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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

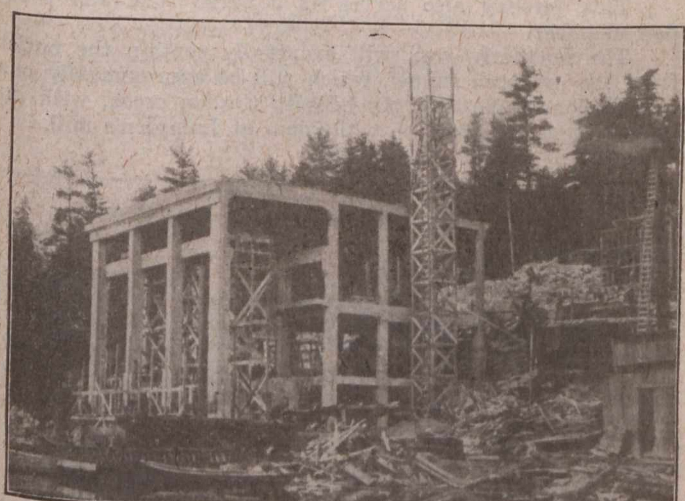
Kipawa Co.'s Pulp Mill and Power Development

First Unit of Bleached Sulphite Pulp Mill Nearing Completion — Ultimate Capacity, 30,000 Tons of Pulp Per Annum — Development of Gordon Creek Utilizes Approximately 200 Ft. Net Head — Wood Stave Power Pipe Line 8 Ft. in Diameter

WITHIN a couple of months the Kipawa Company, Ltd., will have completed the first portion of their construction program in connection with the new pulp mill and townsite at Timiskaming, P.Q.

Situated on the Ottawa river, at the outlet of Gordon creek and adjacent to the Dominion government dams forming the toe of Lake Timiskaming, the site of this new pulp mill is ideal. Pulpwood may be obtained from any or all of four distinct sources of supply: (1) From the northern end of Lake Timiskaming by towing; (2) from the Kipawa Lake district through Kipawa river and chutes to Lake Timiskaming, and thence to plant by towing; (3) from the Kipawa Lake district through Gordon creek, which is an improved creek for lumber interests; and (4) from the south by rail over the Mattawa-Timiskaming branch of the Canadian Pacific Railway.

Upon completion of the full program of construction at Timiskaming, the Riordon Pulp & Paper Co., Ltd., which controls the Kipawa Company, Ltd., will have three large plants supplying material for the pulp and paper industry,



POWER-HOUSE ON LAKE TIMISKAMING

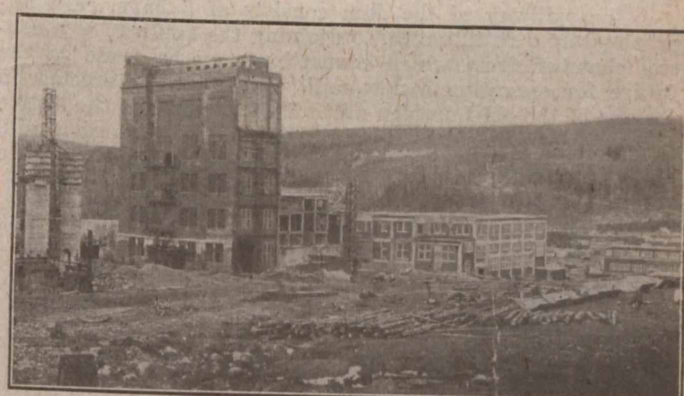
the existing plants being at Merritton, Ont., and Hawkesbury, Ont.

The new plant is being developed under a charter obtained from the province of Quebec, which has leased from the federal government all water rights in connection with the Kipawa lakes for power development or logging on either the Kipawa river or Gordon creek.

The interests of John Lumsden, owner of Lumsden's mill, and of other property owners were purchased, and a compact area of about eleven square miles was brought under control. (See *The Canadian Engineer*, issue of February 27th, 1919, page 260).

Ewing, Lovelace & Tremblay, consulting engineers, Montreal, were instructed to prepare topographical surveys, and Thomas Adams, town planning adviser to the Commission of Conservation, prepared preliminary plans for the model townsite. Upon this plan were located sites for approximately 280 buildings, including churches, hospital, convent, club, hotel, school and institute.

The first portion of the construction program includes the gate house and dam on Gordon creek at Lumsden's mill; a continuous, wood-stave pipe line of 8 ft. diameter; reinforced concrete forebay; riveted steel penstock; power house; combined railway and highway steel girder bridge; barking house; spur lines from the Canadian Pacific Railway; sidings in piling ground; wood room; digestor house; acid



SOME OF THE MILL BUILDINGS—FROM LEFT TO RIGHT, ACID TOWERS, DIGESTORS, SCREEN ROOM, MACHINE SHOP AND SHIPPING ROOM

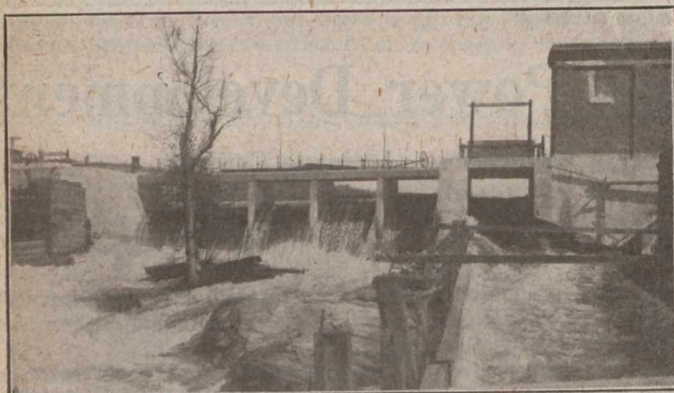
towers; storage tanks; screen room; bleachery; press room; machine shop; transformer sub-station; boiler house; chimney; shipping room; elevators; office building; dwellings; roads; culverts under the Canadian Pacific Railway line to Kipawa; a continuous, wood-stave pipe line of 4 ft. diameter for supply of water to the mill; revolving screen house on mill supply line; sewers; water mains; pressure filter unit and pumping station.

Construction of the above-mentioned works is expected to be complete by the end of November, and the first unit of the mill will likely be in operation early in December. The first unit represents about 30% of the ultimate planned mill construction, but the work now being done on the townsite is only about 10% of that planned by Mr. Adams and the consulting engineers.

Future construction will include a second 8-ft. continuous wood-stave pipe line to the forebay, or else a tunnel through the hill from the dam at Lumsden's mills to the forebay, or possibly both tunnel and pipe line; four more steel penstocks; additions to power house and its equipment; sewage disposal works or sewage-chlorinating plant; street lighting system; filtered water mains crossing Gordon creek to mill; domestic water storage reservoir; hospital; school; churches and hotel.

To control the waters of Gordon creek at the site of the old Lumsden mill, the Kipawa Company have constructed a reinforced concrete dam with wing walls and foundations anchored to solid rock. The crest of the spillway, elevation

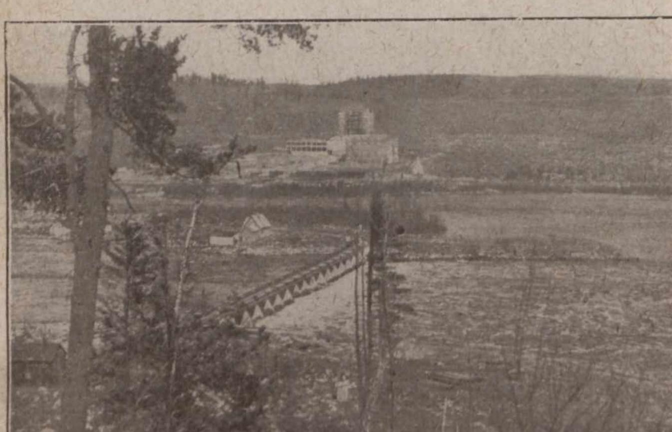
801.12 ft. above mean sea level, raises the level of the impounded water 10 ft. On the south side of the dam is constructed a brick gate house over a 48-in. cast iron gate, which will control the domestic supply through the 4 ft. continuous wood-stave pipe line to the mill. A Bristol recording thermometer has been installed in this building. Adjoining is the log chute opening required by the government



DAM AT LUMSDEN'S MILL

for use of the combined lumber interests along the Kipawa lakes. This opening is controlled by a wooden gate, hand operated.

The spillway of the dam consists of 5 bays, each approximately 6 ft. in width. Adjoining the spillway is a control chamber from which connection may be made in the future for operating a new mill, which may be erected on the site of the old Lumsden mill. This chamber is the source of supply for the old hydraulic turbine in the Lumsden mill, which drives the generator that supplies power for the



VIEW OF KIPAWA MILL FROM ONTARIO SHORE OF OTTAWA RIVER, LOOKING ACROSS ONTARIO DAM

electric lighting system now being used in the town and on the construction work.

Adjoining this chamber, and at the northerly end of the dam, is the inlet chamber which supplies water for the 8-ft. wood-stave power pipe line. This water is also controlled by a wooden gate, hand operated. The usual trash racks are fitted into both chambers.

Power Pipe Line

The 8 ft. power pipe line, which is completed, is of British Columbia fir, with continuous staves, bound by circular bands and supported on 10 by 10 in. wooden sills and blocks, with wedges in rock cuts and bents for fills.

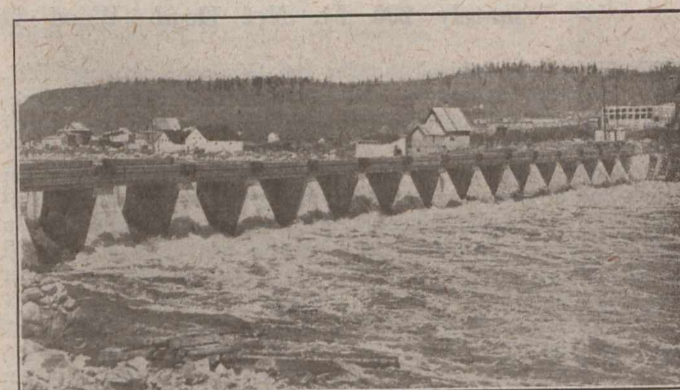
For the greater part of the length, the trench floor was lined to a depth of approximately 12 ins. with one-man-stone and fillers.

From inlet to forebay, the drop in elevation of the pipe line is approximately 20 ft. Along the line has been located 4-in. cast-iron, screw-flange connections, fitted with 4-in. screwed valves, to provide for emergencies such as fire. It was found advisable to clear the ground for 50 ft. on each side of the pipe line to reduce danger from forest fires, one fire which scorched the pipe for a short distance, having threatened the entire line with destruction.

A connection with the pipe line will be constructed to supply the proposed filtration and pumping station with water for domestic use throughout the town, and eventually for domestic use in the mill. The 4-ft. pipe line will continue to supply the mill with water for manufacturing purposes.

Forebay

The forebay is located on side hill. The foundations for the walls and the approaches to the penstock entrances, were drilled out of solid rock. The walls and superstructure are constructed of plain and reinforced concrete, being 36 ins. in

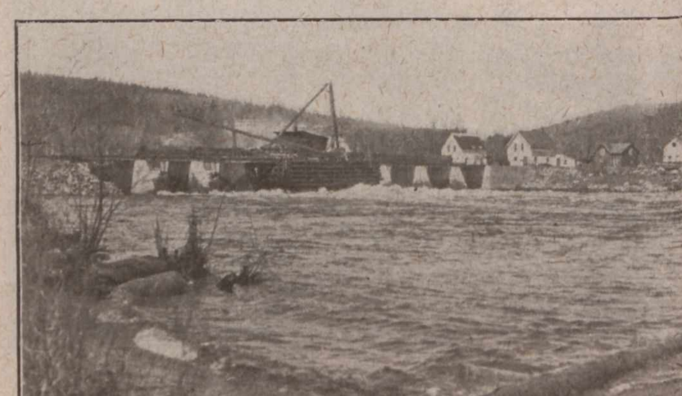


ANOTHER VIEW OF THE ONTARIO DAM

width at the top and about 20 ft. in width at the base. In plan, the forebay is approximately square, with an area of about 10,000 sq. ft. and a depth of about 25 ft. from crest of spillway, which is 3 ft. below the top of the wall.

This forebay also serves as a surge tank and overflow chamber.

The northerly wall will eventually contain the outlet from the proposed tunnel, which will be approximately one mile in length through the hills to Gordon creek, with intake a short distance above the dam at Lumsden's mill.



QUEBEC DAM, OTTAWA RIVER

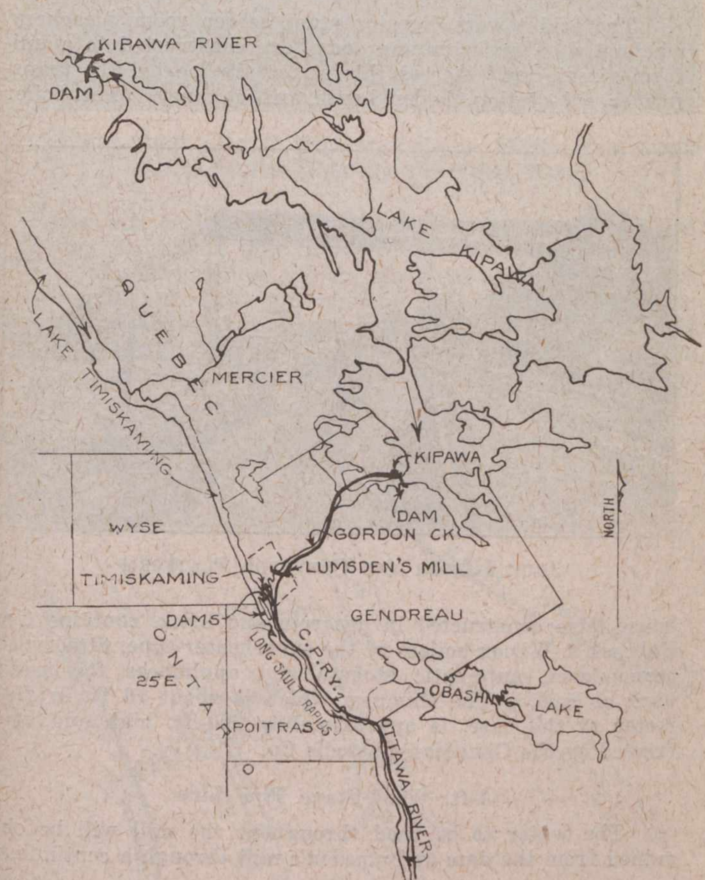
A channel has been drilled and lined with concrete in the rock within the forebay, from the proposed point of entry of the tunnel to the centre line, whence the excavation was carried to full depth and for the entire width. The rock forming that portion of the floor area that was not drilled and blasted, was capped with mass concrete.

