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The Canadian Engineer

A weekly paper for civil engineers and contractors

G. T. P. DRY DOCK AT PRINCE RUPERT, B. C.

SPLENDID TERMINAL FOR PACIFIC COAST SHIPPING COMPLETED BY THE GRAND TRUNK PACIFIC RAILWAY, AFTER MORE THAN THREE YEARS' WORK, AT COST OF APPROXIMATELY $2,500,000.

THE largest dry dock on the Pacific Coast, either in the United States or Canada, and one of the largest of its kind anywhere in Canada, is the Grand Trunk Pacific dock at Prince Rupert, B.C. The land and wharf area is about seventeen acres. Preparation of the site included 96,000 cubic yards of dredging; 82,000 cubic yards of gravel fill; 268,000 lineal feet of piling for the wharf, and 5,000 cubic yards of concrete work for foundations, this being exclusive of any work in connection with the power house.

Middle Section (only) of Dock Submerged. Wrecked Vessel "Delhi" Being Lightered onto Submerged Section. One End Section, Not Submerged, in Background.

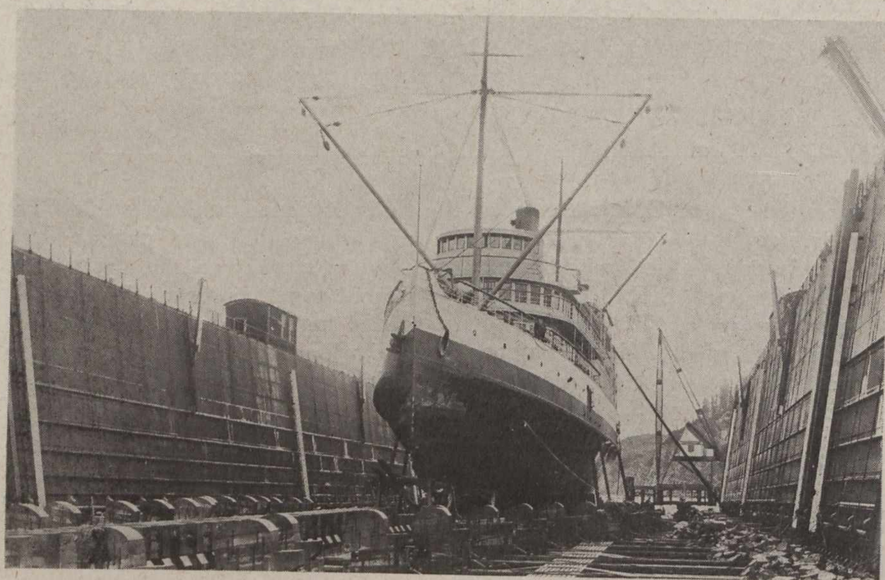
The Floating Dock.—The dock itself is built in three separate but interchangeable sections, the total length when joined together being 600 ft. When used separately, the two end sections are 165 ft. long, and the middle section 270 ft. long. The lifting capacity with the three sections joined is approximately 20,000 tons. The end sections have each a lifting capacity of 5,000 tons, and the middle section of 10,000 tons. The clear width between walls is 100 ft.; the over-all width, 130 ft.

The complete dock consists of twelve pontoons, each 44 ft. wide x 135 ft. long x 15 ft. deep, with a crown of 3 inches at the centre, and having 15 trusses spaced on 3-foot centres. Each pontoon weighs 490 tons, and has a lifting capacity of approximately 1,700 tons. A water-tight bulkhead, 12 inches thick, runs below the keel blocks of each section, and partial bulkheads on each side are used to strengthen the structure. The pontoons are connected together by steel side walls, or wings, which are 38 ft. high, 15 ft. wide at the bottom, and 10 ft. at top, and which contain altogether 2,400 tons of steel, and required 13,000 gallons of paint. The two end sections have three pontoons each; the middle section six pontoons. The pontoons are built of Douglas fir, protected against marine insects, first by a coating of tar and gravel, poisoned with arsenic, then by two layers of hair felt similarly treated, and covered with galvanized iron and an outside layer of 1½-inch creosoted lumber, secured with galvanized nails. The pontoons were caulked with 800,000 white pine wedges and contained 4,000,000 ft. of lumber and 400 tons of galvanized iron fastenings.

The dock, as a whole, is secured to the pier by the engagement of clamps on the dock with a vertical truss secured to the pile platform in such a way that it is free to rise and fall with the tide (which in the spring is often 25 ft.), and when being raised or lowered with a vessel aboard.

When it is desired to use the dock in separate sections, the forward three pontoons can be detached and moved around the corner of the pier and located alongside the platform. To use the remaining portion as two separate docks, the middle section of six pontoons is detached from the rear section and moved forward the length of the front section, and secured in position. The sliding clamps are so arranged that whether the dock is used as separate units or complete, the attachments on the pier will coincide with those on the floating dock.

The Pumping Equipment.—The floating dock is equipped with twenty-four 12-inch centrifugal pumps, one in each end of each pontoon. Each pump has a capacity of 5,000 gallons per minute. The entire dock can be raised or lowered 30 ft., the time required to dewater it being about 90 minutes. The pumps are connected by vertical shafts and bevel gears to a horizontal line shaft, which is operated by four 100-h.p. and two 200-h.p. variable speed A.C. motors. The motors are placed in motor houses, of which there are two on each section of the dock. The motor houses of each section also contain the control apparatus for the motors. This control apparatus is so arranged that each section of the dock can be raised or lowered from either motor house on the section, or the whole dock, with the sections joined together, can be raised or lowered from the motor house on the wharf side of the middle section. Control wires run from one section of the dock to the other, connection being made by means of plugs and sockets. In each cabin there is a master panel, on which are mounted ten knife switches, one motor master switch for each of the six motors, and four speed master switches controlling the speed of all motors.



S.S. "City of Seattle" in G.T.P. Dry Dock, November 16, 1915.

The control system is arranged so that the two motors on any section may be operated from one master panel on either of the two sections, or all six motors on all three sections may be operated from the master panel on the middle or large section. All the motors in operation will run at the same speed, and should a higher or lower speed switch be closed, all motors will automatically take the new speed. When some of the motors are operated at any given speed, if any individual motor switch is closed, the corresponding motor will automatically start and accelerate to the speed of the motors already in operation. The entire electrical equipment was supplied by the Canadian General Electric Co. The cabins on the side of the dock nearest the wharf also each contain a Jenckes motor-driven air compressor.

The General Layout and Buildings.—The dock-yard itself contains several buildings, the principal of which are the power house, carpenter shop and ship-shed, machine shop, boiler and blacksmith shop and foundry. There is a complete water system (including fire hydrants), a sewer system and a compressed air system installed for the whole yard. Standard railway tracks run to every part and to the shops. A 20-ton locomotive crane is used for shunting and hoisting. A 50-ton pier derrick, for handling freight, is mounted on the dock, and a 10-ton steam coal hoist, equipped with clam shell and capable of transferring coal from a boat or barge or railway car at the rate of 16 tons per hour, is located near the pier derrick.

The boiler house contains six water-tube boilers, rated at 400 h.p. each and delivering steam at 175 pds.

General View of Harbor and Terminal, Showing (1) End Section of Dry Dock, (2) Middle Section, (3) End Section, (4) Pier Derrick, (7) Shipbuilding Plant, (8) Power House, (5, 6 and 9) Foundry, Blacksmith and Boiler Shop, and Machine Shop.

per square inch. They are equipped with chain grate stokers. Provision has been made for the installation at a later date of two more boilers and an economizer. The feed water is passed through two heaters by two Allis-Chalmers 4-stage turbine boiler-feed pumps.

The power house, 104 ft. x 148 ft., and the chimney, 175 ft. high x 11 ft. diameter, are built entirely of concrete. The coal used is soft coal screenings and is conveyed from outside storage bins by an electrically operated monorail crane, and deposited in hoppers in front of the boilers, from which it feeds by gravity to the chain grates. The ashes are deposited into self-dumping buckets, which are conveyed to a standard flat-car outside of the power house by means of the same monorail crane which handles the coal.

The high-pressure steam line contains two 12-inch headers, one located in the boiler room and one in the engine room, connected together at three points, and provided with valves placed in such positions as to enable any part of the pipe line to be made dead for repairs without in any way interfering with the operation of the plant. The whole pipe line is covered with 2½ inches of 85 per cent. magnesium pipe covering.

The engine room contains two 1,250 kv.a., 3,600 r.p.m., 2,200-volt, 3-phase, 60-cycle generators, driven by Curtis turbines. To each turbine is connected a jet condenser with motor-driven vacuum and circulating pumps. There are also three 35 kw., 3,600 r.p.m., 120-volt, d.c. exciters, driven by steam turbines operated non-condensing, and one 25 kw., 1,200 r.p.m., 125-volt, d.c. exciter, driven by a 35-h.p. induction motor.

The switchboard is of blue Vermont marble and contains twenty panels, which include the generator and exciter panels and also the panels for the feeders going to the various sub-stations in the dock yard. The power house cables are all varnished cambric, lead covered, run in conduit.

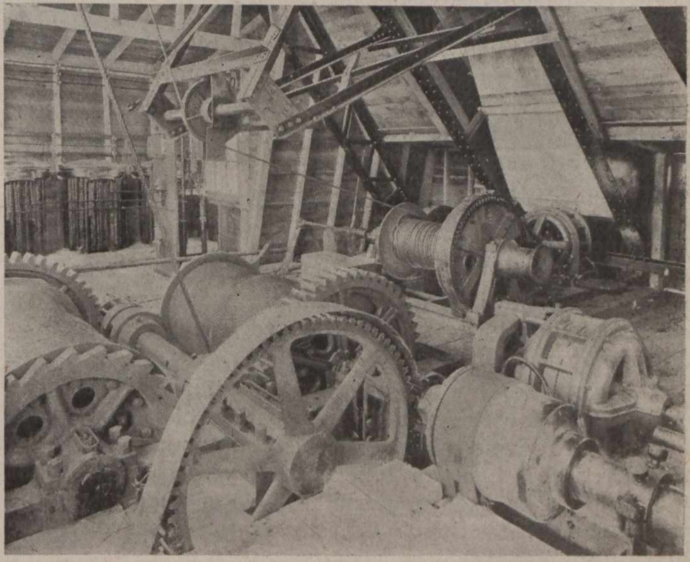
The engine room also contains a cross compound condensing air-compressor of 1,500 cubic feet per minute capacity. This supplies air to the various buildings in the dock yard. There are also two Platt Iron Works' duplex fire pumps, each with a capacity of 1,000 gallons per minute. These pumps are located in the basement and are connected to take salt water from the harbor or fresh water from the mains. They can be used as auxiliary boiler feed pumps and also to furnish water for the condensers if necessary. The engine room is equipped with a 15-ton travelling crane, which is of sufficient capacity to handle the heaviest part in the station.

The carpenter shop and ship-building shed is a steel and wood structure, 160 ft. wide, 300 ft. long and 116 ft. high, the ship-building part having an overhang of 80 ft., giving a clear space, under cover, 80 x 300 x 75 feet high. There are two 10-ton travelling cranes on this overhang, each operating over an area 40 x 300 feet. The other half of this building is used, downstairs as a carpenter shop, and upstairs as a ship hull pattern loft. The ship hull pattern loft has a floor space 80 ft. x 300 ft., entirely clear of columns or obstacles of any kind. It contains the wood-working machines, tool grinders, etc., necessary in a plant of this kind.

All the other buildings are of steel frame construction, with roof and floors of reinforced concrete. The entire equipment is of the most modern type, and the machinery installed is capable of handling the heaviest and largest repairs that may be required upon any vessel operating on the Pacific Coast.

In laying out the general plan for the present site, the possibility of future shipbuilding development was carefully considered, and, while the construction of steel vessels will not materialize for some time to come, it was nevertheless deemed advisable to construct buildings of a permanent nature. The broadside system of launching has been provided for.

The Pier Derrick.—The pier derrick stands on a piling and concrete foundation, and has a capacity of 50 tons at an outreach of 61 ft. 3 in. from the centre of the turning point, giving an outreach of 40 ft. beyond the end of the pier. The centre of the upper hoisting sheave is 100 ft. above mean high water. The derrick elevates 50 tons at a rate of 10 ft. per minute, and by changing gears, 25 tons at a rate of 25 ft. per minute. The hoisting apparatus is operated by a 52-h.p. variable speed motor, with reversing controller. The racking in and out is accomplished by a heavy steel screw, operated by a separate 52-h.p. variable speed motor, with reversing controller. There is also a 5-ton auxiliary hoist provided, operated by a 35-h.p. variable speed motor with reversing controller. The hoisting apparatus of the main derrick is 1¼-in. steel cable running through two 4-sheave blocks, each end being led to a separate drum. It is capable of removing



Interior View of 50-ton Pier Derrick.

or installing the heaviest pieces of machinery from or to the holds of any vessels in Northern Pacific waters. It is also used to transfer material from vessels lying at the dock to cars upon the pier.

Progress of Work.—Work was commenced in April, 1912, and the whole plant was started up in August, 1915, and within a few days, the wrecked vessel "Delhi" was successfully docked on the middle section. The isolated position of Prince Rupert naturally delayed the progress of the work, the nearest supply base being six hundred miles distant. To facilitate the erection of the complete plant, the structures first built were utilized in constructing the remaining buildings and docks. The first work to be completed was the pier and launching platform, followed by the erection of the power house and the installation of the necessary equipment. After the completion of the engineering and administration buildings, the final work of constructing the floating dry dock was accomplished, and the operating machinery erected.

Charles Crowell is the general manager of the dry dock. The engineers who designed the work and had charge of construction, were William T. Donnelly and Frank E. Kirby, of New York City. The resident superintending engineer was J. H. Pillsbury, of Prince Rupert.

RECENT PROGRESS AND TENDENCIES IN MUNICIPAL WATER SUPPLY.

(Concluded from last week.)

Water Disinfection.—The most important single development in the art of water purification in America during the past ten years was the introduction in 1908 of water disinfection by means of calcium hypochlorite, and more recently, by liquid chlorine.

The effectiveness of calcium hypochlorite, commercially known as chloride of lime, or bleaching powder, for the sterilization of both sewage and water, has been known for many years, although its use for destroying bacteria in drinking water appears not to have been proposed until 1894 (by Traube). The possibilities of hypochlorite for the routine disinfection of water supplies were overlooked until very recently.

There are several widely known instances of the early use of hypochlorite sterilization in Europe. As an emergency measure, chloride of lime was applied at Maidstone, England, in 1897, for cleaning the water mains after a typhoid epidemic, and was temporarily used in the water supply at Lincoln, England, in 1904-05. In both these cases comparatively large quantities of bleach were used. The treatment was not considered as a routine method of purification, but for emergency use only. As early as 1903, chloride of lime was used as a disinfectant in connection with a process of chemical water purification in operation at Middelkerke, Belgium. At this same time, as part of another process, peroxide of chlorine was used in connection with other chemicals in purifying the water supply of Ostend, Belgium. During the few years immediately following disinfection of water supplies by calcium hypochlorite was introduced in several cities of Europe on a limited scale.

