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The Canadian Engineer

An Engineering Weekly

THE FINAL COMPLETION AND OPERATION OF THE LOS ANGELES AQUEDUCT.

The Los Angeles aqueduct, which for the past eight years has been under construction, is now nearing completion. Late in February the system should be completed and ready for operation. The enterprise has excited international attention; first, because of its magnitude; second, by reason of the unusual difficulties of operation which have been overcome; third, that with the exception of one comparatively small contract, all the work has been done by the municipality itself; fourth, that it is a public work which will be completed in advance of the time for which it was promised and at a cost well within the original estimate; fifth, the great economic value of the water for irrigation and domestic use and the development of hydro-electric power. In the following paragraphs each of these features will be discussed briefly, the object being to give a general description of the whole work, the economies of construction which have been worked out on a large scale and the economic importance of the enterprise to the whole of Southern California.

Interior of Elizabeth Tunnel.

(Photograph taken 2½ miles within the tunnel. Point of light in centre of picture is north portal of the tunnel)

The city of Los Angeles, a municipality of 400,000 population and growing at the rate of 40,000 per year, in 1904 was confronted by a diminishing water supply, at present obtained from the surface and subterranean flow of a stream called the Los Angeles River. No municipality has greater need for an abundant water supply, for it is situated in a semi-arid region where the average precipitation does not exceed 15.67 inches annually and no rain falls from April to the last of October. The per capita consumption of Los Angeles is 140 gallons daily; the daily per capita consumption of London amounts to only 28 gallons.

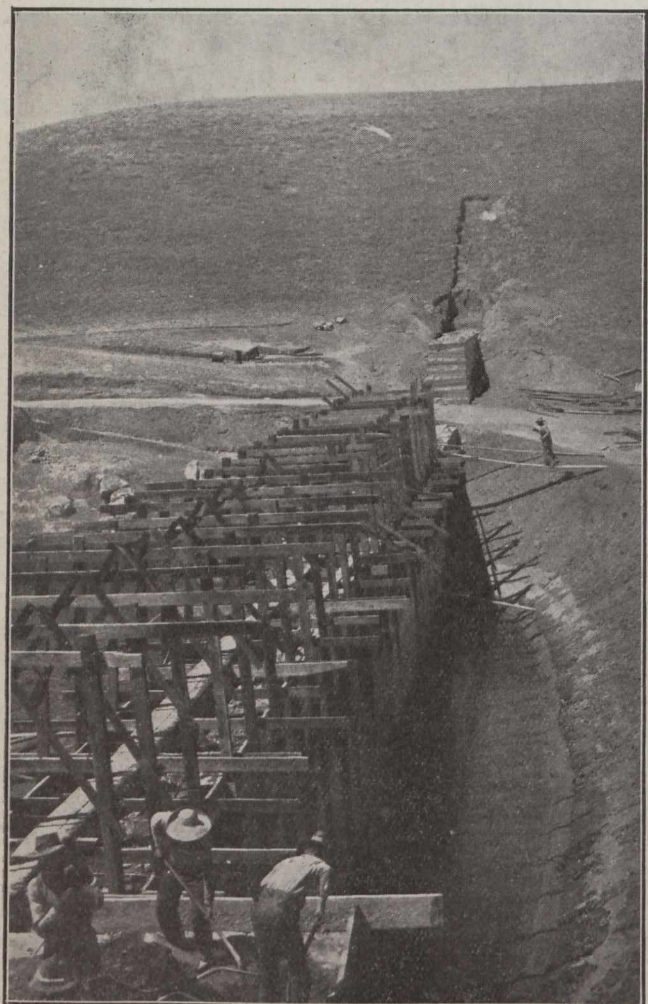
After federal and Los Angeles engineers had investigated the conditions for a period extending over several years, the nearest adequate source of supplementary supply was found to lie in the Owens River, a stream draining the eastern face of the Sierra Nevada Range which forms the roof-shed of the United States. To this source the city has gone. Purchasing 120 square miles of territory in the Owens Valley and with the active co-operation of the United States government in the way of public lands and helpful legislation, Los Angeles has undertaken to carry a daily supply of 280,000,000 gallons from this source into the Fernando Valley, at the mouth of which the city is situated.

To accomplish her purpose the city is constructing a concrete aqueduct across the great Mojave Desert and under the Coast Range (Sierra Madre) of mountains. The aqueduct is reinforced by an extensive system of storage and regulating reservoirs. The length of the aqueduct from the intake to the impounding reservoir at the outlet is 234 miles. From the latter point the water will be distributed for irrigation or carried 10 miles further through steel force mains to be connected with the city's present waterworks. The system is gravity throughout. The intake is 3,812 feet above sea level; the outlet of the lowest reservoir is at elevation 1,020 and the elevation of the Los Angeles city hall is 276 feet above sea level. The total estimated cost of the aqueduct proper, exclusive of other features yet to be discussed, is $24,500,000. This, in a word, is the Los Angeles aqueduct, or, as it is quite popularly known, the Owens River project.

The economic value of the aqueduct lies in the fact that it will provide domestic water for 1,000,000 people; through a municipal irrigation system irrigate 135,000 acres of land surrounding the city, and from its 1,500 feet of fall develop a maximum of 120,000 horse-power of electrical energy, for which funds have already been partially provided.

The foregoing briefly explains the impelling motives of the city in undertaking a work of such magnitude and the ultimate possibilities of the project. It is similar to the Panama Canal in that it is without a parallel in history.

It must be remembered that Los Angeles, to accomplish her purpose, went into a naked desert and among high and desolate mountains—a country practically devoid of habitation, fuel or water. The work of preparation in point of the spectacular outrivals the actual construction.



Building the Concrete Core-Wall of the Fairmount Reservoir.

Only the bare outlines can be given here, but the preparatory features included the construction of a standard gauge steam railroad 142 miles in length by the Southern Pacific Railroad Corporation, which secured thereby the hauling of the 20,000,000 ton miles of freight; the building of 315 miles of mountain roads and trails costing 260,000; the installation of three water systems comprising four reservoirs and 150 miles of mains at a cost of $350,000; the building of a municipal copper line of telephone system with 460 miles of lines and costing $75,000; the erection of three hydro-electric power houses and 268 miles of high-tension transmission line to furnish motive energy and light along the aqueduct zone at a cost of $450,000; the construction of a large number of structures of all classes and description for men, animals and machinery; and, finally the purchase of clay and limestone deposits and the erection of a municipal Portland cement mill with two auxiliary tufa grinding mills at a cost of $800,000. A little over $4,000,000 was expended before the work of aqueduct excavation was even started.

Since June of 1909, the excavation has continued at a rate exceeding 50 miles per year. To-day the excavation totals 220 miles. (This is approximate on the date at which I write—December 7th). Much of it has already been tested wherever water has been obtainable, and while no official date has been set for the dedication of the work, March 1st should see the finishing touches completed.

A tabulation showing the classification of the work, together with the total footage, is as follows:—

Classification.	Total footage.
Tunnel	42.69 miles
Power tunnel	9.23 "
Open unlined canal	21.14 "
Open lined conduit	39.56 "
Concrete-covered conduit	97.72 "
Haiwee By-Pass	1.92 "
Siphons (steel and concrete)	12.06 "
Flumes	.17 "
Power penstock	.44 "
Other power construction	.30 "
Reservoirs	8.5 "
Total length of aqueduct system	233.73 miles

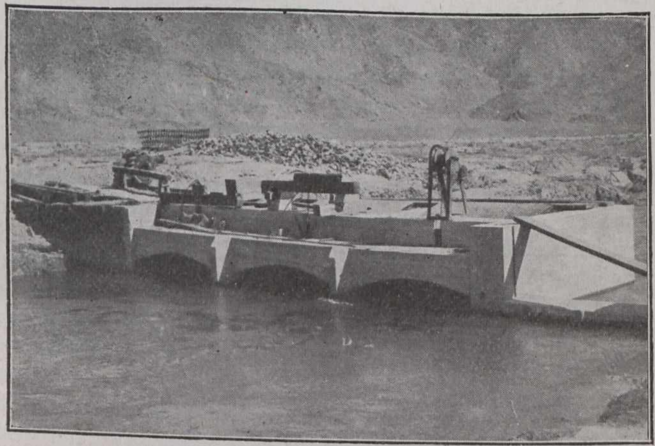
The original design of the aqueduct, if the power was not developed, called for the use of the natural bed of the San Francisquito Canon for a distance of about 12 miles. Owing to the large asset in the power feature, hydro-electric power is to be developed simultaneously with the completion of the aqueduct so that instead of being permitted to follow the stream channel the water will be carried along the rim of the canon. This construction has been denominated as "Power" in the above classification and has been undertaken conjointly by the aqueduct and power bureaux, each bearing their pro rata of the expense. Denominated as "Division No. 14," this work was left to the last, as bonds for power construction were not voted until late in 1910. Otherwise the aqueduct might have been completed some months earlier than the date now set. Construction on this section was begun in August of 1911 and the last of the tunnels should be excavated shortly after the first of the year.

The system of reservoirs which is now under construction is one of the largest in existence. The Round Valley reservoir, with an impounding capacity of 340,890 acre feet, which will be situated 50 miles above the intake, will not be constructed until after the aqueduct is in operation. It has been designed solely for the storage of heavy years of precipitation as a safeguard against years of drought. The other reservoirs of the system are under construction and are as follows:—

Name.	Acre feet.
Haiwee	63,800
Fairmont	7,620
Dry Canon	1,325
Fernando (Lower)	25,000

Of the foregoing the Dry Canon reservoir is completed, the Haiwee is practically completed, while the Fairmont and the Fernando are well under construction. The dam of the Lower Fernando will be 700 feet wide at the base, 7,320 feet in length, 130 feet in height, and the fill amounts to 2,700,000 cubic yards. It is being built by sluicing and exclusive of the Gatun dam of the Panama Canal, will be the largest hydraulic filled dam in existence. This reservoir is at the terminus of the aqueduct and is calculated to afford four months' supply for one million population. Two other large reservoir sites have been surveyed as a part of the general plan of irrigation, but no work has as yet been undertaken on their construction.

The most important phase of the work, in fact one of the controlling factors in the completion of the aqueduct, was the Elizabeth Tunnel. This tunnel was "holed" March 1st, 1911, nearly a year in advance of the estimated time required for its excavation. This tunnel, the second longest water tunnel in the United States, was driven 26,870 feet through the hard gneiss rock of the Sierra Madre range in



The Intake of the Los Angeles Aqueduct, Eleven Miles North of Independence, California.

the short space of 1,240 working days. The average rate of progress from each portal was approximately 12.36 feet per day. United States tunnel records were repeatedly broken, that of 449 lineal feet in a thirty-day month from a single heading being advanced to 604 feet for the same interval. The work was carried on continuously in three eight-hour shifts from opposite sides of the range, the excavation being accomplished with Leyner drills driven by compressed air, and the muck handled by electric motor railways. Throughout the task, the work, excepting at the very start, when crude methods were adopted until the arrival of proper machinery, the most modern electrical equipment was used. The underground and surface forces at each portal averaged 100 men throughout the drilling. From the north portal the progress was made exceedingly difficult by water pockets and swelling earth, and heavy timbering was required. From the north portal 13,500 feet were driven and from the south portal 13,370 feet. The centre lines of the tunnel met within 1⅛ inches and the grades checked to five-eighths inches. The estimate of cost for the completed tunnel was $75 per lineal foot, or $2,015,250. The actual cost of boring and concreting has been $50.69 per foot, or a total of $1,362,040, which is $653,210 below the amount set aside for the purpose. Concreting is now nearing completion.

Including the construction of the Elizabeth Tunnel, the tunnel work of the aqueduct until the first of this year has progressed at an average rate of one mile of tunnel excavation per month.

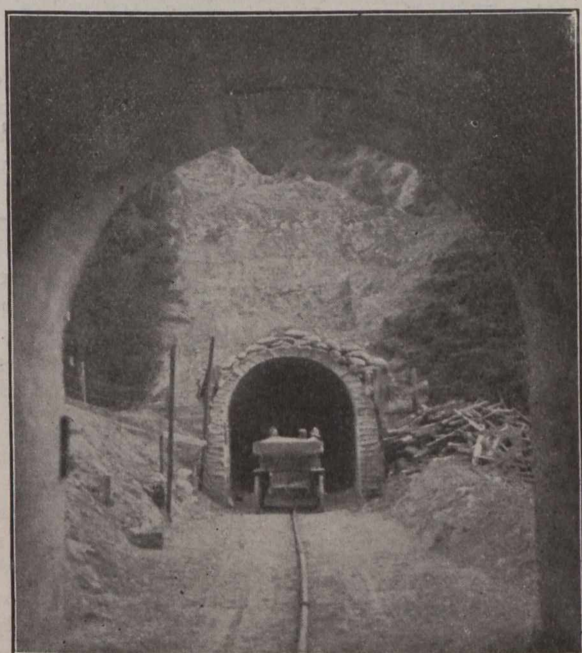
The mechanical excavating equipment for conduit and canal excavation consists of two powerful electric dredges which have now completed their work in the Owens Valley, 13 steam and electric power shovels and one giant excavator. The labor force has ranged from 2,500 to 4,300 men, during the summer season it being difficult to obtain laborers who were willing to go out on the desert.

The hospital department, as well as the commissary were let by contract, the city receiving no financial return and having the privilege of terminating the contracts upon 30 days notice if the city's standard of board, medical and sanitary care of men and camps is lowered. The men pay $1 per month for medical attendance and board is furnished at the rate of 30 cents per meal. Rates of pay for day labor have ranged from $2 to $2.75 for eight hours' work, depending upon the labor market as well as the character of the labor. Miners and mechanics have received from $3.50 to $3.75 for eight-hour shifts and formen $3.50 to $4.50 per day.

With the exception of one small contract representing three per cent. in point of distance and which was in easy construction, all the work has been done directly by city forces from engineers down to day laborers.

On this work, also, the city of Los Angeles for the first time in American municipal history inaugurated the bonus system of payment. Its success surpassed the most sanguine expectations of the city's engineers. Whether it is in conduit excavation, concrete lining, tunnel boring, siphon building or whatnot, the chief engineer sets as a basis of bonus payment, dependent upon the classification of the particular piece of work, the average progress that should be made by the crew or gang in a ten-day period. For all in excess of this amount, each man participating in the work, in addition to his daily wage, is paid an established sum proporportionate to the progress made. On the Elizabeth tunnel, for example, miners were accustomed to receive monthly pay-checks which, with their bonus, ranged from $140 to $170, and muckers and other laborers' checks were in proportion.

This system has brought out the best that was in every man because, in the hope of personal reward, there has been an incentive for him to do his best. Moreover, it created a rivalry between each of the fifty camps and brought an organization of unusually high efficiency. As drones retarded



Showing Completed Tunnels.

the work, delayed progress and so cut down the bonus payment, the workers of their own accord drove out the drones. The working out and development of the system has excited a great amount of interest from engineering publications, engineers and municipal officials throughout the United States.

Another phase of unusual municipal activity in connection with this enterprise has been the building and operation of cement mills and the introduction and use of tufa cement. In this phase of the undertaking, $875,000 of the public funds were expended. The Portland cement mill was erected at Monolith, close to the line of the aqueduct, about equidistant from the intake and outlet, adjacent to large deposits of limestone and clay and with transportation facilities that have reduced freight rates to a minimum. This mill was first fired in March, 1909, and with a capacity of 1,000 barrels per day, to January, 1, 1912, had ground 575,000 barrels.

It was found that at Monolith and two other points in close proximity to the aqueduct line there were large deposits of tufa strikingly similar to the Italian tufas used in

Building a Concrete Siphon.

the construction of the Coliseum and the Roman aqueducts. Tufa is a volcanic ash metamorphosed by volcanic heat and water into a white, brittle, porous rock. A year of tests and experiments demonstrated that an excellent cement could be manufactured by taking equal amounts by volume of Portland cement and ground tufa and regrinding them to a fineness of not less than 90 per cent. passing a 200 mesh screen. The seven-day test shows to the advantage of the Portland, but after that the tufa cement surpasses the Portland in breaking strength and at the end of one year, exceeds Portland by about 20 per cent. In 1909-10, therefore, tufa grinding mills with an aggregate daily capacity of 2,600 barrels were erected on the sites of the deposits.

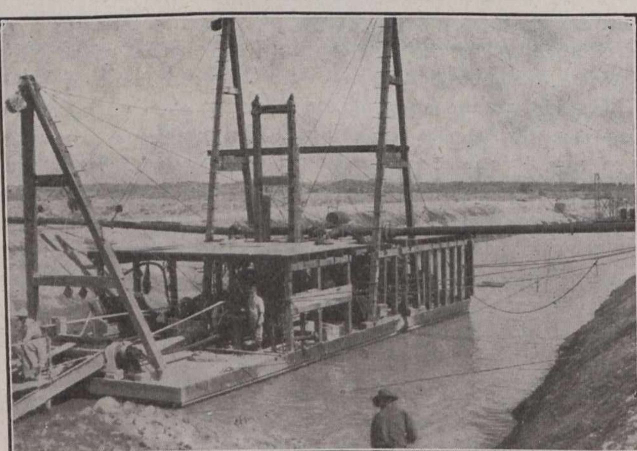
The advantage of this municipal move will be seen in a comparison of cement prices. At the time aqueduct work was started, commercial cement sold in the Los Angeles market at $2.25 per barrel. The city has been able to manufacture her own Portland cement at a cost of approximately $1.30 per barrel and the tufa cement at from 83 cents to 86 cents per barrel, besides reducing freight charges fully fifty per cent. by having two of the tufa mills directly on the aqueduct where the material was to be used. Now that the aqueduct is nearing completion the tufa mill machinery will probably be disposed of to the federal government, while it is possible that the Portland mill may be retained to furnish cement for other large public works now underway.

At the time this is being written, the most interesting phase of construction is the fabrication of the inverted steel siphons by which the waters of the aqueduct are to be carried across canons and valleys. So far as the writer knows, these huge steel pipes are the largest and longest in existence. They range in length from 611 to 15,596 feet, and in diameter from 8 feet 6 inches to 11 feet. The thickness of the steel varies from one-fourth inch to one and one-eighth inches. The aggregate length is 49,576 feet, the cost of which installed represents an expenditure of $1,400,000. The total tonnage amounts to 14,500 tons. These siphons will be under heads ranging from 75 to 450 feet.

