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Main Drainage and Its Relation to River and Harbor Front Improvements

Resumé of Methods Adopted in Many of the World's Leading Cities, with More Detailed Notes Regarding Design of the Essex Border Interceptor — Extracts from Paper Read This Week at Buffalo Convention of the American Society of Municipal Improvements

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IMPROVEMENTS to the water fronts of harbors and rivers, whether they be made for the purpose of commerce, industrial development or the establishment of parkways and open areas, serve to bring their waters to the attention of increasing numbers of people.

Unsanitary and objectionable conditions thereby coming to public notice, ultimately result in the creation of public sentiment demanding their correction.

One of the most objectionable nuisances encountered on water fronts is due to the discharge of raw sewage at or near the margin, and on the surface or at shallow depths.

The most commonly adopted means of correcting this condition is by the interception of the sewers and drains before their points of discharge, and the delivery of their contents to treatment works or to deep outlets where dispersion in large volumes of water is possible.

Main Drainage Improves Water Front

While we find many examples of river and harbor front improvements which have no problems of main drainage, the construction of a main drainage system in cities or towns, with a large harbor or river front, or both, invariably results in the improvement of the water front.

In cities or towns having an extended water front and no adequate sewerage or sewage disposal system, the sewage is usually discharged directly into the river or harbor, causing nuisances, hampering the development of the harbor, both commercially and aesthetically. Waters become polluted, built-up districts adjoining water front depreciate in value until they are abandoned or converted into slums, undeveloped lands remain so, and sanitary conditions of the whole community become dangerous. Sometimes the only source of water supply of a city becomes endangered by the discharge of sewage into it, as was the case in Chicago before the main drainage system was built.

Under these conditions it seems that sewage treatment and disposal are the first things to be considered.

But in order to collect the sewage at one or more centrally located points for treatment or some other method of disposal, a comprehensive system of main drainage is required to take the sewage to disposal or treatment points.

In this paper it is proposed to describe briefly some of the notable projects for river and harbor improvement, both at home and abroad, which involved questions of main drainage, and to describe the methods adopted and proposed for eliminating the nuisances caused by the discharge of raw sewage, and to discuss the methods involving the use of intercepting sewers.

London, England

As might be expected, the general introduction of house drainage into the sewers, after the year 1847, caused decided injury to the River Thames, and the public press began to agitate for a remedy. At one time the stench from the polluted Thames in hot weather rendered the committee rooms in the Houses of Parliament in London uninhabitable.

By the removal of the sewage to treatment works and outfall lower down the river, these nuisances have been abolished, and London is now one of the healthiest and best-drained cities in the world.

Anticipating that it may be necessary to produce an effluent of greater purity than is possible by chemical precipitation, an area of about 750 acres has been obtained in the vicinity of Barking and Crossness, where improved methods of sewage disposal can be employed.

Paris, France

Paris (France) affords a good example of a city of the first class which protects its water highway by a comprehensive plan of main drainage. Except at periods of storm no sewage is allowed to enter the River Seine within the city limits.

The main drainage works are designed to focus at Clichy-on-the-Seine, a considerable distance beyond the city limits. Most of the sewage flows to this point by gravity through three large collectors. Intercepting sewers run parallel to the river banks within the city limits and are tributary to the main sewers which lead to the Clichy station.

The sewage of Paris, except that discharged into the Seine at and below Clichy, is utilized upon farm land.

Glasgow, Scotland

John D. Watson, in his report to the Metropolitan Sewage Commission of New York, says:—

"Many years ago the Clyde became so foul that even poor trippers declined to board pleasure steamers nearer to the Broomielaw than Greenock, several miles down the river. Since that time large sums of money have been spent on sewage disposal works, but the bad repu-

tation justly associated with the name of Glasgow harbor of years ago will not be got rid of for many years to come."

In 1894 a comprehensive system of main drainage was put into effect by which Glasgow was divided into three sections leading to treatment plants from which the sludge is carried away to points down stream, where it is diluted by a large proportion of pure water. The undertaking has removed from the Clyde the solid matters of the sewage of Glasgow and adjacent boroughs and has restored what has been termed a dead river at certain periods of the year to a live and satisfactory condition.

Sheffield, England

The sewage of Sheffield, England, was discharged, untreated, into the rivers and watercourses in the vicinity of the city until 1866, at which time the main drainage works were completed and a sewage disposal plant was built to work on the principle of precipitation by means of time and aeration over weirs, followed by continuous filtration through coke. A few years ago it was decided to construct the works so as to operate in accordance with the principles of sedimentation and subsequent oxidation in contact beds.

Copenhagen, Denmark

From ancient times the sewage of Copenhagen was led to the harbor in open channels along the streets, and it was not until the middle of the past century that a project for main drainage was taken under consideration.

At first a combined system of sewers was built, and the connections with water closets was prohibited. Nevertheless, the harbor became grossly polluted and a general nuisance resulted.

A system of intercepting sewers and pumping stations was completed in 1901 in order to intercept the sewage and pump it to an outfall in the Sound.

There are three pumping stations, one main station and two substations.

The outfall is situated nearly one English mile from the shore, at a point where there is 33 ft. of water at mean sea level.

Dresden, Germany

Dresden, with a population of 560,000, is situated on the Elbe at a good elevation above the river. The sewers are of the combined type, discharging the excess of storm water to the river by overflows, and carrying the dry-weather flow, and four or five times this volume of water at periods of storm, to treatment works.

The disposal works consist of a grit chamber, screens and pumps, the latter being used only at high stages of the river.

New York City

The condition of the waters in New York harbor led to many investigations, and finally a comprehensive system of main drainage was advocated to do away with nuisances and to protect the health of the people.

The system recommended by the Metropolitan Sewerage Commission in the 1914 report consists largely of intercepting sewers, running approximately parallel to the water front, to collect the sewage from the local sewerage systems to a number of centrally located disposal plants where sufficient of the impurities can be removed to permit the effluent to be discharged into the waters without danger or offense. It was recommended that outlets be placed at the bottom of the deep and swiftly-flowing channels in order to facilitate the diffusion and assimilation of the sewage materials by water. The commission was of the opinion that it would not be necessary to keep all the sewage out of the harbor, for these waters can absorb a large amount of sewage in a harmless and inoffensive manner.

Chicago, Ill.

Chicago is situated upon the comparatively low-lying land near the south end of Lake Michigan. The natural drainage is toward the lake, which is the only source of water supply for Chicago and vicinities.

In order to protect the water supply, a canal has been built whose effect is to reverse the direction of natural drainage and provide means for carrying away the sewage of the city.

The works include the construction of the canal, the improvement of the Chicago River, the construction of intercepting and collecting sewers, the building of intakes from the lake, and pumps to provide the large supply of water needed to maintain suitable currents in the canal.

North Shore Drainage Channel at Chicago

This channel takes the sewage of Evanston and other residence towns north of the city of Chicago which was formerly discharged into Lake Michigan and discharges it into the Chicago River, through which it flows to the main drainage canal.

The current from the canal serves also to flush out the north branch of the Chicago River, which had long been in an extremely foul condition.

The new channel commences at the lake shore at Wilmette, Ill., and extends west and south to the north branch of the Chicago River at Lawrence Avenue.

Philadelphia, Pa.

A careful study of conditions here was made by the Department of Public Works, Bureau of Surveys, which says in its report for 1914:—

"To maintain the reputation of this port and to utilize the improvements to the fullest extent, it is necessary that a high sanitary standard be established, and that the channels and banks of the navigable streams shall be kept in decently clean condition."

At that time (1914) great sewers discharged their foul contents into the docks, where there is not sufficient current to carry the sewage away.

To remedy this it was proposed to intercept the sewage from sewers emptying into the Delaware River and its tributaries by means of collecting sewers and carry it to the treatment works, and dispose of the effluent by diffusion in the waters of the Delaware River.

Large sums of money had been expended upon the development of the harbor and of the great commercial avenue along the river front, and in order to utilize these improvements it was required that channels and banks of the navigable streams be kept in decently clean condition.

Boston, Mass.

The improvement of the Boston harbor, Charles River and adjoining lands was accomplished by the construction of the Boston and Metropolitan sewerage system. Further improvements of the Charles River Basin resulted in the reclamation of low and marshy lands, in the building of parks and boulevards along the river banks, and in the elimination of flooding of cellars in Boston and Cambridge.

In Boston, like in New York, various protective measures were first adopted, such as extending the sewers further from shore, and, while these improve-

ments relieved the objectionable conditions for a time, the nuisances soon recurred. It was not until comprehensive works were carried out that substantial and lasting improvement was obtained.

Baltimore, Md.

Before the present system of main drainage was put into effect, Jones' Falf River, which traverses the centre of the city in a general direction south by east, afforded the most available means of draining the districts tributary to it. The collection of offensive matter in its open channel had been for many years a source of continued nuisance and expense. The winds were the most powerful agency affecting the regimen of the harbor. A heavy south-east wind raised the water six feet above mean tide, while, on the other hand, a strong northwester would drive the water out of the river, leaving it some five feet below the mean.

Under these conditions, whatever solid matter was permited to enter the harbor remained there, sinking to the bottom or floating on the surface, but never getting far away from the point of entrance, so that sewage and other filth allowed to enter the harbor with storm water were not finally disposed of, but continued as a source of nuisance, and, after befouling the harbor and silting up the channels, the accumulating matter had to be removed by dredging.

The pollution of the harbor waters was also a matter of concern to the great oyster interests of Baltimore. This led to many investigations as to the best methods of disposal and treatment.

The system finally adopted and built after the fire which destroyed a large part of the city was that recommended by the Sewerage Commissions of the city of Baltimore in its 1897, 1899 and 1906 reports.

The separate system was adopted, collecting the domestic sewage of the city into a high and low interceptor, the sewage being pumped from the lower to the higher at a suitable point. The works are situated about 4½ miles east of the city boundary on the shore of the Back River. The process of disposal comprises sedimentation, screening, sprinkling filters and subsequent settling basins.

New Bedford, Mass.

With few exceptions the sewer outlets were located near the shore line, often at the end of docks, where the current movement of the water was slight.

The pollution of Acushnet River and Clark's Cove by the sewerage had given rise to such nuisances along the city's water front that plans for an intercepting sewer system and pumping stations to care for the entire flow of the municipality were prepared in 1910 and the work completed in 1913.

The intercepting sewer was built with an outlet into the harbor at a point far from shore where the rate of dilution is great enough to avoid nuisances.

Cleveland, O.

The city of Cleveland is ideally located for drainage by a gravity system of sewers and for sewage disposal by dilution, since the Cuyahoga River and its tributaries on the one hand and Lake Erie on the other afford convenient outlets for all the sewers of the city. But on account of the very low velocity of the river the bottom is covered with a heavy sewage deposit, much of which, at the time of the spring freshets, was washed out into the lake, where, at times, it was possible for it to contaminate the water supply. An intercepting sewer system was, therefore, designed for the purpose of intercepting the dry-weather flow of all sewers emptying into the river, its tributaries and the lake, and conveying this flow to an outlet located on the shore of Lake Erie at a safe distance to the east of the new water intake, where it is proposed to treat it before final dispersion in the lake.

Toronto, Ont.

Toronto offers us a good example of the relationship of main drainage to water front development and improvement.

The sewage of Toronto, before the new system was built, was collected by the combined system and discharged at various points in Toronto Bay without treatment of any kind, with the result that nuisances had been created along the water front, especially during the warmer months of the year. This also constituted a danger to the source of water supply of the city.

The sewage disposal problem of Toronto is important from the aesthetic as well as from the sanitary standpoint, the bay being used to a large extent for sailing and bathing. At the outer boundary of the bay, known as the Toronto Island, a great number of residents of the city have estabilshed summer homes, and the pollution of waters by sewage tended to destroy the value of this property as a site for summer cottages. A number of amusement parks on the water front also suffered from pollution of the bay by sewage.

The main drainage system comprises high and low level intercepting sewers, an electrically operated pumping station for the low level flow, a screening and sedimentation plant and a submerged outfall line extending into Lake Ontario.

Syracuse, N.Y.

The city of Syracuse, New York, is drained by two streams, which flow in a northerly direction through the city and discharge into Onondaga Lake.

Two streams, Onondaga Creek and Harbor Brook, served as carriers for the entire storm water and sewage of the city, which are collected on the combined system.

When the loading of the streams with an excessive amount of sewage exhausted the supply of dissolved oxygen in the water and the odor from the putrefaction of the organic matter became objectionable, a system of main drainage was designed to do away with the nuisances caused by these conditions. The main intercepting sewer, built in 1910 and 1911, ran along Onondaga Creek, carrying the flow from the combined system of sewers to a temporary point of discharge into the creek in the northern outskirts of the city.

Another interceptor was built along Harbor Brook on the same principle of design of the main interceptor, but much smaller.

Washington, D.C.

The sewerage of Washington, D.C., may be said to date from 1871. In course of time various defects developed, and there were complaints from odors due to lack of ventilation and from pollution of the watercourses.

In 1890 storm drains were constructed in the low-lying sections, the polluted canals were filled, and intercepting sewers were built to deliver the sewage to a central pumping station on the Anacasta River. From this station the sewage was carried by three siphons for a distance of 2,680 feet under the river, and thence by an outfall sewer 15,483 feet long along the Potomac to an outlet discharging at the bottom of the river, about 500 feet from shore.

Cincinnati, O.

The extension and growth of Cincinnati forced the city authorities to plan and construct a system of main drainage which would answer the present and future needs of the city for a number of years.

The sewage of Cincinnati was discharged untreated into the nearest available watercourses, namely, Mill Creek, Duck Creek and Ohio River, through several outlets.