The easterly wall contains two hexagonal openings providing for entrance of the present 8-ft. pipe line and for future duplication. The westerly wall contains spillway to Lake Timiskaming; one 36-in. dirty-water drainage-tile pipe; and three vertical rectangular gates, about 36 ins. in width, one of which is a high level, and the other two low level, overflows, hand operated.

The south wall contains the orifices leading through massed concrete to the penstocks, and controlled by hand-operated double gates. It is expected that these gates will later be fitted with electrical controls for rapid closing in emergencies.

Penstocks

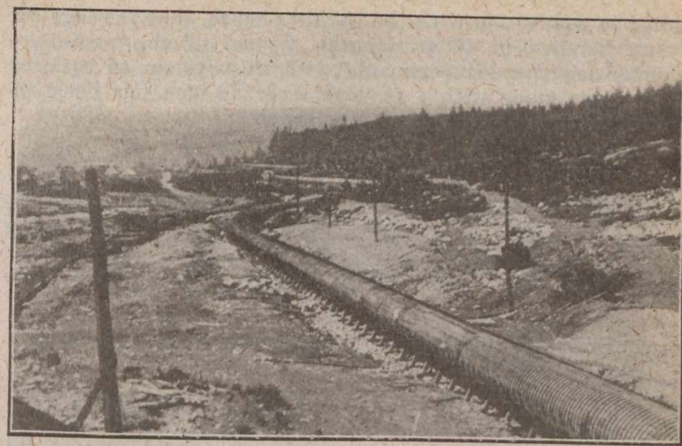
At present, only one penstock has been constructed. It is an 8 ft. steel pipe, field riveted, with double-riveted lap joints. This penstock was constructed in a channel about 16 ft. in width by 10 ft. in depth, which was blasted from solid rock, and leads from the northerly orifice of the fore-bay to the power house, a drop in elevation of approximately 190 ft. Massed concrete anchor piers, four in number, are located between the two structures, and together with the penstock, will eventually be backfilled, thus reducing to a minimum the leakage in joints due to expansion and contraction. Within the power house, the flow from the penstock is divided by installation of a wye-branch, controlled by hydraulically-operated butterfly valves. The branches are designed to feed the present hydraulic turbine, No. 1, and a future turbine, No. 2.



Map of the Kipawa Lake District, Showing Kipawa Co.'s Townsite at Timiskaming

Power House

The power house is located on the shore of Lake Timiskaming, about one-quarter mile north of the Canadian Pacific Railway station, and was constructed partially in cofferdam which extended into the lake in water of a depth of 35 to 40 ft. The building is massively constructed in steel and reinforced concrete, with curtain walls of pressed brick, and is plentifully supplied with windows fitted with interlocked double sash. It is divided into two main parts, separated on all floors by fire-resisting doors. The southern, or main, part of the building houses the turbines, generators, switchboards, pumps, governors, excitor and crane, while the remainder houses the transformers, storage room, oil storage, lightning arrestors and disconnecting switches (each of which is housed in a separate concrete box).



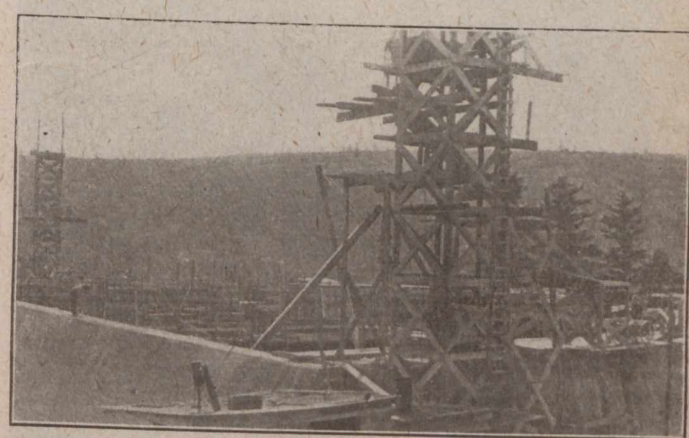
Wood-Stave Pipe Line, 8 Ft. Diameter

The turbine is of standard vertical type, 1,800 h.p. capacity, equipped with Lombard governor.

The capacity of power house will eventually be increased to 18,000 h.p. The southern wall is a wood curtain to permit extension.

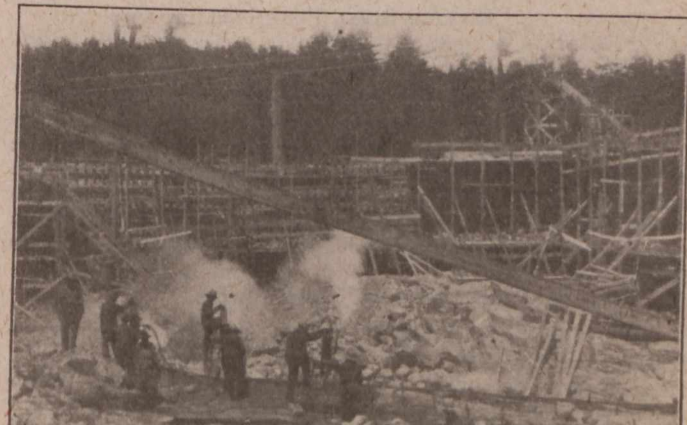
Barking House

A short distance above the Dominion government's Quebec dam, and behind the Canadian Pacific Railway's main



Pouring Walls of Concrete Forebay

track from Timiskaming to Mattawa, is located the barking plant. The logs are lifted from the lake by endless conveyors, forming a jack ladder to an overhead conveyor platform crossing the railway. The logs are dumped into U-shaped troughs and are continually sprayed with water. In these troughs are revolving discs which rip the bark and pass the log from trough to trough to a loading platform on the spur line and thence to the piling ground. It is to be

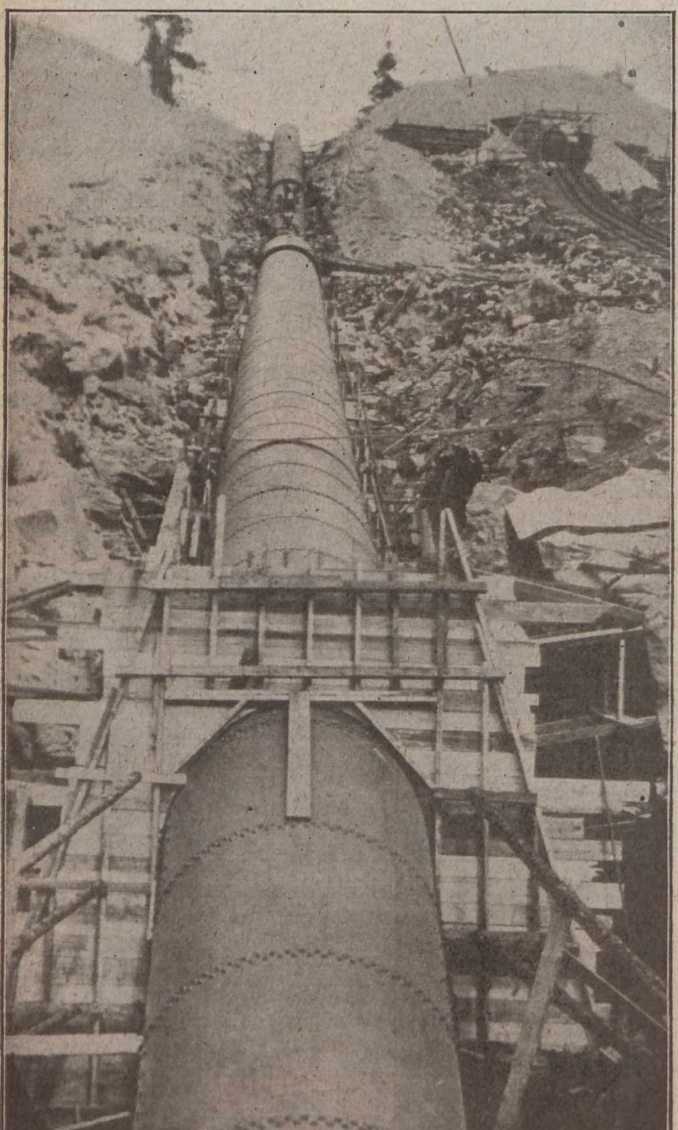


Drilling Channel in Forebay Floor

noted in connection with the barking house, that the logs are being handled in 16 ft. lengths instead of the customary shorter lengths. Experiments with this system of rotating discs were made with 4 ft. logs, and the idea has been enlarged to include logs 16 ft. in length.

Piling Ground

After passing through the barking house, the logs are conveyed over the Kipawa Co.'s sidings to the piling ground, in which are constructed five standard gauge tracks with 72-lb. rail. Straddling each track is a wide-gauge



RIVETED STEEL PENSTOCK

track for an overhead traveller. The centre lines of the five standard gauge tracks have been located about 60 ft. apart to enable the overhead cranes to pile three rows of logs between the tracks and a fourth row on the track as the cars pull out. From the piling ground, the logs are reloaded and conveyed to the wood room, where they are chipped into pieces about ¼ in. by 1½ ins. in size. These chips are carried by an outside, closed conveyor, to the top of the digestors.

Digestors and Acid Towers

The digestors, three in number, are housed in a reinforced concrete and brick building, six stories in height. Each digestor is constructed of steel plate, is 17 ft. in diameter and 56 ft. high, and is brick-lined for protection against acid corrosion. The capacity of each digestor per run is approximately 20 tons, and the ultimate capacity of the battery will be about 100 tons a day.

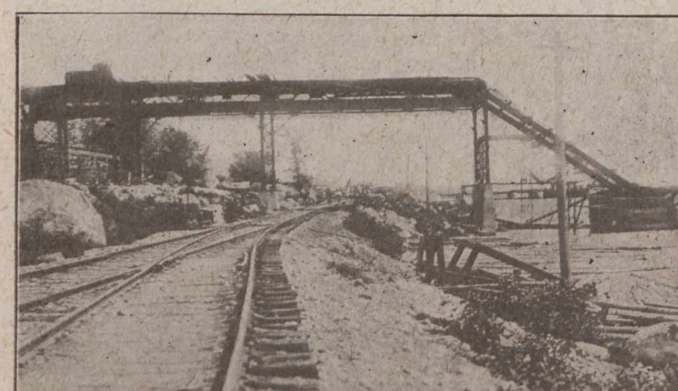
The acid towers are of reinforced concrete, circular, 9 ft. in diameter and 80 ft. high, and at present two in number. They, also, are lined with brick and are insulated by sheet lead. The limestone is loaded into these towers by an elevator located in adjoining rectangular structure. The acid, diluted, is stored in separate tanks which are located near the digestor building.

Screen Room, Bleachery and Press Room

The chips, after passing through the digestor, continue in pulp form through the screen room, where the pulp is thoroughly washed and screened. From the screen room, the pulp goes to the bleachery, and then to the machine shop, where it is rolled into sheets of convenient sizes and pressed into blocks ready for shipment to the paper mills, the hydraulic presses removing nearly all of the moisture.

Boiler House

The acid towers digestor room, screen room, bleachery, machine shop and shipping room, are constructed to a uniform street line. Across this street are located the transformer sub-station, boiler house and chimney. The boiler

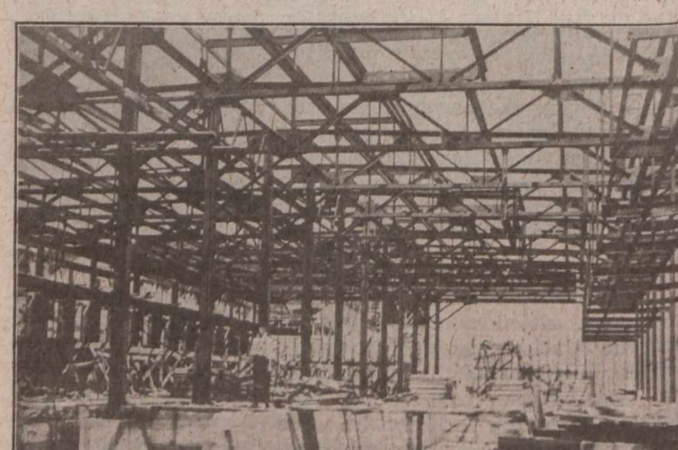


JACK LADDER AND CONVEYOR PLATFORM

house, also constructed in concrete and brick, contains five Babcock & Wilcox boilers of the superheater type, fitted with economizers, automatic stokers and appliances for using bark as fuel. The chimney, which is about 16 ft. in diameter at the base, is approximately 200 ft. high and was erected by the Canadian Custodis Co.

4-ft. Wood-Stave Pipe Line

The water to be used throughout the mill will be obtained from the dam at Lumsden's mill through a continuous



MACHINE ROOM DURING CONSTRUCTION

wood-stave pipe line 4 ft. in diameter, constructed on bents and sills, supported by a 12-in. floor of boulders and stone, and situated on the southerly side of Gordon creek. The water, controlled by a cast-iron valve in the gate house at the dam, passes through revolving screens in a building at present under construction immediately adjacent to the gate house. These screens are horizontal, 5.5 ft. in diameter, and 11 ft. long, revolving at 5 r.p.m., and are electrically controlled.

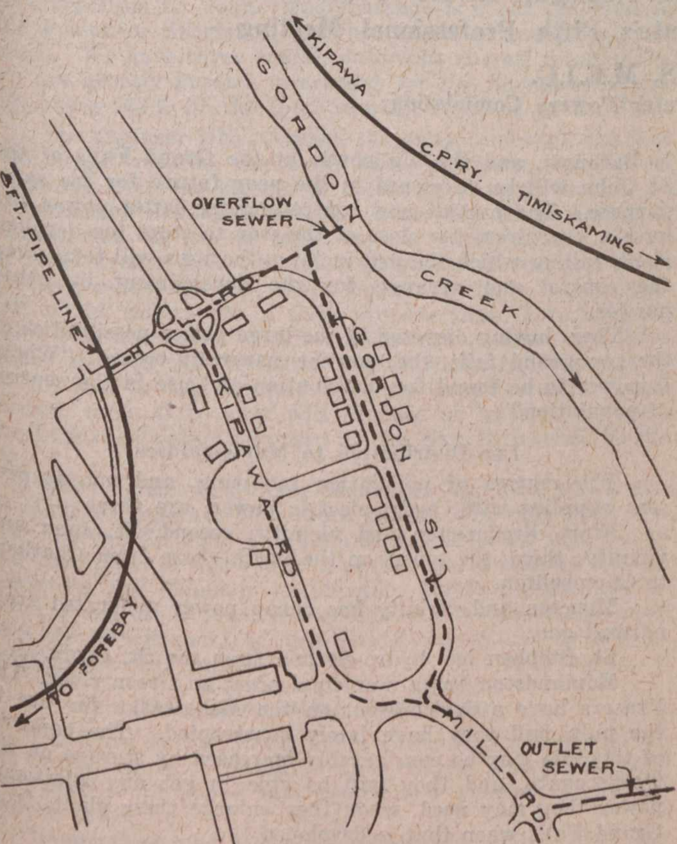
Sewer and Water Mains

Following the recommendations of R. S. & W. S. Lea, consulting engineers, Montreal, it was decided to construct

Another View of the Mill Buildings—When Completed the Capacity Will Be 100 Tons Daily

sewers and water mains along Hill Road, Kipawa Road, Gordon Street and Mill Road.