The siphons are all of single plate construction. The material is furnished under contract and the work of erection is performed by the city. No foundry on the Pacific Coast was equal to the magnitude of the task. The plates are therefore rolled, punched and bevel-sheared, under the eyes of Los Angeles inspectors, in the steel foundries of Pittsburgh, Pa., and Camden, N.J. There they are erected section by section, given a number on a diagram showing the exact location of every plate and rivet hole in the completed structure, are then taken apart, nested on flat cars and dispatched to the railroad station nearest the point of their destination on the Mojave Desert. From here they are freighted by twelve mule team wagons from 5 to a maximum of 30 miles to the point of erection where the diagrams have already preceded them. Here they are lifted by aerial trams to their place along the canon wall and are riveted into place. Twenty-four-inch double disk gate valves are placed at the lowest points of the siphons, first, for cleaning purposes, and secondly, to divert the flow of the aqueduct into natural water channels should a break occur in the conduit high along the mountainside to the south of them. This work is proceeding simultaneously at seven different points and should be completed during the second week in January.

Where the head is low, concrete siphons are used in place of steel on account of the cheaper cost. These pipes, used also in the approaches to the steel siphons, are 10 feet in diameter, strongly reinforced with steel and constructed of very rich cement. The illustration shows the manner of reinforcing.

For the partial development of the hydro-electric power, the city voted $3,500,000 in the spring of 1910. While the aqueduct is being built primarily for a domestic water sup-



One of the Hydraulic Dredges at Work Near the Intake of the Aqueduct.

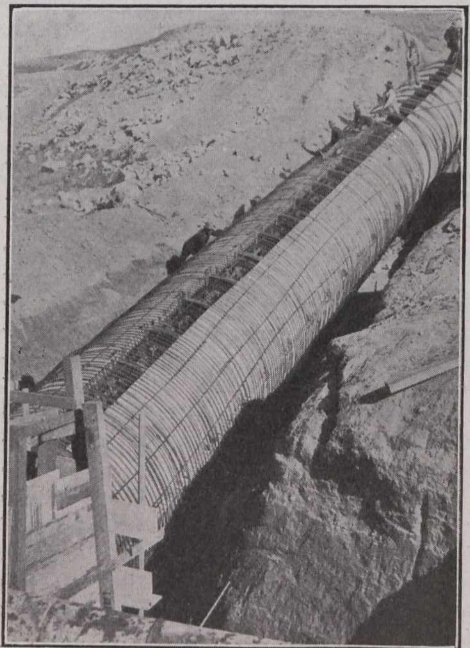
ply this feature in point of revenue is by far the most important. The Board of Electrical Engineers reported in 1910 that a maximum of 99,000 kilowatts, or 120,000 horse-power, can be generated from the aqueduct with all conditions present for reliability of service and favorable low costs of operation. Owing to the regular and assured flow through the aqueduct, they reported that in their opinion no reserve steam plants are necessary and that from this and other favorable conditions, one of which is that the major part of the electric energy can be developed in close proximity to the city, the cost delivered at the Los Angeles city limits will not exceed $60 per horse-power. This is much less than the cost at which hydraulic power is at present developed on the Pacific Coast.

The plans call ultimately for the operation of seven power houses, two of which, Division Creek and Cottonwood, are now in service as construction plants.

These plants are as follows:—

Name.	Maximum net head.	Kilowatts at switch-board max. flow max. head.	Length of transmission line to Los Angeles.
Division Creek	1,216	600	225
Cottonwood, No. 1	1,218	1,500	185
Cottonwood, No. 2	2,065	2,500	190
Haiwee	182	4,590	162
San Francisquito, No. 1...	905	51,750	47
San Francisquito, No. 2...	512	32,900	40
San Fernando	281	7,225	21
Los Angeles sub-station		90,000	

(11 per cent. transmission loss, including step-up and step-down transforming).

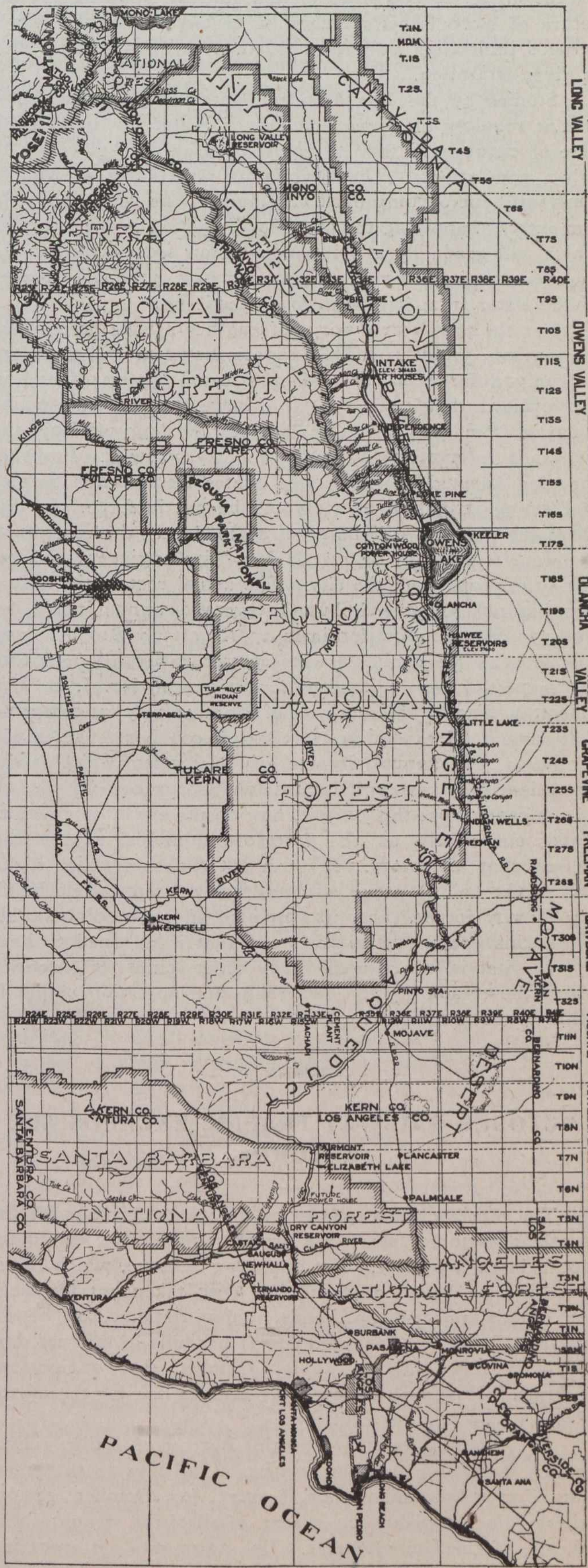


Constructing One of the Concrete Siphons.

Plans for the partial development of power house No. 1 in San Francisquito canon are now ready for the construction department. Contracts have been let to the Union Iron Works and the Westinghouse Company for machinery to cost $300,000 with delivery to be completed by January 1st, when the buildings will be ready to receive it. This plant will have a capacity of 37,500 horse-power and is scheduled to be complete and ready for operation in April of 1913. Other units of power will be installed as a market for the product develops.

Whether the power will be disposed of to the Los Angeles power companies at a wholesale rate or a $5,500,000 distribution system built by the municipality remains to be voted upon by the people, whose attitude at the present time is strongly in favor of the latter alternative.

Irrigation, the last subject to be discussed, is second only to power development from a financial standpoint. It must be kept firmly in mind that Los Angeles lies within a semi-arid region, where land values are directly proportionate to the accessibility of water for irrigation. This is shown by the fact that lands which will be watered by the aqueduct,



Map of the Los Angeles Aqueduct and Adjacent Territory.

as dry land sold from $20 to $50 per acre seven years ago and to-day are being sold from $350 to $500 per acre.

Approximately 225,000 acres of land for which little water is now available lie within a radius of 30 miles of the municipality. The surplus waters of the aqueduct will supply irrigation for 135,000 acres of this amount, allowing for the return of 2,000 miner's inches by seepage into the city's present infiltration galleries, provided the Fernando Valley is given irrigation.

Studies by the Los Angeles Water Department show that it requires the same amount of water to irrigate an acre of citrus trees that is required for an acre given up to urban population. The city, in its remarkable growth, is constantly encroaching on urban lands. The very nice problem enters of applying the water for irrigation in the localities which will gradually and insensibly grow from suburban into urban territory with the accompanying gradual transfer of the water from irrigation to domestic use.

For the past year a corps of engineers have been working on this problem. The irrigation system will therefore probably differ from the concrete canal systems found in California in that it will consist of large steel pressure mains ranging from 4 to 6 feet in diameter leading off from the Fernando reservoir to water the country below it. Probably the plan adopted by the United States Reclamation Service of forming irrigation districts will be put in force. In this event the districts will be required to defray the cost of all the work which will be installed by city engineers and become the property of the city. The actual cost to the irrigators has not been fixed, but the average annual rental for water in Southern California is approximately $10 per acre.

With all the available water power developed and with the surplus water disposed of for irrigation, Mr. J. B. Lippincott, assistant chief engineer of the aqueduct, has computed that for a total expenditure of $31,500,000 Los Angeles will receive a net annual income of $4,425,000, which is the equivalent of 5 per cent. interest on $88,500,000.

In conclusion, this project, now on the eve of completion, stands out clearly as the foremost municipal engineering achievement of history. It is an enterprise of which a nation might well be proud. In its large conception, its building by city forces, and its promise of large economic returns, this project certainly is one that is destined to have a very vital influence upon many other cities of America where the clamor for the ownership and operation of public utilities grows constantly louder.

OCTOBER RAILWAY TRAFFIC EXCEEDS ALL RECORDS.

The receipts and expenses of the steam railways for the month of October, 1912, are greater than for any other month in their history. Net operating revenue, which is the gross income before anything has been taken out for taxes and rentals, interest on bonds, appropriations for betterments or dividends, averaged $15.71 per mile of line per day, which contrasts with $13.74 for October, 1911, an increase of $1.97. This is an increase per mile of line for the month of $61.13, or 14.4 per cent.

The monthly summary of the Bureau of Railway Economics, compiled from the reports of railways to the Interstate Commerce Commission, covers for October 220,636 miles of line, or about 90 per cent. of all of the steam railway mileage of the United States. The aggregate net operating revenue for this mileage was $107,440,518, which is greater by $14,870,125 than that for October, 1911. The increases were due in greatest proportion to the freight traffic, which is always greater in October than in any other month of the year.

GOOD ROADS IN ALBERTA.*

By J. D. Robertson.†

The Local Improvement Organization, and works, done under this organization, have not, in all cases, been satisfactory. Many reasons have contributed to this, one being that the works facing such organizations were of such a character and magnitude that the funds at their disposal were not sufficient to cope with the situation. Another cause has been the fact that earth roads, when once built, in many parts of the Province require so much in the way of maintenance that little of value has been accomplished. The system of commuting taxes by labor has not, in my opinion, contributed much to the improvement of roads, but instead established a system which, while necessary in the new and sparsely settled districts, has frequently been continued after settlement was more dense, when vastly better work could have been accomplished by collecting the money and employing some capable man as foreman to conduct the work under the direction of the Council. The system of each Councillor having charge of the expenditure of all money in his particular division or township, regardless of main road requirements, without any comprehensive plan approved by the whole Council, has resulted in disconnected pieces of works here and there without much continuity of purpose.

Another matter might also be mentioned, which has not, in our opinion, contributed very largely to the improvement of roads, is the fact that the rate of assessment may be placed at anything from one and one-quarter cents to five cents per acre. We find certain districts, since their organization, assessing to the limit, while others, in which works are quite as necessary, assessing at the lowest figure, or very close to it. In other words, one man will pay $8, local improvement taxes, on one quarter section, while perhaps his neighbor, who is using the same roads, is paying only $2 per quarter section, which, to our mind, is certainly not just, and it is noted, in sections of the country where only the one and one-quarter cent per acre or $2 per quarter is levied, they are quite as persistent in their requests for Government assistance as where they are assessing themselves to the limit. Under such conditions the Local Improvement Organization could not be expected to receive the hearty co-operation of the Department that it deserves. It is to be hoped that some of these difficulties and drawbacks will be removed under the Municipal Organization, where such is put in force, and also under the re-organization of Local Improvements Districts, where municipalities are not formed. It should be mentioned here that, while certain districts have been handicapped by the difficulties mentioned above, others have taken the best out of the Act, under which they are working, and have achieved very satisfactory results. In conducting work for the Government, on the improvement of roads, we are well aware of the many difficulties to be contended with, and it is to be hoped, when another year's work is begun, that we may have an even more hearty co-operation with the new organizations than it has been possible to have under the old regime. In most of the Province the building of permanent highways is still in the distance, and, for this reason, I am going to confine my remarks to the more primitive works.

Grading Earth Roads.—The fact should always be borne in mind that water from melting snow or ice and rain is the principal factor against which we have always

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* Address delivered before Alberta Local Improvement Districts Association, Edmonton, Alta., November 26th and 27th, 1912.

† Provincial Engineer of Highways of Alberta.

to contend in the construction and maintenance of earth roads, water on the surface causing clay or loam roads, even under light traffic, to work up into an impassable condition, and, during long continued wet weather or under heavy traffic, such roads will always be bad, though their unsatisfactory condition may be minimized greatly by first building them up to a rounding surface with grader, then maintaining their surface by frequently dragging to fill ruts, caused by wheel traffic, so the water will run off instead of lodging in them and soaking into the road, causing the mudholes so often encountered on earth roads. The split log drag, or several types of similar implements working on the same principle, have been found very effective and economical in maintaining such roads, costing about one-third as much as a blade grader to trim up rutted roads, and, in many cases, doing quite as efficient work. In many parts of the Province the heavy clay loam, so desirable for agricultural purposes, is a most unsatisfactory road material, will not carry heavy traffic when dry, and absorbs water freely in wet weather, with the result that such roads go to pieces. In some parts of the Province gravel is available for top dressing, and, when within a reasonable distance, makes a great improvement for a time, but soon works down into the clay, when the process must be repeated. A top dressing of sand has been experimented with on heavy clay roads and found to give very satisfactory results, but this, like the gravel, soon becomes mixed with the clay, when another coat of the same material is required. Frequently neither gravel or sand are obtainable within a reasonable distance, and are sandy or gritty subsoil, frequently found and exposed by the ditches along roads, generally upon hills or slight elevations, provides a top dressing far superior to the natural clay loam, some of it packing and binding very satisfactorily under wheel traffic, and forming a roadbed quite impervious to water, and since macadam and the many types of asphalt are probably, owing to their cost at the present time, out of our reach, a great improvement might be made on country roads by making the best use of material available.

Draining to Prevent Seepage of Water from Side Ditches Into the Roads.—This, in many places, is of more importance than raising the road by grading, and frequently costs less. It will be noticed, where pools of water are allowed to lie in the ditch alongside of roads, that the road frequently breaks down into impassable mud holes. This is caused by the seepage of water into or through the road bed. In many cases such water can easily be drained along the side of road, or away from it, at a less cost than fixing the mud holes by raising the road after the water has caused the damage. Grading the bottoms of ditches, so water will drain off, is quite as important as grading the surface of road, but, considering that it is a common practice all over the Province to pasture cattle on the road allowance, where the ground is soft and ditches necessary, they are soon tramped in, damming up water and undoing the work that has cost large sums of money. If the owners of cattle, grazing on the roads, were compelled to repair the damage done by them, in wet country where drainage is necessary, the revenue for road improvements might be considerably increased. Considerable damage is also done tramping down the approaches to bridges and culverts, and I never knew of it occurring to the owner of a large or small herd of cattle, that anyone but the public should contribute to the improvements made necessary by his grazing them on the roads. Of course, in certain parts of the country, where there is vacant or unfenced land, it is difficult or impossible to prevent such damage, though in other parts, where well fenced, the highway is considered a convenient public pasture. Proper ditching, on hills or hillsides to carry off the water and prevent it running down the wheel tracks and destroying the road in many parts of the country, receives but scant attention. I have observed many hills, where a road had been well constructed and properly ditched, where immense damage had been done by water running down upon it, when a few dollars spent keeping the drains open would have avoided considerable loss and inconvenience caused by an impassable road, and in this respect I would ask for the hearty cooperation of the Local Improvement District to keep such ditches open. Before closing my remarks on primitive earth roads, I would like to say a few words with reference to the use of brush, where such is available, for a corduroy or bottom on wet or springy ground. It frequently happened, where such is required, that nature has provided brush in the immediate locality, the very nature of the soil causing a growth of willow, and, where such exists, and frequently has to be cleared from the road, it is a good practice to use it for a brush mat in wet places, covering this again with the best material available, when a foundation will be provided for a road that should be passable even in bad weather, while, without brush or corduroy, raising a grade with the material available frequently results in simply adding to the depth of mud to be travelled through. In certain parts of the Province, where the country is wet and drainage not feasible, too much attention cannot be attached to this precaution. Another practice sometimes followed is to grade roads through low wet ground, sloughs and potholes, during dry weather, without much provision to drain the water off, when it turns wet, or, at least, to control it so it will not rise over the road. Large amounts of money have been spent grading such roads in this Province, that were lost when the weather turned wet and the sloughs and potholes filled up with water. When it is not feasible to put in drainage, to at least control the raise of water, and the high water mark is in evidence, and money is not available to raise the grade above such high water mark, then the obstruction should be gone around, otherwise the money put into it is pretty certain, sooner or later, to be lost. There is a very general impression, in the minds of the public, that statutory road allowances, as laid out under our system of sub-division, should be followed regardless of physical difficulties, which is entirely erroneous, and results in an attempt being made to grade down impassable hills, and to grade roads over ground quite unsuitable for road purposes, that might and should be gone around. In the older Provinces the system of survey differed from ours, and the Crown reserved a certain percentage from all lands for such purposes. Our old trails, in many localities, illustrate what we might have had, in the way of roads, where the contour of the country is more generally followed. While on level prairie it is generally quite feasible to follow road allowances, the same system is quite unsatisfactory in rough or broken country, and a very sincere effort should be made to overcome the objections of the owners of lands, where such diversions are necessary so a permanent and safe road may be established.

QUEBEC STREAMS COMMISSION.

The Honorable S. N. Parent, chairman of the Quebec Water Works Commission, which has recently had its name changed to the Quebec Streams Commission and has been invested with the powers of a corporation in order to carry out its scheme of constructing a large storage reservoir on the upper St. Maurice, for the purpose of regulating the flow of that river for generating electricity, is in Quebec in connection with this work. The area of the proposed reservoir will be more than 300 square miles and the amount of water to be stored will be about 160 billion cubic feet. It will drain a basin of more than sixteen thousand square miles in area, and give a regular flow of 18,000 cubic feet per second in Shawinigan and other places.

