamin Baker told the contractors to have full size models made of the suggested adornment and placed on some of the completed parts of the dam so as to make the suggestors ashamed of themselves. These models frightened Lord Cromer who told Sir Benjamin that he could have all the money he needed to make the dam safe, but that he was not going to spend a hundred and fifty thousand or two hundred thousand pounds for architectural details. Sir Benjamin told Lord Cromer there was no intention of doing so, that he had put up the models to show how the ornament would look in strong sun-light with deep shadows. The result was that everyone agreed that what might look all right and proper on paper for a limited length would be madness applied to a cornice 2½ miles long, and here perhaps is an instance where collaboration with architects not understanding the character of the dam would have led the engineer astray in designing such a structure.

†See *The Canadian Engineer* for January 1st, 1914, and September 30th, 1915.

Power Houses.—Canada, in proportion to her population, has in recent years made enormous strides in the development of water power, and from the Atlantic to the Pacific great developments have taken place. In the design of water power plants there is a great opportunity for the engineer to dignify his work by paying more attention to the design of power house buildings and their surroundings. Often these power plants are situated amidst magnificent scenery, and the only blots upon the landscape are the buildings and pipe lines. There are, of course, notable exceptions such as the power houses at Niagara (on the Canadian side) where an attempt has been made to harmonize these plants in such a way as not to detract from the beauty of the Falls. But too little consideration has been given so far by power companies to the erection of buildings that will be a delight to the public. The Water Power Branch of the Department of the Interior has recently taken a great interest in this particular matter, and has been encouraging the idea by offering prizes for the best designs for proposed power houses on the Bow and Winnipeg Rivers. This is an excellent step forward, and I think when plans are forwarded to the Government Department for approval the question of the design of power house exteriors should also be considered by the responsible officials. That the architect can successfully make a beautiful power house, even if constructed of reinforced concrete without other materials, is shown in the design of Lake Buntzen Power House No. 2 (illustrated herewith). This plant has been built upon a site visible for seven or eight miles on an arm of the sea that is a favorite yachting resort, and the design is an imposing one from every point of view, the simple lines and massive proportions harmonizing with the precipitous mountains in the background. This matter is largely in the hands of the engineer who is not often hampered in his desire to produce a fine building, and in many cases by a careful study of proportions and the economical use of material, no extra cost will be incurred.

Municipal Water Supplies.—In municipal water supplies many opportunities occur on a small scale for graceful treatment of such works as service reservoirs, water towers, aqueducts, etc. In Europe and many places in the United States there are numbers of fine works showing that municipalities are becoming proud of their property, and while they are seeking to make them permanent they are also attempting to make them beautiful.

Railway Terminals.—In the design of railway terminals to-day it is the generally accepted practice for great railway corporations to employ architects to collaborate with the engineering staff, but often the architectural style adopted is a severely classic one which does not seem to the engineer to be an expression of 20th century railway progress. Perhaps some day, under the influence of the engineer, the architect will free himself from the traditions of archaeology and classic architecture, and give us a railway architecture that will be an expression of our modern spirit. Examples of the collaboration of the two professions may be seen in the Grand Central and Pennsylvania railway terminals of New York, the Union terminal at Washington, D.C., and the collaboration of the architect and engineer has also been carried out in many of the terminals of the three great transcontinental railways in Canada.

Modern Steel Frame and Reinforced Concrete Buildings.—In the design of modern steel frame and reinforced concrete buildings the modern engineer and architect in Canada have in collaboration one of the most magnificent opportunities of evolving an architectural treatment of their structures unhampered by European traditions. We may perhaps criticize the architect for his neglect of a proper study of the main principles involved in the design of great buildings as he is in danger of becoming merely the adorner or decorator of structures for which he is not primarily responsible. We feel that the ornament on a building should accentuate and add to the beauty of its proportions, and in the complete design the architect and engineer should be in closest sympathy. To the engineer it seems incongruous to pile row on row of classic orders and details one on top of the other in the facade of a modern steel structure when there is an opportunity of maintaining the leading lines of the construction. May we not ask, when we look around and examine many decorated steel structures in Canada and the United States, if the architects are not too much dominated by modern French classic influences. A very simple and beautiful exterior treatment of a reinforced concrete building is seen in the new Birks Building in Vancouver, and here it will be noticed that the architects have not attempted to hide the structural proportions of the building. In New York, in spite of the Government's insistence that all new public buildings shall be of classic design, we find in the Woolworth Building (the highest in the world) a free treatment of Gothic details in terra cotta that does not hide or destroy the proportions of the engineer's steel design. In this building we see a very fine example of the engineer and architect in closest sympathy. No architect or engineer alone could have produced it because the building, from foundation to tower, involved some of the most difficult problems in engineering design. The building is one that fascinates the onlooker and must be regarded as very successful from the architectural point of view. The writer is, however, aware that artists have denounced the architectural treatment and have called the building an eye-sore, but it would be interesting to know what alternative method of treatment they would propose for a building of that character. It seems to the engineer that the architect in adorning a steel frame building should accentuate its proportions if they are true. If they are not true no ornament will help to make the building beautiful, and engineers and architects alike should remember Pope's criticism of the artist and poet:

> "Poets heap virtues, painters gems at will,
> And hide by ornament their want of skill."

and guard against the temptation to adorn with architectural details what might possibly be faulty construction.

Town Planning.—In another field of activity there is great scope for the co-operation of the two professions, namely, that of town planning. The civic idea is a very ancient one and has always dominated the progressive spirit of a great race, and in the creation of beautiful cities this cannot be accomplished by the landscape gardener or architect alone, but by the co-operation of engineers engaged in many different branches of the profession, and it would be well if we as engineers would cordially support and assist the efforts of the new Civic Improvement League in Canada so as to make our cities healthier and more beautiful in the future.

Our citizens should take a keener interest in their great public structures, and aspire to something beyond mere utility. Before we can expect them to do so, we must consider our own attitude and endeavor to educate the public so that the standards of taste and ideals are raised until Art in its highest expression pervades every part of our civic and national life. We need a truer education of the public, and of those chief citizens whom the people, in their collective wisdom, send to represent them in council chambers and in the legislature. As a result of such education we ourselves will create structures which will stand as permanent monuments of a people that endeavor not only to produce great works of utility, but works of beauty, in the service of man.

BETTER RAILWAY EQUIPMENT NEEDED.

Speaking at the annual meeting in Chicago on February 4th, of the American Electric Railway Association, while on the subject of safety on American railroads, Senator Oscar W. Underwood, of Alabama referred as follows to the fact that there are at least 10 employees killed or injured on American lines to one on the railroads of Great Britain.

"It can not be truthfully said the engineers who constructed these roads have builded them with less ability than the engineers who constructed the English roads. It can not be said that our iron and steel, our timber and rock are not as good building material as that which is found in the British Isles. It can not be said that the men who sit at the throttle, or watch the signal tower are less capable, sober and alert than the men who occupy similar positions in a foreign land. Then why should we face conditions that endanger human life, and make a serious charge on transportation, that in the end the public must bear? To my mind it is clear that the dangers involved in our railroad system are almost entirely due to the lack of proper transportation facilities. We endeavor to run trains over a single track where the needs of business require double tracks. We load our freight on weak and defective cars where new cars should long ago have taken their place. We rely on antiquated methods for the movement of our trains when our tracks should be provided with the latest and best signal devices. In fact it cannot be denied that to adopt modern methods and provide proper facilities for transportation would be true economy in the end."

THE USE OF INFILTRATION GALLERIES IN WATER SUPPLY.

THE water supply system of Brooklyn, N.Y., includes two infiltration galleries with a combined length of about six miles, in addition to some 25 driven well stations, collecting from 975 wells varying in depth from 30 to 325 ft. The system was described in a paper read before the New England Waterworks Association last September, and some interesting discussion was subsequently presented concerning the operation of infiltration galleries, in view of the successful use of them in Brooklyn. We refer to the following remarks by Alexander Potter, a New York consulting engineer, which appeared in the Journal of the Association for December:

The procuring of water supplies by means of infiltration galleries is not commonly resorted to. Even where the use of infiltration galleries promises to yield good results, engineers often hesitate to make use of them because of the many failures recorded, the causes for which either are not understood or when understood have not been brought to the attention of the engineering profession.

