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MISSING

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Lindsay-Strathmore Irrigation Flume

Self-Supporting, High Level Flume With Two-Inch Walls Was Built on Inside Forms by the Cement-Gun at the Rate of 130 Lin. Feet Per Eight-Hour Day—Nearly $1,500,000 Expended in Improvements to 15,500 Rich Acres in California

By STEPHEN E. KIEFFER
Chief Engineer, Lindsay-Strathmore Irrigation District

On the east side of the San Joaquin valley, in California, is the Lindsay-Strathmore Irrigation District, comprising approximately 15,500 acres. The greatest length of the district, from north to south, is about eight miles; the greatest width, from east to west, is six miles. The entire area is located in what is known as the citrus belt and will be devoted mostly to the production of citrus fruits.

Some time ago it became apparent that a more adequate water supply would have to be secured for this territory or existing orchards would be lost, not to speak of the impossibility of further development, so the district was organized and plans prepared for an irrigation scheme. Water has been secured from wells some distance north of the district and is pumped through pipe lines to an open canal through which the water flows by gravity for six miles to the main pumping station, where it is lifted to a high level bench flume which skirts the hills for a distance of about six miles, at an elevation sufficiently high to deliver water under pressure to most of the district. Steel pipes carry the water from this flume to the irrigated orchards.

Of the whole enterprising scheme no part is more interesting from an engineering standpoint than the construction of the above-mentioned high level flume described in the following article by S. E. Kieffer, consulting engineer of San Francisco, Cal., who was chief engineer for the district. The resident engineer in charge of construction for Mr. Kieffer was E. C. Eaton, a McGill University graduate, who had previously obtained considerable experience with C.P.R. irrigation projects.—EDITOR.

FIG. 1—CONSTRUCTING THE FORMS

THE Lindsay-Strathmore high level flume is rectangular, having an inside depth of 3.5 ft. and a bottom width of 5.75 ft. The side walls are 2" thick, built of cement mortar applied with a cement-gun, reinforced with woven wire mesh, No. 6 wires, 4" spacing both ways; reinforcement not galvanized. At the top, the side walls terminate in a longitudinal beam 4" deep and 6" wide, reinforced with 2 3/8" square twisted bars around which the side reinforcement is bent.

At the junction of the sides with the floor there is a 4" x 4" fillet, each fillet reinforced with a 3/8" square twisted bar.

Cross-ties tie the beams together at the top every 8 ft. in the length of the flume. These consist of a ¾" twisted square bar around which is cast a 2" x 2" concrete block for protection against rust.

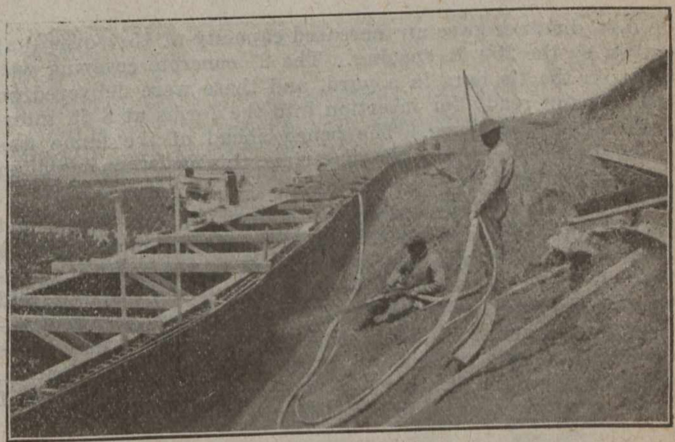


FIG. 2—SHOOTING THE WALL

Where the flume rests on solid cut, the floors are 2½" thick, reinforced with woven wire mesh, No. 12 wires, 5" and 9" spacing. This reinforcement is laced to the side reinforcement with a No. 10 wire. Over fills, the bottom thickness in increased to 3" and the reinforcement made the same size as that used in the walls.

The length of the flume line is 30,030 feet, laid on a grade of 5 ft. per mile, located for the greater part of its distance on a bench cut out of the steep side hill. No trestles are used in crossing water courses, solid fills being used throughout. These were limited to a maximum height of 10 ft. and an average of 6 ft.

The structure is a monolith throughout, no expansion joints being used. Reinforcement was designed for an average maximum range of temperature of 40 deg. Fahr. The actual maximum seasonal temperature range is 90 deg. Fahr. No effort was made to guard entirely against temperature cracks. Only small hair cracks have appeared and these rapidly took up from efflorescence. The structure is entirely tight. The maximum daily temperature recorded during construction was 125 deg. Fahr., and the average maximum daily temperature for one month was 112 deg. Fahr.

The mix adopted was 4½ parts of coarse sand to 1 part cement with 10% hydrated lime added.

Construction Methods

The reinforcing mesh was delivered in rolls 5 ft. in width and 100 ft. long, a 5 ft. strip giving the required width to allow for turning over the beam on top and to lap one mesh with the bottom reinforcement. Sand, cement and lime were placed at 100 ft. intervals in piles. These were first placed at 200 ft. intervals, but it was found that using the

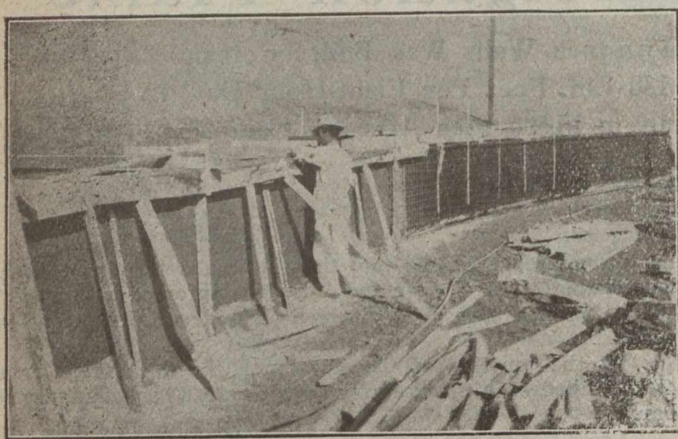


FIG. 3—MOULDING BEAM ON FINISHED WALL

100 ft. distance gave an increased capacity of 15% over that given by the 200 ft. spacing. The 2" concrete covering was cast on the tie bars in a yard, and these were delivered on the ground ready for insertion into the forms at 8 ft. intervals along the flume. The bench ahead of the flume was used for the hauling of the materials, this assisting in rolling down the fills.

A narrow-gauge track was laid on a light trestle just below the bench and on this the cement-gun, mounted on a small car, was run to keep within 50 ft. of the point of application. The gun was made by the Cement-Gun Co., Inc., and was of the type known as "N2." It was found more economical to operate this gun with a 50 ft. length of hose, thus keeping the gun within 50 feet of the point of application, than to use a 100 ft. length of hose, an increased capacity of 15% resulting from using the shorter length.

The temperature during the summer season frequently reaches 115 deg. in the shade (absolute maximum, 125 deg.), and it was found necessary to sprinkle the sand before shovelling into the gun, a small amount of moisture being necessary to hold the material together and to fill the voids partially in order to prevent the air passing through the sand instead of forcing it through the nozzle.

Two trucks were coupled to the rear of the truck carrying the gun, the one next to the gun holding a rectangular box about 6 ft. long by 4 ft. wide by 1 ft. deep, equipped with a screen, and the rear truck carrying the measuring box, into which a measured quantity of cement, sand and lime was placed, mixed dry and shovelled through the screen into the forward box, after which it was shovelled into the gun.

Two rubber nozzles were provided: One at the discharge nozzle where the material is applied; and one at the connection between the gun and the 1½" discharge hose. These two rubbers were worn out and required replacement after about 300 cubic yards of material had been placed.

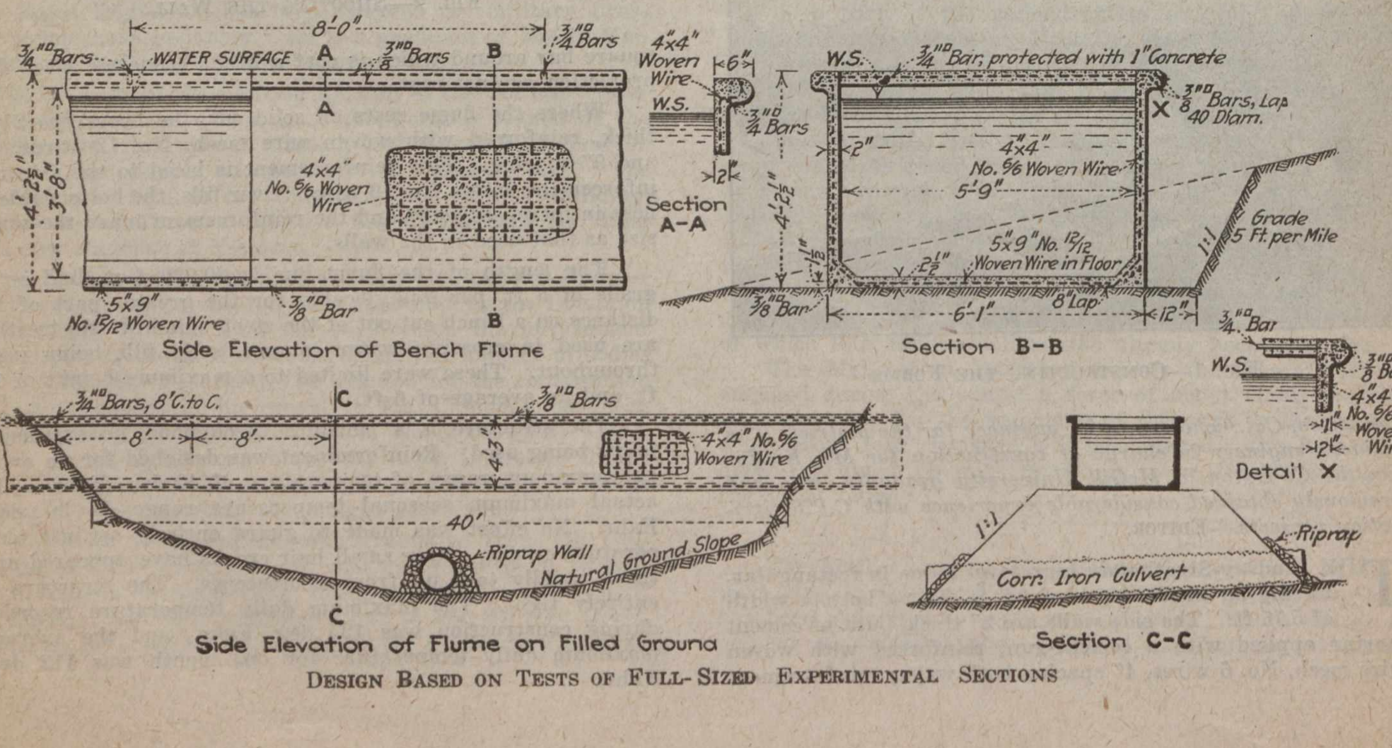
A special air compressor was supplied by the makers of the cement gun, very compact, driven by a gas engine and all mounted on a steel truck. This was kept on the bench ahead of the actual construction work at a distance of not over 500 feet, and a 2" standard pipe run back to the location of the gun. This line was provided with tees every 100 ft. to connect with the gun. An air pressure of 45 lbs. per square inch was kept up at the compressor.

Water for the gun was supplied by means of a 2" x 3" double cylinder pump, driven by a gas engine, which was mounted on a truck carried on the track behind the cement gun, with a 1" wrought iron pipe laid from it to the nozzle. Water for the gun and curing the flume was pumped from wells in the valley under a head of about 250 ft. into the upper end of the flume, flowing down the flume to the work. The flume was bulkheaded at close intervals and kept filled with water, from which the pumps for the gun and spraying got their supply.

Forms

Inside forms only were used, and were made up in 8 ft. sections from 1" T. & G. flooring with 2" x 2" studs, except at the ends, which were 2" x 4". These were placed on the finished grade and cross-braced from one side to the other with diagonal braces. These forms were kept well oiled.

Standard curves having radii of 25, 50, 100, 150, 200 and 250 feet were used. Forms for curves up to 150 ft. radius were made up in 8 ft. sections with a wood framework over which a light steel plate was fastened. Curves with the



DESIGN BASED ON TESTS OF FULL-SIZED EXPERIMENTAL SECTIONS radii of 200 and 250 ft. were made segmentally by using the straight 8 ft. wooden form sections. It was found that the wood form was superior to the steel, since considerable difficulty was experienced in making the cement mortar adhere sufficiently to the steel surface to prevent "overhang."

Fills

Fills were constructed about 8 months ahead of the flume construction, and before the winter rains had stopped. Specifications call for wetting and tamping fills in thin layers. On those fills still showing any considerable amount of settlement, three longitudinal beams of concrete were placed running down to solid material, and flush with the bench grade on which the flume was constructed. Culverts are placed under the flume at all water courses. Cross drains of 6" sewer tile were placed under the flume at intervals of about 400 feet to take care of drainage from above the bench.

Placing Reinforcement

The reinforcement in the side walls was placed 1¼" from the inner face of the flume. 1¼" x ½" bars were placed between the form and the reinforcing wire to hold this in position until the "gunite" had been shot up to these bars, when they were removed.