About 65 per cent. of the sewage was discharged into Mill Creek and Duck Creek, the remainder finding its way into the Ohio River. As a rule, the outlets into the Ohio River had not resulted in any offensive condition. Along Mill Creek and Duck Creek a system of intercepting sewers in the valleys of these streams was planned, and construction was started in 1912 and 1913.

Plans for an interceptor following the Ohio River banks, as well as a comprehensive system of sewerage considering the future extension of the city, were also laid out.

Through the construction of two intercepting sewers, sewage was to be removed from Duck Creek and Mill Creek, and thereby eliminate odors and offensive unsanitary conditions.

A section of Duck Creek was to be eliminated through the construction of the Duck Creek interceptor, thus allowing the reclaiming of the creek bed for park or transportation purposes. Mill Creek was to be confined between masonry walls, thus permitting the reclamation of bottom lands for industrial purposes.

Waterbury, Conn.

The sewerage system of Waterbury, Conn., a city of 74,000 in 1910, consisted of a considerable number of relatively small drainage districts, the sewers of which were designed to discharge into Nangatuck River or its nearby tributaries.

While special conditions of the river near the city prevented any putrefaction and resulting nuisances, putrefaction was active at a point about three miles from the city, and marked nuisances resulted from these conditions.

As a remedy for these unfavorable conditions, the construction of an intercepting sewer and sewage purification works was planned and carried to conclusion.

There were many interesting features governing the design of the sewer section.

The sewer line for a distance of a third of a mile is located either along the precipitous slope of the river bank or in the bed of the stream, and throughout this distance the sewer structure has been so located, designed and constructed as to form a foundation for the lower portion of a retaining wall to be subsequently built for the reclamation of a considerable area of the low level lands now subject to flood inundation. The governing conditions were most favorable for the adoption of a design for a dual purpose structure, and the lands to be reclaimed are of great value for manufacturing purposes.

The saving in total expense effected through this design is estimated to be, at the completion of the river wall, fully two-thirds the cost of the present sewer structure.

For three-quarters of a mile through the site of the proposed sewage purification works, the main intercepting sewer has been built in conjunction with a filter effluent conduit and two pressure mains.

The main outlet sewer running along the bank of Nangatuck River was given permanent protection against the erosive action of the stream through the construction of slope paving.

This work shows how the main drainage problem of a comparatively small city can be handled efficiently in connection with river front improvement.

Harrisburgh, Pa.

The discharge of crude sewage through a number of outfalls along the Susquehanna River front at Harrisburgh, Pa., had resulted in the creation of objectionable conditions along the shore, for in most cases the outfall lines were not carried out to deep water and were often above the water level in the river.

The sewage, therefore, instead of being carried out away quickly by the current, tended to pool and stagnate close to the shore line, and, as the city's streets extend almost down to the water front, there were many complaints from residents whom the unsanitary state of the river affected, especially during the summer months. To remedy these conditions the city has built an intercepting sewer to collect the flow from the old outfalls at the end of each street and deliver it through a single submerged outfall into deep water downstream from the city where the current is swift enough to assure a good degree of dispersion.

Ultimately, all the sewage from this interceptor and others to be built will be conveyed to an island in the river and will be treated there at a sewage disposal plant.

The Boundary Waters Problem

Many other examples could be cited of cities where the improvement of the water front was largely dependent upon improvement of the sewerage system.

The lesson to be drawn from this is obviously that, even in the younger and smaller communities, where nuisance do not yet exist from the discharge of raw sewage into the adjacent waters, foresight requires that sanitary sewer systems be designed with a view to ultimate interception to remove offensive material from the water fronts.

In recent years those cities located upon the boundary waters of the United States and Canada have had to face the possibility of sewage treatment before discharge into the rivers. Extensive investigations have been made by the International Joint Commission and their results published, but no decision has been promulgated. If, as seems likely, standards of maximum pollution are established, it will be necessary for nearly all the cities so situated to treat their sewage before it enters the boundary waters.

Essex Border Interceptor

Detroit and Buffalo have given consideration to this question and have had extensive engineering investigations made to determine the best method of treatment, and the writers had the opportunity of studying this question for the group of municipalities on the Canadian side of the Detroit River opposite Detroit.

This work was carried out under the jurisdiction of the Essex Border Utilities Commission and our conclusions were presented to them in March, 1917, from which may be deduced the following:—

"That the best method of abating the nuisances due to flotation, deposition, putrefaction and infection from the sewage of the Essex border municipalities is the collection of the sewage in an interceptor and its delivery to one or more centrally-located points, where additional treatment may be applied under proper supervision. The works to accomplish this result are planned to consist

ultimately of interceptors, two-story settling tanks, disinfection plants, detention basins and multiple deep dispersion outlets. Designs should be worked out for this ultimate development, and all new sewerage construction made to conform to these designs; and all of the proposed works, excepting the settling tanks, should be built as soon as the financial condition of the community will permit. The construction of the sedimentation works, however, should be deferred until the general policy for the control of the river as a whole has been formulated, at which time much more information will no doubt be available regarding the process of activated sludge and regarding the comparative advantages and economy of this process, fine screening and two-story tank treatment."

The report referred to was accepted by the commission, and the first portion of the intercepting sewer was authorized to be built by an overwhelming vote of the people, and the contract for half of the work was recently let.

Factors Governing Design

In the design of these works the practice of interceptor design was carefully studied, and our conclusions may be of interest.

The east sewage interceptor, for which contract has been let, serves the municipalities of Ford City, Walkerville and Windsor to Parent Avenue in Windsor. The sewage flows by gravity through Ford City and Walkerville to a pumping station, whence it is lifted to a higher level interceptor, through which it flows by gravity to Parent Avenue.

As Ford City had no existing sewerage system it was concluded that it would be sewered on the separate system. Walkerville and Windsor were well provided with a sewerage layout on the combined plan.

The east interceptor was, therefore, planned to meet these conditions. A storm water allowance for Walkerville and Windsor takes care of the first street washing, thus reducing pollution of the river front waters.

Regulating chambers were provided at points where the outlet sewers of Walkerville cross the east interceptor. These chambers divert the dry-weather flow, plus the storm water allowance, into the interceptor.

Measuring chambers, to determine the actual sewage flow from the several municipalities, are provided for at the dividing lines between Ford City and Walkerville and Walkerville and Windsor. The intercepting sewers were designed to serve the estimated (1950) population of the several municipalities.

The factors taken into consideration to obtain the maximum flow for the several municipalities were the following:—

1. Water consumption (domestic use, industrial use, public use).
2. Ground water leakage.
3. Storm water allowance.
4. Economic considerations.

Factor No. 3 was only considered for Walkerville and Windsor, which have a combined system of sewers. To provide for contingencies which may arise and increase the sewage flow, and to avoid future expensive additional construction, it was considered desirable to allow a liberal margin of safety over the present flow per capita. This is based upon the fact that capacity increases at a rate greater than the square of the diameter, whereas cost increases at a much less rate. It was considered that the ratio of maximum to average flow would vary for various structures. A ratio of about 2.5 was used for small sewers, and this was decreased gradually to about 1.75 for interceptors.

It was concluded that 90 per cent. of the domestic water consumption, 85 per cent. of the industrial use and 50 per cent. of the public use would be returned as sewage flow.

The leakage or ground water infiltration through joints was taken as 15,000 Imperial gallons per day per mile of pipe in clay soil and 25,000 Imperial gallons in sandy soil, which on a basis of 1.25 miles of sewer per 1,000 population, gave 31 Imperial gallons per capita per day for sandy soil and 19 Imperial gallons per capita per day for clay soil.

The storm water allowance, to apply only to Walkerville and Windsor, was taken as 80 Imperial gallons per capita per day, equivalent to .005 inches of rainfall runoff per hour.

The ratio of depth of flow to diameter of sewer was taken as not over .50 for all sizes up to 24 in. and not over .80 for sizes 24 in. and over. The minimum velocity for maximum flow was taken as 2.00 feet per second in the Ford City section and 2.50 feet per second in the Walkerville and Windsor sections.

The following table gives estimated future population and assumed quantities for the several Essex border municipalities served by the east interceptor:—

Estimated Population and Assumed Quantities

Municipality.	Estimated population (1950).	Maximum rate assumed in design of interceptor, Imperial gallons per capita day.
Ford	15,000	250
Walkerville	11,000	350
Windsor (eastern portion)	14,000	350

The maximum rate of 350 imperial gallons per capita per day for Walkerville and Windsor include the storm water allowance of 80 imperial gallons per capita per day.

Regulating Chambers

The function of a regulating chamber is to divert the dry-weather flow and the first wash of the rain from the combined sewers to the intercepting sewers.

A considerable amount of study was devoted to determine the best suitable type of regulator to be adopted.

The general experience with mechanically-operated regulators seems to be that they are satisfactory except for their constant need of inspection and formation of deposits around the float chamber.

Many studies were prepared with different types of mechanical apparatus, and finally the choice of regulator was made from three designs that had met successfully all important objections to other types.

The regulator consists of a float in a float chamber directly connected to the intercepted sewer. Two perpendicular and one horizontal bars form the connection between the float and a float-operated gate in a gate chamber at the end of an opening designed to take the dry-weather flow, plus the storm water allowance.

The float, being directly connected with the intercepted sewer, is actuated by the elevation of sewage in the sewer, and thus opens and closes the gate to discharge the desired quantity through the gate area. The ranges in the rise of float and gate were calculated, and the point of support, which is adjustable, for the horizontal bar was determined to accommodate these changes.

A screen is provided between the float chamber and the sewer to avoid deposits in the chamber. A 3-in. pipe drain, with a valve at the lower end, connects the float chamber to the gate chamber to permit drainage of the float chamber.

The sewage flows through the gate, and before it goes to the interceptor it passes through a removable weir at the lower end of the gate chamber, and thence through an outlet to a manhole and interceptor.

A stop plank at the gate entrance and a by-pass outlet are provided in case the apparatus has to be cleaned, removed or repaired.

A dam of sufficient height at the lower end of the intercepted sewer in the chamber diverts the dry-weather flow into the regulating chamber.

Economy of construction, simplicity of arrangement, desirability of continuity of operation, and the fact that this type does not depend on an orifice for its successful operation, dictated its choice. This type has the added advantage that the gate is regulated by one float, which is directly connected to the sewer to be intercepted.

Measuring Chambers

A system by which sewage flow could be measured accurate was necessary, not only to properly apportion annual charges to the several municipalities, but also to fix the responsibility in case of future overcharging of sewers and consequent need of further extensions.

It was considered more satisfactory to measure the sewage where the interceptor crosses the municipal boundaries rather than to attempt to measure the flow from each inlet to interceptor.

A reduced number of meters was advantageous because meters would require constant attention to keep in condition and give reliable data, and the reduction in number would allow use of more expensive and accurate measuring apparatus.

From the standpoint of accuracy and economical considerations, Venturi meters were considered as giving the most satisfactory results. Venturi meters eliminate most of the objections of loss of head, which, in case of weirs, would be rather serious, as each drop at a weir would entail deepening the entire length of sewer below the weir.

The Ford City measuring chamber is located at a point where the interceptor crosses the municipal boundary between Ford City and Walkerville. In its design provision was made for change in meter from a 20 in. x 6 in. to a 20 in. x 10 in. meter. It consists of a cleaning chamber through which the sewage flows before it enters the Venturi tube, which is located in a circular brick chamber, above which are a register chamber and manhole. After the sewage flows through the meter it passes through a cleaning chamber and manhole to the other end of the interceptor.

A by-pass pipe is located along the chamber to divert the flow directly into the lower cleaning chamber. Stop planks are provided at both ends to operate the by-pass pipe.

The Walkerville measuring chamber is located at the lower end of the west main pumping station, about 900 feet east of the municipal boundary between Walkerville and Windsor. It consists of a circular brick chamber covered with a concrete slab and manhole above.

Construction of Essex Interceptor

It may be of interest to know the methods of letting out the work and the bid prices.

When our estimate was made, the unit prices used were those based on prices obtaining in December, 1916, plus a liberal allowance for contingencies. The total estimated cost was $95,200, excluding pumping station and appurtenances.

When bids were called on a unit price basis, the unprecedented cost of labor and materials resulted in the reception of very high bids, the lowest bid being $163,600. These were rejected and new ones called for on an entirely new basis.

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SEWAGE PURIFICATION BY ACTIVATED SLUDGE PROCESS*

By William R. Copeland,
Assistant Engineer, Sewerage Commission, Milwaukee, Wis.

THIS process depends for efficiency upon the application of compressed air to all parts of the sewage in fine bubbles. The air must be applied in sufficient volume and for a sufficient length of time to clothe all particles of matter suspended in the sewage with a gelatinous growth of aerobic bacteria; and these coated particles must be kept moving back and forth through all parts of the sewage until they have absorbed the polluting matters which the raw sewage contains.

Following this period of active motion, the aerated liquor must be passed slowly through settling basins to allow the suspended particles to drop out. Finally, the solid matters removed from the sewage must be freed from water by sedimentation, pressing and drying.

Aeration

Experiments upon aeration of sewage will be considered under four heads: Volume of air; period of contact between the air and sewage; kind of air diffusers; and depth of aeration tank.

Data obtained upon these various topics are given in tables Nos. 1, 2, 3 and 4.

Volume of Air

Air was applied to the aeration tanks in quantities ranging from 0.6 to 2.8 cubic feet per gallon.

Data illustrating the purification secured are given in table No. 1.

