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The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

CONSTRUCTION OF CANADA'S BIGGEST MILITARY CAMP

REVIEW OF METHODS FOLLOWED IN TRANSFORMING PINE PLAINS INTO CAMP BORDEN WITHIN TWO MONTHS—CONSTRUCTION OF MILES OF SEWERS, WATER MAINS, TARGETS, ETC.—MANY PERMANENT BUILDINGS ERECTED AND CAMP MADE ACCESSIBLE BY ROADS AND RAILWAYS.

By W. A. YOUNG,

Resident Engineer at Camp Borden for Aird Murray & Lowes, Consulting Engineers, Toronto.

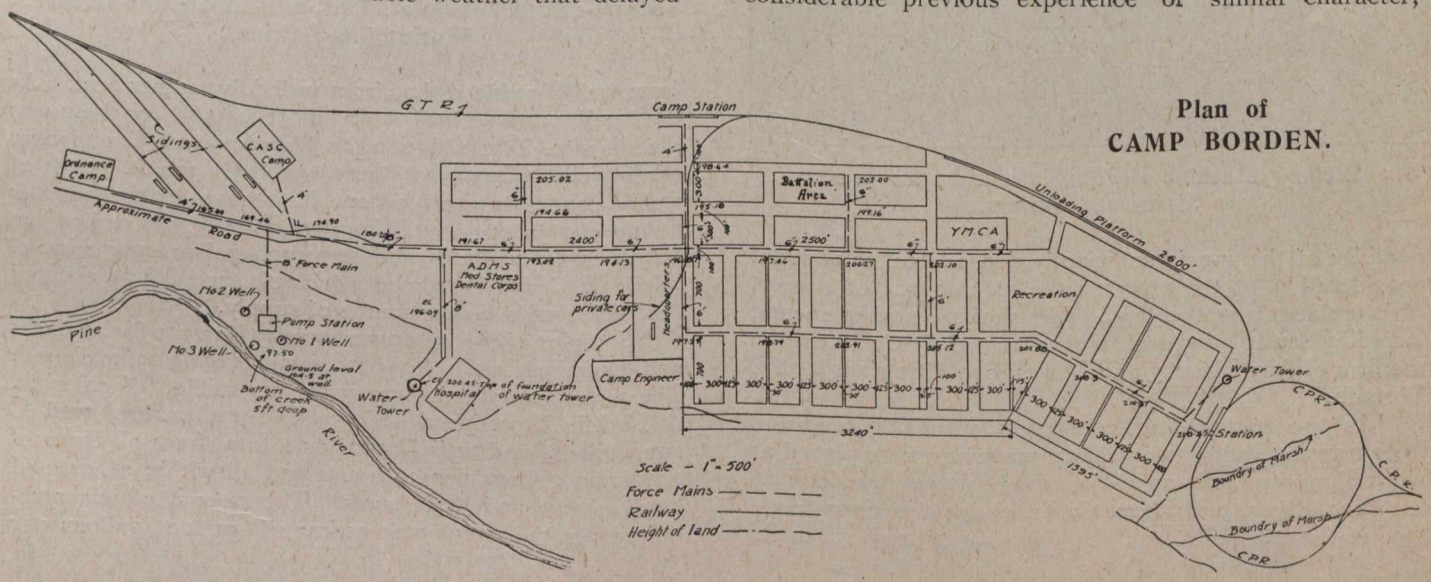
TWO months ago Pine Plains, in Simcoe County, Ontario, was a 20,000-acre tract of sandy, arid waste covered with pine stumps abandoned by lumbermen twenty years ago. To-day Pine Plains is Camp Borden, probably the greatest permanent military concentration camp on the American continent.

With the aid of most modern machinery and materials, and despite rain and unseasonable weather that delayed the work at least a week, energetic engineers and contractors have transformed this large area of rough, wild land into a finished military camp within comparatively few weeks. Many permanent buildings have been erected, streets have been laid out, thousands of tents pitched, miles of watermains and sewers laid, two miles of targets erected and trenched—in fact, a white city has been built—a city of tents and concrete where but shortly before there was not even a furrow.

Camp Borden is on high, very dry, sandy land, 3½ miles northwest of the G.T.R. Angus station. There are 36 battalion areas, practically all of which are now occupied, and the camp is capable of housing a population of 50,000 troops and attendants.

On May 10th, 1916, General Sir Sam Hughes, Minister of Militia and Defence, finally decided upon Pine Plains as the site of the new camp. Orders were immediately placed for surveying instruments, mapping outfits, heavy timber, wagons, steam rollers, carloads of horses, scrapers, motor cars, large motor trucks, saw mills, ditching machines, sewer pipe, valves, water pipe, concrete mixers, stumping machines, back fillers, pumps, motors, cement, food and the scores of other articles needed for work of this description.

Col. Robert Lowe, general manager of the firm of Bate, McMahon & Co., contractors, of Ottawa, Ont., was appointed by General Hughes as the general contractor in charge of the entire construction. Col. Lowe had had considerable previous experience of similar character, having constructed Valcartier Camp, Camp Hughes at Sewell, Man.; Sarcee Camp, Calgary; the Connaught Rifle Ranges, Ottawa; and the new Halifax Barracks.



Plan of CAMP BORDEN.

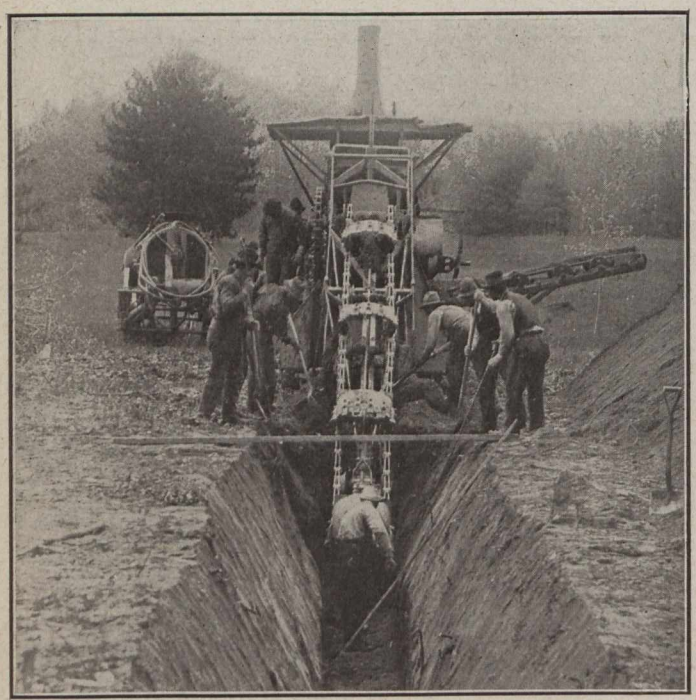
Col. Lowe commenced work with a gang of 300 men, but soon had over fourteen hundred on the job day and night. Many of these were Bulgarians from the internment camps.

A road leading into the camp from the Angus station was the first work that required attention, as it was found impossible to make rapid progress through the sand. Planks 16 ft. long, 6 ins. thick, were immediately laid on all grades and wherever the sand was very loose, and within a day many cars of material had been transported to the camp, and some tents pitched. Meanwhile the Royal Canadian Engineers, under command of Capt. David Barry, who designed Valcartier Camp, were out in parties surveying and mapping a 36-square-mile area within which could be located battalion areas, roads, buildings, etc.

Clearing of the site demanded first attention, and over a million stumps were pulled up or blown up and burned, the men working day and night, in two shifts. Enough

timber was cut to build another town of the size of Angus, Ont.

Water Supply.—The most important problem was to make sure of proper water supply. The Pine River, about 40 feet wide and 6 feet in depth, flows past the camp, but the water was not of good enough quality, nor was the



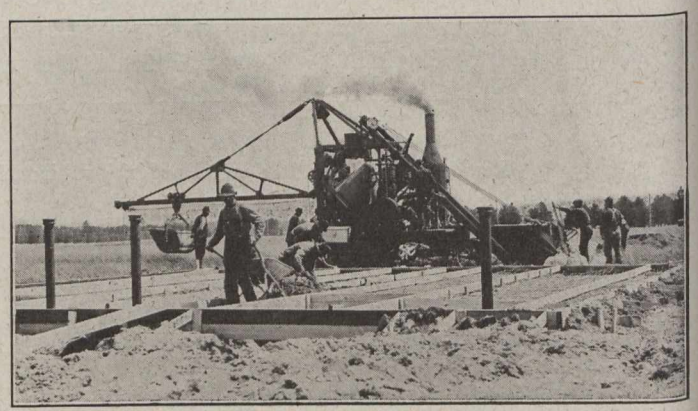
Ditching Machine Digging Trenches for Water Mains and Sewers.

quantity of the supply sufficiently dependable, to warrant consideration of the river as the sole source of supply. This problem, together with other sanitary arrangements, including sewage disposal, was entrusted by Col. Lowe to the firm of Aird Murray and Lowes, consulting engineers, Toronto.

As the surrounding country is plentifully supplied from artesian wells, two drilling machines were placed at work about one mile apart on a high plateau overlooking the Pine River, and about 60 ft. above the river level. One of the test-holes was abandoned at a depth of 50 ft. and the other at a depth of 180 ft. Although water had been obtained, it was not in any considerable quantity.

As it was known that water is obtained at Angus station at a depth of 200 ft., and as the previously mentioned plateau is 40 ft. higher than Angus, it was decided to move the drilling equipment down to the edge of the river.

There two wells (say, A and B) were drilled 1,500 ft. apart, each to a depth of 180 ft. Well A yielded 244 gallons per minute continuous flow. The next day 700 gallons per minute was obtained from well B, but the flow



Steam-driven Concrete Mixer, with Boom and Bucket, Working on Latrines.

from well B reduced that from well A by 40 per cent. As the locality around well A was most suitable for the pump station site, it was decided to abandon well B and bore other wells. One was started (well C) 300 ft. north of well A, and at a depth of 200 ft. it gave 800 gallons per minute continuous flow. Another well (D) was drilled 300 ft. south of well A and gave 500 gallons per minute. Wells A, C and D formed a triangle, and it was decided that this should be the source of supply.

Samples of the water were sent to Toronto for analyses and examinations. No pathogenic germs were found. The water contained three parts per million of chlorine.

Well A produced 166 gallons per minute, well C 800 gallons, and well D 500, or a total from all three of 2,111,040 gallons per 24 hours and all within an area of between two and three acres. The amount of water required for the camp was estimated at 20 gallons per

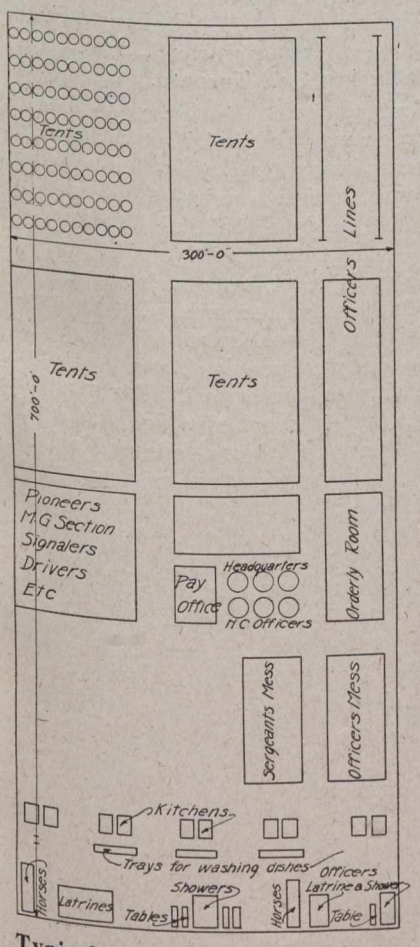
Austin Backfiller at Work on Sewer Trenches.

capita, or a total of 1,000,000 gallons per diem, so that the supply was considered plentiful. After 30,000 soldiers had reached camp, however, it was found that 50 gallons per capita were being used, so drilling was continued and another well of 480,000 gallons per diem was discovered.

To get the water into camp required pumping, so work was immediately started at the pump station, a brick building 40 ft. x 45 ft., with steel roof. Adjoining it was erected the hydro-electric power house, 23 ft. x 18 ft.

The sub-soil in this vicinity is a boggy substance composed of sand and tree roots, so that a concrete foundation was constructed, 2 ft. thick, with 50-lb. rails placed at 24-inch centres both ways to act as reinforcement, and 18 ins. of broken stone was placed for drainage under the concrete floor.

A concrete well 20 ft. x 10 ft. x 10 ft. deep was constructed 30 ft. from the pump station to collect the water which flows from the three wells. Twelve-inch wood pipe lines conduct the water from the flowing wells into this pump well. The wood pipe was coated with asphalt, and was laid upon the surface.



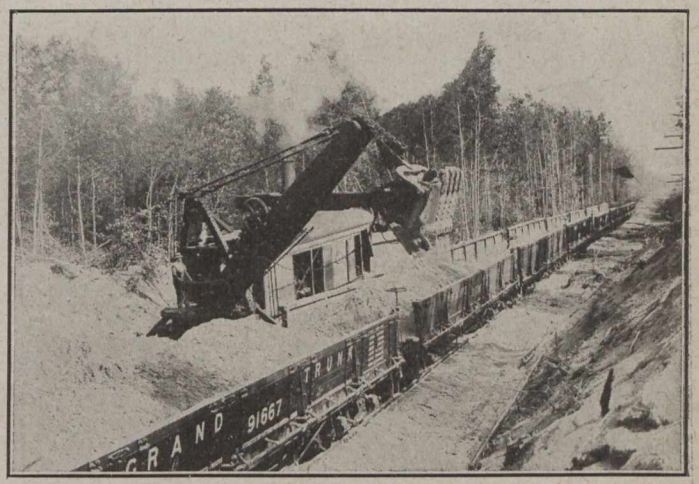
Typical Arrangement of Units in a Battalion Area, or Reserve.

Two 2-stage Morris centrifugal pumps were supplied by the Storey Pump and Equipment Co., Toronto. These pumps have 8-inch discharge and are belt-driven by 150-h.p. electric motors. Each of the two pumps has a capacity of 1,000 gallons per minute against 300 ft. head. One of the motors was supplied by the Canadian General Electric Co., Toronto, and the other by the Canadian Westinghouse Co., Hamilton. Both motors and pumps were purchased and installed by the engineers of the Hydro-Electric Power Commission of Ontario.

A 12-inch intake pipe was laid into Pine River, and the piping in the pump house so arranged that water can be pumped directly from the river in case of emergency. The Pine River water has been piped to the rifle ranges and, if used, will be well chlorinated. This work is in charge of Dr. J. W. S. McCullough, Provincial Health Officer, who is spending much of his time at the camp.