Order of Work

The side walls were shot first and immediately followed up with the beam, a form being clamped to the wall form and the beam poured by hand. The rebound or wastage on the side walls was caught on canvas and used immediately with additional cement to form a beam which was mixed and placed by hand.

Forms were left on 24 hours, when they were removed and the floor shot with the gun. On the completion of the floor, a wood dam was placed at the end of the completed section and a hole cut in the dam of the preceding day's work to admit water. The flume was kept continuously full of water in the completed sections.

Immediately after the side walls were constructed, burlap was hung over them and kept sprinkled with a hose during the day until such time as the water was admitted to the flume. This method of curing resulted in no serious cracks showing up in the entire length of the structure. The re-

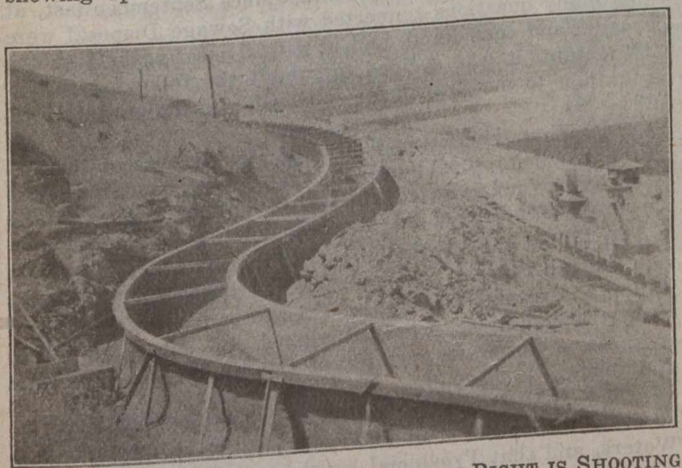


Fig. 4—Inside Forms Removed—Gun at Right is Shooting the Bottom—Temporary Supports for Beam Forms Still in Place

bound amounted to an average of 10% of the material deposited.

Sidewalls were shot in two layers, one up to and over reinforcement, or 1½" thick, after which a set of about 20 minutes was allowed when the final ½" coat was applied.

Crews and Rate of Progress

An average crew was made up of one gun operator, one nozzleman, one nozzleman's assistant, one compressor operator, one laborer shovelling sand, two laborers screening, four laborers mixing and turning material, ten laborers finishing grade and wrecking forms, four men placing steel, three men setting forms, and two men moulding beams.

The average rate of progress with a crew of this size, working eight hours, under existing conditions, was 130 lin. ft. of flume, or 147 cu. yds. of material per day.

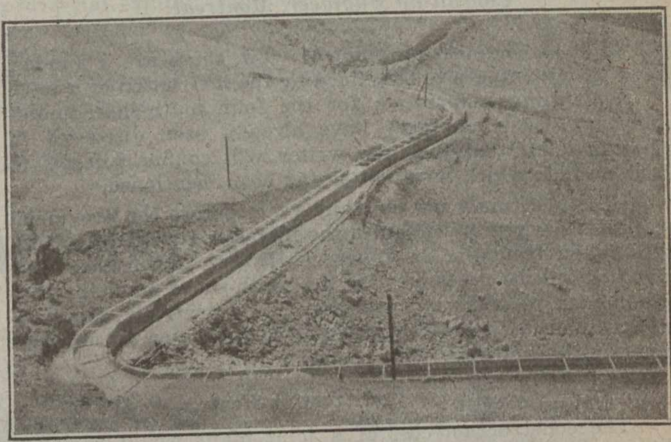
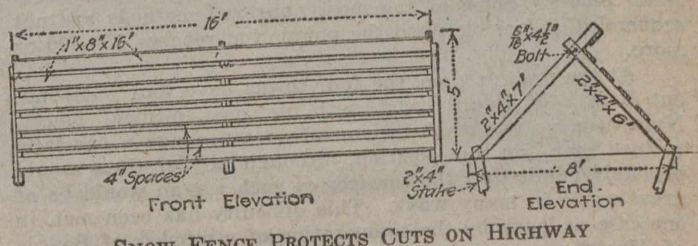


Fig. 5—Flume Follows the Hillside

The flume was designed and constructed under the supervision of the writer, the contract for the work being carried out by James Kennedy, of Los Angeles.

SAND AND SNOW FENCE PROTECTION ON COLORADO ROADS

Four cuts on a state primary road in Colorado over a high divide between Fort Collins and Loveland have in past years blown full of snow several times during the winter. This stretch is through dry sandy land with little vegetation to obstruct a full sweep of the wind. This year the road is protected by portable snow fences of the design shown in the accompanying cut.



Snow Fence Protects Cuts on Highway

During one recent winter traffic was stopped five or six times for several days. In fact the road could hardly be opened before another wind again filled the cuts level full. As the cost ran up to several hundred dollars the officials decided to install seventy-seven 16-ft. panels to protect all four cuts. The cost per panel amounted to $3.62, including construction and placing.—From Engineering News-Record, of New York.

Officers for the coming year were elected last Tuesday evening by the members of the Toronto Branch of the Engineering Institute of Canada. A. W. Harkness, consulting engineer, was elected chairman; W. S. Harvey, construction engineer of the Leaside Munitions Co., secretary. Members of the executive committee: H. G. Acres, hydraulic engineer, Hydro-Electric Power Commission of Ontario; W. A. Bucke, of the Canadian General Electric Co., Ltd.; and Willis Chipman, consulting engineer.

COLLECTIVE PUBLIC SERVICE OPERATION*

As Proposed for the Four Towns on the South Shore of the St. Lawrence River, Opposite Montreal

By Roger DeL. French
Consulting Engineer, Montreal

FROM an engineering point of view, there are a number of advantages to be gained by the institution of a town planning commission for the four south-shore municipalities. Some of these have already been discussed in other articles, therefore the writer will confine himself to three or four which have not so far been mentioned.

It will certainly not be many years before the provincial health authorities will require the filtration of all water supplies taken from the St. Lawrence River. When that time comes, it will be necessary for the south-shore municipalities either each to erect and operate a comparatively small filtration plant, or to join together in building one of sufficient capacity to meet their joint needs.

Lower Construction Cost

The construction cost of a joint plant would be lower than for a number of separate plants having the same total capacity, and the operating costs should also be less. Moreover, it will then be financially possible to engage the services of a trained operator, and thus the efficiency of the one large plant will be much higher than would the efficiencies of three or four separate plants.

It is also probable that the discharge of untreated sewage into inland waters will eventually be prohibited. Already the Dominion Government has taken some steps along this line. When it becomes necessary to treat the sewage from the four municipalities on the south shore, a single large plant can be more cheaply provided than can four small ones.

The remarks with regard to the operation of a water filtration plant apply with equal force to the operation of a sewage disposal plant. A single large plant would probably be located at some point below Longueuil, and thus the entire river front within the district would be safeguarded against pollution, and kept in a clean and sanitary state for the enjoyment of the citizens.

The collection and disposal of garbage, rubbish and ashes is always something of a problem in comparatively small places. Some of the most approved methods are not economically feasible until the population reaches 100,000 or more.

At the present time, the four towns have four independent Boards of Health, each with its own medical officer. Naturally, no one of them can afford to engage a specially trained man for this position, although any of them would probably admit that the services of such a man would be of great value in many ways. This difficulty has been met, in one case at least, by the co-operation of a number of Boards of Health in engaging jointly, at a respectable salary, a medical officer who divides his time among the several boards by whom he is employed, as may seem to him necessary, or as they may agree. Some such arrangement is quite possible on the south-shore.

Could Establish Gas Plant

From time to time in the past, there has been more or less agitation looking toward the establishment of a plant for the manufacture of fuel gas in this locality. The writer was personally connected with one such project some years ago, which failed to be realized because it was not found possible to secure satisfactory franchises from all the territory desired.

Supplying gas to a smaller population than that represented by St. Lambert, Longueuil, Montreal South and Greenfield Park is an enterprise which would not probably pay its own way. But if all the municipalities could be induced to grant reasonable terms it is the writer's belief that capital could be interested in the scheme, and it is not necessary to say that the service is badly needed.

The natural location for a gas plant would be at some point in the eastern part of the territory, with good railway connections and on deep water.

It may be said that all the matters discussed above might be accomplished without the appointment of a Town Planning Commission. This is quite true, but some central board would necessarily have to be created to administer such joint schemes are suggested. As there are other reasons why a Town Planning Commission seems desirable, it might as well control the water supply, sewerage, public health, etc., as to have these utilities under the direction of a separate board.

Precedent for Joint Board

The only novel procedure suggested is the consolidation of all such authority in one board. There are many instances where co-operative commissions have been created for one or two particular purposes, such, for example, as the Metropolitan Water and Sewerage Board of Massachusetts, which supplies Boston and eighteen other municipalities in that vicinity with water, and also takes care of the sewage of the city and twenty-six towns.

In Canada, the Vancouver and Districts Joint Sewerage and Drainage Board, constituted in 1913, and has jurisdiction over municipalities on the Burrard Peninsula. There are numerous other instances of similar joint commissions.

*From the South Shore Board of Trade Review.

ENGINEERS MEMORIALIZE ONTARIO GOVERNMENT ON PUBLIC HEALTH MATTERS

WITH the approval of the Council of the Institute, a memorial was presented yesterday to the Provincial Secretary of Ontario, by the Toronto, Ottawa and Hamilton branches of the Engineering Institute of Canada. The memorial consisted solely of the report that was made January 14th, 1918, to the Toronto Branch by the Committee on Sewage Disposal, as follows:—

"The Committee appointed by the Toronto Branch re Sewage Disposal has held five meetings since September last, at which many questions connected with Sewage Disposal were discussed and considered, and at a final meeting held on the 14th instant, it was decided to submit the following recommendations to the Branch for submission to the parent Institute:—

"1.—That the Provincial Public Health Acts of the different provinces should provide that two or more members of each Provincial Board of Health shall be engineers and Corporate Members of the Engineering Institute of Canada.

"2.—That the Provincial Public Health Acts should provide that all reports, plans, etc., respecting schemes for sanitation and sewage disposal required to be filed by Provincial authorities, shall be prepared, signed and submitted by an engineer, a Corporate member of the Engineering Institute of Canada.

"3.—That Dominion legislation should be enacted respecting the pollution of International and Inter-Provincial Waters, and that Provincial legislation in the different Provinces respecting stream pollution be made uniform as far as practicable.

"4—That the Public Health Acts of each Province should give to the Provincial Boards of Health some measure of control over the operation of municipal water purification plants and sewage disposal works.

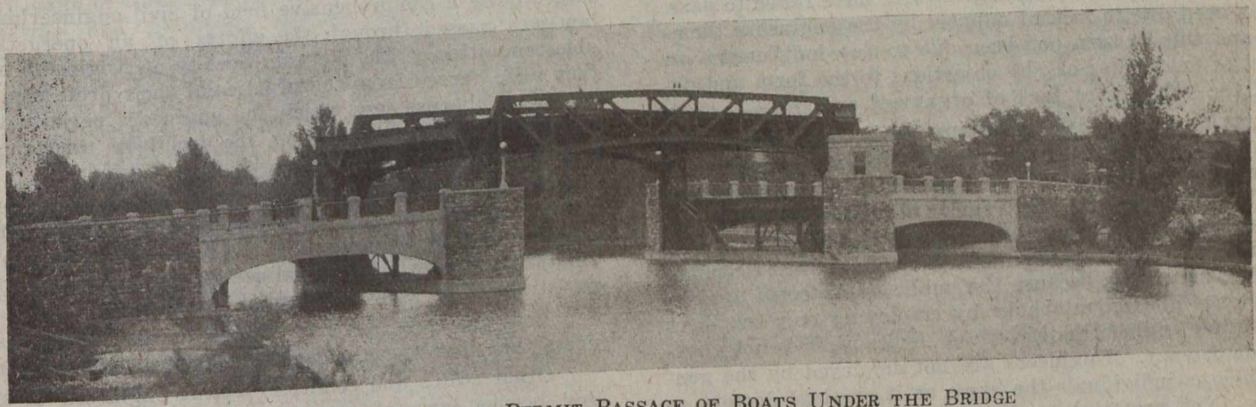
"5.—That all Provincial Public Health Acts should stipulate that no municipality can submit to the votes of the electors and by-law for the raising of money for the construction, alteration or extension of any water works system of water purification works, or of any sewage system or sewage disposal works, without having had the approval of the Provincial Board of Health, based on plans, reports and designs submitted by engineers.

"6.—That the keeping of accurate and up-to-date records of all extensions and services added to sewer and waterworks systems, should be required of municipalities by the Provincial Board of Health. Where municipalities have no system of their own for keeping such records, the adoption of a method endorsed by the Provincial Board might be insisted upon.

"7.—That where Provincial Boards of Health maintain laboratories for the investigation of problems of public sanitation, such laboratories might, under reasonable conditions, and with much advantage to the country, the engineering profession and the Boards themselves, be placed at the disposal of this Institute and through it, of its members, who have problems in municipal sanitation for which they desire solutions.