Disinfection by Calcium Hypochlorite.—Hypochlorite disinfection for the routine purification of public water supplies first came into use in this country in 1908. The late Dr. J. L. Leal, in June of that year, advised that hypochlorite be used to purify the water supply of the Jersey City Water Supply Co. at Boonton Reservoir. The plant for applying the disinfectant was designed by Messrs. Hering and Fuller and put in operation on September 26th, 1908, with Mr. George A. Johnson, of the same firm, in charge. In the meantime, Mr. Johnson had advised that hypochlorite sterilization be used in conjunction with mechanical filtration at the new Bubbly Creek plant of the Union Stock Yards Co. at Chicago. Acting on this recommendation, hypochlorite disinfection was introduced here on August 2nd, 1908.

Water disinfection as practised at these two plants was soon demonstrated to be a success, although it met with some opposition at first. The process attracted wide attention and was quickly recognized by engineers and sanitarians as an economical and revolutionary means of combating water-borne disease.

The use of hypochlorite disinfection followed at a great many waterworks plants throughout the country. The process was applied not only at plants having no other means of purifying water, but came into use also as an auxiliary means of purification to further improve the effluent of filter plants drawing upon unusually polluted sources of supply. At the present time hypochlorite is in intermittent or continual use as a water disinfectant at approximately 600 municipal water supply plants in the United States. This growth has all occurred within the past six years. The beneficial effect of some of these installations on the quality of the water supply is very strikingly shown by the corresponding reductions in the typhoid fever death rates. Table II., giving the figures for eight representative cities, shows that the reduction has been as high as 72 per cent. in some cases, but all of this reduction, as elsewhere pointed out, must not be attributed to the improvement in the water supply.

Disinfection by Liquid Chlorine.—The use of chloride of lime in water disinfection is comparatively simple, and yet is open to serious objections. The variation in the amount of available chlorine in commercial chloride of lime, further complicated by the deterioration of the hypochlorite during storage, and the difficulty of thoroughly mixing with water, makes it difficult to secure solutions of uniform strength. Added to this difficulty is the fact that the degree of pollution, and of organic content of the water to be disinfected, may change rapidly, requiring constantly varying amounts of hypochlorite to properly disinfect the water.

These difficulties connected with the use of hypochlorite have been partly overcome by the substitution of liquid chlorine for hypochlorite. The use of liquid chlorine for disinfecting water appears to have been first introduced by Major C. R. Darnall in 1910. His process was based on the direct absorption of chlorine gas by the water to be purified. Other experimenters working with the same end in view adopted the use of the so-called absorption tower, whereby the chlorine is absorbed by a small amount of water, the latter being then introduced into the supply to be disinfected. It is this latter process which appears so far to have had the wider application.

Liquid chlorine is now used notably at Montreal, Canada, at the Niagara Falls plant of the Western New York Water Co., at Wilmington, Del., at four filter plants at Philadelphia, including the Torresdale plant, Ridgewood Reservoir, Brooklyn, and at Wilmington, N.C., in addition to various more recent installations.

Some of the advantages of the use of liquid chlorine in place of the old hypochlorite process are that an overdose, considerably greater than necessary to sterilize the water, does not result in an objectionable taste, and that the quantity of disinfectant can be much more closely regulated than with solutions of hypochlorite, while the germicidal action is probably superior. There are other advantages due to the less space required for the liquid chlorine plant, and the freedom from objectionable taste and odor about the plant, except during accident. The use of the liquid chlorine process probably requires more skilled attendance, but through saving in labor appears not to be more expensive than the older process.

The very wide use of water disinfection, often under competent technical supervision, has contributed largely to the rapid development of the art. We are now in an excellent position to draw conclusions as to the limitations of disinfection as a means of water purification.

The great improvement brought about by disinfection in many of our municipal water supplies is remarkably shown by the diminished typhoid death rates in certain of these cities. However, it is well known by those familiar with the subject, that water disinfection even more than water filtration is dependent for safe results to a considerable degree upon human vigilance, and to be satisfactory must be in expert hands, and that even then, the process has distinct limitations as a means of water purification.

The early claims made for disinfection have been remarkably well sustained by the great success of this new process, but it is to be pointed out that disinfection is in no way a substitute for filtration where both turbidity and bacterial problems are to be met and overcome. The proper function of water sterilization is conceded to be

Table II.—Decline in Typhoid Fever Death Rate in Eight Cities Following the Use of Hypochlorite Disinfection of the Water Supply.

City.	Began Using Hypo.	Before Using Hypo. Period.	Death Rate.*	After Using Hypo. Period.	Death Rate.*	Reduction in Death Rate.
Baltimore	June, 1911	1900-10	35.2	1912-13	22.8	35%
Cleveland	Sept., 1911	1900-10	35.5	1912-13	10.0	72%
Des Moines	Dec., 1910	1905-10	22.7	1911-13	13.4	41%
Erie	March, 1911	1900-10	38.7	1912-13	13.5	65%
Evanston	Dec., 1911	1907-10	26.0	1912-13	14.5	44%
Jersey City	Sept., 1908	1900-07	18.7	1909-13	9.3	50%
Kansas City	Jan., 1911	1900-10	42.5	1911-13	20.0	53%
Omaha	May, 1910	1900-09	22.5	1911-13	11.8	47%

*Death rate per 100,000.

either as an auxiliary to filtration, or as an emergency measure to render unfiltered supplies safe. Where a supply is continually bad, the tendency is to resort to filtration, and to use disinfection as an added safeguard against disease germs.

Other Methods of Water Disinfection.—None of the other known methods of water sterilization have yet been applied in this country on a commercial and practical scale, but remain largely in the experimental stage, although in Europe the ozone process has been rather extensively used, and the violet ray process has excited interest and attention both in this country and abroad.

Future of Water Disinfection.—The very remarkable development of hypochlorite water disinfection in this country, and the recent modification of the process by the introduction of liquid chlorine has put water disinfection on a sound basis. We are safe in concluding that disinfection as an auxiliary means of water purification has come to stay, even though the disinfecting agent may be changed in the future by the further perfection of processes now known or the discovery of new and better methods.

Accidents to Distribution Systems.—One of the most important requirements in distributing water for municipal supply is to give continuous service. The past ten years have afforded notable examples of serious interruptions of service. In the larger plants these interruptions have been caused usually by breakages in the water mains. Water hammer, defective pipe, settlement or disturbance of pipe or conduits by nearby construction, by flood, by fire and by earthquake, have all had a share in these accidents. Many of the breaks have been unavoidable, but from some of them valuable lessons have been drawn.

The losses sustained, as a result of these breaks, through interference with industry, suspension of fire protection, and pollution of the water supply, have been in some instances very great. Some of the worst conflagrations of the past decade followed water pipe breaks that resulted in failure of fire protection at a critical time. The importance of avoiding such losses and increasing the factor of safety in water distribution has led, in some cases, to the provision of cisterns scattered through the distribution system where there is danger of disruption of the system from any cause. The need of having duplicate supply mains or conduits and the importance of provision for promptly isolating parts of the distribution system, by hydrants always accessible, and other precautions, is perhaps much better recognized to-day than formerly.

Water Consumption.—The question of water consumption has grown to be of vital importance in many American cities. It is now quite generally recognized that the usual very high rates prevailing in our cities result from waste, and increasing attention has been paid during the past ten years to waste prevention. Energetic waste prevention has materially reduced the consumption in some cities, and others have been able to maintain rather enviable low rates of consumption. Notwithstanding this work, very high per capita consumption continues to be typical of many American municipal water supplies.

The consumption of water in this country varies from less than 40 gallons per capita in some cities to 400 gallons in others. This wide range in rate of consumption is still more striking if we compare it with the consumption in Great Britain, where the combined domestic and trade consumption is in several cases even below 25 gallons, and the highest rate only 70 gallons per capita. Even allowing for a somewhat more liberal legitimate domestic use of water in this country, and a greater consumption for industrial uses, it is difficult to reconcile the high rates so common in this country with the low per capita consumption abroad, and the lower rates of consumption in some of our own cities. A partial explanation is found in the very considerable waste of water. This waste is principally underground leakage and leakage in plumbing, as well as careless use, but may also be due to theft.

The total waste from these causes is so great that much attention has been given during the past decade to water waste prevention. This work, especially in the larger cities, has become a very important part of waterworks management, and has made possible very considerable reductions in the consumption. Greater attention has been given to metering services as a means of curtailing waste, and more attention has been given to water waste surveys. Devices for measuring flow in pipes and ingenious methods of detecting leaks have been developed that make it possible, at reasonable cost, to discover and stop large leaks in the distribution system.

Several very instructive water waste surveys have been made during the past few years that throw light on the enormous waste that occurs in some of our principal cities. In Chicago, where about 200 gallons per capita is delivered to the distribution system, it was concluded that 30% of the water entering the mains was wasted through underground leakage, and 20% by leakage in defective plumbing. In Chicago, it is stated that only 50% of the net pumpage actually reaches the consumer.

Considerable new data has been obtained in the last few years in cities where all consumers were metered, and where the station ouptput is also reliably metered. In a considerable number of these cases the proportion of water metered to the consumer to the entire output has been found to be as low as 45 to 50%. The highest percentage has not exceeded 78% to a possible 90%. This is undoubtedly an interesting field for further study.

New York, by systematic surveys and waste prevention, was able, in 1912, to reduce the total water consumption 90 million gallons per day below the estimated needs for that year. This work has been energetically carried on to tide the city over the period until the new Catskill supply becomes available. The results have continued to be so satisfactory that the rate of consumption is now lower than for many years past, and the city is assured of a sufficient supply even though the expected time of completion of the Catskill project has been postponed one year. The New York water waste surveys have cost very much less than the estimated cost of the temporary additional supplies that would otherwise have been needed. At Washington, D.C., and other cities, work of the same kind has been carried out on a less extensive scale, but with results almost as important to the cities involved.

These water waste surveys show clearly that the figures covering what is called "consumption" may, in this country, indicate even as much as twice the amount of water actually used. They point out to the waterworks manager a very fertile field for economies that not only save money, but virtually increase the capacity of the plant. The usual great cost of supplying water and the difficulty of meeting constantly increasing demands make waste prevention of great importance, and we may expect increasing attention to be given to this aspect of the water supply problem.

The tendency is towards increased use of metering to reduce waste. But metering is often unpopular and is still opposed by the public in some of our largest cities. Especially in those localities where there is an abundant visible supply of water, the idea has prevailed that water should be "free as air," and in these cities popular prejudice against meters continues to be particularly strong.

Many of our largest cities, including New York, Chicago, Philadelphia, Buffalo and Pittsburgh, still have very small percentages of service metered or no meters at all, and, as a rule, very high rates of consumption. But the strong tendency, in spite of this local prejudice, is towards the more general use of meters, so that we may look forward to a great extension of the practice of metering services and charging for quantity of water used instead of by flat rate or frontage, regardless of actual use.

The tendency towards the increased use of meters in municipal waterworks service is shown by Table III.

Table III.—Comparison of Percentage of Metered Services at Different Periods in 82 Large American Cities.*

Per cent. services metered.	1900 No. of cities.	1900 Total population.	1906-12† No. of cities.	1906-12† Total population.
100%	1	32,700	7	660,300
75-100	13	848,700	21	2,818,900
50-75	5	509,300	12	1,004,000
25-50	15	1,221,200	14	1,718,600
10-25	9	636,300	10	2,047,100
0-10	39	11,513,500‡	18	11,569,300§
Total and averages	82	14,761,700	82	19,872,200

* These cities were all over 25,000 population in 1900.

† The data in this column was obtained for various years from 1906 to 1912, inclusive, most of it being for the years 1910, 1911, or 1912.

‡ Includes New York and one other city reported as having no meters.

§ Includes New York and six other cities reported as having no meters.

Considerable interest has been taken during the past few years in the classification of water consumption. Figures showing the domestic and trade consumption and use for other purposes are now comparatively rare, but will, without doubt, be more plentiful in the near future when their value is more generally appreciated.

Fire Protection.—Provision for fire protection continues to be a consideration of the utmost importance in municipal water supply. The severe requirements of adequate fire protection service in certain districts of our larger cities have led, during the past ten years, to the development of independent high pressure fire systems to serve those parts of the city in which the fire hazard is unusually great. These high pressure systems have their own separate pumping stations, distributing mains and hydrants, and usually a separate source of water supply, and are in addition to and entirely distinct from the ordinary waterworks system serving the same district and affording some degree of fire protection.

High pressure fire systems are, as a rule, designed to furnish pressures ranging from 200 to 300 pounds per square inch. Intermittent operation, large capacity, safety and reliability in service and the ability to respond almost instantly to demand are the governing features in the design of these high pressure systems. The pumping requirements are met by widely different equipment in the more important installations so far made, showing that practice has not become standardized. One high pressure fire service pumping station is equipped with crank-and-fly-wheel plunger type pumping engines, but, as a rule, centrifugal pumps are used for this service, either gas-driven or actuated by motors or steam turbines. The sanitary quality of water for this service is of no consequence, and the most readily available supply is used regardless of quality, even salt water being used.

The early installations of this kind were made in 1908 and 1909, New York City and Philadelphia being among the first cities to make this departure. At the present time, Baltimore, San Francisco, and Oakland, Cal., as well as Toronto and Winnipeg, Canada, have installed high pressure fire systems.

Equitable Rates, Valuation.—During the decade just past, there has been a notable movement for State and national regulation of public utilities where water supplies have been privately owned, and in some States, where they are municipally owned, this regulation has operated to control more thorough examination of the value of the property devoted to the public use, the proper return to be afforded it and the just and equitable apportionment of the income to be raised among the different classes of consumers. Nearly all of the States now have established Public Utility Commissions having more or less power to regulate rates, require uniform accounting, and value property devoted to the public use. A very few of these commissions, with restricted powers, existed prior to 1907, but the great majority of them, and notably their enlarged powers, have been created since about that date. Inasmuch as these commissions are largely new to their responsibilities and the subject of rate regulation both in the economic, financial, and legal questions raised are admittedly difficult and complicated, their proceedings are watched with interest, and the subject is now being extensively studied.

During the decade ending in 1915, the transfer of water supply utilities to municipal ownership has continued, though less rapidly than in prior years as the number of privately owned plants diminishes. Approximately fifteen million dollars in value of private utility property in water supply has become municipally owned since 1905 in the United States, and several large properties yet remaining in private hands will undoubtedly be transferred to the public control at an early day.