There are two separate 8-inch discharges from the pump house to a water tower situated about 1,400 ft. from the pump house, and as the course of these two force mains is through a swamp, they were laid on 6-in. x 4-in. timbers, and wedged at both sides. Provision is made at the tower to permit pumping directly into the mains.

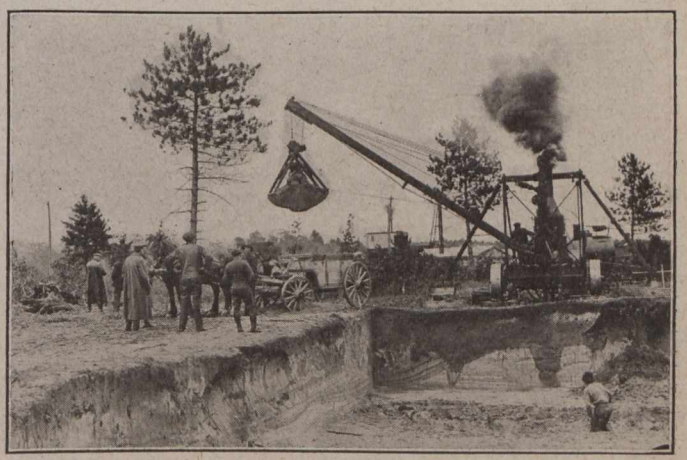
At the other end of the camp another water tower was erected, and the distribution of the entire supply is from these two 50,000-gallon steel tanks, each 100 ft. high. These tanks were erected by the Canadian Chicago Bridge and Iron Works. There are about 10 miles of wrought iron mains, with screw joints, and expansion joints at every 1,500 ft. The 6-inch mains encircle the camp, with 3-inch connections to the building line, the latter running into 2-inch laterals which supply the whole



Revolving Shovel Supplying Sand for a Fill on the G.T.R. Line into Camp Borden.

length of the building line. Therefore, on the 125-ft. streets between the battalion areas, or reserves, the mains are 6-inch diameter, while on both sides are 2-inch supply pipes connected to the mains by 3-inch pipes. From the 2-inch supply pipes there are eleven 1-inch and ½-inch connections for every battalion frontage of 300 ft. All piping was supplied by the Canadian General Fire Extinguisher Co., Montreal.

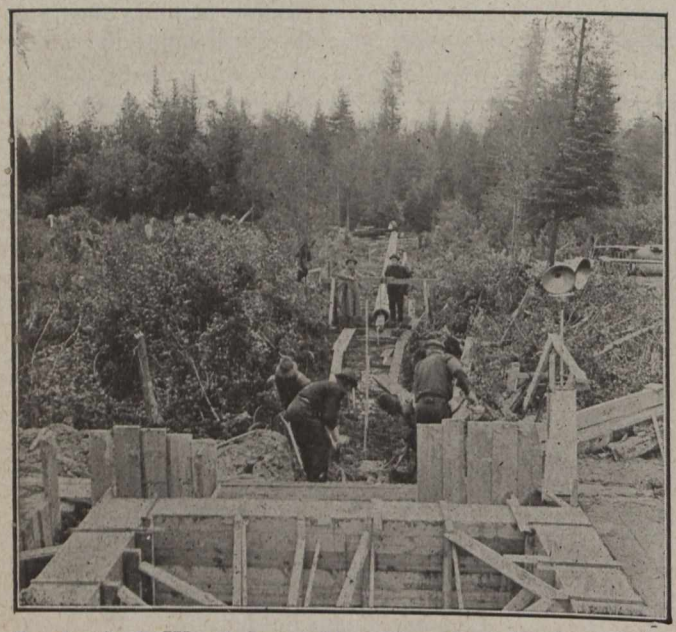
Power.—Electric power for pumping and lighting was brought in from the Hydro-Electric line which runs between Barrie and Waubaushene. A transformer station was erected at the camp and the voltage stepped down



Excavating with Clam Shell for Sewage Disposal Plant.

from 22,000 volts to 2,200 volts for the distribution system. On the main thoroughfares, 150-c.p. gas-filled lamps were placed on every second pole or about 200 ft. apart. The camp is now taking over 300 h.p. The lighting equipment, switchboards, etc., were installed by the Northern Electric Co., Montreal, under the supervision of T. C. James, engineer for the Ontario Hydro-Electric Power Commission.

Sewers.—After a topographical survey had been made of the whole camp, and profiles set up, the sewers were designed. Work was commenced immediately upon completion of the plans, and there were constructed 15 miles



Twelve-inch Wood Stave Pipe Line from Flowing Wells to Pump Well.

of main sewers and connections ranging from 4-inch to 18-inch diameter. While the camp appears to be upon a perfectly level plain, there is actually a fall of 15 ft. and the sewers were constructed at an average depth of 7 ft. throughout the whole system. Three junctions were made for each battalion area, an 8-inch one for the latrines, and two 6-inch laterals extending 62 ft. to the building line and connecting the ablution tables, etc.

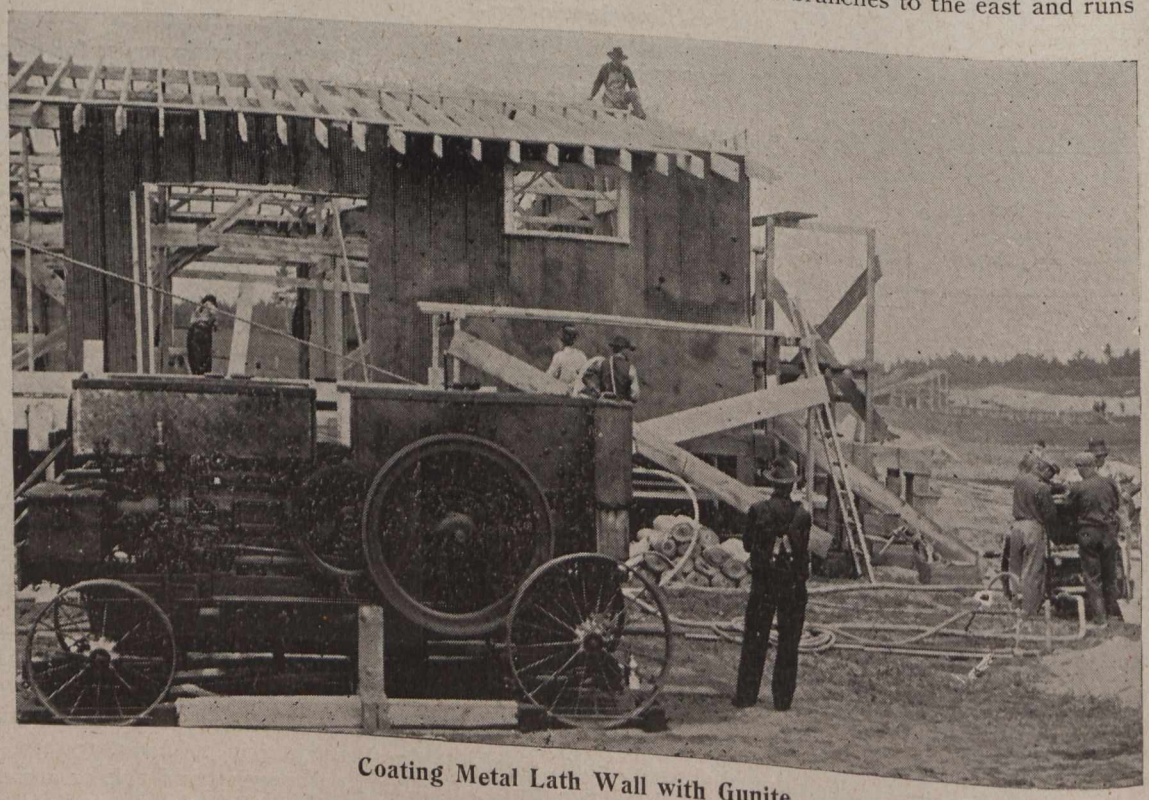
Square man-holes were placed on the main sewers at every 350 ft. They were built of brick with concrete foundations and had cast-iron covers. The water mains were laid in the same trenches as were the sewers, and at every second man-hole a 2-inch tee off the water main was run into the man-hole for use in flushing the sewers. All valves, expansion joints, etc., on the water mains were placed in the man-holes, thus making valve-chambers unnecessary. The main trunk, 18-ins. in diameter and 5,000 ft. long, runs north of the camp, with a fall of 33 ft., to the disposal works, which are situated about a mile from the camp site, on a plateau overlooking Pine River and about 40 ft. above river level. The sewer pipe was furnished by the Hamilton and Toronto Sewer Pipe Co., Hamilton.

The tank is of the two-story type, built of reinforced concrete. Its inside dimensions are 56 ft. wide, 80 ft. long, 33 ft. deep. It has a sedimentation capacity of 200,000 gallons and sludge storage capacity of 400 cubic yards. Retention is 4 hours with a velocity flow of 1 inch in 30 seconds at 100,000 gallons per hour. The effluent from the tanks is carried down the hill to the low-lying level near the river, and eventually finds its way into Pine River by percolation.

The tanks are not roofed, as they will not be used in the winter. They will be emptied in the fall by means of a 12-inch iron sludge pipe which runs longitudinally through the tank about 3 ft. from the bottom and which discharges into sludge-drying beds. All iron work, such as valves, sluice gates, etc., was purchased from the Chapman Valve Manufacturing Co., Toronto.

Railroads.—The first gang of workmen to begin operations at Camp Borden was a Grand Trunk Railroad gang of two hundred men who built a three-mile line from Angus station to the camp, and two miles of sidings, in twenty days. Each siding holds a train of fifty freight cars.

As the land is practically level, not much cutting or filling was required. One of the accompanying illustrations shows a G.T.R. steam shovel supplying sand for one of the few small fills that were required, and this same shovel did whatever cutting was necessary. For most of the way the line followed an old roadbed which was used 20 years ago to haul lumber. Within a mile and a half from the camp the new line branches to the east and runs past the Army Service Corps to the G.T.R. depot site, where one of the largest depots on the G.T.R. system has been constructed, 400 ft. x 80 ft., with a platform nearly a mile long, giving ample room for loading and unloading



Coating Metal Lath Wall with Gunite.

Construction Views of Camp Borden

(1) Laying 8-inch Discharge Mains from Pumping Station to Water Tower; (2) Pumping Out Water and Excavating Sand at Site of Sewage Disposal Plant; (3) The Military Garage; (4) Preparing Sub-grade for Concrete Road; (5) View Along Wood Stave Pipe Leading from One of the Wells, with Pump Well and Steel Water Tower in Background, and Pumping Station to the Left of the Pump Well.

troops. This work was done under the supervision of George Mitchell, superintendent of bridges and buildings of the G.T.R., Toronto division.

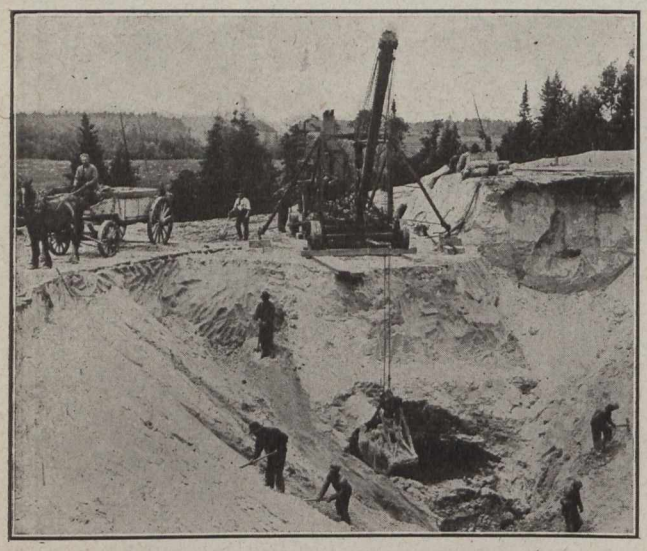
At the station, which is half a mile from the headquarters, a branch leaves the main line and runs right through the headquarters area for the convenience of the general staff and other private car users. Another branch, 1½ miles north of the depot, leads to the Army Service Corps, where a building 300 ft. long x 40 ft. wide has been erected, with unloading platforms and tracks on both sides. This building is of wood, on concrete foundations, with 2-inch stucco or gunite sides and roof, shot on by cement-guns supplied by the Cement-Gun Co., Inc., Allentown, Pa. The cement for this work, and for the other concrete construction, was supplied by the Canada Cement Co., Montreal. All reinforcing was furnished by the Burlington Steel Co., Hamilton.

A distributing tower 70 ft. high was erected for convenience in pouring the concrete into the foundations of these buildings, while water was pumped through a 1½-inch pipe from the Pine River.

The Canadian Pacific Railway also built a loop at the south end of the camp site, with provision within the loop for the storage of goods, etc. This C.P.R. line runs from

Baxter. It is also connected from the loop to the line running along the station and unloading platform, the station and platform being used jointly by both railways.

Excavation Work.—All excavations in the construction of the entire camp were done by machinery. The



Excavating 30 ft. Deep for Sewage Disposal Plant. Water was Encountered at 20 ft. Depth.

trenches for sewers and water mains were dug by two trench excavators furnished by the F. C. Austin Drainage Excavator Co., Chicago. One was driven by a 14-h.p. gasoline engine, and the other by steam. The contractors found but little difference between the two, as both accomplished about 1,600 ft. per 18-hour day, on the average, or practically 1½ ft. per minute. The average trench excavation was 7 ft. deep and 22 ins. wide, all in fine sand. In the southern portion of the camp, water was found in the trench at 4 ft. depth, but in the north half the whole work was dry.

No attempt was made to go deeper than 5 ins. with the machines in water-logged ground, in order to avoid cave-ins, and the banks were braced every 4 ft. In the dry sand no timbering was required. All backfilling was done with three Austin gasoline-driven backfilling machines. Two men handled the scraper on each machine, while a third ran the engine, and each machine backfilled about 800 ft. each day, the machines generally working at a distance of about 5 ft. from the ditch. One had caterpillar wheels, while the others had iron wheels with 2-inch spikes to prevent slipping. A boom over 20 ft. long stretches out over the ditch, carrying the cable and a wood scraper with an iron knife edge.

The trenching inside the battalion lines was done by an Austin tile ditcher with 18-inch buckets fixed on a revolving boom. This ditcher was used for digging the trenches for the 2-inch water mains. It averaged 800 ft. a day at a depth of 6 ft.