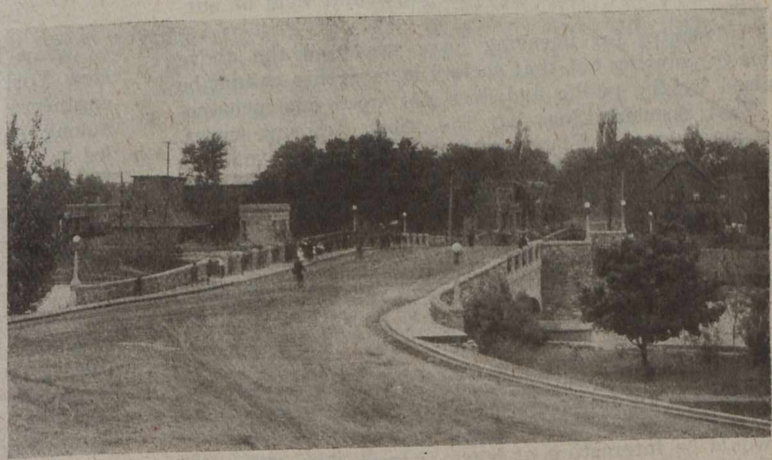
"Committee.—Peter Gillespie, associate professor of Applied Mechanics, University of Toronto; Fred A. Dallyn, provincial sanitary engineer, Ontario; William R. Worthington, engineer of sewers, Department of Works, Toronto; Irving H. Nevitt, engineer-in-charge of Sewage Disposal Works, Toronto; Willis Chipman, chairman, consulting engineer, Toronto."

PRETORIA AVENUE LIFT BRIDGE, OTTAWA

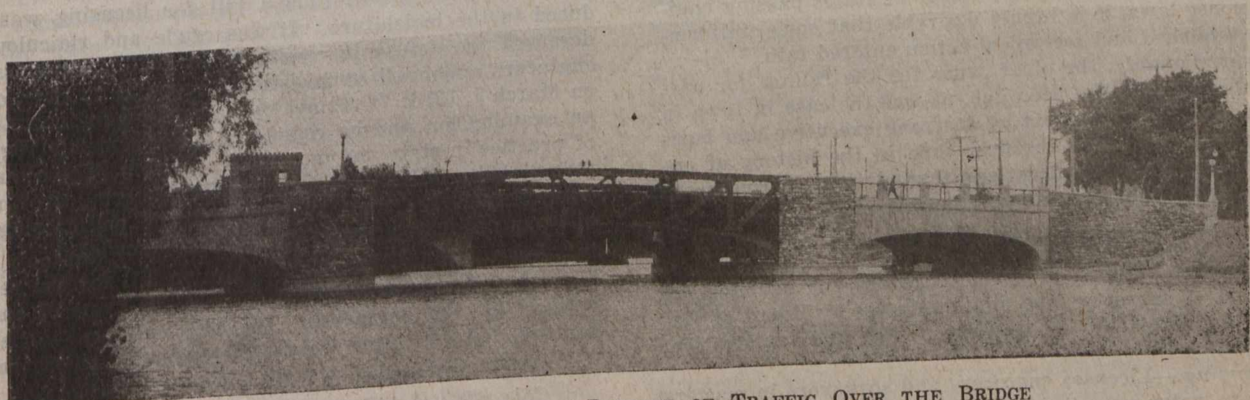


Lift Span Raised to Permit Passage of Boats Under the Bridge

THIS bridge, described in the Jan. 20th and July 6th, 1916, issues of *The Canadian Engineer*, is now in operation. It consists of a 95 ft. lift span and two 52½ ft. spans. The central, or lift span, which is of Strauss design, has a vertical movement of twenty feet, affording a clearance 30 ft. high and 80 ft. wide. The span is raised or lowered by electric motors in one minute. R. Brewder, of Ottawa, was the contractor, the Dominion Bridge Co. fabricating and erecting the steelwork. Robt. Henham, bridge engineer for the city, was in charge of construction, under the supervision of A. F. Macallum, commissioner of works.



Approaches Artistically Planned



Lift Span Lowered to Permit Passage of Traffic Over the Bridge

ENGINEERING LICENSE LAWS

Report of Committee to American Association of Engineers on Existing and Proposed Bills

BY courtesy of C. E. Drayer, secretary of the American Association of Engineers, an advance copy has been given to *The Canadian Engineer* of the preliminary report just made by the Association's Legislative Committee. The committee was directed on September 5th, 1918, by the Executive Board to gather information concerning state engineering license laws, either proposed or in operation, and to draw up a standard license law.

L. K. Sherman, chairman of the Legislative Committee, now reports as follows:—

Most Bills Have Failed to Pass

Most of the bills for engineers' license laws that have been introduced into the state legislatures have failed to pass. This has been due to lack of support by the engineers themselves, and this in turn has been due to (a) indifference on the part of engineers; or (b) objections to the form and details of the bill; or (c) lack of organized support.

A review of the first agitation for license, about 1909, records marked opposition on the part of many engineers. The American Society of Civil Engineers, the Boston Society of Civil Engineers, and the Pennsylvania Society of Engineers, all passed resolutions against the enactment of Engineers' license laws. Among the arguments against licensing were: Not necessary, because the public is protected against incompetence and mountebanks by employing only members of high-grade engineering societies. A license does not guarantee competency. Engineers are not employed by the general public as individuals the same as it employs doctors or lawyers. Not practical to define any comprehensive engineering work, must limit law to one particular field or surveying, etc.

The advocates for licensing have answered the above objections in pointing out that society membership cannot be reorganized by the public and does not weed out incompetency. That licensing does bar the most flagrant cases. That the physicians' and lawyers' licenses do not prevent the appendicitis patient from employing an eye and ear specialist, or the applicant for a divorce employing a corporation attorney, and yet such licenses are of recognized public service. The architects, doctors, lawyers, to say nothing of the plumbers, engine men, and barbers are licensed, and they have found it desirable for themselves and have demonstrated to the state legislature and to the Supreme Court that it was desirable for the public.

While there is no official record, there appears to be a growing opinion in favor of engineers' license laws, more especially in the States where such law exists.

It would be interesting at least, if upon the submission of a proposed license law by this committee, the matter was referred to a referendum vote of the Association.

In view of the increasing number of states passing engineers' license laws, it is highly desirable that some uniformity be established and reciprocal action entered into.

Unquestionably, the chief cause for the failure for passage of license acts has been due, as was the case in Iowa in 1910, to the lack of support by a strong executive and business organization. For the first time in the history of engineering societies the American Association of Engineers now furnishes that executive organization.

Existing License Laws

Louisiana.—Passed in 1908. Provides for examination and license of surveyors and civil engineers by Board of Examiners appointed by the Governor. Fee and registration, $12.00.

Wyoming.—Licenses engineers and surveyors in matters relating to water conservation and irrigation work. Examining Board consists of state engineer and two other engineers appointed by the Governor. Fee, $5.00.

Illinois.—Passed in 1915. Provides for the licensing of all persons practising structural engineering. Defined as follows: "any person engaged as principal in the designing and supervision of construction of structures designed solely for the generation of electricity or for the handling of coal, cement, sand, gravel, or similar materials, elevators, manufacturing plants, docks, bridges, blast furnaces, rolling mills, gas producers and reservoirs, water tanks, sanitary works as applied to the purification of water, or plants for waste and sewage disposal, roundhouses, railroad shops, pumping stations, or power houses shall be considered as structural engineers."

Board of five examiners appointed by the Governor. Plans to be stamped with license seal of engineer. Reciprocity arrangement with other state licensed engineers. Fee and registration, $51.00. Annual fee, $10.00.

Although entitled "a structural engineers' law" it really covers quite a comprehensive field of civil engineering. The law was passed through the efforts of an energetic and able committee of the Western Society of Engineers because they were barred from the practice of their profession by an architects' license law which the engineers permitted to be passed in 1897. At that time the architects throughout the country began to have such legislation affected.

Florida.—Passed in 1917. This law covers the practice of civil engineering. It is almost identical in form with that suggested by the committee of the American Society of Civil Engineers and which is outlined below. Examination and registration fee, $25.00. Annual fee, $5.00.

Your chairman has been advised by several Florida engineers that the law is considered desirable and satisfactory.

Other states and countries having engineers' or surveyors' license laws of various degrees of requirement are: California, Idaho, South Dakota, Canada, and City of Mexico.

Proposed Laws

New York.—In 1910 or 1911 bills were introduced in the New York legislature by the Technical League for licensing engineers. Objection to the form and division of opinion among engineers defeated these measures. The agitation led to the appointment in 1910 of a Committee on Legislation by the American Society of Civil Engineers. The Board declaiming: "that it was the sentiment of the Board that the A.S.C.E. use its influence in the proper formulation of legislation affecting the practice of engineering."

The committee submitted a proposed form of law which was afterward, in 1911, slightly altered by the Board, who presented the same with the prelude: "The Board of Direction of the A.S.C.E. does not deem it necessary or desirable that civil engineers be licensed in any state. If, notwithstanding, any state legislature deems statutes covering the practice of civil engineering desirable, the following draft is recommended: (Synopsis of this is given below and may be found in detail in Transactions of A.S.C.E.)

Pennsylvania.—In 1909 a bill for licensing was introduced in the legislature. It was crude and ridiculous, and deserved the defeat it received. In 1913 a commission of engineers appointed to investigate reported to the Governor on March 2, 1916: "Does not recommend all engineers to pass an examination and be registered. Recommends regulation of practice in state and municipal service." The commission formulated a bill similar to the A.S.C.E. form, covering very comprehensively many specific lines of engineering. The bill was not introduced to our present knowledge.

Iowa.—In 1916 a carefully drawn bill for the registration of civil engineers failed to pass for want of energetic support of the engineers. The bill contained some novel features but which are worthy of serious consideration.

Ohio.—Introduced in 1910. Failed to pass.

Colorado.—A bill formulated by the Colorado Secretary of Civil Engineers is submitted to engineers for suggestions to the committee by W. L. Drager, Denver Colo.

(Concluded on page 535)

DISSOLVED OXYGEN AS AN INDEX OF POLLUTION*

By Kenneth Allen,
Engineer of Sewage Disposal, Board of Estimate and Apportionment, New York City.

EVER since the appointment of the New York Harbor Pollution Commission in 1903, a systematic attempt has been made to keep track of the pollution of the harbor water. The Metropolitan Sewerage Commission, Dr. Geo. A. Soper, president, recognized the value of dissolved oxygen determinations as a measure of the digestive capacity of the water and, inversely, of its pollution, and tests begun by the Commission in 1909 have been continued by the Board of Estimate and Apportionment of the city, of which Nelson P. Lewis is chief engineer, to the present time.

The results of these tests are very significant and show a surprising and persistent decline in the degree of saturation in all parts of the harbor, especially in the Harlem and lower East Rivers. As is recognized by sanitary engineers conversant with the situation, this is a matter of considerable importance to the welfare of this great seaport, and especially to those living or owning property in the vicinity of its shores. The purpose of this paper is to show to what extent the pollution of the main parts of the harbor has progressed, as made manifest by determinations of dissolved oxygen.

In all 2,342 samples were analyzed by the Metropolitan Sewerage Commission and 1,859 by the Board of Estimate and Apportionment.

In the interpretation of results a distinction must be made between those tests made in cold weather and those made in summer. While there is a progressive decrease in the warm weather saturations, the winter figures remain high throughout. Even as late as April this holds good, as will be seen from the following:—

In April of this year, the percentage saturation found in the Hudson River varied from 70.8% to 73.3%; in the Harlem River from 69.8% to 79.0%; in the Lower East River, from 76.0% to 79.3%; in the Upper Bay, from 62.0% to 77.0%; and in the Kill van Kull, from 65.5% to 68.0%.

The lowest average percentage of saturation is seen to be 62% while others range up to 79%; a condition of the water that in this regard may be called entirely satisfactory.

The general conclusion to be drawn from this is that there is no danger of the development of putrefactive conditions with their attendant odors in any of the main bodies of water in New York Harbor during the cold months of the year. And, as a corollary, it follows that for an indefinite time no steos to prevent such putrefactive conditions during cold weather will be necessary. In fact, the saturation figures are so high that even fish life, which in general may be said to require about 50% dissolved oxygen, is not likely to be seriously affected. (N.B.—This refers to the water of the main channels only).

The significant determinations are therefore those made during the warm months, and for our purposes those confined to the months of June, July, August and September only have been compiled, the averages at certain stations being as follows:—

Table I.

	1909*	1911*	1913*	1914	1915	1916	1917
The Narrows	83%	76%	69%	68%	78%	63%	63%
Upper Bay—Robbins Reef	67	72	66	71	72	64	50
Hudson River	72	62	57	50	43	46	42
Harlem River	55	42	29	30	28	24	22
Upper East River ..	86	69	..	50	..	..	47
Lower East River ..	65	54	43	40	33	26	29

*A few of these were tested between October 1st and June 1st.

*Paper read last week before the American Public Health Association.

The latter show graphically the general increase of pollution in the harbor. Stated roughly, we may say that in the Harlem River and the East River there is but half as much dissolved oxygen in summer as there was in 1909, and in the rest of the harbor but about three-fourths as much as in that year. The increase in population during this period directly tributary to the harbor (omitting New Jersey), which is the chief contributing factor in the depletion of oxygen, is shown in Table II.

Table II.