Table No. 1—Comparative Degrees of Purification Obtained with Different Quantities of Air

No. of cu. feet of air per gal.	BACTERIA		SUSPENDED MATTER		ORGANIC MATTER			
					Organic Nitrogen		Oxygen Consumed	
	Number per c.c. in the effluent (20° C)	Per cent. Removed	P. P. M. in the effluent	Per cent. Removed	P. P. M. in the effluent	Per cent. Removed	P. P. M. in the effluent	Per cent. Removed
1.70	66,000	92	25	90	10	46	34	74
1.03	80,000	95	16	92	10	42	36	70
0.85	239,000	91	26	91	13	43	45	66

The data given in table No. 1 show that the larger volumes of air removed more bacteria and organic matter than the smallest volume. The larger volumes of air cost more money than the smaller, however, and a question has been raised as to whether it is worth while to strike

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*From annual report to T. Chalkley Hatton, chief engineer, Sewerage Commission, Milwaukee, Wis.

Western Ports of Canada

Good Prospects for Vancouver as One of the Great Harbors of the World—Consulting Harbor Engineer Needed to Recommend Systematic Policy of Extension by Dominion Government — Prince Rupert Harbor Helping to Win the War — Paper Read Last Month at Boston Convention of the American Association of Port Authorities

By S. McCLAY
Harbor Commissioner, Vancouver, B.C.

IN the establishing on a successful working basis of a port of any magnitude, certain factors must exist, natural and acquired. As a foundation, the location must have behind it a territory in which is found population, natural resources and industrial development of such a character as to provide stable sea-going trade. Before it must lie a territory which may be reached by the water route economically and afford a reciprocal market. The harbor itself must be located so as to afford natural protection for large vessels under advantageous conditions. Upon this foundation must be established rail and subsidiary coastal water connections which thoroughly tap the territory behind the harbor and the natural location must be properly developed, either publicly or privately, by the provision of equipment for the prompt and economical handling of the water-borne business of the port.

All of these conditions are found at Vancouver in a remarkable degree, and because of this fact the development of the point as a port has been phenomenally rapid, its position at the present time being such as to constantly attract with increasing force the attention of the great world interests. Largely as a result of the development of its business as a port, the city has grown from its scattered population of a few hundred in 1885 to its present position of the fourth city of Canada, having urban and suburban population of approximately 175,000. As a port, Vancouver to-day more than rivals Montreal, where systematic port development work has been carried on for years, and the outlook for Vancouver becoming one of the great seaports of the world is not by any means visionary. In the opinion of many who are to speak with authority, such a future is absolutely assured.

History of Vancouver Harbor

A word as to the discovery and early history of the harbor may be interesting at this point. The discovery was made by Capt. George Vancouver, R.N., commanding H.M.S. "Discovery." Capt. Vancouver's vessel, accompanied by the armed tender "Chatham," left Falmouth on April 1st, 1791, and for the following four years followed exploration and discovery work, in the course of which the harbor was for the first time visited by white men. The return of the vessel to home ports, noted in the Annual Register for 1795, under date of September 24th, is as follows:—

"The 'Discovery,' sloop of war, Capt. Vancouver, arrived at Limerick on the 13th inst. in company with the homeward bound East India fleet, having completely effected the object of her expedition and made some important discoveries on the north-west coast of America. She sailed from England with 150 men on board, and such was the attention of the officers to their health that only one died in the course of a very fatiguing voyage of four years. They speak in the highest terms of the inhabitants of the Sandwich Islands, from whom they experienced every possible civility and attention."

For nearly a century after its discovery Vancouver remained a small settlement, its surrounding waters being devoted to only local uses, although Burrard Inlet (its inner harbor) was surveyed by Capt. Richards, H.M.S. "Plumper," in 1859-60. In the early eighties the Canadian Pacific Railway saw the value of the harbor as the western terminal of the first Canadian transcontinental railway, and in 1886 completed its line to the point. The city was then incorporated and the name Vancouver given to it in honor of the man who, ninety-four years previously, discovered the harbor. Since the incoming of the Canadian Pacific Railway the development of the city and port has been phenomenally rapid. The survey of the harbor, which was made by Capt. Richards in 1860, was revised in 1891 by a thorough survey made under the direction of W. J. Stewart, of the Dominion Hydrographic Department.

Outer Harbor Will Develop

The harbor of Vancouver, B.C., is described in ancient Admiralty records as "the first great harbor that indents the coast of British Columbia." It is located on the easterly side of the Straits of Georgia some distance north of the 49th parallel and a few miles northeast of the point where the flood of the Fraser River pours into the straits. The limits of the harbor are particularly described in an Act of Dominion Parliament as follows: "The harbor shall include Burrard Inlet with the North Arm and Port Moody, False Creek and English Bay and all other tidal waters lying east of a line drawn from the Point Atkinson lighthouse southerly to the most westerly point of Point Grey."

English Bay, which may be termed the outer harbor, is an enclosed body of water, having a uniform width of five miles, and extending from the Straits to Prospect Point; it forms the entrance to the central harbor, a distance of six miles. The depth of this portion of the harbor is from 50 to 60 fathoms at its entrance and 5 to 6 fathoms near the shores. This section is sufficient for the accommodation of extensive shipping. Up to the present, however, it has been but little used for the purpose, owing to the far more advantageous location afforded by the central harbor as hereafter described. English Bay is, however, so naturally located as to lend itself admirably to development work, which will make it an ideal location for port business, and, in the opinion of the writer, will, as the port develops, become the most important part of the harbor.

The central harbor is reached through First Narrows, where a channel 900 feet wide (now being developed to a width of 1,400 feet) exists, the depth being from 35 to 72 feet at low water. The central harbor extends from First Narrows to Second Narrows, a distance of five miles, with a maximum width of two and

a half miles, and affording a depth of from 9 to 10 fathoms. It is in this section of the harbor that the greater part of the business as a port is carried on.

East of the central section, Burrard Inlet extends to Port Moody, a distance of about nine miles, with a tributary inlet, the North Arm, extending for some distance to the north from Barnet. This section of the harbor may be termed the industrial section, as its shores offer adequate sites for the establishment of industries, which, on the south side, have the advantage of both rail and water transportation. Already many thriving industries are located in this section. These same remarks apply to False Creek, an arm of English Bay, extending east from Prospect Point, a distance of several miles, on the shores of which some of the principal industries of the city are now operating.

The natural location of the harbor of Vancouver is all that could be desired, view it from whatever standpoint one may. This fact has led both harbor experts and after-dinner speakers to declare it "one of the best natural harbors in the world." It is perfectly sheltered, and the locality is free from periodical disturbances, such as cyclones, hurricanes, and even heavy winds. The greatest wind velocity ever recorded is 30 miles per hour, and the average hourly velocity for the last three years is reported as follows: 1915, 4.5; 1916, 4.6; 1917, 4.4. Even should a hurricane develop, the location of the inner harbor (which is three-fourths of the entire area) is such as to afford perfect shelter under such trying conditions.

Open All Year

The harbor is open all the year round, the question of ice as an impediment to its use in winter being a factor which need not be considered. The status of Vancouver as a winter port is unique in Canada, as it affords a water-borne export outlet at a time when all other ports of the Dominion are either tied up or operated under great difficulties, owing to weather conditions. The prevailing temperatures for the last three years are reported as follows:—

1915—Maximum, 89.5 (August); minimum, 22.9 (December). Average, 51.36.

1916—Maximum, 82.9 (June); minimum, 6.0 (January). Average, 47.2.

1917—Maximum, 82.6 (July); minimum, 10.3 (January). Average, 48.8.

The area of the harbor is so great and its depth so ample as to allow free navigation under any conditions. The bed is chiefly a blue clay formation, which assures a good anchorage. The situation is such as makes it possible, when wharves are congested, to load or discharge cargoes from scows or lighters in the stream with perfect safety. Tidal conditions are also favorable, the greatest rise recorded in 24 hours being 16 feet, with a minimum report of 8¼ feet, and an average rise and fall of less than 12 feet. The harbor is practically free from submerged rocks, shoals and other dangers to navigation, such as are a handicap or a source of enormous expense to so many harbors.

In Strategical Position

I have previously mentioned the location of many thriving industries on the harbor foreshore, a point of manifest economic value in the operation of such plants. The Vancouver harbor is well suited for this purpose, as, out of its entire 98.4 miles of waterfront, there is practically none which is not suitable for either industrial or commercial purposes.

The importance of the port of Vancouver should not be underestimated. I have briefly outlined its natural advantages, and would now hurriedly review the field which it serves and the possibilities which lie before it.

From the standpoint of world trade the port of Vancouver is located in a strategical position. It is to-day practically the only Pacific gateway for the entire Dominion of Canada for water-borne shipments. It is also within 25 miles of the international boundary line, its location for port purposes being one of the facts borne in mind by United States transcontinentals when establishing terminals at the point. Its situation with reference to Panama Canal traffic is advantageous, as it is the first Canadian port on the Pacific in relation to this great trans-oceanic shortcut.

Rich in Resources

Back of Vancouver stands a country with an area of nearly four million square miles, which looks to the port as its natural Pacific outlet. Wonderfully rich in natural resources (the full measure of which has not yet been even approximated), rapidly advancing in population, already established as one of the great grain-growing districts of the world, making rapid strides along every line of industrial development, this territory covers a wonderful field. The port is connected with every portion of the settled districts of this great area by the Canadian Pacific, Canadian Northern, Grand Trunk Pacific and Pacific Great Eastern Railways, all of which have terminals in Vancouver. To this must be joined the business coming from the United States over the Great Northern, Northern Pacific, the Chicago, Milwaukee and St. Paul Railways, all of which have either established terminals or connections with the port. Such is the truly wonderful field which stands behind Vancouver as a port.

Before the city lies the Orient—a fruitful field, as yet only partially developed—the islands of the Pacific and Australia, with all of which the port carries on business. Nor is the story yet all told, for Vancouver claims as a port a far wider field than the Pacific. Previous to the war, water-borne shipments were carried on regular callings at the port to the Old Country, via the Mediterranean and the Suez Canal; and the possibilities opened up by the Panama Canal will undoubtedly still further strengthen its hold and widen its field of service to points upon both shores of the Atlantic.

Advantages of the Port

One of the principal factors in port development is the provision of both rail and water cargoes in either direction, as the running of "empties" or voyages "in ballast" are not economic operations. Vancouver offers advantages in this line which are just now being fully brought out, mention concerning which I may well make at this point. For years the problem of transporting the immense grain crop of North-west Canada to its natural destination (the Old Country) has been hedged with difficulties owing to transportation on the Great Lakes being closed during the winter. As a port which is open all the year round and affording direct connection with England via the Panama Canal, the advantages of Vancouver for such shipments were pointed out. Objection was made as to the danger of the grain deteriorating when shipped in bulk on account of the long voyage and the passage through the tropics. Last year, however, a trial shipment of 100,000 bushels was sent by this route. The experiment was closely watched by the Government authorities, whose report on the trip was recently made. This report shows that the cargo contained 15 per cent. abnormal

moisture when it left Vancouver in November, 1917, but that it reached London in February, 1918, in first-class condition, and was accepted as such by the consignees. This shipment proves beyond all question the possibilities of Vancouver as a port for the shipment of grain in bulk from the Canadian North-West to the Old Country.

Other illustrations as to the possible development of Vancouver as a port because of the Panama Canal short-cut are afforded when it is stated that water-borne shipments of shingles may be made by this route from Vancouver to Boston at 40 cents per thousand, and that a 40-pound box of British Columbia apples may be shipped in cold storage by the route for 25 cents—less in each case than the delivery cost of the single unit within the Boston city limits.

Tonnage Statistics

As showing the present standing of Vancouver as a port, I present the following figures as to tonnage for the fiscal years ended March 31st:—

1917.

	No. vessels.	Tonnage (gross).
Foreign—Inwards	1,520	2,014,859
Outwards	1,392	1,734,629
Coastwise—Inwards	9,493	3,356,050
Outwards	9,793	3,629,551
Grand total		10,735,089

1918.

	No. vessels.	Tonnage (gross).
Foreign—Inwards	1,449	1,890,873
Outwards	1,369	1,392,141
Coastwise—Inwards	9,993	3,549,997
Outwards	10,206	3,806,496
Grand total		10,639,507

In May, 1913, the Dominion Parliament placed the harbor of Vancouver under the control of a Harbor Commission, consisting of a president and two commissioners. Authority was given this commission to establish regulations for the government of shipping in the harbor and to exercise control on the foreshore, as well as appoint a staff to carry out these rules. This work has been done in conformity with the practice observed in the best-regulated harbors of the world.

Reinforced Concrete Wharf

In addition to the regulation and control exercised by the Harbor Commission, it also directly operates one of the finest public wharves on the Pacific Coast. This wharf is located on Burrard Inlet, in the heart of the central harbor. The wharf is of the reinforced concrete type of construction, a new method on the Pacific Coast being employed in the work, involving the use of cribs reinforced with concrete and a heavy mass wall of concrete. The wharf is 800 feet long and 300 feet wide, and so located as to give a depth of 35 feet at low tide. On the wharf are two sheds, with trackage on each side, the easterly being 676 ft. 10 in. in length and 78 ft. 8 in. in width, and the westerly 843 ft. long and 97 ft. 9 in. wide. This shed is provided with a depressed track. There is a steady demand for accommodation at this wharf, and during the past year the Harbor Commission has been compelled to turn away business from it owing to the berths being occupied or storage accommodation being completely taken up.