Mains along these streets serve the section upon which are being erected the 36 semi-detached brick houses comprising the first unit of the housing program. Water is obtained by tapping the 8-ft. power pipe line, whence it flows through cast-iron piping into the suction well at the pumping station.



Plan of That Portion of the Town That is Now Under Construction, Showing Sewers

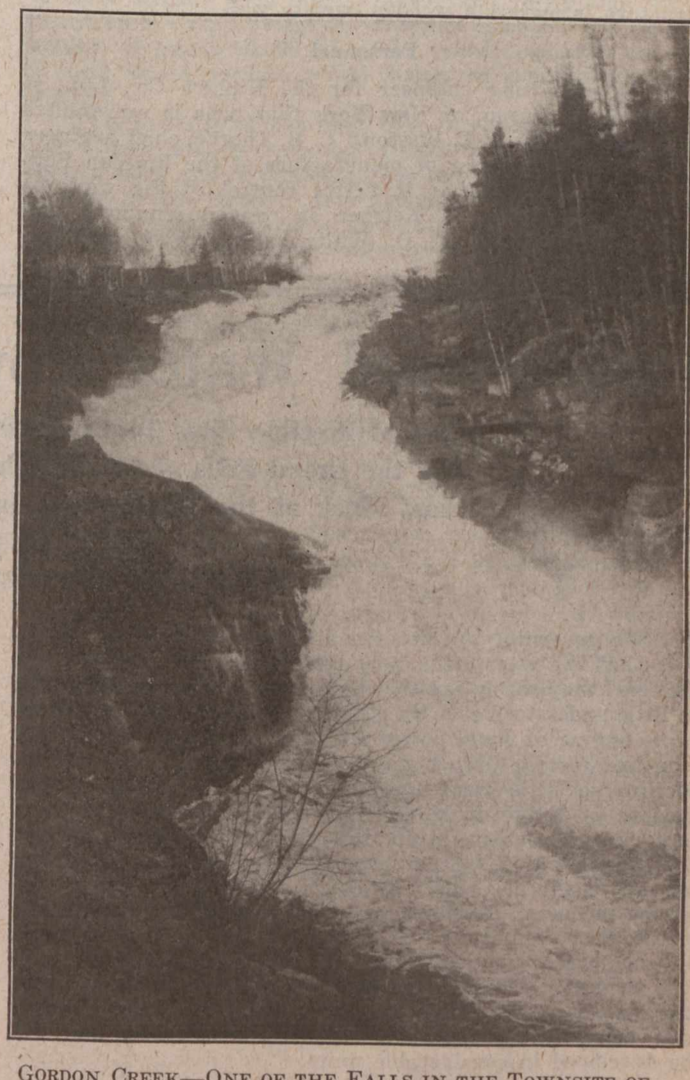
An electrically-driven pump (with a gasoline-engine-driven pump as a standby) will supply the required pressure. Eight-inch and six-inch cast-iron pipe are being laid on these streets, together with necessary hydrants, valves, tees, bends, etc.

Provision has been made for future extensions in any direction required by growth of the population.

Excavation for water and sewer pipe, which are being laid in the same trench, was through a heavy boulder soil, and in many cases solid rock was encountered, necessitating almost constant use of explosives.

The overall difference in elevation between the pumping station and the end of the first section, a distance of about 1,200 ft., is 50 ft. which gives an average grade of 4.2%. Future extensions will cover, possibly, the remaining sections of bench land leading toward the power dam at Lumsden's mill. The pumping station, when completed, will house a small, modern fire station, a filtration unit, suction well and water works equipment.

The sewer pipe commences at the pumping station (the highest point on the system at present), where a 10-in. tile



Gordon Creek—One of the Falls in the Townsite of Timiskaming

pipe has been laid. At the intersection of Hill and Kipawa roads, the diameter is increased to 24 ins. and the pipe continues along Hill Rd. to the centre line intersection with Gordon St., at which point an overflow chamber and manhole has been constructed. The overflow will empty over the nearby high bank into Gordon creek. The normal flow will continue down Gordon St. and at Mill Rd. will intersect the main line along Kipawa Rd. From the intersection, the sewer continues about 1,530 ft., ranging from 8 ins. to 24 ins. in diameter, all constructed in vitrified tile. The remaining 309 ft. to Gordon creek is a 24-in. creosoted continuous wood-stave pipe, with outfall at Gordon creek. Suitable concrete manholes, catch basins and stubs for future extensions have been liberally provided.

Turbine Runner Develops Crack

Water was turned into the 8-ft. power pipe, forebay and penstock August 30th, 1919. The installation tested perfectly with the exception of the runner of the hydraulic turbine. It is said that the runner functioned for only a very short time, when it jammed at full gate opening. Upon examination it was found that the runner had developed a crack from the shaft both ways to the vanes. Fortunately a spare runner had arrived the same day and is now being installed, so it is expected that power will soon be available.

By the end of this month the barking house will be able to handle logs and to prepare a stock for storage at the piling ground. Work is being carried on day and night on some portions of the undertaking, in an effort to produce pulp before December 1st, 1919.

Future extensions to the main mill buildings will be facilitated by the fact that the wall at one end of each structure is merely a wooden curtain wall.

Personnel

The consulting engineer for the Kipawa Co., Ltd., is Hardy S. Ferguson, of New York City, who is represented on the ground by B. T. Weston. C. B. Thorne, chief engineer and technical manager of manufacture of the Riordan Pulp and Paper Co., Ltd., is in active control of the work at Timiskaming. W. L. Ketchen is resident engineer and local manager, with F. O. White as his chief assistant. Allan K. Grimmer is town engineer. The G. A. Fuller Co., of Montreal, are the chief contractors, constructing the mill, with the exception of the acid towers and acid tanks, power house and dam. The Dickie Construction Co., of Toronto, are erecting the houses. McAuslan & Anderson, of North Bay, Ont., are contractors for the sewers and water mains, tracks in the piling ground, outside piping in mill yard, superstructure of bridge crossing Gordon creek, and screen house on 4-ft. pipe line. The Sherwood Construction Co., of Toronto, are constructing the tracks leading to the coal and sulphur storage, which involves considerable rock cut and fill, and also installing the fire protection in the piling ground. Among the other contractors are the Stebbins Engineering Co., Philadelphia, acid towers; Danforth Co., Buffalo, inside piping; Dominion Bridge Co., Montreal, combined railway and highway bridge crossing Gordon creek, and the coal and the chip conveyors; Pacific Coast Pipe Co., Vancouver, both of the wood-stave pipe lines; Rensselaer Valve Co., Troy, N.Y., and Chapman Valve Mfg. Co., Indian Orchard, Mass., gate valves and sluice gates; I. P. Morris Co., Philadelphia, hydraulic turbine; Canadian General Electric Co., Toronto, and Canadian Westinghouse Co., Hamilton, electrical equipment; Herbert Morris Crane & Hoist Co., Niagara Falls, Ont., crane for power house and chain hoists.

Undeveloped Water Powers of New Brunswick

List of Possible Sites Totals 23,000 H.P. (24-Hour Power), Not Including the Grand Falls of the St. John and Nepisguit Rivers—Paper Read Last Week at the Engineering Institute's Fifth Professional Meeting

By C. O. FOSS, M.E.I.C.
Chairman, New Brunswick Water Powers Commission

LAWS governing hydrostatics and hydraulics are so simple that the way-faring may readily understand them, yet I think I may safely say that there are no other natural laws so little understood even by people of high intelligence. There is no engine of equal power which is so simple of construction and installation, so uniformly sure in action, and subject to so little wear and tear and depreciation, as the modern up-to-date hydro-turbine. I need not say that there is nothing miraculous about water power; and that in a comparison of water with other methods of power generation, we may easily make the mistake of spending so much money in the purchase, development and transmission of hydraulic power that the output may cost more than power generated in some other way, especially when the consumption is small and limited. However, these exceptions only serve to prove the very general rule that hydro power is cheaper, surer and more flexible than any other form of power that can be developed in considerable units.

As regards water power possibilities in New Brunswick, it has been considered by the people generally that there are no power possibilities of any value outside of the Grand Falls of the St. John, and a very moderate possibility at the Grand Falls of the Nepisguit, and this opinion has been strengthened by statements to that effect by parties who are supposed to be authorities upon the subject.

Grand Falls Too Remote

If this were true, the distribution of hydro-electric power in centres of population would be well nigh hopeless, for the cost of developing the Grand Falls of the St. John would be so great, and its location is so remote from the centres of population, with the market at present in sight so limited, that the interest and overhead would make the cost greater than power generated by other methods.

To make these powers commercially possible of development and use, the output must be used at or near the site in the manufacture of pulp and paper, the logical large industry for this province. In the case of the Nepisguit power the Bathurst Lumber Co. are having plans prepared for the development and transmission to their pulp and saw mills in Bathurst, and the big power at the Grand Falls of the St. John will be developed in the near future for the same purpose. The parties now controlling the latter power site have a year from the close of the war to start the development, failing which the provincial authorities will take away the control and arrange for the development by other parties.

Then, having disposed of the large power possibilities at the two grand falls, the question naturally occurs: "Where is power to be found for distribution and use in the centres of population?"

For Distribution to Municipalities

The centres of population requiring, and not at present supplied with, hydro-electric power, are three:—

First, Fredericton and vicinity; second, St. John and vicinity; third, the towns on the north shore from Chatham to Campbellton.

Moncton and vicinity has cheap power generated from natural gas.

St. Stephen has hydro-electric from the St. Croix.

Edmundston has a municipal plant on Green river. The Frasers have a development on the Madawaska for use in the pulp mill they have lately constructed. The capacity of this site may be considerably increased by storage on the Temiscouata, and they will be able to get any additional power they may need, when they enlarge their plant, from Grand Falls when that is developed.

Woodstock also has a good hydro plant.

Taking the requirement of Fredericton:—

There are two streams falling into the St. John north of Fredericton, the Pokiok and Shogomoc, 37 and 40 miles, respectively, following the highway which parallels the river, and 30 and 33 miles in an air line.

These streams each drain about 50,000 acres. The Shogomoc falls 300 ft. in the last two miles, and the Pokiok falls 200 ft. in 1½ miles and 100 ft. more in about 500 ft.

Both these streams have excellent opportunities for storage, as they drain a country which is comparatively flat to a point about 2 miles from the St. John river. In other words, the St. John has eroded a valley 300 to 350 ft. deep, and on this flat country there is opportunity for storing large quantities of water by the building of comparatively inexpensive dams.

These two streams, if fully developed, with all possible storage provided, will yield at least 7,000 h.p. (24-hr. power), or 14,000 h.p. (12-hr. power); or assuming that the working day of the future will be 8 hours, then 20,000 h.p. if the pondage at the different plants be sufficient to take care of the fluctuations.

The plan is to develop a small unit on the lower 100-ft. drop of the Pokiok, protected by the storage which is already provided by the existing dam at the outlet of Lake George. This will give power enough to cover the present requirements of Fredericton, with quite a margin for increase of requirement. When more power is demanded, the first unit can be more than doubled by building a new storage dam about 4½ miles from the St. John. When this is outgrown, the 200-ft. fall can be developed; and when that has been absorbed, the Shogomoc can be developed. This should put Fredericton on the map as a manufacturing centre just as it already is a railway centre.

St. John's Hydro-Electric Possibilities

The second and largest centre of population requiring hydro power is St. John. All the power generated in St. John is by coal, and the New Brunswick Power Co. had to be given a very substantial increase in its rates to meet the greatly increased cost of coal and labor. They have been investigating possible water power for some time and now that the war is over they will have to go ahead with the development very soon.

The Lepreaux river empties into the Bay of Fundy about 20 miles from St. John. The drainage is about the same as the Pokiok or Shogomoc, but the run-off is nearly twice as much. We have three years' continuous run-off records, and we are greatly puzzled to account for the phenomenal run-off, being 133% of the total rainfall recorded in St. John.

The engineer who installed the gauge and took the first two years' records, explained the phenomenal run-off by assuming that the stream is receiving a large amount of subterranean drainage from the watershed of an adjoining stream, but we, having taken several checks of the run-off of this stream find the same phenomenal run-off, which proves conclusively that there must be a much larger rainfall on the watersheds of these streams than there is in St. John, only a distance of a few miles away. There are three power sites on the Lepreaux, two of 90 ft. fall and one of 64 ft., and having in mind the very great run-off of this stream, these three sites will produce at least three times the amount of power now used by the New Brunswick Power Co.

There is one power site known as big falls which can be made to generate 40% more power than they used last year. When St. John and vicinity has absorbed and put to use the 5,000 to 6,000 h.p. that can be developed on the Lepreaux, the Maguadavic, 20 miles further away, can be made to produce as much more. There is no reason apparent why the development of this power should not be put in hand in the near future.

Conditions Along North Shore

The third district where hydro power is required is along the North Shore. Bathurst alone has a small and very indifferently developed and distributed system of hydro-electric power.

Campbellton and Dalhousie drive their plants with gas engines, using gas produced from anthracite coal, and the cost of that makes their power very expensive.

Newcastle uses steam at big expense, and Chatham uses oil engines.

In addition to the requirements of these several towns, the Dominion pulp mill at Chatham requires some 400 or 500 h.p.