The proper design of an infiltration gallery should not be at all difficult, for the process which takes place in an infiltration gallery is duplicated in nature by the diffused seepage of the underground waters into surface streams. This ground-water seepage maintains the flow in surface streams long after the direct effects of the rainfall have ceased. The fundamental laws governing the ground-water flow of surface streams are fairly well understood and apply with slight modifications to infiltration galleries. They may be stated as follows:

1. The ground-water stream flow is fixed and limited to the surplus underground waters accumulating and stored in the valley.

2. The rate of seepage varies with the transverse hydraulic slope of the ground-water table and the porosity of the material through which the ground water flows.

3. When the hydraulic slope is not steep enough to discharge the surplus ground waters as fast as they collect in the valley, the ground-water table rises until equilibrium is established, and vice versâ if opposite conditions exist.

4. Except as affected by the seasonal changes of the rising and lowering of the ground-water level, the ground-water stream flow is constant.

There is no reason why the seepage of ground-water into an infiltration gallery under proper conditions should not be equally as dependable as the identical natural process of ground-water seepage into surface streams.

An infiltration gallery may derive its supply of water from two distinct sources: A supply derived by intercepting the surface underground waters which were under natural conditions joining the surface waters by diffused seepage, and a supply derived by infiltration from bodies of surface waters adjacent to the infiltration gallery. It appears that many infiltration galleries derive by far the larger portion of their supply from the second source. A carefully made scientific investigation will, in nearly every case, reveal within quite narrow limits the quantity of water available for an infiltration gallery from the two sources above mentioned, and as long as the draft does not exceed the available supply there is no reason why the yield of a properly designed infiltration gallery should gradually decrease with time, as is only too often the case. The recorded failures of infiltration galleries can, in the writer's opinion, be largely attributed to the erroneous assumption that a pipe laid below water level with open joints or perforations and surrounded by a porous material will continue to deliver the volume of flow developed when first constructed, ignoring entirely the fundamental law of supply and demand.

This is not true with infiltration galleries constructed on the floor of an impervious strata intercepting the transverse ground-water flow in a pervious strata of coarse sand immediately above. Under such conditions, infiltration galleries have been very successful. A typical example of such a gallery is the one constructed at Munich.

Under conditions other than that just stated, and where the supply appears to be adequate, there is often noted a gradual breaking down of the infiltration gallery, apparently due to the silting up of the filter media immediately surrounding the gallery. Under the natural conditions of ground-water seepage into surface streams, no such silting appears to take place, and when such silting up occurs in connection with an infiltration gallery, it can only be due to the peculiar ground-water conditions set up by construction of the gallery. The writer believes that the silting phenomena are primarily due to the high velocities of the ground water through the filter media immediately adjacent to the gallery, velocities so great that the finer particles of soil are transported to the gallery, gradually clogging the interstices in the filtering media and the gallery proper. This phenomenon of clogging is aggravated by the lowering of the ground-water level in the vicinity of the filter gallery below the top of the gallery. For a definite yield, as the wetted perimeter of the gallery decreases, the entrance velocity increases in inverse proportion. To attempt, therefore, to force an infiltration gallery to the extent of lowering the ground-water table below the top of the gallery, will tend to increase the danger from clogging and materially shorten the life of the infiltration gallery, especially when constructed in the finer sands.

With tubular wells, the question of high entrance velocity in the filtering media surrounding the well screen is not of equal importance; wells are comparatively short-lived, and when clogging does occur it can be remedied by back-flushing or other known methods. No such remedies are available for clogged infiltration galleries. When properly designed so that the yield of the gallery does not exceed the supply available from the surplus underground waters and the supply derived by infiltration from a nearby body of surface water, and the entrance velocities are sufficiently low so as not to transport the finest soil particle, the useful life of the infiltration gallery should be practically unlimited.

The yield from an infiltration gallery constructed in the finer sands should be automatically controlled so that it cannot exceed a certain predetermined amount, in order to prevent the lowering of the ground-water plane below the top of the gallery, so as to keep the entrance velocities within safe limits. This condition can best be secured by restricting the flow from the gallery to an amount which will keep the gallery constantly full of water for its entire length.

In many cases the requirements as outlined herein will for a given yield call for the construction of much longer lines of infiltration galleries, constructed in finer sands than has been the practice in the past, so that in many instances other methods of supply will be found to be more economical. Throughout the country, however, deposits of gravel and sand exist in the valleys of rivers and along lakes and seacoasts, in which infiltration galleries can be economically constructed to yield adequate supplies either from the surplus underground waters or from the water derived by infiltration from adjacent natural and artificial bodies of water, or from both sources. The

(Continued on page 272.)

BRITISH COLUMBIA HARBORS.

An illustrated article in *The Canadian Engineer* for January 13, 1915, described the new Grand Trunk Pacific Railway dry dock and terminal at Prince Rupert, B.C. A few notes relating to the harbors and facilities along the Pacific Coast of Canada may not be amiss.

Prince Rupert, with a population of 6,000, is 583 miles north of Vancouver on the British Columbia coast line. It has a broad, open harbor 16 miles in length with an average width of 1½ miles and an average depth of 26 fathoms. Besides the Grand Trunk Pacific Railway wharf there is a Provincial Government wharf 600 ft. long and also an open dock 375 ft. long and a dry dock 120 ft. in length, all of which are equipped with storage warehouses.

The Imperial Oil Company is constructing a 5-tank wharf and oil dock with pumping station and complete facilities.

The industries of Prince Rupert comprise seven cold storage concerns, a large fishing industry, two small boat-building concerns and a number of saw and shingle mills.

The New Westminster harbor is situated about 12 miles from salt water on the Fraser River. The city has a population of 20,000, and is a market centre of a rich agricultural district with a population of over 70,000. Salmon fishing is its big industry, there being over thirty canneries in the neighborhood. The city is also the centre of the lumber industry of the southern part of the province, the Fraser mills being claimed to be the largest in the world.

Vancouver, with a population of 125,000, has a harbor extending from Point Atkinson on the west to Port Moody on the east, a distance of 24 miles. It varies in depth from 28 ft. at the wharves to 200 ft. in midstream. There are many wharves, the chief owners of which are Canadian Pacific Railway, Great Northern Railway, Grand Trunk Pacific, British Columbia Sugar Refinery Co., Evans, Coleman and Evans Wharf Co., Johnson Wharf Co., New Vancouver Ferries, etc. The Dominion Government has just completed a wharf at the foot of Salisbury Drive on the south side of Burrard Inlet. This wharf has cost $1,500,000 exclusive of buildings, cranes, etc. It has a total length of 800 ft. and is 300 ft. wide with slips at either side, of 132 ft. These slips have a minimum depth of 35 ft. at low water. A similar wharf is proposed by the government for the north shore of the inlet. The Canadian Pacific Railway and the Grand Trunk Pacific have oil docks in use.

The new outer harbor at Victoria, at present under construction by the Department of Public Works, will provide approximately 10,000 ft. of berthing and will be fully equipped with most modern machinery, warehouses, etc., the cost approximating $2,300,000, exclusive of equipment. It will be one of the best harbors on the Pacific Coast. Two immense concrete piers with warehouses and excellent cargo-handling facilities are being built out into the Straits of Juan de Fuca and a railway slip will enable car ferries to load and unload at the dock. A stone breakwater with concrete blocks surmounted by a concrete wall 2,500 ft. in length will extend westward from Ogden Point. The piers will be 1,000 ft. long. The harbor comprises an area of nearly 300 acres of water, varying in depth from 30 to 80 ft. The breakwater mentioned above will effectually shelter all the piers to be constructed under present arrangements, all piers proposed for construction northward and will, in addition, protect the entrance to the inner harbor. There will be direct rail connection with the harbor from the railway terminals to be built on the Songhees reserve.

In addition to the Dominion Government docks, the Grand Trunk Pacific, the Canadian Pacific Railway and Messrs. R. P. Rithet & Co., have extensive wharves. Of the latter, one pier is 688 ft. x 100 ft., and has a shed with a floor space of 32,000 ft. It is provided with three slips on the west side and two on the east with water 33 ft. deep at low tide. Another is 1,050 ft. x 125 ft. with a shed 818 ft. long and a floor space of 39,500 ft. The depth is 35 ft. at low water.

FEDERAL GOVERNMENT EXPENDITURES IN 1916-17.