Adjoining this wharf is a Dominion Government grain elevator which has a capacity of 1,250,000 bushels. The receiving capacity is 20,000 bushels per hour and the loading capacity 60,000 bushels per hour, the plans providing for this loading being carried on for four vessels at one time. The equipment also includes a sacking plant, capable of handling from 3,000 to 5,000 bushels per hour.

Fostering Industrial Development

The Harbor Commission judges that the fostering of industrial development comes within its field, and has, to that end, reclaimed 33.13 acres of land in False Creek. This work was done in 1917, the reclamation being accomplished by dredging in the waterway; 971,457 cubic yards of material were used, and the reclamation work cost 14 cents per square foot. The Harbor Commission named the tract Industrial Island, and has divided it into three zones, offering the sites to industries on 21 years leases, with privilege of renewal for two additional terms. Zone A contains 11.24 acres, and fronts on the main channel, with 20 feet of water at low tide, the annual rental here charged being $1,500 per acre. Zone B, 11.35 acres, with 12 feet of water, rents for $1,000 per acre per year, and Zone C, 5.60 acres, which has only trackage facilities, rents at an annual payment of $800 per acre. The Harbor Commission's plan of granting to industrial plants practically permanent leases on a ground rental basis has been heartily welcomed, and over half of the property has already been leased, with many industries now in operation.

I have previously mentioned the numerous industries which have been established on the shores of the port of Vancouver. It is fitting, however, that special mention be made of the shipbuilding industry, which has developed at the point during the last year, inasmuch as these are indirectly a feature of port development, as they provide tonnage at a time when there is a crying demand for carriers for water-borne shipments on the Pacific. On the shores of the port, four shipyards are now operating. From these were launched during the past year vessels aggregating 98,200 tons, with operations still under way on other vessels. The shipyard of J. Coughlan & Sons has launched four steel vessels, each of 8,800 tons, these being the largest vessels ever launched from a Canadian shipyard. The Wallace shipyards have launched three steel ships, each of 4,800 tons, and six wooden vessels of 2,500 tons each. At the Lyall shipyards six wooden vessels of 2,800 tons each have been launched, while the Western Canada Shipyards has made a similar contribution to the tonnage of the Empire.

Future Needs

While the Harbor Commission has already done valuable work in developing the port business of Vancouver along many lines and putting port affairs on a sound working basis, it is admitted that there is much which still remains to be done in the line of provision of equipment, etc., to adequately prepare the port for its future needs. The Harbor Commission recently took up with Hon. C. C. Ballantyne, Dominion Minister of Marine and Fisheries, many questions of this character. The minister showed a hearty interest in the development of the port, as to the future of which he had no doubt, and promised hearty co-operation in the plans outlined. The first step of the programme agreed upon is now under way in the sending of an expert harbor engineer to the coast to look over the situation and recommend to the Ottawa authorities a systematic policy of extension as

to improvements and equipment designed to cover the demands of the port for the next fifteen years. It is with genuine pleasure that I record this progressive policy of the honorable minister, as all connected with port development know that in this field it is necessary to plan several years ahead in order to properly meet demands as they arise.

Prince Rupert

Prince Rupert Harbor, the northern port on the mainland of British Columbia, is located in latitude 54′ 20″ N. and longitude 130′ 20″ W. The place came into prominence as a city and a port when the Grand Trunk Pacific Railway made it the Pacific terminus of its transcontinental. The name was given in 1906 as a result of a "suggestion contest," arranged by the Grand Trunk Pacific, in which 12,000 names were suggested, the winner of the prize being Miss Eleanor M. MacDonald, of Winnipeg. The name is suitable, as it places on the map of the Pacific Coast the name of the dashing cousin of King Charles II. and the first Governor of the Hudson's Bay Company. After the accession of King Charles II., Prince Rupert (an illustrious soldier and explorer) joined the Duke of Albermarle and others on the discovery of a supposed passage through Canada to the South Seas, and in June, 1668, despatched two vessels to Hudson's Bay for the purpose. The outcome of this expedition was the granting in May, 1670, of a Royal Charter to Prince Rupert and others under the title, "The Honorable Company of Gentlemen and Adventurers Trading to Hudson's Bay," the concern being now known throughout the world as the Hudson's Bay Company. This charter gave the sole right to trade and proprietorship in an enormous area of what is now Canada, termed "Rupert's Land."

The harbor of Prince Rupert is large and commodious, and affords a perfect shelter for large vessels. It is entered from the north by Chatham Sound, from the south by several channels, and from the Pacific by Dixon Entrance and Brown's Passage. The harbor proper is about ten miles in length, and varies from half a mile to two miles in width. A survey shows a depth of 20 fathoms north and east of the town site, from 17 to 23 fathoms opposite the point and about six fathoms at the wharves. Tidal conditions in the harbor are favorable for port purposes. The tide rises from 17 to 24 feet at alternate spring tides and 16 feet at neap tides, making an average rise and fall of tide of 15 feet.

Up to the present the business of this port has been chiefly coastwise, the Grand Trunk Pacific operating a fleet with regular sailings to the Queen Charlotte Islands, Alaska, Vancouver and other southern ports. The port is the centre of a large business in fish and lumber, having played an important part in the "win-the-war" program through its handling of enormous quantities of fresh fish, as well as spruce for aeroplane construction.

The port is provided with a floating drydock with a lifting capacity of 20,000 tons, particulars of which may be outlined as follows:—

	Length. Feet.	Lifting capacity. Tons.
Dock, over all	600	20,000
Middle section	270	10,000
Each end section	165	5,000
Middle and end section	435	15,000
Two ends	330	10,000

With this drydock is connected a thoroughly modern machine shop and equipment, including a 15-ton travelling crane. The entire plant, covering 17 acres, was constructed by the Grand Trunk Pacific Railway at a cost of approximately $2,500,000.

Prince Rupert harbor is not yet directly controlled by a harbor commission, its development being under the direction of the Dominion Department of Marine and Fisheries. A large number of private wharves have been constructed, and the Dominion Government maintains at the point a lighthouse depot, with wharves and full equipment. The Provincial Government has provided a wharf, 600 feet in length, accommodating vessels of 25 feet draught, which is equipped with sheds, etc. The Grand Trunk Pacific is about to start work on the construction of an ocean wharf of 1,000 feet in length, and equipped with storage sheds and modern equipment, for the handling of cargoes.

The total tonnage entered and cleared at this port during the fiscal year for 1911 to 1912 was 1,656,489 tons.

HAMILTON ENGINEERS START BRANCH

UNDER the chairmanship of E. R. Gray, city engineer of Hamilton, the opening meeting of the newly formed branch of the Engineering Institute of Canada, was held in that city on Saturday evening, September 21st. The lecturer of the evening was P. M. Lincoln, past-president of the American Institute of Electrical Engineers, and engineer of the Westinghouse Electric and Manufacturing Company, Pittsburg. His subject was "The Development of Electric Power Transmission," and his lecture included a short historical review and a comprehensive summary of the many difficult problems encountered and solved by transmission engineers, and a forecast of probable developments in the near future.

BIG ORDER FOR CANADA CEMENT COMPANY

WHAT is regarded as the largest single order for munitions that has come to any Canadian company from the United States government has just been placed with the Canada Cement Company. The amount exceeds $10,000,000. This order is for the larger shell that this company has been turning out for some time past, and involves the building of a new shop and other changes that will cost over $1,000,000. As in the case of the Lyall company, this expenditure will be guaranteed by the United States government, and if through any reason, as a stoppage of the war, the order is not filled, there is an agreement by which the cement company will be reimbursed for the capital expenditure on plant.

While no definite plans have been made for after the war, the cement company will retain the steel plant and the forging plant, while the machine shop is regarded as a purely temporary branch of the company's business.

Following are some of the Canadian patents recently issued through the agency of Messrs. Ridout and Maybee, Toronto: Harvey M. Russ, dump wagons; Albert E. Salway, multi-cylinder internal combustion engine; and John G. Robinson, steam superheater.

A mass concrete dam is being constructed on the Lynn River at Port Dover, Ont., for Penman's, Limited. Plans and specifications have been prepared by T. Pringle and Son, Limited, of Montreal and Toronto, and the contract is being carried out by the Foundation Co., Limited, of Montreal.

The price at which the Montreal Light, Heat and Power Company has offered to supply the city of Montreal with electric current for half of the pumping station requirements is said to be $25 per horse-power per annum. It is estimated that if half the plant were electrified, about 3,000 horse-power would be required.

PLANNING A SYSTEM OF RURAL HIGHWAYS IN THE PROVINCE OF SASKATCHEWAN*

By W. M. Stewart

IN all rural districts the working out and adoption of a definite scheme for road development is essential if there is to be efficient service and economy in road development and this is particularly true in the western provinces, where development is still comparatively in its initial stages.

The first step in working out a rural road development scheme should be the planning of a system of roads, classifying the roads according to the traffic they are to carry and drawing up a plan showing the system of roads adopted.

Four Classes of Roads

Roads in the Province of Saskatchewan are usually divided into four classes, *viz.* :—

Provincial roads: those carrying a large proportion of through traffic, originating outside the district under consideration.

Main market roads: those carrying a considerable concentration of market traffic, originating principally in the district.

Main feeder roads: those serving as the principal feeders to the provincial or main market roads.

And local roads: those carrying only, or but little more than, the traffic originating upon the farms actually adjacent to the road.

The first class, the provincial roads, are not usually separately defined at present in Saskatchewan, as it is understood to be the policy of the Provincial Highways Department to leave the defining of these roads in abeyance and in the future, as the main market road systems are developed, to then work out a system of provincial roads by linking up the various main market roads. If it were possible to at present define a system of provincial highways it would be a considerable advantage in planning highway systems, and probably save unnecessary duplication of main roads in the future. It is recognized, however, that in the present stage of development the defining of a system of provincial highways which would satisfactorily meet future conditions, would be very difficult, if not impossible, and as the class of road built for some time to come will be largely dirt roads, the objection to the policy is not a very serious one.

In locating the "main market" roads, the purpose is to so locate them as to serve the market traffic in the districts tributary to various marketing points to the best advantage and to link up one with another to provide for through traffic.

The "main feeder" roads are located so as to serve those areas which are somewhat remote from the "main market" roads.

The "local" roads constitute the balance of the roads in the district.

Preliminary System Planned

A method which has been found to work out very satisfactorily in planning a system of rural highways under Saskatchewan conditions, is to first draw up a preliminary system of roads, based upon the readily available information as to existing topographical and settlement conditions and then use the preliminary system so worked out as a basis for the detailed field examination and final determination of the system of roads.

In older communities, where many main routes of travel are well established and difficult to change, this method might not be satisfactory, but in Saskatchewan, where there is more freedom of choice in deciding upon main road locations and the problem is principally to decide what would be the most advantageous main road location and to direct traffic into that route, the method works out very satisfactorily.

Traffic Development is Estimated

When working out the preliminary road system, a plan is first prepared of the district under consideration and intimately related adjacent districts, showing all railroads, marketing points, public gathering places and the principal topographical features, information in regard to which is readily available. It is also usually possible to readily obtain fairly accurate information as to density of settlement, the amount and class of production in the settled areas and the class of the land, both vacant and settled. From this information a fairly accurate estimate of the existing traffic may be made and a conclusion arrived at as to probable future development.

Based upon the information so gathered, the district is divided into sub-districts, each of which is naturally tributary to a marketing point. With the sub-districts decided upon, the problem then is to locate the main market and main feeder roads so as to best serve the market traffic and to link up these roads to provide for through traffic. In working out their location no general rules can be made applicable and each case must be approached as a separate problem. The main roads must generally follow the existing road allowances, or the section or quarter-section boundaries, except for minor diversions to avoid serious obstacles. In some cases the most advantageous location for a main market road is a road having a general diagonal direction across the sub-district, but following the regular road allowances. Diagonal roads, cutting across country, while possessing many advantages, cannot usually be adopted where the system of land subdivision is rectangular in form, as in Saskatchewan, owing to the resulting waste of land and inconvenience to farming operations. Existing railroad lines, or peculiarly suitable topographical conditions in some cases make possible the adoption of diagonal roads, and in such cases they are a great advantage.

Usually the aim is to so plan the main road system that no quarter-section of land in the district is more than three miles (following the regular road allowances) from a main market or main feeder road.

Detailed Field Examination

The preliminary road system so worked out is then used as a basis for the detailed field examination, which consists of checking up the information already gathered as to existing settlement and production and the class of the land; the examination of the proposed main road locations to determine if the physical features are such as to permit of their development to main road standard at a cost warranted by the traffic to be carried, and also to determine if their location is such as to make them readily accessible to the traffic which they are to serve. The main road system adopted upon the preliminary plan is then amended according to the information so developed in the field examination.

When worked out upon the basis described, the main market and main feeder roads usually comprise from

*Paper read August 8th, 1918, at the Saskatoon meeting of the Engineering Institute of Canada.

twenty to twenty-five per cent. of the total road mileage in the district and (taking the average of the whole district) the average distance of quarter-sections from a main market or main feeder road is usually about 1¾ miles.

So far as the writer is aware, no traffic census has been taken in Saskatchewan to determine the percentage of the total traffic in any district which is carried by main market or main feeder roads. A fairly close estimate of this percentage may, however, be made by calculating the total mileage which each quarter-section is from its market town, by the route which traffic must follow and in each case noting also the mileage in such total distance which is travelled over main market or main feeder roads. In cases so investigated it was found that the mileage travelled over main market or main feeder roads, in marketing produce, represented from eighty to eighty-three per cent. of the total haul.

Traffic Concentrated on Few Roads

It is, therefore, a conservative statement to make when it is said that twenty-five per cent. of the roads, if properly selected, will carry eighty-five per cent. of the traffic, for the above estimate has not taken into account at all the through traffic, which is confined almost exclusively to the main roads.