The Tete-a-gouche river, which enters Bathurst harbor a little north of the town, drains about 100,000 acres and has an ideal opportunity for very large storage. About 8 miles above its mouth, it enters a deep and narrow gorge of nearly perpendicular rock walls; the fall through this gorge admits of four power sites, each created by a dam built to the top of the walls and flowing the water back to the next dam up the stream. At the first or upper site, a dam 70 ft. high will give a head of 105 ft., there being a sheer fall of 35 ft. in the flow of the gorge. It will flow the water back for about 4½ miles. At the second site a dam can be built to a height of 130 ft.; the third, 65 ft.; and the fourth 35 ft.; or a total of 335 ft. These four sites will put out 6,000 h.p. (24-hr. power), or 18,000 h.p. (8-hr. power).

So it will be noted that while it was represented to the provincial authorities only a few years ago that there is no water power in New Brunswick aside from Grand Falls, we have already been able to locate and fairly well prove (apart from Grand Falls) the existence of 23,000 h.p. (24-hr. power), or nearly 70,000 h.p. (8-hr. power), which if all put to work would produce a big change of conditions in this province.

This commission has only been in existence for a little over a year, and is composed of three men busy with their regular work and so unable to give any considerable amount of time to the matter. Our people in the Maritime Provinces are surely if slowly awakening to the fact that we may overcome to a considerable extent the handicap which the upper provinces hold over us in manufacturing, due to their enormous water powers, by developing what we have discovered and looking for more.

THE BEAR RIVER BRIDGE*

By A. T. Macdonald, A.M.E.I.C.

PRIOR to 1912, the Bear river was crossed by the Dominion Atlantic Railway by a bridge consisting of about 750 ft. of wooden trestle on pile bents and five-Howe truss spans, 150 ft. long, on concrete piers with pile foundation, the piles being cut off about 2 ft. above the original bed of the river. This bridge was used for upwards of 25 years, but the piers were disintegrating rapidly between low and high water marks from the action of the river ice, and were also gradually moving downstream.

This bridge was what one might call "ripe," and certain tired souls had been known to leave the train at Deep Brook and drive by road to Bear river station, or Digby, continuing their journey the next day, in order to avoid crossing the bridge. These people, no doubt, exaggerated the state of affairs, but their nerves were not equal to the strain of travelling over 1,600 ft. of bridge at the rate of two miles an hour.

Our first work there was to make the old bridge safe for traffic until it could be replaced by the new one. This in itself was a very costly proceeding. A double row of piles were driven first, clear of the footings of each pier, and framed bents of 12 by 12-in. spruce erected on these and braced to form a tower. The bottom chord of the truss was given a bearing on this tower about 10 ft. away from the end of the truss, which was reinforced to suit this new bearing.

In this way the old piers, which were increasing their downstream movement, were largely relieved of their loads. The pier supporting the swing span slid downstream to such an extent, 10½ ins. if I remember rightly, that it became impossible to operate it. This necessitated another opening to permit vessels to pass.

Towers on pile bents were therefore erected to support a 40 ft. plate girder about 200 ft. east of the existing swing span, and when everything was in readiness, an opening was cut in the bridge and the girders dropped into position. With the aid of the Dominion Bridge Co.'s derrick car, this was accomplished without any interruption to train traffic.

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*Paper read at the fifth professional meeting of the Engineering Institute of Canada, September 10th-12th, St. John, N.B.

This span was operated as a lift span whenever the occasion arose, the derrick car furnishing the power. The clearance for vessels going through this opening was just about the minimum, and called for expert seamanship on the part of the skippers. On one occasion a 400-ton schooner frightened everyone badly. Part of her rigging fouled the deck of the bridge, and only some very lively play with axes and prompt action by the tug, saved a very nasty situation.

Construction of a new bridge 50 ft. downstream and parallel to the old one was begun in June, 1912, and completed in June, 1914. The design, starting from the west end, called D. T. swing span, one 150-ft. D. P. G., one 100-ft. D. P. G.; one 156-ft. D. P. G.; one 144-ft. D. T. swing span; three 156-ft. D. P. G.; six 100-ft. D. P. G.; and one 85-ft. D. P. G.; the total weight, 2,500,000 lbs. of steel. These spans are carried on concrete piers on pile foundation, with the exception of piers 3, 4 and 5, which rest on a bed of coarse gravel and boulders.

Proximity of Old Bridge

The proximity of the old bridge to the proposed work provided another reason for the expenditure of money to strengthen its foundations. With a distance of only 50 ft. between lines, the noses of corresponding piers on the two bridges lay side by side, and as dredging proceeded for the new pier, in some cases being carried below the points of the piles in the old, the tendency was for the old pier to slide bodily into the excavation. Therefore the work had to be carried on with the greatest care and divers were freely employed to keep the old foundations under close observation. Of course the old bridge in many ways helped in the construction, the contractors being able to utilize it for the running of water lines and trolley lines for conveying materials, etc., and the engineering party for laying out the work and as a ready means of communication from shore to shore. But it was not a blessing, as the cofferdams were on several occasions hung up by old timber and piles.

Layout of Work

From pier 8 to the west abutment, the bridge is on a 6 deg. 10 min. curve to the left, with a central angle of 59 degs. 20 mins. A base line was carefully run over the centre line of the old bridge, and permanent hubs set on each bank, well clear of the work, from which the bridge tangent was located by off-setting 50 ft., and marked by permanent hubs which were used for giving the centre line of all piers on tangent. The transverse centre line of these piers were given from points on the deck of the old bridge. Owing to the movement of the deck, as mentioned above, these points had to be located anew for each day that it was necessary to use them. In order to eliminate as much as possible any chance of error in locating the piers on the curve, it was decided to determine the exact geometric centre of the curve and erect there a sight which would be visible at all stages of the tide. The transverse centres of the piers, being on radial lines, could then be located from hubs on the semi-tangent, using the centre of the curve as a foresight.

Accordingly the P. I. of the curve was found, and as it came on the beach at high water mark, a concrete pedestal 18 by 18 ins. and 2 ft. high was put in on pieces of 4 by 4-in., 8 ft. long, as piles, and on this the P. I. (hub A) was definitely set after repeated checking.

To establish the centre of the curve was more difficult, as the water only left it for about two hours each day. With the transit on A and backsighting on T on the west end of the bridge tangent, an angle of 60 degs. 20 mins. was laid off, and the point of intersection found with a line at right angles to the tangent of the curve at the E. C. Around this point a rock-filled crib 6 ft. square and 4 ft. high was built, and a 2 in. pipe, 24 ft. long, was securely guyed there. (Hub C).

As a check, the calculated distance from P to C was measured on the ground with 100 ft. steel tape over stakes driven to the same elevation and 100 ft. apart. The distances along the semi-tangent from P, where the radial lines for each pier intersected, were then calculated and hubs set.

The distances along the radial line from the hubs to the curve were also calculated and recorded for use when required. A hub was put in at M, the mid-point of the curve, from which the angles of the centre of each pier could be turned as a check on the above method. All measurements were made with a 100-ft. steel tape and corrections made for temperature.

Foundations

The west abutment and piers 1 and 2 were built on solid rock, and the concrete poured in the dry, no pumping being necessary. The foundation of the east abutment is on sand and gravel. The excavation for this was taken down 6 ft. below original ground and piles driven to refusal at a penetration averaging 18 ft.

Piers 12 to 14 were on typical Bay of Fundy mud and dry at low water. Cofferdams of 10 by 10 in. hemlock were built in place and sunk as the excavation progressed, being loaded with old rails to a depth of 18 ft., and piling driven. The penetration averaged 25 ft., the penetration under the last blow being from ½ in. to ¾ in., a 2,400-lb. hammer being used, with a fall of 25 ft. These cofferdams were pumped out and the piling cut off 2 ft. above the bottom and the concrete poured in the dry.

The foundations of piers 9 to 11 inclusive were built in the same manner, but the penetration and number of the piles used increased as they approached mid-stream.

In pier 8 the cofferdam was 21.7 ft. deep and the average penetration of the piles 58 ft. The piles, about 90 in number, were cut off under water and the concrete deposited with a bottom dumping bucket; the bottom of this pier covers an area of 749 sq. ft. and there are 451 cu. yds. of concrete in the footing course. In all the piers the footing course is carried about 4 ft. above low water. Between low water and extremely high water the concrete is sheathed with 4 by 6-in. southern pine, with ½-in. iron plates 2 ft. wide on the angles, attached by galvanized iron bolts 15½ ins. long. All concrete below high water mark is 1: 2: 4: mixture; above 1: 3: 6.

The remaining piers, 3 to 7 inclusive, were a somewhat different proposition. At extreme low water the depth of water varied from 20 to 27 ft., and with a rise of the tide of 28 ft., this meant a depth of 55 ft. at high water for pier 3. Borings showed for piers 3, 4 and 5, a belt of fine sand about 8 ft. thick, followed by 8-ft. of mud and then 5 ft. of gravel. At pier 6, 12 ft. of mud, 5 ft. of sand and 60 ft. of mud.

The borings were taken after the work of construction had begun and were very hurried and the information obtained not very dependable. They were taken from a platform in some cases, or from a scow moored over the site of the pier. A 3-in. casing pipe with a 1-in. water pipe attached to a force pump working inside of it, to which the bit was attached, was driven down and the washings examined. A diamond drill was used to penetrate the gravel.

No Solid Rock Encountered

At pier 7 a penetration of about 90 ft. was obtained, at which depth solid rock was reported. The platform from which the borings were taken had to be above high water mark so that the work might go on continuously; so after penetrating the overlying mud there would be about 70 ft. of casing pipe when the gravel was reached. When the inner pipe was raised and allowed to drop on this compact mass of gravel, it bounced up again, giving the impression that solid rock had been encountered. This idea was strengthened when the drilling made no further progress until the diamond was put on. I may say here that no solid rock was encountered at any of these piers when the work was completed.

It was finally decided to sink foundations for piers 3, 4 and 5 down to the gravel, or about 20 ft. of excavation by open dredging. Pier 3 was started first. A double wall cofferdam was constructed with a space of 4 ft. between the walls. The inner wall stopped about 12-ft. short of the outer and they were connected by a solid floor of 10 by 10 in. hemlock, forming a cutting edge. Projecting below this was about 16 ins. of ½-in. steel plate. The cofferdam, about 30 ft. high, was floated into position, the space between the walls filled with concrete, and old rails piled on. Dredging was

(Concluded on page 320)

STREAM FLOW AND PERCOLATION WATER

By Samuel Hall
Assistant Water Engineer, Belfast

(Continued from last week's issue)

Let us now assume that before and after a particular rainfall the stream flow curve has assumed the basic curve form, and at particular times before and after the peak the rate of 2 M.G. per day is recorded; the gain is the total discharge between those two times, because the available amount of percolation water, as indicated by the basic curve, was the same at both times; thus the benefit accruing from a particular rainfall is measured. In this case, should the stream flow curve assume the basic curve form, but not continue so far as to show the rate of 2 M.G., but only, say, 4 M.G. per day, the basic curve can be applied to the flow curve to continue the latter to the time at which the rate of 2 M.G. per day is shown. Then the total discharge, as shown by the flow curve and its continuation, between the two times represents the amount of gain.

Supply and Discharge

This case is illustrated by Fig. 5, which shows an inserted curve EF, which is a reproduction of a part of the basic curve. The time J is fixed by the rate IJ, which is the same as GH. A, B and C show the total gain due to the particular rainfall. A is the estimated surface run-off, whilst B and C show the gain of percolation water. The curve at G must be of basic form, otherwise the principles are not applicable to this case. It was not necessary to draw the portion C, as its equivalent was measurable between ordinates of the basic curve, in this case representing 4 and 2 M.G. per day, but it suffices to illustrate plainly how much more percolation water was in store at the time K than at the time H, and shows what might be called the "correction" for percolation storage. It is suggested that this correction be made in figures representing calculated evaporation loss; and as in cases where these figures are taken over a period the correction might be equivalent to two inches of rainfall, it is plain that uncorrected figures may be inaccurate. Were the basic curve only approximately obtained, it would be of some value for making this correction. The basic curve serves to illustrate the fact that over a period when percolation supply becomes reduced, "depletion" of percolation storage takes place, and this will continue until the average rate of supply and the average discharge are roughly balanced, though neither is actually constant. Conversely, when percolation supply over a period becomes increased, the "filling up" of percolation storage takes place before supply and discharge roughly balance. From another point of view, it might be seen that the average rate of discharge does not immediately change to equal an average rate of supply, but the difference goes to, or is taken from, storage, until the surface of saturation is at such a level that average supply and discharge are about balanced; thus a year's minimum can only occur after a period of small supplies, and a year's maximum only after a period of large supplies.

Maintaining Constant Supply

It occurred to the author originally that if one could determine the available percolation water stored in a drainage area at the end of a winter period, there would be something of value in estimating the amount of artificial storage required to maintain a constant supply, because with a greater amount of natural storage less artificial storage would apparently be necessary. The available percolation storage can be ascertained with the assistance of a basic curve, no doubt in many cases within near limits; yet the author thinks this figure would be of doubtful value, for it is obvious that before percolation discharge can become equal to its average rate, supplies from subsequent rainfall must first replenish the depleted percolation storage according to the amount which has been temporarily available from that source. And for the same reason it is doubtful whether the figure of minimum rate of flow is of much value where a large proportion of the mean flow is required for a constant supply.

The author suggests another use for the basic curve in which it might be of more value. As evaporation during the winter is small and the gains from rainfall should nearly equal the rainfall, the former is the discharge, plus or minus the difference in percolation storage at the beginning and end of a test period. If the difference between the rainfall and the total gain could be accounted for by evaporation, it would be safe to presume that the drainage area was water-tight; if not, there might be proof that percolation water from outside sources was feeding the stream, or, on the other hand, indications of a serious loss of percolation water from the drainage area. In the latter case there would be warning that the installation of a dam might be unfortunate, or even disastrous. There has been sufficient evidence put forward by observers to show that the percolation drainage area is in some cases considerably different from the topographical drainage area, and to consider them as equivalent without satisfactory evidence that such was the case might be an unsound presumption.