METHODS OF WASHING SLOW SAND FILTERS.*

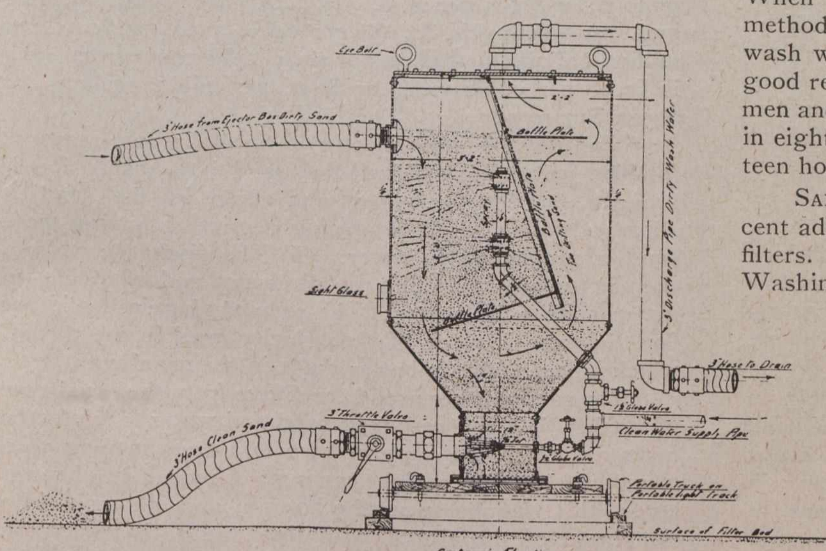
By John Gaub,
Superintendent of Filtration Plant, Washington, D.C.

IN late years various processes for cleaning the sand of a filter bed have been advanced; some partly destroying and others exterminating the filter film on the bed. These ideas have in some cases caused trouble and in others only repair. There is no doubt that the rough treatment of the sand surface, a penetration of organic matter and filth into the bed cause deep clogging, which prevents the yield of water, and causes the beds to become inefficient.

Attempts to reduce the work of cleaning filters are commendable, because scraping, sand handling and raking are the items of greatest expense in slow-sand filter maintenance; hence it is the endeavor of the writer to show what attempts along this line have been made, both from an economical and efficient standpoint.

In this country it is bad economy to discard the sand scraped from the filters, for the expense attached to the preparation of new sand is very high, since it must be washed free from clay and screened before it is ready to be placed in the filter. Yet, in Osaka, Japan, the sand is dredged from the Yodo River opposite the waterworks, and made suitable for the beds and placed therein for about 65 cents per cubic yard, a figure so low that no attempt is made to recover by washing the sand scraped from the filters.

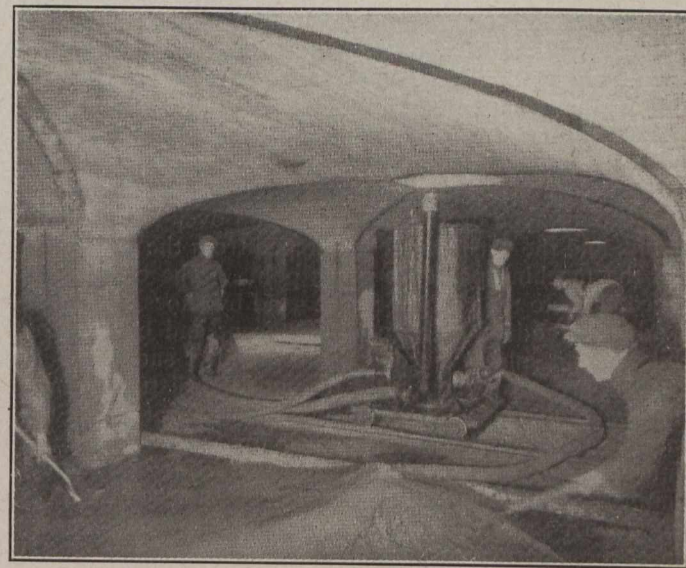
In handling the sand for slow sand filters several methods have been tried, each giving results at a small cost in some places, while in others the contrary is true. The writer, therefore, compiled tables from plants using



Portable Sand Washer Used at Toronto.

these methods, together with their costs. However, before delving into the methods as practised at the various plants, a brief description of the methods commonly used will not be out of place.

THE BROOKLYN METHOD.—This method was first used in 1905 at the Hempstead filters, at Rockville Centre, Long Island, and consists in lowering the water to a few inches in depth above the surface of the sand on the filter. Unfiltered water is taken from an adjacent filter in service and run in a stream over the bed to the outlet drain, a depth of about 1 inch of flowing water being maintained over the section to be cleaned. Men in boots agitate the surface of the sand with long-toothed garden rakes, thus stirring the dirt from the sand and having it carried away to the drain. The filter is generally cleaned in sections by cutting off the part undergoing cleaning from the rest of



Sand Washer in Use at Toronto.

the filter by boards set on edge and driven down into the sand, forming a miniature flume with board sides. After cleaning, the boards are removed to a new position. When the filter is clean, filtration is resumed. This method is somewhat costly, in that about 1 per cent. of wash water is used. In cases of emergency it has given good results. At Philadelphia, it is reported that with 14 men and a foreman a three-quarter acre bed can be cleaned in eight hours and that such a bed will be out about nineteen hours a month.

SAND WASHING MACHINES.—These machines are recent additions to the washing apparatus used in slow sand filters. They began their existence about 1909, when the Washington plant adopted the "ejector washer" system. Previous to this time the dirty sand, after being scraped, was shovelled into portable ejectors on the beds, to be thence forced by water pressure through pipes to stationary sand washers. After being washed, the sand was discharged into storage bins, from which carts driven underneath may be loaded, and the sand carried to the filter and placed.

THE BLAISDELL MACHINE.—This machine may be described as a travelling crane spanning a filter unit and supporting a watertight rectangular chamber containing the machinery necessary, and provided with means for lowering this chamber to the sand surface and travelling over the filter while the process of washing is in progress. The chamber wherein the washing takes place may be raised so as to clear the rim of the filter and thereby remove the machine to another filter.

About two inches above the sand or bottom of the sand chamber there is a plate or diaphragm dividing the washing chamber into two compartments placed above each other; the lower, used as a suction chamber from which the dirty wash water is withdrawn, contains stirrer

*Abstract of paper written for the current issue of the American Waterworks Association's Journal.

wheels mounted on vertical shafts; the upper contains the driving mechanism for the stirrer wheels and also the pressure and suction pumps.

From the stirrer wheels, in the lower chamber, supported on vertical shafts above the sand, numerous teeth project into the sand to any desired depth. The teeth are hollow and perforated in order to create a water jet action from the supply delivered by the pressure pump. The water for the pump is taken from the water on the filter, while at the same time a suction pump joined to the top chamber withdraws not only all the water the pressure pumps supply through the perforated teeth, but also an additional amount from the filtered water in the sand. In operation, the teeth scour the sand, while the wash water, by its jet action, drives the dirt into the suction chamber and the clear water stored in the filter bed is drawn into the washing zone by the excess suction over the pressure supply, and the wash water is pumped from the supply before the machine passes a given point. The chamber is placed close to the surface of the sand by shoes extending in advance and to the rear of the front end back plate, while the side plates cut down into the filter sand.

The pressure water rises through the disturbed sand zone and is displaced by the inrush of clear water, the upward current of which occurs well toward the centre of disturbance created by the teeth and covered by the suction chamber. The sand is forced apart by the teeth, and as they return the strong upward current of wash water causes a temporary suspension and churning action within the suction chamber. During this time the dirt and light particles are brought to the surface and withdrawn with the wash water. The sand in suspension settles after the violent upcast subsides, so that when the sand comes to rest it is uniformly water packed and free from air. The wash water from the machine is discharged to a gutter formed generally in the party wall between filter units. The wash water may be so controlled that sizing may be done by working all very fine sand to the surface and removing that which is too fine from the filter. This sizing is done by increasing the duty of the pressure and suction pumps so as to secure a downward velocity by which to hold the sand in suspension.

All of the operations of this machine are controlled by separate motors which are operated from a platform. Generally there are six motors mounted on the machine with variable speed controllers. With this machine it is possible to wash a bed of an acre in about twelve hours, and in about fifteen hours the bed can be in service, allowing three hours for closing valves, etc.

The Nichols Washer.—This machine has been in use since 1910. It enables the operator to wash the sand on the filter without removing it from the bed, thereby saving not only in wash water, but also in labor, etc.; in other words, the total saving being about 35 per cent. of what it would cost to use the old method of scraping, removing, washing and replacing the sand. Briefly, the machine consists of an inverted cylinder inside a closed jacket. The dirty sand is fed into ejectors in the usual way, and the wash water with the sand and dirt passes through the machine. The water strikes the side of the cylinder, and the sand being heavy drops to the bottom and passes through a nozzle on to the filter. About 2 per cent. of fine sand passes out with the water and dirt to the court where it generally settles while the débris goes to the sewer. It has been shown at some places that it is possible to clean 10 cubic yards per hour using 1,200 gallons of water per cubic yard, whereas by the old method 2,800 gallons of water were used. Again, at some places this machine has been modified, in that several sprays of water play on the sand within the machine; also more baffles have been added, thus causing a better wash for the sand.

Methods of Washing Sand at Various Plants.

Washington, D.C.—Until 1909 the filters were scraped and the sand piled, and then removed by ejector and one or more lengths of hose to the sand washers. After the sand was washed, it was discharged into storage bins from which carts were loaded and the sand brought to the desired place on top of the bed, and there dumped and spread evenly. After 1909 the hydraulic method of replacing was used, whereby an ejector is placed underneath the outlet gate in the storage bin, and the sand is carried in a reverse direction from the bin through piping and one or more lengths of hose to the bed. This process has decreased the cost of resanding and has proved very satisfactory in every way. This method has been used or tried in several places with more or less good results. At Washington the filters are resanded as follows: The filters are filled with water to the desired depth of the sand layer. The outlet end of the hose is joined to a 3-inch pipe supported on a boat, and the sand is discharged through the pipe at the point required. Generally work is begun at the far end of the filter, and is gradually filled by swinging the boat from side to side and backing it by degrees to the front end. By this method the sand has no tendency to separate into different sizes, if the discharge has a slope of about 40 to 45 degrees from the horizontal. By this position of the discharge pipe the old surface of the sand is cut and moved ahead with the new sand, thus breaking up the possibility of forming a mud layer between the old and new layers.

The average cost of scraping is $0.096 per cubic yard, or $0.07 per million gallons, or $16.08 per acre. The cost of raking is $0.042 per cubic yard, or $0.03 per million gallons, or $6.64 per acre. The cost of ejecting, washing and transporting is $0.168 per cubic yard, or $0.11 per million gallons, or $28.32 per acre. The cost of replacing is $0.08 per cubic yard, or $0.06 per million gallons, or about $13.10 per acre.

The movable sand ejector is novel for two reasons: (*a*) The water for making the sand into suspension is brought up from the bottom and rises as the sand is shovelled into it, thus producing a mixture having more sand in proportion to water. (*b*) The discharge ends of the ejector are made like the discharge end of a Venturi meter, with a flat batter. The economy herein lies in the fact that use is made of the velocity head in the throat, which is lost with the batter made in the usual way.

The sand washer used here differs from the usual type of washer, in that the mixed sand and water fall into the hopper. From the hopper there is a free opening to a chamber formed by a globe casting. A second jet of water enters this chamber near the bottom, and is carried into the throat of the ejector with the sand as it leaves the hopper. The sand settles through the water into the chamber and is separated from all dirty water which came with it. The hopper usually used dilutes the dirty water in the sand, but the one devised at Washington makes a complete separation.

Toronto, Ont.—Sand is washed by a portable washer. After being scraped in piles it is put into an ejector box from which it is carried to the washer. In the washer it passes through sprays of clear water, and by the action of baffles, falls to the bottom, where a strong spray drives it out through a hose, which distributes the clean sand on the filter. The wash water used is about ⅓ per cent. of the net yield of the filter. The wash water passes up to the top of the washer, then down to a 3-inch drain which connects with a 36-inch drain. The cost per cubic yard of sand, washed and replaced, including washer pump, handling sand, repairs, etc., is about $0.61.

DENVER, COL.—The sand is conveyed from the filters to the washer through an ejector and sand line of hose at a pressure of about 150 pounds. In this plant the ejector method of replacing was tried, but owing to the stratification, was abandoned. The cause of stratification probably was a too high uniformity coefficient of the sand as it left the washer. The sand is replaced from dump cars, the cars being loaded by hand, hauled to the side of the bed by horse power, dumped, reloaded into side-dump cars, pushed by hand to the place desired, dumped and spread. This is very costly, but owing to the thoroughness of mixing, it appears to be the best in the end. The total cost per cubic yard for cleaning and washing the sand on a bed is about $0.73.

NEW HAVEN, CONN.—Here the water is drawn off and the sand piled, and wheeled to the hopper and carried to the washer by hydraulic means. From the washer the sand goes to a receiver in the bed having the lowest depth of sand, in which it is spread around and allowed to accumulate until the maximum depth of 40 inches is reached, when the apparatus is put into the next bed having the least depth. By this process about 5 cubic yards per hour can be washed, using about fifteen volumes of water to one of sand. The cost of cleaning per acre is about $75, not including the cost of water. About 60 cubic yards of sand are removed per cleaning, making the cost per cubic yard about $0.43.

LAWRENCE, MASS.—The sand is ejected to a set of three hoppers outside the bed. The sand from the last hopper is ejected to a large box having a weir which holds back the sand and permits an overflow of waste water. The sand is then shovelled out from the box down one of the ventilation holes for distribution on the bed. The cost per cubic yard is about 25 cents. It is claimed at this plant that the wheeling of the sand to the desired place and casting insures proper mixing, while the use of water pressure causes stratification due to the uniformity coefficient of the sand.

WILMINGTON, DEL.—At this plant a very good example of the Blaisdell machine is seen. The machine is used for raking and washing the sand on the beds. It was expected that the cost of sand washing, etc., would not be greater than $1 per million gallons. However, since the plant requires intelligent superintendence at all times, and skilled mechanics for operating the washing machine, and notwithstanding that the machine is idle about 70 per cent. of the available working time, the cost has been a little over the expected cost. The total cost per million gallons is approximately $1.23.

CONCLUSIONS.—Each method has its advantages and disadvantages. The Blaisdell machine is very economical in that the time in which a filter is out is practically at a minimum; however, the days in which the filter is operated after the wash are somewhat at a minimum also. As for total yields the process practised at Washington appears to show up better. From a standpoint of duration in days the Washington methods are the best and cheapest.

From the experiences at the various plants cited it is seen that much improvement in sand handling has been in progress, especially in building machines.

The cost of cleaning a filter by machine has not been reduced below that for cleaning and replacing sand by the improved hydraulic processes. The uniformity coefficient of the sand is an important factor to consider when hydraulic processes are used.

THE MAPPING OF CANADIAN CITIES.

By Douglas H. Nelles, D.L.S., M.Can.Soc.C.E.

(Concluded from last week.)

IT will be seen from the first part of this article, which appeared in last week's issue, that in order to have a standard set of city maps with a standard degree of accuracy, and made in the most economical manner possible, there should be a special branch of a Dominion Government surveying department, organized on a strictly business basis, for the purpose of making maps of Canadian cities.