Swamps were numerous in the southern portion of the plain, and although they were not near the actual camp site, it was deemed advisable from a sanitary standpoint to have them drained. The trenching machinery was used on this work, and many acres of mosquito-breeding swamp were transformed into well-drained and useful areas. The machines worked well in the swamps, plank roads being constructed for their advance. V-shaped ditches, 6 ft. wide at the top and 2 ft. wide at the bottom, were cut through the swamps for miles, with outlets into the Pine River.

Buildings.—The buildings, like everything else at Camp Borden, were constructed in a hurry, but they were built with a view toward being as nearly fire-proof as possible under the circumstances. The chief fire danger is from without rather than from within, due to grass fires, particularly when the camp is unoccupied. There are no basements, so the first step in constructing each building was to lay a reinforced concrete floor, and excepting in the case of the warehouses, all of these floors were laid directly upon the soil.

There are five large warehouses, uniform in type and size. The floors of these warehouses are raised so that the sills are level with the railroad car floors. The studs are 2 ins. x 6 ins., 18 ins. on centres, covered with herringbone lath and shot on both sides with 2 ins. of Gunite. The roofs are of wooden girders on wooden columns, with 2-in. x 10-in. joists, 18-in. centres, with metal lath carrying Gunite covering. Wooden panels 3 ft. x 9 ft. were braced against the outside of the walls to form a backing against which the Gunite was shot from the inside. The panels were then removed, and a layer of Gunite was shot on from the outside, completing the walls. Very rapid progress was made with this construction, and a dense, strong and impervious wall was the result.

There are two ordnance-stores warehouses and two Army Service Corps warehouses, each 66 ft. x 160 ft., and one engineers' warehouse, 60 ft. x 66 ft. Among the other buildings are the headquarters offices, the post office, telephone and telegraph offices and paymaster's bureau, all 28 ft. 6 ins. wide, but of varying lengths. The frame-work is of mill construction, with the walls and roof of Self-Sentering, or Trussit, coated with Gunite.

The dental clinic and the hospital are of balloon construction, the walls being formed as previously described with herringbone lath and Gunite. The roofs are of wood, covered with Paroid, supplied by Bird & Son, Hamilton, Ont.

There are 36 men's latrines, each 48 ft. square, and 36 officers' latrines. All of the latrines are of the same type of construction as the hospital.

The transformer and pump house is the only building that is of brick. As previously mentioned, a foundation slab, or raft, of reinforced concrete was laid, covering the entire site of this building, as it is constructed on a marsh. The roof is of reinforced concrete.

The First Flowing Well that was Drilled at Camp Borden.

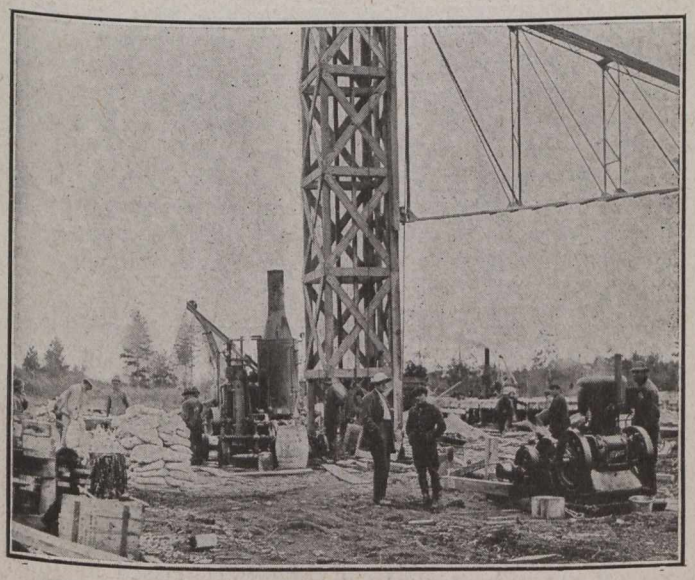
Tents are used for all kitchens and, of course, for all sleeping quarters. Two field bakeries were erected, with enormous ovens, having a capacity of 40,000 loaves a day.

While the buildings are designed only for summer habitation, they are constructed with a view to permanency. Clarence W. Noble, of Toronto, was appointed

by Col. Lowe as consulting engineer in charge of design of all buildings. The construction was under the supervision of Lieut.-Col. A. P. Deroche, director of Works and Buildings of the Militia Department.

The Bank of Montreal, the railroads, the Y.M.C.A., the Canada Railway News & Restaurant Co., the Bell Telephone Co., the telegraph companies, and other institutions have erected buildings of various types for their own purposes. Telephone and telegraph lines were quickly strung into the camp. The union station is of wood, with metallic roofing, and has a large waiting-room, booking office, freight shed, lavatories, and all of the other conveniences that one would find in a city depot. Most of the platform is under cover. A water tank at one end of the platform supplies the engines, and is replenished from the camp system through a 4-inch pipe.

Surveying.—The camp is being placed on the map officially by the Royal Canadian Engineers who have been very busy making surveys. Parties have been out over the 20,000-acre area from sunrise to sunset, with transits,



Concrete Mixer and Distributing Tower at Work on Ordnance-stores Buildings.

levels, plane tables, sketching-boards and all other necessary apparatus. About twenty-five men have been engaged steadily in surveying roads, creeks, ponds, bush, etc., for the compilation of a map that can be used by the officers in manoeuvring the troops.

A plan of the camp site proper has been drawn to a scale of 200 ft. to the inch. Position of the water mains, sewers, wells, buildings, etc., are clearly shown. This map includes a complete record of all the sewer and waterworks connections. During the construction, stakes were left to mark the connections, and these have all been measured and a record made of all specials, depths of man-holes, distances between man-holes, etc.

Levels for the construction of the sewers were sometimes given during the night, as construction of sewers and waterworks was carried on both day and night. By the use of carbide, a powerful spot light was obtained and was placed in such position that the rays shone directly upon the staff. Even at a distance of 500 ft. it was quite easy to read the figures on the staff.

All drafting was done in the engineer's office, a 20-ft. x 30-ft. building which adjoins Col. Lowe's private office. This drawing office was completely furnished with the most modern equipment. Much of the work was done in the evening, a pressure gasoline lamp giving good light.

Lay-Out.—There are 36 battalion areas, each having a frontage of 300 ft. on a 125-ft. roadway, and a depth of 700 ft. On one side of each area is a reserve road of 100 ft., and on the other side is a lane 30 ft. wide. The limits of each area are marked at the four corners with large stakes, upon which are fastened notice boards pointing both ways at 90° and bearing the number of each particular unit.

One of the accompanying illustrations shows the detail, approximately drawn to scale, of a typical lay-out of a battalion area. All of these areas, or reserves, are located on high, level land. A swamp between the lines has been thoroughly drained and is now a large recreation ground, near the Y.M.C.A. building. Toward the south there are amusement buildings, including moving picture theatres, bowling alleys, etc.

Roads.—Roadwork was practically left to the last in building Camp Borden. The construction of concrete and bituminous macadam roads through the main streets in the camp, is now being proceeded with, however. A 20-ft. concrete road, with macadam shoulders, will be laid from Angus station to the camp headquarters, and on through the lines for a distance in all of 6 miles. To facilitate work of this nature, some of the railroad sidings have been elevated 20 ft. above ground, and chutes have been built on 8-in. pine piles, which were driven to a depth of 10 ft. by a G.T.R. steam hammer, so that stone, gravel and other materials can be dumped directly from cars into motor trucks and wagons.

PROGRESS OF CIVIC IMPROVEMENT IN CANADA.*

Nova Scotia.—The Halifax Civic Improvement League is one of the most active propagandist bodies in Canada. Its executive is wisely directed and enjoys the advantage of having considerable influence with the legislative and municipal authorities. It does not neglect such work as promoting cleaning-up, garden improvement, and other practical forms of securing the "city beautiful" by means of individual action, but, on the other hand, it does not permit these things so to absorb its energies that it is unable to find time for the even more important work of promoting legislative and administrative action to deal with the causes of bad social conditions. Nova Scotia leads the provinces of Canada in its housing and town-planning legislation, and the work of the league has greatly helped in placing the province in that position. Now that the necessary legal powers have been obtained to enable some effective reform to be achieved, the league is directing its attention to the practical application of these powers. Town planning boards are being formed in the different cities and towns and a scheme is being promoted to erect a model village as an object lesson on housing reform. A housing act was passed in May to facilitate the raising of capital for a housing scheme.

The first steps have been taken to secure the preparation of a town-planning scheme for Greater Halifax.

At the annual meeting of the Nova Scotia Union of Municipalities, to be held in August next, it is intended to arrange for a full discussion of the question of the desirability of setting up a Department of Municipal Affairs

*From "Conservation of Life," an official publication of the Commission of Conservation, Ottawa.

for the province. This is the next urgent need in the matter of legislation in Nova Scotia.

New Brunswick.—The preparation of the town-planning scheme for Greater St. John is proceeding somewhat slowly owing to the conditions created by the war. Following a recent municipal election, which changed the personnel of the City Commission, from which a proportion of members of the Town Planning Commission are selected, the latter commission has been reconstituted. Mayor Hayes takes the place of ex-Mayor Frink and Mr. J. H. Burditt has been appointed chairman.

Prince Edward Island.—An influential commission has been appointed to take up questions affecting the future development of the province. A conference is to be held at Charlottetown in the early part of August, when various civic problems will be discussed.

Quebec.—The need for housing accommodation in Sherbrooke has caused the Board of Trade of that city to take up the question of forming a housing company under the Provincial Act to encourage the provision of dwellings for the people. There is reason to believe that a scheme will be launched to provide additional dwellings in the form of cottages with gardens in one of the suburbs of the city.

At different times there have been proposals for creating a garden suburb near Montreal. One of the difficulties has been to obtain a suitable site at a reasonable price, suburban land around Montreal being notoriously "boosted" in value and hard to acquire. This difficulty is being lessened by the depression in real estate values and there appears to be a prospect of getting a large housing scheme started on an estate of over 1,000 acres. The matter is being investigated by the town planning adviser of the Commission of Conservation.

The presentation of a town-planning bill to the legislature has been deferred till next session.

Ontario.—Progress in town planning in Ontario is slow, owing to the absence of suitable legislation, and keen disappointment is felt in many parts of the province that the government was not able to introduce a town-planning bill at the last sitting of the legislature. There is no province in which there is more urgent need for legislation and none in which public opinion has shown itself so strongly in favor of it. It is hoped that something will be done to meet the public demand when Parliament resumes its sittings, but meanwhile several important schemes have had to be deferred.

THE EXAMPLE OF RENFREW.—Real estate development is very active at Renfrew and several new subdivisions were placed on the market in April and May. The city council has taken the advice of the town planning branch of the Commission of Conservation in regard to all the sub-divisions. The result has been that all the real estate operators agreed to every proposal made for improving their plans and for linking them up in a satisfactory manner with the general plan of the town. Main arterial roads 100 feet in width were obtained where needed for purposes of traffic thoroughfares, sites for public buildings and recreation have been reserved without cost to the tax-payers, and it has been agreed that a wooded ravine which intersects one of the properties shall be handed over by the owner to the town. All this does not mean that the owners of real estate in Renfrew are philanthropic; on the contrary they are acting frankly in their own interest in thus adapting their plans to the requirements of the town council. But their self-interest is of an enlightened character; they are merely responsive to the argument that their interests and the general interests of the community are in harmony. The Renfrew case proves that the blame for bad land development rests in the final analysis with the local authorities. Without any expert guidance or knowledge of their own requirements, councils are usually unable to make constructive suggestions to owners when plans are submitted. Perhaps, to give themselves some sort of satisfaction that they are looking after the public interest, or to prevent the repetition of some evil that has previously come to their notice, they impose conditions which cost the owners of land a good deal without giving the public any corresponding advantage. What is most exacting and costly to the real estate owner is not necessarily best for the public; indeed, so much are their interests in common that unnecessary loss to the one is loss to the other. Real estate development will proceed on satisfactory lines in proportion as a local authority has, first, adequate powers under a town-planning act and, second, the expert guidance necessary to enable it to put forward constructive suggestions in lieu of destructive criticism.

One unfortunate weakness in the Renfrew scheme is that both the council and the owners alike have, by reason of a provincial by-law, to face the great and wasteful burden of making all the streets, even the subsidiary side streets, not less than 66 feet wide, although to accommodate traffic some are to be made 100 feet wide. The result is to waste large areas of valuable land that might be used for gardening, to increase the extent of surface for accumulating insanitary dust, to cause ultimately the spending of hundreds of thousands of dollars in making unnecessary pavements or boulevards, and too lengthy connections from sewers and water and other mains.

One indirect effect is to cause money to be stinted on sanitary arrangements in the home in order to pay for streets that are not needed.

At a time like this, when economy is so important, it cannot be too strongly urged that the passing of a town-planning act to combat this absurdly expensive system in Ontario should not be further deferred.

Manitoba.—The town-planning bill introduced into the Legislative Assembly of Manitoba passed its third reading in April last. Although without the compulsory clauses of the Nova Scotia act, it is an excellent measure and will pave the way for a better system of land development in the province.

Saskatchewan.—A well-drafted town-planning bill was introduced into the Saskatchewan Assembly in February last by the Hon. Geo. Langley, Minister of Municipal Affairs. The bill passed its first reading but, for reasons connected with other questions of a local character, had to be held over for another year.

British Columbia.—The question of civic improvement organization in the cities of British Columbia is being taken up by the town planning branch of the Commission of Conservation. Conferences are to be held in July. When the political situation is more settled it is expected that a town planning bill will be brought forward for consideration of Parliament.

The Board of Engineers, which will prepare plans for a joint sewer system for municipalities in the Windsor District, consists of city engineer Morris Knowles, of Ojibway; city engineer Edward Brian, of Windsor; city engineer Owen McKay, of Ford City and Walkerville; J. J. Newman, civil engineer, Sandwich; and Chas. R. McColl, Sandwich. It is stated unofficially that a consulting engineer will be appointed to co-operate with this board.

UNPRECEDENTED BRIDGE ERECTION PLANT.

UNDER the above heading, "Contracting," of New York, publishes an editorial expressing the greatest admiration for the manner in which the Quebec Bridge work is being handled. As every Canadian engineer and contractor is also particularly proud of this splendid accomplishment by the St. Lawrence Bridge Co., it will undoubtedly be pleasing to them to note the American paper's opinions; therefore, the editorial is reprinted practically in toto:—

The erection of the Quebec Bridge is the most important work of its class ever executed, involving some vital features of method and equipment that are wholly unprecedented and rank among the most difficult, important and brilliant of all construction.