The main estimates for the fiscal year 1916-17, tabled in the House of Commons at Ottawa by Sir Thos. White, on February 3rd, indicate that it is the intention of the Government to continue the construction of public works already under way. Further, there has been provision made for a certain amount of new work. Some of the important items for new work or for work now under contract include the following:

Port Arthur and Fort William harbor improvements	$1,000,000
Quebec dry dock	1,500,000
St. John harbor improvements	1,000,000
Intercolonial Railway bridges	483,000
Halifax terminals	3,000,000
Quebec bridge	3,450,000
Hudson Bay Railway	3,000,000
National Transcontinental Railway	1,500,000
Welland Canal	4,500,000
Trent Canal	1,000,000
Toronto Harbor improvements	600,000
Toronto Customs Building	500,000
Postal Station "A," Toronto	455,000
Ottawa Customs Building	530,000

MUNICIPAL IMPROVEMENTS AT NORTH VANCOUVER.

In his report for 1915, Mr. A. R. Clucas, city engineer of North Vancouver, summarizes the following expenditures in his department: Road construction, $18,214.94; board of works general expenditure, $10,663.85; local improvements, $2,337.03; waterworks construction, $980.75; waterworks general, $5,319.34; reservoir at Rice Lake, work in progress, $10,551.44; lanes, $606.57; parks, cemeteries and boulevards, $6,392.12; making a total of $55,066.04.

INTERNATIONAL ENGINEERING CONGRESS, 1915.

The committee of management, International Engineering Congress, 1915, announces that the volume on Mechanical Engineering is ready for distribution and the members who have subscribed to this volume will soon receive it.

The other volumes will be issued as rapidly as possible. Owing to the large amount of material to be reprinted, and the thousands of copies to be bound, the work cannot be carried on with greater speed. However, it is hoped that within two months the entire set will be completed.

Members who did not send in their final selections may be disappointed in not securing all the volumes they might have had in mind, and at this date the Committee has decided to close the lists for certain volumes which have been sent to the press. It may be possible to supply members who would apply at this late hour with copies of volumes which have not gone to press.

ROAD CONSTRUCTION AND IMPROVEMENT

ABSTRACTS FROM THE PAPERS READ AT THE RECENT CONFERENCE ON ROAD CONSTRUCTION HELD IN TORONTO BY THE ONTARIO DEPARTMENT OF PUBLIC HIGHWAYS.

PAINTING AND MAINTAINING STEEL HIGHWAY BRIDGES.

By George Hogarth, O.L.S., A.M.Can.Soc.C.E.
Chief Engineer of Highways for Ontario.

THE steel bridges on our highways were built of members which had probably been unprotected and exposed to the weather for a more or less extended period. The condition of the surface of the steel before it is painted has a very important relation to the length of life of the coat of paint applied to it, and also to the length of life of the completed structure. Possibly many of the pieces of steel had been recently rolled and were new and clean and bright. Some sections may have had a slight coating of rust, while others may have been pitted, rusted and scaled due to the length of exposure. New steel, when built into a bridge, will usually provide a structure which will last longer than one built of sections already rusted and decayed. Further, the new steel presents a surface which readily takes the paint, and that surface has none of the rust which, when painted over, causes the early failure of such covering. To properly prepare the steel surface for painting, all rust must be removed by means of steel scrapers, chisels and wire brushes, so that the clean surface of the steel is exposed. In carrying out that operation considerable care and muscular exertion on the part of the workmen is necessary and unless a good inspector is present the work may be slighted and an inferior result obtained, or complete failure of the shop coat of paint may occur.

Great emphasis is to be given to the fact that all rust, dirt and grease must be thoroughly removed from the steel just before the shop coat of paint is applied since upon this foundation coat the life of the second and finishing coats depends. If the shop coat is carelessly applied over rust and scale it will disappear entirely when that scale falls away and the surface of the metal will then be exposed to further rusting.

Painting steel bridges adds to the cost of such structures, and the reasons for going to this additional expense should be investigated. The practice of painting new steel bridges is defended and justified by the fact that it is a universal custom and all bridge specifications require that paint of one kind or another be applied to the structures after they are fabricated. Painting also improves the appearance of the bridge and lengthens the life of the structure by preventing rusting and corrosion of the steel.

To develop and encourage a provincial custom of keeping steel highway bridges well and properly painted is a duty which those in authority should at once assume and efforts towards establishing a definite course of action in that respect require immediate consideration. Such frequent painting has not been carried out in the past because of the mistaken belief that a steel bridge once built will last forever. This neglect has in recent years resulted in many bridges being found to be so badly rusted that steps must be taken to replace them.

On large bridges, which are carefully and systematically looked after, painters are employed during the favorable seasons of each year and they are kept steadily at work scraping and painting the various parts of the structures. The railways of this country have millions of dollars invested in steel bridges and they insist that experienced men paint all steel structures as often as necessary. In every case the reasons given for all the care and expense are that the life of the bridge is prolonged and the structure is kept in its original good condition as long as it is carefully looked after. A bridge which is painted every four years after being built will require only five complete paintings to last 24 or 25 years, and at the end of that time it will be in good condition. Yet, the experience is that bridges built 20 and 22 years ago are to-day in a very doubtful condition, due to the rusting away of a considerable quantity of steel. The cost of a few paintings is only a fraction of the cost of any steel structure, and when at small cost the life of such structure can be prolonged indefinitely it is economy to use paint.

All experience points to the fact that steel bridges should be painted periodically. The business corporations have found it best to properly paint and maintain their steel structures and it is advisable that municipal organizations carefully consider the financing of similar work with a view to prolonging the life and improving the appearance of structures under their control.

The new bridge is painted when it is built and that covering will last probably from one to four years, depending on the condition of the surface of the steel, the quality of the paint and the care used in applying it. At the end of that time patches of paint of varying sizes have disappeared and the exposed steelwork is rusting away as rapidly as possible. A neglected bridge on a well-kept public highway is an eyesore and demands the labor of the painter in order that its appearance may be in keeping with that of the roadway.

Careful attention to the painting of steel bridges should be given from the day the structure is first completed. Semi-annual inspections in the early spring and fall should be made of all structures, and wherever small failures of the film of paint are discovered the painter should at once be ordered out to carefully scrape and repaint the exposed parts. Every four or five years the structure will require complete repainting. Immediately before the paint is applied, the steelwork must be carefully and systematically cleaned of all dirt, loose paint and rust. A complete supply of steel brushes, scrapers and chisels should be provided for the men and frequent visits to the work should be made to see that these tools are used. The structure should be painted in sections as fast as the cleaning progresses, and three coats of paint applied. In all cases ample time should be allowed between coats to enable the proper drying of the film. Weather conditions during painting have considerable influence on the life of paint, and it is advisable that the complete repainting of bridges be undertaken only during the warm, dry months of the year. Care should be taken to see that the steel is dry before commencing work in the morning and probably the best plan would be to have the men attend to other work till, say, 8.30 a.m. Actual experiments have proved that painting on wet or damp surfaces shortens the life of the paint.

For the information of the official in charge of the work, the date of painting should be stencilled on some convenient part of the structure in order to facilitate the recording of the action of the paint during its life.

The selection of a paint for steel bridges is a problem that possibly all have been called upon to solve at one time or another. To be satisfactory, a paint must fulfil many exacting requirements which may be enumerated as follows: It must be low in price; it must be readily obtained in convenient quantities and in satisfactory containers; it must completely hide the surface of the steel in two coats; should cement itself together and stick to damp or dry metallic surfaces; should expand and contract without cracking the film; should present a hard, tough outer surface; should be impervious to water or gases; should be unaffected by sunshine, heat, frost, dew or climatic changes; should be unaffected by ordinary mechanical abrasion; should wear evenly; should fail by gradual wear and not by disintegration; should leave a good surface for repainting; should not require an unreasonable amount of skill or muscle in application; should be homogeneous; should dry properly; should not be readily ignited; should have power to absorb and remove moisture or dampness from the metal; should have properties that will prevent corrosive action of traces of water in contact with the metal and should not stimulate corrosion of the steel. In connection with the last requirement it would be well to state that paints made from certain materials have been found to slowly produce rusting of the steel in small patches.

While these requirements are numerous and apparently difficult to fulfil, it is possible to-day to purchase in any locality the necessary ingredients which, when combined, will produce a perfectly reliable paint for steel structures. There are also on the market to-day a number of ready-mixed paints which the manufacturers recommend as a protection for structural steel. For many years a red lead and linseed oil paint has been extensively used for priming and field coats for a large number of bridges. At times there has been a tendency to abandon such coverings of proven merit in favor of more modern proprietary paints, but usually, after unfavorable experience with the newer ideas, a return is made to the red lead. Where objection is made to the bright color of red lead in the finishing coat it is suggested that the third coat be darkened by the addition of lampblack. If pure lampblack is used in the final coat, the life of the paint will not be shortened.