Estimated population of New York City directly tributary to certain branches of the harbor:—

	1909	1917	Increase
Upper Bay and Narrows ..	526,000	712,000	35%
Hudson River—Lower	711,000	855,000	20%
Harlem River	620,000	833,000	34%
Lower East River	2,107,000	2,709,000	28%

Now, while odors may occur with the discharge of large volumes of septic sewage or by the generation of gas bubbles by fermentation of the underlying sludge, they are not *produced* in polluted water until the dissolved oxygen is entirely used up. The change is then rapid to the putrefactive stage with its repulsive odors. The importance of avoiding this condition is evident, and it follows that *minimum* saturations are of prime significance. These, for several points in the harbor, are given in Table III.

Table III.

Minimum degree of saturation with dissolved oxygen observed at certain stations in New York Harbor:—

	1909	1911	1912	1913	1914	1915	1916	1917
The Narrows ..	65%	62%	61%	43%	45%	54%	48%	46%
Robbins Reef ..	62	64	53	38	70	58	51	42
Hudson River								
Pier "A" ...	57	49	51	25	31	25	29	25
155th St. ..	55	57	..	..	36	22	25	20
Spuyten Duy'l	55	68	..	50	64	35	28	..
Harlem River								
Morris H'ghts ..		46	..	..	6	8	..	1
Willis Ave..	54	29	..	..	0	6	1	0
Lower East River								
23rd Street..	52	..	..	39	28	19	8	10
Pier 10	52	49	49	13	19	22	17	19

As the worst conditions naturally occur near sewer outlets and at other points near the shore where currents are retarded and where deposits of sludge have formed, we may infer from these figures that:

(a)—The conditions in the Lower East River and the Harlem River are such that local nuisances from foul odors may be looked for at any time after several days of very hot weather.

(b)—The conditions in certain parts of the Hudson River and of the Upper East River are approaching those that already obtain in the Lower East River.

The operating and traffic departments of the Canadian National Railways (formerly the Canadian Northern Railway, the Intercolonial and the Transcontinental) have taken over the building formerly known as the Imperial Hotel, on Adelaide Street East, Toronto.

Many delegations have interviewed the Ontario Cabinet in an effort to influence the choice of route for the proposed provincial highway through the southwestern counties. Premier Hearst has stated that the cabinet will be influenced in their decision only by the Highways Department's report on distances, grades, costs, character of traffic, population served, grade crossings, etc.

ELECTRIC POWER GENERATION IN ONTARIO ON SYSTEMS OF HYDRO-ELECTRIC POWER COMMISSION

By Arthur H. Hull

Assistant Electrical Engineer, H.E.P. Commission of Ontario

(Continued from last week's issue)

THE St. Lawrence system at the present time has no generating station owned by the Commission. Power is secured by contract from the hydrauic station of the M.F. Beach Company at Iroquois, but the amount obtainable proved inadequate and was supplemented by power obtained from the steam generating station of the town of Brockville. As additional power is needed arrangements are now being made to obtain an adequate supply from another source, near Cornwall. To take this power the Commission is now constructing a transforming station near Cornwall which will contain one bank of three 1,250-kv-a., single-phase, 63,500/26,400-volt, 60-cycle transformers connected star-delta, and switching equipment for two incoming 110,000-volt circuits and for two outgoing 26,400-volt circuits.

This system now supplies power to Brockville, Prescott, Morrisburg, Winchester and Chesterville.

Rideau System

A new network is being developed called the Rideau system and covering a district in the neighborhood of the Rideau River. Plans are now being prepared for a hydraulic generating station at High Falls on the Mississippi River near Clarendon, a point 50 miles northerly from Kingston, Ontario. The installation at this point will consist of four 350-kw., 2,200-volt, three-phase, 60-cycle, 300-rev. per min. horizontal generators connected to two turbines, one generator being at each end of turbine; and one 875-kv-a. 80 per cent. power factor, three-phase, 60-cycle, 2,200-volt, 300-rev. per min. generator direct-connected to its turbine with necessary switching and transformer equipment to transmit the full 2,100-k.w. output, at 26,400 volts to the Rideau system.

A portion of this system is now in operation, power being obtained at 26,400 volts, three phase, 60-cycles, under contract from the Rideau Power Co. at Merrickville, and transmitted to Smith Falls where at the substation the municipality's own generating stations are paralleled with this system on the lower tension bus.

This system may ultimately be connected with the St. Lawrence System.

Niagara System

The Niagara system comprises all lines and sub-stations that receive power from Niagara Falls, and covers the entire district from Niagara River to the Detroit River and River St. Clair and north to Goderich and Harriston and east to Toronto. Power is received at a transformer station at Niagara Falls from the Ontario Power Co. (now controlled and operated by the Commission) and from the Canadian Niagara Power Company, at 12,000 volts, three phase, 25 cycles, and is transformed to 110,000 volts and to 45,700 volts for transmission. There is now installed in the Niagara transformer station 132,000-kv-a. of 110,000-volt transformers in eight banks and 42,000-kv-a. of 45,700-volt transformers in four banks, not including spare units. Four banks of 110-000-volt units are composed of twelve 7,500-kv-a., single-phase, shell-type, 12,000/63,500-volt transformers, all other transformers being of 3,500-kv-a. rating. This station, in point of transformer capacity, is the largest in the world, having a total capacity of 174,000-kv-a., with 7,000-kv-a. in spare units additional.

Four outgoing 110,000-volt circuits feed to Dundas transformer and switching station and from there power is distributed to thirteen 110-000-volt transformer stations. Four 45,700-volt lines feed to Welland to the sub-stations of the Electric Steel and Metals Company, the Union Carbide Co. and the city of Welland. From this latter point a single-circuit, 45,700-volt line runs to Dunnville.

This system was placed in operation in October, 1910. The accompanying curve shows the monthly increase in power load of municipalities on this system from October, 1910, to October, 1918. This gives some idea of the growth of the system in this period, but the latter portion of the curve cannot be regarded as normal owing to the increase in power required for munitions manufacture and the consequent restrictions on other uses to cut their requirements to a minimum.

The transmission net work on this system contains 760 miles of 110,000-volt circuits; 65 miles of 45,700-volt circuits; 529 miles of 26,400-volt circuits; 489 miles of 13,200-volt circuits; 27 miles of 6,600-volt circuits; 180 miles of 4,000-volt circuits; and 20 miles of 2,200-volt circuits. The 110,000-volt and 45,700-volt circuits are carried on steel towers (with exception of one 45,700-volt line from Welland to Dunnville), while the other circuits mentioned above are standard wood pole line construction.

The Commission early in 1917 purchased the Erindale Power Company which had a hydraulic generating station on the Credit River at Erindale, 14 miles west of Toronto, containing two 600-kw., three-phase, 60-cycle, 13,200-volt, 200-rev. per min. generators, each direct-connected to a 1,000-h.p. turbine designed for a 60-ft. head. The present operating head is about 50 ft. Water is carried from the dam to the power house through a 12 ft. 6 in. diameter tunnel 900 ft. long. Two 60-kw. belted exciters furnish the excitation.

The output of this generating station is now transmitted to the Cooksville transformer station at 13,200 volts, 60 cycles, and is fed into the 13,200-volt, 25-cycle bus in that station through a 1,000-kv-a., 60/25-cycle frequency changer set, augmenting the power supply on the Niagara system, and serving also to raise the power factor at the Cooksville station.

It is not the writer's intention to describe the plant of the Ontario Power Co. as descriptions of this plant have appeared in the A.I.E.E. TRANSACTIONS (see Volume XXIV 1905, page 807). Extensions to the plant have been made since then until, when the operation was taken over by the Commission in 1917, the generating station contained 14 generator units, generating 12,000-volt, three-phase, 25-cycle power with a total rating of 149,012-kv-a. The original excitation scheme had been changed by the Ontario Power Company and a very complete description of this scheme as it now exists may be found in the "Electric Journal," Vol. 1914, p. 612, in article by Mr. J. A. Johnston. The distributing station of the company contains the 12,000, 30,000 and 60,000-volt busses, the transformer banks and the outgoing line equipments and the control room for the plant. The switching scheme as originally laid out has been considerably rearranged, the busses being sectionalized and connected through reactors, these changes being due to the great amount of power generated and to the large proportion leaving the station at generator voltage.

The Commission, on behalf of the company, is now making extensions to the generating station. The building is being extended north about 90 ft. and a third pipe line of temporary nature consisting of wood stave pipe is being constructed. Two additional generating units are being installed each rated at 15,000-kv-a. maximum rating at 75 per cent. power factor.

These new generators are the same speed as the previous units, namely 187.5-rev. per min. and the frames are the same size as the 8,775-kv-a. units most recently installed. They have, however, a higher temperature guarantee and are so designed that they may be operated as synchronous condenser at zero power factor if it ever becomes necessary to remove them from this station. These generators were made in Canada, under war conditions, and all parts, except the laminated steel and the insulation, were produced in this country. This speaks well for Canadian industry in these trying times.

Each of these new units is excited by a 125-kw., 250-volt, motor-driven exciter, thus extending the excitation scheme referred to above.

The Ontario Power Company obtain some power from the Electrical Development Company's generating station at Niagara, this being brought into the distributing station on two incoming 12,000-volt feeders. When the present extensions to the distributing station are completed, there will be six main bus sections connected together through reactors. Three of these bus sections will supply the power delivered to the 12,000-volt bus in the Commission's transformer station to which the feeders from the Canadian Niagara Power Company are also connected through a bus reactor. The concentration of generator capacity on this 12,000-volt bus is consequently very great and has necessitated material changes in the switching equipment and bus construction. The studies covering the installation of reactors on this 12,000-volt system have been most interesting. As these studies are still not fully completed, no diagram of the connections for the Ontario Power Company stations and the Commission's Niagara transformer station can be shown at this time. It will be sufficient to state that there is no 12,000-volt bus in the generating station, and that each generator feeds through an automatic oil circuit breaker in the generating station to its individual cables in the cable tunnels up the hill, thence to its group of circuit breakers in the distributing station where switching arrangements are such that each generator and each feeder may be connected to either of two bus sections. In the Commission's Niagara transformer station there is a single sectionalized 12,000-volt transfer bus system so arranged that feeders are connected through an auxiliary bus to the main bus or direct to a transformer bank.

It is of interest to note that the cables for the two new 15,000-kv-a. generators were purchased after laboratory tests were made on manufacturers' samples to determine the dielectric losses and tendency of compound to flow, and guarantees on dielectric losses were obtained from the contractor.

Another interesting point in connection with the feeders entering the Commission's transformer station is that eight of these are three-conductor, armored cables laid directly in the earth without ducts. These armored cables all have sector-shaped conductors, with 8/32-in x 8/32-in. paper insulation, a lead sheath and a double steel tape armor with jute bedding and jute covering. They are placed three feet below the surface and two and three feet apart centre to centre. Where these buried cables cross ducts containing other cables, arrangements are provided to moisten the surrounding earth either by sprays above the surface or by porous tile in the ground.

The Queenston Development

When the Commission in March, 1908, contracted with the Ontario Power Company for 100,000 horse-power, it was thought by many that such amount of power would meet the requirement for many years. This supply was, however, exhausted in 1915, that is, in 5 years from date of first delivery of power, and the additional power secured by arrangements with the Canadian Niagara Power Company has proved insufficient to meet the demands. It became necessary, therefore, to look to a new development to secure a further supply and the final decision was to proceed with a development called the Queenston Development which is authorized by an Act passed by Ontario Government in April, 1917, called The Ontario Niagara Development Act.

Between Lakes Erie and Ontario there is a difference in elevation of 330 feet. The greatest net head now utilized on the Canadian side at Niagara Falls is about 160 ft. Canada is entitled to divert 36,000 cu. ft. per second from the Niagara River, and of this amount, by an Ontario Government Order-in-Council in 1915, the Commission were allotted 6,610 cu. ft. per second. The Ontario Power Company were allotted 11,180 cu. ft. per second, so that, within the control of the Commission, there is now available 17,799 cu. ft. per second.

To obtain the greatest amount of power from the water available, after careful surveys and studies, it was decided to locate the generating station just above Queenston, and to take water from the Niagara River, through the Welland River (reversing the flow in same) and canals encircling the city of Niagara Falls to Queenston. The first canal is now under construction and the accompanying map of the Niagara District, shows its location.

The total length of waterway from the Niagara River to the generating station site is about 12½ miles, 4¼ miles of this distance being in the Welland River and the balance in an excavated canal. The net effective head will be about 305 ft. and the first canal is normally designed for 10,000 cu. ft. per second at minimum low water.

The generating station will be located about one mile up stream from Queenston, in the Gorge just at the end of the last rapids in the river. At this point the banks are steep and short penstocks only will be required. Provision is being made for extensions, and right-of-way for two additional canals has been purchased.

To show the effect of utilizing the greatest possible head of water, it may be pointed out that about 30 h.p. will be developed for each cubic foot per second in this development, whereas about 14 h.p. is all that is obtained in existing plants at Niagara Falls.

The development now under construction is designed as regards canal, forebay, gate house sub-structure and power house sub-structure, for a capacity of 300,000 h.p. It is proposed to construct the gatehouse and power house superstructure for an initial installation of 200,000 h.p. in four units. The designs are made so that extensions of power house and gate house can be made to almost any extent. Future plans contemplate the use of 100,000-h.p. units.