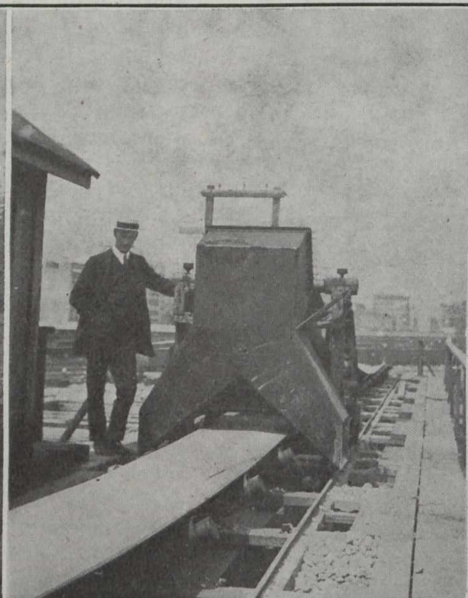
A GRAVEL SCREENING AND WASHING PLANT.

A gravel screening and washing plant built about a year and a half ago for the J. A. Dewar Company, Limited, in Vancouver, is of considerable interest from the standpoint of economical layout. The pits are located near Coquitlam, seventeen miles east of Vancouver, and the distributing plant is on False Creek in the city of Vancouver. demand for crushed stone has been in advance of the supply it was decided to crush the big stones.

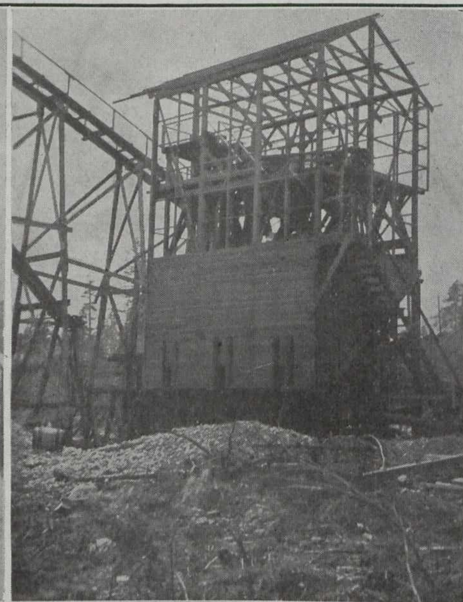
Fig. 1 shows a plan of the railroad, gravel pit and pipe line from the river. Fig. 2 shows on a larger scale the general arrangement of the washing and crushing plants and their relation to the pit and dumping hopper, also the system of extension. Fig. 3 shows the plant in the city.

The railway gives shipping facilities to Vancouver and all other points. The spur to the pit is connected to a siding along the main railway line of 1,300 feet, also to a siding of 800 feet along the gravel company's line, so that empties and loaded cars may be easily changed and switched without any interference with the railway company. The length of the gravel company's line from the railway to the pit is 1.5 miles and is on their own right-of-way. the grade averaging 1.7 per cent., the maximum being 2 per cent. for a short distance at one place. With the loading, repairing and shovel tracks, there is a total of 11,300 feet of track.

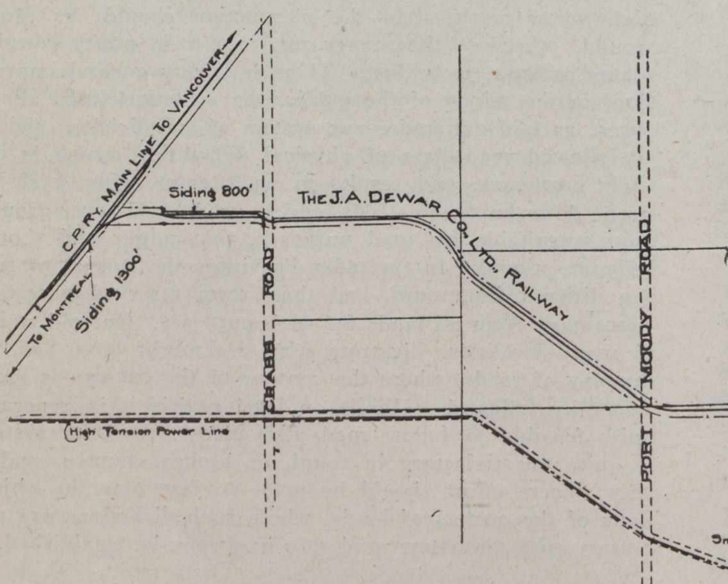
Rock Bin, Westminster Junction, B.C.



Tripper for Distribution to Bins.



Gravel Bin, Westminster Junction, B.C.



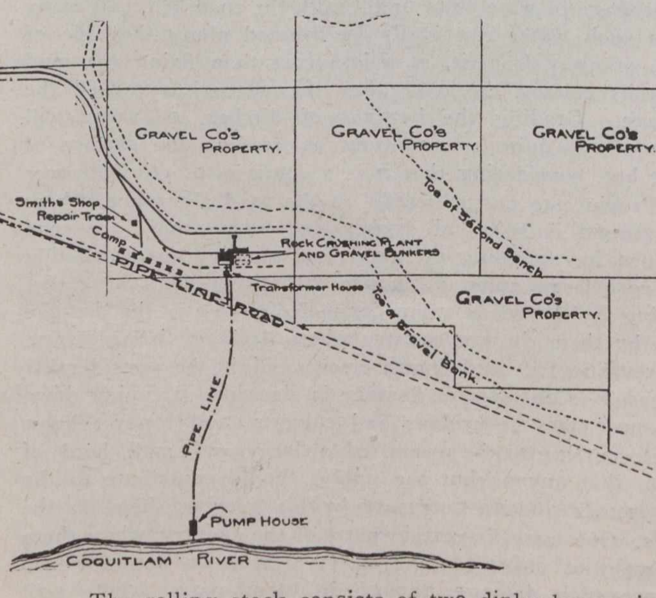


Fig. 1.—Plan of Railroad, Gravel Pit, and Pipe Line of the Gravel Screening and Washing Plant, J. A. Dewar Company, Coquitlam.

In the design and arrangement, the local demands received special consideration and although many gravel dealers brought the pit run to the machines at the city bunkers to be treated, it was decided that the place to treat the gravel was at the pit. The correctness of this decision has since proved itself.

The pit contains some 20 per cent. of stone too large for classification as gravel. It was therefore necessary to devise some means of disposing of it at slight cost or to put in an auxiliary rock crushing plant, and as of late the

The rolling stock consists of two dinky locomotives, 13 tons and 26 tons respectively, one 1½-yard Bucyrus steam shovel and 60 Hart convertible, centre bottom dump cars with a capacity of 30 yards each.

Owing to the difficulty of obtaining right-of-way on certain property, the line is somewhat sinuous but it is practically a surface line and was constructed cheaply.

The pit consists of a bank some 40 feet high above the

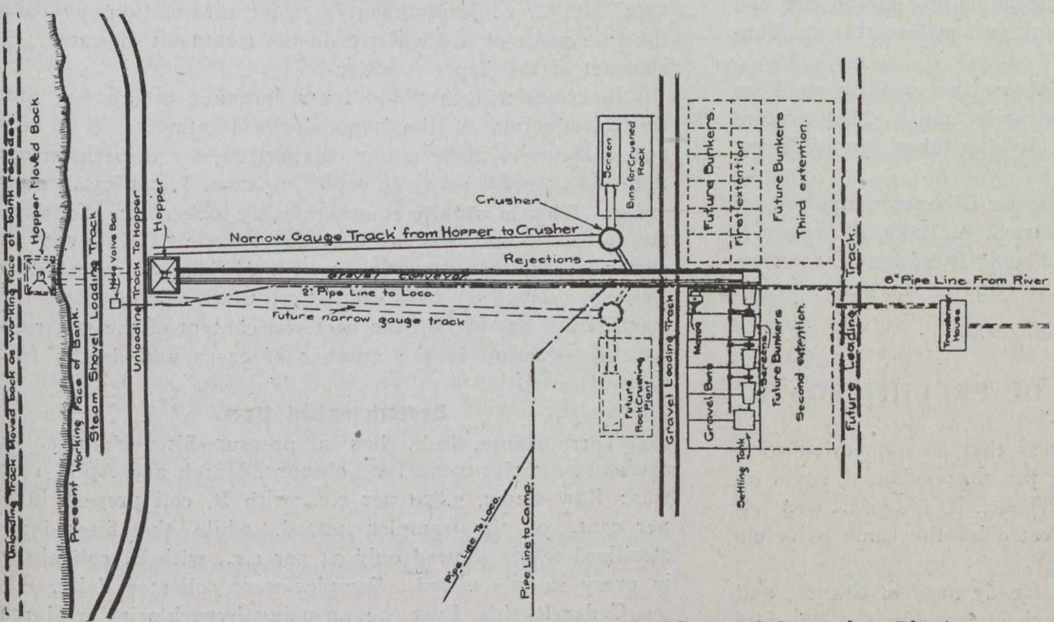


Fig. 2.—General Arrangement of the Gravel Washing and Screening Plant.

general level which gives an ideal steam shovel working face, the deposit extending over some 160 acres.

The method of operation is obvious from the layout. The steam shovel loads a 6-yard side dump car which is

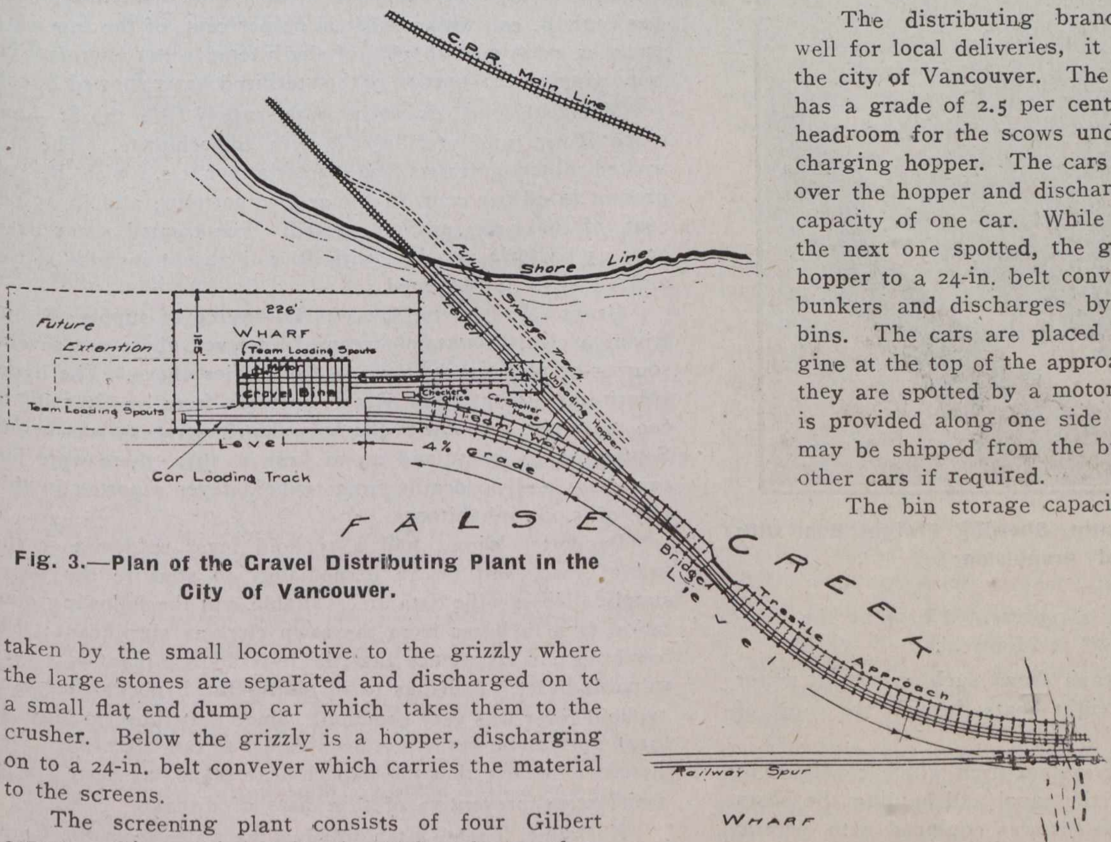


Fig. 3.—Plan of the Gravel Distributing Plant in the City of Vancouver.

taken by the small locomotive to the grizzly where the large stones are separated and discharged on to a small flat end dump car which takes them to the crusher. Below the grizzly is a hopper, discharging on to a 24-in. belt conveyer which carries the material to the screens.

The screening plant consists of four Gilbert screens, 36 in. x 54 in. x 6 ft. 0 in. (driven by a 15 h.p. motor), giving four separations 2 in., 1 in., ½ in., and sand. The sand passes through a gravity setting tank to remove the water. The rejections from the first screen pass by chute to the crusher. After being crushed they are elevated by a chain bucket elevator to the revolving rock screen which separates into three sizes, the rejections being passed back to the crusher for re-crushing.

The bunkers are arranged to discharge into the cars on the loading track alongside, the cars being pushed in by the larger loop.

As will be seen from the plan, extensions may be made to any desired capacity and the machinery duplicated without alteration or interference with the present layout. The capacity is 500 yards of gravel and 200 yards of crushed rock per 10-hour day. On the plan is shown the order of extension up to 2,000 yards of gravel and 400 yards of crushed rock.

The water used by the plant for the boilers, camp, etc., is supplied by a three stage, 4-in. centrifugal pump, located in the pump house at the Coquitlam River, a distance of 3,300 feet, and is driven by a 35-h.p. motor. The wiring is arranged so that the motor must be started from the pump-house, but may be shut down from the camp if necessary. The pipe line is a 6-in. wood pipe. Power is supplied by the B.C.E. Railway Company, at 2,200 volts, to the transformer house, where it is stepped down and fed through the switchboard to the several motors and lighting circuit at 220 volts.

The distributing branch is located exceptionally well for local deliveries, it being right in the heart of the city of Vancouver. The trestle, as shown in Fig. 3, has a grade of 2.5 per cent. on the approach to obtain headroom for the scows underneath bridge and for discharging hopper. The cars of graded gravel are placed over the hopper and discharged, the hopper having the capacity of one car. While the car is being moved and the next one spotted, the gravel has passed out of the hopper to a 24-in. belt conveyer which conveys it to the bunkers and discharges by tripper into the respective bins. The cars are placed by the C.P.R. switching engine at the top of the approach trestle, from which point they are spotted by a motor-driven car haul. Trackage is provided along one side of the bins so that gravel may be shipped from the bunkers by street railway or other cars if required.

The bin storage capacity is 1,200 yards and is arranged for team delivery. Here, again, the capacity may be increased without much alteration to the present layout, the only change being an extension to the belt conveyer and moving the conveyer head drive as bunkers extend.

Although in two branches the plant easily competes with the scow delivery usual in Vancouver, it being greatly favored by the non-liability of being held up by fogs or storms. An interesting feature at both branches of the plant is the crib type of construction for the bins, which, though not reducing the B.M. of lumber in the structure, yet allows a cheaper class of labor to be employed and requires less time for construction.

This gravel plant has been in operation 1½ years and is giving every satisfaction, both commercially and mechanically. Eighteen men are employed, including superintendent, at the pit, and two men, including checker, for the teaming at the city branch. The unloading at the city end is stated to be the most efficient and economical in Vancouver.

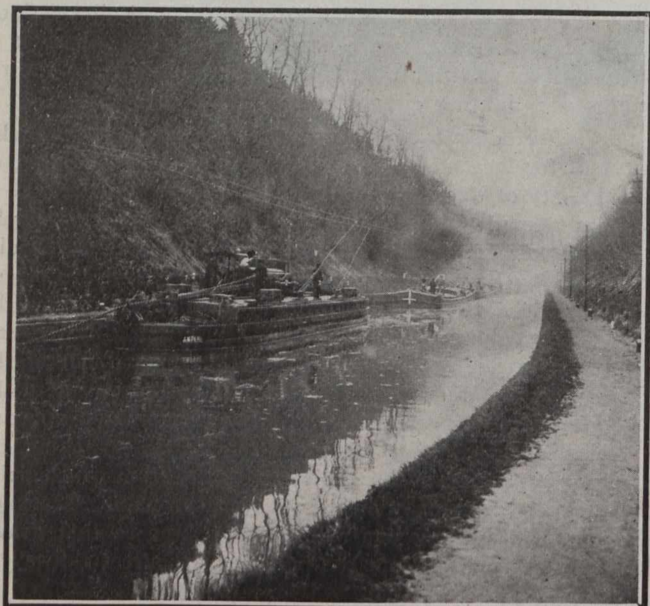
The gravel company own their own rolling stock as mentioned, also telephone system and camp. They erected the Westminster Junction plant by day labor but built the Vancouver branch by contract.

The owners are The J. A. Dewar Company, Limited, of 429 Pender Street, Vancouver. Mr. S. A. Lake, of Wilson & Lake, consulting engineers, 422 Pacific Building, Vancouver, designed and superintended the erection of the plant.

ELECTRIC PROPULSION OF FREIGHT BOATS.

It has been stated in the press that a navigation company of Montreal is considering the propulsion of boats on the Lakes. One electric motor boat, it is said, was already designed and will be operated on the same principle as an electric car.

This mode of propulsion is already used in France, and boats have been fitted out for such purpose by the "Société



View of Canal of St. Quentin, Showing Freight Boat with Electrical Propulsion.

Alsacienne"; this company is represented here by the "Engineering Works of Canada," of Montreal.

The reproduced photograph shows such an electric motor boat hauling five loaded freight boats through the canal of St. Quentin.

There was also another system tried which consisted in a motor car running along the canal and hauling the boats by means of ropes. The car was equipped with electric motors which received their power from a trolley; however, it has been found much more advantageous from every point of view to use a special boat equipped with electric motors which are mounted on the propeller shaft; the motive power is supplied from a trolley line.

This system is, of course, not applicable in the present case, but in special instances, like for ferry boats, etc., it could be used with advantage.

WHAT HYPOCHLORITE ACCOMPLISHES.

In a paper delivered before the International Congress of Applied Chemistry, held in New York City in September, 1912, Mr. C. A. Jennings gives some information regarding the true place of hypochlorite in the treatment of water. An abstract of the paper follows:—

In considering typhoid fever statistics before and after the introduction of the hypochlorite treatment, it is often very difficult to make a fair comparison, for the reason that there is a woeful laxity in reporting these statistics in many cities. This is usually conscientiously looked after following an epidemic, but seldom previous to one. However, the writer has gathered sufficient reliable bacteriological data, as well as typhoid fever statistics, to show the effect that sterilization has had on the bacterial content of the water and on the reduction in the number of cases and deaths from typhoid fever.

Bacteriological Data.

Terre Haute, Ind., has a pressure-filter plant. The average bacterial count for February, March and April, 1912, was: Raw water, 3,870 per c.c., with B. coli present in 68 per cent. of the samples tested, while the filtered and sterilized water showed only 34 per c.c., with B. coli absent in every sample tested. Samples were collected daily.