While the dimensions of the structure are so great, the conditions so special, and the costs so large, that work of such a nature must necessarily be infrequent, and, therefore, unlikely to serve as a model for exact repetition, it must be of interest to all interested in construction to know the radical differences from other notable work of a similar nature, and the general character of the highly specialized methods and plant that have been developed for its execution. While this information may not have a direct practical application to the great mass of work that is involved in ordinary construction, it shows the possibilities of achievement and indicates the direction in which wonderful development has been made and remarkable success attained.

It is also a matter of pride and satisfaction that it merely repeats and emphasizes the often-demonstrated superiority of American practice in bridge erection, which so notably excels that of all other nations that it has frequently been called upon to perform successfully tasks so difficult that foreign engineers and contractors refused to undertake them.

The greatest bridge spans in the world are cantilever and arch trusses or suspended structures, which are erected by the self-supporting cantilever method, assembled on temporary falsework provided at the site, or suspended from overhead cables. Sometimes these methods are combined, and all of them have been demonstrated in the construction of the East River bridges, New York, and the bridges crossing the Mississippi, Ohio, Niagara, and Missouri Rivers, which excel most others in the world.

The characteristic essentials of American practice are notably that the design is largely governed or influenced by considerations of economy, safety, and rapidity in erection, and that the bridge members are completely fabricated in specialized shops and erected as units, involving the least possible amount of field labor, and generally assembled with pin connections at panel points. This has developed a considerable degree of standardization in the design, fabrication, and plant of erection which is notably absent in foreign practice, where the designs are largely dependent on individual whim or preference, and the fabrication and erection are often undertaken in ordinary shops and by general contractors.

The longest span in the world yet finished is the famous Forth Bridge, having two 1,610-ft. cantilever spans with enormous tubular riveted members, some of them 12 ft. or more in diameter, which were built up piecemeal at the site as erected, thus involving the equipment of a large fabricating plant at site. The next longest span, with a much greater carrying capacity, is the 1,600-ft. six-track Williamsburg Suspension Bridge across the East River, New York, closely followed by the similar Manhattan Bridge and by the cantilever and great connecting spans of the Queensborough Bridge.

The original Quebec Bridge, commenced about 16 years ago, is to carry two tracks of the Grand Trunk Pacific Railway across the St. Lawrence River with an 1,800-ft. main span across the deep channel, subject to high tide and rapid current, where the traffic of ocean-going ships could not be impeded. A beautiful structure was designed of large and unprecedented dimensions. Many novel features to meet these conditions, great skill, originality and ingenuity had been displayed in the erection, which was nearly half completed when it was totally wrecked by sudden collapse in 1907.

Since then the reconstruction of the bridge with a much greater capacity, and at a considerably greater cost, has been undertaken by the Dominion Government and carried on in charge of a commission of expert engineers, who have profited by the latest developments of the other great spans in perfecting its design and in assuring its strength, durability and efficiency. The members have been completely fabricated by powerful special and standard tools installed in a very costly shop, and the most experienced and conservative contractors have undertaken the erection of the structure, which is now so far advanced that its completion is expected during the present season.

The fact that principal members have lengths of over 300 ft. and that others have weights up to 1,000 tons, and that they are shipped and assembled in the structure in sections weighing up to 100 tons each, and that they must be rapidly connected in self-supporting structures at a maximum height of nearly 400 ft. above the unobstructed river surface, makes the construction of the 130,000,000-lb. superstructure an unprecedented achievement of colossal magnitude. The eminent success so far attained, with unusual freedom from even minor accident, reflects the highest credit on both the engineers and contractors.

The prominent features of erection are the use of massive steel viaducts and towers for falsework to support the 515-ft. anchor arms during erection, the two 1,000-ton steel travellers with towers 200 ft. high that are equipped with travelling girder cranes overhead, larger than those in many large machine shops, and numerous hoisting tackles of from 10 to 55 tons capacity, by which the heaviest members are rapidly hoisted and accurately placed, the use of special hydraulic jacks of nearly 300 tons capacity for adjusting the falsework and bending the massive girder-like members so as to force them to required position, the system of erecting the principal members in sections, tied together in the field, and thus allowing a maximum of shop construction, the construction of the great trusses in upper and lower portions, the building out of cantilever panels of semi-length at a great reduction of stress and waste of materials, the employment of massive flying bridges swung out in advance of the projecting structure, and the final operation of floating the 640-ft. 5,000-ton centre span under the cantilever arms and hoisting it bodily 150 ft. to position in a few hours.

The United States Congress has passed the Bankhead Bill, appropriating $75,000,000 for aid to the states improving their public roads and $10,000,000 for the survey, construction and maintenance of roads within or partly within the National Forests, when necessary for the use and development of resources upon which nearby communities are dependent.

WATERWORKS OF CANADA.

CANADA has spent approximately $125,000,000 for waterworks plants, according to "Waterworks and Sewerage Systems," by Leo G. Denis, which has recently been issued by the Commission of Conservation. In 1850 there were only 3 plants in Canada, in 1875 there were 15, and in 1900 there were 235. There are now 528 plants, of which 109 were built between 1910 and 1915. The period showing the greatest activity in the construction of such plants was between 1905 and 1910, when no less than 122 new plants were placed in operation.

Tables 1 and 2 show the cost and number of the plants, maintenance charges, consumption, modes of supply, etc.

Montreal consumes the greatest amount of water. Fifty-one million gallons daily is pumped by the municipal system and 30 million gallons by the Montreal Water & Power Co. In per capita consumption, Sarnia, Ont., leads with 292 gallons per capita daily. Notre-Dame-de-Grace, P.Q., is a close second with 291 gallons per capita daily.

Barrie, Ont., is the most economical, using only 29 gallons per capita daily, while St. Boniface, Man., takes second place at 32 gallons per capita. In making these comparisons only cities and towns with a population greater than 5,000 were considered.

The average daily consumption for all towns and cities in Canada is 111 gallons per capita. In comparing these figures with figures from American cities, it must be remembered that the Canadian figures are given in Imperial gallons.

Table 1.—Total Cost of Waterworks, Maintenance Charges, Consumption, Etc., for the Different Provinces.

(In this compilation, the items, which it was impossible to obtain from the municipalities, have been estimated and included.)

Province	Cost of Plants (dollars)	Total Daily Consumption (imp. gal.)	Annual Maintenance Exclusive of Interest (dollars)	Total Length of Mains (miles)	Daily Consumption per Capita (imp. gal.)	Estimated Cost per 1,000 gal.* (cents)	Estimated Cost per Capita per Year* (dollars)
Nova Scotia	5,046,375	23,450,000	186,178	431	127	8.1	3 73
Prince Edward Island	341,119	933,000	15,953	30	54	14.7	2.91
New Brunswick	3,920 429	14,580,000	114,491	213	143	9 5	4.96
Quebec	36,087 735	140,218,000	941,654	1,545	120	8 9	3.90
Ontario	44,506,759	169,554,000	1,821,205	2,643	116	10.1	4.30
Manitoba	8,378,491	10,740,000	486,414	388	50	33 8	6.22
Saskatchewan	6,339,258	7,866,000	296,702	327	55	32.4	6.54
Alberta	8,089,523	23,789,000	271,245	520	121	12.4	5.51
British Columbia	11,015,944	35,747,000	424,697	1,052	100	11.7	4.29
Canada	123 725,633	426,877,000	4,5?8,539	7,149	111	10 9	4.12

* These costs are approximate only, and have been calculated from the annual maintenance costs, plus an allowance of 10 per cent. of the cost of plants for interest and depreciation.

Table 2.—Number of Waterworks Plants in Each Province, Classified According to Source of Supply, Mode of Supply, Power Used, Etc.

Province	No. of Plants Supplied from:			No. of Plants Using		Mode of Supply		Kind of Power where Pumping is Used							Ownership		Rates on which Charges are Made		
	Springs or Wells	Lakes or Streams: Distant	Lakes or Streams: Possibly Polluted	Filters	Hypo.	Gravity	Pumped	Water Power	Steam	Electric	Gas	Gasolene	Oil	Wind	Municipal	Private	Flat	Meter	Both F. and M.
Nova Scotia	7	25	1	2	...	22	11	2	8	1	...	...	...	...	30	3	20	...	11
Prince Edward Island	3	...	...	...	...	1	2	...	2	...	...	...	...	...	2	1	...	...	2
New Brunswick	10	7	3	1	...	9	11	...	4	4	2	...	...	1	18	2	13	...	6
Quebec	76	29	72	19	10	93	84	10	27	29	...	5	...	7	102	75	46	1	19
Ontario	66	6	94	27	10	23	143	18	66	41	8	3	2	1	148	18	76	6	70
Manitoba	6	1	6	5	...	2	11	...	5	2	1	2	1	...	13	...	1	6	3
Saskatchewan	21	2	7	6	...	6	24	...	4	11	2	4	3	...	30	...	10	11	4
Alberta	9	5	19	10	1	11	22	...	16	2	2	1	1	...	24	9	10	4	12
British Columbia	8	31	14	2	...	46	7	...	3	3	...	1	...	...	29	24	33	2	14
Canada	206	106	216	72	21	213	315	30	135	93	15	16	7	9	396	132	209	30	141

DISCHARGED CITY ENGINEERS REINSTATED.

The reinstatement in civic employ of three Boston engineers, who were removed last winter for political reasons, is the end of a case that in many ways parallels some incidents in Canadian municipal engineering history. The Boston engineers were aided in their fight, in every way possible, financially and otherwise, by all of their fellow Boston engineers.

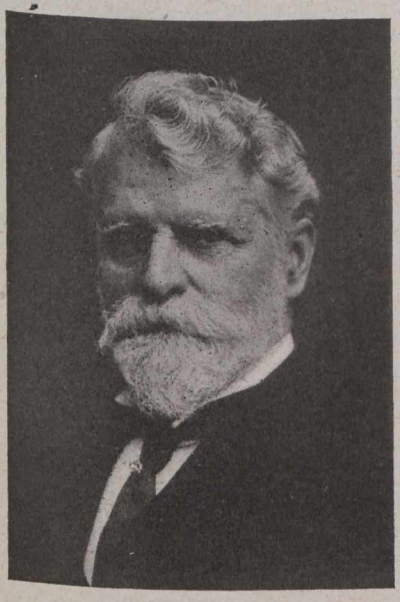
"Under the guise of the abolition of positions for the sake of efficiency and economy," says "Engineering News," of New York, "seventeen men in the Department of Works, mostly engineers, were summarily removed from office. Many had served Boston for years. The testimony in the lawsuit that has just terminated favorably indicated that the real causes of the removal were lack of political activity in favor of Mayor Curley, as shown by failure to attend political meetings and to contribute to party campaign funds. The attorney for the city objected naively to this line of testimony that there was nothing new in expecting political activity and soliciting campaign contributions. The testimony also appeared to show that appointments to offices new in title, the incumbents of which are to perform the same general duties as fell to those abolished, and increases in salaries, added to instead of taking from the expenses of the Department.

"It was also alleged that notwithstanding a charter provision requiring the appointing officer to certify that each appointee is qualified by training and experience for the duties of the position to be filled, at least one of the appointees to replace the politically decapitated men lacked experience in some of the new duties beyond having once run an instrument on that class of work. Some of these allegations may or may not be trivial in themselves, according to one's viewpoint, but taken together and with other factors the Judge decided that the men had been removed or displaced in bad faith and ordered them reinstated."

THE GREAT DOMINION TELESCOPE.

THE Astronomical Branch of the Department of the Interior, Ottawa, is erecting at Victoria, B.C., what will be the world's largest, most modern and most powerful telescope. It was designed by Prof. J. S. Plaskett, of Ottawa, and combines all of the skill of science and engineering in an endeavor to push back the celestial veil a few more million miles and possibly reveal a few more million stars.

All structural parts, including the revolving dome and observing bridge, have been constructed by the Warner & Swasey Co., Cleveland, Ohio, who built the Lick, Yerkes, and United States Naval Observatory telescopes. Dr. Ambrose Swasey, the president of the firm, is a past-president of the American Society of Mechanical Engineers, and is known internationally as the producer of some of the world's finest precise machine work.



Dr. Ambrose Swasey.

Builder of the Victoria Telescope. In 1900 Dr. Swasey was decorated with the Legion of Honor for his achievements in the astronomical field. He was the founder of "The Engineering Foundation," having made an initial gift of $200,000 to that fund.

The principal mirror, or speculum, and all optical accessories are from the works of Dr. John A. Brashear, Pittsburg, Pa.

Victoria was selected as the site for this observatory after about $10,000 had been spent in preliminary investigations as to the best place in Canada to erect the telescope, having regard to climatic conditions.

The following main facts concerning the telescope are abstracted from a letter written by D. P. Clevens, of Cleveland, to the secretary of the American Society of Mechanical Engineers, and published in the last issue of the society's official journal:—

The reflecting surface of the 72-in. mirror is ground with such precision that it nowhere deviates from the parabolic theoretical curve more than two one-hundred-thousandths of an inch. The mirror is a casting of glass 12 in. thick at the edge, and weighs two and a quarter tons, the great thickness being necessary to prevent all flexure. A full-sized model has been on exhibition with the tube, and may be seen near the right edge of the photograph (Fig. 1) as a white disk with a hole in the centre, not unlike a huge grindstone.

A working model of the structural parts was made, in the early stages of manufacture, of cast aluminum, at a cost of about $10,000. This model is shown in Fig. 2.

The telescope is of the equatorial-mounting type, supported at the north and south ends by bearings in a direction parallel to the earth's axis. The declination axis, to which the tube is attached at 90 deg., passes rectangularly through the central cubical portion of the polar axis. The instrument weighs 55 tons and will be mounted on reinforced concrete piers. It may be used

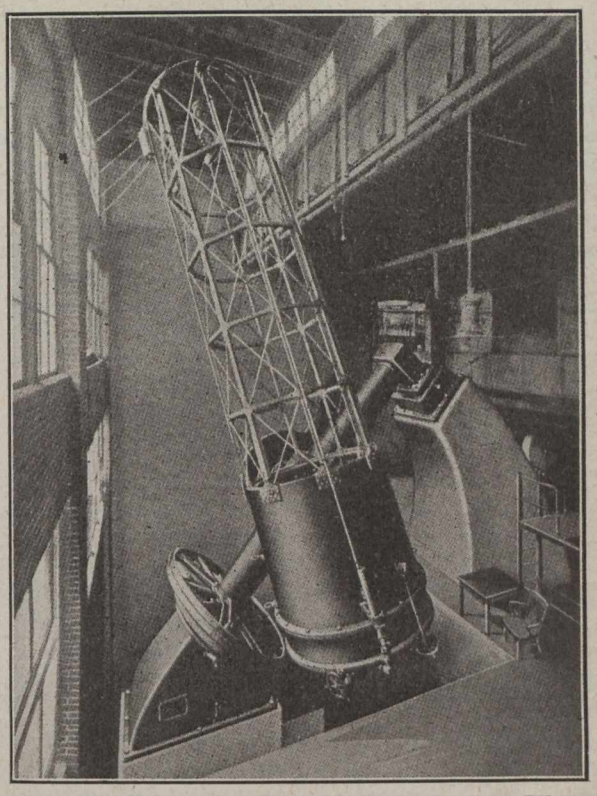


Fig. 1.—The 72-inch Reflecting Telescope in Works of the Warner & Swasey Co.

in three forms, observations being made at the Prime focus, at the Newtonian focus, or at the Cassegrain focus. The principal work at the Cassegrain focus will be to analyze the light of the stars with spectograph. The resulting photographed spectra not only reveal the composition of the stars' atmosphere, but give by their flame length an accurate determination of their velocity toward or from the earth.