The enormous amount of power to be transmitted from this Queenston development involves much engineering study to work out a solution particularly when it is borne in mind that a large amount of capital is invested in existing stations and lines operating at 110,000 volts.

[NOTE.—For more complete description of the Queenston project, see the June 20th, 1918, issue of *The Canadian Engineer*. For turbine specifications, see September 26th issue; for generators, November 21st issue.—EDITOR.]

RELATION OF HIGHWAYS TO MOTOR TRANSPORT EFFICIENCY*

THE efficient development of highway transportation through the means of the motor truck parcel post service, return load bureaus, inter-city freight delivery, rural express and other methods of motor transportation, necessitates the utilization of highways during 365 days of the year and the construction and maintenance of good roads everywhere. The practical development of this program calls for the expenditure of vast sums of money, at least one billion dollars annually.

The cost of highways of the future is problematical. An indefinite period will elapse before the wages of labor and the cost of materials will be adjusted to normal conditions. These economic questions constitute a problem which must be given exhaustive consideration. One phase, upon which it is advisable for all to deliberate, is the sources of the unskilled labor so largely used in highway improvement. The world war has materially reduced the available supply in this country and the reconstruction of Europe will prevent the usual additions through the avenue of immigration. The belief is rapidly growing that the solution is the importation of Asiatic labor.

Reckless Financing

To-day there are in the United States 2,500,000 miles of rural roads, 12 per cent. of which are classed as improved, A conservative estimate would indicate that not more than one-fourth of 1 per cent. of the total mileage is suitable for motor truck highway traffic. During 1917 there was appropriated for the improvement of rural roads $300,000,000. This work is under the jurisdiction of the Federal Government, the State Highway Departments, over 3,000 counties in the various states, and the innumerable townships. The scope of this brief resume will not allow a discussion of the methods of financing highway improvement, but it is advisable to strongly emphasize the indisputable fact that it is reckless financing to construct roadway surfaces, which will have a life of 10 years, with 50-year bonds.

To-day there is no national system of highways in the United States comparable to the world renowned national system of France. Indications point, however, to a rapidly developing sentiment and demand for the creation of a system of interstate highways aggregating between 50,000 and 150,000 miles which shall be constructed and maintained under the supervision and at the expense of the Federal Government. Such systems of highway as we now have are practically developed through the individual or co-operative action of our state, county and township governments, Federal aid constituting a very small percentage of the total amount expended. The development of systems in many parts of the United States is in a chaotic condition due primarily to lack of foresight and wise administration, local jealousies and ineffective laws.

In Hands of Laymen

Efficient and economical highway improvement has been seriously jeopardized in the United States through political interference and the placing of highway work in the hands of laymen who have had no experience in this important technical profession. Unfortunately the public neither appreciates the character of the duties of highway officials nor does it take proper interest in the expenditure of its funds. The people must be educated with respect to the complex work for which highway officials are held responsible and the waste of public funds directly attributable to having highway work in the hands of laymen. It should be emphasized that the primary objects of the educational campaign advocated are: First, the economical and efficient expenditure of the millions of dollars annually appropriated for highway work; and second, the appointment of members of the highway engineering profession to the innumerable positions of responsibility in public life which demand the combination of administrative ability, honest character, and the technical knowledge, training, and experience possessed by qualified engineers.

European Methods

As in the case of many public activities, it is practicable in connection with this problem to derive valuable suggestions from practice in foreign countries. A review of their histories indicates that they have passed through the same transition period which we are entering. In France, many years ago, the people and the servants of the people realized the advantages accruing from the establishment of a permanent organization of efficient, well-trained highway engineers, and hence there was created the renowned Department of Roads and Bridges of France. Passing across the English Channel, we find similar conditions in Great Britain. In order to secure a dollar's worth for every dollar expended, the British public realized that it was necessary to have in control of their public works men trained in a profession directly dealing with every economic and engineering phase of public improvements. It has therefore inaugurated the practice of requiring that applicants for a given municipal or county position shall have attained the grade of membership in the Institution of Civil Engineers of Great Britain commensurate with the responsibility of the work of the particular office. Many leading municipal and county positions require that the applicant shall, first of all, hold the highest grade of membership in the Institution, while positions in small counties, towns and districts require in many cases associate membership. It would seem desirable in this country that a step along the line of English practice might be taken and, in the case of positions of highway officials, that there be incorporated in the constitution of a state or the ordinances of a city the stipulation that the applicant shall hold a certain grade of membership in the American Society of Civil Engineers, and have had a certain number of years of experience in highway work.

The problems confronting the highway engineer of today are entirely different from those which existed 15 years ago. At that time, the motor vehicle was not a factor. To-day between 5,000,000 and 6,000,000 motor vehicles use our highways, 10 per cent. of which are motor trucks. Instead of constituting practically 100 per cent. of the traffic as in 1903, horse-drawn vehicles at present amount to 5 to 20 per cent. on highways outside of urban districts.

Established Practices Remodelled

With the enormous developments of motor truck highway transportation, which this country is to witness in the next five years, many established practices in highway work must be remodelled. It is self-evident that the increased tonnage will call for ideal drainage, strong foundations and roadway surfacings suitable for motor truck traffic. In this connection may be cited the recommendation of the former New York State Department of Efficiency and Economy, in 1915, that all trunk highways should be built with cement-concrete foundations. Dependent upon the amount and character of the traffic to which a trunk highway will be subjected during the life of its surface and other factors influencing its selection, the following types are suitable: Bituminous concrete; cement-concrete; brick; and stone block.

As of particular interest to the advocates of the development of motor truck transportation is the present condition pertaining to the width of pavements on trunk highways. Reviewing the construction of the past few years of the types of pavements heretofore mentioned used on trunk highways, it is found that the widths vary from 12 to 18 ft. with a few instances of greater widths. In this connection it is of value to note that the Highway Committee of the American Society of Civil Engineers recommended several years ago that "where motor truck forms

*Abstracted from an address by Arthur H. Blanchard, before the conference on "Modern Methods of Motor Transportation," held under the auspices of the Colt-Stratton Company, 1847 Broadway, New York City.

a considerable portion of the total traffic likely to use a highway, the unit width of traffic lines should be considered as 9 to 10 ft., instead of 7 or 8 ft. as heretofore." Furthermore, as far back as 1908, the First International Road Congress, held in Paris, adopted this resolution: "There should be but one roadway for every kind of vehicle, 19 ft. 8 in. wide at least." It is, of course, well known that many of the main county highways of England have an improved surface of from 20 to 22 ft. And that the main trunk highways of France are practically 24 ft. in width. When the rapid development of touring car, motor truck traffic and motor bus routes are given consideration, it is obvious that our important inter- and intra-state trunk highways should have roadway width of not less than 20 ft.

Factors Requiring Consideration

During the next few years such other factors as strengthening of highway bridges, grades, location and alignment of highways, adequate guard rails, and uniform highway signs must be given careful consideration.

The people of the United States are beginning to appreciate the fact that in order that value be received for the money expended in the construction of highways, it is necessary that the highways should be efficiently maintained. Some method must be devised by which the legislatures shall annually appropriate sufficient funds to properly and economically maintain improved highways. Legislature after legislature has followed the procedure of discounting the estimates submitted by highway departments. Hundreds upon hundreds of miles of highways are to-day improperly maintained due to a lack of funds. It should be borne in mind that if maintenance is curtailed in one year in a given state to the extent of $500,000, and miles of highways are thereby left unrepaired, the appropriation required in the following year to repair the damage to the highways not maintained may amount to $1,000,000.

Uniform Traffic Laws Needed

It is of vital import that uniform highway traffic laws should be placed on our statutes. Such laws must cover the physical factors and the operation of all types of vehicular traffic. Laws will be based on available data and opinions. There are, at present, innumerable investigations which should be made to ascertain facts pertaining to the interrelationship of motor truck traffic and the durability and serviceability of highways. If highway departments do not conduct such investigations, they should be undertaken at once by motor truck interests. If the essential data is not available, naturally traffic laws will be based upon conservative conclusions reached by highway officials and members of our legislative bodies.

ENGINEERING LICENSE LAWS

(Continued from page 530)

Minnesota.—The Minnesota State Engineers' and Surveyors' Society has appointed a committee to report upon the questions of the licensing of engineers. Geo. L. Wilson, Engineer, M. of W., Minneapolis Street Railway Co., is chairman.

Michigan.—A bill has been formulated for the registration of civil engineers to go into effect, August, 1919. Your chairman has a copy of bill, but no knowledge of the backers.

What Class of Work Should be Covered?

No existing license law includes all of the branches of engineering. Some states include surveying, others civil engineering. Illinois includes structural engineering. Other states license the practice of hydraulic and irrigation work and mining engineering. Electrical and mechanical engineering are not licensed to our knowledge, but almost invariably the operator of a steam or electric plant requires a license. The fact that steam boilers, elevators, and electric wiring are subject to either state or municipal inspection probably accounts for this. Inasmuch as there is no apparent demand for license by the mechanical engineers, and as the works of the mechanical and electrical engineers can be readily proven by actual tests, which is not the case, in general, in the works of the civil engineer, it is here suggested that the committee consider only a license law as applying to civil engineering or specific branches thereof. The views of members of the Association and others upon this point are invited.

Essentials of an Engineers' License Law

The desirability of a license law for the engineer, architect, doctor or plumber individually or as a class does not furnish, in law, the slightest basis for its existence. It is essential to demonstrate to the legislature and the court later, if necessary, that the license law will serve for the conservation and protection of life, health, or property of the public at large. Obvious as this principle appears, its oversight has led to many faultily drawn acts and to much wasted energy.

Approval of Plans as Protection

Protection for the public can be secured not only by a state license to the properly examined and qualified practitioner, but it can also be secured by the requirement for approval of plans and by inspection by duly qualified state officials. For example, the approval of plans and construction for dams is required by state boards in Connecticut, New York, and Pennsylvania. Almost all states require approval of plans for sewage disposal by the State Board of Health, and many states make the same requirement for water supply. State and municipal building codes furnish an example. Massachusetts requires state approval of plans for railway bridges, and other state utility commissions through their engineering staff supervise engineering construction to a greater or less degree. State supervision as just outlined is the more obvious procedure to the public. Examination and licensing acts require initiation from the engineer.

American Society's Suggestions

The essentials for a satisfactory engineers' license law, as set forth in the form suggested by the American Society of Civil Engineers and as incorporated in the Florida act, and to a modified degree in all other existing acts, are as follows:—

1. An exact definition of civil engineering as illustrated by a statement of specific works covered.

2. The appointment of a Board of Examiners, usually five, and made by the Governor. Requirements for membership of the Board. Appointment of a secretary.

3. Minimum requirements from candidates in qualifying for examination. Six years' experience, one of which is in responsible charge. Two years' allowance for graduate of approved technical school. It has been suggested that a minimum educational standard be a preliminary requirement.

4. Exemptions from examination. Those in actual practice prior to the act. (To avoid an *ex post facto* law.) Those licensed in other states having equal requirements. It is suggested that no additional fee be required of such parties other than a nominal registration fee. Consulting engineers for licensed engineers. Also sufficient time for engineers of other states to permit them to register without interruption of work. (See Louisiana Law).

5. Reciprocity with other states.

6. Conditions and limitation of the examination.

7. Penalty for violation of the act. It has been suggested also that a license is required to qualify an expert witness and that no legal collection for engineering fees be granted unless licensed.

9. Required seal on plans.

10. Investigation and prosecutions. The Board to be active and responsible for this burden.

WATER TREATMENT AT COUNCIL GROVE, KANSAS*

By Louis L. Tribus

IN 1915 the American Waterworks Association published a brief description of the then recently remodelled water works station at Council Grove, Kansas, the special item of interest being that portion of the plant treating the raw river water. The feature of novelty lay in the plan for successive application of dissolved coagulant, as the water passed from one part of the system to another. The use of coagulant could be very closely regulated as river conditions required and as the water exhibited its very varying characteristics and behavior while going through the different original stages from sometimes serious foulness to clear and safe potability.

After three years of operation, it may be of interest to note some of the results secured under the peculiar difficulties that have had to be met.

The Neosho River has but a limited watershed; it flows largely over a rocky bed, traversing a black soil belt but sparsely wooded. The general region is subject to sudden

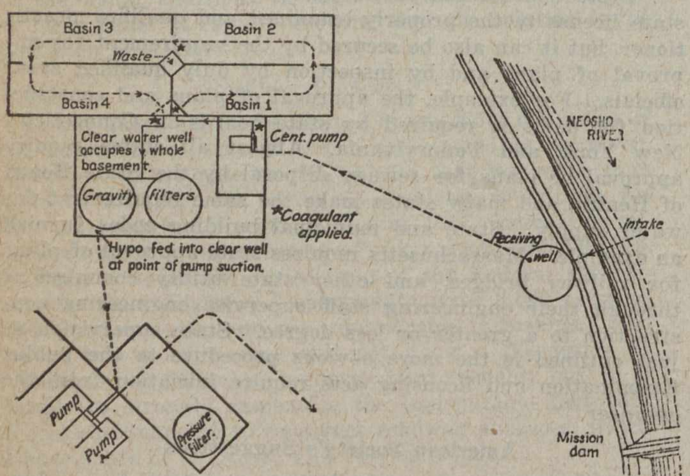


Fig. 1—Course of Water Through Purification Plant

and violent storms which are without regularity as to season. These conditions produce high floods and varying turbidities, at times well over 5,000 parts per million. How much more than that is not recorded, for the local testing apparatus has no higher range. The river flow varies from almost nothing (a slight spring supply) to an over-abundant maximum running from 7 to 15 feet in depth over the dam, having a crest length of 100 feet or over.