[Mr. Hogarth exhibited four specimens of steel angle sections painted with red lead, each specimen illustrating a different degree of surface deterioration and the variation that may occur in the quality of material built into a structure, emphasizing the necessity for careful inspection.]

Maintaining Steel Highway Bridges.—A steel highway bridge requires the proper careful attention due to that class of structure. Changes are constantly occurring in various parts of its members and thorough semi-annual inspections are imperative if the structure is to continue in a safe condition for public travel.

The inspection in the spring should be undertaken with a view to ascertaining the general condition of the structure and also to lay out and decide on the manner of carrying out whatever work is to be done at the bridge during the following summer. The fall inspection should be made with a view to estimating the cost of whatever repairs may be required during the following summer.

Many instances could be cited where an inspection of a bridge has revealed a serious condition of affairs due to broken sections which, if unattended to, might result in serious damage or complete collapse of the structure. Until recently, many of the structures built were pin-connected and were provided with tension members composed of square rods with a welded eye at each end. Indifferent workmanship in forming the weld creates a weak spot which, after a few years of service, becomes apparent when the weld breaks open. If there are two bars in the member there is still sufficient strength available to carry the structure pending immediate repairs, but in no case should unnecessary chances be taken and if the inspector is in any doubt as to the ability of the structure to stand up, the best course to pursue is to close the bridge till repairs are completed. The manner in which steel sometimes breaks is very difficult to account for, and frequent inspection is the only way in which the safety of the bridge can be certified to. Steel is the same as any other commercial product and carelessness in manufacture is reflected in the action of the finished article.

The semi-annual inspections should include every portion of the bridge—the handrail, the approaches and the river channel. Attention to the condition of the approach handrails to discover loose or decayed sections is advisable. Notice boards calling the attention of fast travellers to certain laws may be in place, but are in all probability illegible, due to disappearance of the paint. In many cases these boards are still necessary. They should be painted with easily read type and placed conspicuously so as to impress the public and obtain compliance with the stated request. The fact that a notice board cannot be read, usually results in a lack of observance of a very necessary restriction on the speed of horses crossing a bridge.

The trusses should be inspected to see if they are still in line and the chords carefully examined to discover any twists or deflection and ascertain if the camber is true and uniform or irregular. All tension members should have quality of stress in each, tested by springing them with a sharp blow of the hand and particular attention to the joints of such members should be given. The posts and lateral struts should be straight and free from twists. All lateral bracing is to be examined to see that it is straight and tight, and taking such stresses as it should. In some bridges lateral members are adjustable and where such is the case, all nuts had best be tightened to a good full bearing. After the nut is tightened it should be secured by burring the thread of the bolt in two or three places with a centre punch or chisel.

Some of the pin-connected spans are detailed with the floor beams hung from the pins by a "U" bolt. A careful examination should be made to see that all nuts are tight and sound, and threads burred to prevent slackening. Also that no cracks have developed or corrosion taken place in any part of the connection. These connections should be all carefully cleaned since they are usually located in such a manner that considerable debris from the roadway is caught and held against the steel so that water is retained and assists rusting. In pin-connected bridges, any pins which indicate movement should be noted, and nuts should be examined for tightness. Any members having closed sections which catch and retain water should have proper drain holes drilled. Look for loose rods, hangers and braces and other defects of a like character which require adjusting in order that each of the different parts may have proper bearings and carry its proportion of the load. Observe the structure during the passage of a heavy load and note any undue vibration or deflection which, if followed up, may lead to the discovery of a defective part. Carefully examine the connections between stringers and floor beams and floor beam and truss. See that rivets are tight and connection angles sound. The expansion and fixed end shoes and anchor bolts also call for careful attention to discover any movement of piers or abutments. Rollers of expansion bearings require careful cleaning to preserve them and allow proper operation. It is advisable to sweep and clean the bridge seats as often as necessary, since a considerable amount of mud usually is washed down from the roadway and, gathering around the steel, tends to induce rapid rusting.

The practical test of observing the bridge during the passage of a heavy load may result in the discovery that the various parts appear to be loose and that the entire structure appears to be working or moving. If there are a number of adjustable members in the trusses and lower laterals, it is probable that the tightening of such, while no load is on the structure, will cure any apparent looseness, while, if the bridge is fully riveted, it is desirable that close attention be given the various joints to see that rivets are still tight. If a number of loose rivets are found, it is best to cut them out and redrive so as to produce a tight joint.

Careful attention should be given to the drainage of the floor. If the bridge has a concrete floor, the drains should extend through and beyond the concrete for a distance of one or two inches and should be so placed that the drip does not strike any part of the steelwork. Drains less than three inches in diameter should not be used and they should be cleaned out at frequent intervals. Where drains have been omitted from a floor, it is desirable that holes be drilled along the curb at the low points and that suitable drains be concreted into place. The proper drainage of the floor prevents the water running off each end of the bridge where it either damages the approach roadway or carries dirt down the ballast wall to litter up the bridge seats. The bridge seats should also be examined, preferably after a rainstorm, to see if they are sloped so as to drain the water and not allow it to gather where it might assist corrosion.

Should any member of the structure be accidentally crippled while in service, the best method of repair requires careful consideration, but as a general principle, it is advisable to entirely remove the damaged part and renew it. Sections which have been subjected to heavy punishment are not reliable and a new member completes the repair in the most satisfactory manner. A slight fire on part of the structure may reach and affect some of the members and yet not cause the collapse of the bridge. The effect of such heat treatment on the strength of the steel is so uncertain that it is very desirable to remove the members which have been heated. Wooden floors of various descriptions are in some cases bad fire hazards and may imperil the entire structure. The danger to structures from fire due to nearby material or buildings is evidently not as great outside the cities, yet it is desirable that such points be kept in mind during inspections. Wood lying around on the ground under the structure, or driftwood in the river, may be the cause of trouble, if allowed to accumulate. A few dollars paid out in clearing away and carefully burning such material is usually well spent. The river above and below the site of the bridge should be inspected to see that the channel is not changing or the banks being carried away in such a manner as to sooner or later interfere with the security of the approach roadway or the abutments. Such an occurrence demands prompt attention and the supply of an ample quantity of rip-rap or the excavating of a new river bed to afford a proper escape for the water.

During repairs to the structures or flooring where traffic has to be maintained on busy roads, adequate precautions to prevent accidents to pedestrians and vehicles should be carefully taken. Proper fencing is imperative and the customary lights provided at night.

In many cases the carrying capacity of a bridge of slender appearance is seriously questioned merely because of its looks. A light steel bridge which was well built, and is properly maintained, is practically speaking, safe to-day to carry any load that can be moved along the highway. The weak part of the entire structure is usually the floor, and if that is sound, a little care is all that is required to pass the load across the bridge. It is thus possible in many instances to so maintain a bridge as to lengthen its working life and postpone the day when the expense of renewal must be considered.

In conclusion, the painting and maintaining of steel highway bridges resolves itself into a large number of small but nevertheless important details which, with proper attention, will result in the appearance of the structures being always pleasing to the eye and the constant care which is given them, will lengthen the life of the steel and prove an economy to the owners of the structure. Our highways are to receive more careful attention in the future than they have in the past and to be in accordance with that evidence of care which the roads reflect, it is imperative that the steel bridges be efficiently looked after and their maintenance kept up to the same degree of excellence.

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ROAD CONSTRUCTION AS GOVERNED BY TRAFFIC REQUIREMENTS.

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TRAFFIC affects the location, grades, width and foundation of a road. It affects the decision as to the nature of surfacing to be selected. It also affects the character and the cost of maintenance. As a matter of public necessity, the roads must be made fit to bear the traffic which passes over them, and which is steadily changing in character and increasing in volume.

The practice of construction and maintenance of roads to-day is of a much more scientific nature than previously. The effects of the modern mechanically propelled traffic, especially in and around cities, requires very careful consideration, and it is left to road engineers to devise ways and means best to deal with it. Despite the change that has taken place in the methods of transport on our roads, the percentage of self-propelled vehicles to the total volume of traffic is still comparatively small, and the difficulty has still to be faced of constructing roads which will serve effectively every kind of traffic.