A 1/10000 Scale Map.—As mentioned in the Introduction, there should be a smaller scale map published besides the 1/1000 scale suggested. For the second set of maps a natural scale of 1/10000 is suggested. This is the scale upon which the Geodetic Survey of Canada is publishing the topographic maps of the Thirty-one-Mile Lake watershed, Quebec. It is the standard scale of the United States, Coast and Geodetic Survey for harbor surveys, etc. Their field instructions read as follows: "For all general coast topography in new regions, unless otherwise specified, a scale of 1/20000 will be used. Larger scales, such as 1/10000, and, in exceptional cases, 1/500, are to be used for special harbor surveys where the amount of detail or the importance of the locality warrants."

As before mentioned, the whole of the United Kingdom of Great Britain and Ireland is mapped upon a 1/10560 scale. The city of Cincinnati is now publishing a smaller scale of wall-map on a scale of 1/14400. The 1/10000 maps would be published in sheets, representing five minutes in latitude and five minutes in longitude, which measures, on the ground, four miles east and west and five miles 4,000 feet north and south. On paper, the topography would cover a space of 25½ inches by 36½ inches. If 144 square miles were to be taken for the proposed Federal District of Ottawa, six of these sheets would cover the district, and if mounted on linen, would make a wall-map six feet and five inches wide and six feet and one inch high.

The 1/1000 Scale Map.—The topography on the published sheets of this scale would cover as much paper as that of the 1/10000 scale, and the bounding lines would be parallels of latitude and meridians of longitude, and enclose thirty seconds of each, which would measure on the ground a space 2,100 feet wide and 3,050 feet high.

On this scale the convergence of the meridians could not be shown. The latitude and longitude lines which would form the boundaries of the topography would, therefore, be drawn at right angles to each other. The projection lines of the sheet, for the convenience of making measurements from it for engineering purposes, would be latitude and departure lines, drawn one thousand feet apart, and having for their zero some geodetic triangulation station.

This particular size sheet is chosen for two reasons: first, to cheapen the cost of publishing the 1/10000 scale maps; and secondly, to give a universal system of numbering the sheets which would be applicable anywhere in Canada. It would take just 100 sheets of the 1/1000 scale to make one sheet of the 1/10000 scale. They would, therefore, be numbered from one to a hundred, and the number of the 1/10000 scale sheet attached, as well as that of the degree sheet of the Canadian standard topographical map on a scale of four miles to an inch. It would take 144 1/10000 scale sheets to make one degree of latitude and longitude, so that they would be numbered from one to 144, and the number of the degree sheet of the standard topographical map attached. This method of numbering maps would give a universal system, so that the number of any sheet, on any scale, any place in Canada, would always be fixed.

Mathematical Publications.—Besides publishing the map upon two scales, there would be what the writer calls "Mathematical Publications." They would be issued in pamphlet form, similar to what are called "Publications of the Dominion Observatory," in which are issued the astronomical results obtained at the Observatory, and also the results of the operations of the Geodetic Survey of Canada. Of these latter, there have been five publications issued, embracing the results of the Geodetic or Precise Levelling Division, which can be obtained by application to the superintendent of the Survey at Ottawa.

The mathematical results of a city survey would be as follows: First a list of all triangulation stations, their descriptions, elevations, latitudes, longitudes, azimuths and back azimuths, distance between stations and their logarithms, latitude and departures from the station chosen as the zero point for the co-ordinates of the map, and a map of the triangulation. Secondly, a list of all traverse stations containing their latitude and departure from a chosen triangulation station, the bearings of courses, elevations above mean sea level, and their descriptions. Thirdly, a list containing all the survey bench-marks, and also all the old city bench-marks, together with their descriptions and elevations above mean sea level.

Besides the city being supplied with the two sets of maps and the mathematical publications, they would also be given a duplicate card index system similar to the one kept by the survey.

From these published results of the traverse the distance and azimuth between any two stations in the whole district could be computed accurately. They could also be authorized by a special act of legislature to act as the bases for land surveys and be used in the description of property. In this case it would be necessary for the city to employ upon its engineering staff a Provincial Land Surveyor. In any case it is good business policy of any city to have a Provincial Land Surveyor upon its staff. A recent mayor of Ottawa some years ago stated that the city paid out more than enough money for the services of surveyors in settling infringement and other cases than would pay the salary of a permanently engaged surveyor.

A Great Saving in Cost.—It will be seen from the mathematical publications used in connection with the maps that the civil engineer will be abe to make a close calculation as to the cost of any engineering project that is put forward without being put to the trouble and expense of costly preliminary surveys.

As an example: When the Ottawa Federal Plan Commission got down to work they found it necessary to spend the sum of $7,000 in rough preliminary surveys, none of which would have been necessary if they had had to their hand the published information outlined above. Again, the city of Ottawa has spent for reports upon its water problem, since the year 1904, a sum in the close neighborhood of $120,695, according to a detailed list furnished through the city auditor. It is safe to say that half this sum could have been saved on the surveys made by the "water experts" if they had had a published topographical map of the city and surrounding district. It is also probable that a saving could have been made upon the other half by not finding it necessary to get the advice of so many experts. Many other cities are probably in much the same position as Ottawa in regard to the cost of various engineering works.

Having followed the paper through this far the reader will have arrived at the conclusion that the writer is strongly in favor of having the map-making of the Canadian cities done by the Dominion Government, in order that the whole work may be properly systematized and cost kept down to the lowest possible point. When precise surveying of any kind is undertaken the cost of instruments mounts up pretty high, a sum much higher than it would be advisable for individual cities to invest in instruments which would be used very seldom after the mapping was finished. A primary triangulation instrumental outfit for one party costs about $1,800. A geodetic level instrumental outfit for one party costs about $400, other classes of work in proportion.

Cost of City Maps.—An estimate has been made of the cost of the field work for an Ottawa city map on a 1/1000 scale as described which comes to $1.55 an acre for an average of an area embracing 144 square miles. The city of St. Louis map on a 1/2400 scale cost $11.15 an acre. The map of London, England, on a 1/1056 scale, as per illustration, cost $3.25 per acre.

METHODS OF SURVEY IN DIFFERENT CITIES.

The memorandum on the survey of London on a 1/1056 scale and the memorandum on the revision of the survey of London on a 1/2500 scale were supplied to the writer by the Director-General of the Ordnance Survey of Great Britain.

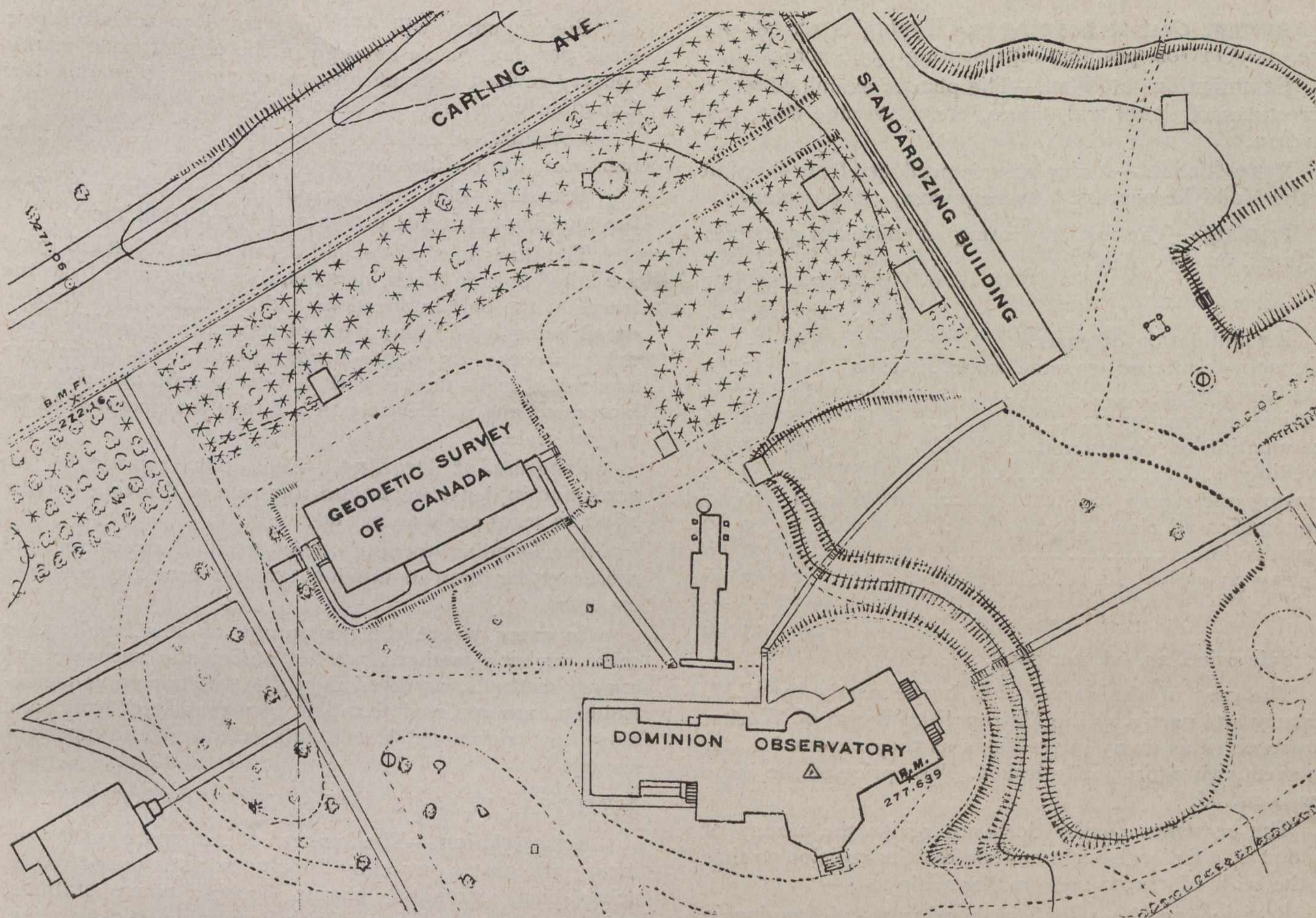
The memorandum on the Survey of St. Louis is condensed from a paper published in the transactions of the American Association of Engineering Societies January, 1893, by B. H. Colby, First Assistant Engineer in Charge of Surveys, Sewer Department, St. Louis, Mo., Member Engineers' Club, of St. Louis.

The memorandum on the Topographic Survey of Cincinnati is condensed from a paper published in the "Engineering News," April 3rd, 1913, by Hugh C. Mitchell, Engineer in Charge of Topographic Survey, Cincinnati, Ohio, formerly Assistant and Computer, United States Coast and Geodetic Survey, Washington, D.C., and also from information by Mr. W. N. Brown, of Brown & Clarkson, topographic engineers, of Washington, D.C., who had the contract from the city for the topographic part of the work, and from H. S. Morse, Engineer in Charge, Division of Sewerage, city of Cincinnati.

MEMORANDUM ON THE SURVEY OF LONDON. SCALE, 1/1056.

Trigonometrical Work.—Points on high buildings directly connected with the main triangulation of the country are fixed and permanently marked. These points are about three-quarters of a mile apart. From these points others on the ground level are fixed about one-quarter of a mile apart and are permanently marked.

These ground level points, marked by a metal bolt let into the pavement or road surface were chosen with a view to facilitate direct chain survey between points, and were fixed from the stations on the top of buildings



Portion of Specimen Sheet of Proposed Canadian City Map. Scale, 1/1000. Surveyed and Drawn by C. R. Westland, B.Sc., D.L.S.

by using a tall pole, 60 feet high, plumbed over the selected point.

When the original trigonometrical work was extended in 1909-10 the points fixed trigonometrically were somewhat further apart, and intermediate points at the junction of roads and other suitable places were fixed by traverse with theodolite and steel chain, the permissible error in traversing being 1/4000.

Organization.—A trigonometrical party consists of one observer and three laborers. A traverse party consists of one observer and three laborers.

Cost.—From 7½d. to 1s. 5d. per acre, dependent largely on interruptions due to traffic. A traverse party should traverse 1¼ miles per day.

Detail Survey.—This hangs on the traverse, and is carried out with a steel chain of 100 links and an offset rod of 10 links. Permissible error in chaining, 2/1000. No offset exceeds 20 links.

Organization.—A detail party consists of one superintendent, seven surveyors and eight laborers. Such a party would survey 10 acres per day.

Average Cost.—7s. per acre. Subterranean detail is not surveyed.

Examination on the Ground.—The plans having been plotted in pencil on paper (hand-made from pure rags) are traced. The traces are examined on the ground, corrected where necessary, and minor detail and names added to them.

Organization for Examination.—One superintendent, four examiners, and five tape boys. The superintendent finally examines the work already examined by the men of his party. Such a party would examine about eight acres per day.

Average Cost.—5s. per acre for field work; 1s. per acre for plotting and tracing.

Levelling.—The levelling is based on the main network of the country; 8 or 9 lineal miles of levelling for every square mile of country is given for town plans (5 or 6 km. per square km.). Bench marks are cut in the walls of the houses about 120 meters apart, and surface stations given at the junction of roads, and highest and lowest points on roads, at sudden changes of grade and at least one every 40 meters. This is probably more than is necessary.

Cost.—Cost per lineal mile depends on the density of traffic and on the weather. For London, about 21d. per mile, including levelling in the field, and calculating and plotting in the office, and all incidental and established charges, say, 6½d. per acre.

Organization.—The field levelling parties are independent of the detail surveyors and of each other, each party consists of one leveller and two assistants. They work all the year round in the field and should do nearly a kilometer a day.

Office Work.

Drawing.—The size of the plans is 36 inches by 24 inches and the scale 1/1056. The plans already plotted in pencil are corrected by the traces that have been examined on the ground, drawn in ink and the names of the streets typed.

Average Cost of Drawing and Typing is 1s. 6d. per acre, or £11 10s. per plan representing 153.6 acres.

Examination of Plan.—The plan is examined as to correctness of detail and names, etc. Average cost, £1 per plan.

Reproduction.—A zinc plate is produced from the plan by the Vandyke process. Average cost, 6s. per plan.

Printing.—The cost of printing an edition of 50 copies is £2 7s. 6d. per plan.

Recapitulation of costs.	Per acre. s.	d.	Per plan of 153.6 acres. £	s.	d.
Trigonometrical and traverse work..	1	0	7	13	0
Detail surveying	7	0	53	15	0
Plotting and tracing	1	0	7	13	0
Examination on the ground	5	0	38	8	0
Levelling		6½	4	3	0
Drawing and typing	1	6	11	10	0
Examination of plan			1	0	0
Reproduction				6	0
Printing 50 copies			2	7	6
			126	15	6

Sale price, 2s. 6d. per copy.

The cost of the survey was borne partly by H.M. treasury and partly by the Metropolitan Board of Works, who received as many impressions as they required at 1s. per sheet, when originally issued. The price of the issue now is 2s. 6d.

The ordnance survey does not revise the survey of London on this large scale but confines its revision to that on the scale of 1/2500 and smaller scales.

Revision on the 1/1056 scale of parts of London is carried out by the Land Registry Office, London, who could supply details as to their organization and the costs of keeping the 1/1056 plans up to date. Only the drawing and printing is carried out by the ordnance survey for the Land Registry Office, and the costs of these services are similar to those already detailed in connection with the original survey.