A precision driving clock moves the telescope with great accuracy. With the Cassegrain focal length of

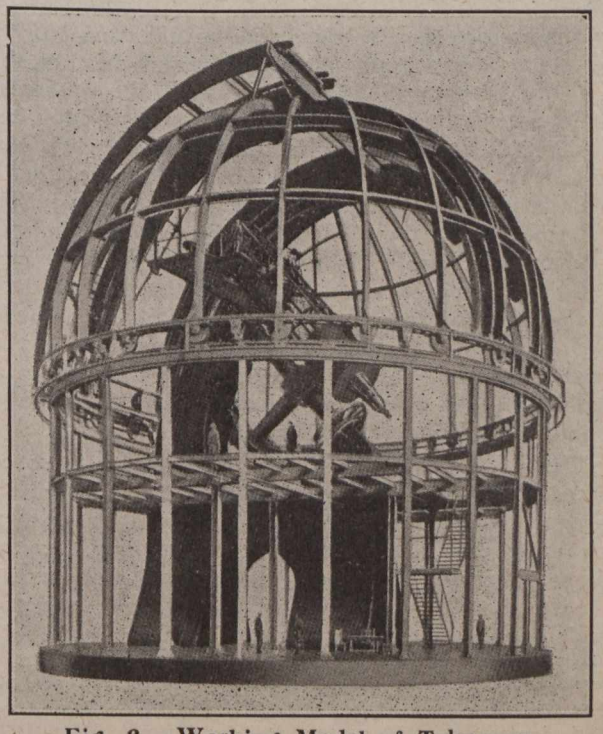


Fig. 2.—Working Model of Telescope.

108 ft., the guiding speed of the star image at the focal plane is one three-hundredth inch per second.

The engineering and mechanical problems involved in designing and constructing a telescope of such proportions and accuracy are apparent only when an appreciation is had of the fineness of astronomical work. Accuracy in astronomy is illustrated by the study which accounts for the motion of the perigee of the moon within 1-300,000 per cent. Also by the fact that astronomers are searching for the cause of a monthly change of less than 1-1,000 of a second in the length of the month.

SARNIA, ONT., SEWAGE DISPOSAL.*

THE city of Sarnia, Ontario, is situated on the St. Clair River, practically at its source. It is opposite the central portion of Port Huron, and is separated from the shore of Lake Huron by the small village of Point Edward. It is connected with the east and west by the Grand Trunk and Pere Marquette railroads, and possesses a fair amount of industrial development, including important oil refineries and brass works.

The city is somewhat more rugged in contour than many of the cities on the Michigan side, with fairly high ground in the southern part and to the south thereof, outside of the city limits.

Most of the existing sewers which discharge near normal river stages have their outlets fairly close together, and a relatively short distance from a vacant tract of land near Devine St., which is suitable in size and location for a treatment plant.

The population was 6,700 in 1891, 8,200 in 1911, and is estimated at about 11,500 for 1915. This indicates a good, healthy growth, and there is no reason to believe that it will not be continued, or even increased, in case the Ontario oil fields should become of increasing importance in the future. It seems entirely possible that the population will reach 25,000 within the next 25 or 35 years.

The water records, after making allowance for railroad use, indicate a daily per capita consumption of about 350 United States gallons. According to the waterworks superintendent, there is a very great waste through leaky mains and fixtures and continuously running closets and faucets. In fact, the consumption was at one time cut down by careful inspection to about 175 United States gallons per capita daily. It seems reasonable, therefore, to presume that the consumption may again be reduced, and for the purpose of this study it has been assumed that the daily per capita consumption will be limited to 180 United States gallons, of which 80 per cent., or 144 United States gallons, has been considered as the sewage contribution. An additional allowance of 1,500 gallons per acre for ground water has also been made.

The existing system of combined sewers is so constructed that they are quite shallow at Russell St., making it impossible for them to collect sanitary sewage much above that street. At some future time, therefore, an interceptor will be required in order that the area to the east may be properly sewered. This interceptor should be built in or near Mackenzie St., and should be designed to carry sanitary sewage only. The storm water from this area and the rural district, which drains through the city, should be taken care of by a storm-water sewer in Confederation St.

The interceptors, which have been designed to serve the present sewerage system, and the above proposed future interceptor as well, on the basis of the increased population previously mentioned, are two in number. The main one begins at Cromwell St. and follows Front and Christina Sts. to Devine St., where it is joined by the smaller one, which follows Christina St. from Clifford St. From the junction point the course is along Devine St. to the railroad tracks, where it turns south and proceeds to the pumping station located at the proposed treatment plant.

As an alternative plan the treatment plant might be located at a point farther downstream, near where the Grand Trunk tunnel passes under the St. Clair River. This location would call for a somewhat greater first cost and a greater pumping lift.

It should be observed that no ground level or sewer level data was obtainable at Sarnia, and that consequently the cost estimates presented herewith are necessarily very approximate. Indeed, the entire study should be considered as incomplete for the same reason. The interceptor is designed for 25,000 persons and based on an assumed average cut of 20 feet for the interceptor and an assumed pumping lift of 20 feet.

Cost of Disposal Plant for Sarnia, Ont., 16,000 Population.

Item.	Unit price.	Cost.	Total cost.
3,000 feet of 10 and 12-inch sewer	*$ 2.30	$13,800	
3,200 feet of 24, 30 and 36-inch sewer	*8.00	25,600	
850 feet of outfall sewer	*11.00	9,350	
Appurtenances	.....	1,000	
			$49,750
Pumping station:			
Buildings	.....	$ 4,500	
Machinery	.....	3,800	
			8,300
Treatment plant, including Imhoff tanks, sludge beds, grit chambers, and disinfection apparatus	†$ 2.45	.....	$30,200
Land	.....	.....	3,000
Total	.....	.....	$100,250

*Per foot. †Per capita.

The total of the annual charge which results from the estimate given above, and the cost of operation, is estimated at $6,000 per annum.

Allen Hazen, in his presidential address to the New England Waterworks Association, urged that "dead-heads" be abolished in connection with city waterworks, stating that the dead-head takers are in general those who waste the most water and those whom it costs the most to take care of. He suggests that fire departments and all other users be billed for the cost of the water used by them, this charge to be transferred in turn, in the form of a fire tax, to the buildings protected by the department, the tax being properly adjusted in proportion to the hazard.

*From report of H. C. McRae, district engineer, to Prof. Phelps, consulting sanitary engineer to the International Joint Commission.

LAKE OF THE WOODS LEVELS.

III.

TWO proposed methods of regulating the levels and outflow of Rainy Lake were explained in last week's issue of *The Canadian Engineer*, *viz.*, Method A, whereby the storage is so regulated as to augment the flow over the extreme low-water period which might last possibly a few years, yet which would probably occur, say, only every twenty, twenty-five or thirty years; and Method B, whereby the storage is so regulated as to augment to the greatest possible extent the annual low-water flow, without any special consideration for very extreme and rare conditions.

Engineers White and Meyer, in their report to the International Joint Commission, after explaining these two methods fully, consider the effect which the two methods of regulating the outflow from Rainy Lake, both with 100 and 150 billion cubic feet of total storage capacity, will have upon the regulation of the levels and outflow from the Lake of the Woods.

The regulated outflow from Rainy Lake has been combined with the run-off from the drainage area below Rainy Lake, according to four different schemes, and the results are presented in four mass curves, which are shown in the volume of plates of the engineers' report.

Inasmuch as, under Method A, the Lake of the Woods reservoir is considered, under normal conditions, to be filled each spring—in which event it may be assumed to be full at the beginning of the protracted dry period—a study is first made of the equalization of outflow which could have been effected over the dry period by means of various drafts on available storage on the Lake of the Woods itself. This dry period began June, 1910, and, for total drafts greater than 3 or 4 feet, extended beyond December, 1914, but its termination could not be predicted when this report was prepared. In view of the fact that the maximum draft on storage, for the higher rates, occurred in the spring of 1914, there is some doubt whether these high rates could really be maintained through the coming years. Assuming, however, that greater depletion would not have occurred in the spring of 1915 or later, then the increase from 100 to 150 billion cubic feet of storage capacity on the Upper Rainy watershed would have resulted in an increase in the low-water flow from the Lake of the Woods over the dry period of years, according to the values given in the following table:—

Method of Regulation A on Both Upper Rainy Reservoirs and Lake of the Woods.

Max. Draft on Lake of Woods in Feet Depth on Lake Area	Regulated Outflow from Lake of the Woods			
	100 Billion Cu. Ft. Total Storage Capacity Upper Rainy	Increase Per Foot	150 Billion Cu. Ft. Total Storage Capacity Upper Rainy	Increase Per Foot
3	8,950		9,820	
4	9,670	720	10,530	710
5	10,390	720	11,050	520
6	10,770	380	11,400	350
7	11,120	350	11,740	340

It is at once apparent from the preceding table that, considering the past records as a criterion, for each of the quantities of available storage under Method A, drafts of 3, 4 and 5 feet in depth on the Lake of the Woods result in a much greater increase, per foot of draft, in the regulated outflow than do the higher drafts of 6 and 7 feet. This fact would indicate that the most economical maximum draft on storage on the Lake of the Woods, viewed only from the standpoint of determining the maximum rate of outflow, is 5 feet. Adopting, then, this value, the study may be continued. It will be assumed that at the beginning of each yearly period following the filling of the reservoir, the regulated outflow, in accordance with the principle of Method A, is limited to the rate maintainable by a 5-foot draft on storage extending throughout the extreme low-water period which began in 1910. This rate of outflow is 10,390 and 11,050 c.f.s. respectively, for the 100 billion and 150 billion cubic feet of total storage capacity on the Upper Rainy reservoirs.

If, some months after the beginning of the yearly low-water period, it is perceived that, owing to increase of inflow, the reservoir has again become filled so that water is being wasted, then the rate utilized may be increased. It has been concluded that the highest rate which thus could have been economically utilized for power development on the Winnipeg River during the wasting period, under method of regulation A, and with 5 feet draft on the Lake of the Woods, would be 13,000 c.f.s. Higher rates of flow than 13,000 c.f.s. would have been available for such short periods of time that it is questionable whether it would have been advisable to have installed the additional machinery necessary for the utilization of a higher rate.

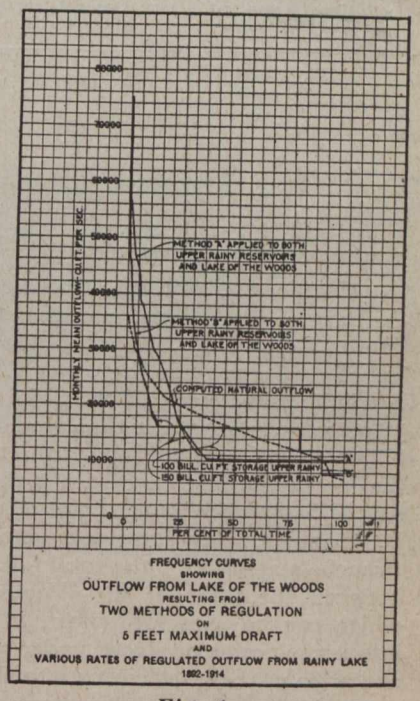


Fig. 1.

If both the Upper Rainy reservoirs and the Lake of the Woods itself had been regulated according to Method B, and with both 100 and 150 billion cubic feet of total storage capacity available on the Upper Rainy watershed, it would have been feasible to utilize up to 16,000 c.f.s. on the Winnipeg River, in that this amount of water would be discharged from the lake at all times except when, on the basis of evidence furnished by existing storage on the Upper Rainy reservoirs and by the winter and spring precipitation on the watershed, the setting in of a protracted dry period could clearly be foreseen.

By means of 100 billion cubic feet of available storage on the Upper Rainy reservoirs, it would have been possible to have secured a minimum regulated outflow from the Lake of the Woods of 7,710 c.f.s. on 5-foot draft, and 9,140 c.f.s. on 7-foot draft. With 150 billion cubic feet of available storage, it would have been possible to have increased the low-water flow to 8,570 c.f.s. on 5-foot draft, and to 10,000 c.f.s. on 7-foot draft on the Lake of the Woods.

Frequency curves of outflow, which furnish a means for ready comparisons of the rate of outflow maintainable from the Lake of the Woods under the different methods of regulation, have been prepared and are shown as Fig. 1.

The computations entering into the construction of these frequency curves show that:—

1. Under Method A, a storage capacity of 150 billion cubic feet on the Upper Rainy reservoirs would have maintained, with a 5-foot draft on Lake of the Woods storage, an average utilizable rate of outflow which is 384 c.f.s., or 3.4 per cent., higher than that maintainable with a correspondingly used storage of 100 billion cubic feet.

2. Under Method B, 150 billion cubic feet storage on the Upper Rainy reservoirs would have maintained, with 5-foot draft on the Lake of the Woods storage, an average utilizable rate of outflow which is 87 c.f.s., or 0.6 per cent., higher than that maintainable with a correspondingly used storage of 100 billion cubic feet.

The quantities expressing the utilizable rates of outflow which could have been maintained over the years 1892 to 1914 are summarized as follows:—

Summary of Utilizable Outflow from Lake of the Woods.