This demonstrates the great advantage resulting from the proper planning of the main road system and of concentrating as far as possible upon main road construction, and when it is remembered that for economy in construction and efficient service the roads should be built to a standard suitable to the class of traffic to be carried, the necessity for defining the main road system is further emphasized.

Coincident with the defining and adoption of the road system, a scheme for its development should be worked out in order to secure the gradual development from year to year of the system in such a way as to give the greatest service from the available yearly road funds.

Probably the best method of securing this result would be to draw up a tentative program of yearly construction to be carried out from year to year to the final completion of the system. The program so adopted would undoubtedly have to be amended from year to year as conditions called for. It would, however, serve as a guide in deciding upon each season's work and provide a definite goal to work to. This step, however, is probably more than we can at present expect of our municipal councils and the best we can hope for is the adoption by municipalities of "development by-laws" as provided for by the new Town Planning and Rural Development Act. Such development by-laws could define in a general way the road policy of the municipality and could specify the standards of construction to be adhered to for various classes of road and could also specify the minimum percentage of the available yearly road funds which must be devoted to main road construction and also require that not less than a certain minimum sum per mile of improved road must each year be set aside and expended for maintenance and repair. Numerous other points could, of course, be covered in the by-law, but the points mentioned illustrate the manner in which the development by-law could operate to direct development along proper lines.

Permanent Paving Soon Coming

A number of our Saskatchewan municipalities are as strong financially as many of the communities in the older districts, which have adopted comprehensive road development schemes, including surfaced roads of various types, and while road development in the West will be more costly than in most of the older communities, it nevertheless seems reasonable to assume that at no very distant date some of our municipalities, also, will adopt a full scheme of development, including a program of yearly development and a certain proportion of surfaced roads.

Knowledge Necessary for Development

In working out such a scheme of development it is necessary to know:—

1st—Those roads the early improvement of which will give the greatest benefit;

2nd—The type of surface which the existing and prospective traffic requires and if the cost of such a surface would be warranted;

3rd—The financial capacity of the municipality.

From a knowledge of the existing settlement and production and the class of the land, a fairly accurate estimate can be made of the existing and prospective traffic and based upon these estimates the relative importance of the various roads may be compared; the type of surface necessary to provide a satisfactory road can be deduced; the approximate saving in haulage costs determined and from this a conclusion arrived at as to the type of surface warranted.

In making such an estimate the traffic area for the road under consideration is first determined and information is then gathered as to the area under cultivation, the nature of the products and the class of the land. The average annual area under crop tributary to the road and the average yield per acre will, under Saskatchewan conditions, determine with sufficient accuracy the yearly tonnage of the principal market traffic, and this information can be supplemented by details as to the tonnage of return haul farm supplies, an approximation as to which can be obtained from the town merchants.

One way of considering the traffic is to divide the total tonnage by the number of hauling days per year (usually taken at 300) which gives the tons per day; multiplying this by the average haul gives the ton-miles per day and dividing by the total length of the road gives the daily average tonnage per mile hauled over the entire road and the tonnage hauled is the most satisfactory basis for comparing the relative importance of market roads and from which to determine the economic value of a road. In this connection it may be noted that the average haul is usually from sixty-five to seventy per cent. of the maximum haul.

As to the weight of the yield per acre of cultivated land: This can usually be determined from a knowledge of local conditions. The United States census returns show an approximate average product of 322 pounds per acre of farm land and the average yield per acre on improved farm land in crops was 1,674 pounds. The average weight per acre of forest products on unimproved timbered farm land was 122 pounds.

Securing Lowest Annual Cost

From such an estimate of the volume and class of traffic to be provided for, a comparison may be made of the relative importance of various roads and the types of road surface which will satisfactorily carry the traffic may be determined.

The problem is then narrowed down to the selecting of that one of the various satisfactory types of road surface which will show the least total annual cost; the total annual cost of a road being annual interest on first

cost, annual maintenance and repair and a yearly amount necessary to be set aside to create a sinking fund which will renew the surface when it wears out, or in the case of roads built by bond issue, will retire the bonds when they fall due.

If, then, investigation shows the necessary funds are available and that the improvement is warranted by the benefits accruing, the type of road so determined upon should be adopted. If the necessary funds are not available, a compromise will have to be made and a type of road surface of less cost selected and traffic will have to accommodate itself to a road which will be more or less unsatisfactory during certain seasons of the year.

In some communities it has been made a general rule that "to be justified, the road improvement should show a saving in the unit cost of hauling as before and after the improvement and this saving should be sufficient, after all costs for maintenance and repair are deducted, to pay a reasonable interest on the original investment." This rule in other cases is further enlarged by the provision that "in order that the burden upon the local community paying for the road may not be too heavy, road and bridge construction must be justified by the traffic, not only in existence, but which also is productive and road construction projects should only be started when funds are assured for their maintenance."

Other Factors Besides Haulage

To the average taxpayer and user of the road, however, while cost of haulage is, of course, of great importance, there are so many other factors entering into the question, such as improved social conditions, general convenience, enhanced land values, etc., that actual saving in haulage costs is not an entirely satisfactory basis for justifying a road improvement project and in practice it usually narrows down to a question of the yearly tax the user of the road is prepared to carry in order to secure the boon of good roads.

It is generally recognized that before any considerable advance in road betterment can be achieved there must be an improvement in the methods of management and a definite, well-planned system adopted, both as regards the scheme of development and the method of carrying on construction, repair and maintenance. The planning of the system of roads is the first essential step in this direction and the opportunity exists for the engineer of rendering a useful public service, as well as a service to the profession, by advocating the general adoption of this policy by municipalities.

In an address at the first general meeting of the Chemistry Committee of the Honorary Research Council, the chairman of the committee, Dr. R. F. Ruttan, discussed informatively the question of the possible Canadian sources of a potash supply, says the Bulletin of the Canadian Mining Institute. While at the present time no process is being economically applied in Canada for the obtaining of potash from feldspar, in spite of announcements in the newspapers to the contrary, Dr. Ruttan stated that the hydrolysis of potash-feldspar by means of lime and steam at a high pressure has, so far as it has gone, proved commercially successful at a plant in New Jersey. Meanwhile, it has been found that glauconite gives a higher yield of potash than feldspar and it was recently reported that a deposit of glauconite had been discovered in British Columbia which, if true, promises possibilities. The recovery of potash from straw did not appear to be practicable; but the condensation of potash salt from vapors of cement works had given good results in the United States and Dr. Ruttan suggested that analyses should be made of the flue dust of all the large cement works in the country, for many he believed would find thereby that they could save sufficient potash by means of the Cottrell process to justify the installation of a plant.

STANDARDIZATION OF REQUIRED CONSISTENCY FOR ASPHALT

By J. R. Draney,
Sales Manager, United States Asphalt Refining Co.,
New York City

ABOUT three or four years ago the writer contributed a communication which was published in "Engineering News" regarding the many varieties of penetration required in the production of asphalt for paving purposes. At that time it was set forth that the demand upon asphalt refiners for so many different penetrations of asphalt was an undue hardship, and one which, from a practical viewpoint, was totally unnecessary. For example, under similar conditions, one city will prefer a penetration of from 60-65, while another city will require a penetration of from 55-60 or 65-70, and there are some cases where a penetration of from 70-75 has been required for sheet asphalt. Penetrations of from 35-40, 40-45, 45-50 are also required.

Wide Variations at Present

There is also a variation in penetration requirements for asphalt to be used in asphaltic concrete, but these variations do not cover as wide a range as the asphalt required for sheet asphalt work. Penetration requirements for asphaltic concrete range from 60-65, 65-70, 70-75 and 70-80, and in some cases between 80 and 90, but the latter is only demanded where asphaltic concrete carrying a goodly proportion of large size stone is used.

Asphalt to be used in asphaltic macadam by the penetration or pouring process is likewise called for by the trade in penetrations ranging from 90-190. We have many instances where penetration of from 90-100 is demanded. Probably the penetration that is more largely required averages from 110 to 120. The specifications of the New York State Highway Department require from 140-190.

These wide ranges in penetrations for asphalt to be used in the same type of work are due principally to a lack of concordant ideas and are the result of individual tastes. It has caused a lot of extra work, expense, time, trouble and worry to asphalt refiners, and during the present season has become more obnoxious than ever, due to the shortage of asphalt.

The company with which the writer is connected has manufactured asphalt in the last few years with penetrations covering a total aggregate of twenty different ranges for sheet asphalt, asphaltic concrete and asphaltic macadam. Quite often the refinery may have on hand a stock of asphalt with several ranges of penetration, but will be out of the penetration required for that "hurry-up" order which must be shipped immediately. The contractor is awaiting the material, but we dare not ship anything but the penetration within the range that he has ordered, as the authorities under whom he is working would not permit it to be used otherwise.

Need for Efficiency

The war has impressed upon all of us the pronounced need for greater efficiency and economy. Therefore, why the necessity of producing so many different varieties in a material when there is no real excuse or reason for it except that of individual ideas?

Co-ordination of ideas, with a resultant standardization, should be realized. We trust that the American Society for Municipal Improvements will inaugurate such a movement affecting the use of asphalt for paving, and that other societies will follow suit.

There are but three varieties of penetration necessary for sheet asphalt: one for streets with heavy traffic, one for moderate traffic and one for light traffic. The same may be said of asphalt required for asphaltic concrete pavement. For asphaltic macadam there should be one range of penetration, and that a fairly wide one. For example, a specification giving a penetration requirement of from 100 to 125 would cover the matter properly and effectively.

This matter should be given serious thought, and we hope for concordant action which will result in a practice that will make for increased efficiency and economy and at the same time secure a much-needed standardization in the consistency of asphaltic material for paving purposes.

THE PRIVATE SEWERAGE QUESTION*

By D. H. Wyatt, M.E.
Columbus, Ohio

FOR many months my time has been almost exclusively given over to the subject of private sewerage. It appeared to me at the outset that the weak spot in our mastery of the sewerage question lay somewhere between the public sewer, in which the municipal engineer is a specialist, and the house installation, which plumbing progress has carried to a high degree of perfection. But the sewage and wastes entering through the plumbing system must find their way to the sewer and the zone between the foot of the plumber's sanitary stack and the street sewer has been in many cases a sort of no man's land, sometimes coming under the supervision of the building contractor, sometimes the plumber and also, to a certain extent, the subject of public regulation.

It has been customary to divide the horizontal part of a private sanitary installation under two designations, although they are essentially one installation. But, yielding to custom in my choice of terms, I will refer to the portion of the sewer from the base of the stack to the foundation wall as the "building drain" and the part extending outside the foundation to the public sewer as the "building sewer." "House drain" and "house sewer" are equivalent terms in a sense to those which I will use, but restricted in their application to residences.

Faulty From Structural Standpoint

From a structural standpoint, private sewer installations are faulty in a large number of cases and these faults are a serious menace to sanitation. Few plights are so tragic, either in the case of a residence or a business building, as the stopping of sewage, with its accompaniment of flooded fixtures and foul odors. As the trouble is underground, the mere discovery of its location may mean tearing up a whole concrete cellar bottom or many yards of lawn or paving and the correction of the trouble is a laborious and nauseating task. I wish to make the point in this connection that less tolerance of mediocre installation is permissible in work which is buried in the ground than in structures which are in plain sight and easily repaired. In practice, on the contrary, it is quite customary for faulty underground jobs to be rushed through and covered up. The mere fact that it is out of sight salves the professional conscience of contractors who otherwise would not permit anything but the best workmanship.

*Paper read before the American Society of Municipal Improvements, Buffalo, October 2nd, 1918.

Leaky building drains and building sewers produce certain typical results which may be enumerated.

Typical Results

1. Escape of sewage. This is perhaps the least serious result, but it does produce foul cellar bottoms and sometimes moist areas in streets. It stimulates neighboring root-growth and invites:—

2. Intrusion of roots. This is one of the most serious and the commonest menace to the proper working of a private sewer. Roots have been known to extend sixty feet from the tree, to enter the pipe as mere tendrils and to swell until they fill the whole pipe. The crisis that they create can be imagined, if you have not had actual experience with it.

3. Intrusion of ground water. This tends to flood the system and interfere with the proper functioning of disposal plants. Where the carrying system is overburdened, it means the flooding or stoppage of the plumbing appliances and suspension of their usefulness.

4. Intrusion of gases. Where gas pipes parallel the public or private sewer, the system often becomes surcharged with gas. It may force the seal of building traps and contaminate the air of a building. Explosions in sewers not infrequently blow up manholes and wreck the walls of sewers. Garage wastes often introduce gas into sewers. Leaky house drains allow the gas thus introduced to permeate the buildings.

When any of these things have gone wrong, the immediate S.O.S. of the building owner is addressed to the plumber. Hence the plumber has taken upon himself the solution of the question both as a matter of cure and prevention. His preventive measures have been the most natural in the world. He is primarily a metal worker and understands the joining of iron pipes. Where he has been consulted, he has usually recommended a building drain of cast iron, as the remedy in which he has confidence. At his advice, there has been a widespread legal propaganda, first for cast-iron building drains, prescribed in many building codes; second for cast-iron building sewers, prevailing only in a few localities; and finally for public sewers of cast iron, a step which is still in the conversational stage.

Cast Iron Sewerage

Anyone must be struck, at the start, with the enormously increased expense of substituting cast iron for the sewerage materials in more general use. Yet if cast iron is the only material capable of being tightly joined, the logic of this movement cannot stop short of complete cast-iron sewer systems, for leaky sewerage is intolerable whether in the private sewer or the public sewer.