MEMORANDUM ON THE REVISION OF THE SURVEY OF LONDON. SCALE, 1/2500.

Preliminary.—Accurately drawn plans on the 1/2500 scale exist, having been reduced by photography from the 1/1056 scale revision of 1891-95 and redrawn on 1/2500 scale on hand-made paper. Size of plan, 37.00 inches by 26.34 inches.

Although drawn some eighteen years ago, these plans have retained their size within the limits that permit of of their reproduction by photography to true scale size with no greater error than 10 links in 120 chains.

A plate, true to size having been produced, an impression in blue on hand-made paper is made and retained in the drawing office to form the basis of the revised plan.

Red impressions on tracing paper are pulled at the same time. These are cut to a convenient size and revised on the ground.

Revision.—The revision cancels obsolete detail with black crosses, supplies new detail in black on the trace, and adds names of streets, etc.

The final reviser examines the revisers' work, and makes any necessary corrections in green ink.

Organization for Revision.—One superintendent, 3 revisers, and tape boys as required. The superintendent finally revises the work of the revisers.

Such a party will deal with 20 to 30 acres of town work per day, on an average in the largest cities in this country revised after an interval of about 20 years. For Canadian work, say, 40 to 60 acres.

Levelling.—Levelling is detailed in the accompanying memorandum on the survey of London.

Drawing.—On the return of the traces from the field the blue impression is drawn and typed from them.

The blue lines of the old detail that still stand good are inked over in black, new detail is transferred from the traces to the blue impressions and inked in. The obsolete detail being left in blue will not reproduce either by Vandyke process or photo-zincography. The plans are especially finely drawn with a view to photographic enlargement and publication on a 1/1250 scale as well as on 1/2500 scale.

Progress at Drawing.—Each plan represents 960 acres and in dense town work the rate of drawing is from 16 to 20 acres per man per day.

In Canadian towns, where detail is straighter and more regular than in London, greater progress could be expected.

In areas where the percentage of new buildings is great revision methods are not sufficiently accurate and survey methods, as detailed in the accompanying memorandum, are resorted to. The traverses start from, and close on trigonometrical points used on the previous survey.

MEMORANDUM ON THE SURVEY OF ST. LOUIS.

Triangulation.—The location of stations were for the most part, places owned by the city, such as public parks, school-house grounds, engine houses, police stations, waterworks, reservoirs, conduits, hospitals and cemeteries. After these, streets and alleys, and lastly, roofs of public and private buildings.

The instruments used were: Gamy 8-inch transit reading to 5 inches; Gamy 8-inch reading to 10 inches; Buff and Berger 8-inch reading to 10 inches.

The method of observing was that of repetitions, four sets of five repetitions each were taken, making 80 measures of each angle.

The average closing error was 03″.7 per triangle.

The adjustment of the system was made by least squares.

A pole painted alternately black and white was used for sighting on at first, but a 1-inch heliograph was used on the majority of stations. The average closing error of triangles in which the pole was used was 4.6 ins. and where the heliograph was used, was 2.7 ins., bringing the mean to 3.7 ins.

The number of stations was 87, making one station to 319 acres, or two stations to each square mile. There were 26 stations situated upon the roofs of buildings and two-thirds of the angles were from these roof stations.

Precise Levels.—The make of the level was Fauth & Co., with Kern rods.

The number of bench-marks was 743, an average of 12 per square mile.

The location of bench-marks was distributed over the entire city for use of all departments of municipal government and also for city surveyors. An up-to-date list is issued each year by the sewer commissioner, which any person can get. Bench-marks are located on stone or iron sills of buildings, stone bridges, culverts, city limits, triangulation stones, and some are copper bolts leaded in tile slabs, buried below frost line, and connected with the surface by tile pipes.

The length of lines up to January, 1893, was 240 miles. The average length between benches was 484 meters or 1,588 feet.

The average closing error per mile was 0.009 feet.

Topography.—The scale of the map was 1 in = 200 ft.; contour interval, 3 ft.; size of sheet, 28 x 50 ins.

Method.—The triangulation stations were used as starting points and the topography taken by transit and stadia. The direction of all lines and side shots were astronomical bearings.

Cost.—Topography, $20,503.59, $0.732 per acre; precise levels, $10,890.31, $0.277 per acre; triangulation, $4,079.43, $0.145 per acre; total cost per acre, $1.154; cost of sewers per acre, $638.

MEMORANDUM ON THE RE-SURVEY OF THE CITY OF CINCINNATI.

Triangulation.—Main stations are especially built, tripod and scaffold signals with flag pole. These rest either on the ground or on some solid building. In this city the public school buildings afforded good location for these towers. Several of the primary stations were spires, cupolas, or flag poles on prominent buildings, occupied eccentrically.

The lines of primary triangulation were 1½ to 9 miles in length, the measured base line being 1½ miles long, and in addition to this measured base the scheme was tied on to the United States C. and G. S. transcontinental triangulation net along the 39th parallel by occupying two of their stations, and using their computed length.

The intersection stations were spires and chimneys mostly, there being one of these stations to every two or three square miles.

No connections were made with city surveys, but direct connection made between triangulation stations and measured traverses by observing at least three angles to the triangulation stations from points on the traverse.

The instruments used were a 12-in. direction theodolite used in 16 positions of its circle, and a 10-in. repeating theodolite with which each angle and its explement were measured in sets of six D and six R, five sets being taken. Limit of rejection for direction instrument 5 ins. Limit of rejection for repeating theodolite 4 ins. from mean.

This primary triangulation was done according to the specifications for primary triangulation of the Coast and Geodetic Survey.

There were 17 primary, 2 secondary and 50 tertiary stations, and the average triangle closing error was 2″.61.

Traverse.—Traverse lines were run with a steel tape and transit. These traverses were from 3,000 to 5,000 feet apart and have stations every 800 feet or less along their lines.

The traverses were controlled horizontally by triangulation and vertically by precise levels. The average closing error was 0.37 feet in 1,000 feet, which is a ratio of 1/3000.

Levels.—Precise levels were run over an area of about 100 square miles and in this district 145 lineal miles were run and 217 bench-marks placed.

A Coast and Geodetic Survey precise level was used and their methods followed throughout.

The bench-marks were bronze caps, on iron pipes, set in concrete, and were placed in pairs, with the idea of always running wye levels from a pair, and thus guarding against using a bench-mark which had settled or otherwise changed.

Wye levels were run over all traverse lines and connected with P.L.B.M.'s and checked upon precise level bench-marks.

The average wye level's closing error was 0.031 feet per mile.

Topography.—The plane-table was used altogether in mapping the topography which varied from river flats to very steep hills several hundred feet in elevation.

The plane-table work always started from a traverse station and ended at a traverse station, and the line was required to close to within five feet, which is as close as can be measured on a 1/4,800 scale. Marks were always left at each plane-table station so that if the line did not close properly, each course could be checked, and the survey adjusted.

The scale of the map is one inch equals 400 feet, or a natural scale of 1/4,800. The contour interval is 5 feet, except that on slopes of less than six degrees the 2½-foot contour was put in.

It is the intention of the city to publish a reduced wall map on a scale of one inch equals 1,200 feet, or on a natural scale of 1/14,400.

Purpose of the Map.—The purpose of the topographic map is for use in both the Department of Public Service and the Park Department, for the preliminary location and estimates for sewerage, streets, viaducts and parkways.

Before the map was completed it was utilized to advantage for all those different purposes. In addition to this, a newly organized survey for a rapid transit system in the city made tracings from the sheets, so that they could proceed at once with the preliminary location and estimate.

METALS USED IN SHELL-MAKING.

The following figures, taken from "Conservation," the official organ of the Canadian Commission of Conservation, furnish a comparison between the quantities of the different metals used in the manufacture of the 22,000,000 shells, for which orders have been placed in Canada, with our production of such metals in 1913:—

Steel used, 400,000 tons. In 1913 it was estimated that the production of iron ore in Canada, 307,634 tons, did not exceed 5 per cent. of the country's requirements of iron in that year.

Zinc used, contained in brass, 11,200,000 pounds. No zinc was refined in Canada in 1913 but the exports of metallic zinc in ore shipped amounted to slightly over 7,000,000 pounds.

Copper used, 55,000,000 pounds. The total production in 1913 was about 77,000,000 pounds and all of it was exported for refining.

Lead, 101,760,000 pounds. The production in 1913 was about 37,665,000 pounds, of which over 97 per cent. was recovered as refined lead.

About 32,000 tons of steel were placed in the Quebec bridge in somewhat over six months, during 1915. The work included the erection of the falsework on the south shore, the south 515-ft. cantilever arm and main posts, part of the north anchor arm and the 580-ft. north cantilever arm. About 44,000 tons, of the total 63,000 tons of steel in the bridge, have been erected. The double pins at the joints, driven in two or three minutes each, the extreme accuracy of the shop work, the yard-assembly reaming and the excellent field appliances, including flying falsework and electrically operated travelers, all contributed to rapid work. While the record day's tonnage in 1914 was 410 for one traveler, in 1915 the figure was 670.

EXAMINATION OF BITUMINOUS ROAD MATERIALS.

THE United States Office of Public Roads has issued a bulletin, written by Prévost Hubbard and Charles S. Reeve, on methods for examination of bituminous road materials. For the purpose of examination, the bulletin says road materials may be classified as follows:—

1. Petroleums and petroleum products, including heavy distillates, malthas, residual petroleums, fluxes, oil-asphalts, and fluxed or cut-back oil-asphalts.
2. Asphalts and other solid native bitumens, and asphaltic cements produced by fluxing them.
3. Petroleum and asphalt emulsions.
4. Tars and tar products.
5. Mixtures of tar with petroleum or asphalt products.
6. Bituminous aggregates, including rock asphalts or bituminous rocks, bituminous concrete, asphalt block, and bituminous topping.

All petroleum, maltha, and solid native bitumen products are subject to the following tests:—

Specific gravity.
Volatilization at 163° C.
Bitumen soluble in carbon disulphide.
Bitumen insoluble in 86° B. paraffin naphtha.
Fixed carbon.

Of these types the very fluid and sometimes the more viscous products may be subjected to the viscosity, flash, and burning-point determinations. Very viscous materials, too soft for the penetration test, are subjected to the float test, and semi-solid and solid products to the penetration test. If the material is sufficiently hard at ordinary temperatures, a melting-point determination may also prove of value. Sometimes two or more of the above-mentioned tests, depending upon the character of the material and the use to which it is to be put, may be made to advantage on a single material. When for any reason it is suspected that the material under examination has been overheated and possibly injured during process of manufacture, or prepared from a solid native indurated bitumen, the determination of bitumen insoluble in carbon tetrachloride may be made. The paraffin scale determination is made on those materials which are to be identified as being partly composed of heavy paraffin hydrocarbons. The residue obtained from the volatilization test is usually subjected to either the float or penetration test, and in addition it may be subjected to any or all of the above-described tests as occasion may require.

Tar and tar products are subjected to the following tests:—

Specific gravity.
Distillation.
Bitumen soluble in carbon disulphide.

Petroleum and asphalt emulsions are subjected to some of the methods of examination applicable to fluid and viscous residual petroleums and also to the following tests:—

Determination of water.
Determination of ammonia.
Determination of fixed alkali.
Determination of fatty and resin acids.

In addition, the viscosity test may be employed for fluid products and it is highly desirable that the float test be made on all of the viscous and semi-solid tar products. The more or less solid refined tars or tar pitches are also subjected to the melting-point determination. Mixtures of tar and petroleum or asphalt products are in addition subjected to the dimethyl sulphate test.

Some exceptional materials can not be satisfactorily examined according to any one predetermined scheme, and at the present time this matter must be left to the judgment and experience of the analyst.

Bituminous aggregates are first of all examined for the percentage of bitumen soluble in carbon disulphide. If the amount is in excess of 5 per cent., an extraction is then made on a large sample and the recovered bitumen is examined according to one of the above-mentioned schemes if it can be identified, or, if not, it is subjected to those tests which are of most value as suggested above. The extracted mineral aggregate is usually quantitatively graded and, if it is to be used or has been used as an integral part of the road proper, its percentage of voids is sometimes determined.

Special attention is called to recent modifications in the penetration test, determination of fixed carbon, and determination of paraffin scale, and to the substitution of different methods for the old distillation tests and for determination of voids in the mineral aggregate.

Penetration Test.—The object of the penetration test is to ascertain the consistency of the material under examination by determining the distance a weighted needle will penetrate into it at a given temperature. A standard needle is employed for this purpose and this needle is usually weighted with 100 grams. The depth of penetration is determined upon the bitumen maintained at 25° C., while the load is applied for five seconds. This test is made on all semi-solid and solid oil-asphalts, asphaltic cements, and native asphalts, but seldom on tar products. It is also often made on the residues of materials subjected to the volatilization tests, when sufficiently hard.

Fixed Carbon Test.—One gram of the material is placed in a platinum crucible weighing from 20 to 30 grams and having a tightly fitting cover. It is then heated for seven minutes over the full flame of a Bunsen burner. The crucible should be supported on a platinum triangle with the bottom from 6 to 8 centimeters above the top of the burner. The flame should be fully 20 centimeters high when burning freely, and the determination should be made in a place free from drafts. The upper surface of the cover should burn clear, but the under surface should remain covered with carbon, excepting in the case of some of the more fluid bitumens, when the under surface of the cover may be quite clean. The crucible is removed to a desiccator and when cool is weighed, after which the cover is removed, and the crucible is placed in an inclined position over the Bunsen burner and ignited until nothing but ash remains. Any carbon deposited on the cover is also burned off. The weight of ash remaining is deducted from the weight of the residue after the first ignition of the sample. This gives the weight of the so-called fixed or residual carbon, which is calculated on a basis of the total weight of the sample, exclusive of mineral matter. If the presence of a carbonate mineral is suspected, the percentage of mineral matter may be most accurately obtained by treating the ash with a few drops of ammonium carbonate solution, drying at 100° C., then heating for a few minutes at a full red heat, cooling and weighing.

Owing to the error introduced by the presence of considerable quantities of free carbon, reliable results cannot be obtained with tars by this test.