Method of Regulation on both Upper Rainy and Lake of the Woods	Total Storage on Upper Rainy Billion Cu. Ft.	Utilizable Rate of Ou flow c.f.s.
A	100	11,276
A	150	11,660
B	100	14,742
B	150	14,829

Comparing, now, the two methods of regulation on the Lake of the Woods, in connection with similar regulation on Rainy Lake, it appears that with 100 billion cubic feet of total storage in the Upper Rainy reservoirs, Method B would have permitted the utilization of 3,466 c.f.s., or 31 per cent. more water than would Method A. With 150 billion cubic feet of storage in the Upper Rainy reservoirs, the increase would have been 3,169 c.f.s. or 27 per cent. At the September, 1912, Lake of the Woods hearings, J. B. Challies, Superintendent Dominion Water Power Branch, stated that "the total fall of the Winnipeg River between the Lake of the Woods and Lake Winnipeg, which can be used for power, is 291 feet." Translated into horse-power produced under 290 feet of available fall, and at 80 per cent. efficiency, the above quantities of water represent 91,380 and 83,550 continuous horse-power, which, if saleable, at a return of even $10 per horse-power, would have an *annual* value of $913,800 and $835,500 respectively.

Outflow Capacity Required Under Various Methods of Regulation.—As indicated in the discussion of reservoir control in general (July 13th issue), Nature's way of absorbing excessive run-off from the drainage area tributary to lakes is both by means of increased discharge, and by storage in the lakes.

In order to take care of excessive run-off under the condition of artificial control of outflow from the Lake of the Woods, either the outflow capacity must be very much increased, or else a certain amount of reserve storage capacity must be provided.

In case of reservoirs whose outflow is regulated according to Method A, either the increased outflow capacity, or the reserve storage capacity, or both, must be very much larger than in the case of reservoirs regulated according to Method B.

To have kept the level of the Lake of the Woods from rising above a prescribed, ordinary, maximum stage, it would, on the basis of the records of the past twenty-two years, with regulation according to Method A on both Rainy Lake and on Lake of the Woods, and with 100 billion cubic feet of total storage capacity on the Upper Rainy watershed, have been necessary, if no provision had been made for reserve storage, to have provided for an outflow capacity of 75,000 c.f.s., or about twice what would have been the maximum natural discharge from the lake during the same period.

With both Rainy Lake and Lake of the Woods regulated according to Method B, it would have been necessary to provide outflow capacity equal to 57,000 c.f.s., if no reserve storage capacity had been provided.

In case both Rainy Lake and Lake of the Woods had been regulated according to Method B, and the outflow capacity of the Lake of the Woods had been increased to 40,000 c.f.s. at the ordinary maximum stage, with correspondingly greater discharge at higher stages, a reserve storage capacity of 0.9 foot would have been required in order to absorb the excess run-off into the lake during June and July, 1899. If regulated according to Method A, more than 2.0 feet of reserve storage would have been required. From the standpoint of taking care of excessive rates of inflow alone, method of regulation A would appear to be impracticable, even disregarding the unsatisfactory results in power development from this method.

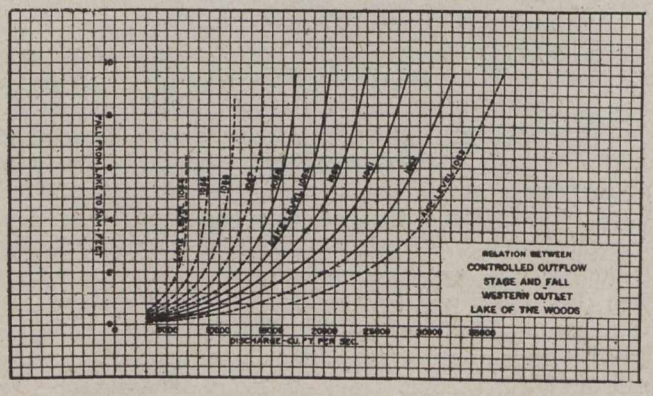


Fig. 2.

In case method of regulation B, modified by providing a total discharge capacity of 40,000 c.f.s. at the ordinary maximum level, and also providing for about one foot of reserve storage capacity, were adopted, it would be necessary to discharge 16,000 c.f.s., or over, during all years except the extremely dry ones, because efforts to save water by holding it over because not immediately needed by present installations are likely to result, sooner or later, in a higher lake stage than the prescribed one.

It appears from the curves of Fig. 2 that the present outflow capacity of the western outlet is relatively small. At a lake stage of 1,060 it is possible to discharge only about 25,000 c.f.s., through the Norman Dam, even if wide open. If regulation of the level of the Lake of the Woods is to be secured through control of the outflow through the western outlet by manipulation of the Norman Dam, with its present discharging capacity, this site will be economically valueless for any large power development during a portion of every high-water year.

In order to discharge more water through the western outlet, extensive excavation, particularly at the C.P.R. bridge, and between the bridge and the lake, would be required, and, with the co-operation of those interested, could no doubt be made.

In order to conserve the water supply, it will be necessary to improve the Norman Dam so as to prevent the excessive leakage at present occurring, and to replace

the present stop-logs with gates which permit of more ready and satisfactory manipulation.

At a lake stage of 1,061.5 the discharge capacity of the eastern outlet in a state of nature was 5,150 c.f.s. The tailwater level at Keewatin, corresponding to a discharge of 40,000 c.f.s., is 1,046.5, leaving a head at the Kenora plant, during flood discharge, of only about 15 feet. Under this head the completed Kenora plant of 6 generator units and 2 exciters can discharge only about 3,500 c.f.s. At the present daily load factor this would represent a continuous discharge of only about 2,000 c.f.s., or more than 3,000 c.f.s. less than when the eastern outlet was in a state of nature. This fact would appear to require recognition when considering the provision of the necessary discharge capacity to permit the regulation of the levels of the lake.

[NOTE—The fourth article of this series will appear in next week's issue of *The Canadian Engineer*, covering the desirability and practicability of regulating the levels and outflow of the Lake of the Woods.—EDITOR.]

FORMATION OF ICE IN WATER MAINS.

The formation of ice in water mains is dependent upon the temperature of the water in the main and the velocity of current, the pressure being of negligible effect. It is probable that the water as drawn from a reservoir or stream is seldom below 33° F., as the formation of ice and the density of the water generally prevents the cooling of the water below this temperature. If the water in passing through the main is not reduced in temperature to below 32° F. there will be no danger of freezing. If it is reduced below 32° F. ice will begin to form, the ice forming a coating on the inside of the pipe, due to the high conductivity of the iron.

As the ice film thickens, the transmission of the heat of the water to the surrounding earth and thence to the air is greatly retarded, the conductivity of the ice being such a small fraction of the conductivity of the iron. If the velocity in the main is reduced through a lowering of the rate of draft, the water in the main is more readily cooled, and the rate of ice formation correspondingly increases. This ice formation may be properly classified as surface ice.

It is probable that in a main where the velocity is high, the water is cooled slightly below the freezing point and a form of frazil ice created. Such ice might eventually clog the main, stopping the flow, and the whole mass of water in the main quickly change to solid ice.

In the report of the committee of the New England Waterworks Association on the depth at which mains should be laid to prevent freezing, submitted in 1909, reference is made to slush ice forming in a main laid in a salt marsh at New Brunswick, N.J. The velocity in this main was high and frazil ice probably formed.

A stoppage in flow may also occur after a thaw, due to the loosening of the film of ice which has formed during the cold spell, and which may break up and flow through the water until it reaches a point in the main where the ice may not have broken loose and where the floating ice will become packed in such a manner as to completely stop the flow. While this might account for the stoppage of flow in mains, especially in house services, after a thaw, which is an experience not uncommon to waterworks superintendents, there is a record of an actual reduction in temperature of soil below 32° F. following a thaw, and such reduction would be ample reason for the freezing up of water mains.—[Engineering & Contracting, Chicago.]

OPERATING COSTS FOR MUNICIPAL GAS-ENGINE PLANTS.*

By H. T. Melling,
Superintendent, Gas Power Department, Edmonton, Alta.

IN 1908 the city of Edmonton installed in its electric-power plant a gas engine using producer gas generated from local lignite coal. This engine is a double-acting twin-tandem type having cylinders 24 in. diameter by 32-in. stroke and running at 150 r.p.m. It is directly connected to a 700-kw. 2,300-volt, three-phase, 60-cycle generator.

Compressed air at 200 lb. is used for starting and is supplied by a two-stage steam-driven compressor, which is also used in the station for other purposes. Circulating water for the engine and producers is supplied by a 4-in. two-stage centrifugal pump and a special 3½-in. low-lift pump for discharging the water back to the reservoir. Both these pumps are on one base and connected by flexible couplings to a 40-h.p. induction motor.

Gas is supplied under pressure by two sets of down-draft producers which are operated alternately. Their respective sizes are 5 ft. 10 in. diameter by 7 ft. 5 in. high.

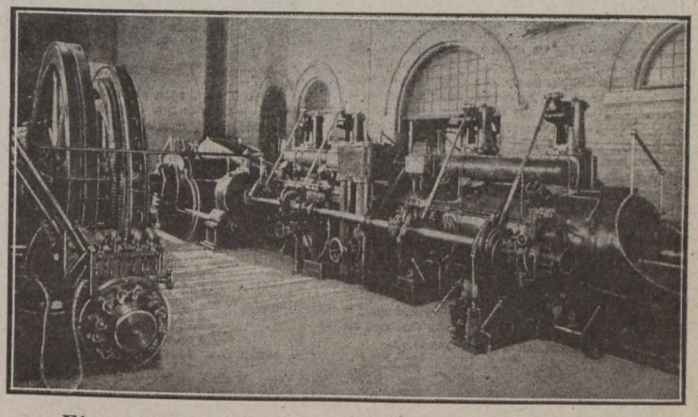


Fig. 1.—Twin-tandem Gas Engine at Edmonton Municipal Plant.

and 6 ft. 9 in. diameter by 8 ft. 8 in. high. Each has its own steam-driven exhauster and wet and dry scrubbers, the gas piping on the exhausters being so arranged that they can be worked on either set of producers. The gas, after leaving the producers, passes through a vertical tubular boiler which supplies steam for the exhauster engines, then to the wet-coke scrubber, after which it passes to dry scrubbers containing wood shavings, and finally is forced through the main dry scrubber to the gas holder.

An average of 2,000 lb. of furnace coke is required in the bottom of the producers. This coke, when heated, destroys all the volatile matter distilled from the fresh fuel in the upper strata of the fire. Sixty per cent. of this coke is recovered on cleaning out the producers.

The actual operating time between cleaning the producers varies with the ash content of the coal from 100 hours on the small set to 140 hours on the large. Water is sprayed into the fires on shutting down the producers for cleaning, which greatly reduces the time and cost of cleaning. Should occasion arise, three men can clean and recharge the set and supply gas to the engine within five hours.

*Abstract of article contributed to "Power," New York.

Lignite coal is used varying in price from $1.50 per ton to $2.30 delivered, the proximate analysis being: Moisture, 18.1 per cent.; volatile, 33.3 per cent.; fixed carbon, 41.3 per cent.; ash, 7.3 per cent.; calorific value per pound as fired, 9,160 B.t.u.

The gas generated contains a net heat value of 115 to 120 B.t.u. per cu. ft. To assist the producer operators, a recording gas calorimeter is connected to the gas main.

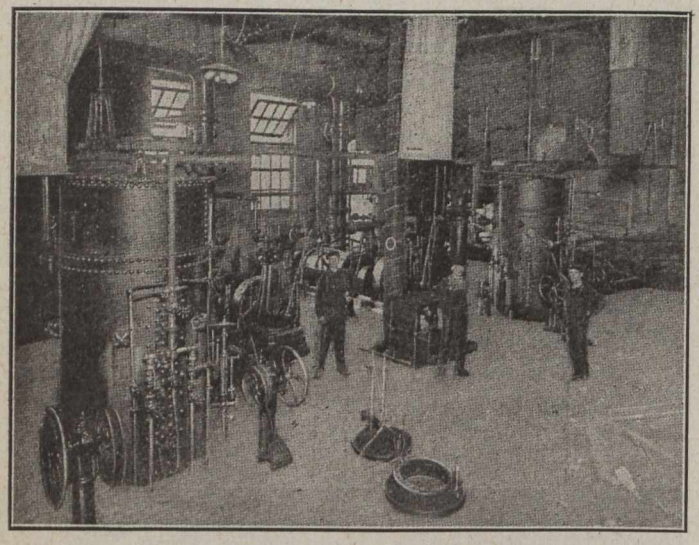


Fig. 2.—View of Gas-producer Room.

The gas contains no tar, is practically free from dust, and is delivered to the engine at 3 in. water pressure.

It was found that owing to the high piston speed a cylinder oil having a higher viscosity than that used on the piston rods gave the best results. Tests of the oil gave the following readings:—

	Flash Point.	Fire Point.	Viscosity (Saybolt).	Specific Gravity, Baume.
Heavy cylinder oil	485 deg.	545 deg.	206 @ 210	21.9
Light piston-rod oil	415 deg.	463 deg.	56 @ 210	25.7

The operating force consists of two engine operators, three producer operators and three producer cleaners and coal handlers, all on 8-hour shifts.

During the first two years it was impossible to get more than half-load out of the engine and considerable trouble was experienced with scored cylinders and pistons. It was finally decided to re-bore the cylinders, put in hard-metal liners and fix the plant up in the best possible condition, also to purchase an additional set of gas producers of larger capacity than the first set installed. After the plant was again put in service, a close watch was kept on its operation and costs and its troubles and defects were gradually overcome.

Daily report sheets are kept of the producer and engine operation, and an hourly kilowatt reading is taken. The actual operation and maintenance costs for the past two years were as given in the accompanying table.

Operating Costs, January 1, 1914, to December 31, 1915.

	Jan. 1, 1914, to Dec. 31, 1914.		Jan. 1, 1915, to Dec. 31, 1915.	
	Total Costs.	Cost per Kw.-Hr., C.	Total Costs.	Cost per Kw.-Hr., C.
Coal and coke	$11,019.76	0.328	$ 9,312.32	0.299
Coal and coke handling, firing, cleaning producers	1,683.31	0.050	2,524 28	0 081
Firing producers' wages	2,553.23	0.076	1,229 93	0.039
Stores, waste, oil, etc.	1,237.54	0.074	2,302.21	0.074
Water for engine and producers	321 51	0.010	295 01	0.009
Engine-room wages	7,525.43	0.224	6,129 81	0.199
Salaries and administration	1,795.35	0.052	1,243.71	0.040
Insurance	57.40	0 002	.....	.....
Debenture interest and sinking fund.	17,535.47	0.523	17,582.23	0.568
Cleaning producers	1,237.54	0.037	891.68	0.028
Repairs and maintenance:				
Buildings	207 64	0.006	410 13	0 013
Gas engine and auxiliaries	7,661 55	0 229	2,475.73	0 079
Producers	2,3?7.29	0 070	2,317.65	0.074
Generator, switchboard and lighting	222.31	0.007	316.41	0 010
	$56,628.09	1.688	$47,031.10	1.513
Hours operated	5.408.00	....	4,911.35	....
Kilowatt-hours generated	33,545.70	...	31,058.00	....
Pounds of coal	100,850 05	....	87,474.95	....
Pounds of coal per kilowatt-hour	3 00	....	2.81	....