Alkalinity ranges from a minimum of 48 to a maximum of 365, decreasing as the river rises.

With the silt burden come also various colloidal troubles.

The water temperature fluctuates from a minimum of 33° to a maximum of 86°.

The bacterial content has naturally a very wide range, due to the nature of the watershed and varying character of the flow of the river.

Algae are prolific at times in the summer season when the river is low; copper sulphate is used sparingly, but with success, in the lower reservoir. The natural quality of the water at low river stages is quite fair, although high in permanent hardness, which lessens somewhat as storm waters raise the river level.

It can be well imagined that with these characteristics, the treatment problem is one that can not be left to unintelligent handling.

The two successive superintendents of the plant have taken very great personal interest in its operation, endeavoring constantly to not only secure the delivery of an effluent that would be as near perfect as possible, but to reduce costs at the same time.

The water flows from the river into a reception well in which considerable deposition of suspended matter takes place. From this a low-lift centrifugal pump raises it to the first of a series of four basins. At the pump it can receive a first dose of liquid sulphate of alumina, which becomes pretty thoroughly mixed in the discharge pipe before entering the first basin near the bottom through a triangular down-chute.

At this point a second dose can be given. The water then passes the length of basin 1 and through a low-level submerged opening enters basin 2. Passing through this, a third dose can be added just as it reaches basin 3 through a second submerged opening, placed at a higher level than that between basins 1 and 2. Flowing through basin 3 and into basin 4 at a still higher elevation, though still submerged, the water finds, at the farther end, the inlet to the filters, where a fourth dose of coagulant can be added.

It was found in the early stages of experimenting that in a turbid state of the river the whole charge of coagulant at the pump or at basin 1 alone, was ineffective, for the globules of aluminum hydrate became coated with mud

Table 1.

Bacterial Reduction in Council Grove Plant

Date of Report	Bacteria per Cubic Centimeter		Date of Report	Bacteria per Cubic Centimeter		Date of Report	Bacteria per Cubic Centimeter	
	Raw water	Filtrate		Raw water	Filtrate		Raw water	Filtrate
1915			*1916*			*1917*		
July 22	5,000	750	May 8	5,000	25	Mar. 19	80	45
July 31	3,000	120	May 12	300	60	Mar. 23	120	50
Aug. 5	2,000	50	May 20	1,900	310	Apr. 3	40	20
Aug. 13	1,200	30	June 3	21,000	60	Apr. 9	60	15
Aug. 19	82,000	22	June 16	2,000	60	Apr. 13	50	30
Aug. 30	4,000	100	June 26	6,000	30	Apr. 27	3,710	80
Sept. 4	3,000	75	July 6	600	460	May 7	1,360	20
Sept. 9	460	130	July 14	500	10	May 18	600	11
Sept. 18	450	15	July 20	1,900	70	May 25	450	18
Sept. 27	65,000	16	July 28	300	10	June 7	15,000	65
Oct. 6	92,000	42	Aug. 3	300	150	June 11	10,000	100
Oct. 11	27,000	410	Aug. 19	4,000	1,000	June 21	150	50
Oct. 15	300	25	Aug. 26	1,400	400	June 28	300	5
Oct. 22	70,000	30	Sept. 2	1,400	150	July 10	150	25
Nov. 2	1,900	26	Sept. 9	900	14	July 13	2,500	40
Nov. 8	3,100	64	Sept. 15	2,000	200	July 18	400	10
Nov. 12	1,600	30	Sept. 23	250	15	July 28	600	60
Nov. 22	4,500	25	Sept. 30	1,600	20	Aug. 4	1,500	150
Nov. 29	420	16	Oct. 7	90	15	Aug. 9	1,900	175
Dec. 4	200	15	Oct. 13	150	6	Sept. 5	1,800	8
Dec. 13	400	70	Oct. 20	200	16	Sept. 15	15	1
Dec. 17	1,400	25	Nov 4	900	35	Oct. 6	750	550
1916			Nov. 11	500	30	Oct. 15	700	5
Jan. 17	3,000	50	Nov 17	2,000	10	Oct. 20	200	9
Feb. 3	11,000	120	Nov. 24	800	90	Oct. 25	1,900	5
Feb. 11	40,000	35	Dec. 18	630	19	Nov. 3	1,000	8
Feb. 21	4,100	130	*1917*			Nov. 9	650	15
Feb. 26	1,400	25	Jan. 10	.3,400	200	Nov. 16	900	125
Mar. 7	6,300	80	Jan. 15	1,400	290	Nov. 24	600	20
Mar. 13	250	100	Jan. 26	180	15	Dec. 3	1,000	50
Mar. 18	900	30	Jan. 28	400	220	Dec. 7	500	40
Mar. 23	1,000,000	840	Feb. 10	80	30	Dec. 27	225	90
Apr. 13	500	50	Feb. 17	70	20	*1918*		
Apr. 17	2,500	120	Feb. 23	150	26	Feb. 1	250	5
Apr. 23	850	225	Mar. 5	90	60	Feb. 14	450	55
May 1	1,500	800	Mar. 12	50	30	Feb. 18	150	15

"The tests required for the filtered water shall be a reduction of bacterial content of at least 98% from the content in the raw water, except that when the total number of bacteria is less than 3,500 per c.c. in the raw water, the filtrate must not contain in excess of 75 per c.c."—Paragraph from contract, concerning bacterial removal.

*Read at the St. Louis Convention of the American Waterworks Association.

long before full service had been rendered, consequently practically untreated water passed to the filters. If, however, the charge was sub-divided and applied at points as observation showed necessary, each reached the water at a time when additional treatment was needed, and consequently before flowing upon the filters a large proportion of the suspended matter had been thrown down. There are cross-wall baffles in each of the basins which exert some influence in checking flow and causing deposition of solids.

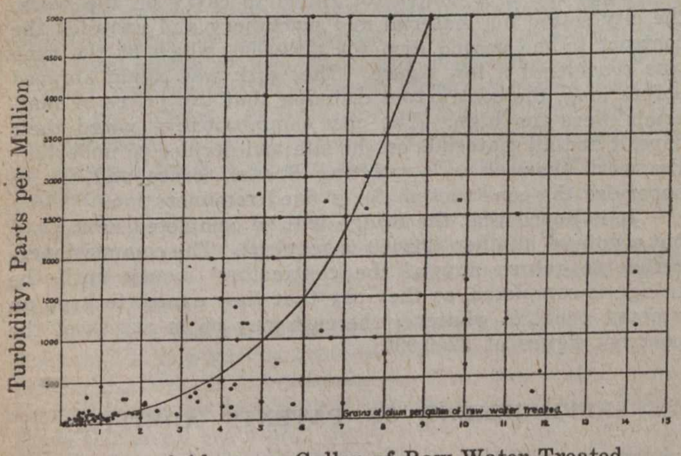
The relative deposition of solids in the different basins under different combinations of treatment indicates very clearly the value of successive and cumulative attention. Cleaning has not been as systematic as could be desired, so the quantities of accumulations removed could not well be compared with the rates of flow and coagulant used, as it would be interesting to learn and may some day be studied. The gross use of coagulant in the sum of the separate doses has nowhere nearly equalled the quantity that would have been needed with the raw water treated at but one point.

Very perplexing in the early operations was the experience with large doses of coagulant. It seemed as if the turbidity would not yield; apparently no floc formed and the filters soon became choked. Then suddenly action would begin and all would go satisfactorily and the results could thereafter be secured with very much smaller doses.

Temperature and alkalinity changes also exert a decided influence upon the purifying action, though studies have not yet been sufficient to standardize the treatment and reach definite conclusions.

It has been impossible, for financial reasons, to employ a chemist regularly, so that operations, other than those determined by turbidity and alkalinity, have depended upon the operator's judgment, which has been largely controlled by the show of floc in the basins or on the filters and of course by the appearance of the filtered effluent.

Just as the water is drawn from the clear well for delivery by the main pumps into the city system, it receives dis-



Grains of Alum per Gallon of Raw Water Treated

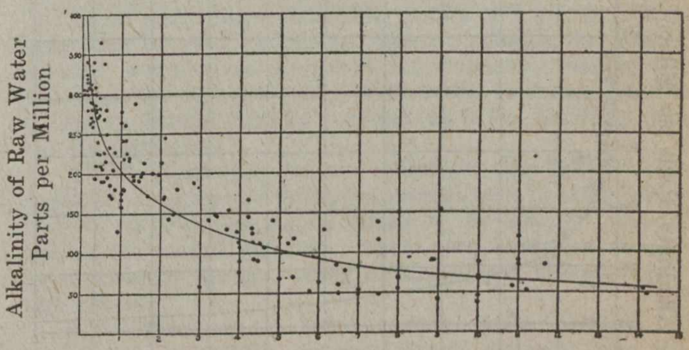
FIG. 2—TURBIDITY AND ALUM; 150 DAILY READINGS

solved hypochlorite to the extent of 2 to 2½ pounds per day (dry chemical) for the 250,000 to 350,000 gallons of water pumped or about 10 pounds per million gallons ordinarily. This renders the water practically sterile, though the preceding operations remove the bacteria to a very satisfactory degree.

Weekly samples have been sent to the headquarters of the State Board of Health at Lawrence, where regular analyses are made with a view particularly to noting the presence of pathogenic bacteria and the values of turbidity and alkalinity. The reports received following such examination serve as a fair guide to the superintendent and give him a very good idea as to his success in handling the plant, confirming his own observations or causing him to use greater care if the danger is indicated.

In the earlier weeks of operation following construction, the use of sulphate of alumina sometimes was as high as 20 grains per gallon of water pumped, but during 1916 and 1917, even with several periods of very high turbidity, the maximum was but 11 on one occasion and 9 on another; otherwise nothing above 7 in any of the flood periods, while the usual total rate has been considerably less than one grain per gallon.

With the exception of a few single days when the turbidity in the final effluent reached 30 parts per million, it has



Grains of Alum per Gallon of Water Treated

FIG. 3—ALKALINITY AND ALUM; 150 TYPICAL READINGS

normally been zero. The successive improvement of the water, basin by basin, has very greatly eased the work of the filters, and hence in turn saves a large use of filtered water for back washing. The filters are of the open gravity type, the washing being aided by agitation with rotating stirrers. The wash-water pressure has been too variable for the best results, but a regulating valve is to be installed and perhaps a meter, so that future betterment should follow.

Upon the official tests of the plant, as well as in later operations, the bacterial removal by the basins and filters proved very satisfactory, though as before mentioned, as a final safeguard hypochlorite is used in small quantity.

The State Board of Health began making its tests in July, 1915; out of 102 reports since then received, 85 stated the water to be in "excellent," "very good," "good" and "fair" condition. Of the remaining 17, only two condemned the water, the others, though reporting "poor" rather raised question as to details of treatment, as the best results were not being secured. The bacterial count varies very greatly in the raw water and colon bacilli are usually indicated. The Board of Health makes its tests usually of the raw water and the finished effluent as taken from a service tap at the station. The original acceptance test of the filters was made subject to its approval.

The contract paragraph concerning bacterial removal is repeated at the foot of Table 1, so that it may be compared with the results of the 2¾ years succeeding, as reported by the chemists of the Board.

Of the 105 bacterial reports, 81 show results handsomely within the test conditions, and but few of the others indicate any special deficiency in action. At times of heavy turbidity, when bacterial count runs specially high, the operations have been signally efficient; this indicates, perhaps, more special care in operation, due to the difficulty in securing clear filtrate.

Taken as a whole, therefore, without a resident chemist, with several changes of station engineer and assistant, the breaking in of inexperienced men each time, and during quite a portion of 1917 with a superintendent in ill health, the showing is quite favorable to the working of the plant.

In a few tests which have been made, the percentage of successive betterment through treatment in the basins and the filters has been very interesting, but no consistent regular record has been kept, due to lack of sufficient time of the superintendent or engineer.

The operation of the plant as a whole has abundantly justified its design, and responds effectively to good care;

though the filter strainers clog rather more than is desired and may have to be changed in type before long.

The diagrams illustrating this paper, other than figure 1, a plan showing course of the water from river to consumers, are made up from typical daily notations of turbidity, alkalinity and grains per gallon of sulphate of alumina used in the treatment.

From 1,100 observations recorded during 1915 to 1917 inclusive, 150 have been selected, regardless of season, so as

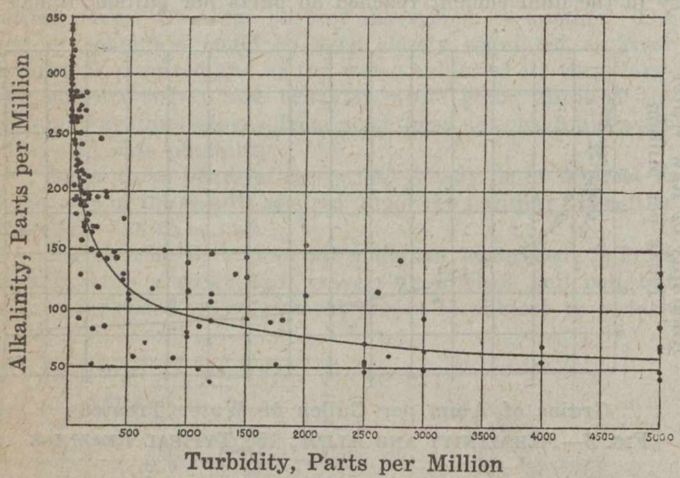


Fig. 4—Alkalinity and Turbidity; 150 Daily Readings

to cover so far as possible several readings at each rate throughout the whole range of variation.