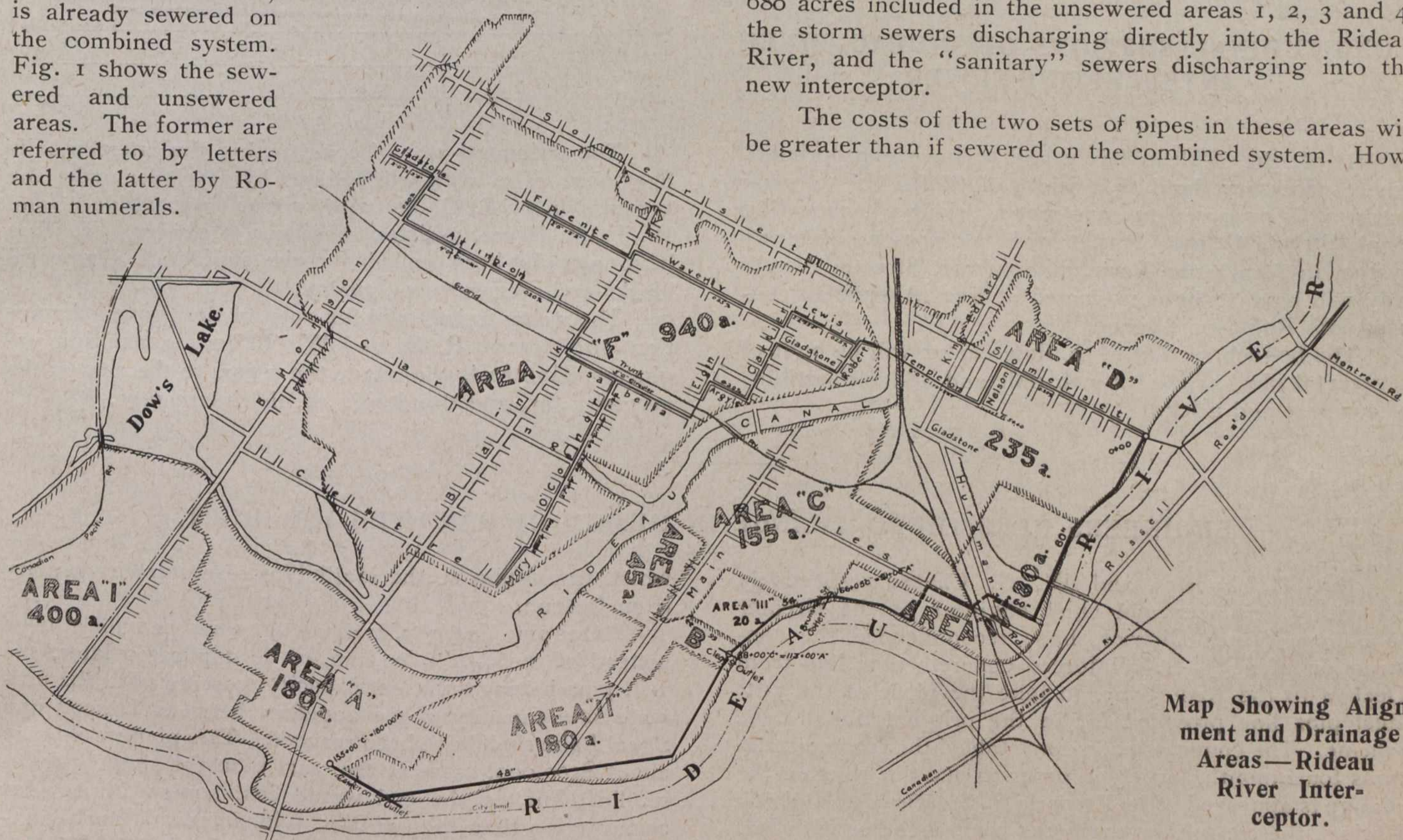
Paraffin Scale.—The method of determination of paraffin scale is fully described in the bulletin, and it is stated that the test may be made on all native bitumens and their products which are suspected of being of a paraffin nature. The authors state, however, that it is not an extremely accurate determination, and is seldom employed by the Office of Public Roads.

RIDEAU RIVER INTERCEPTING SEWER

By L. McLaren Hunter, C.E.,
City Engineer's Department, Ottawa.

In designing the Rideau River intercepting sewer, it was important to adopt such a route and grade as would permit of its convenient incorporation in the main drainage scheme which must be provided eventually for the whole city of Ottawa and its suburbs.

The new interceptor is to serve that part of the city lying between the canal and Rideau River, extending from an upstream limit along the canal, to the vicinity of Hurdman Road and Gladstone Avenue, or rather, to the boundary of the area naturally tributary to the Somerset Street main sewer. The area of this section is 1,060 acres, 36 per cent. of which (380 acres in the Ottawa South and Ottawa East districts) is already sewered on the combined system. Fig. 1 shows the sewered and unsewered areas. The former are referred to by letters and the latter by Roman numerals.



Map Showing Alignment and Drainage Areas—Rideau River Interceptor.

It will be noted that area "A" includes 180 acres in Ottawa South, with an outlet at Cameron Street. Area "B" includes 45 acres in Ottawa East, with an outlet at Clegg Street, and area "E" includes 155 acres in Ottawa East, with an outlet at Brunswick Street. The unsewered areas are as follows:—

Area "I." Including 400 acres above the Cameron Street outlet.

Area "II." Including 180 acres between the Cameron Street and Clegg Street outlets.

Area "III." Including 20 acres between the Clegg Street and Brunswick Street outlets.

Area "IV." Including 80 acres lying along the Rideau River between the Ottawa East district and the area tributary to the Somerset Street main sewer, viz., area "D."

The present main sewer has its outlet in the Ottawa River at Edwards Mill, at the foot of John Street, and crosses the canal at Templeton Street. Some of the areas tributary to this main sewer within the city are shown in Fig. 1, and are as follows:—

Area "D," including 235 acres between the canal and the Rideau River.

Area "F," including 940 acres west of the canal.

Area "E" (not shown on plan), including 290 acres in Rideau Ward.

The greater portion of these areas is already sewered on the combined system and the remainder in all probability will be completed on the same system.

The controlling features in the design of the interceptor were:—

(1) The standard of cleanliness necessary with respect to the Rideau River.

(2) The system to be adopted for the 680 acres of unsewered territory tributary to this interceptor.

In order to keep the Rideau River clean in its course through the city, the discharge of domestic sewerage into this section of the river has to be practically eliminated, and it is imperative to adopt the separate system for the 680 acres included in the unsewered areas 1, 2, 3 and 4, the storm sewers discharging directly into the Rideau River, and the "sanitary" sewers discharging into the new interceptor.

The costs of the two sets of pipes in these areas will be greater than if sewered on the combined system. However, the immediate cost of the interceptor would be very much greater if the separate system were not adopted.

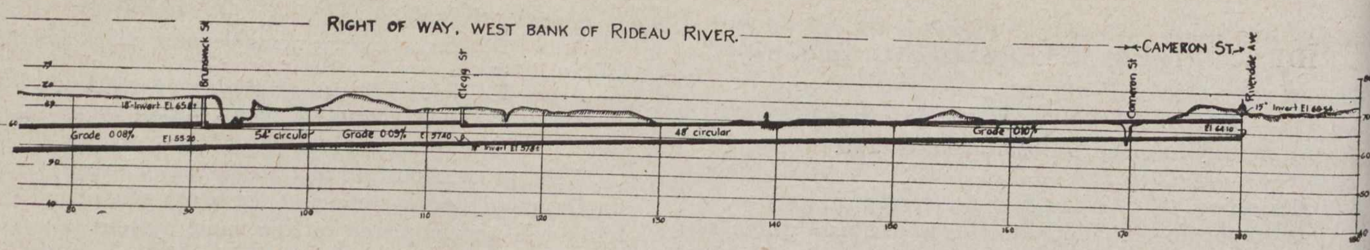
Another factor in the recommendation of the separate system is the upstream area "1," which is so low that it would cost too much to drain by gravity.

A relief sewer must also be built, to take care of the 940 acres west of the canal in area "F", as the Somerset Street main is not large enough to carry the maximum discharge which will eventually take place.

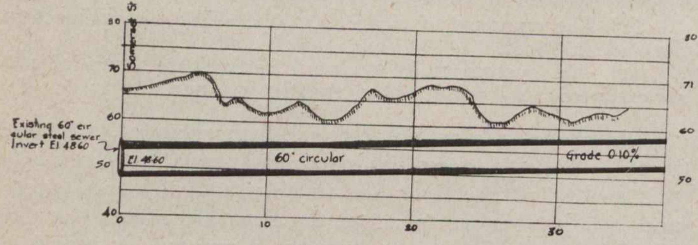
The proposed route for the interceptor is as follows:—

Along the low side of the territory, following more or less closely to the west bank of the Rideau River, until it nears the railways at Hurdman Road, where it turns northwards on to Lees Avenue, along Lees Avenue under the railway tracks to Robinson Avenue, until it reaches the Rideau River again. Then it follows the west bank of the Rideau until it flows into the main sewer on Somerset Street.

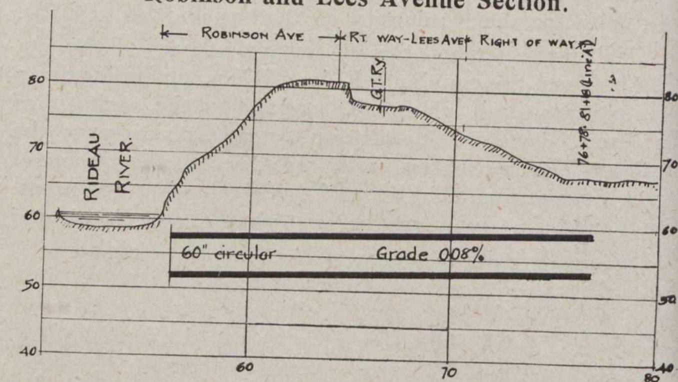
In conjunction with the new Rideau River interceptor, the city council has decided to open up a street along the



Section, West Bank of Rideau River.



Robinson and Lees Avenue Section.



LONGITUDINAL SECTIONS OF RIDEAU RIVER INTERCEPTING SEWER

banks of the Rideau River and to have expropriated, where necessary, land to a width of 66 ft. In the near future it is proposed to construct a driveway connecting Bank Street, Ottawa South, with the present driveway system in Strathcona Park, at Somerset Street. A subway will have to be constructed at Lees Avenue to connect with Robinson Avenue.

The 60-inch section of the interceptor will be built of segmental blocks; the 54-inch unit and 48-inch sections, of concrete and brick.

The estimated cost of constructing the interceptor is $315,000. The work will be done by day labor under the supervision of F. C. Askwith, acting city engineer, and W. F. M. Bryce, assistant engineer of sewers. Tenders have already been called for the supply of segmental blocks and necessary equipment.

The writer is indebted for most of the above information to Messrs. R. S. and W. S. Lea, consulting engineers, Montreal, who made the report to the city on the necessity for, and the design of, the interceptor.

ENGINEERS RECOMMEND CHANGE IN DESIGN OF WINNIPEG AQUEDUCT.

Jas. H. Fuertes and W. G. Chace, respectively consulting engineer and chief engineer of the Greater Winnipeg Water District, have recommended the construction of a 5½-ft. reinforced concrete pipe line from Deacon to the Red River, to take the place of the 5-ft. steel pipe line provided for in the original Shoal Lake scheme. The commissioners have tabled the recommendations for a month, largely in order to find out whether the change is approved of by Frederic P. Stearns and Rudolph Hering, the consulting engineers who, together with Mr. Fuertes, originally designed the entire project. In their report to the commission, Messrs. Fuertes and Chace say:—

"The site finally chosen for the location of the Transcona reservoir site and the final alignment of the aqueduct, as well as other circumstances, have altered both the hydraulic features of the problem and the costs of construction and operation, and careful studies now show that it would be more advantageous to the district and to the city of Winnipeg, from the financial as well as operation standpoint, to provide a reinforced concrete pressure pipe line instead of a 5-ft. steel pipe, from Deacon to the Red River.

"The concrete pipe should be of sufficient strength to deliver the water to the Red River, crossing under the head due to the Deacon reservoir, and having a capacity equal to the maximum daily rate of water consumption. Booster pumps installed at the Red River crossing would send the water along to the McPhillips Street reservoirs, when the consumption shall have reached the quantity which would flow to the McPhillips reservoirs by gravity from Deacon.

"One pipe line, 7 ft. in diameter, could be built at once instead of the 5-ft. 6-in. line, to be duplicated later, the 7-ft. pipe having sufficient capacity to serve until the ultimate safe capacity of the aqueduct between Deacon and Shoal Lake shall have been reached. This plan would cost about $500,000, more at the start than the single 5-ft. 6-in. line, but, in the end would cost somewhat less for construction than the two 5-ft. 6-in. lines. When the investment is considered in connection with interest, depreciation, and pumping costs, the single 7-ft. line appears to possess no merit sufficiently substantial to offset the great advantage accruing from the possession of two independent lines for the delivery of water from Deacon to the heart of the district when the population to be served shall have reached about 400,000 people.

"The cost of the pipe line from Deacon reservoir site to the Red River, differs but slightly in unit price per foot from the consulting engineer's report for a 5-ft. steel pipe line, being about $21.60 as against 20.74. The greater diameter is required on account of greater length, and will deliver to the centre of population, one-half of the entire delivery to Deacon of the aqueduct now under construction.

"Moreover—and this is important to note—this will not be a force main, but will operate under the gravity head available, whereas the steel pipe first proposed was a force main and required for its capacity the installation in future of a pumping station at Deacon. The necessity for such a pumping station is now forever removed."

Editorial

TRANSPORTATION COMMISSION FOR TORONTO.

The Toronto city council will discuss at an early meeting the report on semi-rapid transit presented by the commissioner of works of the city, the chief engineer of the Ontario Hydro-Electric Power Commission and the chief engineer of the Harbor Commission. A transportation commission, composed of business men who will serve without remuneration, will be appointed to prepare for the taking over of the Toronto Street Railway System at the expiration of the company's franchise in 1921. Such a commission will have a vast amount of preliminary work of organization to do, and it is not too early to appoint it, if the city has really decided definitely not to renew the franchise.

If the T.S.R. system is to become a publicly owned enterprise, all of the present civic lines and all civic lines built between now and 1921, should be arranged so as to be readily unified with the T.S.R. system. The projected hydro-radials should also form an integral part of the whole scheme, and all interests must be co-ordinated and must work in harmony if efficiency is to result.

The water front property controlled by the Harbor Commission will be used to a great extent, so the harbor board should have a member on the new commission. Hydro power will be needed, and interchange of traffic with the hydro radials will be most desirable, so "the Hydro" should be represented on the transportation board.

The city, of course, has the largest interest in the project, and should hold control in the membership of the new commission. The commission should be aided by, and all detailed work done through, a board of engineers. These engineers will really need the four or five years' time that they will have, in order properly to accomplish their work. Careful appraisals of all physical property owned by the private system must be made. Contracts must be arranged for supply of power, and the power actually made available for instant use upon taking over the railway. The street car men's union must be met and a scale of wages arranged and accepted by both sides. The entire clerical and operating staff must be made ready to step into their new positions at the stroke of the clock which marks the beginning of the altered ownership. Financial arrangements must be perfected, and the necessary actual cash secured. Contracts for supplies of all kinds will need attention. In other words, it is not the task of a month or even of a year, to take over as a going concern—and to keep it going—a street railway which operates over 125 miles of track, employs more than 2,200 men, and has a stock and bond issue of $17,139,500, according to its last published report, and assets valued at $23,731,635.

CANADIAN RESEARCH BUREAU.

Canadian universities are co-operating in the establishment of a bureau of scientific and industrial research. The attainment of national efficiency and commercial independence is possible only through such an established research bureau. The need for Canadian research is great, for the treasures that are hidden in the rocks and forests of this country, waiting to be utilized, are unlimited.