My researches have convinced me that there is no sound argument for the use of cast-iron sewerage and many reasons against it.

Take a temporarily pressing reason; the need for metal to win the war is so pressing as to make it questionable patriotism for anyone to use a pound of iron or steel underground. Cast iron used for pipe diverts pig iron from the manufacture of steel. The government's need for steel in the current six months amounts to 200,000,000 tons, where the greatest production record for any preceding six months in the history of the industry has been 160,000,000 tons, both for public and private use. Every five feet of 18-inch iron pipe buried in the ground deprives the government of sufficient metal to build a 430-h.p. Liberty motor or enough to build any standard truck engine in the 30 to 40-h.p. class. Every 2-foot length of cast iron pipe represents enough material

to make a Ford power unit complete, which might be rendering Red Cross duty on the fields of France.

To reason apart from temporary war conditions, everyone knows that iron is one of the metals most subject to chemical attack. It rusts readily and the introduction of acids into the sewage, such as is increasingly experienced through varied lines of manufacture, means the destruction of heavy pipe in a few weeks or months. Electrolysis is also a scourge that must be taken into serious account.

Vitrified pipe, on the other hand, which has been the standard sewerage material for moderate diameters of sewer for half a century, is well constituted to withstand chemical attack, consisting largely of alumina and silica, both highly inert compounds. Examinations of faulty vitrified building sewers reveals the fact that, almost without exception, the joint is the cause of the trouble.

Impervious Joint Needed

I and my associates saw no reason, therefore, to accept the iron pipe as the solution of the private-sewer question until we had exhausted the possibility of producing an impervious joint in vitrified pipe. If we succeeded only in making it a temporarily acceptable war substitute, we would be performing a patriotic service. But our solution was good enough, we confidently believe, to establish vitrified pipe as the preferred material, not the substitute.

The remedy proved extremely simple, once we were on the right track. It consists, essentially, in pouring the joint in liquid form, rather than applying it with a trowel at a stiffer consistency.

Most trowelled joints are made so badly that the workmanship would not pass muster anywhere that the results were exposed to view. Some workers, on the other hand, conscientiously and carefully fill the pipe bell with mortar, in making hand-formed joints. In this case it was a good joint and remained good for perhaps three minutes. At the end of that period, the workman would progress to the point of making another joint. He would manipulate the end of one of the pipes just joined. The new-made joint would be disturbed, causing the mortar to crack away from the surface of the pipe. Thus the day's work was a pathetic sequence of making good joints and immediately spoiling them.

Pouring Grout or Bitumen

The pouring process, with the aid of the mechanism which we devised, cuts the human element to the minimum. The pipes are brought together and lightly caulked to prevent the intrusion of joint material in the pipe. The joint-mold is applied and clamped tightly about the joined bell and spigot. The molds are sufficient in number for the entire job, or at least a day's work. When all are in position, the whole job is poured with a thin mixture of Portland-cement grout, similar to that used in filling brick or stone pavements. There is an alternative practice of pouring the joint with a good bituminous compound heated to liquefaction. The mold works equally well with either joint material. It has one advantage over the old fashioned asbestos runner in that it provides space for a distinct bevel of joint material and the heat of liquefaction is retained until penetration is complete, a result that was sometimes lacking when the compound was compelled to flow in the narrow annular space of the pipe-bell, between two cold surfaces of pipe. The bituminous joint provides a degree of elasticity and is a safeguard against perpendicular breaking strains and it is also to be preferred where the need of prompt back-filling forbids waiting for the setting of a grout joint.

The form itself is of overlapping sheet metal scales or plates, strung on two small steel cables and provided with clamps for joining and a funnel for pouring.

The importance of vitrified-pipe installations that are thoroughly impervious cannot be overestimated. I have dealt only with the private sewer, but every advantage accruing to my solution of the private sewer question applies with equal force to the public sewer and many other fields of usefulness, such as irrigation and certain phases of oil transportation.

Engineers on Health Boards

At the same time, the private sewer is well worth the emphasis I have given it. Engineers have frequently underestimated the harm that comes to public sewers through faulty private laterals. It was stated on prominent authority in the American Society of Civil Engineers that the measure for the infiltration of ground water should be the standard of square inches of evposed joint. An estimate of infiltration in a typical sewer installation on a residence street showed that in every hundred feet of public sewer there was three times as much infiltration from the private laterals as from the joints of the public sewer itself. The case presumed was that of an 8-inch sewer, laid in 3-foot lengths with a lateral every 25 feet right and left. The laterals are of 4-inch pipe in 2-foot lengths and extend an average of 60 feet into the abutting private property. Another point to be considered in regard to infiltration is the protection that the public sewer receives from water-proof pavements, while the private sewer is not thus protected.

When we survey the failures, mistakes and evils of private construction, we need not be surprised that things are as they are. The problem of tight sewerage, whether public or private, is an engineering problem. Yet boards of health who draft codes for private sewering are composed, not infrequently, of plumbers and physicians. There ought to be at least one good engineer on every board of health. The city engineer is the logical man, since through his presence there the essential unity of the whole sewer system, public and private, could be maintained and conditions enforced in private sewerage most in harmony with the needs of the public sewer system.

Letter to the Editor

No Security of Tenure in Municipal Positions?

Sir,—Your article under the above heading in the issue of September 12th, was of particular interest to me, as I was engineer of the adjacent municipality of Burnaby for almost eight years, and was therefore associated with Mr. Bennett, formerly engineer of South Vancouver, and his predecessors, in several matters of an inter-municipal nature.

While not wishing to commence any controversy, I feel that an unwarranted injustice has been done Canadian corporations and officials, particularly municipal engineers, in the condemnatory statement attributed to Mr. Bennett, and in the interests of the truth, would like to set forth the particulars as I have found them.

This can best be done by statement of fact, and the following is the "life history" of the engineers of munici-

palities adjacent to South Vancouver, where Mr. Bennett was formerly engineer:—

Municipality.	Approx. Length of Service.	Reasons for Leaving, Etc.
1—Burnaby	8 years	For better government position.
2—New Westminster	8 "	To join Overseas Forces (position being kept open).
3—Vancouver	6 "	Still City Engineer.
4—Point Grey	5 "	To accept more remunerative position as Mun. Engr. to Saanich, Vancouver Island, which position he held for about 2½ years, when he enlisted.
5—N. Vancouver (City)	3 "	Overseas service (position kept open).
6—N. Vancouver (District)	4½ "	Overseas service (position kept open).
7—Port Coquitlam	4 "	To accept more remunerative position as Mun. Engr.
8—Surrey	3 "	To accept better position.

In Nos. 1, 2, 4, 6, the officials were the first resident engineers ever employed by these municipalities,—a factor which in itself is significant of their satisfactory tenure of office.

Moreover, in none of the positions referred to above were any of the officials "asked to resign." Those sufficiently interested can have the above statements verified on application to the clerks of the municipalities.

With the exception of the municipality of South Vancouver, where there have been six different engineers during the period above referred to, this table includes all the municipalities on the Burrard Peninsula where engineers were employed.

Whether or not, as averred by Mr. Bennett, "a man who can hold a responsible position for two years is something of a rarity," can safely be left to the readers to judge for themselves insofar as it concerns the engineers on the lower mainland of British Columbia. Not being sufficiently acquainted with engineers in the interior of British Columbia I cannot, of course, speak for them, but as the bulk of the population of British Columbia is tributary to Vancouver, New Westminster and Victoria (where, by the way, the esteemed city engineer recently resigned to join an eastern railway undertaking after a successful six year term of office), the foregoing facts are truly illustrative of conditions obtaining in British Columbia.

True, many engineers in the small provincial towns had to resign their positions, but that was primarily due to adverse financial conditions prior to the outbreak of the war, whereby municipalities had perforce to curtail public works and thus dispense with the services of their engineers. In such cases a Works Superintendent was usually employed in the dual capacity of engineer and superintendent.

So far as Mr. Bennett's experience in South Vancouver is concerned, I do not deny that the situation there was an undesirable one. Political factors largely entered into the conduct of the business affairs of that municipality, where things went from bad to worse so much so that eventually the Provincial Government had to assume control of municipal matters. An engineer placed in such an unenviable position has one's entire sympathy. But, unfortunately, it is just that very political factor which has been the undoing of many officials, including engineers. They soon learn to play the political game, and becoming so obsessed with it, too frequently permit personalities and politics instead of principles to govern their actions and decisions, and small wonder, then, that such men should find themselves officially decapitated on the return to power of governing bodies whom they have opposed individually or collectively prior to and during annual elections.

Another factor that accounts for the many changes in the heads of municipal engineering departments is frequently one of partial incompetence. Oft-times, under the same political patronage evil, so-called engineers are pitchforked into positions which they may *occupy* for a time but cannot efficiently *fill*, either because they have qualified only as land surveyors (and no disrespect is intended for that splendid profession), or because their engineering experience has not been sufficiently connected with municipal undertakings. Moreover, many otherwise good engineers lack the initiative, tact and resource so essential for dealing with the successive governing bodies, not forgetting the sometimes critical and hard-to-please ratepayers.

So far as my own municipal experiences are concerned, while not wishing to enlarge on same, it is but fair to state generally that frequently my position was a trying one, there being much opposition, both internally and externally, and unfair and unjustifiable criticism to withstand. However, in consistently attempting to adhere to principles, both in engineering and in ethics, and always avoiding politics, municipal or provincial, I succeeded in maintaining the status quo.

Someone has humorously remarked that so difficult is the position of a municipal engineer to fill that it requires a man "to combine the wisdom of a philosopher with the hind legs of an ass," and no doubt a little dispassionate "kicking" is necessary now and again to gain one's point and to justify one's municipal existence.

I feel sure, however, that any fairly capable municipal engineer who will carefully carry out the work entrusted to him in a conscientious manner, persistently shunning politics, will ultimately have the confidence of the broader-minded and bigger-souled members of any corporation, together with the support of an interested and appreciative general public.

As to warning engineers from the Motherland not to emigrate to Canada,—even after undergoing about eight years of municipal "trials and tribulations,"—I would not discourage the young engineer from coming to this country for the reasons alleged in the article referred to, but rather because of the abnormal situation in municipalities generally, created by the world war. The few openings now occurring are usually given, and justifiably so, to engineers of Canadian birth or adoption.

I might have referred to many other matters,—for instance, that Mr. Bennett was "a successful engineer to *several* Canadian municipalities" is open to question so far as the extent of his municipal experience is concerned. The general object of this letter will, however, be served in reiterating that, while the individual experience of Mr. Bennett may be unfortunately near the truth, it is an exceptional record and therefore entirely misleading, and certainly in no wise representative of conditions as they are in British Columbia. Probably some other members of the highly respected profession of municipal engineers will be able to speak favorably for the other provinces.

FRED. L. MACPHERSON,
Assistant Engineer,
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Province of British Columbia.

Victoria, B.C., September 26th, 1918.

Power—Canada's Opportunity

War Has Emphasized Value of Developed Power Resources—European Nations Have Found Construction Necessary in Spite of War—American Efforts Have Been in Right Direction, But So Far Inadequate—Function of Dominion Power Board

By A. M. BEALE

Assistant Engineer, Water Power Branch, Department of Interior, Ottawa

THE return of peace will find most of the nations of the world burdened with debt. Vast areas devastated by war will have to be completely rehabilitated and for a considerable period at least will be non-productive. Belligerent countries will have to make renewals and replacements in many directions whence material has been diverted for war requirements. Finally, the war has brought about the consumption of natural resources on such a vast scale that it will be essential to see to it that in future our resources are used to the best advantage.

It is obvious, therefore, that if the world is to make a speedy recovery, there must be a quick industrial revival and the country most prompt to produce in excess of its needs will be able to dispose of its surplus in foreign markets to the best advantage, and being first in the field will be in a position to build up an export trade whereby its national credit will be maintained, its national obligations met and imports requisite for its needs, comfort and general well-being secured. Canada should be in a position to be early in the field, but must look to her industrial efficiency, if she is to progress in face of the keen competition which will develop amongst the nations striving to regain their sadly impaired prosperity.

Industrial Civilization Requires Power

"Motive power," in the words of Sir Dugald Clerk, the eminent British engineer, "is of fundamental importance to industrial civilization." It has been pointed out that the development of power resources has gone hand in hand with civilization; lack of mechanical sources of energy to replace manual labor or the neglect of such sources has always retarded progress, as, for example, in China, whereas the discovery or development of power has led to prompt industrial progress. The early location of the iron and woolen industries in Yorkshire is attributed to the existence there of water power, while Great Britain's commercial supremacy is in a great measure due to the discovery and exploitation of her coal, which placed large quantities of power at her disposal.

The world war, bringing with it a tremendous speeding up of industry in the manufacture and transportation of munitions, has taxed the power resources of every nation; the immediate cause of fuel and consequent power shortage has varied, but the result has been the same, namely, an almost feverish energy to attain greater efficiency in the use of existing power resources and in the search for and investigation of new ones. Every country, of which we have news, is studying its power resources not so much from the standpoint of present needs but rather for those of the future.

In Great Britain, proposals have been set forth for vast central station fuel-power plants at strategic points for the supply of power for all industries, so as to secure a more efficient use of coal, the extraction of all by-products is being urged not merely on account of their value, which is enormous, but also because a cheap fuel will thereby become available to reduce the cost of power. A recent report by the committee on electrical trades appointed by the British Board of Trade states: "The prosperity of industries depends largely on cheap energy for driving machinery, and even a fractional reduction in price is of importance in determining the ability of manufacturers to compete in the world's markets." Stock, too, is being taken of the water powers of the British Isles.