Evaporation

The rate of evaporation from water surfaces appears to follow an ill-defined relation to the power of the sun and the duration of sunshine, whilst wind also has a slight influence; but evaporation from a drainage area is influenced by other conditions, such as the soil, percolation rate, elevation and vegetation. The most important factor other than the sun is probably the capacity of the surface soil for moisture. The power of the soil to retain water is known as capillary attraction, and it is a power which defies to some extent the force of gravity. When these conflicting forces are balanced, the amount of water retained in the soil is relatively large (no doubt often equivalent to three inches of rainfall), but very variable, according to depth and fineness, and perhaps also variable with weather conditions. The power of evaporation, due largely to the influence of the sun, appears to be a stronger force than that of the capillary attraction of the soil, for the soil is robbed of part of its moisture, and therefore makes a toll of subsequent rainfall. It is doubtful whether the soil can take its full share from a particularly heavy fall as it requires too much time to do so, and consequently part of the rainfall percolates before the soil is fully satisfied. Though this latter point remains in doubt, it is quite clear that a large part of the evaporation loss in a dry period is replaced from subsequent rainfall, and at times there is but a small balance available to supplement stream flow. In hot, dry months evaporation loss from a drainage area is smaller in the absence of rain than it would otherwise be, because the moisture is not available for evaporation. The surface soil probably draws to some extent upon the subsoil immediately below it, for even vegetation which derives supplies from some depth below the surface has at such times difficulty in maintaining life. Evaporation cannot reduce the percolation storage where the latter is in deep subsoil, but may reduce very slightly the discharge from such a source by evaporation from the stream surface.

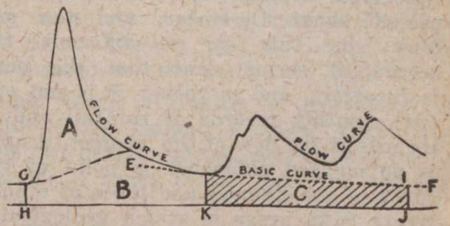

Fig. 5—Flow and Basic Curves

Figures quoted as calculated evaporation losses from drainage areas, though amended by the correction already suggested, would also include losses due to percolation water escaping from the drainage area, and for these reasons they are of doubtful value. The same remarks apply to the figures given in certain text-books to represent evaporation losses due to different forms of vegetation, as they are probably based on differences between rainfall and stream flow.

Investigations of loss by evaporation have been made by means of percolation gauges, but there does not appear to be such definite agreement between the records as might enable accurate conclusions to be deduced therefrom. It is difficult to see how soil and subsoil can be disturbed and placed in a percolation gauge in a condition equivalent to that in which they originally existed, and as in the usual form of percolation gauge no surface run-off is possible, the surface water is exposed to absorption and to evaporation influences for a longer time than it would be on a steep drainage area.

Lag

This term appears to be frequently used to denote the time taken for percolation water to influence flow, and apparently is the result of investigations of the flow of the River Thames, in which there was shown to be a lag of five months between the maximum rainfall and the maximum flow, and the minimum rainfall and the minimum flow respectively. These results were obtained from average monthly figures of a period of twenty years, and it is very questionable whether it is correct to say that percolation water takes five months to reach the river. It is clear that it is not the total rainfall which constitutes flow, but only so much as is available after accounting for losses. If we were able to determine monthly evaporation losses and deduct them from the total monthly rainfall, we might make a diagram of "available rainfall," which from established facts would be relatively very small in summer, and very little different from total monthly rainfall in winter. If five months lag were allowed for, the minimum monthly flow from averages over a number of years would be expected about December, and the maximum flow about May; as this is so different from what actually occurs, it seems clear that the period of five months is incorrect, and moreover it is not even supported by actual monthly records of rainfall and flow. From monthly records of the flow of the Thames, it appears clear that there is no marked difference in point of time between the flow curve of the Thames and those of other British streams and rivers from areas in which geological conditions are a remarkable contrast. It might be reasonably expected that percolation from rain which falls near the banks of the river would feed the surface of saturation close to the river, causing some increase of flow within a very few days at most. It may be noted that percolation equivalent to one inch of rainfall might raise the surface of saturation by several feet if the fissures were of small size. The monthly records of the flow of the Thames appear to the author to show a measure of agreement with his conclusions based on observations from totally different sources; there are indications of depletion of percolation storage towards the end of the summer, and the filling up towards the end of the winter, where the maximum percolation discharge is most liable to occur in not only the Thames, but in every British stream or river.

Snow

Snow is another source of error in calculating evaporation losses from drainage areas; its presence, or any doubt as to its presence, spoils the value of comparisons of precipitation, flow and evaporation. Wherever gaugings are taken, weather conditions, and especially the existence of snow, should be recorded.

Floods

The maximum flood rate, or average rate of a short period, is of importance as the basis for determination of sizes of reservoir culverts and weirs. It is the custom to base calculations on the highest flood rate which obtained in a particular drainage area, and allow a little more to be "on the safe side." Though it may be safe, it is not a very scientific method of determination, for figures which apply to one area do not correctly apply to another. Flood discharge is chiefly surface run-off and is dependent upon a factor which varies for each area, and probably largely on intensity of rainfall, so that unless the latter has been observed in conjunction with stream flow, reliable estimates cannot be made for possible maximum rates.

Springs

The flow curve of a spring is that of percolation water alone. The author would expect a spring flow curve to have similar features to that of a stream flow curve were the "peaks" of the latter removed, and would expect the principles stated to be capable of application in most cases.

There should be little need to repeat what many observers have already stated, that to apply to any one area figures obtained from another is obviously wrong. Evaporation loss is known to vary considerably in different areas, and percolation loss cannot be determined by a mere inspection of a drainage area. Thus calculations and estimates of storage capacity, size of weir and outlet culvert, based on "rule-of-thumb" formulæ and so-called "judgment" are liable to lead, and have in some cases led, to waste of money. On the other hand, stream flow data can be had at a cost which is small in comparison with that of a water supply scheme, and which might often be saved many times over in the reduction of the size of the weir and outlet culvert. There is much need for further investigation of stream flow and evaporation, subjects which particularly concern water engineers, and which have been sadly neglected up to the present. Every drainage area has its peculiarities due to conditions therein, and all the conditions, so far as they concern water engineers, can probably be determined by investigation of the flow curve. To investigate the smaller rates of flow, it is advisable to use V notches, or a small weir in conjunction with a larger one at a higher level, also automatic recording apparatus.

TOWN-PLANNING IN WESTERN CANADA*

UNFORTUNATELY, owing to the conditions under which municipalities in Saskatchewan may borrow, it has not been practicable to put the federal housing scheme in operation in that province. Commissioner C. J. Yorath states that the chief stumbling block in western Canada for the carrying out of a housing scheme is the fact that the provincial government intends to make any loans which may be advanced for this purpose part of the municipalities' debt. In the matter of town planning and control of municipal affairs Saskatchewan has perhaps the most advanced legislation in the Dominion. The Town Planning and Rural Development Act is administered by the Department of Municipal Affairs. The comprehensive nature of this act may be gathered from the following list of regulations which have been issued under it:—

Regulations Under Saskatchewan's Act

(1) Town Planning and Rural Development (Scheme) Procedure Regulations;

(2) Town Planning and Rural Development (By-law) Procedure Regulations;

(3) Regulations applicable to new development within the jurisdiction of municipalities which have not made regulations as authorized by section five of the Town Planning and Rural Development Act, and to new development in unorganized territory;

(4) Model regulations respecting new development for adoption by urban municipalities;

(5) Model regulations respecting new development for adoption by rural municipalities.

The object of the act is effectively to control the development of cities, town and rural municipalities. The importance of this being done is fully realized in Saskatchewan. Not only has the necessary legislation been obtained, but M. B. Weeks, Director of Surveys, has been appointed Director of Town Planning, and W. A. Begg, formerly Townsite Engineer for the Department of Highways, has been appointed Town Planning Engineer. The services of both will be available to local authorities to assist and advise in the preparation of schemes and development by-laws.

Conditions Similar in Alberta

The conditions regarding the housing scheme are the same in Alberta as in Saskatchewan and, consequently, no action is being taken to put the scheme in operation.

The preparation of town planning schemes for the larger cities is proceeding.

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*From "Conservation of Life," published by the Commission of Conservation, Ottawa.

THE KELLEY SYSTEM OF PAYMENT TO CONTRACTORS FOR ESTIMATING*

SINCE the "Nelson Plan" was conceived, other plans which contemplate payment for estimating have been proposed and put into operation. One of these which has received some attention, particularly in the middle west, is the so-called "Kelley Plan." This is a plan owned and controlled by "The National Contractors' Association, Inc.", a private corporation operated for profit, which acts (1) as organizer in keeping contractors in line as regards charging for estimates on a particular project, and (2) as agent for all contractors bidding on a project, in pooling and dividing the amount charged for estimating.

The plan derives its name from J. J. Kelley, president and chief stockholder of the "association." The chief elements of the plan are briefly as follows:—

Definite Schedule of Charges

A definite schedule of charges for estimating the cost of projects valued at from $2,000 to $1,000,000 or over has been established by Mr. Kelley. A contractor, party to the plan, submitting an estimate on a job, adds to his original estimate a sum equal to as many times the cost of estimating that job, as indicated by the schedule, as there are contractors party to the plan bidding on the job. Ordinarily, however, no contractor adds this amount to his bid unless all contractors bidding agree to do so. After the contract has been awarded and the job has progressed to a reasonable stage of completion, the successful contractor pays the total amount which he has added to his estimate, to the local agent of the "association." The agent divides that amount equally among the bidders, except 15%, half of which goes to the local agent and half to the "association" as commissions.

Contractors, party to the plan, must be "members" of the national "association." Membership dues were originally $10 for life; recently it has been announced that membership is free to any contractor, "general" or "sub," who will agree to adopt the schedule announced by the "association," add the proper amount to each estimate to which the plan is applied, and "divide up" with the unsuccessful bidders if he is awarded the contract.

For example:—Ten contractors, members of the "association," are bidding on a project approximating $75,000 to build. The average cost of estimating such a job has been set at $125. Each of the ten bidders then estimates the job in his own way and adds $1,250 to his bid, or ten times $125. After the contract has been awarded and the job has progressed to a reasonable stage of completion, the successful bidder pays $1,250 to the local agent of the "association." The agent gives each of the ten bidders $106.25, keeps $93.75 himself, and pays $93.75 to Mr. Kelley, of the national "association."

Results of Week's Operation

A further example of what this may amount to can be seen from the following figures, given by Mr. Kelley as the results of one week's estimating among "association" members in Toledo from March 16th, 1918, to March 23rd, 1918:—

Total received for estimating		$6,487.10
"Dues" in "National Association" for 19 members at $10	$ 190.00	
7½% commission to local agent	486.53	
7½% commission to Mr. Kelley	486.53	
85% returned to 19 members to cover cost of estimating in amounts varying from $51 to $1,095, average $280.21	$5,324.04	$6,487.10

In favor of the Kelley system are urged most of the arguments advanced in favor of any plan providing payment for estimating, especially that the owner thereby pays for estimates on his job only, that he can have just as many estimates as he is willing to pay for, and that the contractor thereby gets a fair fee for his professional services.

In contrast to the "Nelson Form" it has been urged by Mr. Kelley that his system encourages competition, which tends to reduce ultimate building costs 10%. An investigation of the operation of the system in one city in the middle west brought out the information that whereas formerly five contractors was the average bidding on work, since the Kelley system has been adopted, the average is nearer twenty.

Weakness in Kelley System

On the other hand, this very fact is urged against this particular system, and it is further stated that it encourages unscrupulous and irresponsible men to enter the field with the purpose of receiving sufficient bidding money to make a considerable profit on estimating without really contracting at all. Various elements in the Kelley system make this appear inevitable.

First, the contractor's fee for estimating is part of his bid on the job, which he controls and pays himself, rather than a separate fee paid by the owner for his services in estimating. This makes it possible for contractors to agree among themselves without the consent of the owner or the architect, to add to their bids a sum equal to the cost of estimating. So long as this is possible, there is bound to exist a tendency to do so secretly, and to "let in" on the job as many as are desired or "the traffic will bear."

With this possible, there is nothing to prevent an unscrupulous contractor from making a rough guess, high enough to insure his bid being rejected, add on the cost of estimating, and receive a share in the payment for estimating.

It is no case to state that the system is designed to be operated in co-operation with the architect and with the full approval of the owner, who would eliminate such a possibility, for, despite the good intentions of the originator and the honesty of most contractors, the actual facts show that the system falls down seriously at just this point.

Investigation in cities where the Kelley system is in operation shows that, while the number of bidders increases on some jobs because the architect is willing to pay for estimates, frequently it increases because he is unaware that he is being charged for the bids.

Accepted More Than Cost

A local agent in one city recently stated that the system did not work on a particular job where the owner took bids directly, as the contractors then had no means of finding out who was bidding in order to line everybody up, and apparently did not care to inform the owner of the plan. In another instance, where two of the announced bidders on a public contract failed to submit bids, their share of the total cost of estimating, instead of being returned to the state, was divided among the remaining bidders, showing clearly that the charge for estimating was being made without the knowledge of the engineer in charge, or else in collusion with him, to the detriment of the state. Where such secrecy is possible, excessive bidding by irresponsible contractors is also possible, and the whole system is thus brought into disrepute. This is the fundamental weakness of the Kelley system.

Other minor elements contribute to establish this fundamental weakness. According to the system, *all* or *none* of the bidders on a project must be party to the plan unless undue advantage is given those who do not include a charge for estimating in their bids. This makes it essential to employ a middleman, whose business it is to "line up" all the bidders on a project. The commission of this agent increases directly as the number of bidders increase. No matter how honest, therefore, may be the principles on which the plan is based, it is to the agent's advantage to increase the number of bidders, either as a party to the plan to charge for estimating secretly or in collusion with the owner's representative. The possibility and the actual existence of practices of this sort again bring the plan into disrepute.

*From a report of the "Committee on Methods" of the Associated General Contractors of America.

In answer to these objections, it is urged that the co-operation of the architect and the approval of the owner, if sought and gained in each instance, will remove all chance of excessive bidding. True; but it will also remove to a great extent all need for a middleman at a fancy commission. If recognition of the right to charge a fee for estimating is made by the architect or the owner, there is no reason for including the fee in the bid. If it is not included in the bid on the contract, it will not affect the total estimate, and hence it will no longer be necessary for *all* or *none* of the contractors to agree to charge for estimating. Thus will be removed the necessity for a middleman as organizer. If a fee is paid each contractor for estimating, there will be no necessity for the contractors to form a pool from which their payment may be made. Thus will be removed any necessity for a middleman as broker. Except, therefore, to educate small and irresponsible contractors in good business methods, there will be no need of special agents to make payment for estimating possible, once architects, owners and contractors see that it is desirable. Then if a system can be developed with the proper checks and balances, its adoption will be a matter of good business for all concerned.

Some General Considerations

To date, only the "Nelson Form" has proposed anything that would make the plan applicable to public work, which involves a reconciliation of the principle of free and open competition with payment for *all* estimates. If applied under the Kelley system, it must be applied secretly as noted above, or else the state would acknowledge no limit to the amount it would pay for estimates on any project. This is one of the most important and difficult problems involved in the whole situation, and one which deserves particular attention.