It is of vital importance to engineers, also, that native industries should be encouraged, and that they should be carried on scientifically and profitably. Engineering work largely depends upon research by scientists.

Many dividends have been increased and many failures avoided by the work of scientists. In fact, commercial competition demands the services of such men, and a number of American firms are spending large sums of money on research work. The General Electric Co., for example, spends over $200,000 per annum. It must not, however, be thought that no original research work has been conducted in Canada, because very important investigations have been and are being made, such as those in connection with cobalt, peat coal, fisheries, forestry, etc. Notwithstanding what has been done in this direction—principally by the Government—there is scope for enormous work of this character to be undertaken by the universities and by private enterprise.

In this connection, attention might with advantage be directed to the papers and discussions on the subject of research in chemical industry, at the New York Section of the Society of Chemical Industry, as reported in the "Metallurgical and Chemical Engineering." C. F. Burgess stated that research work pays as it pays to advertise—that there is a wide gap between factory and research laboratory when it comes to developing a process and putting it on a commercial basis, that there ought to be an intimate contact between the two departments, and that the average university graduate must give up some of his delusions, yet he must not lose his enthusiasm. President Maclaurin maintained that industries will never rise to what they ought to be until they become imbued with the spirit of the university—the scientific spirit. On the other hand, the universities will never rise to their true level until they become permeated with the spirit of industries. The function of the university is to help to organize industries on a scientific basis.

So long as we continue to draw the technical directors of our industries, the men on whom decision as to development work depends, from the purely commercial side of the organization, rather than from those men with scientific training, just so long shall we continue to cry for a more protective tariff, more favorable patent laws, etc.

The war has rendered it necessary for countries to rely more on their own resources, hence there is need for united action on the part of business men, technical men and the general public to encourage this research movement, as it tends to the conservation of our own resources.

LETTER TO THE EDITOR.

Rapid Transit for Toronto.

Sir,—The writer had been looking forward with interest to the publication of the report on radial railway entrances and rapid transit for the city of Toronto, but having read what has so far appeared, is somewhat disappointed at the conclusions reached by the engineers.

It is stated, in what may be called a preface, as follows: "The extension of adequate transportation facilities should, and usually does, precede the population, but in Toronto of late years, the conditions have been reversed."

I have yet to learn of a single city of the first class, where "adequate transportation facilities" have been provided prior to absolute necessity. Toronto is not by any means alone in this misfortune. Everywhere it is the same story of crowded and congested streets, and the incapacity to meet transit requirements. New York, though spending 300 millions on new subways and other methods of transportation, falls short of meeting the requirements of the situation, and will never probably catch up to it. The increase in population far exceeds the capacity of transportation. Philadelphia, Chicago and Boston are building subways and elevated railways and otherwise trying to catch up with belated facilities as fast as money can be provided.

Here in Montreal we have the same conditions, and our city officials look no further than they can see, and seem indifferent to the whole question, other than what is pressing at the moment.

This leads up to what I wish to say with reference to the Toronto report. The suggestions offered for increased facilities of transportation, to my mind, provide only for the immediate present. The report takes account of the radial entrance east and west into Toronto, but misses, I think, to provide real rapid transit for the city itself. The unfortunate water front is again to be utilized for additional railway traffic. Thirty years ago the writer lived in Toronto, and the old Union Station on the water front was not far distant, and easily to be reached by the entire population. A few years later, a second station was built, again on the water front, but by this time the population had expanded and it became increasingly inconvenient to reach it. Twenty-five years have passed, and a still larger and more magnificent station is to be built, and still on the water front. A map of Toronto, of the present day, has only to be glanced at to see how remotely removed this station is from the mass of the travelling public. What will be the state of things twenty-five years hence?

This is more or less aside from the question of rapid transit in the city itself, though connected with it, because the people must be brought into close communication with all these stations; and more rapidly than they are at present. Semi-rapid transit, whatever that covers, will not meet the need of the case.

The report further states: "We presume that persons who can travel from the central area to their abodes, or vice versâ, in 35 minutes, do not require more rapid transit." If this is all the rapid transit Toronto is to have, I am sorry for Toronto. A man leaving his office, say, south of King Street, should not have to spend 35 minutes on the journey home to any part of greater Toronto. The fact is, no surface transportation can give real rapid, or even semi-rapid, service. The time is coming when, as I have stated on several occasions, surface cars will be removed from the congested streets in the central areas of our large cities. Our streets are dangerously crowded with vehicles, in addition to the tram cars, and they should be free for these vehicles alone. Rapid travel to and from our homes and offices can be secured only by underground lines, with motor buses and street cars as feeders thereto.

Speeding up the service of street cars adds but little to the relief of congestion, and materially increases the dangers to the public. If it is argued, as it may be, that subway transportation will not bring adequate returns at once, it must be remembered that the municipalities have other duties to their citizens, and two of these are safety and speed in travel; for, without these, cities cannot grow.

In closing, I am constrained to say, the report as a whole is a valuable contribution to transportation literature, and interesting in its treatment of the east and west radial lines, but does not seem to offer a real solution of the rapid transportation of passengers in the city of Toronto itself.

The suggestion that a permanent commission be appointed to further investigate, construct and control all transportation improvements in the city and suburbs is an excellent one, and is in line with what I have been advocating for Montreal for several years. There must be local bodies created, jointly by the provinces and cities, with paramount authority to supervise this most important of questions—urban transportation.

F. STUART WILLIAMSON, M.Can.Soc.C.E.
(Consulting Engineer, Montreal.)

Montreal, January 4th, 1916.

ADVANCES IN SEWAGE DISPOSAL.

During recent years, marked progress in sewage disposal has been made in Canada. A recent investigation made by the Commission of Conservation revealed the following:—

In Ontario, of the total number of municipalities having sewerage systems, 37 per cent. treat their sewage; in Quebec, 12½ per cent.; in Manitoba, 33 per cent.; in Saskatchewan, 80 per cent.; in Alberta, 43 per cent.; in British Columbia, 44 per cent. The Maritime Provinces cannot be compared on the same basis, as most of the sewerage systems there discharge directly into the ocean, and treatment would be superfluous.

Conditions with regard to sewage disposal are better in the west, largely because the systems have been more recently installed, after the necessity of treatment had become apparent to all. The great majority of the systems in the eastern provinces were installed before this necessity had become so universally recognized, and, as they were not laid out for this purpose, it is in some cases costly to make the change. However, marked improvement is also to be noted, and practically all new sewerage systems either include treatment plants or are designed and installed with the view to the future installation of such plants at the minimum expense.

In the report of City Engineer A. B. Manson, of Stratford, Ont., for the year 1915, it is stated that 16,632 square yards of pavement were laid. The city placed 5,264 yards of base, and all surface, by day labor. Two miles of macadam roadways were resurfaced or repaired. Four miles of concrete sidewalks were laid by day labor. The sedimentation tanks for the sewage disposal works were placed in operation, about 350,000,000 gallons of sewage being treated annually, at a maintenance cost of $3.15 per million gallons. The cost per ton for incinerating garbage was 21 cents. Additional sanitary sewers were constructed to the extent of 1.71 miles.

LAYING SUBMERGED WATER MAINS AT VANCOUVER, B.C.*

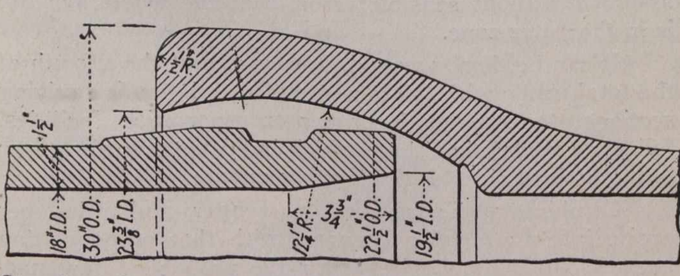
THE entire water-supply for the city of Vancouver, B.C., is brought in submerged pipes across the channels connecting the city's harbor with the ocean. These pipes have been successfully laid under conditions of exceptional difficulty.

The city of Vancouver is built on a narrow peninsula between two arms of the sea. The only possible source of an adequate water supply is in the mountains which rise to a great height only a short distance north of Burrard Inlet, on the southern shores of which the city lies. As may be seen on the accompanying map, the city's water supply is taken from Capilano River and Seymour Creek. The water from the former is brought down in steel pipes to the first Narrows just below the city, and the water from Seymour Creek to the second Narrows 5 miles above.

The tidal range on this coast is from 14 to 17 ft. As Burrard Inlet has an area of several square miles and as the deep channel connecting it with the ocean is only some 900 ft. in width, a tidal current of high velocity, 8 miles an hour or more, sweeps back and forth through the channel with every rising or falling tide. Almost as rapid a tidal current exists at the second Narrows. The period of slack water in the Narrows is very short, often not more than 20 minutes. The maximum depth of water is 75 ft. at the first Narrows and 80 ft. at the second Narrows. The channel bottom is very rough and strewn with large boulders on the shore next the city; on the opposite shore is a level stretch of mud flats, bare at low tide.

Early Experience in Pipe Laying.—The first pipe laid across the Narrows from Seymour Creek was a 12-inch cast-iron pipe with Ward flexible joints. It is stated that Mr. Ward himself came to Vancouver to lay the pipe, but when he saw the swift current in which it had to be placed, he refused to attempt the job and the pipe was laid by a local contractor, who offered to do the work for a lump sum of $10,000, the city, of course, furnishing the pipe and the jointing material. He carried out his task with little difficulty and at a cost of only about a third of his contract price. Since then there has not been any difficulty in finding men to do the work.

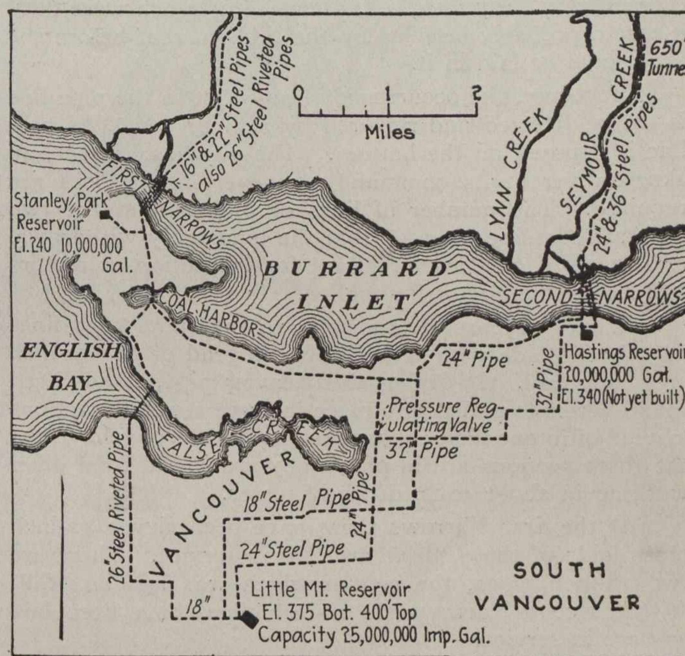
When the supply through the first pipe became inadequate, a second pipe was laid, and additional ones have



Standard Section of Flexible Joint for 18-in. Cast Iron Pipe, Vancouver Waterworks.

been added as the water consumption increased. The method of laying is substantially as follows: On the flat tidal marsh on the north shore of the river a low wooden trestle is built, extending back from the shore a distance as great as the entire width of the channel, some 1,300 ft. Upon the plank floor of this trestle the pipe is laid, and the joints are leaded and caulked. The bell of each pipe length rests on a flat wooden block free to slide on the plank floor, which is greased with tallow.

Hauling the Pipe Across the Channel.—After the pipe has been subjected to a hydrostatic test of 300 lb. per sq. in. and any leaks found have been made tight, a hauling tackle for pulling the pipe across the channel is applied. Originally a wire rope was led through the interior of the pipe and secured to the rear end of the pipe line; but the resistance of the front end as it plowed its way across the channel was so much greater than that of the rear part of



Map Showing Location of Submerged Pipe Line Crossings at Vancouver.

the line sliding on the floor of the trestle that the pipe line buckled, notwithstanding the tension on the cable inside it. The present practice, therefore, is to run a couple of hauling cables the length of the pipe line and lash them securely to it at three or four points. To the front end of the pipe line a heavy wooden prow is attached to enable it to plow its way across and take the shocks of contact with ledges and boulders.

When all is ready, a cable is carried from the end of the hauling tackle across the stream and secured to the drum of a hoisting engine on the opposite bank, and the string of pipe is thus hauled across. After the pipe is in place, connections are made at each end and the pipe is again subjected to hydrostatic test. A diver is sent down and caulks any leaks which may be found. The diver has a powerful electric light and can readily discover any leaks by the current of sand and dirt raised by the water jet issuing from the leak. The water in the Narrows is remarkably clear, there being only a trifling inflow of fresh water or sewage compared with the vast volume of fresh sea water entering at each tide.

It may be noted in this connection that the Capilano intake is 485 ft. above sea level, and the Seymour Creek lower intake is 465 ft., while "Little Mountain" reservoir, into which the conduits deliver, is 395 ft. above sea level. The maximum head of water on the submerged pipe at greatest depth is about 480 ft.

Maintenance of the Pipes.—Once laid and made tight, the pipes give little trouble. Dredging which has been undertaken by the government in recent years to widen

*Article reproduced from December 30th issue, Engineering News, of New York.

the channel on the north side made it necessary to take up some of these pipe lines, and the oldest pipes were not put down again, as it was found that the erosion of the sand carried by the swift tidal current back and forth across the pipe had worn it thin in spots during its 25 years of service. It was therefore determined to lay an 18-inch main in its place, and this was done.

This erosion of the pipe could be prevented, of course, if the pipe could be buried in a trench across the channel; but the dredging of a trench in 65 ft. depth of water on a bottom strewn with boulders and with the swift tidal current is no easy task. And even if a trench were dug, it would probably be filled by the tidal current before the pipe could be laid in it.

Moreover, the occurrence of any leak in the pipe line is easily detected and repaired by a diver when the pipe line is exposed on the bottom. The city has, in fact, an expert diver at its command whenever his services are required. The number of lines of pipe laid at the two separate crossings is such that the temporary withdrawal of service of one or more lines for inspection or repairs still leaves the city well supplied.

In recent years all additions to the submerged lines have been made with 18-inch pipe instead of the 12-inch originally laid. In laying this heavier pipe, it has been found better to pull it into place in three separate sections instead of in one line, as was done with the 12-inch. After the three sections are in place they are joined by a diver working in about 40-ft. depth of water.

At the first Narrows there have been eleven 12-inch pipes laid; of these, three are still in service. There are two 18-inch pipes, the last of which was laid last fall. At the second Narrows six 18-inch pipes have been laid and are in service.

The flexible pipe used is of the well-known Ward pattern, but has been modified in shape somewhat to reduce the resistance in hauling. A section is shown herewith. This pipe can be deflected 12½° before binding occurs. The pipe is cast in Glasgow and costs $61.50 per long ton delivered at Vancouver. Its weight is about 400 lb. per ft. The total cost of the 18-inch submerged crossings, including the cost of laying, is about $11.50 per lin. ft.