Cedar Rapids, Iowa, began using hypochlorite in March, 1912, as an adjunct to its rapid sand filters, and the results have been spectacular. During the period from March 29 to May 15, 1912, the raw water averaged 40,200 bacteria per c.c.; filtration alone showed a reduction in bacteria of 1,700 per c.c., or 95.8 per cent., while the hypochlorite treated water count was only 44 per c.c., or a total reduction of 99.9 per cent. B. coli was present in 63 per cent. of the raw water samples examined, in 36% of the filtered water samples, but not a single 1 c.c. portion of the sterilized water showed B. coli.

Montreal, Que., draws its water supply from the St. Lawrence River, and sterilizes it with hypochlorite. The untreated water averages 800 bacteria per c.c., with B. coli present in 98 per cent. of the 10-c.c. portions, and in 45 per cent. of the 1-c.c. portions tested. The treated water averages 25 bacteria per c.c., with B. coli absent in both 10-c.c. and 1-c.c. portions tested.

Grant's Pass, Ore., has, as its source of supply, Rogue River, a clear mountain stream. However, there are several sources of pollution by sewage from cities above. The hypochlorite treatment reduces the bacteria from an average of 600 to 15 per c.c. Since the hypochlorite process was begun September 16, 1911, and up to June 1, 1912, there were but two cases and no deaths from typhoid fever reported in this city of 5,000 inhabitants.

Baudette, Minn., had a typhoid fever epidemic in the fall of 1910, and began immediately to sterilize the water supply. No specific data are available, but the following quotation from a letter from the town clerk is significant: "It has been our experience that the hypochlorite plant is a very valuable asset. Previous to installing the hypochlorite plant typhoid fever was very common. Since that time (to May 30, 1912) no typhoid fever has been called to our attention. We, therefore, believe that the hypochlorite plant has been a very satisfactory preventive of this class of disease."

Nashville, Tenn., after drawing the water from the Cumberland River, coagulates it with alum and allows it to settle in large basins. It is then sterilized with hypochlorite of lime. The average bacterial content of the raw water is 3,000 per c.c., with 90 per cent. of the 1-c.c. portions tested showing B. coli present. The settled and sterilized water shows an average of only 70 bacteria per c.c., and during the year 1910 only three samples out of 1,200 tested showed B. coli present.

Danville, Ill.—Although Danville has been using the hypochlorite treatment as an adjunct to its rapid sand-filter plant for only a very short time (since February, 1912), nevertheless the bacterial data on the filtered water are very interesting. During the time that hypochlorite was used the average bacterial content of the sterilized filtered water was only 57 per c.c. During the period from March 20-25, inclusive, the supply of hypochlorite was exhausted and so none was used. The bacterial content of the untreated filtered water during this period was 4100 per c.c. With hypochlorite treatment in use Mar. 19, the count was but 20 per c.c.: on Mar. 20, without hypochlorite, the count jumped up to 8400 per c.c. The removal by filtration without hypochlorite, from the raw water averaging 67,000 bacteria per c.c., was 93.9%; by filtration and hypochlorite from the raw water averaging 52,496 bacteria per c.c., the removal was 99.89%. Without sterilization, B. coli was present in the filtered water on five of the six days; with sterilization, B. coli was present on one day out of 34. The turbidity of the raw water was so low from May 26 to June 1, 1912, that no coagulant was used and only hypochlorite added to the filtered water. The average reduction in bacteria during this period was 99.6%.

Typhoid Statistics.—A comparison of typhoid-fever statistics before and after the introduction of hypochlorite is very interesting.

North Yakima, Wash.—In 1910 there was a typhoid epidemic caused by a contamination of the domestic supply through a cross-connection with a highly-polluted fire service. During the period September, 1911, to June, 1912, there was not a single death from typhoid fever and only one case was reported between Dec. 22, 1911, and June, 1, 1912. The water sterilization began July 9, 1911. The source of supply is a mountain stream which is open to contamination. The reduction in the number of cases and deaths from typhoid fever is due in part to the general clean-up and condemnation of many polluted shallow wells as well as to the hypochlorite treatment in this booming city of the Northwest.

Council Bluffs, Iowa.—The wonderful efficiency of hypochlorite is shown by a typhoid-fever epidemic in Council Bluffs, Iowa, which began in the fall of 1909 and ended with the introduction of hypochlorite in April, 1910. Since this treatment was inaugurated, a period of 25 months to June 1, 1912, there have been but five deaths from typhoid fever in this city with a population of 30,000 and one of these five deaths was that of an imported case. This is a remarkable record. For the eight months following the introduction of hypochlorite there was not a single death from typhoid fever.

Cleveland, Ohio., draws its water-supply from Lake Erie, which is polluted in part by its own sewage and in part by neighboring cities. After typhoid fever had been prevalent to a great degree in this city for years a remarkable reduction in the number of cases and deaths from this disease followed the beginning of the treatment with hypochlorite in September, 1911. There was 159 cases and 19 deaths reported for that month. For the eight months, Oct. 1, 1911, to June 1, 1912, there were totals of 180 cases and 28 deaths reported. During similar periods in previous years the figures are:

	Cases.	Deaths
Oct. 1, 1907 to June 1, 1908	290	46
Oct. 1, 1908 to June 1, 1909	311	52
Oct. 1, 1909 to June 1, 1910	343	66
Oct. 1, 1910 to June 1, 1911	347	65
Average 1907-1911	323	57

These figures compared with 180 and 28 cases and deaths, respectively, for 1911 to 1912 show reductions of 44% in the number of cases and 50.8% in the number of deaths. This represents an average of 29 fewer deaths in eight months, while hypochlorite was being used compared with the period before the water was treated. Taking the figure of $5,000 as the value of each life sacrificed to typhoid fever, the financial saving effected by hypochlorite in eight months has been $145,000, which amount capitalized at 5% represents the tremendous sum of $2,900,000.

Erie, Penn.—Although it is acknowledged that the typhoid epidemic at Erie was water borne, nevertheless the exact point of introduction of the contamination has not been definitely determined. The water-supply is taken from Lake Erie and, previous to Mar. 15, 1911, was not treated with hypochlorite. December, 1910, with 31 cases and 2 deaths was followed by January, 1911, with 239 cases and 24 deaths. The Pennsylvania State Board of Health began treating the water-supply with copper sulphate Jan. 28, 1911, and this was continued until the hypochlorite was substituted. The latter process has been in use without cessation since Mar. 15, 1911. The number of cases and deaths from typhoid fever during the twelve months from June 1 to May 31, during the past four years, is as follows:

	Cases.	Deaths.
1908-1909	153	16
1909-1910	202	29
1910-1911	1140	136
1911-1912	91	11

Thus it will be seen what a good record the hypochlorite treatment has made at Erie in the reduction of typhoid fever. The average number of cases and deaths for the three years 1908-1911 was 498 and 60 compared with 91 cases and 11 deaths since hypochlorite has been used. The value of 49 lives saved from typhoid fever at $5,000 each is $245,000, which, capitalized at 5%, amounts to a total of $4,900,000. The raw water averaged 674 bacteria per c.c., with B. coli present in 11% of the samples tested, while the treated water averaged only 49 bacteria per c.c., with B. coli present in only 1 sample out of 1,025 examined—less than 0.1%.

Toronto, Ont.—During the first two months of 1910 there were 723% more cases and 450% more deaths from typhoid than the average for the same two months during the five years previous. Hypochlorite treatment was begun in March, 1910, and an immediate reduction in the number of cases and deaths was effected. The cause for a rise of cases to 90 for two consecutive months in 1911 is explained in a quotation from a letter from Dr. Geo. C. Nasmith, Director of Municipal Laboratories:

I may say that last year our intake plugged with sand and we were forced to short circuit our water-supply and take it from the Bay into which all our sewage empties. We had the makings of the largest typhoid epidemic ever known on this continent, but fortunately we had hypochlorite to depend on and we came through with a typhoid death rate of 20 per 100,000 in 1911, as compared with 45 per 100,000 in 1910, which, you will agree, was an extremely satisfactory showing.

The first four months of 1912 show 64% fewer cases reported than the same period in 1911 and 65% fewer cases than the average for the same periods 1905 to 1910 inclusive and 50% fewer deaths.

Baltimore, Md., drawing its water-supply from two impounding reservoirs, began to sterilize the water with hypochlorite on June 6, 1911, to keep down the annual autumn typhoid-fever epidemic. Since then both cases and deaths have been lower than before the use of hypochlorite. For the period June 1, 1910, to May 31, 1911, there were 1,964 cases and 233 deaths from typhoid fever, while from June 1, 1911, to May 31, 1912, while using hypochlorite, there were 1,155 cases and 160 deaths, reductions of 41% and 31%, respectively. Hypochlorite treatment presumably saved 73 lives in one year. These valued at $5,000 each, amount to $365,000, which totals the enormous sum of $7,300,000 when capitalized at 5%. This is a wonderful saving to a community of 564,000 people in twelve months.

Evanston, Ill.—During the past winter Evanston, Ill., had a typhoid epidemic, traceable to the water-supply, contaminated by the sewage of the city itself. Although the use of hypochlorite was not begun until December 19, 1911, nevertheless there was a reduction from 49 cases reported in December, 1911, to 12 cases in January, 1912, which dropped still further to nine cases in February, showing how thoroughly the hypochlorite treatment did its work. The untreated lake water, averaging 5,000 bacteria per c.c., with B. coli present, was reduced to an average of 75 per c.c., with B. coli shown to be present in all 1-c.c. portions tested.

Waukegan, Ill.—Conditions as to the pollution of the water-supply of this city with the city's own sewage are identical with those of Evanston. The increase in typhoid-fever cases reported, however, occurred later than in Evanston. A total of 82 cases in March was reduced to 56 in April and 27 in May, hypochlorite having been used for the first time on April 16, 1912.

Minneapolis, Minn.—There was an abnormal amount of typhoid fever in 1909 and 1910. The water-supply was taken from the Mississippi River without any treatment. The use of hypochlorite was begun late in 1910 and has been continued without interruption since that time. A modern filter plant of the rapid sand type is now being constructed, but the hypochlorite process will be used in conjunction with it when completed. The water is reduced from an average of 816 bacteria per c.c. to 5 per c.c. The 39 typhoid deaths in the ten months before hypochlorite and the two deaths in the ten months after hypochlorite was used, or a reduction of 95%, is remarkable.

Omaha, Neb.—Hypochlorite has been used since May, 1910, at which time there was an epidemic of typhoid in the city. The Omaha typhoid fever death rates per 100,000 for the last four years have been:

1908	1909	1910	1911
16	26	67	13

A reduction from 67 to 13 per 100,000 is remarkable and it is difficult to say how much higher the rate would have been in 1910 had not the sterilizing process been installed in May of that year. It is worthy of mention that the treated and settled water shows an average of only 43 bacteria per c.c., whereas the raw water from the Missouri River averages 30,447 per c.c.

Jersey City, N.J., was one of the first cities to adopt hypochlorite treatment for municipal water-supplies. The water from the storage reservoir averages 12,000 bacteria per c.c., with B. coli present, but the treated water averages only 10 per c.c., with B. coli absent. Hypochlorite treatment was begun in September, 1908. The average for 1905, 1906 and 1907 was 18.5 per 100,000, and this was reduced to an average of 9.6 per 100,000 for the three years following the use of hypochlorite, namely, 1909, 1910 and 1911, a reduction of 48% in the average typhoid fever death rate.

Kansas City, Mo., takes its water-supply from the muddy and polluted Missouri River and by means of sedimentation and sterilization reduces the bacterial content from an average of 5,500 per c.c. to 65 per c.c. The raw water shows B coli present in 0.2 c.c., whereas this sewage organism is absent in all 1-c.c. portions of the treated water tested. The number of typhoid deaths reported during 1910 without sterilization of the water was 107, while for 1911, with hypochlorite treatment in use, it was 61, a reduction of 43%. Many people in Kansas City use the clear and sparkling waters that issue in many places from springs and which can be pumped from surface wells. These waters have been shown to be very highly contaminated, although they are of very attractive appearance. The city is now conducting a campaign to discontinue the use of these waters for drinking.

Cincinnati, Ohio., has a rapid sand-filter plant with a capacity of 112,000,000 gal. per day. The hypochlorite treatment has been used as an adjunct to the filtration process since December, 1910, with a reduction from an average of 315 to 26 per c.c., or 91.7% reduction in the filtered water itself. B. coli was present in 0.6% of the 1-c.c. samples and in 91.1% of the 100-c.c. samples of filtered water examined, but in the treated filtered water tested no 1-c.c. portions showed B. coli present and only 12% of the 100-c.c. portions were positive.

These data show conclusively that the hypochlorite of lime treatment of water-supplies is wonderfully effective; that it reduces the bacterial content of water to a very low number; that it practically eliminates B. coli and, therefore, we think, B. typhosus, from water-supplies; that it is a very valuable adjunct to filter plants; that mountain streams and impounded reservoir supplies are made safe by its use; that it has stopped many typhoid-fever epidemics already begun and in all probability it has prevented many epidemics from occurring. Hypochlorite is not a panacea for all troubles arising from water-supplies, but when properly applied to the proper water in the correct quantities, it will accomplish wonderful results. Its great cheapness as to installation and operation, the short time necessary to install the treatment and its comparative simplicity, will surely cause disinfection by hypochlorite of lime to be continued and to be adopted by other cities where the supply is not all that it should be.

NEW HARBOR COMMISSIONERS.

Messrs. W. G. Ross, F. Robertson and Lieutenant-Colonel A. E. Labelle are the new harbor commissioners for Montreal.

Mr. Ross is a prominent business man and is a Montrealer by birth. His business career has been a bright one, and as managing director of the Montreal Street Railway from 1905 to 1911, he did much to make that one of the strongest of Canadian corporations. At the present, Mr. Ross holds the following offices: President of the Asbestos Corporation of Canada, director in the Dominion Steel Corporation, in the Quebec Railway, Montreal Light, Heat and Power Company; also many other official connections with noted Canadian corporations.

Mr. Farquhar Robertson, coal merchant, hails from Glengarry county, Ontario, having devoted several years of his life to farming in that district. His first step into commercialism was made when he became manager of a Montreal lumber concern. He started his coal business in 1879. Mr. Robertson is a director of the Montreal Transportation Company, the Prudential Trust Company, and was president of the Montreal Board of Trade in 1909, having been vice-president the year before. He is prominently identified with charitable undertakings, and was three times elected by acclamation to represent St. Andrew's ward in the city council.

Lieutenant-Colonel Alfred E. Labelle was born in Montreal, and has been for more than a quarter of a century one of Canada's most prominent grain merchants. In company with Sir Rodolphe Forget, George A. Grier and Thomas Williamson, he organized the St. Lawrence Flour Mills Company, of which he was chosen managing director. He is the president of the Chambre de Commerce and is prominently identified with the Canadian militia.

THE IMPROVEMENT OF VANCOUVER HARBOR.

In an article published in a recent issue of the British Columbia Magazine, Mr. R. H. Parkinson outlines certain improvements for the improvement of Vancouver Harbor by a suggested sea-wall across the Second Narrows. As the matter is of considerable interest on account of the rapid approach of the completion of the Panama Canal we herewith present the discussion.

Canada's western portal—"the lion's gate"—gives entry to Vancouver Harbor, a salt water basin bounded on the west and east respectively by the First and Second Narrows of Burrard Inlet. This arm of the sea continues some sixteen miles inland in an easterly and northerly direction beyond the Second Narrows.

The whole area of Burrard Inlet is approximately 14,000 acres, while the area of Vancouver Harbor, lying between the First and Second Narrows, is about 3,200 acres.

The purpose of this paper is to point out some of the defects of this harbor, and to suggest a means of eliminating them, and of so improving the conditions as to make Vancouver one of the finest seaports in the world.

The shore line or possible length of wharf (parallel thereto) in this harbor exceeds eleven miles; but, owing to existing conditions, only a small proportion of shore line is used for wharves.

The existing wharves are built on piles, which are very short-lived, owing to the action of the teredo navalis, which honeycombs them and makes re-piling a constant necessity and expense.

The greatest disadvantage of the harbor is, however, its difficulty of entry through the First Narrows. This channel, which has a width of 780 feet, and a depth in mid-channel of 12 fathoms, has a cross-sectional area of 30,500 square feet, through which, at spring tides, the water rushes at the rate of six to eight knots an hour, causing back eddies and whirlpools, which are very dangerous to small crafts and even to large steamess during the period of foggy weather which prevails in winter. The tidal conditions are, indeed, so adverse as to cause serious menace and delay to shipping, and the accidents, collisions and wrecks that have occurred in these Narrows must be attributed to the high velocity of the tides and the cross currents caused thereby.

This high speed of the tide is also found in a lesser degree along the north shore of the harbor, where the city of North Vancouver is situated, and detracts from its value as a location for wharves at a point where the need of them is becoming more and more apparent.

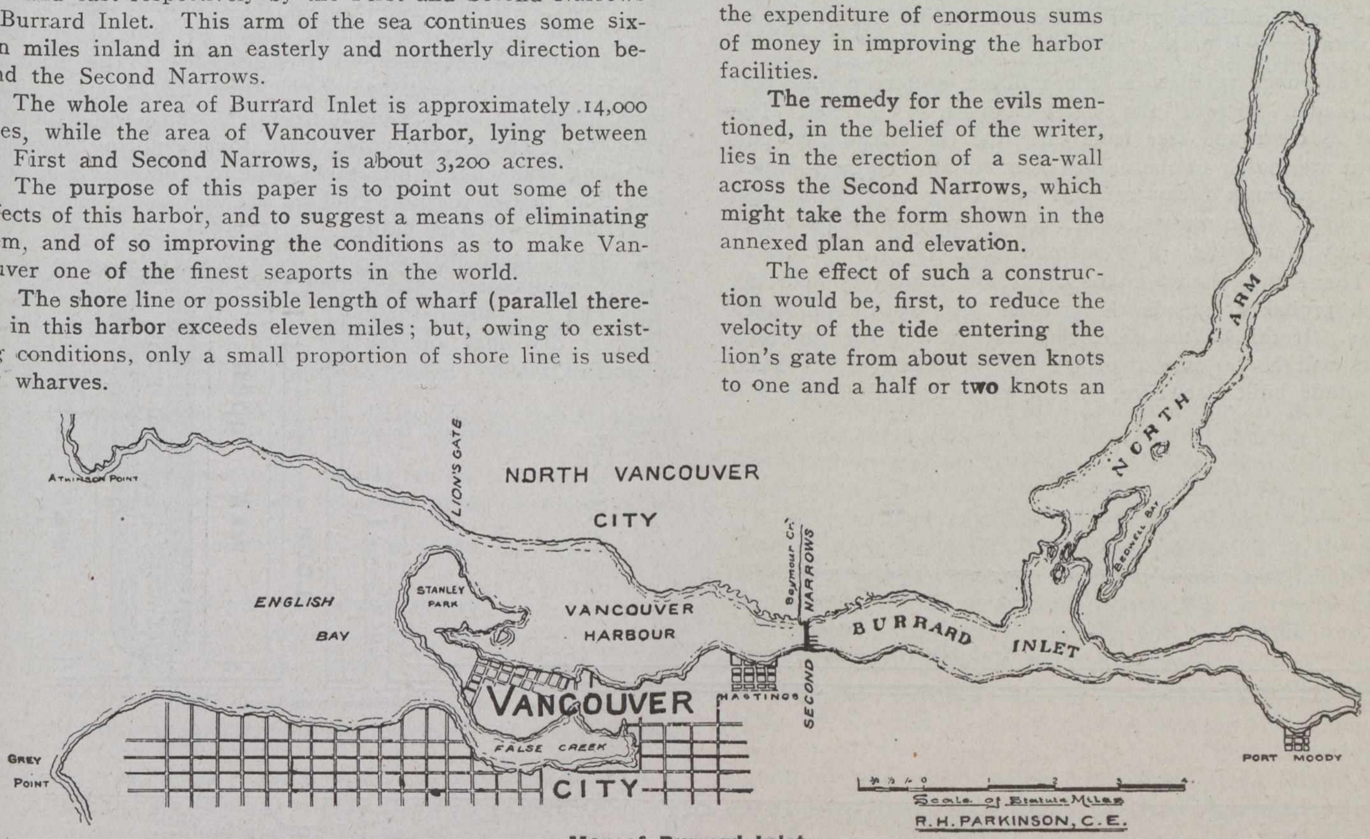
Another disadvantage at present existing is the lack of anything but steamer communication between Vancouver and her sister city across the harbor.