Another important consideration is the extension of the principle to the sub-contractors on a project where the general contractor submits the final estimate. Here again the "Nelson Form" is particularly interesting.

General contractors, in an effort to reduce their overhead costs, have been asking: "If an owner is willing to pay for plans and specifications in order that he may see how his ideas work out on paper, why should he not also pay contractors for the benefit of their experience and efforts in determining what it would cost to transfer these ideas on paper into a concrete structure?"

Since "the owner reserves the right to reject any and all bids," contractors frequently submit bids where the work does not proceed, and where no remuneration is thus paid anyone for the expense of bidding. On the other hand, while it is true that the cost of estimating is a legitimate overhead expense, it is likewise true that modern business methods teach the segregation of general overhead expense as closely as possible, and charge as many items as possible directly against the account where they belong. Applied to the expense of estimating, this means that each job should bear its full share of such cost.

With these views in mind, the "Committee on Methods" presents the following questions to general contractors and others interested, with the desire to secure as much advice as possible in formulating their conclusions on this problem:—

Questionnaire

1. Is estimating a service for which a fee should be charged, regardless of who gets the contract?

2. Is it fair to have owners of jobs undertaken pay costs of estimate (a) on projects which are not constructed, or (b) on jobs that his successful contractor has figured for other owners?

3. If selected architects are each paid for architectural competition, would a similar plan work for payment of bidding by selected contractors?

4. If this plan is not universally adopted, will not architects select contractors who do not endorse it to save these bidding fees, and thus possibly eliminate the chances of the latter on such work?

5. Should payments for bidding be based on the lowest bid submitted if work is not awarded; on the accepted bid if awarded; or on what basis?

6. If payment for bidding is appropriate and possible for building work, is it also feasible for railroad work or industrial work let on the unit price basis?

7. Should bids submitted be so itemized as to permit the owners to trade on same to competitors, and thus take possible undue advantage?

8. How many alternates should be included in bids submitted under a plan of payment for estimating?

9. Should bids be opened publicly?

10. Should payments for bidding be made only when all bids are rejected?

11. Should not cubic feet and square feet estimates be included for payment, as competitors otherwise might work out detailed estimates first and then convert same into above units?

12. What provision should be made for re-figuring altered plans?

13. How will each contractor know that another contractor is charging and insisting upon payment of his fee? Is it essential?

14. If this plan is proper for general contractors, shall general contractors extend the same practice to their sub-contractors? How?

15. Will publication of a plan in current technical periodicals bring satisfactory answers; should the letter ballot plan be adopted among responsible contractors; how should a plan be put into operation?

16. Is this plan of duplicate cost of bidding really the most economical for the industry, or should one quantity surveyor be employed by the owner and no charge for pricing such survey then be made by the contractors?

17. What plan do you believe should be advocated for the best service to the public?

PROPOSE DAM ACROSS BELLE ISLE STRAITS TO CHANGE NEWFOUNDLAND'S CLIMATE

"NEWFOUNDLAND is contemplating changing its climate," states a despatch from St. Johns, Newfoundland, recently published in a large number of daily newspapers.

"The climate of Newfoundland would be changed if a breakwater were built across the Straits of Belle Isle, between the island and the mainland, and the cold Labrador current were shunted out into the Atlantic Ocean. Such a dam is being seriously considered. It would cost an immense sum of money but engineers say it presents few difficulties.

"The Labrador current at present is the chief factor in moulding the climate, not only of Newfoundland, but of the Maritime Provinces and New England. Coming down from the Arctic Ocean it pours through the Straits of Belle Island, and, circulating around the Gulf of St. Lawrence, washes with its cold flood the coasts of Newfoundland, Quebec, New Brunswick and Nova Scotia. Then, passing through Cabot Strait, it turns south and sweeps along New England. Its strong southward flow acts as a cold wedge which pries the Gulf Stream away from all these coasts and shunts that ocean river, bearing the warmth of the tropics, off north-eastward across the ocean.

"If the Belle Isle dam is built, the Labrador current would be blocked out of the Gulf of St. Lawrence and, shearing off south-east, would miss the mainland and continue to affect only the north-eastern coast of Newfoundland. The Gulf Stream then would ease in against the continent and, flowing into the Gulf of St. Lawrence, warm all the surrounding shores and islands.

"The Gulf Stream is responsible for the mild winter climate of England and northern France. England is farther north than Newfoundland. If, after cooling off in its long passage across the northern seas, the Gulf Stream is still such a factor in tempering England's climate, it would have an even greater effect, it is believed, in tempering the winter climate of Eastern Canada and New England."

Operation of Slow Sand Filters at Toronto

Ten Thousand Samples Tested During Year 1918 Show 99.7% Average Reduction in B. Coli, 99.1% in Total Bacteria, and 99% in Excremental Bacteria—Pollution of Raw Water Increased 61.9% in Five Years Judged by B. Coli Tests

By NORMAN J. HOWARD

Bacteriologist-in-Charge, Filtration Plant Laboratory, Toronto

THE water supply for the city of Toronto is drawn out of Lake Ontario, the intakes being situated a little more than 2,000 feet due south of the plant. Filtration is effected by means of two modern installations, one being a mechanical plant of the drifting sand type, and the other a slow sand system. As the mechanical plant is being made the subject of a special report, it is proposed to deal only with the slow sand system for the period of twelve months ending December, 1918.

Out of 15,880 samples examined in the laboratory, either chemically, physically, microscopically or bacteriologically, some 10,000 were from the slow sand system.

Bacteriological Results

Tests for the enumeration of bacteria growing on agar and rebipelagar at blood temperature, and for the isolation of the colon bacillus were made on the raw and filtered water throughout the year. The average number of bacteria per c.c. growing on nutrient agar for twenty-four hours at blood temperature was 356.3 in the raw water and 2.2 in the filtered water, a reduction of 99.1 per cent. Excremental bacteria growing under the same conditions showed that the raw water contained 26.5 and the filtered water 0.25 per c.c., respectively, giving a reduction of 99 per cent. The media used in test was neutral red, lactose bile-salt, peptone agar, as used by Dr. A. C. Houston, of the Metropolitan Water Board, London, Eng. For the isolation of the colon bacillus, lactose ox gall was used. The raw water showed the colon bacillus to be present in one cubic centimetre on 121 days (39.9 per cent.). The average indicated number of B. Coli present in the raw water was 11.36 per c.c., whilst the filtered water contained .027 per c.c. The total percentage removal of the colon bacillus in the filtered water was 99.7. Reference to table D will show the complete figures covering the colon tests for the past six years.

TABLE A

Number of Examinations Made During the Year

Month	Bacteriological	Physical and Microscopical	Chemical
January	660	447	169
February	579	374	124
March	614	425	143
April	704	510	162
May	699	426	136
June	638	532	135
July	735	451	155
August	686	549	187
September	661	545	160
October	644	664	201
November	678	581	167
December	590	533	167
Total	7,888	6,037	1,906
Total			15,831

Special Examinations

Aluminium Sulphate	26
Boiler Incrustations	3
Boiler Compounds	2
Trap Rock	3
Copper and Brass	12
Cement	3
Total	49
Grand Total	15,880
Examinations made in 1912	8,096
" " " 1913	9,382
" " " 1914	9,848
" " " 1915	10,292
" " " 1916	12,076
" " " 1917	15,041

Physical examination of the water was made daily, and showed that, whilst the turbidity varied considerably in the raw water, ranging between 1 to 160 parts per million, the filtered water was at all times free from turbidity, the effluent being clear, bright and sparkling. The microscopical examination was not carried out as frequently or as thoroughly as in previous years, due to the extra laboratory work involved by the new mechanical plant. Nevertheless, the observations made at the different seasons of the year were extremely valuable, and often threw light on the fluctuation in the loss of head of the filters, which otherwise would have been difficult to understand.

Amongst the many types noted were the diatoms cymbella, cocconeis, navicula gracilis, stauroneis, epithemia, himantidium, asterionella, synedra, fragilaria, diatoma, tabellaria, nitzschia sigmoida and longissima, melosira, cyclotella, stephanodiscus, the cyanophyceae microcystis, coelosphaerium, anabaena, the chlorophyceae palmella, tetraspora, scenedsmus, hydrodicton, sorastrum, volvox, ulothrix, the protozoa actinophrys, uroglena, dinobryon, ceratium, vorticella, codonella, coleps, and several types of rotifera, crustacea, and infusoria. There were many other varieties which were not identified. Many of the above mentioned when present are known to be objectionable on account of their imparting a taste or smell to the water. During the summer months, when the water was warm, particularly during August and September, a faint taste appeared to be present in the raw water. The filtered water was practically free from organisms; occasionally there was a trace of amorphous matter, but the taste previously mentioned, whilst considerably lessened, was not completely eliminated. It is doubtful if the taste was noticed by the consumer.

TABLE B

Bacteria growing on Agar at 37-39 degs. C., 24 hours incubation, showing monthly maximum, minimum, and average number per c.c. in raw and filtered water; yearly average number per c.c. in raw and filtered water, and the total percentage reduction in the filtered water for the year.

Month.	Raw Water Maximum	Raw Water Minimum	Raw Water Average	Filtered Water Maximum	Filtered Water Minimum	Filtered Water Average
Jan.	550	0	50.4	5	0	.96
Feb.	280	0	27.6	3	0	.87
Mar.	320	1	37.8	6	0	.32
Apr.	970	0	139.0	6	0	.76
May	1,800	1	114.0	6	0	1.36
June	1,340	0	195.46	14	0	1.83
July	620	0	110.23	5	0	.96
Aug.	3,800	16	654.27	46	0	2.96
Sept.	2,200	1	564.2	25	0	3.5
Oct.	17,200	8	1,466.6	30	0	5.6
Nov.	3,825	2	309.2	12	0	3.5
Dec.	1,850	2	573.35	7	0	2.4
Average for year	.....	.	356.3	.	.	2.2

Total reduction for the year, 99.1 per cent.

Chemical Examination

Considerable time was devoted to the chemical examination of the raw and filtered water. The test for the determination of ammoniacal nitrogen is practically the only known test for ascertaining rapidly the condition of the raw water. On many occasions this information was most useful in the operation of the filters. The general reduction of the organic matter in the filtered water was satisfactory, the free and albuminoid nitrogen and the oxygen consumed showing substantial reductions. The nitrates increased, pointing to oxidation caused by nitrifying bacteria on the surface of the filters. A further increase in the chlorides cannot be regarded as satisfactory, and is another indication of the degree of pollution that is yearly increasing.

The rate of filtration for the year was 3.27 million Imperial gallons per acre per day, this being slightly lower than in the previous year. The total amount of water filtered was 11,470 million Imperial gallons. In the yearly report for 1916 special reference was made to the quality of the sand, particularly as regards the effective size and the uniformity coefficient. At that time the portable sand washer was being used in the summer months. This practice was discontinued and the washer is now used only during the winter months. The quality of the sand greatly improved during 1918 and is now in good condition.

Table C

Excremental bacteria growing on Bile-Salt Agar (Rebipelagar) at 37-39 deg. C., 24 hours incubation, showing monthly maximum, minimum and average number per c.c. in raw and filtered water; yearly average number per c.c. in raw and filtered water, and the total percentage reduction in filtered water for the year.

Month.	Raw Water Maximum	Raw Water Minimum	Raw Water Average	Filtered Water Maximum	Filtered Water Minimum	Filtered Water Average
Jan.	188	0	11.1	2	0	.2
Feb.	80	0	4.4	2	0	.125
Mar.	164	0	13.3	4	0	.32
Apr.	300	0	40.8	1	0	.16
May	57	0	8.6	6	0	.44
June	170	0	29.58	8	0	.5
July	27	0	2.65	2	0	.08
Aug.	270	0	16.73	1	0	.08
Sept.	86	0	12.8	10	0	.5
Oct.	1,250	0	91.62	1	0	.12
Nov.	29	0	6.12	1	0	.08
Dec.	440	0	73.2	3	0	.58
Average for year.	...	.	26.5	..	.	0.25

Total reduction for the year, 99.0 per cent.

Summary

(1) Over 10,000 samples were examined from the slow sand system during the year.

(2) The average number of bacteria growing on agar at blood temperature was 356.3 per c.c. in the raw water and 2.2 per c.c. in the filtered water. Total reduction, 99.1%.

(3) The average number of excremental bacteria growing on bile-salt agar at blood temperature was 26.5 per c.c. in the raw water and 0.25 per c.c. in the filtered water. Reduction, 99.0%.

Table D

Monthly Percentage of Samples Showing B. Coli in Raw and Filtered Water

Month	Raw Water 100cc	10cc	1cc	.1cc	.01cc	.001cc	Filtered Water 100cc	10cc	1cc	0.1cc
Jan.	76.0	40.0	32.0	12.0	0.0	0.0	19.0	4.0	0.0	0
Feb.	100.	66.6	16.6	0.0	0.0	0.0	75.0	20.8	0.0	0
Mar.	96.0	52.0	28.0	8.0	0.0	0.0	88.0	24.0	4.0	0
Apr.	96.0	80.0	48.0	20.0	0.0	0.0	88.0	24.0	0.0	0
May	96.1	57.7	30.8	7.7	0.0	0.0	53.8	11.5	0.0	0
June	95.8	50.0	41.6	8.3	0.0	0.0	29.1	0.0	0.0	0
July	92.3	61.5	23.0	7.7	0.0	0.0	30.8	3.8	0.0	0
Aug.	100.	96.1	65.4	26.9	7.7	0.0	50.0	11.5	0.0	0
Sept.	100.	75.0	50.0	20.8	4.2	0.0	45.8	8.3	0.0	0
Oct.	96.1	76.9	53.8	30.8	7.7	0.0	61.5	15.3	0.0	0
Nov.	96.1	50.0	23.0	7.7	0.0	0.0	38.4	11.5	0.0	0
Dec.	92.0	88.0	68.0	36.0	28.0	8.0	92.0	60.0	4.0	0

Efficiency as Judged by B. Coli Test, Showing Percentage Reduction in Filtered Water.

100cc., 36.0%; 10cc., 74.0%; 1cc., 98.3%; 0.1cc., 100%; 0.01cc., 100%; 0.001cc., 100%.

Indicated Number of B. Coli per 100cc., and 1cc.

Average of 302 samples: Raw water, per 100cc., 1,136; per 1cc., 11.36. Filtered water, per 100cc., 2.7; per 1cc., .027.

Total reduction of B. Coli in Filtered Water, 99.7%.