Construction.—Traffic affects foundations. Many road materials have been unjustly condemned when the real difficulty lay in the foundation and not in the surface material. Surfacing is secondary to foundations. It is the foundation that carries the loads coming on the road surface, where, by peculiarities of the road crust, the strains are more or less distributed at the time they reach the subgrade, and the supporting power of the foundation must be sufficient under the most unfavorable conditions likely to occur to safely resist these strains. Therefore, to determine many of the questions on foundations, it is necessary to know the kind and amount of the strains to be borne by it.

If the traffic is to be local farm and light traffic, the dependence for foundation may be placed wholly on the earth subgrade. To this end, there must be thorough drainage of the soil underlying the road. The surface for such traffic, having regard for foothold for horses, may be built with gravel or stone and should be so compacted and bonded that it forms a waterproof covering. If the traffic is to consist of heavily loaded wagons with narrow tires, with a large proportion of heavy and fast motor vehicles, a stronger foundation is necessary. Into this field enters the Telford foundation and the concrete foundation. The more frequent and faster traffic calls for a resilient surface, such as surface treatment of tar or asphalt, commonly called a carpet coat, the heavier type of bituminous surfacing, either penetration or mixing methods, being used on roads carrying heavy motor traffic.

Grades.—The grades on a highway are affected by the character of traffic. If it be mainly pleasure, the economic disadvantages of heavy grades are not as perceptible as in the case of heavy commercial traffic conditions. Also, with some kinds of traffic, a heavy grade, if established, will result in an irresistible demand for an expensive surfacing in order that the traffic conditions may be properly met.

The damaging effect of horse traffic in particular, is considerably increased by heavy grades, the digging and pounding action of the horses' feet in drawing loads up the hill being very destructive of the road surface. On macadamized roads it loosens the surface and digs out the stones, while in wet weather the surface, being soft, is pounded to a pulp and the stones rounded in such a way that the breaking up in dry weather is greatly facilitated.

Tires.—It is plain that different tires—rubber, rubber studded with steel, steel and steel with transverse bars, as on traction engines—have widely varying effects on the surface of the road. It has often been suggested that the width of tires should be proportionate to the maximum load upon and the diameter of the wheels. There appears to be considerable difference of opinion as to the relative amount of damage caused by steel and rubber-tired wheels. It cannot be disputed that rubber-tired motor trucks are most destructive to macadam roads. It is suggested that the cause of this is to be found chiefly in the high speeds and small diameter wheels employed, together with the great weights transported and the limited use of springs. It is agreed that cross-bars should not be allowed on steel tires, but that, if the grip with smooth tires is insufficient, the surface of the tires should be grooved.

Width of Road.—The width of the roadway to be provided is determined by the traffic conditions. The determination of width for all classes of roads is of the utmost importance, and should be given careful consideration. Narrow roadways encourage the concentration of traffic and the development of ruts, especially where the shoulders are properly provided with sufficient slope (usually 1½ inches to the foot).

A committee in connection with the American Road Builders' Association recently made a recommendation that roads carrying a large proportion of fast motor traffic should have the unit width of traffic lines nine feet or ten feet, instead of seven feet or eight feet, as at present, because of the greater clearance required for safe passing of the units of such traffic.

On many of our roads vehicles are constantly forced to turn out on to the shoulders, thus causing them to wear down rapidly, and making necessary a large yearly expenditure for maintaining the shoulders.

In Britain, all main highways have been increased to a minimum width of 21 feet; also in many of the States the width of roads has been increased to 18 feet in tangent and 21 feet in curves, with 3-foot shoulders.

That the radii of curves are affected by traffic is evident when the conditions of the various classes of traffic are taken into consideration. Slow-moving horse-drawn vehicles can readily pass around much sharper curves than can fast motor vehicles. Also, in the case of the former, not as much warning of the approach of other vehicles is needed as in the latter case. Hence the necessity for unobstructed vision for a reasonable distance at curves is not as great.

In 1913 the International Association of Roads Congresses made a recommendation that the radii of curves in roads used by fast traffic should, wherever practicable, provide the best possible and an unobstructed view, and that where this is not possible, the curve being of too short a radius, means should be provided whereby the approach thereto is in some way clearly indicated.

Maintenance.—In many cases a certain minimum of traffic is required in order that the maintenance may be most satisfactory and economical. This may seem a strange statement, but nevertheless it is true, that traffic up to a certain amount is desirable on some surfaces to keep them in good condition. For instance, unless a waterbound trap rock macadam gets a sufficient amount of hard-tired traffic to produce by abrasion sufficient fine material to offset that lost through the effects of wind and rain, the condition of the road surface will not be satisfactory, and its maintenance will be expensive. The Massachusetts Highway Commission has paid about $50 per mile annually for the spreading of sand on the lightly travelled trap rock waterbound macadam roads in order to prevent the macadam ravelling after the blowing away of the fine material from its surface. Again, the sweeping effect of soft-tired motor traffic requires the abrasive effect of hard-tired traffic to counteract it. The dislodging effect of horses' feet needs the rolling effect of wheels to prevent the ravelling otherwise inevitable.

Destructive Factors.—There are three factors of traffic which may destroy the road, when it is assumed that the surface is ideal, and that the drainage and foundation are good in every respect: (1) The shocks of the horses' feet or of hard tires of vehicles; (2) the crushing effect of loads, a maximum per unit of width of tire; (3) the shearing action of motor car traffic.

High speed and small wheels, combined with heavy loading, is a destructive factor. Even exceptionally heavy loads on wheels of large diameter and reasonable width, travelling at a slow rate, cause very little damage to macadam roads in fair condition, except immediately after a frost, whereas fast traffic on small wheels and with much lighter loads soon causes considerable damage. It must, moreover, be borne in mind that the better and more regular the surface of the roads the smaller the damage, even with this type of traffic, and the damage increases at an alarming rate as the surface becomes worn and uneven.

Weather.—Where the atmosphere is generally humid, and there is a considerable proportion of wet days, the damaging effect will be greater on roads generally, and particularly on waterbound roads, than in the case of a drier atmosphere and with fewer wet days. It is not so much a question of comparing rainfall as the number of wet days and the general humidity.

Selection of Surface Material.—The road engineer must not only choose the type of surface over which it will be easiest to haul a load, which will prove durable under the traffic that it will carry, and which will be suitable to local conditions, but he must choose the surface that will produce these results with the minimum cost. It is not always possible to decide with facility what surface will prove the most satisfactory for the lowest total expenditure per ton carried over it. Nevertheless, this is the question to be solved in every new construction.

The chief points which should determine the selection of a type of surface are: (1) The volume and nature of the probable traffic over the road; (2) Conditions incident to the location of the road, including the character of the adjacent land and improvements, the character of the foundation, the existing grades, the climatic conditions, and the cost and availability of materials.

The volume and nature of probable future traffic is the most essential point. This must necessarily be approximated, and due allowance should be made for increase during the life of the road. The nature of the future traffic is difficult to foresee, owing to rapid changes in the weight and speed of motor-driven vehicles.

It has often been asked, "What type of road is best for country roads, especially those that are subjected to a mixed motor and horse-drawn traffic?" The answer to the question embraces several factors. These may be summarized under three general heads—utility, durability and cost.

One answer to this question is, to construct a surface adapted to each class of traffic; in other words, making a double roadway. This is done to the great advantage of the users of the road where the travel is sufficiently dense to require it, as adjacent to many of our cities.

Many miles of roads in New Jersey have been constructed as a double roadway in the following manner: The centre of the road is paved with bituminous concrete 2 inches thick for a width of 12 feet on a macadam foundation, and on each side of this a waterbound macadam road is constructed 6 inches thick and 4 feet wide, making a total width of 20 feet. The horses can travel on macadam surface when the bituminous surface is slippery, allowing one wheel of the wagon to run on bituminous surface, and leaving sufficient room for motor cars to run on centre of road. By following this method three ends are attained: First, the horses are able to travel over the road without slipping; second, a more satisfactory and wider road is obtained for less money; and third, there is less obstruction to traffic.