BEHIND THE GERMAN TRENCHES.

SCARCELY any German or Austrian technical journals are now allowed to enter Switzerland or any other neutral country, despite their being severely censored before going to press. Needless to say, no publications are more strictly watched than those dealing with engineering. Nevertheless, the Swiss correspondent of The Engineer, of London, Eng., has been able to obtain some news both from Germany and also from Austria concerning what is being done or contemplated there in engineering circles.

The most important project, he reports, the realization of which seems now certain, is the construction within a short time of a waterway, navigable for vessels of considerable size and tonnage, from the Danube to the Main and the Rhine. Once this was accomplished there would inevitably arise the questions of the necessity of a connection with the Elbe or the Weser, of making the Danube navigable as far as Ulm, and then connecting with the Lake of Constance, as far as which the Rhine would be canalized. One of the great objects of the Germans in carrying out this project would be, as they frankly admit, to become more independent of England as regards communications, and to divert the great stream of traffic eastwards. Moreover, the Danube-Main-Rhine canal would further that much-caressed idea, "Central Europe," the union of the Central European States, industrially, politically, and economically.

Apparently Bavaria also, whether with or without prisoners of war labor it is impossible to ascertain, has so far advanced in the utilization of her various lakes and other water-power that she hopes at the end of the indefinite period known as "within measurable distance of the conclusion of peace," all the sources of water-power in the kingdom will be available for the generation of electricity. The Rhine-Danube canal, however, is an undertaking of such magnitude as to throw entirely into the shade the utilization of Bavarian water-power for

electrical purposes. Well might it be called "a turning point in German policy with regard to inland waterways."

At the beginning of this year an important meeting was held at Nürnberg, attended by commercial men and representatives of trade and industry generally, not from Bavaria, Württemberg, and Baden only, but also from North Germany, and by a number of members of the Bavarian Diet as well. The principal subject of discussion was the commercial, political, and military importance, not to say necessity, of this very proposal, the connection by water, for steamers of large tonnage, of the Danube and the Rhine. A lengthy resolution was passed, insisting upon the desirability of speedily executing this project, and asserting that the main stream of German trade and communications must not be in future exclusively dependent upon overseas communications.

The Germans behind the front are obviously not idle, and are laying countless plans and forming countless projects for the period "after the war." They are even discussing utilizing the special war rolling-stock, of which they and the Austrian railways now possess so much, for commercial purposes after the war.

The Austrians and Germans as a rule believe or pretend to believe that the war will be followed by a period of immensely enhanced prosperity, when there will be a far greater demand for than supply of labor, and when production in every department of commercial life will be proceeding with the utmost speed. Many of the buildings now used for army purposes it is proposed to utilize after the war for manufacturing purposes.

A trade war against the United Kingdom and British Dominions generally is to begin the moment hostilities cease. No one should be under any delusion on this point: the Germans and Austrians expect to be fought and expect to fight commercially, after the fighting on the battlefield is over.

PROPOSED SPECIFICATIONS FOR DOUGLAS FIR BRIDGE AND TRESTLE TIMBERS.*

I. **Definitions.**—1. The following definitions are used in connection with these specifications:—

(*a*) *Annual Ring.*—Each annual ring is composed of two distinct types of wood structure, namely, the porous, light-colored and light-weight spring wood formed during the first part of the growing season, and the hard, dense and darker colored summer wood formed during the latter part of the growing season.

(*b*) *Summer Wood.*—Summer wood is the hard, dense portion of the annual ring. It is darker in color than the more porous spring wood.

(*c*) *Sound and Tight Knot.*—A sound and tight knot is one which is solid across its face and which is as hard as the wood surrounding it; and is so fixed by growth or position that it will retain its place in the piece.

(*d*) *Encased Knot.*—An encased knot is one whose growth rings are not intergrown and homogeneous with the growth rings of the piece it is in. The encasement may be partial or complete; if intergrown partially or so fixed by growth or position that it will retain its place in the piece, it shall be considered a sound and tight knot.

(*e*) *Loose Knot.*—A loose knot is one not firmly held in place by growth or position.

(*f*) *Rotten Knot.*—A rotten knot is one not as hard as the wood it is in.

(*g*) *Measurement of Knots.*

In Beams, the diameter of a knot on the narrow or horizontal face shall be taken as its projection on a line perpendicular to the edge of the timber. On the wide or vertical face, the smallest dimension of a knot is to be taken as its diameter.

In Columns, the diameter of a knot on any face shall be taken as its projection on a line perpendicular to the edge of the timber.

(*h*) *Diagonal Grain.*—(Including cross and spiral grain.) Diagonal grain is grain not parallel with all the edges of the piece.

(*i*) *Dense and Sound Douglas Fir.*—Under this heading two classes of timber are designated: (1) Dense Douglas fir and (2) sound Douglas fir. It is understood that these two terms are descriptive of the quality of the clear wood.

(*j*) *Dense Douglas Fir.*—Dense Douglas fir shall show on either one end or the other an average of at least six annual rings per inch or 18 rings in three inches and at least 33⅓ per cent. summer wood, as measured over the third, fourth and fifth inches on a radial line from the pith, for girders not exceeding 20 in. in height, and for columns 16 in. square or less. For larger timbers

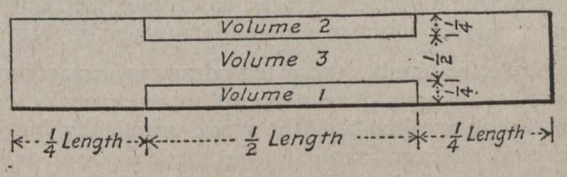


FIG. 1.

the inspection shall be made over the central three inches on the longest radial line from the pith to the corner of the piece. Wide-ring material excluded by the above will be accepted, provided the amount of summer wood as above measured shall be at least 50 per cent.

In cases where timbers do not contain the pith, and it is impossible to locate it with any degree of accuracy, the same inspection shall be made over three inches on an approximate radial line beginning at the edge nearest the pith.

The radial line chosen shall be representative. In case of disagreement between purchaser and seller as to what is a representative radial line, the average summer wood and number of rings shall be the average of the two radial lines chosen.

(*k*) *Sound Douglas Fir.*—Sound Douglas fir shall include pieces of Douglas fir without any ring or summer wood requirement.

II. **General Requirements.**—2. (*a*) The timber shall be only "Dense Douglas fir" as defined in section 1 (*j*).

(*b* The timber shall be well manufactured, square edge, and sawed standard size; solid and free from defects, such as ring shakes and injurious diagonal grain, loose or rotten knots, knots in groups, decay, pitch pockets over 6 in. long or ⅜ in. wide, or other defects that will materially impair its strength.

(*c*) Occasional variation in sawing, not to exceed ¼ in. scant at the time of manufacture, will be allowed.

(*d*) When timbers 4 by 4 in. and larger are ordered sized, they shall be ½ in. less than rough size, either S1S1E or S4S, unless otherwise specified.

III. **Stringers, Girders and Deep Joists.**—3. The timber shall show not less than 85 per cent. of heart on

(*Continued on page 60.*)

*Presented, by a committee, to the American Society for Testing Materials, Philadelphia, Pa., for discussion, amendment and possible adoption at next annual meeting.

STONE AS ROAD MATERIAL.

By James S. Wilson,
of The Sirdar Granite Co., Calgary, Alta.

THE construction of a system of highways, with connecting service roads, is a matter of the utmost importance to Canada. If she intends to avail herself of the opportunities presented in the commercial disorganization of Europe in consequence of the war, immediate steps must be taken to commence the task of creating the arterial system of roads that this vast Dominion requires.

Roads connecting the various provinces must be constructed, with the necessary service roads or feeders, allowing easier access from centre to centre and to railway points. This huge task of constructing an arterial system of roadways is one that requires to be handled boldly by men of wide experience, involving, as it does, enormous expense and engineering difficulties of no mean order.

Hitherto, the methods generally pursued in road construction have been of the most makeshift description, building more with the view temporarily to serve but a small area rather than on a permanent basis to a predetermined plan, which would form a standardized unit that would connect district to district, and ultimately become part of a great Dominion system of highways.

While, no doubt, these temporary roads act in some fashion as a means of transportation, their period of usefulness soon expires and the work practically has to be performed all over again. The grading and draining, of course, once done, is good for all time, so long as it has been executed to plan, but the system of gravelling is no doubt a poor outlay for the money expended and can only be considered as a temporary expedient.

Instead of undertaking the surfacing part, the laying of a road foundation should be the first consideration—a foundation that will be permanent and ever remain an asset, no matter what class of finishing will be required. In almost every part of the provinces stone in limestone, sandstone, schist, granite, boulders, etc., is available, and can generally be procured within reasonable distance of place where required. These stones, laid to a uniform level with proper contour and bound with material which generally can also be procured near the site of the work, would more serviceably perform the work of the temporary gravel roads and be a permanent part of a first-class highway, the surfacing of which would be executed at a later and more opportune time.

Of the above material, sandstone is the most suitable stone for bottoming. Experience has taught the European surveyor and road-maker that this stone has more give to it than the harder stone and does not require so much material to maintain the surface in good condition. In constructing first-class bottoming or foundation, after the grading and draining, which is necessary in any case, has been executed, care should be taken to see that the subgrade conforms to the required contour, due allowance being made for consolidation of rolling. Stakes should be driven in at sides, quarters and centre to the proposed finished level of road surface; lines should be carried from stake to stake at the height to which the bottoming is to be laid.

The stone for this foundation or bottoming should consist of pieces of any of the previous named material in sizes up to 15 in. in length and 9 to 10 in. deep by 10 to 12 in. broad, should be laid by hand, in courses having their longer axes at right angles to the side of the road, with their broadest side down, the irregular tops knapped off and the interstices filled in with broken material, the whole well knit, bound with ashes or some gritty material, and, where possible, rolled with a heavy roller.

The cost of this part of a first-class road would, of course, be in excess of the present type of road, the excess practically amounting to the cost of hauling and laying the bottoming, an inconsiderate amount in view of the permanence of the structure and its service qualities. To meet this extra cost a levy or overtax should be imposed upon the taxpayers of the district through which the proposed road is to pass—no great hardship when it is considered that the overtax levied will be distributed in their district, the hauling of material and cost of labor being executed locally, offsetting the extra imposition.

To keep these roads in condition a certain amount of maintenance would be necessary, but where this is done on a thoroughly organized basis the cost per mile is very small. The system adopted by the French and other governments, and the county councils of England, Scotland and Ireland, is to divide the roads into sections, each of which is in the care of a patrolman, who performs necessary repairs, material being deposited at convenient places alongside of the roadway for this purpose, so that he can even up any discrepancies of road surfaces. Over a certain number of patrolmen is a supervisor, who sees that the patrolmen are provided with material to fulfil any repairs required, etc.

In the case of the bottomed road, one patrolman would be able to attend to a large area, and, as the material for repairs does not cost much, the expense of this item would scarcely be felt. Roadways require continuous repair. Experience has shown that it is the holes that make the holes, and only by prompt attention to the minor inequalities can extensive repairs be avoided,

To effectively carry out this scheme of road construction it would be necessary to appoint a board of control, similar to that appointed by the British government some years ago. The functions of this Board are to receive applications from districts desirous of constructing roads, advising them as to the most suitable road to be adopted, and, where the district making the application is unable financially to undertake the work, make a grant to assist them in the carrying out of the most suitable and modern structure that can be procured. By this means a system of standardized roads would be built and the best value received. While Government aid is not likely to be afforded for some time here, there is no reason why this should be a barrier to the appointment of such a board in Canada, whose duties of determining the need for road construction in any given district and the standardizing of the work would greatly tend to lessen the cost of same and prevent an excessive taxation for this purpose.

A great deal of the stone used for road bottoming would be supplied by farmers, who, instead of picking them off their land and depositing in some corner, would haul to an arranged place by the site of the proposed work, receiving payment when the material was used.

In many cases this would be most helpful to the farmer breaking new land and act as an incentive to the better preparation of the soil; also promote interest in the question of good roads that would not otherwise be aroused.

Editorial

THE ECONOMIC PROBLEM OF NIAGARA.

During the last session of the Ontario provincial legislature, an act entitled "The Water Powers Regulation Act," was passed, giving the officials of the province wide powers in the matter of providing for the proper and efficient use of waters for power purposes.

The passage of this act is particularly timely as related to the conditions now existing at Niagara Falls, and the immediate enforcement of its provisions would go far toward relieving the critical situation caused by the operations of the power companies and the limitations imposed upon the use of Niagara waters for power purposes by the Boundary Waters Treaty.

Under the terms of the treaty the province is entitled to divert 36,000 cu. ft. per second of water from the Niagara River above the falls for power purposes. So long as this treaty continues in force, therefore, the power which can be produced by 36,000 sec. ft. of water is a measure of the benefit which Ontario, and Canada as a whole, can derive from the development of power at Niagara. Its value, from the standpoint of public use and industrial application, is almost beyond computation.

By virtue of certain agreements entered into with the province, the three large power companies at Niagara Falls have the right to generate an aggregate of 405,000 h.p., and for this purpose it is understood that they will require to divert about 29,500 cu. ft. of water from the Niagara River. This means that when these power companies have developed the 405,000 h.p. to which they are entitled, 80 per cent. of the treaty allotment of 36,000 cu. ft. will have been absorbed, and only the small residue of 6,500 cu. ft. will be available for the logical and inevitable expansion of the Hydro-Electric Power Commission.

As the matter now stands, therefore, the private power companies of Niagara Falls have a prior claim on 80 per cent. of Ontario's treaty allotment. A simple computation shows that these companies will produce only about 14 h.p. from every cubic foot of water used. Furthermore, each company is so deeply committed to its present scheme of development, that it would appear impossible, with any reasonable expenditure of capital, to make any material improvement in existing methods of use except, possibly, such as might be derived from the installation of the most modern types of hydraulic and electrical machinery.

The mean difference in level between Lake Erie and Lake Ontario is 327 ft., and the Hydro-Electric Power Commission reports that at least 300 ft. of this fall can be effectively used for the development of power through the agency of its projected Chippewa-Queenston scheme. This is more than double the general average of effective head now being used by the power companies at Niagara Falls. It means that with the unallotted surplus of treaty water, the Hydro Commission can develop nearly 200,000 h.p. at Queenston. It means that from one cubic foot of water the Commission can produce 30 h.p. as against 14 h.p. which the private companies at Niagara Falls can produce.