Total Percentage of Samples Showing B. Coli in Raw and Filtered Water During Past Six Years

Year	Raw Water 100cc	10cc	1cc	0.1cc	0.01cc	0.001	Filtered Water 100cc	10cc	1cc	0.01cc
1913	81.2	54.6	24.6	4.9	0.0	0.0	33.2	7.5	0.3	0.0
1914	87.4	61.0	30.7	8.6	0.99	0.0	35.2	8.9	1.3	0.0
1915	91.4	60.2	31.9	8.2	1.6	0.3	46.4	11.1	1.7	0.0
1916	96.4	68.7	35.8	10.5	0.98	0.0	56.9	11.5	0.65	0.0
1917	92.7	67.1	32.2	8.5	2.6	0.0	59.8	14.4	0.32	0.0
1918	94.7	66.2	40.0	15.5	3.9	0.66	60.6	17.2	0.66	0.0

(4) The total percentage of samples showing B. Coli in one c.c. was 39.9 in the raw water and 0.66 in the filtered water.

(5) The average indicated number of B. Coli present per 100 c.c. of water examined was 1,136 in the raw water and 2.7 in the filtered water, showing a total reduction of 99.7%.

(6) Pollution of the raw water as judged by the B. Coli test has increased by 61.9% since 1913.

(7) The highest temperature recorded in the water was 64 degs. F. and the lowest 33.9 degs. F.

(8) The highest degree of turbidity occurring in the raw water was 160 p.p.m., whilst the lowest was 1. The filtered water was free from turbidity throughout the year.

(9) The chlorides in the raw water were 8.2 p.p.m. in 1913, whilst in 1918, the figures had increased to 9.89 p.p.m.

(10) The total number of filters cleaned during the year was 181.

(11) The average rate of filtration was 3.27 million Imperial gallons per acre per day.

Table E

Average Monthly Turbidities, Showing Maximum and Minimum Figures

Month	Raw Water Maximum	Raw Water Minimum	Raw Water Average	Filtered Water Maximum	Filtered Water Minimum	Filtered Water Average
January	24	1	4.0	0.5	0.5	0.5
February	39	1	4.0	0.5	0.5	0.5
March	51	1	8.3	0.5	0.5	0.5
April	160	1	26.5	0.5	0.5	0.5
May	7	1	2.0	0.5	0.5	0.5
June	7	1	1.7	0.5	0.5	0.5
July	3	1	1.6	0.5	0.5	0.5
August	8	1	1.8	0.5	0.5	0.5
September	14	1	2.9	0.5	0.5	0.5
October	7	1	1.6	0.5	0.5	0.5
November	12	1	1.9	0.5	0.5	0.5
December	65	1	18.7	0.5	0.5	0.5

(12) The average amount of water filtered was 31.42 million Imperial gallons, or 50% of the average amount of water daily consumed.

(13) *The maximum and minimum consumption daily during the year was 77.49 and 45.61 million Imperial gallons, respectively, whilst the average daily consumption was 62.72 million Imperial gallons.

(14) *The average daily consumption per capita was 128 Imperial gallons.

Conclusions

For several years past attention has been directed to the continual deterioration in the quality of the raw water. Observations were based upon the percentage number of days in the year that the raw water contained the typical colon bacillus in one cubic centimetre of water examined. The figures for the past six years which read as follows: 1913, 24.6%; 1914, 30.7%; 1915, 31.9%; 1916, 35.8%; 1917, 32.2%; 1918, 39.9%, show conclusively that the raw water is becoming impurer. The slight reduction in 1917 was due to the more favorable weather rather than to any improvement in the quality of the water.

Table F

Temperatures of Air and Water in Degrees Fahrenheit at 9.30 a.m.

Month	Water Maximum	Water Minimum	Water Average	Air Maximum	Air Minimum	Air Average
January	37.0	32.0	34.7	33	–8	12.29
February	36.0	33.0	34.8	39	–15	21.7
March	35.9	32.9	33.9	46	14	32.6
April	39.2	33.8	36.6	49	28	40.3
May	44.6	37.4	40.6	68	40	50.42
June	50.0	41.0	44.3	70	52	60.1
July	46.4	41.0	43.9	78	51	66.5
August	64.0	41.0	56.9	76	56	67.0
September	60.8	41.0	47.0	66	42	54.8
October	50.0	41.0	45.1	58	41	48.9
November	50.0	42.0	45.4	55	24	42.3
December	42.0	36.0	38.6	44	18	33.2

In 1913 the colon bacillus was present on seventy-five days (24.6%) of the total number of days upon which examination of the raw water was made. This figure had increased in 1918 to 121 days (39.9%). From the figures submitted it will be seen that the pollution in the raw water was progressive in character, and that the actual percentage increase in the number of days upon which the water was seriously polluted had increased 61.9% in six years. The normal increase in population and the consequent discharge of sewage into the lake may have been the principal rea-

*Figures kindly supplied by Department of Works.

son for this. This applies not only to Toronto, but to the many cities, towns and municipalities in the vicinity which are daily discharging enormous quantities of sewage into the lake. With the exception of the city of Toronto, little attempt is being made to treat the effluents so as to render them innocuous. As far back as 1912 (city engineer's report) it was clearly shown that the water of Lake Ontario was polluted by currents some seven miles out from the intakes. When these conditions are taken into consideration, together with the various pollutions arising from marine traffic, dredging operations, spring freshets and the frequent pollution following summer storm floods, it will be seen that the contributory causes are numerous. Probably there are no cities on the great lakes where the pollution of the raw water in the immediate vicinity is not yearly increasing, regardless of the steps taken to prevent the discharge of putrescrible matter into the rivers or lakes involved, those responsible for the purification of water supplies depending upon filtration for clarification and chlorine for final sterilization.

While the occurrence of pollution in the raw water is yearly increasing, the degree of pollution is intensifying. As has been the case for several years past, the most serious pollution occurred in the summer and fall months. On forty-seven days the raw water contained the colon bacillus in 1/10th part of one cubic centimetre, on twelve occasions in 1/100th part, and on two occasions in 1/1000th part of one cubic centimetre. Assuming that crude sewage contains at

Table G

Average Monthly Chemical Figures: Results Expressed in Parts Per Million Raw Water

Month	Ammoniacal Nitrogen Free	Ammoniacal Nitrogen Albuminoid	Ammoniacal Nitrogen Total	Nitrates	Chlorides	Oxygen Consumed 4 hours at 80° F.	Oxygen Dissolved	Alkalinity as CaCo3
Jan.	.009	.073	.082	....	9.64	.45	.....	.....
Feb.	.005	.074	.079	....	9.63	.44	13.21	93.35
Mar.	.020	.082	.102	....	.....	...	13.49	92.20
Apr.	.018	.084	.102	....	.....	...	13.46	94.05
May	.013	.079	.092	....	.....	...	13.28	95.80
June	.007	.073	.080	.069	10.17	.49	12.92	94.15
July	.003	.077	.080	....	10.10	.56	12.97	94.25
Aug.	.007	....	....	.065	.....	...	11.41	95.20
Sept.	.008	....	....	.020	10.05	.66	11.35	93.70
Oct.	.021	.069	.090	.093	10.04	.54	11.67	94.88
Nov.	.007	.051	.058	.040	9.57	.45	11.39	94.30
Dec.	.036	.037	.063	.013	.....	...	12.16	94.80
Average	.013	.070	.083	.050	9.89	.51	12.48	94.24
Filtered Water								
Jan.	.001	.048	.049	....	9.6	.29	.....	.....
Feb.	.001	.051	.052	....	9.6	.30	12.80	93.25
Mar.	.001	.051	.052	....	...	...	.....	91.92
Apr.	.001	.049	.050	....	...	...	.....	94.00
May	.001	.048	.049	....	...	...	.....	.....
June	.001	.038	.039	.109	10.17	.29	.....	94.55
July	.001	....	....	.083	10.10	.41	.....	95.28
Aug.	.001	....	....	.080	.....	...	.....	95.05
Sept.	.001	....	....	.070	10.00	.43	10.10	.....
Oct.	.001	.032	.033	.098	10.04	.32	10.38	96.74
Nov.	.001	.027	.028	.078	9.55	.31	10.16	95.44
Dec.	.001	.023	.024	.040	.....	...	11.63	93.50
Average	.001	.041	.042	.080	9.87	.34	11.01	94.41

Per Cent. Purification Figures

Ammoniacal Nitrogen		
Free	90.6%	Reduction
Albuminoid	41.9%	"
Total	49.4%	"
Oxygen consumed	34.4%	"
Nitrates	59.2%	Increase

Chlorides and Alkalinity showed little change.

least 100,000 B. Coli per c.c. the last two figures showed the raw water to contain a pollution equivalent to 1,000 and 10,000 parts of sewage, respectively, to each million gallons of water.

Final Sterilization Always Necessary

The daily examination showed the raw water to be subject to a continuous and increasing degree of pollution, which condition was almost entirely controlled by the meterological conditions prevailing at the time. From this it would seem desirable that early action should be taken to treat sewage that is being discharged into the lake, so that the effluents are rendered innocuous. The remarkable figures obtained by filtration reduced very materially the degree of pollution previously mentioned as occurring in the raw water, and show that the actual results achieved by filtration alone would almost have rendered the water fit for consumption without final sterilization, but it must be remembered that a water that is initially polluted with matter of excremental origin can never be filtered so efficiently as to render it innocuous. For instance, if a water before filtration contained 5,000 bacteria per cubic centimetre and filtration removed 99.5%, there would still be twenty-five remaining, some of which might belong to the pathogenic group, which, if of a virulent nature, might be capable of causing a serious

Table H.—Filter Operation

Average Rate of Filtration for the Year.—3.27 million Imperial gallons per acre per day.

Total Amount of Water Filtered.—11,470 million Imperial gallons.

Maximum and Minimum Amount of Water Filtered in 24 hours.—Maximum, 40.04; minimum, 18.58 million Imperial gallons.

Average Amount of Water Filtered Daily.—31.42 million Imperial gallons.

Number of Filters Raked or Cleaned.—181.

Filter runs, length of runs in days completed during each month, showing maximum, minimum and average figures, and yield per run in million Imperial gallons per acre.

Month	Maximum	Minimum	Average	Yield Per Run Per Acre
January	42	1	20.7	75.368
February	50	7	26.5	99.96
March	46	8	30.0	116.20
April	35	13	20.9	77.56
May	38	8	28.2	106.55
June	33	3	21.2	78.36
July	24	5	17.1	56.91
August	30	7	18.1	68.67
September	25	3	19.1	70.42
October	35	15	25.1	86.86
November	32	13	23.2	73.37
December	39	2	19.4	65.04

epidemic. The necessity of final sterilization then becomes apparent. Throughout the year the figures obtained by filtration showed splendid efficiencies equalled by few plants on the American continent. At present Toronto is fortunate in having a water supply that is both filtered and chlorinated. The excellent system of chlorination is directed by Col. Geo. G. Nasmith, Director of Civic Laboratories, and consequently the water as finally delivered to the consumers is splendid, being clear, bright and of high bacterial quality.

The name of the firm of Brennan and Hollingworth, contractors, Hamilton, Ont., has been changed to the W. C. Brennan Contracting Co.

A good roads association has been organized at Chilliwack, B.C. Following are the officers: Hon. presidents, F. B. Stacey, M.P., Hon. E. D. Barrow, M.L.A., Mayor Ashwell and Reeve Evans; president, W. L. Mackin; vice-president, E. H. Barton; secretary, W. R. Theal; treasurer, G. O. Nesbitt.

The New England Water Works Association will hold its annual convention September 30th to October 3rd, inclusive, in Albany, N.Y. The preliminary program, which will be published in full next week, includes a paper by Norman J. Howard, of Toronto, on the "Operation of and Purification Effected by the New Drifting Sand Filter System at Toronto." The president of the association is S. E. Killam, superintendent of pipe lines and reservoirs of the Boston, Mass., Water Works. The secretary is Williard Kent, civil engineer, Narragansett Pier, R.I.

The Greater Winnipeg Water Board has decided to wait until next spring before proceeding with the work of underdrainage for a section of the Shoal Lake aqueduct. It is estimated that this work will cost $330,000. It is necessitated by the alkali waters in the soil surrounding one section of the aqueduct. The proposed pipe line to Transcona will likely be built this fall, the councils of all the municipalities interested having tentatively agreed upon the extension. It is likely that the price of 2c. per 1,000 gals., which is now being charged, will be reduced to 1¼c., as the Board has recommended this reduction, claiming that it has found that the water can be sold without loss at the lower rate. All the municipalities interested have not yet agreed to the reduction, so it is being held in abeyance for the time being.

CANADIAN ENGINEERING STANDARDS ASSOCIATION

Visit from Secretary of the British Association—Appointment of Committees and Sub-Committees—Report to be Prepared on Standard National Electric Code

AT a meeting of the main committee of the Canadian Engineering Standards Association, held September 8th, H. H. Vaughan presiding, the following new members were appointed:—

J. M. R. Fairbairn, nominated by the Canadian Pacific Railway; H. H. Kelley, nominated by the Grand Trunk Railway; A. F. Stewart, nominated by the Canadian National Railways; F. A. Gaby, nominated by the Hydro-Electric Power Commission of Ontario; A. A. Dion, nominated by the Canadian Electrical Association; and J. Stadler, nominated by the Canadian Pulp and Paper Association.

The lists of members for the following sectional committees were approved:—

Electrical sectional committee, Dr. L. A. Herdt, chairman.

Sectional committee on steel bridges and construction, G. H. Duggan, chairman.

Sectional committee on wire rope, Prof. H. M. Mackay, chairman.

Recommendations as to membership of the following sub-committees were received, and the committees appointed accordingly:—

Sub-committee on steel railway bridges, P. B. Motley, chairman.

Sub-committee on incandescent lamps, John Murphy, chairman.

Sub-committee on transformers, A. A. Dion, chairman.

The secretary reported the progress made with regard to various questions already under consideration, and further reported a number of requests for action on the part of the association. Several of these were approved for further enquiry and report.

The chairman welcomed C. Le Maistre, the secretary of the British Engineering Standards Association, who is now on a visit to Canada and the United States. Mr. Le Maistre described briefly the work of the B.E.S.A., and drew the attention of the committee to certain matters in which his association would welcome the assistance and co-operation of the Canadian Engineering Standards Association, referring especially to proposals which have been made with a view of obtaining some degree of Anglo-American agreement as to screw thread standards. Mr. Le Maistre further pointed out the desirability of international agreement as to rules affecting electrical appliances and fittings, particularly for interior use.

As regards the first suggestion, it was decided to appoint a sub-committee on screw-threads, with instructions to consider and report on Mr. Le Maistre's communication.