The difference of level between high and low tides is about fifteen feet, and this is a serious inconvenience, causing increased expense in the loading and unloading of ships. In older countries dependent largely on their sea traffic, vast systems of wet docks have been constructed to overcome the disadvantage of excessive tidal rise. The Thames has a tidal rise of 20 feet, and to contend with this London has built over 400 acres of wet docks.

Liverpool, with a tidal rise of from 20 to 30 feet, has the finest dock system in the world, consisting of over 600 acres of wet basins, with over 40 miles, of dock space. Part of these docks have cost as high as $244,000 an acre. It is therefore evident that a large tidal rise is considered such a detriment to a port as to warrant the expenditure of enormous sums of money in improving the harbor facilities.

The remedy for the evils mentioned, in the belief of the writer, lies in the erection of a sea-wall across the Second Narrows, which might take the form shown in the annexed plan and elevation.

The effect of such a construction would be, first, to reduce the velocity of the tide entering the lion's gate from about seven knots to one and a half or two knots an hour; that is, to reduce the current to one-third of its present velocity, thus making the harbor free of entry without danger even to the smallest craft at any stage of the tide.



Map of Burrard Inlet.

This would have the effect of changing the Inlet above the Second Narrows from an arm of the sea into a vast wet basin of fresh water, since the many streams flowing into the Inlet would not only drive out the salt water from above the Second Narrows, but would most likely have the effect of freshening the then limited area of water in Vancouver Harbor to such an extent as to entirely check the ravages of the teredo navalis.

The suggested sea-wall would be provided with locks of sufficient capacity to accommodate the largest ships. It would be provided with graving docks, with subways for electric power lines and aqueducts. On the surface would be tramways, and a railway for the common use of railroads entering Vancouver, obviating the necessity for the intended railroad cantilever bridge across the Narrows, and would very likely render unnecessary the projected improvements to the channel of the lion's gate. Moreover, by giving ships access to fresh water it would make it possible to clear them of barnacles and other impediments in the cheapest manner.

By the aid of this sea-wall the water above could be maintained at or about the present level of high water, and would consequently simplify the matter of stevedoring and wharf-building throughout the upper arm of Burrard Inlet.

This highwater level would also render the upper arm navigable to the largest ships, and would in time undoubtedly have the effect of promoting manufacturing enterprises on lands free from the taxes of a large city and yet within reach, by tram or train, of the working classes residing there.

The people and the factories cannot exist together in perfect conditions of health. In every large town the factories are crowding the residences further and further into the suburbs, and Vancouver must now decide whether she will gradually give up her unrivalled and beautiful situation to the demands of commerce or whether she will provide for a vaster commerce and a healthful people, by encouraging the establishment of industries without her gates and yet within reach of her workers.

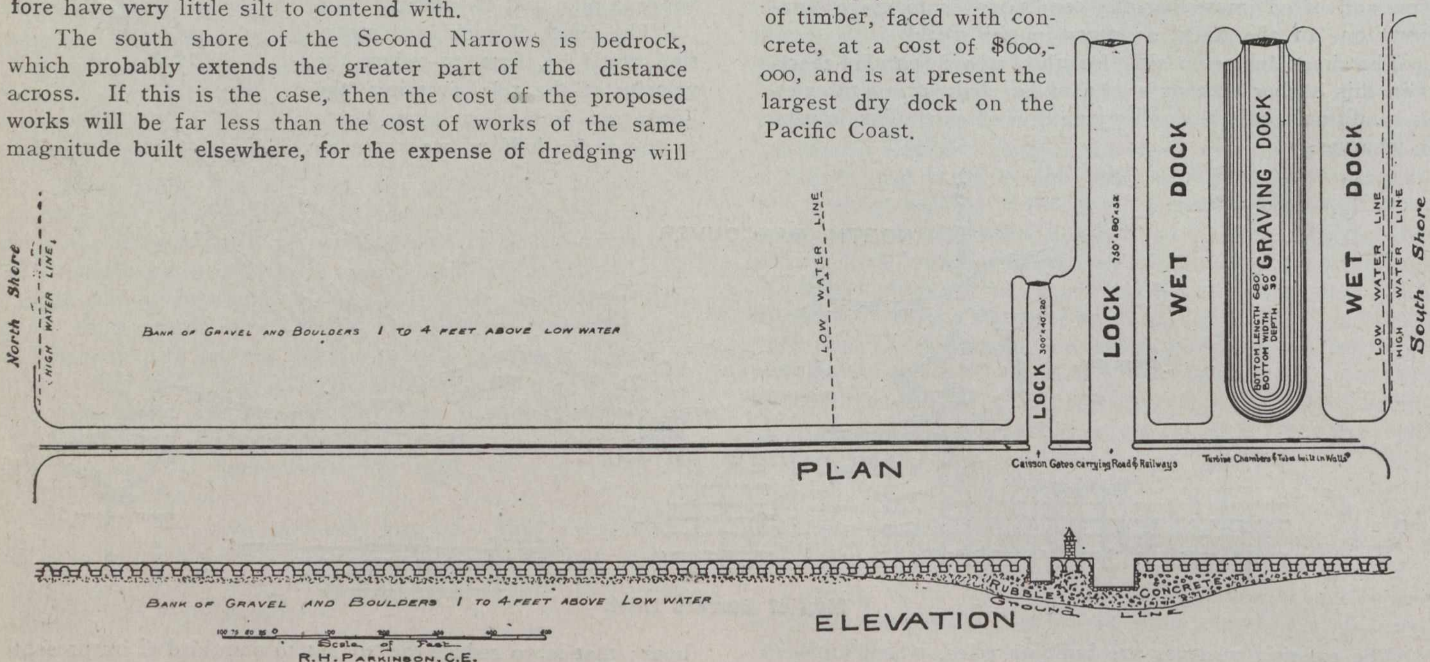
Vancouver rejoices in the mildest winter of any port in Canada. Burrard Inlet is free from ice at all times. The water is clear and free from silt, and the streams flowing into it are mostly of the nature of mountain cataracts, which descend through rocky canyons and carry very little wash with them. The sea-wall and docks suggested would therefore have very little silt to contend with.

The south shore of the Second Narrows is bedrock, which probably extends the greater part of the distance across. If this is the case, then the cost of the proposed works will be far less than the cost of works of the same magnitude built elsewhere, for the expense of dredging will

one-third of the gross bulk of the walls and piers shown on the plan, and this volume could be reduced by filling in the walls with boulders, of which there is a plentiful supply along the north shore.

Roughly the gross volume of rubble and reinforced concrete required for the works shown would be about 400,000 cubic yards, the average cost of which should not exceed $6 a cubic yard. Therefore, with caissons, tracks, turbines and other equipment the total cost of the proposed works should not greatly exceed two and a half million dollars.

When it is considered that the Esquimalt dry dock (475 feet long, built of masonry) cost three million dollars, one can realize the great advantage which the site of the proposed dry dock possesses, as it is designed to be built at a point where the rock bed of the Inlet lies at just a sufficient depth (35 feet) below high water, which would be the permanent level of the upper inlet, thus requiring only the retaining walls and altars to be built of concrete at a cost less than that of the Port Orchard, California, dry dock (675 feet long), which is built of timber, faced with concrete, at a cost of $600,000, and is at present the largest dry dock on the Pacific Coast.



Suggested Sea-Wall at Second Narrows, Vancouver Harbor.

not be encountered, except in the gravel bank on the north shore, and this is dry at low water. To find the cost of the proposed works will therefore be largely a calculation of the cost of so many cubic yards of reinforced concrete, to be laid under rather difficult conditions; together with the cost of the necessary caisson gates for the locks and bridges for the railways and highway. The main wall and dock walls shown on the plan are from 30 to 50 feet wide on the surface; these widths are, of course, excessive as far as strength is concerned, and they may be constructed of parallel walls of ten feet in thickness, filled in with boulders or joined at the tops by arches or girders to form the floor of the quay. It would be advisable to build in the walls tubes of over six feet in diameter, which could be used for such purposes as aqueducts and conveyers of electric high-voltage wires. Cross tubes would be provided in the main wall for spillway and also chambers about low-water level for turbines, the water supply for which could be taken in at the foot of the pier ends and thence through tubes laid in the dock walls to the turbine chambers.

The filling and emptying conduits of the docks and dry docks would require to be of large aggregate area, so that when all these voids in the walls are accounted for the volume of concrete used in construction would not exceed

The writer has at present nothing but an Admiralty chart and his own observation (during a three years' residence in Vancouver) of the existing conditions to guide him in this design, and it would be necessary, of course, to make a careful survey of the site of the proposed sea-wall in order to prove the nature of the channel-bed and the exact dimensions of the channel, before a proper design could be prepared or an accurate estimate of the cost determined.

The proposed works might well be located at the First Narrows, were it not for the delay which would be caused to the passenger traffic.

As an investment of capital the proposed works should pay well, since the tram and railway tolls and harbor dues should amount in the course of a few years to enough to pay a good percentage on the investment.

But the competition of the United States ports to the south makes it important that Vancouver Harbor should be made attractive to shipping, and even if the works were toll free and dues free, the enormous impetus they would give to Canadian ocean traffic and to manufacturing enterprises would be a vast gain to the Dominion, not to be measured merely in dollars and cents, but in commerce and population—in enterprise and prosperity.

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JAMES J. SALMOND, MANAGING DIRECTOR

T. H. HOGG, B.A.Sc., MANAGING EDITOR; A. E. JENNINGS, ADVERTISING MANAGER; P. G. CHERRY, B.A.Sc., CIRCULATION MANAGER

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CONTENTS OF THIS ISSUE.

TORONTO'S WATER SUPPLY: FROM SCARBORO OR CENTRE ISLAND?

The editorial on Toronto's Water By-law, which appeared in these columns in the issue of December 26th, has been productive of criticism on the part of Mr. Isham Randolph and Mr. Willis Chipman, who are members of the Board of Water Commissioners, which Commission recommended the establishment of the duplicate water plant for Toronto at Scarboro Bluffs.

Our criticisms of their report were made from facts, and, as is obvious, were intended in no sense as a personal attack on these gentlemen. Mr. Randolph, of Chicago, however, in commenting on the editorial, through the medium of the daily press, states that: "Now, personally, *The Canadian Engineer* carries no weight with me. Its editors do not impress me as being fair-minded." His attitude is due, no doubt, to the fact that several times during the past year we have had occasion to comment unfavorably on reports and recommendations made by him on other matters. A reference to the files of *The Canadian Engineer* will make clear why Mr. Randolph does not feel that we are fair-minded. A perusal of these editorials will give the reader the opportunity of judging for himself on that question.

The following quotation, made from Mr. Randolph's criticism, exemplifies very clearly his attitude of mind (or shall we say of "I") upon which we commented, with regard to his report on the Chicago Drainage Canal: "**I** have to deal with such a variety of questions that **I** fear **I** have the habit of relieving **my** mind of the whys and wherefores that have influenced **my** conclusion upon a subject, when once that conclusion is reached and announced; so, feeling mentally freer to tackle the next question with which **I** have to deal."

In the Toronto Star of December 26th Mr. Chipman states that in the Scarboro scheme the water will only need to be pumped once, and that the cost of pumping the water twice from the Centre Island plant would be more than the extra cost occasioned by the extra lift. Evidently, Mr. Chipman had forgotten the comments made on page 14 of the Board of Commissioners' report, in which it is stated that: "West Toronto will thus be supplied from the Scarboro reservoir by gravity. For the higher districts lying north of Davenport Road and the easterly branch of the Don it will be necessary to re-pump the water required, and, as this district is rapidly increasing in population, additions to the pumping machinery will be frequently demanded."

In the Toronto Telegram of December 27th Mr. Chipman states: "We do not say that continuous filtration is absolutely necessary. There is a possibility that filtration will not be required there (at Scarboro) all the time. We believe that there are times when neither filtration nor chlorination will be necessary." Evidently, Mr. Chipman has revised his opinion since the report of the Board of Commissioners was made, for on page 13 of the report it is stated that: "It should be borne in mind that bodies of infected water are floating in the lake, and to guard against the possibility of danger from this source it is advisable that the water should at all times be filtered."

We have no desire to engage in a controversy over the relative merits of Scarboro or Centre Island as a source of supply. In our previous editorial we presented certain facts, and these facts have been questioned by members of the Commission and others. The facts demand that an unbiased and unprejudiced view of the whole matter be presented.

The statement is often repeated, both by the Commissioners and by the public, that there is a greater probability of obtaining purer water for greater lengths of time at Scarboro than at Centre Island. On page 71 of the report the Board of Commissioners state that the transporting currents depend entirely upon the wind. The results of certain experiments made in the year 1909, by City Engineer Rust, and given on page 76 of the Commissioners' report, were that "the net result of our observations is that the wind controls the current, and that during the last year the wind blew away from the present intake 68.9 per cent. of the time." Records of the Meteorological Service show that the greater proportion of winds at Toronto come from the west.

With these facts clearly in mind, it is hard to understand Mr. Chipman's statement that it will not be necessary to filter at all times at Scarboro.

It is agreed by the Commissioners that it will cost more to pump the water at Scarboro than it will at Centre Island, but they claim that this extra cost will be off-set by the fact that he Centre Island has to be pumped twice under present conditions. Yet, they expressly state that "booster" pumping stations will be required throughout the city on the feeder from Scarboro.

The serious defect in the Scarboro scheme, more serious than the question of first cost or the question of operating cost, is the defect which is common to all gravity systems; and it might well be questioned whether it would be advisable to use Scarboro as a source of supply, even if it was unnecessary to raise the water 330 feet from lake level to the elevation of Scarboro Bluffs. This defect is the fact that the elevation of the reservoir at Scarboro, with the gravity pipe line feeder, absolutely fixes the amount of energy present in the system. That is, when no water is flowing through the gravity line the pressure head will stand at the level of the reservoir. When the demand increases the head drops as the friction loss increases, until at the point of maximum water demand the minimum head is available. There is no way of controlling this variation in the pressure in a gravity system, and the result is the most undesirable condition of maximum demand and minimum pressure. On the other hand, with the present pumping system, as the demand increases, more energy is put into the system by increasing the pumping capacity, and, therefore, the pressure can be kept at almost a constant.

This fact in favor of the pumping system cannot be too strongly emphasized. It is a matter which has been entirely overlooked in the Board of Commissioners' report. To show what the result would be, it is only necessary to take an example. Mr. Chipman states in the Toronto Telegram of December 27th that with the maximum demand there will be a loss of head of about seven feet in the mile. That is, at the present high-level pumping station there will be a loss of 84 feet of head under conditions of maximum load. When there is no demand for water the pressure level will be at the elevation of the Scarboro reservoir. This will mean that the house services in that neighborhood are subjected to a daily variation in pressure of 84 feet. At West Toronto conditions will be far worse than this unless "booster" pumps are used. It would be interesting to know if the Commissioners had at all considered this variation in pressure. It would also be interesting to know how they intended to control the excess pressure in the east end where the ground level is 250 to 275 feet below the elevation of the Scarboro reservoir.

The absolute lack of flexibility of a gravity scheme such as that from Scarboro, together with its greater first cost and the greater continuous cost of operation, demands the city's consideration of a duplicate Centre Island plant.

LETTER TO THE EDITOR.

DESCRIPTIONS OF LAND.

Sir,—I send you herewith copy of description taken from deed of a lot of land in New Brunswick. This is a fair sample of hundreds of descriptions still used in that province.

The registration system is antiquated and, as there is no complete system of lot numbers, a separate index for each lot is not used in the registry offices.

This entails enormous waste of time and money in making searches against titles and uncertainty as to completeness.

It would be a decided benefit to land owners in New Brunswick if the Dominion Government would apply part of the annual subsidy to establishing a registry system similar to the Cadastral system in Quebec province.

The Provincial Government seems to be helpless in the matter.

Yours truly,

H. IRWIN, Q.L.S.

370 Kensington Avenue, Westmount, P.Q., 28th Dec., 1912.

Description.

"All that certain lot of land situate in the Parish of Douglas . . . bounded and described . . . as follows: On the south by the Saint John River, extending eastward to an oak tree near a brook, thence northerly to a hemlock tree near the highway road, thence westerly to a willow tree on the north side of the said road; thence northward to a cedar post near a brook; thence following the said brook to near the head, and so on to a spruce tree on Hallett's line, and thence following the said Hallett's line to the oak tree aforesaid on the bank of the River St. John, being the same lot of land conveyed to the said Thomas E. Wheeler by Charles J. Tozier."

GENERAL NOTES.

The table shows for fifteen stations, included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for December, 1912:

	Depth in inches.	Departure from the average of twenty years
Calgary, Alta.	...	......
Edmonton, Alta.	0.1	—0.70
Swift Current, Sask.	0.3	—0.42
Winnipeg, Man.	...	......
Port Stanley, Ont.	3.4	+0.32
Toronto, Ont.	1.85	—0.76
Parry Sound, Ont.	7.7	+3.04
Ottawa, Ont.	2.2	—0.51
Kingston, Ont.	2.4	—0.44
Montreal, Que.	2.9	—0.92
Quebec, Que.	3.0	—0.16
Chatham, N.B.	3.2	+0.02
Halifax, N.S.	8.4	+2.71
Victoria, B.C.	5.8	—0.47
Kamloops, B.C.	0.5	—0.32

REINFORCED CONCRETE ELEVATED WATER TANK AT BERLIN, ONTARIO.