The private companies will require 29,500 cu. ft. of water to develop 405,000 h.p. According to the above figures, this same amount of water, if used by the Commission, would develop about 900,000 h.p. The significance of this fact is tremendous. It apparently means that as long as the existing private companies at Niagara Falls continue to operate, nearly half a million horse-power of Niagara's precious commodity will be lost to Canada and its citizens.

In view of the present demand for power, and the inevitable expansion of the market, it is sufficiently obvious that some means must be found to reclaim this half million horse-power of wasted capacity in the not distant future.

Pending the solution of this vital economic problem, public interest demands that the private power companies at Niagara Falls shall develop their respective quantities of power with the utmost degree of efficiency and economy in the matter of water consumption, and if the newly enacted Water Power Act can be used as a means to this end, its provisions should be enforced without delay.

Finally, assuming that the value of this wasted power is so immense that some means of reclaiming it must of necessity be found, it should be the hope of every citizen of Canada that, when preparing plans for the 200,000 h.p. development at Queenston, the engineers of the Hydro Commission will be able to design, and will design, with a view to the ultimate construction of a great central plant which will extract the last horse-power of energy from the available waters of Niagara.

MUCH RAILROAD WORK AHEAD.

One paragraph of the official summary of the Eastern freight rates decision will particularly interest the engineers who specialize on railroad work, and also those industrial plants which cater to the needs of the railroads. It was pointed out that economical financing of the Grand Trunk has been rendered extremely difficult and that appropriations of all kinds have been cut and repairs have been postponed. On December 31st, 1915, over 4,000 cars were held for repairs, notwithstanding the lighter traffic of the year.

In order to keep the equipment in proper shape it will be necessary to obtain 1,249 new freight cars at an expenditure of $2,238,000. Normal track renewals would require 431 miles; for the period of 1913 to 1915, inclusive, the track renewals were only 45 per cent. of this standard; and for the year 1915 the renewals fell to 67 miles. The renewal work on bridges and culverts during 1915 is $20,000 below the average yearly expenditure of the period of 1906 to 1915.

A similar position applies, to some extent, not only to the Grand Trunk but to the other railroads of the country and, as the railway board say in their finding, "The economies so made, cannot continue indefinitely without great loss and inconvenience to the public."

By the time the war ceases, a long period will have passed when practically no renewals will have been made and little new work undertaken by the railroads. They have continued destroying cars without replacement and have been doing as little as possible in the way of repairs, rebuilding of tracks and other works. With the coming of peace there will therefore be a substantial accommoda-

tion of railroad work. It will probably take a long time to overtake what has been postponed during the war and postponement cannot be continued indefinitely. This factor should have a fairly important bearing upon general industrial conditions at that time, and upon engineering employment conditions.

BUSINESS PROFITS TAX.

The new war tax on business profits is now in operation. It is a tax of 25 per cent. of all profits made since the war commenced in excess of 7 per cent. in the case of incorporated companies, and 10 per cent. in the case of firms, individuals and partnerships. Assessment will be made at Ottawa before September 1st and payment of the tax must be made before November 1st. Without doubt, every engineer, contractor and manufacturer will find it desirable to be well posted on all phases of this new tax, so as to avoid unnecessary friction, and also so as to avoid paying more than the Act is really intended to demand.

Clause 7 of the Act states: "In estimating the value of stock issued for any consideration other than cash, regard shall be had to the value of the assets, real and personal, movable and immovable and to the liabilities of the company at the date as of which such value is to be determined." A correspondent inquires if goodwill is an asset under this head and if so, whether there is any basis upon which its value can be estimated for the purpose of a tax.

Goodwill, as a general rule, will not likely be considered by the finance department as an asset under that head. Goodwill has always been a much-discussed item in the balance sheet. Some companies have included it in their financial statements as representing the value of $1. In other statements, it has been put at $1,000,000 and sometimes more. Each case will be given separate consideration.

Provision is being made for the valuation of new capital issues after February, 1916, but outside of that, "will the amount of capital employed in the business as on January 1st, 1915 (being the cash value of the capital stock plus reserve and rest at that date) remain unchanged throughout the three-year period of taxation as the basis for a 7 per cent. allowance?" The reply is that the amount of capital will remain unchanged throughout the three-year period of taxation.

A third question of interest is this: "Will the income tax charges for the first and second years be admitted as legitimate deduction from the profits of the second and third years respectively?" The answer is "No."

A charge for salaries reasonably representing the value of services rendered will be recognized by the commissioner of taxation as a legitimate expense. In some cases partnerships do not pay management salaries but instead, apportion profits at the end of the year. Some private corporations pay only nominal salaries. These practices tend to show larger profits than properly should be shown. Consequently business will be subjected to heavier taxes. Therefore, a reasonable charge for salaries will be admitted.

Unimpaired reserves or accumulated profits which have been put back into the business may, according to the act, be included in determining the amount of capital employed. Private corporations should take credit for everything for which they are entitled in the way of capital, as all such capital is entitled to earn 7 per cent. before the tax begins to operate.

Several firms are carrying business or partnership insurance; that is, insurance on the lives of their managers, directors and chief executive officials. They ask as to how the premiums paid on such insurance policies should be treated in making returns to the government under the Act. The premiums paid on such policies are regarded as an asset and, therefore, cannot be deducted as an expense from gross profits. At the commencement of the accounting period following the period in which the premium was paid, the amount can be treated as rest and added to capital for the purpose of the Act.

It is useless to submit hypothetical questions to the department of finance in regard to the operation of this act. They refuse to answer any excepting specific and definite inquiries. The act will be administered in a commonsense way and each knotty point will be considered separately and solely upon its merits.

The notices which have been mailed to companies in regard to the new taxation include a copy of the act. Copies may also be obtained at the head office of *The Canadian Engineer*, as a supply has been furnished to us for the benefit of our readers.

PROPOSED SPECIFICATIONS FOR DOUGLAS FIR BRIDGE AND TRESTLE TIMBERS.

(Continued from page 57.)

each of the four sides, measured across the sides anywhere in the length of the piece. It shall not have in volumes 1 and 2 (Fig. 1) knots greater in diameter than one-fourth the width of the face in which they occur with a maximum of 1½ in. in diameter. It shall not have in volume 3 (Fig. 1) knots larger than one-third the width of the face in which they occur, with a maximum of 3 in. in diameter. Knots within the centre half of the span shall not exceed in the aggregate the width of the face in which they occur. Diagonal grain in volumes 1 or 2 with a slope greater than 1 in 20 will not be permitted. When stringers are of two-span length they shall be considered as two separate pieces and the above restrictions applied to each half. The inspector shall place his stamp on the edge of the stringer to be placed "up" in service.

IV. **Caps and Sills.**—4. The timber shall show 85 per cent. of heart on each of the four sides, measured across the sides anywhere in the length of the piece, and shall be free from knots larger than one-fourth the width of the face in which they occur, with a maximum of 3 in. in diameter. Knots shall not be in groups.

V. **Posts.**—5. The timber shall show not less than 85 per cent. of heart on each of the four sides, measured across the face anywhere in the length of the piece, and shall be free from knots larger than one-fourth the width of the face in which they occur, with a maximum of 3 in. in diameter. Knots shall not be in groups.

VI. **Longitudinal Struts or Girts.**—6. The timber shall show all heart on one face; the other face and two sides shall show not less than 85 per cent. of heart, measured across the face or side anywhere in the length of the piece, and shall be free from knots over 2 in. in diameter.

VII. **Longitudinal X-Braces, Sash Braces and Sway Braces.**—7. The timber shall show not less than 85 per cent. of heart on two faces and shall be free from knots larger than one third the width of the face in which they occur, with a maximum of 2 in. in diameter.

VIII. **Branding.**—8. The inspector shall brand each timber which conforms to the above requirements "Selected Structural Douglas Fir."

PERSONAL.

Prof. G. A. GUESS, professor of Metallurgy at the University of Toronto, has been engaged to re-open the large smelter at South Stafford, Vt.

HENRY CLARK, Canadian representative of Head, Wrightson & Co., Limited, has returned to his Victoria, B.C., headquarters, after a trip to Japan.

T. C. DENIS, superintendent of mines for the province of Quebec, has been released from military service in France and has returned to his civil duties.

P. R. FARROW, superintendent of the Kaministiquia Power Co., Kakabeka Falls, Ont., has been elected a member of the American Electrochemical Society.

GEO. W. FULLER, M.Can.Soc.C.E., of New York City, has been appointed special lecturer on sewage disposal at the Sheffield Scientific School, Yale University.

W. M. BREWER, of Victoria, B.C., is making an investigation regarding metalliferous mining on Vancouver Island for report to the British Columbia Department of Mines.

FRED. A. ROBERTSON has resigned from the engineering sales staff of the Canada Cement Co. to accept a position with the Ontario Hydro-Electric Power Commission.

F. P. GUTELIUS, general manager of government railways, underwent an operation for appendicitis last week in the Western Hospital, Montreal. He is reported as progressing favorably.

M. M. INGLIS, public utilities manager in charge of telephones, light and street railway at Port Arthur, Ont., has resigned. W. P. COOKE, who has been joint manager, will be the manager pro tem.

Col. R. W. LEONARD, of St. Catharines, formerly chairman of the National Transcontinental Railway, has been appointed assistant adjutant general in connection with the Army Headquarters Staff at London, Ont.

HAROLD K. BEACH, until recently connected with the staff of Lockwood, Greene & Co., New York, has been appointed mechanical superintendent of Brown's Copper and Brass Rolling Mills, Limited, New Toronto, Ont.

WATSON GRIFFIN, formerly special Canadian commissioner in the British West Indies, has been appointed superintendent of the Commercial Intelligence Branch of the Department of Trade and Commerce Ottawa.

R. F. HAYWARD, general manager of the Western Canada Power Co., has been re-elected chairman, and H. N. KEIFER, sales engineer of the Northern Electric Co., has been re-elected secretary of the Vancouver section of the American Institution of Electrical Engineers.

Sir HENRY DRAYTON, chairman of the Board of Railway Commissioners of Canada; Sir GEO. PAISH, editor of the London "Statist," and ALFRED H. SMITH, president of the New York Central Railway, have been appointed by the Dominion Government as a commission to probe Canada's railway problems and to report upon the status of the three Canadian transcontinental railroads.

OBITUARY.

GEORGE J. CONWAY, of the firm of Archambault & Conway, contractors, Montreal, died on July 14th from injuries received while superintending some concrete work on the roof of a new munitions building at Lachine, Quebec. Mr. Conway was born in Portland, England, 41 years ago, but had been a resident of Montreal for many years.

CHAS. HODGSON OSLER, civil engineer of the Montreal Light, Heat & Power Co.'s staff, died suddenly last week. He was born in Sheffield, England, but came to Canada forty-four years ago. He commenced his career with the Kingston & Pembroke Railway, then went west as C.P.R. engineer in charge of locations. He joined the western staff of the Canadian Northern Railway, and finally went with the Montreal company. He joined the Canadian Society of Civil Engineers in 1887, the year in which the Society was established. Mr. Osler is survived by five sons.

NEW INCORPORATIONS.

Nelson, B.C.—Echo Silver Lead Mining Company, Limited, $50,000.

Calgary, Alta.—The Automatic Thresher and Machinery Company, Limited, $250,000.

Redcliff, Alta.—The Canadian Western Power and Fuel Company, Limited, $500,000.

Quebec, Que.—The United Contractors, Limited, $49,000. N. Trudel, D. Roy, J. B. Cloutier.

Three Rivers, Que.—Electric Products Company, Limited, $95,000. J. A. Oligny, G. D. Quillan, A. Boivin.

New Liskeard, Ont.—Elstone Dunkin Mines, Limited, $1,500,000. H. Williamson, W. P. Crow, F. H. Barlow.

Ottawa, Ont.—The Art Terra Cotta Company of Canada, Limited, $45,000. E. E. Prince, W. Bowie, H. MacCarthy.

Fort Erie, Ont.—Erie Beach Scenic Railway Company, Limited, $40,000. J. O. Buckley, D. McArthur, A. Fasken.

Montmagny, Que.—The Construction Company of Montmagny, $49,000. C. A. Paquet, A. N. Normand, M. Rousseau.

Winnipeg, Man.—Fegles-Bellows Engineering Company, Limited, $100,000. D. B. Fegles, W. S. Bellows, W. H. Carter.

London, Ont.—The W. A. Jenkins Manufacturing Company, Limited, $150,000. W. A. H. Jenkins, S. G. Lougheed, J. A. Lougheed.

Calgary, Alta.—The Canadian Western Steel Company, Limited, $750,000; Aiello Marconi Manufacturing Company, Limited, $10,000.

St. John, N.B.—St. John Dry Dock and Shipbuilding Company, Limited, $1,000,000. R. T. Heneker, H. E. Walker, H. N. Chauvin.

Dundas, Ont.—The Chapman Engine and Manufacturing Company, Limited, $250,000. S. H. Chapman, G. W. Williams, F. E. Lennard.

Vancouver, B.C.—Alaska Mining Company, Limited, $20,000; New Hazelton Gold Cobalt Mines, Limited, $500,000; Lee Mines, Limited, $500,000.

Toronto, Ont.—Murray-Kay Building Co., Limited, $2,000,000. G. Grant, D. I. Grant, G. W. Adams; Hollinger Consolidated Gold Mines, Limited, $25,000,000. N. A. Timmins, L. H. Timmins, J. McMartin.

Fort William, Ont.—Standard Terminal Company, Limited, $250,000. W. F. Langworthy, A. J. McComber, G. A. McTeigue; the Fort William Terminal Development Company, Limited, $250,000. A. J. McComber, G. A. McTeigue, Etta E. Allen.

Toronto, Ont.—Kamiskotia Mining Company, Limited, $2,000,000. H. H. Shaver, J. C. Thomson, J. Parker; the Contractors' Equipment Company, Limited, $40,000. R. E. Fennell, J. S. McLaughlin, F. E. Earl; Otis-Fensom Elevator Company, Limited, $3,500,000.

Montreal, Que.—The Canada Stove and Foundry Company, Limited, $1,500,000. E. R. Parkins, R. E. Allan, W. Taylor; Barnes Construction Company, Limited, $5,000. F. G. Bush, F. B. Common, H. W. Jackson; the Canadian Construction Company, Limited, $90,000. J. E. Valin, J. A. Beaudry, E. T. Shavers; Maisonneuve Quarry Company, Limited, $45,000. J. Rheaume, A. Gilbert, J. A. Boutet.