A bituminous concrete road 16 feet wide would cost more than a double road 20 feet wide. Another advantage of the latter is that the traffic would be distributed over the entire road. A road laid according to the above method would be free from the unsightly drop at edges often seen on sides of bituminous roads. This sharp drop at edges of road is very injurious, owing to the breaking off of the edges by the wheels when vehicles are driven off and on. This is most destructive to the life of the road; water is allowed into the body of the road, and as a consequence disintegration begins. The durability of the road is thus greatly lessened, as the breaking of the bond permits a movement of the stone particles. This increases the wear, thereby augmenting the cost of maintenance, with the result that the annual expenditure is increased.

It is, therefore, seen that this double roadway is the cheapest, whether measured on the basis of first or maintenance cost.

Traffic Census.—Traffic enumeration is now becoming an important element in the design of road crusts, or, at any rate, in the studies which have an influence in the choice of methods and materials. A traffic census should be considered one of the most important points in the decision of that important problem, the selection of that type of construction best suited to local conditions considered from the standpoints of both economy and efficiency.

At one time it was considered sufficient in taking a traffic census to count the vehicles passing a point in a given time, but it has now been recognized that such a method of enumeration is useless for comparing a mixed mass of traffic on one road with a mixed and possibly very dissimilar traffic on another road.

The standard system in Britain is to reduce traffic to tons per yard width of road per day. While this is a great advance on the previous method, it does not take sufficient note of the character of the traffic, each class of vehicle being given an assumed weight.

It is readily seen that tonnage alone is not the proper unit to which a reduction of the traffic census should be made. A load of four tons drawn by horses and proceeding on hard-tired wheels at three miles an hour produces quite a different effect on the road than the same load proceeding at twelve miles an hour on rubber-tired wheels on a self-propelled vehicle. A heavy touring car travelling 25 miles an hour requires quite a different consideration from those in the case of a light motor express wagon, averaging 12 miles an hour.

Conclusion.—Relation between the traffic and maintenance costs is difficult to express in any particular case. (1) Many factors other than traffic are involved, such as climatic conditions, grades and drainage; (2) the present condition of traffic records and of the records of relation of traffic conditions to wear has not reached the point where such conclusions can be drawn.

In view of the present impracticability of making roads sufficiently strong to withstand any kind of traffic, it is important that a concise record be kept of the expenditure, character, and effects of traffic, weather conditions and other details including the condition of the surface and sub-crust in respect of all roads. By this means it may be proved conclusively that the difference in cost of maintenance of the roads before and after the traffic in question comes upon them is a material amount, and that the extent of repairs is reasonable. The method of collecting evidence and of keeping accounts is a matter of extreme importance, and it would be well if some standard form were adopted.

In order to proceed with system in the matter of choice of a road, the engineer should have the necessary data as to traffic; as to cost of construction and maintenance of similar type of road under like conditions; as to the life of road; as to climatic conditions, and, in fact, all available information on the subject.

The Eugene Dietzgen Co., Limited, dealers in engineering and scientific instruments and supplies, have moved their head Canadian office from 116 Adelaide Street West, Toronto, to 31 Richmond Street West, Toronto. They now occupy the old Methodist Book Room quarters, which provide more floor space.

It is announced that the American Coal Products Company, well known in connection with the sale of sulphate of ammonia, and parent organization of the even more widely known Barrett Manufacturing Company, has decided to unite both concerns under the name of "The Barrett Company." The fact that all the roofing, waterproofing and building materials, as well as coal tar, oils, chemicals, and similar products are made and widely advertised in the name of the Barrett Manufacturing Company, has added immensely to the good-will attached to the name, which increase has not been connected in the mind of the general public with the securities of the American Coal Products Company, although this concern owns the stock of the Barrett Manufacturing Company. The commercial dealings of the American Coal Products Company included the disposal of ammonia, more especially sulphate of ammonia, which enters largely into the composition of commercial fertilizers. These transactions will be carried on by the same personnel in the name of "The Barrett Company, Ammonia Sales Agency Department." The Agricultural Department, which has carried on propaganda for the use of sulphate of ammonia as a fertilizer, will continue as a department of The Barrett Company. The Barrett products are made and sold in Canada by The Paterson Manufacturing Company, Limited, and by The Carritte-Paterson Manufacturing Company, Limited.

Editorial

CONFERENCE ON HIGHWAY CONSTRUCTION.

Beginning with this issue of *The Canadian Engineer*, and continuing through several numbers to follow, we present a series of abstracts from the papers and lectures given before the Conference on Road Construction, held at the Parliament Buildings, Toronto, during the week of February 7th. This conference, arranged especially for county road superintendents and engineers by W. A. McLean, C.E., Deputy Minister of Highways for the Province, is the second of its kind in Ontario. The first conference, held in February, 1915, was an exceedingly successful one, and its measure of usefulness, combined with the high efficiency and service of the Department, has undoubtedly established in the opinion of the Government of Ontario, as well as in the minds of the road engineers and superintendents of the province, the value of a yearly conference.

The series of lectures and demonstrations has as its chief object a means of giving departmental instruction to county engineers and superintendents who are in charge of roads subsidized by the Provincial Government under the Highway Improvement Act. The information which these lectures convey, however, is sufficiently general to be of interest to every road man in Canada. It has been presented by engineers in close touch with advanced practice, and whose knowledge of new and tried methods of construction and maintenance, as well as of materials and equipment, bespeaks a large sphere of observation and study.

Last year *The Canadian Engineer* reviewed the papers presented at the various sessions, publishing in as complete form as space would permit those of more marked interest to the majority of our readers. Through the kindness of Mr. McLean, and of Mr. Hogarth, Chief Engineer of Highways, this year's conference will be reviewed in a similar manner in so far as available space will permit.

MILITARY TRAINING AND ENGINEERING.

The Institution of Civil Engineers (London) is making special provision for candidates for admission, who, in the midst of their studies and practical work, have joined the army or navy. The council, recognizing that the unavoidable interruption, serious in any case, would make it practically impossible for many of them after the war to complete those studies and courses of training in exact accordance with the existing requirements, have submitted to the members of the Institution the desirability of modifying the requirements in order to meet such cases. With this purpose they have asked to be empowered to accept military or other approved national service as part fulfilment of the conditions of training; and, further, in certain circumstances, to exempt from examination candidates who have been engaged in military or other approved national war service for a period of at least one year.

Under the existing regulations a candidate for admission to corporate membership in the Institution is required, in addition to passing an examination, to produce evidence that he has served for at least three years as a pupil or apprentice of a civil engineer. In the case of a candidate holding a recognized qualifying degree exempting him from further examination, the period of service is reduced to two years, and may be fulfilled by service under agreement to a civil engineer.

Commenting upon the proposed modification of the standard for admission, the "Times" (London) editorially emphasizes its relation to the interests of the Institution and the public at large, membership in the former being so widely accepted as a guarantee of professional efficiency. It observes that the standard of actual efficiency required from those candidates who may be admitted under the proposed modified regulations will in effect be raised rather than lowered.

The exigencies of the war have certainly interfered with the trend of engineering study and practice. While the effect may not be so pronounced in Canada as in Great Britain, it is interesting, at all events, to learn that the governing body of the Institution of Civil Engineers contemplates professional recognition for the training that its candidates are undergoing while in service on land and sea.

SERIOUS POLLUTION OF STREAMS IN CANADA.

In "Conservation" it is stated that sewerage and sewage disposal is dealt with thoroughly in a report on "Waterworks and Sewerage Systems in Canada," to be published shortly by the Commission of Conservation. The gravity of the problem of stream pollution in Canada is shown by the great number of our inland waters receiving raw or untreated sewage. Particularly is this the case in the eastern portion of the Dominion. In the West we have the excellent example of the Province of Saskatchewan where 80 per cent. of the sewerage systems have treatment plants.

The supply of water to communities is universally recognized as the most important function of inland waters. If these waters are allowed to become polluted, they constitute a grave menace to public health. This may be the case even where filters are employed, as a grossly polluted source of supply may overload the filter, which latter should only be regarded as an additional safeguard in an operation which should begin with the proper treatment of the sewage before it is discharged into any body of water.

RAILWAY WORK IN NORTHERN ALBERTA.

The J. D. McArthur Co., which has under construction the Edmonton, Dunvegan and British Columbia Railway, the Alberta and Great Waterways Railway, and the Central Canada Railway from McLennan to Peace River, recently made some interesting announcements concerning the work projected for this year. They are as follows: The last spike on the Grande Prairie branch (60 miles) of the E.D. & B.C. will be driven in March. The Heart River bridge will also be completed next month, allowing trains to enter Peace River Crossing. Plans are being prepared for a large steel bridge across the Peace River at this point, the cost of which is estimated at $750,000, including highway deck. This bridge will enable the Central Canada Railway to project, as contemplated, 100 miles westward. The line has been located as far as the Waterhole District.