It has occasionally happened that in laying, caulking and testing the pipe a bell has been split at one of the joints. Breaks have also occurred from contact with keels of ships which have gone ashore in the Narrows during foggy weather. Repairs of such breaks have been effected by placing on the pipe to cover the split a sleeve with a stuffing-box and rubber packing at each end.

We are indebted to Edward M. LeFlufy, assistant engineer of the Waterworks Department of Vancouver, for information from which this article has been prepared.

Keuffel & Esser Company, of New York City and Montreal, have purchased the entire stock, good-will, trade marks, etc., of E. G. Soltmann, New York, who recently went into bankruptcy. The stock was inventoried at more than $100,000. It included the Soltmann specialties, which Keuffel & Esser Company will continue to market for engineers and architects.

In the article, "The Use of Pure Iron by Railroads," which appeared in *The Canadian Engineer*, issue of December 30th, 1915, it was stated, "It is possible to make a technically pure iron containing not more than 10 per cent. of carbon, manganese, sulphur, phosphorus and silicon." This sentence should have read: "0.10 per cent. of carbon, manganese," etc.

GROWTH OF STREET RAILWAY TRAFFIC IN RELATION TO POPULATION.*

It is evident that the total street railway traffic in any city is a function of the population, as is also the fact that there is a limit to the riding that any one person may conveniently do; or in other words, after a city has reached a certain period in its growth, the number of rides per capita will tend to become constant.

Estimates of future traffic have formerly been based largely, and in our opinion, falsely, upon the "Law of Squares," which is, that "revenue rides increase as the square of the factor of increase of population."

While this has held, and even up to a critical point in population been exceeded in many cities, consideration shows the fallacy of such assumption as applied throughout the total length of the population scale.

The law manifestly cannot be admitted except as an approximation applied to a city in its earlier periods of growth. The problem is to determine empirical formulæ, which, while covering past conditions, give results which may be reasonably applied to the future.

The increase of riding habit in a growing city, assuming that the facilities for transportation keep pace with requirements, may be divided into two independent factors:—

(a) The normal increase due to an increasing proportion of the city's total population, who, because of distance, ride each day, to and from the central business district, together with the increase due to those who ride for social, shopping or other purposes.

(b) The increase in the actual habit of riding, cultivated by improved transportation.

When population is contained within a circle of, say, one mile radius, a street railway is unnecessary, but as the city grows, and people settle outside this zone, a street railway system becomes essential. The effect of this continued growth is to increase the proportion of those living without the central area, and thus of those who daily ride to such district. While it is a fact that the inner zone usually becomes more densely populated, the actual population added to this area is comparatively small, and for the purposes of this investigation it may be assumed without sensible error, that the whole increase is in the outer zone.

It can be demonstrated, however, that the growth of the total traffic with the increase of population in outlying sections, together with proper transportation facilities, follows a well defined law, which indicates that about 520 is the limit of rides per capita per annum.

Combining the revenue passenger and rides per capita information for Toronto, with that of population growth, the following table for the probable future passenger traffic conditions has been compiled, always assuming adequate development of transportation facilities:—

Year.	Population.	Revenue passengers per annum.	Revenue rides per capita, per annum.
1914	470,000	153,000,000	325
1920	590,000	225,000,000	375
1925	705,000	282,000,000	400
1930	835,000	350,000,000	420
1935	975,000	425,000,000	435
1940	1,135,000	510,000,000	450

* From Toronto Civic Transportation Report.

RAILWAY ORDERS

24565—December 13—Authorizing C.N.O.R. to construct spur for Godson Contracting Co. in Cons. 4 and 5, Lot 8, Tp. Pickering, Ont., and to cross road allowance in Lot 8 with said spur.

24566—December 13—Directing that G.T.R. install gates at highway immediately west of Lorne Park Station, Ont., by June 1st, 1916.

24567—December 14—Directing that Elgin and Havelock Ry. trains operated over three bridges north of Petitcodiac be limited to speed not exceeding 8 miles an hour, pending laying of 8" x 8" ties 12 ft. long, when guard-rails shall be installed; ties and guard-rails be laid by May 1st, 1917; crossing signs to be erected at all highways on said Ry. by Dec. 31st, 1915.

24568—December 11—Authorizing Mont. and Southern Cos. and C.P.R. Companies to operate trains over crossing on Lot 34 (St. Hyacinthe to Farnham), without first being brought to a stop.

24569—December 18—Dismissing complaint City Transfer Co., Edmonton, Alta., re breaches of contract between it and C.N.R., dated Feb. 1st, 1911.

24570—December 14—Approving revised location G.T.R. Branch Lines Co.'s Battleford Branch in Secs. 10, 15 and 22-38-16, W. 3 M., Sask.

24571—December 11—Authorizing Montreal and Southern Co.'s Ry. to operate certain bridges.

24572—December 15—Authorizing C.P.R. to construct industrial siding for Fraser, Ltd., at Victoria, mileage 20.02, Fredericton Sub. Div.

24573—December 10—Approving agreement between Bell Tel. Co. and Camden Independent Tel. Co., Ltd., dated Nov. 30th, 1915; and rescinding Order No. 11929, Oct. 11th, 1910, approving agreement dated Sept. 16th, 1910.

24574—December 10—Approving agreement between Bell Tel. Co. and Urban and Rural Tel. Co., Ltd., dated Dec. 1st, 1915; and rescinding Order No. 12253, Nov. 11th, 1910, approving agreement of Sept. 30th, 1910.

24575—December 20—Extending, until June 30th, 1916, time within which C. N. Ry. equip its cabooses with air-brakes, subject to condition that cabooses already so equipped be kept in service as much as possible.

24576—December 20—Authorizing C.P.R. to construct extension to siding of Pembroke Shook Mills, Ltd., at mileage 106.5, Chalk River Sub. Div.

24577—December 18—Authorizing N. St. C. and T. Ry. to operate spur from its Queenston St. line down Phelps St. a distance of 1,062 ft. in City of St. Catharines, Ontario.

24578—December 20—Authorizing C.N.R. to cross road between Secs. 9 and 8-18-22, W. 1. M., Manitoba.

24579—December 20—Authorizing St. Lawrence and Adirondack Ry. to construct spur across Salaberry St., Valleyfield, Que., for Castings Co. of Canada, Ltd.

24580—December 18—Directing C.P.R. to fence right-of-way on Sirdar Sub. Div. from mileage 75.45 to 77, Province of B.C.; work be completed by May 15th, 1915.

24581—December 17—Authorizing C.P.R., at own expense, to construct road diversion across its Outlook Sub. Div., mileage 48.4, proposed road diversion comprising Pt. N.E. ¼ Sec. 33-21-2, W. 3.

24582—December 18—Extending, until May 15th, 1916, time within which G.T.P. Ry. fence Ballast Pit, on edge Souris River Valley, Regina-Boundary Branch, known as Souris Pit.

NEW INCORPORATIONS.

Castor, Alta.—Farmer's Hardware, Limited, $20,000.

New Westminster, B.C.—Western Canada Lime Company, Limited, $100,000.

Port Arthur, Ont.—The Western Machinery Company, Limited, $40,000. R. E. Roberts, P. F. Munroe, W. F. Langworthy.

Toronto, Ont.—Swastika Gold Mines, Limited, $2,000,000. D. I. Grant, G. Adams, E. Smily; Consolidated Steel Company, Limited, $100,000. W. H. Beatty, F. A. Hammond, C. B. McClurg.

COAST TO COAST

Brantford, Ont.—The new Brantford Municipal Railway Board was formed last week, consisting of C. H. Hartman, F. J. Calbeck and W. R. Turnbull.

North Vancouver, B.C.—David B. Boyd, of Vancouver, is asking for exemption from taxation and free water for a shipbuilding industry on the north shore water front.

Toronto, Ont.—J. W. Leonard, superintendent of the Toronto Terminal Company, states that the structural work on the new Union Station will be commenced next June, provided the steel can be obtained.

Winnipeg, Man.—The Munro Steel and Wire Works, Limited, have moved their plant to Elmwood and amalgamated with the Hero Manufacturing Co., Limited, increasing their combined capital to $100,000.

South Vancouver, B.C.—S. B. Bennett, municipal engineer, in his annual report to the council, states that about 1½ miles of streets were graded during 1915, nearly 2 miles of streets were macadamized, over 4¾ miles of sewers were constructed, and about 2 miles of water mains (4-in., 6-in., 8-in. and 12-in.) were laid.

Glacier, B.C.—Foley Bros., Welch & Stewart, contractors, report that the progress of the Roger's Pass tunnel for the past year has been 3½ miles of heading and 2 8/10 miles of double-track tunnel enlargement. The heading has now been finished and the progress in tunnel enlargement is averaging somewhat over 50 ft. per day.

Winnipeg, Man.—The contracts in connection with aqueduct construction awarded by the Greater Winnipeg Water District to November 30th, 1915, amounted to $11,640,567. The estimate for the whole work was $13,045,600. The amount paid out on contracts was $3,468,406, and there was a balance to be paid of $156,998.

Ottawa, Ont.—The Dominion Government is negotiating for a new arrangement with the New Brunswick Government in regard to the operation of the St. John Valley Railway. Under the present contract, the Intercolonial pays 40 per cent. of the gross receipts, which is said to mean a considerable loss to the government railway system.

Vancouver, B.C.—The first portions of protective work to safeguard the city's water mains, from the intake station on the Capilano River to a point over a mile and a half south, have been completed at a cost of about $8,500, under the supervision of F. L. Fellowes, city engineer. It is expected that the remainder of the work will be completed this year.

Toronto, Ont.—The estimates for this year's work on the Toronto harbor, which were passed by the board of harbor commissioners last week, amount to $2,500,000. Of this sum $650,000 is for reclamation work, $100,000 for the proposed lift bridge over the Don at Cherry Street, and the remainder for various construction works. Last year there was spent $1,200,000.

Winnipeg, Man.—All contracts entered into between C. H. Simpson and the Government of Manitoba in connection with the construction of the Winnipeg law courts building, are to be ignored, and two valuators will determine the amount which the contractor is to receive, according to an agreement made by the parties and approved of by the chief justice, who has been conducting the law courts inquiry.

New Toronto, Ont.—Water pipes have been laid to about thirty residences in this village from the municipality's new waterworks system, and it is expected that water will be supplied very soon. Mimico has arranged to take 50,000 gallons per day, which will necessitate the erection of a large standpipe on the boundary line between the two municipalities. The Grand Trunk Railway has also signed a contract for a large supply.

Hamilton, Ont.—According to the report of H. E. Waterman, secretary of the harbor board, the appropriations last year for the development of the harbor amounted to $400,000, of which $250,000 represented a preliminary appropriation for the development scheme at Stipes' Inlet, the total cost of which will be about $2,000,000. Dredging operations were continued on a larger scale than in 1914, with 247,643 cubic yards dredged. The new dock wall was completed on December 18th, the total cost of the work being about $225,000.

PERSONAL.

A. R. MACGOWAN has been appointed principal assistant engineer of the Canadian Government Railways.

D. E. RUDD has been elected chairman of the Sewerage and Public Works Commission at Guelph, Ont.

GEORGE J. GUY has been elected chairman of the harbor board of Hamilton, Ont., succeeding commissioner W. J. Clark.

FRED O. CONDON has been appointed division engineer of districts 3 and 4 of the Intercolonial Railway, and of the Prince Edward Island Railway, with headquarters at Moncton, N.B.

F. W. SUMNER, of Moncton, N.B., has been elected president of the St. John and Quebec Railway Company, in succession to Mr. Irving R. Todd, of St. Stephen, who recently resigned.

WILLIAM ASHMAN, of Moose Jaw, Sask., formerly chief of the department of investigation, Saskatchewan division of the Canadian Pacific Railway, has been promoted to the office of assistant to Major MacLeod, assistant chief of the department for the entire C.P.R. system. W. G. Cheesier, chief of the Alberta department, succeeds Mr. Ashman at Moose Jaw.

HENRY W. HODGE, M.Can.Soc.C.E., M.Inst. C.E., has been appointed as public service commissioner of New York State. Mr. Hodge is a consulting engineer, with offices in New York City, and is well known in Canada, having been retained by the government in a consulting capacity in connection with the new design for the Quebec Bridge. He is a director of the American Society of Civil Engineers, and a member of the council of the American Institute of Consulting Engineers. The firm of Boller, Hodge & Baird, in which he is a partner, were the engineers for the Singer Tower, the Metropolitan Tower, and many other important structures in New York.

OBITUARY.

JERRY J. FLYNN, assistant superintendent of the old Welland Canal since 1896, died in St. Catharines on January 7th. Mr. Flynn was born in Hamilton.

FRANK HOLDER, a graduate of Queen's University, was murdered last week at Hammond, Ind. Mr. Holder was general foreman of the erecting department of the Standard Steel Car Company's plant at Hammond. He was born at Kingston, and was 50 years of age.

WILLIAM WESTLAKE, a contractor, died at Whitby, Ont., recently. Mr. Westlake had erected many buildings in Whitby, Oshawa and Bowmanville before he retired from business fifteen years ago. He was born in Yorkshire, England, and came to this country when ten years of age.

GRAHAM FRASER, one of the founders of the iron and steel industry in Canada, died December 25th, 1915, at New Glasgow, N.S. In 1872, Mr. Fraser and others established the Hope Iron Works. In 1881 he was one of the organizers of the Nova Scotia Steel Company. When that company had acquired coal mines in Cape Breton and had developed ore deposits in Newfoundland, it became the Nova Scotia Steel and Coal Company.

Pte. ALEX. MURRAY, who was the son of T. Aird Murray, consulting engineer, of Toronto, died last week in England, as a result of wounds received on the firing line. Mr. Murray, who was a student at S.P.S., Toronto, was 22 years of age. He went to the front with the first contingent, as a member of the Queen's Own Rifles, and served through the battles around Ypres. Some months ago he survived an attack of spinal meningitis, and returned to the trenches, only to be fatally wounded not long afterwards. He will be buried at Newcastle, England, where he was born.

COMING MEETINGS.

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

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

AMERICAN WOOD PRESERVERS' ASSOCIATION.—The Twelfth Annual Convention to be held in Chicago, January 18, 19 and 20, 1916. Chas. C. Schnatterbeck, chairman, Committee on Publicity and Promotion, American Wood Preservers' Association, Baltimore, Maryland.

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

AMERICAN ELECTRIC RAILWAY ASSOCIATION.—To be held in Chicago, Ill., February 4th, 1916. Joint dinner that evening with American Electric Railway Manufacturers' Association.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.—Second National conference to be held at Chicago, Ill., February 15th to 18th, 1916. Secretary of Advisory Committee, J. P. Beck, 208 South La Salle Street, Chicago, Ill.

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

CANADIAN LUMBERMEN'S ASSOCIATION.—At Ottawa, February 18th, 19th and 20th, 1916, annual convention. Frank Hawkins, secretary, Ottawa.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—At Sohmer Park, Montreal, March 6th to 10th, 1916. Geo. A. McNamee, secretary, New Birks Building, Montreal.