A conjoint board of scientific societies acting under the auspices of the Imperial Government and recruited from the highest ranks of technical men in Great Britain is studying the resources of the Empire. Recognizing the importance of water power, a strong sub-committee was appointed to take stock of this resource and, thanks to the co-operation of the dominions, a large amount of valuable data has been secured and steps taken towards a fuller knowledge and appreciation of the water power resources of the Empire. Whilst Canada leads, New Guinea, New Zealand, Tasmania may be instanced amongst others of the British dominions as having great and vastly important water power possibilities.

It may not be amiss to draw attention here to the Tata hydro-electric undertaking in India which, to those unfamiliar with tropical conditions, is truly remarkable. It is a scheme to provide approximately 100,000 horse-power for 3,600 hours per year from valleys which have hitherto been dry for nine months of the year. This undertaking depends for its water supply on the storage of the monsoon rains which, it is stated, averaged, over a period of 34 years, 3¼ inches per day, for 45 days.

This scheme, as yet incomplete, is nevertheless in operation. It was financed in India and during the first year of operation earned and paid a dividend on its full capital.

Handicapped by Unsatisfactory Laws

Amongst our allies, the United States, faced with similar fuel conditions to ourselves, is taking active steps to mobilize her power resources but is handicapped, as are some parts of Canada, by unsatisfactory water power laws.

Water power is a salient feature in the contrast between the United States-Canadian boundary and the frontiers of Europe. To a traveller journeying along the frontiers of continental Europe in times of peace, the most conspicuous handiwork of man would probably be the mighty fortresses designed for defence against war-like aggression. These must always serve to remind the frontier dwellers that they live in the shadow of a continual war-menace. Here, on the contrary, the handiwork of man has been devoted to the erection of undefended bridges and canals along boundary waters, and of hydro-electric stations, which attract dwellers to the border regions that they may mutually enjoy a natural industrial asset, and must remind them that they live in the light of what promises to be a perpetual peace.

France, until the war an importer of one-third of her coal, was faced by the loss to the enemy of a considerable proportion of her own mines and the rising price and

difficulty of transportation for imported fuel. Promptly, and in spite of many difficulties, she has proceeded with hydro developments and by the end of this year will have 1,100,000 horse-power developed, an increase of 450,000 horse-power since 1910, two-thirds of which has been secured since war broke out.

Italy, lacking coal, is an excellent field for water power development and through the famous A.E.G. the Germans secured a stranglehold on Italian industry and by 1910 515,000 horse-power was developed. Since the outbreak of war, the Italian government has not merely broken the Teutonic hold but has proceeded with an active water power policy. A recent news item states that concessions for 208,000 horse-power were granted in 1917 and that in December, 1917, there were 218 requests for concessions, estimated at 816,000 horse-power, in course of examination.

What Other Countries Are Doing

In Russia, the provisional government has recently appointed a water power committee with absolute control over the development of all water power schemes in the Empire exceeding 300 horse-power.

Neutral countries are well aware that they will have to compete in a much keener market after the war and we see signs of stimulated activities in the Scandanavian countries.

A recent despatch from Mr. Albert Halstead, the United States Consul-General at Stockholm, states that the present capacity of water plants in Sweden is about four million turbine horse-power, of which one million was completed during 1917. This is such an enormous advance from the figure of 850,000 turbine horse-power, reported by Sven Lübeck in 1915, that one is inclined to doubt the accuracy of Mr. Halstead's figures, particularly since former estimates only credit Sweden with four and one-half million horse-power available.

Mr. Halstead states that 92 per cent. of the power is being used for the larger industries and 8 per cent. for illumination and the lesser industries.

Information collected during 1915 by the Dominion Water Power Branch indicated that Norway had five and one-half million water horse-power available, of which 1,120,000 turbine horse-power was developed, 400,000 horse-power being utilized for nitrogen fixation. It would be interesting to learn if progress in Norway has been on the same scale as that reported for Sweden. The governments of both countries are rendering every possible encouragement in the development and use of "white coal."

Denmark has practically no water power and it is interesting to note, as indicating the national importance of power, that a suggestion has been put forward for a triangular agreement whereby Norway and Sweden should export hydro-electric power to Denmark, Norway to make up any power deficiencies caused thereby in Southern Sweden where the water powers are less extensive than in the north.

Barcelona, the "Manchester of Spain," a city of 300,000, is replacing steam power by hydro-electricity and a Canadian company has already completed a large portion of an extensive system of reservoirs and hydro-electric stations on the Noguera Pallaresa and Segre rivers. A recent number of the Journal of the Royal Society of Arts reports the formation of a powerful company to exploit the Douro Falls on the Portugal-Spain frontier where 350,000 horse-power is said to be available.

Switzerland has been called the "Industrial Annex" of Germany, and in 1910 25 per cent. of her two million available water horse-power had already been developed. More recent information is not available; nevertheless, the mere fact that 32 horse-power had been developed in 1910 for each square mile of area is sufficient indication of the economic importance of Swiss water powers.

Concerning enemy countries, information filters through from time to time and in July last the British Board of Trade Journal contained a special article on the proposals for the centralization and development of electric power supply in Germany as part of the reconstruction policy after the war. In Wurtemburg, the State is to participate in the administration of a scheme for the consolidation of all electricity works for the purpose of the uniform distribution of current. The Saxon Second Chamber in December, 1917, voted forty million marks for developing state electricity works on condition that light and power should be furnished at cheap rates for industrial and commercial use. In Bavaria, a syndicate has been formed to exploit the water power on the Lower Inn, backed by the Deutsche Bank and native Bavarian financial and industrial interests. This syndicate has two million marks at its disposal for preliminary work and it is estimated that the complete scheme will require 150 million marks. Another scheme, backed by the A.E.G. of Berlin proposes a development of Bavarian water power to be begun three months after the conclusion of peace, the estimated output being over 21 million kilowatt hours. Prussia seems to be committed to the policy of State control of electricity supply.

In Austria, the government announces the establishment of a special department of the Ministry of Public Works to control the electrical system which is to be augmented by a great development of water power. This system is to be centralized and future concessionnaires, whether private or public, made to conform to the general scheme. In Hungary, similar legislation is in preparation.

The above summary sets out briefly what is taking place in other countries and renders it quite obvious that mechanical energy is the life-blood of the national industrial body, and that the nation which has a dependable source of power capable of producing energy cheaper than other nations will have a tremendous advantage. It behoves Canada, therefore, to take steps, and quickly, to assure her industries of adequate supply of cheap power. To quote again from the British Board of Trade report, we find the recommendation, "That government should recognize the dependence of the State both from military and industrial standpoints, upon the supply of electrical energy regarded as a 'key industry.'"

Displacing Other Forms of Energy

In the course of little more than a generation, electricity has, by a series of swift, offensive movements, made a conquest of the lighting, heating, transport and industrial power fields, and seems likely, for most purposes, to displace other forms of mechanical energy. As successful competition in the commercial world depends very largely upon the resourceful use of electric power, whether obtained from fuel or water power, the consideration of measures by which it may be readily available in dependable quantities and at low rates, is a matter of vital importance, as affecting the position of Canada in the approaching period of reconstruction.

Until the organization of the Dominion Power Board, no adequate attempt has been made to mobilize for the general advantage of Canada, the various Dominion and provincial organizations having to do with the administration and the investigation of the fuel and power resources of the Dominion. In co-ordinating and directing the efforts of these various organizations, the board has a good opportunity for rendering service not only to Canada but to the Empire at large.

SEWAGE PURIFICATION BY ACTIVATED SLUDGE PROCESS

(Continued from page 302)

for the greater efficiency in view of the comparatively small gain.

Two things must be considered here. The first is that the data, listed against the 0.85 cu. ft. of air, were obtained in warm weather when the bacterial reaction of the sludge is exceptionally brisk; and, second, that the data were obtained upon the basis of a uniform rate of flow equivalent to the average rather than to the maximum flow of the day, to which a large storm flow will be added at times.

During the winters of 1915 and 1916 more than 2 cu. ft. of air per gallon were applied. The daily peak load will be 50 per cent. greater than the average flow; and the maximum storm flow will be 150 per cent. greater than the average.

Period of Contact

Air was applied to the sewage in the aeration tanks for periods ranging from 2.4 to 11 hours.

Data are given in the following table to show the relative effect of increasing periods of contact upon purification.

Table No. 2—Purification Obtained with Increasing Periods of Contact

Period of contact in Aeration Tank (Hrs.)	BACTERIA		SUSPENDED MATTER		ORGANIC MATTER			
					Organic Nitrogen		Oxygen Consumed	
	Number of per c.c. in the effluent	Per cent. Removed	P. P. M. in the effluent	Per cent. Removed	P. P. M. in the effluent	Per cent. Removed	P. P. M. in the effluent	Per cent. Removed
3	280,000	87	20	86	8	37	40	66
4	68,000	95	16	92	10	42	36	71
10	171,000	95	17	92	6	60	32	75

The data given in this table show that the longer periods of contact removed the larger percentage of bacteria and the larger amounts of organic matter. The question has been raised here, also, as to whether the advantage gained is commensurate with the increased cost. By way of answer, it is important to note that sludge collects rapidly if the aeration period is short because the sludge does not become well digested. With three hours' aeration the plant may pick up as much sludge as 8 per cent. per day of the liquid volume of the aeration tanks whereas with 6 hours of aeration the plant will not pick up over 2 per cent.

The conditions of operation in the experiments were not quite typical of those which will prevail in the future municipal plant for the data given above were obtained with liquor flowing through the plant at a uniform rate representing the average flow of a day. Had the tank in service been subjected to the greatly increased flows which will strike the purification works with the daily peak loads of the future city sewage, especially if accentuated by storm water, then the purification obtained would have fallen far below our standard.

Six hours of aeration for sewage, based on the average daily flow, must be provided to maintain our standard of purification.

Air Diffusers

Experiments were made with filtros plates, wood blocks, and perforated iron pipe grids as air diffusers. Owing to the fact that the sewage carried quantities of hair, grit, and other debris that passed through ½-in. bar screens, deposits gathered around the pipe grids and choked the holes. As these obstructions to a free discharge of air accumulated the pressures built up, the air bubbles grew large, and the efficiency of aeration decreased.

The sludge did not become aerated well enough to remove the colloidal matter. Therefore the samples of effluent were not analyzed.

Data obtained with wood plate and filtros diffusers are given in Table No. 3.

The data given in this third table show that the wood plate diffusers gave somewhat better purification than the filtros, the most noticeable difference being found in the removal of bacteria. It should be noted in this connection, however, that the numbers of bacteria in the sewage fed to the wood plates averaged only 1,200,000 per c.c. compared with 3,768,000 fed to the filtros.

The volume of air applied to the wood plates was somewhat larger than that applied to the filtros. Moreover, the surface area of the wood diffuser plates was 4.58 square feet whereas the area of the filtros plates was only 1.75 square feet.

Evidently the conditions were more favorable for aeration with the wood than with the filtros plates and may account for part of the increased efficiency. When the wood plates were new and clean the air bubbles were small. After the plates became coated with grit and debris the bubbles swelled to a larger size. Upon rubbing the surfaces of the plates with a stiff wood fibre scrubbing brush, to clean off the sediment, the bubbles immediately returned to their former small volume. But the pressure required to force the air through the plates built up after scrubbing until the plates "blew out" of their containers.

Sediment gathered on the surfaces of the filtros plates also and when these plates were scrubbed the bubbles decreased at once in size, but the pressure did not build up, and the filtros plates did not blow out of their containers.

Clean Air

The subject of aeration would not be treated completely without referring to the importance of cleaning the air before it is delivered to the filtros plates.

When the wind blows across the city, coal smoke loads the air on Jones Island with soot. This sifts through fine cloth, excelsior or cotton batting. If it enters the pores of the filtros plates, they choke, the pressure required to force air through increases and air diffusion becomes very bad.

A spray washer was installed to wash the air and it took out the dust—but loaded the compressed air with moisture which froze in and

Table No. 3—Data Obtained with Wood Plate and Filtros Air Diffusers

Kind of Diffuser Plate Used	No. of Cu. ft. air per Gall.	Period of Contact in Aeration Tank.	BACTERIA		SUSPENDED MATTER		ORGANIC NITROGEN		OXYGEN CONSUMED	
			Number per c.c. in the effl. 20° C.	Per cent. Removed	P. P. M. in the effluent	Per cent. Removed	P. P. M. in the effluent	Per cent. Removed	P. P. M. in the effluent	Per cent. Removed
Wood plate.	0.91	2.4	38,000	96	17	93	11	35	37	70
Filtros	0.85	2.7	272,000	92	29	90	8	34	46	65

Table No. 4—Comparative Data—Tanks 10 ft. and 15 ft. Deep

Depth of Tank in feet	Date	Cu. ft. of air Per Gal.	Av. No. of Gals. of Sewage treated per day	No. of mill. gals treated per acre per day	BACTERIA No. per c. c. in the effl. grow. at (20° c.)	BACTERIA Per cent. Removed	SUSPENDED MATTER P.P.M. in the effl.	SUSPENDED MATTER Per cent. Removed	ORGANIC MATTER Organic Nitrogen P.P.M. in the effl.	ORGANIC MATTER Organic Nitrogen Per cent. Removed	ORGANIC MATTER Oxygen Consumed P.P.M. in the effl.	ORGANIC MATTER Oxygen Consumed Per cent. Removed
	1915											
10	Oct.	1.46	59,100	8.8	56,000	96	16	94	4	77	19	85
10	Nov.	1.70	62,900	9.4	119,000	91	16	96	8	58	27	92
	1917											
15	July	1.03	110,000	16.9	68,000	95	16	92	10	42	36	71
15	Aug.	1.25	110,900	17.0	515,000	86	27	87	7	37	53	57
15	Sept.	1.14	117,900	18.1	280,000	87	20	86	7	37	40	66
15	Oct.	1.25	111,900	17.2	321,000	91	18	92	6	48	44	61
15	Nov.	1.19	105,000	16.1	216,000	90	33	86	4	41	50	62
Average		1.17	111,000	17.1	280,000	90	23	89	6	41	45	63
15 feet Standard		1.5	101,000	15.0	.....	90	..	95	..	..	..	..

choked up the exposed air ducts. Therefore, all compressed air pipes must be covered in cold weather.