Although elevated water tanks were the first important reinforced concrete structures built in Europe and although there are some railroad tanks made of this material still in existence which were built over fifty years ago, the construction of large elevated water tanks for municipal use is still something of a novelty in this country. The following description and illustrations of reinforced concrete tank recently completed at Berlin, Ontario, are taken from a recent issue of "Engineering-Contracting," to whom acknowledgement is here made:—

The capacities and heights of elevated tanks are increasing each year. With increase in size, economical design of the bottom and supports of elevated concrete tanks becomes highly important, since the cost of these parts of such structures is by far the greatest item of expense in building a tank of this character. The ordinary girder and slab construction for the bottom of large tanks is a very expensive feature in concrete tank construction. Loads of from 1,000 to 3,000 lbs. per sq. ft. require very heavy beams and slabs and a great many supports. There is no more ideal design for tank bottoms than the dome and frustum shape bottom as shown in the illustrations here given.

Concrete, being an ideal building material for compression, is strained to its best advantage in this type. The inner dome is under compression in every direction, and the frustum or outer dome is in compression in one direction and in tension from water pressure in the other direction. At the junction of the inverted dome and the inner dome, the thrust from these two domes may be balanced by the adoption of proper inclinations and sizes of the domes, or there may exist a tension in the ring by the thrust of the inner dome being greater than the thrust of the outer dome, or there may exist a compression caused by the thrust of the outer dome being greater than that of the inner dome. In most cases there is at this region a very massive ring of concrete to take care of eventual changing conditions, for the tank empty, for the tank half full, or for the tank filled to its top. This ring may be supported by four or more columns according to the size of the tank, in which case the ring must serve also as a girder and must be designed accordingly. On account of the comparatively small spans and great loads, these girders are designed mostly for shear and less for bending, and it thereby lends itself readily to architectural treatment, as the rational form of such a grider is really an arch on top of the support. Where only four columns are used, this grider is subjected to a considerable torsional moment, and must be designed accordingly.

Another way of supporting the ring at the junction of the two domes is to support it on a shell of concrete, or, as it is preferred in Europe, of brick or stone. If the shell is built of brick or stone, it is rarely made less than 18 to 24 ins. thick, and, although offering opportunity for elegant architectural treatment, it is very much more expensive than reinforced concrete shells, which can be made very much thinner.

A very cuch larger tank of the second type was recently designed and built by Mr. Mensch for the city of Berlin, Ontario. The construction of this tank was begun in August and completed in November of this year. The tank has a capacity of 600,000 U.S. gals. The details of design of the tank are shown in Figs. 1 and 2.

As will be seen from Fig. 1, the tank is supported by a reinfored concrete shell 75 ft. 11ins. high and 12 ins. thick. This supporting shell rests upon a circular beveled ring foundation 13 ft. wide on its base and 18 ins. wide on its upper face. The two main parts of the tank bottom are referred to as the inner and outer domes. The inner dome is a portion of the surface of a sphere of 27 ft. radius. The outer dome is the frustum of a right circular cone. The inner and outer domes intersect at the top of the supporting cylindrical shell. The tank proper is 50 ft. in inside diameter. The depth of water in the tank when full is 39 ft., measured from the median plane of the base to the elevation of the overflow. The tank shell is a cylinder 41 ft. high with 12-in. walls. The roof is a portion of a spherical surface 4 ins. thick. The total height of the structure from the top of the foundation ring to the top of the roof is 127 ft. 4 ins.

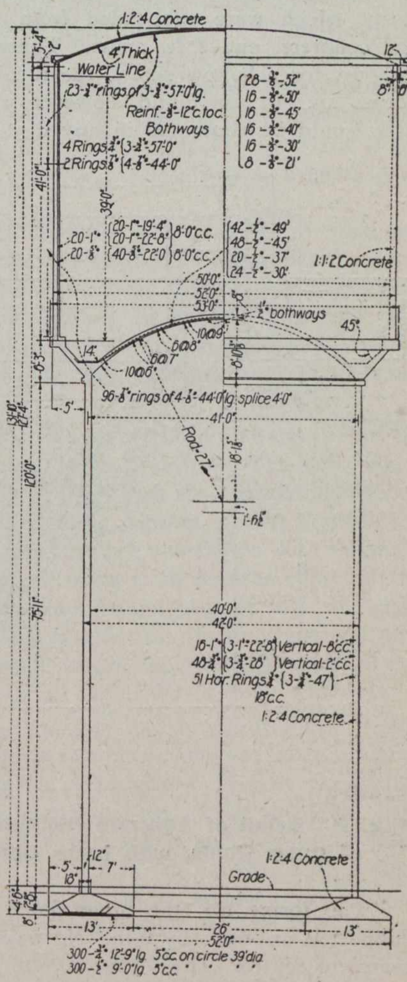


Fig. 1.
Sectional Elevation of Concrete Water Tank for Berlin, Ont.

The supporting shell is made incidentally to house a booster pumping unit composed of a turbine pump direct connected to an electric motor. This pump is held in reserve for use in case of very heavy water consumption when the pressure on the mains produced by the head of water in the tank may become insufficient in the higher zones of the distribution system. This pump is placed in operation by automatic electric control from a remote point. In addition to the pumping unit the supporting shell houses the regulating device which controls the admission of water to the tank.

The lower shell is provided with a door and several windows. The ladder to the tank rises from the floor of the pump-room and extends, inside the supporting shell, to an opening 2 ft. 6 ins. by 5 ft., which is made in the shell just below the tank bottom. Outside the shell at the level of the bottom of this opening there is a platform 2 ft. 6 ins. by 7 ft., which is supported on brackets from the shell. An outside ladder extends from this platform to a manhole opening in the roof of the tank.

The inner dome varies in thickness from 14 ins. to 8 ins. The outer dome varies from 12 ins. to 10 ins. A large scale detail drawing of the intersection of the two domes is shown herewith in Fig. 2. These two domes are so proportioned that their thrusts nearly balance. At the junction of the outer dome and shell of the tank there exists a great outward thrust from the weight of the shell of the tank and of the roof, which necessitated the placing of a large amount of steel, and in order to secure the co-operation of the steel and the concrete there was provided a section of concrete at this junction of 18 ins. by 30 ins.

The reinforcing of the tank consisted of ⅞-in. and ¾-in. square bars of high carbon steel. They are placed in two separate layers where the spacing is less than 4 ins. At the junction of the two domes, a great excess of concrete was provided to take care of the thurst of the outer dome while the tank was empty or partially full. The reinforcing of the inner dome consists of ½-in. rods placed on 6 to 8-in. centres. These rods were provided to take care of stresses, due to the elastic deformation; otherwise the dome is stressed in both directions in compression only, and would not require any reinforcing.

A mixture of concrete of 1:1:2, or slightly richer, was used in all portions of the tank in direct contact with the water. All other concrete consisted of a mixture of 1:2:4. The lower sheel was built by means of wooden forms 6 ft. deep, which were suspended from 1-in. rods imbedded in the concrete, and 8 ft. apart. These 1-in. rods served as a support for a hollow screw, the turning of which moved the forms up. It was found, however, that not more than 4 to 6 ft. could be concreted in any day.

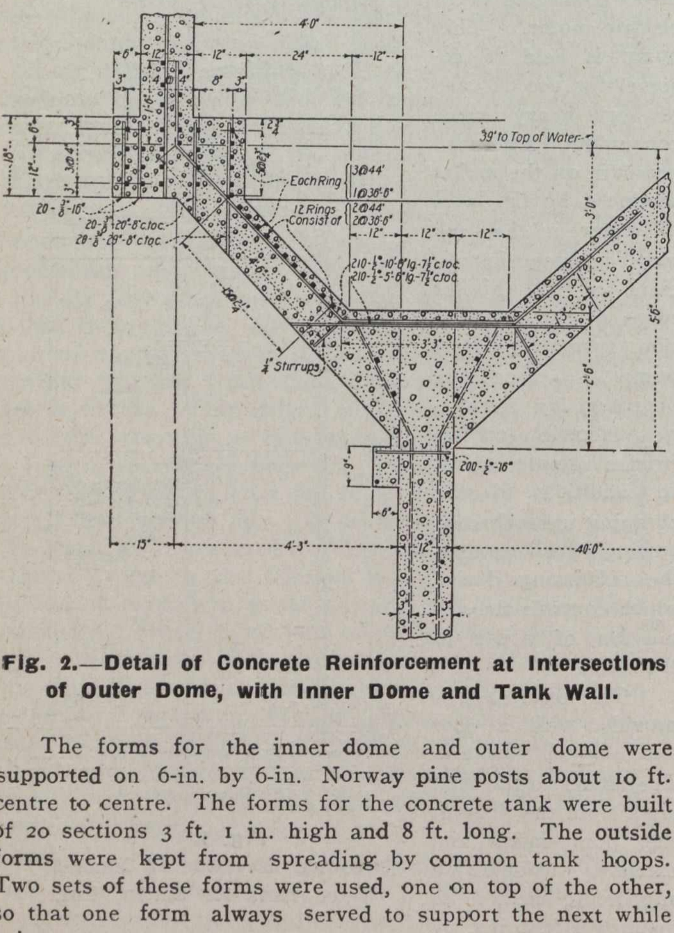


Fig. 2.—Detail of Concrete Reinforcement at Intersections of Outer Dome, with Inner Dome and Tank Wall.

The forms for the inner dome and outer dome were supported on 6-in. by 6-in. Norway pine posts about 10 ft. centre to centre. The forms for the concrete tank were built of 20 sections 3 ft. 1 in. high and 8 ft. long. The outside forms were kept from spreading by common tank hoops. Two sets of these forms were used, one on top of the other, so that one form always served to support the next while being set up.

In order to prevent a leak at the junction of two days' work, due to careless removal of laitance or insufficient tamping of the new concrete, a dam or sheet steel 6 ins. wide and No. 28 gauge was imbedded 3 ins. in the concrete at the end of each day's work. These dams came in lengths of 82 ft., which is one-half the circumference of the tank. The roof forms were supported on 4-in. by 4-in. uprights about 8 ft. centre to centre. As they were 44 ft. long, they were braced in two directions every 10 ft.

The concrete plant consisted of a Chain Belt mixer placed near the centre of the tank, which discharged the concrete into a hoisting bucket. The bucket ran inside of a wooden tower, which was built of four 4-in. by 6-in. uprights suitably braced and 140 ft. high. It was raised by means of a hoisting engine placed about 50 ft. from the centre of the tank and outside of the structure. The hoisting bucket discharged the concrete into a hopper, which was also placed inside of the hoisting tower, and from here was spouted through a system of pipes and flexible spouts into place. The hoisting tower placed in the centre necessitated an opening in the bottom and the roof of the tank. These openings were closed and concreted after the rest of the structure was finished. The contract cost of the tank was $23,500.

In the opinion of Mr. Mensch designer and builder of this tank, there are two reasons for the comparatively rare use of concrete for elevated tanks, namely:—

First, because of the inexperience of engineers and contractors in designing and building an absolute water-tight structure of concrete. In a reservoir, which is placed on the ground, wet spots in the walls, or even slight leaks, are not very objectionable, while in elevated structures they are sources of danger from frost, and decidedly unsightly. While wet spots and slight leaks are often overlooked in wooden and steel tanks, they are sources of anxiety in concrete tanks.

Second, because the cost of a concrete structure of this character is, as a rule, considerably higher than that of a steel structure.

Elevated concrete tanks possess some points of advantage, however, over steel tanks. An important advantage of concrete tanks for service in northern climates is that their thick walls prevent, to a considerable extent, the formation of ice within the tank. Under unfavorable conditions of weather and protection from freezing, ice formed within large tanks sometimes attains a thickness of 5 ft. or more. Other points of advantage of concrete tanks are that they do not require painting, and that from the nature of the construction material employed ornamental effects are readily available for slight additional cost.

The tank herein described was built as one part of the extensive improvements to the water works system of Berlin, which have been made during the past year. Messrs. Bowman and Connor Consulting Engineers, of Berlin and Toronto, planned these improvements, with the exception of the water tank. The design of the tank was checked by Mr. Connor.

The length of the Esquimalt Graving Dock at Victoria dock to gate is 450 feet, level with keel blocks; 480 feet with gate on outer kerb. The width of gates is 65 feet. The depth of water varies from 27 feet to 29 feet 6 inches at springs, according to the season of year. The use of the dock will be subject to the following tariff:—

Gross tonnage of vessel.	For the first day of docking.	For each following day, including undocking day.
For all vessels up to 1,000 tons	$300.00	5 cents per ton.
From 1,000 to 2,000 tons	350.00	4½ cents per ton.
For all vessels above 2,000 tons	400.00	4 cents per ton up to 2,000 tons and 2 cts. per ton on all tonnage above 2,000.
Vessels from 430 to 450 ft. in length	550.00	
Vessels from 450 to 480 ft. in length	700.00	

Possessing a large quantity of paper-making woods, British Columbia affords a promising field for the paper-maker. Pulpwood forests border the ocean and many navigable waters, simplifying transportation, and there are numerous water-powers to supply motive power to the mills. The rapid denudation of the pulp areas of the United States will soon compel it to look to Canada for its supply of wood pulp, which, according to the regulations now in force, must be manufactured in the province. There is, besides, a present demand for pulp in Japan, China and Australia, and when the industry is fairly developed, the ocean freights will enable profitable exportation to Great Britain and Europe.

SEWAGE DISPOSAL.*

By J. Darlington Whitmore.

In preparing this paper on Sewage Disposal, I have not considered it necessary to review all the various methods now adopted, but have confined my remarks to that method which seems most applicable to our province and peculiar local conditions, and as this is a maiden paper for a maiden society I must ask your forbearance for any maidenly coyness that may permeate the following lines.

Sewage disposal methods rightly commence on the property of the producer, and I therefore propose to glance lightly over an imaginary scheme, commencing at an imaginary household and following the sewage to its reception and treatment at the disposal works.

I shall not in this present paper deal with other than water borne sewage; the outside closet and privy, etc., together with the objectionable methods of emptying and cleansing same, being thoroughly familiar to us all.

As you are all no doubt aware, the close of the year 1909 saw the ratification of a very excellent Public Health Act for this province, patterned largely upon the laws and regulations enforced by the various local government boards of Great Britain, and controlling the methods of sewage disposal and water supply, as also the pollution of streams and waterways.

The authority is vested in a "Bureau of Health" acting for the government and having a duly qualified medical man at its head as commissioner, who in turn has a sanitary engineer on his staff to advise with him on the various questions that arise.

No scheme for water supply, sewage disposal or sewerage can now be constructed in this province without the sanction of this body, and as time passes and the various plants now completed or under construction come into use, much valuable information will be obtained, and a careful record of regular tests and analyses at the various works will further enlarge our knowledge of this subject and enable us to take a seat in the forefront in the vexed question of the efficient and sanitary disposal of sewage.

Plumbing.—Commencing with the household, our first step in connection with sewage disposal is to install satisfactory plumbing whereby the liquid wastes and fæcal matters are quickly passed away into the sewers without causing any nuisance to the occupiers of the premises.

It has been abundantly proved that, where perfect ventilation in the plumbing system does not exist, the foul gases generated by the sewage and ever present in the pipes will force their way through the water seal of the traps to the interior of the dwelling with a consequence of disease and sometimes death to those persons inhaling the impure mixture.

It is, therefore, absolutely necessary to arrange for perfect ventilation to the whole system and in each case all traps should be back vented with efficient vent pipes and every fixture should be trapped.

The system in vogue for many years, of placing an intercepting trap on each individual system, thereby separating the house plumbing from the sewers, has not borne out the expectations conceived for it and the majority of new systems being or to be installed will be without this fixture.

The idea governing the adoption of the intercepting trap was to exclude sewer gases in the main sewers from rising into habited premises and also to prevent the ingress of rodents; each separate plumbing system was then vented on the house side of the intercepting trap, and it was for a long time considered that the acme of plumbing ventilation had been achieved.

A short vent pipe was connected with the house system close to the intercepting trap, generally in a manhole, whilst the main soil pipe was continued up above the roof; the idea being that the short pipe would always act as an inlet and the long one as an outlet.

This theory was, however, soon exploded, it being discovered that both long and short pipes acted alternately as inlet and outlet, depending upon changes of wind, temperature, etc., and, as the short pipe was always at the lower end of the system, extremely foul odors were ofter discharged at most dangerous points to passing pedestrians, and, where open windows or doors were near the supposed inlet, the malicious influence of the sewer air soon became only too well manifest.

To overcome these difficulties at the supposed inlet end various valves were made, the chief kind being fitted with a mica flap to allow air to enter from outside but to prevent foul air emanating from within; the success attending the adoption of these expedients was but meagre and unsatisfactory and the adoption of this system cannot be recommended.

Personally I consider that efficient plumbing in the interior of dwellings should be as follows: The soil, waste and vent pipes should be of iron, with the caulked lead joint, all fixtures such as baths, sinks, closets, grease traps, etc., should be of porcelain, and through ventilation with the main sewers be always acting; all traps to all fixtures being vented into either a separate anti-syphonage pipe or into the main soil pipe well above the highest fixture; further, the soil pipe should be carried up well above the ridge of the roof and should discharge clear of all chimneys or open windows.

To be certain of satisfactory and air-tight joints in the plumbing at least two tests are necessary, the hydraulic and smoke test. The hydraulic or roughing in test is applied before the fixtures are installed; the pipes including soil, waste and vents being filled with water and allowed to stand a reasonable time; after this test is satisfactorily accomplished and any faults made good, the fixtures are placed, and a smoke test of sufficient pressure so as just not to break the trap seals is further applied; the plumbing after satisfactorily passing these two tests being ready for use.

Sewers.—The sewers can be of either concrete, vitrified tile, vitrified brick or other impervious and smooth construction, and should be so designed as to grade and size as to be self-cleansing.

The velocities of the sewage through the sewers should range from two to six feet per second when flowing half full, and wherever possible should flow by gravity without the aid of pumping.

Where, owing to the topography of the ground, lifting is necessary, it can be accomplished either by some of the various pneumatic devices now on the market or by centrifugal pumps; reciprocating or plunger pumps are not satisfactory for this purpose owing to the excessive wear on the valves and pistons, etc.

In this province the tendency is towards the separate system; the storm water being carried in separate pipes, the advantage of the separate system being that the disposal works can be designed to deal with a known quantity of sewage, and much of the expense and uncertainty attaching to combined systems is thus eliminated.