About 340 miles of railway north of Edmonton is to be ballasted this year.

By spring it is expected that the total mileage constructed will be as follows:

E.D. & B.C. main line to Spirit River	357
Grande Prairie branch	60
Central Canada from McLennan to Peace River ...	50
A. & G.W.	250
Total mileage	717

These roads all were built under the guarantee policy of the provincial government and run through districts that were badly in need of railway facilities.

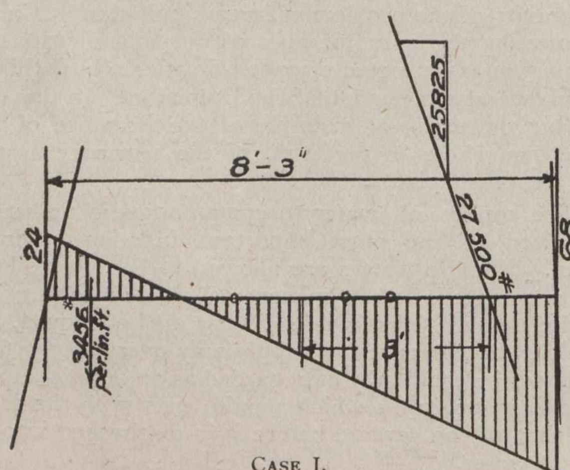
LETTER TO THE EDITOR.

An Interesting Point in Retaining Wall Design.

Sir,—An interesting point in design came up the other day and, thinking that some of your readers might be interested, I give you the problem.

The discussion came up in connection with the design for a semi-gravity retaining wall. One section of the body of the wall with the resultant stress is shown. Three methods of figuring the stresses are given. Which one is correct?

CASE I.—Figuring the stresses in the ordinary manner, we get 68 lbs. per sq. in. compression at the toe and 24 lbs. per sq. in. tension at the heel. A 9/16 inch diameter



CASE I.

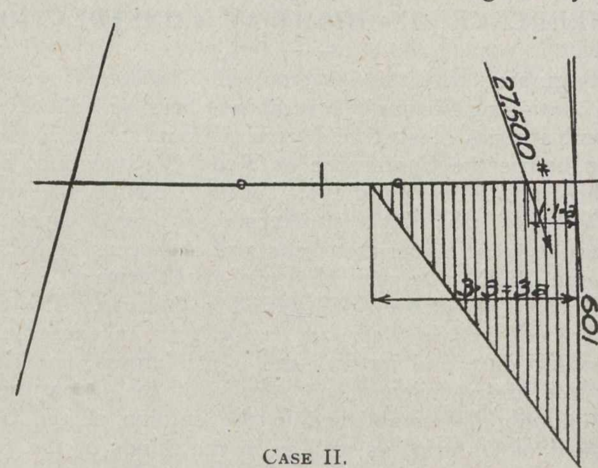
$$P = \frac{25825}{8.25}\left(1 \pm \frac{6\times 3}{8.5}\right) \times \frac{1}{144} = \begin{matrix} +68 \\ -24 \end{matrix} \text{ pds. per sq. in.}$$

rod at 1-ft. centres placed 8 in. from back of wall would develop the entire tension.

CASE II.—Assuming no tension acting, we get 109 lbs. per sq. in. compression at the toe, using the formula $p = \frac{2}{3}\frac{V}{a}$, where V = vertical component of load and a = distance from toe to point of intersection of line of resultant with base.

CASE III.—Figuring the section as a reinforced concrete beam by commonly accepted formulæ, we require a ⅞ inch diameter rod at 12½-in. centres and get a compression at the toe of 163.5 pounds per square inch.

Should the steel be left out, as in Case II., or put in, as in Cases I. or III., in no case do we get compressive stresses that come anywhere near the working value of concrete. Both Case I. and Case III. are figured by com-

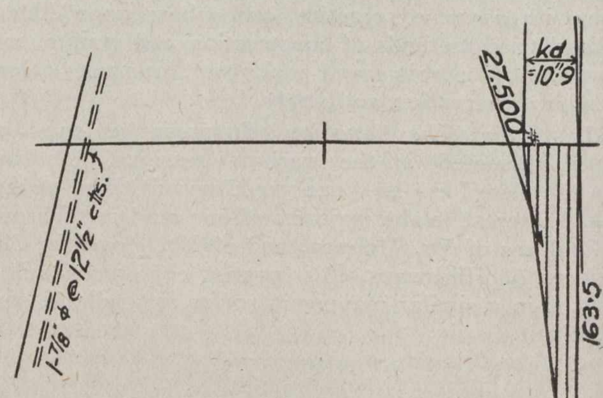


CASE II.

$$P = \frac{2}{3} \times \frac{25825}{1.1} \times \frac{1}{144} = 109 \text{ pds. per sq. in.}$$

monly adopted theories. In Case III. twice as much steel is required as in Case I., and the stress in the concrete is over twice as much.

A common method very much used is to widen the base so that the resultant will pass through the middle third, but is there any need for this when the concrete is



CASE III.

M = 25825 × 3 × 12 = 930,000 in.-pds.

Effective depth = 95 in.

Steel % = .055 = .627 pds. per ft.

$fc = \frac{M}{\frac{1}{2} k j b d^2}$ = 163.5 pds. per sq. in. k = 115.

fs = 16,000 pds. per sq. in.

so lightly stressed? The writer believes that as long as the resultant does not go too near the face of the wall that the stress found by Case II. is the governing factor. The opinion of other engineers would be of interest.

E. M. PROCTOR.

Toronto, January 31st, 1916.

The Winnipeg office of The Canadian Engineer has been moved from Room 1008 to Room 1208, McArthur Building. The new telephone number is Main 2663. Mr. C. W. Goodall remains in charge of the office.

COAST TO COAST

Edmonton, Alta.—The C.N.R. is getting out 725,000 ties and 2,000,000 feet of piling for use on 100 miles of the Oliver Branch and 40 miles of the Peace River line beyond Sangudo. F. Owens, of Edmonton, has the contract.

Toronto, Ont.—Mr. H. H. Couzens, general manager of the Toronto Hydro-Electric System, reported that an expenditure of $1,375,000 was necessary to provide adequate extensions and equipment for the System. An issue of debentures for this amount is under consideration.

Toronto, Ont.—Good progress is being made by the Hamilton Bridge Co., sub-contractors for steel under Quinlan and Robertson on the Don Section of the Bloor Street Viaduct. The same applies to the Rosedale Section, which the Dominion Bridge Co. has under contract. On both sections the contractors are considerably ahead of schedule.

Galt, Ont.—The electrification of the Galt-Elmira branch of the G.T.R. was discussed at a city council meeting recently. It was pointed out that the line should be continued to Hamilton and Niagara Falls, and it was also proposed to construct a branch radial to Guelph. The electrification of the Galt-Elmira branch was strongly favored.

Kingston, Ont.—The Board of Trade is agitating for a better harbor, and has approached the government in the matter. It is desired to improve the present harbor to enable it to receive vessels of increased tonnage for the traffic that results from the completion of the new Welland Ship Canal. It is proposed to dredge the harbor to 25 feet in depth.

Ottawa, Ont.—According to Hon. Frank Cochrane, Minister of Railways and Canals, up to January 1st, 1916, $5,018,711 had been spent in dredging, lighting and other improvements at Port Nelson. It would take another $5,000,000 to complete these harbor improvements. On the Hudson Bay Railway, $9,957,340 had been spent to date and $5,500,000 would be required to finish the work.

Ottawa, Ont.—The new pumping plant at Lemieux Island, together with alterations and improvements to intake pipes, have enabled the maximum pumping capacity of the city to be raised from 22,500,000 gallons to 27,000,000 gallons per day, the latter figure having been reached at one period during the recent Parliament Buildings fire. The average pumping rate at present is about 19,000,000 gallons per day.

Toronto, Ont.—Special legislation may be necessary for an arrangement between the city and the township of York whereby the latter may obtain a water supply from the former. The matter is under consideration at the present time. Although the city is now using about 50,000,000 gallons per day, and is pumping only enough for its own requirements, it is stated that by June next the pumping capacity will have been increased to 110,000,000 gallons per day.