All questions in regard to character of diffuser, size of bubbles, etc., sink into insignificance when compared with the importance of furnishing clean air to the filtros plates. Dirty air will run the cost of aeration up higher than economies introduced by fine bubbles can overcome.

The only practical remedy for such a condition is to take the plates out and replace them. This is an expensive and time-consuming operation during which the portion of the plant in service must carry an extra load thrown upon it by the tanks cut out for cleaning.

Depth of Aeration Tanks

There are certain structural reasons why 15-ft. tanks would be cheaper than 10-ft. tanks.

To determine whether 15-ft. tanks would be as efficient as 10-ft. tanks, we built a 15-ft. aeration chamber with three 15-ft. settling basins. The chamber holds 15 ft. of liquor above the filtros plates, has a surface area of 284 sq. ft.; a liquid capacity of 31,500 gallons, and contains 64 filtros plates set across the flow of the sewage.

The 15-ft. tank was put into operation on July 15th and ran through to November 12th.

The sewage fed to the tank was delivered by a centrifugal pump over the surface of a ½-in. bar screen, but received very little, if any, preliminary sedimentation. Therefore, it contained more grit and rough suspended matter than the aeration tanks in the future municipal plant, which is to be protected by grit chambers and fine screens, will receive.

Comparative Data from 10-ft. and 15-ft. Tanks

We did not have a 10-ft. tank in operation during 1917 that ran under normal conditions.

Therefore, in order to obtain data for comparison with the 15-ft. tank, records have been taken from the operation of the continuous flow, south tank in 1915, and are given in Table No. 4, together with those from the 15-ft. tank in 1917.

The data found in the preceding table show that the 15-ft. tank handled more sewage and used less air than the 10-ft. tank, and less than our standard provides. The purification obtained by the 15-ft. tank was not up to the standard set by the Commission. The efficiency would have been improved by reducing the volume of sewage treated and by increasing the air as called for in the standard. The period of contact between sewage and air was less than four hours. Therefore, the sludge became watery and would not settle well in the settling basins. For that reason abnormally large volumes of sludge were returned to the aeration chamber, cutting down the period of contact and decreasing the efficiency of aeration.

Sedimentation

Before the treated sewage can be discharged into the lake it must be separated from the sludge with which it is mixed at the outlet of the aeration tanks.

Experiments conducted at the sewage testing station during the last three years have shown:

1st—That when the sludge is well activated it settles readily.

2nd—That the settled sludge must be removed as fast as it collects.

3rd—That clarification depends upon area rather than upon depth.

4th—That in order to secure complete removal of sludge the flow of liquor through the tank must not be allowed to exceed three linear feet per minute.

Sludge that has been underaerated contains a large percentage of flocculent material that will not settle well. This fact makes it necessary to provide larger tanks for underaerated sludge than would be required to handle sludge which has been treated for six hours. Samples of the latter placed in cylinders on a laboratory table, show after 10 minutes, a clearly defined layer of sediment in the bottom of the glass, with the supernatant liquor practically free from coarse suspended matter and turbidity.

In order to take advantage of this rapid separation of solids from liquids, settling basins at the station have been provided with adjustable baffles, at the inlet end. These were raised or lowered to accommodate fluctuating conditions of the liquors entering the tanks.

Baffles submerged from 30 ins. to 36 ins. gave the best efficiency on the average. Wherever such baffles are set, clear liquor appears behind them as long as the capacity of the tank is not overtaxed. If the settled sludge is removed as fast as it accumulates, comparatively few particles rise into this clear zone. But when the rate of sludge removed is decreased, by choking the discharge pipe with rags or heavy sludge or when the volume of sludge is increased radically, by increased flows, due to peak loads, or when the sludge in the aeration chambers picks up to more than 20 per cent. of the liquid volume of the chambers, a blanket of sludge will rise behind the

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IMPERIAL WATER POWER BOARD

AN Imperial Water Board should be formed at once, including a representative nominated by each of the overseas Dominions. That is the conclusion that has been reached by the special committee of engineers and scientists which was appointed by the British Government not long ago for the purpose of investigating the power resources of the British Empire. This subject is of such tremendous import to Canada that it is hoped the Dominion Government will take prompt and favorable action upon any invitation extended by the Imperial Government in carrying out the committee's suggestion.

The Canadian Government has already given evidence of its appreciation of the prime importance of a thorough knowledge of our power resources, and of the urgent necessity of their development to meet all the needs of the country. By the creation of the Dominion Power Board, under the chairmanship of the Hon. Arthur Meighen, the government has provided a means for concentrating upon this great problem the experience and considered judgment of the Dominion and Provincial organizations concerned with the administration and the investigation of water power. While the board has but recently been constituted, it has already given evidence of its usefulness and will undoubtedly reach results of lasting benefit to the country.

The creation of an Imperial Water Power Board is essential to British efficiency in successfully competing with other nations and empires in the reconstruction period that will follow Germany's defeat.

ANOTHER ST. LAWRENCE CASE

FOLLOWING the favorable decision by the International Joint Commission on the St. Lawrence Power Company's application for a submerged weir in the St. Lawrence River, another company is applying for permission to build somewhat similar works. The New York & Ontario Power Co. wants to reconstruct the dam used in connection with its Waddington, N.Y., plant.

The company requests the privilege of increasing the flow through the channel between Ogden Island and the American mainland to 30,000 cubic feet per second.

To divert 30,000 c.f.s. through the smaller channel would, according to the Dominion Government engineers, seriously affect the flow in the main channel, lowering the level by about eighteen inches. The application is being considered this week by the International Joint Commission. If any further privileges are granted by the commission, they should be only of a temporary character for war purposes, as in the case of the St. Lawrence Power Company.

GLADSTONE WAS RIGHT

BRITAIN'S grand old man declared, "A Chancellor of the Exchequer is not worth his salt if he is not ready to save candle-ends and cheese-parings in the cause of the country."

Canadians at home are not worth the sacrifices now being made for them at the Front if they are not ready to save everything they earn, over the essential expenditures, to back up the army and make their victory sure.

SEWAGE PURIFICATION BY ACTIVATED SLUDGE PROCESS

(Continued from page 316)

baffle. Unless checked, the blanket will continue to rise until it flows over the outlet weir and will pollute the effluent.

In as much as a depth of 30 ins. provides good facilities for settling activated sludge, shallow basins with large surface areas can handle limited volumes of sludge if combined with a uniform flow of sewage.

Sludge settling to the bottom displaces water that formerly lay there. When the water so displaced is given ample room to rise, the columns of liquid flowing upward escape readily through the openings between the particles of descending sludge.

Under these conditions the suspended matter falls quickly to the bottom and the supernatant liquor remains clear.

But if the volume of water displaced is large and confined in a deep, narrow chamber with perpendicular walls, the rising currents of water do not have such favorable conditions for escaping between the particles of sludge. As a result, the rising columns of water get tangled up with the descending blanket of sludge, work through the blanket slowly and keep the solid particles suspended for long periods of time.

The efficiency of settling activated sludge, then, is not governed as much by the distance which the sludge has to fall as it is by the relation between the area over which the sludge can spread out, the amount of sludge entering in a given time and the velocity at which the mixed liquors enter.

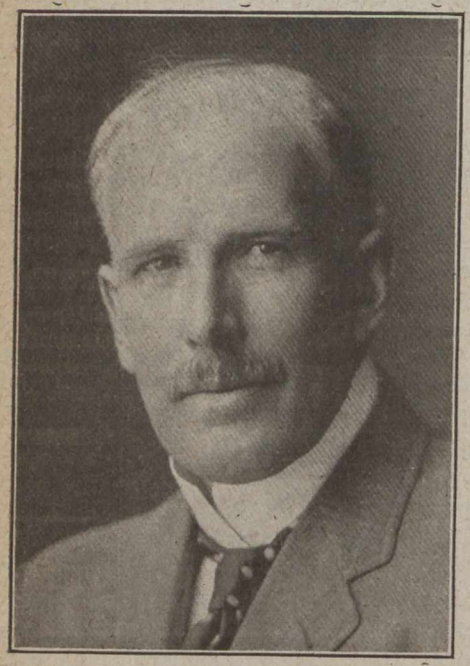
PERSONALS

A. W. ROBERTSON, contractor, of Montreal, has joined the board of directors of the Capital Trust Corporation, Limited, Ottawa.

R. G. EDWARDS, of the Canadian Pacific Railway Co., Co., has been appointed assistant superintendent of the Windsor subdivision.

J. R. CASWELL, of the Canadian Pacific Railway Co., has been appointed division engineer, replacing Mr. Silliman, who has resigned.

HON. CHARLES ALEXANDER MAGRATH, chairman of the Canadian section of the International Joint Commission, and Fuel Controller of Canada, whose duties were recently increased by his appointment as Director of Coal Operations for Nova Scotia and New Brunswick, was born April 22nd, 1860, in North Augusta, Ont. He was educated privately and became a provincial land surveyor for Ontario, Quebec and Manitoba, and later a D.L.S. and a D.T.S. Not long ago he was elected a member of the Engineering Institute of Canada. Mr. Magrath went to the North-West Territories in 1878 and practised surveying there for seven years. He was land agent for the Alberta Railway and Coal Company and became prominently identified with development work as manager of the Canadian Northwest Irrigation Co., operating extensive irrigation works in southern Alberta. Mr. Magrath represented Lethbridge in the Provincial Legislature from 1891 to 1902, being elected twice by acclamation. He sat in Mr. Haultain's administration without office from 1898 to 1901. In 1908 he was elected to the House of Commons as representative for Medicine Hat, but was defeated in 1911 on account of his opposition to the Taft-Laurier reciprocity agreement. In November, 1910, he was appointed permanent chairman of the conservative caucus of the House of Commons. Mr. Magrath is the author of "Canada's Growth and Some Problems Affecting It" (1910), and of a number of articles and lectures on western problems and on international relations. He was among those selected to represent the House of Commons at the coronation of King George in June, 1911. He has been Fuel Controller of Canada since the creation of that office in June, 1917. He has been chairman of the Canadian section of the International Joint Commission since January, 1915, and a member since the organization of that body in 1912, and in that capacity, as well as in connection with the fuel control problems, he has rendered conspicuous national service.



LIEUT. H. N. DARLING, who went from Toronto with the C.P.R. Battalion of Railway Construction, has received a bar to his Military Cross.

M. W. BARD has been appointed acting superintendent of the Farnham Division, C.P.R., in place of J. B. Blair, who has been transferred to the position of superintendent of the Montreal Terminals Division.

RICHARD WRIGHT, who has been assistant chief architect of the Public Works Department, Ottawa, for some years past, has been promoted to be chief architect. Mr. Wright takes the place vacated by E. L. Horwood.

JOHN COYLE, who for nearly ten years has been manager of the Dominion Equipment and Supply Co., of Winnipeg, has organized a new firm in that city to handle new and used equipment and machinery. The firm will be known as the John Coyle Co., with offices in the Curry Building, 208 Notre Dame Avenue.

OBITUARIES

WILLIAM KENT, a well-known authority on the properties of structural iron and steel, died September 18th at Gananoque, Ont. He was the author of "Kent's Mechanical Engineers' Handbook" and of several other books dealing with mechanical engineering subjects.

MAJOR ROSS CAMERON, formerly sales manager of the William Hamilton Co., Ltd., of Peterboro, Ont., was killed in action about August 30th. Major Cameron was born in Peterboro, and was connected with the William Hamilton Co. throughout his business career of about eighteen years. He left Canada as a lieutenant with the 39th Battalion, and after that battalion was broken up, he was appointed as instructor in a reserve battalion in England, and in that work won his captaincy and majority, becoming second in command. Early this year he reverted to captain in order to go to France. Major Cameron's only brother is also at the Front.

MAIN DRAINAGE AND ITS RELATION TO RIVER AND HARBOR FRONT IMPROVEMENTS

(Continued from page 302)

By this new plan the commission agreed to pay the amount estimated by the lowest reliable bidder on a unit price bid, plus a fee of $12,000, which will be increased by 25 per cent. of the saving over the estimated cost and decreased by 10 per cent. of any amount that the work costs more than the agreed estimate.

Bids were closed on August 22nd, and the contract awarded on an estimated cost by the low bidder of $108,600, not including the fee.

Where river and harbor front improvements are needed, experience has demonstrated that an adequate system of main drainage must be provided which will take care of nuisances due to the discharge of the raw sewage at improperly located outlet.

This can generally be secured by intercepting sewers collecting the flow from the sewers installed during the early life of the community.

The design of these interceptors may involve special problems of diversion and pumping, as well as estimates of future population and sewage flow and consideration of sewage treatment.

The designs should be made on the basis of a comprehensive study as soon as conditions permit to ensure that lateral sewers will fit in with the final project without increasing the expense of the latter unduly.