The ventilation of the sewers is an important feature and should be achieved by through ventilation with all house or

* Paper delivered before Regina Engineering Society, Regina, Sask.

other connections; every separate house connection being untrapped on the main line and thus permitting a free flow of air from the sewers through the house plumbing to the outer air or vice versâ.

It is only reasonable that each householder contaminating the sewers should also provide a means of ventilating them, and without a doubt this offers the best method of ventilation providing the soil pipes are carried up well above the ridge of the roof of any dwelling, and the plumbing is kept in good condition, for which safeguard a compulsory yearly inspection of the plumbing would be advisable.

The practice of ventilating the sewers at the street level through perforated manhole covers as adhered to by many cities and towns, cannot be too strongly condemned, the nuisance arising from such methods being too palpable to the senses of sight and smell.

Up to within about eight years ago I was a firm advocate of the intercepting trap and the ventilation of sewers at the street level, but later observation has changed my views, and I do not consider that any community adopting these methods to-day can be considered as otherwise than behind the times and disregardful of the most obvious laws of health.

Anyone who has walked along the streets of a city or town where the sewers have been ventilated at the street level must have noticed in winter the dense, unhealthy vapor that arises, and in summer they cannot have failed to have become convinced through their olfactory nerves of the monstrosity of this method and its great menace to health and life.

The inhalation of sewer gas will not of itself bring disease unless the sewage is sprayed in it, but it will undoubtedly lower the vitality of the human frame, and so render the body subject to speedy capitulation to the many forms of disease that we humans are heir to.

By ventilating the sewers through the house plumbing the obnoxious gases are carried well up into the air above the roof tops, each house system acting alternately as inlet or outlet, dependent upon the direction of the wind or degree of temperature, and thus carried far away and purified by dilution.

Disposal Works.—The aim of the provincial authorities is to prevent any septic action taking place at the disposal works, and with this end in view the ordinary septic tank is not countenanced, but plain sedimentation has been enforced in all the systems designed under the new Act up to the present time.

This is a very laudable ambition, as a non-septic effluent can be better treated on the bacteriological filters than can a septic fluid, but I do not see how these conditions are to prevail all the year round with our present designs taking into consideration the extreme severity and duration of our winter months.

Beginning with the freeze-up in November, our winters may be said not to terminate till well on into April, and during that period we experience temperatures as low or lower than 50 degrees below zero.

During this period of low temperature it does not appear to me to be either advisable or feasible to empty the sludge from the sedimentation tanks on to the sludge beds as even if the sludge were thus deposited it would freeze into a solid mass and thus neither drain nor dry, whilst it is more than probable that the sludge pipes leading from the sedimentation tanks to the sludge beds would, when operated, quickly become frozen and fail to accomplish their object.

With fresh frozen sludge being deposited on the sludge beds from time to time during the winter, a great mass would accumulate which would take a long time to drain and dry after the winter was over, if it ever did dry, and, I am afraid, would materially interfere with and retard the successful operation of the plant.

If, on the other hand, the sludge is allowed to remain collecting in the sedimentation tanks during the winter months, it will become septic, and the professed object of the provincial authorities will not be obtained with the sedimentation tanks as at present designed.

Fresh sludge from a sedimentation tank contains from 90 per cent. to 95 per cent. water, whereas sludge that is septic contains only 80 per cent. water; it is therefore easy to understand that the removal and subsequent treatment of septic sludge entails much less labor and costs considerably less than that of fresh sludge.

Having in mind the duration and severity of our winters and the difference in volume of fresh wet sludge as against wet septic sludge, I am in favor of a tank so designed that the sludge can be retained for long periods and become septic without coming into long contact with the effluent passing through the tank, and the Emscher tank apparently complies with these requirements with its deep sludge well accommodation.

Septic sludge, being viscous and denser than fresh sludge, is much easier to handle, and both drains and dries quicker, becoming under normal conditions spadable in about five days after being spread upon the drying beds, whereas fresh sludge is very sloppy owing to its large content of water and does not become spadable in less than fifteen to twenty days under similar conditions; it has also a tendency to clog and choke the drainage material of which the sludge beds are composed.

In many of the larger European plants the sludge is drained and dried in pressing machines and centrifuges and afterwards pressed into cakes and used for manure on farm lands, or as fill in low lying ground or sometimes burnt; the grease is also sometimes extracted and sold, but up to the present at a financial loss in most instances

The sludge has but little value as manure and in many cases farmers or others have demanded and obtained payment for removing it from the works.

Personally I am of the opinion that in this province where farmers have not yet attempted to manure the land, that the best and most satisfactory method of disposal of sludge is to burn it in an incinerator after it has been dried upon the sludge beds to a consistency of about 50 per cent. moisture, in which condition it is easily spadable.

For the smaller communities that do not possess garbage incinerators, the dried sludge can be buried in shallow trenches in and reserved for this purpose adjoining the disposal works.

I have spoken at some length on the sludge question, as it is undoubtedly the most troublesome feature to deal with in the modern system of sewage disposal for inland communities, and there is a good sized fortune in store for that individual who can discover some better and more sanitary and economical method of sludge disposal than that which prevails to-day.

Whilst speaking of the sludge it occurs to me that up to the present no attempt has been made to control the fly nuisance that will arise whilst the sludge is being drained and dried upon the beds.

Residual oils sprayed upon the sludge will effectually prevent the fly evil, but at the same time will considerably retard the drying process, and on that account may not be advisable.

For my part, I would favor the construction of a cheap framing around the sludge beds; the openings between the uprights being filled in with wire mosquito netting and the top roofed over with shingles, the sides having doors for the ingress and egress of the workmen for removing the dried sludge.

This construction would confine the flies to the sludge beds and prevent their wandering into human habitations, and at the same time would allow free access of light and air whilst excluding the rain; the flies could be exterminated from time to time by smoke or other methods.

The severity of our winters has made it debatable as to whether the filters will, without the aid of artificial heat, freeze during the winter months, and to overome this tendency the sedimentation tanks and filter beds have, where possible, been designed under one roof and practically within one enclosure in the hope that the latent heat in the fresh sewage will be sufficient to counteract the frost.

From my personal observations at the septic tanks at Moose Jaw, extending over a period of five years, I found that the temperature of the blanket in the tanks ranged from 40 to 45 degrees Fahr.; the lower temperature being recorded when the air outside the tank registered 40 degrees or more below zero Fahr.; the tanks being of reinforced concrete construction roofed in and covered with a dirt fill of at least two feet on the crown of the arch and increasing towards the haunches and walls.

It remains to be seen whether the latent heat of the sewage will be sufficient to overcome the tendency to freeze in the filters, and I am inclined to the belief that it will, providing proper care is observed in their construction with a view to keeping out the frost. Should the filters, however, show signs of freezing artificial heat will have to be resorted to with its attendant additional outlay and expense.

It is, of course, understood that in locating a site for a sewage disposal plant the topography of the land be well studied with a view to the avoidance of pumping with all its attendant heavy costs, that it be placed as far from the community it serves as possible, and so that the prevailing winds shall carry the odors that will arise, even in the best of plants, away from the city or town.

With this digression I will proceed to describe my imaginary disposal works, which will be typical of those installed in the province up to the present time in conformity with the requirements of the Bureau of Health.

Upon the arrival of the sewage at the works it is received in a screening chamber, passed on into a detritus chamber, thence into a sedimentation tank or system of tanks, from whence it is distributed over bacteriological filter beds, and after emerging, passed into a humus tank where it can be disinfected if necessary before being finally disposed of.

Screening Chamber.—The screening chamber is a small rectangular compartment fitted with bar screens spaced about half an inch apart, the bars being of wrought iron and 1¾ by ½ inch section; in this chamber all foreign substances such as sticks, flannels, scrubbing brushes, corks, matches, hair, etc., are caught and retained and periodically removed and buried or burnt.

Detritus Chamber.—The detritus chamber is rectangular in shape and placed between the screening chamber and the sedimentation tank, being really part of the tank, its capacity is from 3 per cent. to 5 per cent. that of the tank and its functions that of intercepting the heavier mineral matters in the sewage during its passage to the tank.

Were we sure that no sand or other mineral matter would find its way into the sewage, the detritus tank would not be necessary with our separate system of sewage, but we cannot always guarantee that the joints in the tile sewers will remain perfect and it is considered advisable to exclude these substances from the sludge of the sedimentation tanks.

The accumulation of detritus is removed at regular intervals through sludge pipes placed at the bottom of the tank, and is subsequently dried and buried.

Sedimentation Tank.—From the detritus chamber the sewage flows over a long weir into the sedimentation tank by means of a submerged inlet, the tank being so designed as to obtain a large sedimentation of the organic matter in the sewage with a continuous flow of the effluent to the filters.

The velocity of the sewage where it enters the screening chamber is three feet per second, but in the tank it is reduced to one-sixty-fourth of an inch per second, which gives us practically quiescent sedimentation with a continuous flow.

The effluent passes out to the collecting channel through submerged outlets, and no scum boards are used, as their adoption tends to set up currents in the tank.

The tank I have in mind is divided into two compartments and so controlled by valves that either compartment can be used or thrown out of commission at will, thus enabling us to treat the sewage with different durations of contact, or to empty one division for inspection or cleansing at any time without disorganizing the operation of the works.

The walls and floor are trowelled smooth, the latter having a slope of one in fifteen to the shallow sludge pits, to facilitate the gravitation of the sludge.

The rate of flow through the tank is four and three hours respectively, so that if desired for experimental purposes rates of flow of three, four and seven hours can be obtained. The amount of dried sludge extracted from the tank per capita per day is approximately two ounces, depending, of course, largely upon the habits of the persons contributing to the sewage, and as this is increased in bulk nineteen or twenty times by the large amount of water mixed with it, being approximately in the mass 90 degrees to 95 degrees water, weekly extraction of the sludge is necessary to keep the effluent fresh.

For this purpose sludge pipes controlled by cone-shaped valves are carried from the bottom of the shallow sludge pits to the sludge beds, where the sludge is regularly deposited and dried during the seasonable months.

The tank is easy of approach and is fitted with gangways inside so that inspection is at all times easy and can be accomplished without climbing down dark and dirty manholes, or soiling the hands or clothing.

The tank is of reinforced concrete and roofed in as is indeed all other parts of the plant, and a thermometer is kept constantly suspended in the sewage to show the degree of temperature.

The outlet of the tank is fitted with a measuring weir so that the production of sewage can be tabulated and recorded.

Bacteriological Filter.—After passing the measuring weir, the clarified effluent is conducted by a main channel running lengthwise along the centre of the filter, from which subsidiary channels branching off at right angles lead it to a system of Stoddart trays by means of which it is distributed over the filtering material in the form of fine rain drops.

The trays discharge at three inches above the filter, so that no splashing occurs and are laid perfectly level by means of thumb screws affixed to wrought iron chairs.

This method gives a very satisfactory distribution of the effluent and the Stoddart trays have the added advantage of requiring but little attention.

The filtering medium is composed of three-inch crushed stone, well screened and free from dust, and has an average depth of 8 feet, for treating the effluent at the rate of 150 Imperial gallons per cubic yard per 24 hours.

The floor of the filter is of concrete, trowelled smooth with a fall of 1 in 30 towards the centre channel, where the filtered effluent is collected and discharged.

Upon the floor rocks of about 9-inch to 12-inch section are laid to admit of free access of air and easy drainage, and provision for an efficient circulation of air through the filter is further obtained by carrying down from above the ground a set of 12-inch diameter inlet pipes which discharge into the base of the filter and are spaced at 25-foot intervals longitudinally around the walls.

The roof of the filter is further fitted with ventilators for discharging the air, so that good aeration and ventilation are obtained.

Sunlight is admitted through windows in the roof, which are kept open in the summer and closed during winter. The action of this type of continuous filter is aerobic and the degree of purification obtained about 98 per cent.

All operating parts of the filter are of easy and comfortable access and an arched passageway runs along the centre of the filter for its full depth, so that inspection of the collecting channel is obtainable at all times with the aid of a covered lantern.

Disinfecting Channel.—From the filter the now considerably purified effluent is conducted into a long, rectangular channel fitted at intervals with baffle plates, where, if the circumstances so demand, it is disinfected by a minute solution of calcium hydrochlorite which, by means of the baffle plates, is thoroughly incorporated into the effluent, and the whole fully aerated.

Humus Tank.—From the disinfecting channel the effluent flows into a rectangular tank of shallow depth, divided into two longitudinal sections, where it deposits any humus that it may have carried with it during its progress of purification, and from thence is discharged into a small watercourse in a non-putrescible condition, dangerous neither to animal nor fish life.

The tank is fitted with an overfall weir and also floating arms, and one division can be thrown out of use and cleaned whilst the other is operating.

The time of the passage through the tank is twenty minutes to allow of sufficient period for the disinfectant to act.

Sludge Drying Beds.—The sludge drying beds are rectangular in shape, with wide passage ways for the convenience of the workmen who attend to the duties of spreading and drying the sludge and afterwards removing it.

The floors and walls are of reinforced wire mesh concrete to take up the thermal changes, and the floor is laid with a fall of one in ten to the centre to facilitate drainage.

Upon the floor are placed diagonal rows of 4-inch open tile pipes connecting with and discharging into the main connecting channel.

Upon these 18 inches of coarse gravel or crushed stone is placed, surmounted with a six-inch covering of medium sized sand grains, making a total thickness of straining material of 24 inches.

The sludge from the sedimentation tanks and detritus chambers is gravitated to this bed in 9-inch diameter cast iron pipes, and is conducted along the beds in half open channel pipes, from whence it is spread evenly upon the beds in six-inch layers by the workmen and left to drain and dry.

The liquid draining from the fresh sludge is highly putrescible, in contradistinction to that from septic sludge, which is not putrescible, and is conducted by means of the subdrains mentioned to pipes which convey it back to the sedimentation tanks for further treatment.

The sludge, after being dried until it becomes spadable, is removed and buried in shallow trenches upon land reserved for the purpose adjacent to the disposal works.

Conclusion.—I regret that the time at my disposal in preparing this paper has not been sufficient to enable me to prepare any drawings to illustrate my remarks, but I sincerely trust that I have made the various stages of sewage disposal operation sufficiently vivid by word pictures to counterbalance that defect.

The system explained is, as before stated, emblematical of all the new plants so far installed in this province, the only important difference being that the plants at the cities of Regina and Saskatoon have been fitted with revolving sprinkler apparatus for distribution of the effluent upon the filter beds.

In conclusion I would impress upon you that no modern sewage disposal plant, however well designed, is fool proof, and the success of each individual installation is largely dependent upon the care and skill of the attendants. A log should be kept daily of all the happenings at the works and complete records of temperatures, volumes and analyses.

CONCRETE PAVEMENTS TAMPED WITH MECHANICAL VIBRATOR.

Concrete pavements, surfaced with crushed granite and compacted to a high density by means of a mechanical vibrator, have been laid in certain cities in Texas. This method of road building was described by Mr. R. D. Stubbs, contracting engineer, of Dallas, in a paper presented at the ninth annual convention of the National Association of Cement Users at Pittsburgh. A summary of the paper is given below.

Concrete is delivered to the subgrade, after it has been properly shaped and rolled, by inclined chutes from a mixer. The proportions are 1 part Portland cement and 5 parts of aggregate, consisting of sharp sand and gravel. The amount of coarse aggregate passing a ¼-in. sieve should not exceed 40 per cent. nor be less than 33 per cent. The mix is made rather wet.

The surface is brought to the desired shape by means of long-handled floats, and is immediately covered with a coating of crushed granite, graded from ⅝ to 1¼ in. in size. The surface is then ready for the vibratory treatment. Platforms 20 in. wide, made of ⅝ x 4-in. strips, cleated ¼ in. apart, are then placed along or across the street and a movable vibrator is rolled over the road, compacting the concrete to a high density. As the work progresses the platforms are brought forward and the granite surfacing behind is immediately covered with sharp sand and watered. Two or three days later the sand is swept off the surface into the gutter with stiff wire brooms and the street surface is treated with Tarvia. Upon the Tarvia is spread a coating of hard stone from ¼ to ⅜ in. in size. Upon this surface is spread the sand formerly swept into the gutter. The surface is then rolled with a 500-lb. road roller and after the work is seven days old the street is opened to traffic.

Mr. Stubbs states that he employs no bituminous filled joints for the expansion of the pavement, but he does provide for contraction while the concrete is setting by placing on edge on the subgrade at intervals ¼ x 3-in. wooden strips so that these will be buried in the concrete and will occupy the bottom half of the cross section. Within 48 hours after the concrete has been laid, according to Mr. Stubbs, thin, straight lines of relief will appear over the breaker strips. These thin relief lines never exceed 1/16 in. in width. Mr. Stubbs advocates the use of these relief joints only in the case of very dense concrete, but in the case of poured concrete not compacted by vibration he does not favor their use.

THE PRESERVATION OF WOOD BY THE POWELL PROCESS.

Archæologist reports often make mention of the various tactics employed by the ancients in their endeavors to preserve wood, and especially wood that was underground. Probably the Romans brought this art to the highest state of perfection recorded in ancient writings, and this they did by charring the wood on the surface before its interment. Some buried work of the Romans has been unearthed in England after 2,000 years and found to be unaffected. This system is very good for woodwork that is hidden, but for exposed sections is not practical; thus the many preservatives now employed have been introduced with a view of preserving woods employed in the modern arts. One of the methods now being given considerable publicity in England is known as the Powell Wood Process, and is dependent on its working to a discovery made in 1902, when it was found that saccharine matter was a very desirable wood preservative.

The process consists essentially in treating the wood in a saccharine solution, for which wood has a decided affinity. The solutions vary in composition, and to them are added certain other substances to suit the special purpose for which the wood is required. When the wood has been specially dried the process is complete, and the wood is ready for immediate use.

The requisite plant consists of open tanks of suitable dimensions, heated by steam pipes; drying chambers; storage tanks for holding the liquor; trollies, etc.

The timber is not subjected to any external pressure or vacuum at any stage of the process. The wood is immersed in a solution in open tanks. This solution is gradually raised to specific temperatures for certain periods, depending on the size and density of the wood. When the process is completed the wood is removed and placed in a drying chamber. When sufficient desiccation has taken place the wood is ready for use.

The time occupied in the whole treatment, including drying, is in general a few days, though in special cases and for large-sized timber it may be extended to three or four weeks.

The action which takes place is as follows: As the temperature of the solution in which the wood is immersed is raised, the air in the wood expands and the greater portion escapes in a series of bubbles. As a saccharine solution boils at a slightly higher temperature than water, the moisture in the wood is gradually converted into vapor and escapes along with the air. During the treatment the albuminous matter in the wood is coagulated and rendered inert. In some measure this coagulation accounts for the strength of the wood being increased by the process. During immersion, and especially while cooling, the solution is readily absorbed by the wood and penetrates to every part of it.