The diagram showing "turbidities" compared with "grains of alum," figure 2, does not indicate clearly any particular law, though a suggestive curve, is shown, more based on general knowledge of the plant than determined from a close study of the turbidities. This is not surprising, for most of the turbidity is caused by heavy suspended matter carried by the high velocity in flood stage and quite ready to settle when brought to reasonable rest.

Occasionally a bad colloidal condition obtains, when the hydrate of alumina finds hard work to perform, but there has been little opportunity to study it carefully as a separate problem.

The diagram comparing "alkalinity" with "grains of alum," figure 3 indicates very nicely a relationship that permits the selection of a fair, smooth curve to represent normal working, except when some special river condition upsets all theories and gives several hours of perplexing activity and experiment.

The remaining diagram, comparing "alkalinity" and "turbidity," figure 4, indicates a chance for a fairly good curve, but one not specially conclusive in nature, and possibly to be changed materially as further observations are made.

The higher alkalinities prevail generally in the winter season, during the lowest river stages, when turbidities would naturally not run high, even with fair-size floods, for frozen lands do not yield so readily to erosion.

In all of the 150 records taken for plotting, the effluents were reported as having zero turbidity.

It is rather an interesting commentary on human nature, however, that while the water company has furnished safe filtered water for twenty years and brilliantly clear, sterilized, filtered water for three years, there are still many residents who hold to the rain tanks with roof washings, and shallow back-yard wells. Rates have been held at the low figures established 30 years ago, based on the low schedules of the city of St. Louis. A change, however, must shortly be made, so as to give more adequate return upon the investment in use.

It is often in the smaller plants that some of the most perplexing problems arise for the water works engineer to solve. This plant has been very interesting to the author, for it has illustrated many of the difficulties of operating a water treatment system and well repaid his occasional trips to examine its workings, suggest improvements, and generally consult face to face with the operating officials, during 20 odd years of advisory service.

ELECTRIFICATION OF C.N.R. TUNNEL, MONTREAL

At the last meeting of the Toronto Section of the American Institute of Electrical Engineers, W. G. Gordon, Transportation Engineer of the Canadian General Electric Co., Ltd., Toronto, described the electrification of the C.N.R. tunnel at Montreal.

The Montreal Light, Heat and Power Co. supplies power at 63 cycles, 3 phase, 11,000 volts. Direct current is provided by two motor generator sets each 750 kw., 1,200 volts. Six locomotives are now in operation.

Special local conditions and temperatures made necessary an extraordinary design of the catenary system. The pantograph is of the sliding type and the conductor wire is of special bronze composition with a strength of 65,000 lbs. per square inch. Mr. Gordon stated that this wire was installed in preference to hard drawn copper because of longer life when subjected to the wear caused by the sliding pantograph, and also because, on account of its greater strength, it can be strung tighter than copper.

RECOMMEND RETURN OF DEPOSITS

Montreal aldermen have made a recommendation to the city commissioners that the latter should pay the sums now being withheld from the two contracting firms who were connected with the La Salle bridge work. The commissioners are holding $21,000 deposit of J. Sullivan, the first contractor for the bridge, and also $15,000 due him for work done. They are also holding $76,939 due Pion and and Grothe, the second contractors for the bridge, consisting of deposit of $25,939, and a balance on account of work done of $51,000.

When the first contractor failed to carry on the work, the city seized his material and machinery and awarded the contract to the second firm for $259,000, which at the time was considered a low figure. The work was again stopped before long, the contractors claiming that the prices of materials were too high. The city commissioners seized their deposit and all materials on the site and decided to undertake the work themselves, appointing Fraser, Brace and Co. to supervise the construction for a fixed remuneration.

It is hoped that the bridge will be completed next year but a vote of another $96,450 is required. The commissioners refuse to return any of the contractors' money until the bridge is completed, as they say that they expect to keep an amount equal to whatever the cost may be in excess of the contract figure of $259,000.

INFRINGEMENT OF PATENTS ADMITTED

Infringement of the cement-gun patents have been admitted by Concrete Constructions, Ltd., of Ottawa. This firm had the contract for fireproofing the structural steel work in the Parliament Buildings, Ottawa.

John A. Pearson, the architect for the Parliament Buildings, had specified that the cement-gun be used for the fireproofing work, and the contract was awarded to the abovementioned company, who were alleged to have devised a "home-made" apparatus which the Cement-Gun Co., Inc., of Allentown, Pa., claimed to be a direct infringement on their patents for applying sand and cement mortar by means of a compressed air jet.

Suit was entered by the Cement-Gun Co., Inc., but the case has been settled out of court by the acknowledgment on the part of the Ottawa contractors that they had infringed, that they recognize the full validity of the cement-gun patents, and that they agree in future not to infringe in any way upon same. It is not known just what monetary settlement was made regarding the admitted infringement.

THE GROWTH OF ELECTRIC SYSTEMS*

By Julian C. Smith
Chief Engineer, Shawinigan Water & Power Co., Montreal

DURING the past few years data has been accumulating in the census reports and from many other sources, indicating the increasing use of electric energy. This increasing use is represented by an increased number of kilowatt hours used per capita during the year. The reasons for this increased use are of fundamental importance, and relate to the increasing wealth of the country.

Each man and woman in the United States actually utilizes a greater number of kilowatt hours each year, not only by travelling more times on electric trains, and by using more electric energy in the form of light, but also by other and more indirect means. The fact that the average wealth per capita has been increasing at a rapid rate, is reflected in more food, more clothing, more luxuries such as automobiles, player-pianos and all kinds of things which are produced either directly or indirectly by the use of electrical energy.

Million Men Employed

The result of this growth has been the development within recent years of an enormous industry, including not only the electrical generating and distributing systems, but also those manufacturing companies which are manufacturing apparatus used in the extension of these systems. The number of men employed in this whole industry exceeds 1,000,000; the gross annual income involved exceeds $2,000,000,000; and the astonishing thing is that practically the whole of this development has taken place since 1880.

It is interesting to note the evolution which has occurred in this industry. Certain schemes originated and were developed gradually until the limitation of these schemes was reached. Parallel with these schemes were others which did not have this limitation, and gradually these later and more important systems displaced the former ones. This evolution has taken place constantly, and is going on today.

The present systems have their limitations, but before reaching these, we may, however, look forward to a great development along present lines, and particularly to a much greater standardization of these systems as they exist today. The present systems are capable of supplying the demand as it exists at present, and the development must go forward for a long way before any radical changes are required.

As regards the development of the generating and distributing systems, a brief description of their early history is of interest. I will also touch upon the evolution which has taken place.

The first stations were then known as the Edison Stations, and it is generally conceded that one of the New York Edison Stations, if not actually the first, was within a few days of being the first central station in the United States. From this small beginning, thirty-seven years ago, there has developed an industry which directly or indirectly affects the lives and happiness of everyone in the United States.

Began About 1882

Beginning about 1882 with small direct current systems, the various Edison Electric Companies started distributing electric light at several points in the United States. These plants were originally steam operated. In the very earliest development, belt-driven, high-speed machines were adopted, the size of these machines gradually increasing from about fifty kilowatts in the early eighties to about 750 kilowatts in 1893, this being the size of a machine which was built for the World's Fair by the General Electric Co.

It soon became evident to engineers and the managers of these small enterprises that, while direct current distribution by the Edison three-wire system was suitable for use in thickly-settled communities, for lighting purposes in general other systems must be adopted.

There was very little discussion of power distribution in these early days, but a few men appreciated the fact that if a system of distribution of electric power could be developed, that the whole industry would be revolutionized.

"Too Dangerous and Too Expensive"

At that time the principal use of electric current was for lighting the streets in municipalities, using as a medium the so-called open arc light.

These early days were long before the amalgamation took place between the gas and electric systems, and one of my early recollections deals with the statement made by the gas companies that electricity would never be substituted for gas for residential lighting purposes, as it was too dangerous and too expensive.

The fight between gas and electricity for lighting continued for a number of years, but soon electric lighting began to drive out gas lighting by virtue of the inherent advantages of the electric lighting. There soon became developed quite extensive systems using direct current Edison three-wire schemes.

The expense of the heavy copper mains involved in transmitting electricity any considerable distance from the power station became pronounced, and numbers of stations were developed in the larger cities each to supply the zone in its own neighborhood.

About this time,—that is, in the early eighties,—alternating current systems were first discussed. Then came the invention of the transformer, which was apparently thought of simultaneously by several men, an American, Mr. Stanley, having apparently worked the scheme out to a successful conclusion a little earlier than anyone else. With the transformer was completed a scheme which, with the exception of the number of phases involved, is the basic idea of the present time—that is, the generator to develop power at low voltage, a transformer increasing the voltage, the transmission line transmitting the power for a distance, a second transformer unit reducing the voltage for further sub-division.

Poly-Phase System in 1887

In 1887-1888, the poly-phase system of generating power was proposed. This system is of the greatest importance because successful motors of large size have not been developed for operation on single-phase systems. Thus was developed, in 1890, all of the fundamental elements involved in the present system.

It must, of course, be understood that this development did not consist at first of a complete scheme, with the exception of Edison's own distribution system. This invention of Mr. Edison's was so remarkable that it has lasted practically intact up to the present time, and is in use, not only in direct current distribution where it started, but in alternating current distribution to-day.

The first poly-phase motors of the Tesla design, induction motors, were designed and built, I think, by the Westinghouse Company in the United States about 1892. During the early nineties there was a slow growth in this industry. Alternating current voltages rose to about 10,000 volts in 1895, and distribution by transmission line had been extended up to about twenty-five miles before 1900. The one great step forward in the industry occurred about 1895, when the development at Niagara Falls took place.

The Niagara Falls Power Co. was organized to construct a water-power station at Niagara Falls, and in connection with this work a great technical commission was formed, including engineers from the United States and abroad. This commission spent a good deal of time and thought on the various phases of the problem, and endeavored to foresee the possible future development in the use of electric energy.

Most of the decisions of this commission and of the engineers of the companies manufacturing the apparatus were

*From one of the "J. E. Aldred Lectures on Engineering Practice" at Johns Hopkins University.

remarkable in their wisdom, and the plant was successful from a technical stand-point from the start. The Niagara Falls development was completed in 1894, and power was transmitted to Buffalo in 1896.

The voltage used in this transmission, 11,000 volts, was not the highest voltage then in use, nor was the distance of transmission, some twenty miles, the longest, but the scheme was of the greatest importance on account of its magnitude and possibilities. In the larger cities the steam-driven plants, mostly single-phase, were still being built. In Colorado at Teluride, there was in operation previous to this a power plant and transmission line at a higher voltage and longer distance. Other schemes were started, and the development of huge central stations, driven by water-power or by steam, and distributing poly-phase electrical energy, has kept growing at a rapid rate ever since the Niagara Falls development.

Larger Systems Gradually Merge

In 1900 the large cities were using considerable quantities of electrical energy, but principally for lighting the streets and to a small extent for residential lighting. Electric tramways had been introduced some ten years before on a large scale, and large amounts of power were used for this purpose.

About this time, that is, in 1900, many schemes were initiated which, in the seventeen years which have passed since that time, have developed into the huge systems which now cover the principal parts of the United States with a network of transmission lines.

As these larger systems increase in size they approach one another, and sooner or later a physical connection will be made. Some arrangement of interchange of power will take place, and from the point of view of the distribution of electrical energy, the systems will become one. Thus we may look forward to a time in the near future when a network of lines will cover the thickly-settled parts of the United States, and will consist of a huge interconnected system.

Owing to the abnormal conditions arising from the war, four great companies in California have recently pooled their lines and generating stations, and by interconnection are striving to get the maximum benefit. These four companies control thousands of miles of lines, and supply the energy requirements over 40,000 square miles of territory.

Since about 1900 no very fundamental changes have occurred in the general scheme of power generation and distribution.

The greatest factor in the development of the steam-driven central station has been the growth of the steam-turbine. Steam turbines first made their appearance in this country on a commercial scale in 1899. Since that date the sizes have grown from 1,000 kilowatts to 50,000 kilowatts. The development of the steam turbine has placed the steam central station once more in the race. It has practically eliminated all talk of gas engines, and to-day with coal at peace prices, the large machine steam station favorably located, can produce power at ordinary load factors, more economically, everything considered, than most water-powers with their long transmission lines.

Growth of Transmission Systems

The most surprising thing has been the growth of the transmission system. A few figures will show this clearly. In 1900 the Shawinigan Water and Power Co. owned no system. In 1910 the total mileage of circuits of over 12,500 volts was 315 miles. In 1917 the total mileage was 1060 miles.