Considerable discussion took place on the question of rules for electrical appliances, and the committee agreed that the formulation of a "Canadian Electric Code" was most desirable. The committee then directed that a sub-committee should be called together to enquire and report further as to this point.

H.R.H. the Prince of Wales unveiled commemorative tablets on the Quebec bridge during his recent visit at Quebec. These tablets bear the names of the engineers chiefly responsible for the successful completion of the bridge.

Regina's Board of Trade favors the proposed pipe line from Elbow, Sask., for supplying Regina and Moose Jaw with Saskatchewan river water. A committee has been appointed to interview the provincial government.

A. C. Grant, of the Grant Construction Co., has asked Toronto's city council to excuse him from carrying out his contract to lay a concrete roadway on Keewatin Ave., North Toronto. Mr. Grant complains that he cannot obtain labor even at fifty cents an hour and carfare. He states that he also has a contract in Brampton, Ont., which he will not be able to complete this year for the same reason.

THE BEAR RIVER BRIDGE

(Continued from page 312)

then begun with an orange-peel bucket, through a well in the centre of the dam. As the cofferdam went down, it was built up to keep the top above low water level. The position of the cutting edge was determined daily by obtaining the levels of four points on the dam equidistant from the cutting edge, and the dredging was directed accordingly to keep the dam vertical.

This was quite successful until a depth of 12 ft. had been obtained, when one side of the dam got hung up on a large boulder, with the result that the dam took a list of about 15 degs. from the vertical.

Divers were then sent down to direct water jets around the obstructions and dredging was carried on the outside of the dam on the high side. Finally the dam was straightened up into its correct position at a penetration of about 28 ft. and resting on a bed of coarse gravel and boulders. The total height of the dam is 62.4 ft. containing 130,000 ft. of timber and 1,473 cu. yds. of concrete.

Pier 4, the pivot pier, was sunk in similar manner to the depth of 36 ft. and contains 175,000 ft. of timber and 19,000 cu. yds. of concrete. Pier 5 was sunk to a depth of 40 ft. and contains 142,000 ft. of timber and 1,453 cu. yds. of concrete.

Under-Water Pile Driving

At piers 6 and 7, where the boring showed a considerable depth of mud, it was decided to excavate about 15 ft. and drive piles. After the excavation was complete, there was a depth of 35 ft. of water at low water, and the under-water method of driving piles was introduced.

This method caused considerable discussion on the work, some claiming that it would develop at least 85% efficiency as compared with the ordinary method of driving piles with a drop hammer. I may here say that the average penetration with the under-water method was only about one-half of what was obtained at the same location with a lighter hammer falling through air. In the under-water method, the guide pile and hammer were handled by a stiff derrick operated by a 25 h.p., 3-drum hoist. The guide, constructed of four 3½-in. steel angles, latticed together, was 22 in. sq., inside measurement, and all rivets were sunk on the inside. It was made in 15 ft. sections, capable of being bolted together to give the required length. Lugs riveted to the top section rested on crossed timbers on the cofferdams, and the guide hung therefrom, just clear of the bottom of the excavation and over the spot where the pile was to be driven.

The pile was then inserted in the guide and allowed to drop to the bottom. With heavy piles, as much as 10 ft. penetration was obtained in some cases right at the start. The hammer weighing about 5,000 lbs., was built to give a clearance of about ¼ in. all round inside the guide, and terminated in a truncated pyramid. The hammer was lowered into the guide after the pile and driving commenced, a fall of from 12 to 15 ft. being given. The fall was thus limited, as it was found that the pile heads broomed badly.

Prevented Interruption of Work

The piles used were exceptionally good, but many of them failed to stand up under this treatment. The maximum penetration obtained was 46 ft., whilst test piles, driven from the same location from a scow with a 24,000 lb. hammer and a trolly, gave a penetration of 65 ft.

However, the big advantage of being able to drive under water was that the work could go on at all stages of the tide, and this meant that at high water the driving was being done through 70 ft. of water. The condition of the old bridge was such that anything within reason which would hasten completion of the new could not be neglected.

The length of the bridge is 1,640 ft. The total amount of concrete used was 13,000 cu. yds. The contractors for the abutment and for piers 1 and 2 and 8 to 14 inclusive were Powers & Brewer, of St. John; for piers 3 to 7 inclusive, the Foundation Co., Ltd., of Montreal. G. G. Hare was the engineer for the Dominion Atlantic Railway, and the writer was resident engineer.

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PRINCIPAL CONTENTS

EFFICIENCY, PRODUCTION AND CONSERVATION CANADA'S NEEDS OF THE HOUR

CONSERVATION of material, in order to assist in national reconstruction, must find expression in the following eight measures, says a writer in the last issue of "Conservation," the official bulletin of the Commission of Conservation:—

(1) Increase the fertility of the soil and reclaim areas not under cultivation at present.

(2) Protect our forests from fire and reforest denuded areas.

(3) Guard certain species of fish and wild life against extinction.

(4) Exploit our mines conservatively, extracting the maximum output of ore.

(5) Develop our potential resources of hydro-electric power.

(6) Organize our manufactures to secure maximum efficiency and to recover by-products.

(7) Eliminate extravagance in consumption.

(8) Find an economic use for materials now treated as refuse.

This is a succinct statement of a very comprehensive program, and one that must be followed if Canada is to hold her own in the economic struggle. The second phase of conservation necessary for efficiency during the reconstruction period, is conservation of our human resources. As pointed out by the Commission of Conservation, work under this heading must include:—

(a) Efficiency in public hygiene and sanitation.

(b) Sound town-planning schemes and improved housing.

(c) Better roads and better organization of all systems of transportation, so that products may be conveyed from producers to consumers with minimum effort and expense.

Some of this work is beyond the jurisdiction of the Commission of Conservation, but that commission is performing useful service in repeatedly calling the attention of the public to basic requirements. With the active co-operation of the newly-organized departments of Public Health and Public Highways, the good work of the Commission of Conservation will be given a great impetus.

ONTARIO HIGHWAY AWARDS RESCINDED

TWO weeks ago the Department of Public Highways of the Province of Ontario announced the award of four contracts for the construction of 50 miles of the provincial highway; yesterday the deputy minister in charge of the department rescinded the awards and stated that the contracts would not be signed. The reason given is that the lowest tenders received were 50% higher than expected.

The specifications called for bituminous construction, penetration method. The lowest bid received for any section was $32,000 a mile; for another section the lowest bid was $40,000 a mile; while for the other two sections the lowest bids ranged between those two figures. These prices were exclusive of the cost of culverts.

W. A. McLean, deputy minister of the department, declares that the work will be carried out by day labor, and that a great saving will thereby be effected. The department, says Mr. McLean, pays labor 30 to 35 cents an hour, while contractors offer 45 to 55 cents in order to persuade men to enter their employment at once. "Time is more important to the contractor than to the province," says Mr. McLean. "The contractor loses money if he cannot finish the work quickly. The province can wait and engage men from the farms whenever they are willing to work for the wages offered. The fact that the province's plant is tied up for a long period is not considered to be a serious factor, whereas a contractor must keep his plant in more or less constant use."

The fact that the awards have been rescinded does not mean that the roads will not be built, says Mr. McLean, but they will be built at a slower rate and by provincial forces, but, he prophesies, at less expense. The change in policy regarding these awards involves more than the question of day labor vs. contracts, as Mr. McLean intimates that the department may construct water-bound macadam and gravel roads at first and may not surface them in any more permanent manner for a few years. That is, cheaper roads may possibly be built with the intention of using them, after consolidation by traffic, as foundations for more expensive types of construction such as asphaltic or tar macadam or cement-concrete. Mr. McLean states that the better types of surfacing will be laid as soon as the macadam has fully settled and that meanwhile the roads will be well oiled.

FAIR PLAY FOR THE G.T.R.

AS the pioneer railroad of Canada, the Grand Trunk Railway is entitled to the benefits of arbitration in establishing a fair price for its assets and prospects. Conferences are now being held in Ottawa by the prime minister of Canada, Sir Robert Borden, and the chairman of the G.T.R. directorate, Sir Alfred Smithers, and it is thought that the result may be mutually satisfactory without recourse to either litigation or arbitration. Should unforeseen difficulties be encountered, the G.T.R. should agree to a reasonable minimum payment and the government should agree to arbitrate, as there appears to have been a difference of more than $4,000,000 per annum between the G.T.R.'s earlier claims and the rental which the government offered in the first negotiations. The old G.T.R. deserves fair play.

PERSONALS

WILLIAM GORE, consulting engineer on the staff of the John ver Mehr Engineering Co., Ltd., Toronto, has tendered his resignation to that company in order to become a member of the new consulting firm of Gore, Nasmith and Storrie. Mr. Gore was born April 13th, 1871, at King's Lynn, Norfolk, Eng., and received his preliminary education at the King's Lynn Technical School. From 1888 to 1892 he was an articled pupil at the Highgate Iron Works, King's Lynn, and for the following two years was assistant engineer at that plant. In 1893 he won the Norfolk County Council scholarship and in 1894 the Witworth Exhibition scholarship, and entered the mechanical engineering course at the Technical College of the City and Guilds Institution of London, Eng., where he graduated in 1896. For more than a year after graduation, Mr. Gore was chief draftsman of the Western Electric Co., of Woolwich. In 1897 he joined the staff of the late George F. Deacon, consulting water works engineer, and was the latter's chief assistant until 1909, when, upon Dr. Deacon's death, the business was taken over by Sir Alexander Binnie. From 1897 to 1912 Mr. Gore had experience on many large water supply, sewerage, irrigation and hydro-electric projects in various parts of the world, including Great Britain, Russia, Italy, Greece, India and Australia. During that time he designed and constructed a considerable number of masonry dams. In 1912 Mr. Gore completed the invention of what is now known as the Ransome drifting sand filter, and joined the Ransome-ver Mehr Machinery Co., of London, Eng., for the purpose of developing that system of water filtration. When tenders were called in 1913 for a new mechanical filtration plant for the city of Toronto, the London company incorporated a Canadian branch, the John ver Mehr Engineering Co., Ltd., of Toronto, and obtained the contract for the construction of a plant of 60-million Imperial gallons daily capacity. It was stipulated as part of the contract between the city and the company, that the inventor of the process would reside in Toronto during the construction of the plant and until its acceptance by the city. As a result of this contract, Mr. Gore came to Canada and devoted most of his time to the new plant at Toronto Island until its formal acceptance several months ago. During the past few years Mr. Gore, in collaboration with Mr. Storrie, also designed and constructed small filtration units for the Collingwood fisheries, the Dominion Bank building at Toronto, and the Sun Life building at Montreal. He also designed and recently completed a filtration plant of 1,728,000 Imperial gallons daily capacity for the town of Oshawa, and an effluent disposal works for the Robson tanneries at Oshawa. Under Mr. Gore's direction, the ver Mehr Co. is now constructing a small filtration plant at Rockland, Ont. Mr. Gore is a member of the Institution of Civil Engineers of Great Britain, of which he is a George Stevenson gold medallist of the year 1907. He is also a member of the Engineering Institute of Canada and of the American Water Works Association.

G. CORDON COTTRELL, general manager of the Dominion Salvage and Wrecking Co., Toronto, has resigned.

HON. ANTONIO GALIPEAULT has been "sworn in" as Minister of Public Works in the Quebec provincial cabinet.

A. S. CLARSON, who a couple of weeks ago resigned the secertaryship of the Association of Canadian Building and Construction Industries, intends to re-engage in private practice in Montreal. Mr. Clarson was formerly city engineer of Verdun, P.Q.

THEO. J. LAFRENIERE, sanitary engineer of the Quebec Provincial Board of Health, is one of the three men named by the lieutenant-governor of Quebec as members of the provincial housing commission. Mr. Lafreniere is also a professor of sanitary engineering at Ecole Polytechnique, Montreal.

D. H. SCOTT, formerly assistant chief draftsman of the Manitoba Public Works Department, has been appointed chief draftsman, succeeding the late G. H. Baird. Mr. Scott enlisted early in the war and upon his return was attached to the Hospital Commission. He returned to the provincial works department in July.

E. A. JAMES, MAJ. T. R. LOUDON and LT.-COL. C. S. L. HERTZBERG, who have been the partners in the consulting firm of James, Loudon & Hertzberg, Ltd., Toronto, have decided to dissolve partnership. Mr. James will continue the present business, probably under the firm name of E. A. James, Ltd., while Maj. Loudon, Col. Hertzberg and a well-known Montreal engineer will establish a new firm as consulting and supervising structural engineers, with offices in Toronto and Montreal.

NEW CONSULTING FIRM, GORE, NASMITH & STORRIE, TO SPECIALIZE IN PUBLIC HEALTH

ANNOUNCEMENT has been made of the organization of a new firm of consulting engineers, Gore, Nasmith & Storrie, of Toronto, who will specialize in all forms of public health engineering, including water works, sewerage, sewage disposal and bacteriological research.

The partners in the firm will be William Gore, consulting engineer of the John ver Mehr Engineering Co., Ltd, Toronto; Col. Geo. G. Nasmith, director of laboratories of the Department of Health, city of Toronto; and William Storrie, chief engineer and general manager of the John ver Mehr Engineering Co., Ltd.

Both Mr. Gore and Mr. Storrie have tendered their resignations to the ver Mehr Co., but Mr. Gore's resignation will not take effect until other arrangements have been completed by Mr. ver Mehr for the management of the latter's Toronto office. Mr. Storrie's resignation took effect at the beginning of this month. It is not expected that Col. Nasmith will sever his relations with the city of Toronto until the end of this year, and meanwhile the work of the new firm will be carried on mainly by Mr. Storrie.

A detailed record of Mr. Gore's career appears in the "Personals" column of this page.

Col. Nasmith is a graduate of the University of Toronto and has received the degrees of M.A., Ph.D., D.Sc., and D.P.H. (Doctor of Public Health), and as a result of his sanitation work at the front for the British army, he was honored two years ago with the Companionship of St. Michael and St. George. He has been director of laboratories at Toronto for the past eight years.

Mr. Storrie is a graduate of the Glasgow and West of Scotland technical college. He came to Canada in 1909 as resident engineer on the construction of the slow sand filtration plant at Toronto Island. In 1912 he was appointed in control of the water works system at Ottawa during that city's second typhoid epidemic. In 1913 he returned to Toronto to accept the position from which he has just resigned. Early in 1918, Mr. Storrie went to England to take charge of the construction of several concrete ships for which the ver Mehr Co. had Admiralty contracts, returning again to Canada about two months ago.