Lethbridge, Alta.—The Dominion Government contemplates an irrigation project north of this city that will comprise about 100,000 acres. The engineering staff of the Department has been working on detailed surveys for some time. There are several other projects under way, such as the Taber extension (nearing completion) comprising 17,000 acres, and also a 350,000-acre block east of Lethbridge, upon which the Irrigation Branch of the Department are at present conducting surveys.

TORONTO BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The February meeting of the Toronto Branch of the Canadian Society of Civil Engineers was held at the Engineers' Club, Toronto, on the 10th inst., Mr. G. A. McCarthy, chairman of the Branch, presiding.

During the business session preceding the presentation of the technical subject under discussion for the evening, the secretary, Mr. L. M. Arkley, read a letter from Prof. C. H. McLeod, secretary of the Society, announcing that at the recent annual meeting a resolution had been adopted providing for the election of a committee to devise ways and means of increasing the prestige and activities of the Society, and calling upon the Toronto Branch to make six or more nominations from which three would be elected as representatives of the Toronto district. The members nominated at the meeting were Messrs. G. A. McCarthy, J. R. W. Ambrose, J. G. G. Kerry, A. F. Macallum, S. B. Clement, H. E. T. Haultain, E. W. Oliver and A. H. Harkness. The executive was given power to make an alternative nomination in the case of any of the above desiring not to act.

When this and other business was concluded, Mr. G. R. G. Conway, consulting engineer, Toronto, gave an informal lecture on "Recent Dam Construction in British Columbia," with particular reference to work with which he has been associated as chief engineer and consulting engineer.

The lecture, which was illustrated with a fine series of lantern views, described the construction of the Bear Creek dam on Vancouver Island, which forms one of a number of dams built for the storage of water at Jordan River, 40 miles west of the city of Victoria, for the hydro-electric plants of the British Columbia Electric Railway Company.

This dam is 1,020 feet in length and 50 feet in height, with 2½ to 1 downstream slope and 3 to 1 upstream slope, and contains 148,400 cubic yards of material. The dam was built by the hydraulic process and impounds 328 million cubic feet of water, the top elevation being 1,483 feet above sea level.

Five miles below Bear Creek dam has been constructed the Jordan River dam of the "Ambursen" type, which is the highest dam in Canada, the extreme height being 128 feet. It is, so far, the second highest reinforced concrete dam that has been built, the highest being the La Prele dam in Wyoming, which has a maximum height of 136 feet. The Jordan River dam is 891 feet in length with a spillway 305 feet long provided with 8 feet of free-board. It contains 21,200 cubic yards of concrete and 380 tons of reinforcing steel was used in its construction. The dam impounds 612 million cubic feet of water, the top elevation being 1,360 feet. From this dam the main water supply is delivered by flume to a forebay from which the penstock pipes are taken so as to utilize a head of 1,145 feet at the power house where impulse wheels have been installed to a capacity of 25,000 horse-power.

Mr. Conway also described the construction features of Coquitlam dam which impounds water for the Coquitlam-Buntzen hydro-electric project of the British Columbia Electric Railway Company. This dam, which is the best and largest example of hydraulic fill construction in Canada, is 99 feet in height, 950 feet in length exclusive of spillway. The storage obtained by building this dam amounts to 180,500 acre-feet, or 7,873 million cubic feet.

The lecturer described in detail the hydraulic sluicing operations in which 4-inch and 5-inch monitors were employed with a nozzle pressure of 80 lbs. per square inch.

Of the 550,000 cubic yards of material in the dam, 427,000 cubic yards was placed in position by sluicing, the remainder—consisting of heavy rock toes—being placed by electrically operated cableways.

A description was also given of the intake works for the supply of water to New Westminster, and some interesting data regarding the rainfall in this part of British Columbia, which has varied at Coquitlam between the extremes of 132 inches and 190 inches, the average being 153 inches per annum.

At the conclusion of the paper an interesting discussion took place and many questions were asked the lecturer.

CALGARY BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The Calgary Branch of the Canadian Society of Civil Engineers held its second dinner of the season at the Alexandra Hotel at 6.30 p.m., February 3, 1916. About 70 members and guests were present. After the dinner Mr. C. D. Howe, chief engineer, Dominion Government Grain Commission, addressed the society on the subject of "Government Elevator Construction." His address was fully illustrated with lantern slides. It was listened to with much interest by the members present and a general discussion followed.

The Calgary Branch expects to be favored with an address by Mr. J. G. Sullivan, chief engineer, Canadian Pacific Railway Company, on the Roger's Pass Tunnel, at an early date.

PERSONALS.

THOS. RODGER has been appointed superintendent of telegraphs for the Grand Trunk Railway System.

JAMES MACKINTOSH, of Hydroglen, Ont., has been elected an associated member of the Institution of Civil Engineers (London).

C. W. PRICE, formerly assistant superintendent of the Sydney Division of the Intercolonial Railway, has been appointed terminal manager at Moncton, N.B.

F. M. BRICKENDEN, until recently a member of the city engineer's staff of London, Ont., is now a lieutenant in the Engineers' Training Depot, Ottawa.

A. J. LATORNELL, B.A.Sc., A.M. Can. Soc. C.E., has resigned his position as city engineer of Edmonton, Alta., in order to enlist for overseas service. Mr. Latornell has been city engineer of Edmonton since 1908, for two years prior to which he was assistant city engineer.

C. W. BAKER, B.Sc., of the Canadian Westinghouse Company, addressed a meeting of the Hamilton Scientific Association last week on the subject of "The Development and Utilization of Electricity."

K. F. NYSTROM, chief draughtsman of the car department of the Grand Trunk Railway, addressed the February meeting of the Canadian Railway Club on "Improvement in Passenger Car Construction and Design."

Lieut. R. H. HOPKINS, formerly a lecturer in electrical engineering, University of Toronto, and a lieutenant in the C.O.T.C., but at present attached to the 39th Battalion, now in England, was severely injured in a motor car accident, in which his brother, Lieut.-Col. F. H. Hopkins, lost his life.

JOHN HADDIN, M.Can.Soc.C.E., A.M.I.C.E., and E. L. MILES, A.M.Can.Soc.C.E., who have for many years been in partnership as consulting engineers under the name of the John Galt Engineering Co., Limited, have changed the firm name to Haddin & Miles, Limited. They are retaining their offices and organization in Winnipeg and Calgary as previously.

Sergeant GEO. LAW, formerly superintendent for Foley Bros., Welch and Stewart on railway construction, and later with the Cook Construction Company on the double-tracking of the C.P.R. west of Sudbury, Ont., has received the Distinguished Conduct Medal. Sergeant Law is with the 2nd Field Company, Canadian Engineers, and went to the front with the First Contingent.

Lieut. JAMES CAMPBELL McDONALD, B.A., A.M.Can.Soc.C.E., graduate of Dalhousie University, Halifax, N.S., and now in the Engineering Corps of the 1st Canadian Contingent, has, according to a recent list of honors to officers and men of the Canadian Expeditionary Force, been awarded the Military Cross. Lieut. McDonald served in the South African war under Major Stairs, of Halifax, and in recent years was with the firm of Cleveland & Cameron, Vancouver.

OBITUARY.

The death occurred in Winnipeg on February 2nd of Mr. Duncan MacDonald, a well-known railway contractor of Western Canada. The deceased was in his 75th year.

The death occurred in London, Eng., on February 9th of Sir Charles Rivers-Wilson, formerly president of the Grand Trunk Railway, which position he held from 1895 to 1909. For 20 years previous to this distinctive connection with railway development in Canada the deceased was associated with the construction and operation of the Suez Canal.

THE USE OF INFILTRATION GALLERIES IN WATER SUPPLY.

(Continued from page 262.)

successful results on Long Island show the maximum possibility of such a supply.

In tropical countries, where there exists so strong a prejudice against the use of stored surface water for a public water supply, due to the deterioration resulting from the luxuriant vegetable growth abounding in such waters, the use of an infiltration gallery is often advisable. The natural purification which takes place in the water while passing from the surface reservoir to the infiltration gallery has been found to be effective. The ability to economically produce a good, clean potable supply even from a very inferior raw water by double filtration, or by other methods, has not been generally recognized. It appears that ground waters are largely preferred, and the proper use of infiltration galleries alone or as a supplement to a well supply is an important matter.

TORONTO BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

A special meeting of the above society will be held on Friday, February 18th, to consider the nominations for the reorganization committee of the society.