The Hydro-Electric Power Commission's system of the Province of Ontario, Canada, in 1900 did not exist. In 1917 it possessed over 1,000 miles of circuits.

The Southern Power Company's system started about 1910. At the present time this system has a total mileage of 1,500 miles.

If you plot a map of the system of electrical distribution "main lines," you will find that generally speaking this system corresponds with the water-power development. All along the eastern seaboard, rising in the Appalachian Mountains, rivers flow eastward to the sea, On account of the proximity of the mountains to the ocean, waterfalls are numerous in New England and in the South. In the middle West and North we find electric systems, principally in those sections traversed by rivers flowing into the Great Lakes. In the South, in the mountainous districts of Colorado and Utah, have arisen also water-power stations and electrical networks; finally, on the Pacific Coast, there has grown up one of the greatest groups of systems existing in the world, extending practically from the Mexican boundary to Canada.

As one examines the story of one of these systems, he finds something like this: A water-power was harnessed, and a transmission line built to some not far distant point. As the demand for power increased the voltage was increased, the lines lengthened, and the original water-power station enlarged so that gradually systems which were installed at various points finally met and merged into one.

We have to-day reached a point in the building of transmission lines when it seems clear that in many ways the story of the growth of the railroads is being duplicated. First, small branch lines were built; these were connected or joined together at some junction point, and trunk lines connected those junction points.

When alternating electric current systems started there were many frequencies. A frequency of 133 cycles was common, and then the frequency was gradually reduced year by year until the lowest frequency (25 cycles) used on any extended scale in this country, was reached.

Why the "Hydro" is 25 Cycles

At the present time it is fair to say that there are only two standard frequencies: 60 cycles, which is now generally recognized as the most important and the one which is adopted in probably 80% of the cases—the other 25 cycles, which was adopted as the frequency of the Niagara system, and in other cases where rotary converters were installed.

An interesting side-light is thrown on the choice of the 25-frequency by the story of the Niagara plant. The consulting engineers of that plant wanted 16 2-3 cycles chosen as the frequency, and the manufacturing companies manufacturing the apparatus wanted 33 1/3 cycles. Both sides presented claims of great merit; finally they compromised and made a choice at exactly half-way between the claims of the two parties interested, so 25 cycles became a national frequency, but not on its own merits, because it is generally recognized that the higher frequency of 33 1/3 or even 40 cycles would have been the wiser choice.

Thrust Bearings and Vertical Units

Turning to the water-power stations, we find that no standard system of apparatus had been evolved up to about 1905. At that time new types of thrust bearings commenced to appear, and the vertical water-wheel unit soon became the leading design. These units have now become so improved both as regards specific speed and efficiency that little more may be looked for.

Under favorable conditions, perhaps the years to come may bring plants surpassing the existing ones by 8% to 10% in over-all efficiency, but the real hope in water-power developments lies more on the financial side of the operation. Perhaps by more careful design, cheaper raw materials such as cement, and better and more economical financing, water-powers may be developed for less money per horse-power.

(Concluded in next week's issue)

The Admiralty Court recently reduced the bill of the Canadian Vickers, Limited, against the owners of the steamship "Susquehanna" from $53,983 to $35,000. The firm had contracted to convert the vessel for ocean traffic. No contract price was fixed, however, and the owners appealed against the amount for which they were billed.

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PRINCIPAL CONTENTS

PROFESSIONAL EMPLOYMENT SERVICE

OFFICERS and men of the United States army and navy, who are University graduates in civil, mechanical or electrical engineering, or in chemistry, or who are technical men with a number of years' practical experience, are now registered with the Professional Division of the United States Employment Service.

This Service is a branch of the United States Department of Labor, and therefore is directly under federal government supervision.

The object of the registration is to help professional men to find suitable employment when they are honorably discharged from the army or navy. The record of each man is carefully investigated before registration is permitted.

Employers are asked to make use of the Service. This is facilitated by the fact that the Service has opened an office in many leading cities, with a special agent in charge. Employers are asked to inform the nearest agent of the precise nature of the positions available and the Service guarantees that only men well qualified for the positions will be sent to interview the employers.

This is a splendid scheme and one which should without delay be followed by the Dominion Government. The men who willingly severed their business connections one, two, three or four years ago, to give their services to the Empire, are returning to civil life under changed conditions. Although the industry of this country has great need of their services, neither the men nor the employers are able, without assistance, to discover each other immediately.

To avoid delay in the readjustment process, not only the labor of the country but also the highly trained directors of industry should be mobilized by the government with the aim that each man be fitted into that part of the country's business organization where he can do his best work.

The task of dealing with thoroughly trained men who, in many instances, can and should demand high salaries, requires the assistance of a special organization in charge of men who are familiar with the placing of University graduates and other technical workers. Such work is being done in an extremely limited way at the present time by two or three engineering societies in Canada, but they have not the funds, nor the organization, nor the authority, to carry on the work in the manner in which it should be carried on in fairness to our returning heroes. The establishment of a Canadian Professional Employment Service would not interfere with the work of these societies, but would make the latter all the more efficient by earnest co-operation with them.

Experience in the United States shows that the engineering field presents the largest problem in the Professional Division. Thus far nearly one-half of all applicants are men who are qualified for some kind of work in the engineering profession. By the time that the overseas forces have been demobilized upon any large scale, construction work will undoubtedly be in full swing. Many men will be seeking positions and many men will be sought for responsible undertakings. It is in the interest of the nation's efficiency, as well as of the individual happiness of these men, that round pegs should not be fitted into square holes.

The Professional Division, or whatever it may be called by the Dominion Government, should have a staff of experts in the selection of men. It should have sufficient funds to retain psychologists, engineering and other technical advisers, and keen business organizers. There is great need of such a service in Canada to-day in order to conserve the brain power and energy of the trained young men of our country.

METER ALL WATER SERVICES

WHEN economy in coal consumption is enjoined upon all, as at present, attention is forcibly directed to the recently published statement that the water consumers of nineteen cities of the State of New York are annually responsible for the waste of at least 75,000 tons of coal.

This statement was made in a report by one of the directors of the New York State Bureau of Municipal Research. The direct causes of this waste are said to be inattention to leaks of water and general indifference to economy. As an illustration, the instance is cited of five cities which collectively pump 41,243,220,000 gallons of water more than are needed during the year. This pumping is done by steam, meaning an excess consumption of 43,500 tons of coal. Four other cities, using electric power, pump 6,295,278,400 gallons over and above requirements, allowing one hundred gallons per capita as a reasonable daily consumption; and in order to generate the power, they burn an excess 15,700 tons of coal.

Had the report referred to included all the water plants in the State of New York, instead of only a limited number, the wastage figures would have assumed still greater proportions. And a like condition exists in all other States and in the provinces of this Dominion. The Bureau of Public Efficiency of Chicago estimates that more than 100,000 tons of coal are being consumed needlessly in that city each year to pump water that is lost through waste and leakage.

That effective means should be taken to reduce this wastage to a minimum is evident. The remedy is largely in hands of the consumers themselves. Consider the case of the average householder who pays a flat rate for his supply of water for domestic purposes. He uses it freely and without stint; he disregards dripping taps, when a few minutes work and the expenditure of a few cents on a new washer, would prevent that waste of water. In summer he waters his garden, and gives no thought to the number of gallons used. The remedy is metering of all services.

If Mr. Waterwaster were compelled to have a water-meter, just as he is obliged to use a gas-meter, and pay for the amount actually consumed, he would give the matter of water waste more serious consideration.

The consumer should be made to realize that his own carelessness is not only costing the whole community vast sums of money, but that an appreciable portion of that money is coming out of his own pocket.

Sir Thomas White recently pointed out the advisability of proceeding at once with all work of a productive character.

In the municipal field there are few possible investments that would be so immediately productive as the metering of all water services.

PERSONALS

CHARLES FREDERICK GRAY, consulting electrical engineer, has been elected mayor of Winnipeg, Man., for the coming year, having defeated the present mayor at the recent election by over 4,000 majority. Mayor Gray was born December 17th, 1879, in England, and was educated at Dulwich College, London. After two years on an English trading vessel, and some months in the Ballarat gold fields of Australia, he came to Canada in 1897, and for two years was engaged in telephone line construction in British Columbia. After a brief experience in New York, he returned to British Columbia in 1900 as engineer in charge of the West Kootenay Power and Light plant. Again going to New York in 1902, he joined the staff of the Interborough Rapid Transit Co., and was chief high tension operator for two years. From 1904 to 1906 he was engineer in charge of erection during the electrification of the Metropolitan District Underground Railroad, London, Eng., and was superintendent of operation until the system was turned over to the London County Council. Returning to Canada in 1906, he became construction superintendent of the Canadian Westinghouse Co., and for six years was in charge of the installation of that company's machinery in many large power plants in every province of the Dominion. On May 1st, 1912, he entered private practice and has since been consulted by the city of Winnipeg and other municipalities, the C.P.R., and a number of manufacturing firms of various kinds. For several years he has served on the Board of Control of Winnipeg. Mayor Gray is a member of the American Institute of Electrical Engineers and an associate member of the Institution of Electrical Engineers of Great Britain.

SIR HENRY DRAYTON intends to resign as Power Controller on January 1st and the office will be abolished.

WILLIAM M. KINNEY has been appointed general manager of the Portland Cement Association, Chicago, to succeed H. E. Hiltz, resigned.

F. H. NEWELL, professor of civil engineering at the University of Illinois, will soon address the Toronto branch of the Engineering Institute of Canada on reconstruction problems.

E. DESJARDINS, of the Intercolonial Railway Co., has been appointed superintendent with headquarters at Levis, to supersede J. E. Marazin, who has been promoted to the position of General Superintendent of Government Railways.

J. E. MARAZIN, who for some years past was superintendent of the Intercolonial Railway at Levis, has been appointed to the position of General Superintendent of Government Railways with jurisdiction from Montreal to St. Flavie.

ROLAND C. HARRIS, Commissioner of Works of the city of Toronto, will address the Toronto Section of the American Institute of Electrical Engineers on January 17th at the Engineers' Club. Mr. Harris will discuss civic engineering in general and the Bloor Street Viaduct in particular.

DR. SAUL DUSHMAN, of Schenectady, N.Y., addressed the Toronto Section of the American Institute of Electrical Engineers December 6th on "Some Recent Applications of the Election Theory," making a number of demonstrations with apparatus from the General Electric Company's laboratory.

MAJOR BRUCE HARKNESS, of Edmonton, Alta., has been commissioned Lieut.-Colonel of his present battalion, the 19th Pioneer Battalion, Welsh Regiment. Major Harkness has been overseas for three and one-half years. Previous to enlisting with the Canadian Engineers, he was connected with the construction of the Edmonton and Dunvegan Railway.

E. L. COUSINS, general manager and chief engineer of the Toronto Harbor Commission, has been appointed industrial commissioner for the city of Toronto. Mr. Cousins will undertake this duty in addition to his present work. There will be no salary attached to the new office. The appointment was made by the Board of Control after conference with the Board of Trade, the Harbor Commissioners, and the Hydro-Electric Power Commission of Ontario.

SERGT. H. T. EATON, of Hamilton, has been commissioned a lieutenant in the Canadian Engineers. Prior to the outbreak of the war, he was engaged in Controller Tyrrell's office as a civil engineer. He left Hamilton for Valcartier in 1914, and proceeded to the front with the 1st field troop, Canadian Engineers, with which unit he has been serving ever since. Lieut. Eaton spent three years in science courses at Toronto University, and was formerly a member of the Queen's University Engineering Corps.

LIEUT. OLAF P. HERTZBERG, who went overseas in August, 1914, as a private in the 3rd Battalion, Queen's Own Rifles, has been awarded the Military Cross. After transfer to the 5th Battalion, he was wounded and was invalided home, but returned overseas with the Canadian Railway Construction Troops and is still in France. Before the war Lieut. Hertzberg was connected with the C.P.R. engineering department. He is a son of A. L. Hertzberg, division engineer of the C.P.R. at Toronto, and a grandson of the late Col. Hertzberg, Royal Engineers, Norway, and of the late Capt. W. F. McMaster, Toronto.

LIEUT. J. R. MCCOLL, of the 11th Battalion, Canadian Engineers, has been awarded the Military Cross for distinguished service in action performed on September 4th. Lieut. McColl was a fourth year School of Science man at the University of Toronto, and enlisted as a private with the 124th Canadian Infantry in January, 1916, with which unit he went overseas, receiving his commission in England in January, 1917. He was then attached to the 124th Canadian Pioneers and saw almost continuous service in France until October 2nd, when he was wounded at Cambrai. He was then serving with the 11th Battalion, Canadian Engineers, having received his transfer to that unit in June. He is at present convalescing in the General Hospital, Manchester, England.

PUBLICATIONS RECEIVED

STANDARDIZED ELEVATORS.—Catalogue No. 244, issued by the Jeffrey Manufacturing Co., of Columbus, Ohio, and Montreal, P.Q. Forty pages are devoted to details of numerous styles of elevators used in handling wide range of materials. One page is given to each standard elevator, which is illustrated both in perspective and in line drawing giving dimensions. There is also an illustration showing the chain and bucket used with each type and at the bottom of each page is given the full specification applying to that particular elevator. 8½ x 10¾ ins., 72 pp. and stiff cardboard cover, coated paper, two colors.