When the process is completed it is found that the absorbed saccharine matter has been thoroughly assimilated by the tissues, and is invisible either as crystals or syrup, but chemical analysis shows its presence in the tissues, and that it is held in molecular combination with the cellular fibres of the wood.

Complete impregnation of all wood with sacharine matter is effected by this process, though some woods absorb the solution more readily than others, a heavy, close-grained wood taking longer to treat than one with an open grain. The sacharine matter, however, penerates even the hardest woods without pressure of any kind.

"The question whether the timber is impregnated throughout by this process is a most important one. From records to hand it seems that it is so, especially in the case where moderate sized scantlings have been treated."

The cost of treatment is low. For railway sleepers, paving blocks, pier piles and constructional timber generally Powellizing, from the viewpoint of cost, commands every consideration. The process has been used to a considerable extent in the treatment of railway timbers in India and Australia, where it has been found to preserve the sleepers from dry-rot and the attack of insects. A report was made following an examination of several Powellized sleepers, a portion of which reads as follows:—

	Powellized Sleepers			Untreated Sleepers		
No.	No. laid down	Date of laying in open line	Present Condition	No. laid down	Date of laying in open line	Present Condition
1	10	March, 1908	10 still left: cracking a little on top.	10	15th Apl., 1907	1 removed in July, 1910; 2 in 1911-12; 7 cracking,
2	10	Do.	10 still left; much cracked above; good underneath.	10	Do.	1 removed in 1909; 9 fair cracking rather badly.
3	10	Do.	10 still left; 1 may have to be removed this year; 9 cracked beginning from ends, otherwise fair.	10	Do.	1 removed in July, 1910; 3 in 1911-12; 6 gone badly underneath.
4	10	Do.	1 removed in 1911-12; 1 may have to be removed this year; 3 cracking from outside; 5 fair.	10	Do.	All removed in 1909. (Experiment closed.)
5	10	Do.	All good; slight cracking.	10	Do.	1 removed in 1911-12; 1 may have to be removed this year; 8 very much cracked.
6	9	Sept., 1907	1 removed in 1909 and 1 in 1911-12; 7 still serviceable.	10 1	January, 1907 Sept., 1907	4 rem'v'd in 1908 and 7 in 1909. (Experiment closed in 1909.

The Powell Wood Process Syndicate, Limited, of 718 Salisbury House, London Wall, London, E.C., hold the patent rights to the Powell Wood Process.

PULP AND PAPER MAGAZINE OF CANADA.

The New Year number of this magazine, published by the Industrial and Educational Press, Limited, Toronto, has just come off the press in its enlarged size, and will hereafter appear twice a month, instead of monthly, as formerly. This is the first number from the pen of the new editor, A. G. McIntyre, formerly chemical engineer for Price Bros. & Co., Limited. Mr. McIntyre is a graduate of Acadia University in Arts and Science, and McGill University in Chemical Engineering, and joins this magazine after a wide engineering and paper mill experience.

The year's progress and development are fully reviewed in this number, and many valuable articles are contributed.

Mr. H. S. Ross, K.C., of Montreal, writes an able and exhaustive resume of the Workmen's Compensation Act of Quebec, with references to those of other countries.

The new mills of Price Bros. & Co., Limited, are fully described in an elaborate illustrated article by the editor. The new development of utilization of wood waste for gas producers is discussed by E. B. Archibald, B.Sc., of Montreal.

The Canadian water powers, timber regulations, pulp and paper tariffs, exports and imports, and the entire condition of the trade and its many ramifications are thoroughly dealt with. All this, with the numerous specially contributed technical articles for pulp and paper mill men, combine to make the Pulp and Paper Magazine a true fulfilment of its heading, "A magazine devoted to the science and practice of the manufacture of pulp and paper, with up-to-date news of the allied trades."

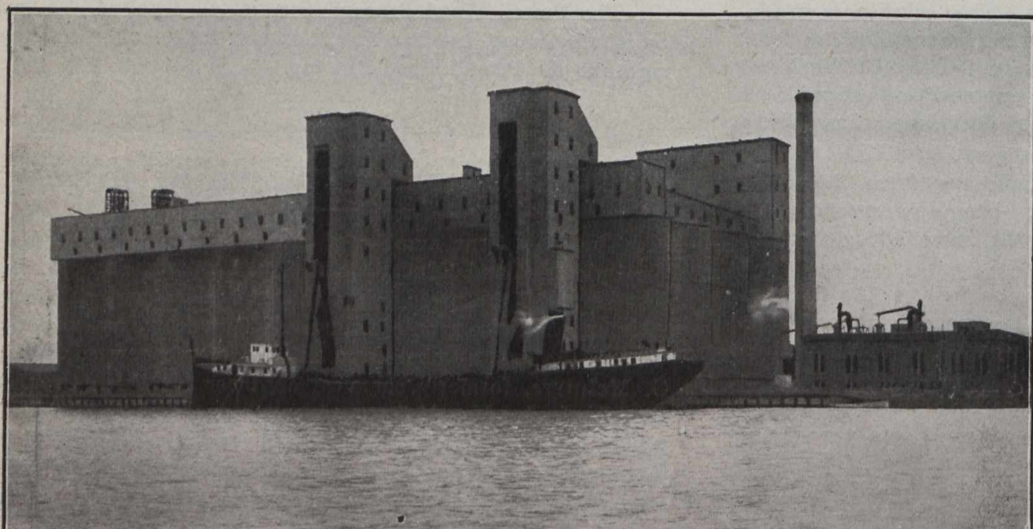
FOUR MILLION BUSHEL ELEVATOR AT PORT McNICHOLL, ONTARIO.

Some time ago we described and illustrated a 2,000,000-bushel elevator which was completed in 1910 by the John S. Metcalf Company, Limited, Montreal and Chicago, for the Canadian Pacific Railway at their new Georgian Bay terminal, Port McNicoll, Ontario. The business proved too large for the elevator by the time the latter had been in operation one year only; and the same engineers were accordingly instructed to build an additional storage unit of the same capacity as the original elevator, making the total capacity 4,000,000 bushels.

The new storage unit, which was completed in time to be entirely filled with the 1911 crop before the close of lake navigation, is a duplicate of the first. It is 179 feet wide, and 226 feet long, making the new length of the elevator 452 feet. Each unit contains 32 cylindrical bins 32 feet 11 inches in diameter, and 31 interspace bins; the bin walls are 80 feet high.

The entire structure is of steel and concrete. The two marine towers, which travel alongside the original elevator, fill the new storage in the same manner as they filled the first unit. The longitudinal conveyers receiving from the marine towers run the entire length of the two units. Grain for shipment from the new portion is conveyed through the basement of the first storage to the car-shipping house.

All machinery is electrically driven, power being generated in a steam plant built in connection with the original elevator.



View of Grain Elevator at Port McNicoll.

The work of the John S. Metcalf Company, Limited, for the Canadian Pacific Railway at this point includes: Two travelling marine towers, capacity 20,000 bushels per hour each; a 4,000,000 bushels fireproof storage; one car-shipping house, 200 cars in 10 hours; a 1,500 h.p. power plant; about 1⅓ miles of wharves; a flour shed, 700 feet long; a freight shed, 700 feet long; customs house; carpenter shop; coal platform; sleeping house for freight porters; eating house for freight porters; pump house; water system for fire protection and general supply.

For the railroad the work has been under the direction of Mr. J. M. R. Fairbairn, assistant chief engineer, and Mr. C. W. P. Ramsey, engineer of construction.

ELECTRIC STEEL REFINING.

A paper read by Dr. Paul Heroult at the recent International Congress of Applied Chemistry, at New York, pointed out that the electric steel furnace has now reached a point when the reduction of costs depends entirely on improvements in detail, both in furnace construction and manipulation. In Europe the process was developed more for the high-priced steels, but in the United States the principal problem has been that of making rails. At the present time the application of the electric furnace for the manufacture of intermediate steel and all qualities of alloy and special steels is established. By the use of the electric furnace the quantity of blowholes and waste can be reduced to a minimum, and saving in the cost of machine work alone would justify paying a very much higher price for electric steel castings, if this were necessary. In the case of many low-carbon high-quality castings made in the electric furnace, it is unnecessary to anneal them, which makes an additional saving in the cost of manufacture. The following tests were given for ordinary mild-steel castings from an electric furnace:—

Test No.	Mn. area. Sq. in.	Reduction of area. Per cent.	Elastic limit per sq. in. Lbs.	Ultimate strength per sq. in. Lbs.	Elongation, Dia. ½ in.
36,138	0.2454	39.5	45,696	71,456	3-in.—28.75%
36,139	0.2359	53.2	33,376	63,616	3-in.—35.00%
					2-in.—34.00%

Analysis.—Carbon 0.12%. Mn. 0.40%. Si. 0.20%. Sulphur and phosphorus below 0.02%.

From these figures it will be seen that it is possible to make a mild-steel casting comparing favorably with plate steel.

Another application of the electric furnace which is of great importance to manufacturers of alloy steel depends upon the fact that any quality of scrap can be worked up and the valuable metals retained. Thus, for example: It is not common in practice to melt up charges of miscellaneous tungsten steel including various tools, turnings, hammer scale and "spillings" from crucibles, all of which contain a certain quality of tungsten. Such a charge can be melted up and the necessary additions made to bring the composition up to the required specification. Chrome, nickel, and vanadium steels for automobile work may also be made in this way in the electric furnace by melting up miscellaneous scrap.

Two years ago it was considered good practice to melt and refine steel scrap in six hours at a power consumption of 750-kw.-hours per ton, whereas at present furnaces are working steadily carrying out the same operation in four hours at a power consumption of under 600-kw.-hours over periods of six months. Similar reductions in operating expenses have been made in all other details.

In this issue will be found the index to *The Canadian Engineer* for the past six months. Attention is drawn to this.

ESSENTIALS OF MACADAM ROAD MAINTENANCE.

W. Huber, B.Sc.

Eternal vigilance is the price of a good permanent macadam road. No matter how much care may be exercised in building it, no matter what the quality of the material used, it can be considered at best but a temporary solution of the good roads problem if at the time of building or immediately thereafter proper provision is not made for its systematic maintenance.

The proper and most economical time to commerce the maintenance of this class of road is the day it is opened to traffic. No stone used on road construction is absolutely homogeneous, no bottom is absolutely uniform in its bearing power, and, therefore, no two consecutive sections of road can be considered to have absolutely the same strength. Curious as it may seem, ordinary traffic will sometimes show up small weak spots in a road bottom over which the roller passed showing no indication of their existence, the result of which will probably be a small rut—a rut, perhaps, too small to inconvenience traffic or even to be noticeable to a person driving over it, yet large enough to collect water and soften the surrounding roadway.

Assuming that the road has been properly constructed, i.e., with well compacted sub-grade, properly under-drained, the drains running to free outlets, side-ditches carefully constructed, the road properly crowned and the metal properly bound, the idea of maintenance is to maintain these ideal conditions. As the stability of the new road is in so large a measure influenced by the facilities for drainage supplied, so will the durability of the road depend largely upon the care with which these drainage facilities are maintained. The principal work of the man on maintenance will, therefore, be to keep the drainage both above and under the road as perfect as when it was first constructed. This includes keeping the road well crowned, the sides clean and sloping to the ditches, the side-ditches open and their outlets free, drain and culvert openings clean, and ruts and depressions filled immediately they become noticeable.

The amount of work required in such maintenance will depend, of course, on several factors—quality of material used in construction, nature and amount of traffic, nature of soil, grades, climate, weather, etc.

The system of maintenance should be as simple as possible and not more than two men should be concerned in the work of any one section, viz., the road superintendent and the man actually engaged in the work. Regarding the latter, it is true, as in many other cases, that it pays to have a first-class man, even at a rate of pay higher than paid to one of mediocre ability. He must be a man who can understand the principles on which roads are built for permanency, and who can reason for himself. A man at this work will often be working for days at a time without direct supervision, and he must be a man who can be trusted to do his work and who can also be trusted to find work for himself. A man of this description will save the road superintendent many gray hairs, and will leave him time to devote to his heavier problems.

The equipment required for road maintenance other than complete re-surfacing is simple—a pick, a shovel, a wheelbarrow, a fairly heavy tamping-iron, and a pail being all that is required. There should also be deposited at short intervals on the road-side, small piles of crushed stone and grit. For small repairs the stone may be somewhat finer than the regulation two-inch size used in construction. From one to one and a half-inch will be found most satisfactory. The grit for repair work should be selected for its cementing quality, even more than in construction work. For this work it will be found profitable to secure and store a car of the very best grit obtainable, even at a higher price and freight rate than ordinary grit.

The length of road which one man can properly look after varies with local conditions, but ordinarily a single man can keep from four to six miles in good repair. If it is found that he cannot keep up with the work, his section should be shortened, rather than another man added, as it is found the most economical work is done by men working singly.

The best time for examining the entire length of a section is just after a rain. This will show up all ruts and other depressions, and also any obstructions or lack of grade in side ditches, drains and culverts.

The best method for filling ruts and low spots in the surface is to pick the stone loose in and for several inches around the depression, add a little fresh stone and grit, wet it, and tamp thoroughly. It may be found that traffic will disarrange the stone somewhat, but if it is gone over a few times at intervals of a day or so it will be found to have set and become an integral part of the road, and, if the work has been carefully done, indistinguishable from the remainder of the road. These small depressions should be remedied as soon as they appear, remembering that each one forms a basin for the collection and retention of water which in turn softens the road. This work all resolves itself into an attempt to keep the surface drainage perfect.

Another cause of trouble in macadam roads is the allowing of the earth sides to become cut up and become higher than the edge of the stone, thus impounding water that would otherwise run off. These earth shoulders should be kept trimmed below the level of the stone. In this connection an occasional trip over the road with a split-log or plank drag will be found economical. This will necessitate the hiring of a team for an occasional day, but the expenditure will be well justified, and it will be found that the longer this practice is continued, the less dragging will be required, as the surface of the earth shoulder will become hard, smooth and impervious to water and able to support traffic almost as well as the stone section. In fact, this part of the road, where this method has been followed, is in dry weather often preferable for driving to the macadam section.

The remaining most important part of the maintenance man's work is the keeping of all ditches and drain and culvert outlets open. This work will be heaviest in the spring and fall, when ditches tend to become clogged with leaves and other debris. During the winter special pains must be taken to keep all these water-courses in first-class working order, bearing in mind that the principal idea in winter is to have a course ready for the water as soon as the snow starts to melt. In this as in other work it is easier and cheaper to anticipate trouble than to remedy it after it occurs.

These few points, then, comprise what seem to be the essential features in Macdam Road Maintenance, and if they can be put any more briefly, may be stated as follows:

Start maintenance as soon as the road is built.

Put a good man at the work.

Keep both stone and earth sections smooth and properly crowned.

Remove every obstruction to water running off and from under the road both in summer and winter.

And, lastly, and most important of all—keep eternally at it.

WINNIPEG BUILDERS' EXCHANGE

At the annual meeting of the Winnipeg Builders' Exchange, the financial report of the secretary, Mr. A. M. Rose, showed the exchange to be in flourishing condition. The election of officers resulted in the re-election of Mr. W. J. Davidson as president; Mr. F. Hinds, 1st vice-president; Mr. J. McQuarrie, 2nd vice-president; Mr. Thomas D. Robinson, treasurer; and the following to the board of directors: Messrs. W. P. Alsip, J. W. Morley, H. C. McMartin, and R. W. Paterson. The board is composed of twelve members, four retiring each year.

OIL FOR MACADAM ROADS.

Automobile traffic has revolutionized our ideas of permanent road construction. Whereas a dozen years ago a well-constructed waterbound macadam road was considered about as permanent a road as could be desired for country traffic; with the constantly increasing use of the high-speed rubber-tired automobile, such roads have in many cases disintegrated faster than they could be maintained.

It has been clearly demonstrated that the bond in ordinary macadam road is insufficient to protect it against the somewhat complex action of the automobile tire travelling at high speed. The dust raised by this class of vehicles is blown entirely off the road and a fresh lot of dust raised; this repeated action resulting in the wearing down of the road surface, in some cases several inches in a single season.

While oiling a road is not considered a permanent remedy for this disintegration, it serves to keep the dust down, thus preventing the next lot of dust being raised, and by this means temporarily preserving the road. There are many varieties of oil on the market for this purpose, some of which are little better than water, while others, having a bituminous base, on the evaporation of the volatile constituents, leave a certain amount of bitumen to act as an aid to the binder in the road. This bituminous residue is increased at each successive application, so that as time passes the applications may be made fewer and lighter.

The cost per year of applying oil at current prices, amounts to from eight to fifteen per cent. of the original cost of the road if built by day labor, or from five to ten per cent. if built by contract. This expenditure will be well repaid in the elimination of the dust nuisance and the decreased cost of maintenance, as well as in the increased life of the road.

Cost, per application, of oiling one mile of road, of different widths with varying quantities of material.

Oil, 7½ cents per gallon.

Cost of application, $25.00 per mile.

Width of Road	Square yards per mile	¼ gallon per square yard	½ gallon per square yard	¾ gallon per square yard	1 gallon per square yard	1¼ gallons per square yard
10ft.	5,867	$135	$245	$355	$465	$ 575
12	7,040	157	289	421	553	685
14	8,213	179	333	487	641	795
16	9.387	201	377	554	729	905
18	10,560	223	421	619	817	1,015
20	11,733	235	465	685	905	1,125

Oil, 8½ cents per gallon.

Cost of application, $25.00 per mile.

Width of Road	Square yards per mile	¼ gallon per square yard	½ gallon per square yard	¾ gallon per square yard	1 gallon per square yard	1¼ gallons per square yard
10ft.	5,867	$150	$275	$400	$525	$ 650
12	7,040	175	325	475	625	775
14	8,213	200	375	550	725	900
16	9,387	225	425	625	825	1,025
18	10,560	250	475	700	925	1,150
20	11,733	275	525	775	1,025	1,275

Ordinarily the following applications will suffice:—

FIRST YEAR—First application, ½ gallon per square yard.
Second application, ¼ gallon per square yard.

SUBSEQUENT YEARS—Two applications, each ¼ gallon per square yard.

LUBRICATION OF STREET RAILWAY RAILS.

Water lubrication of street railway rails has been in use for some time on a street in Rome, Italy, carrying heavy traffic. The street is on steep grade and has numerous curves. At the top of the slope a stream of water is fed into each of the four rails of the double track line and flows downhill along the groove of the rail. Every 20 to 30 inches a small wooden block is wedged in the groove, reaching up to wheel flange level, to break the flow of the water. It is reported that cars ride very smoothly on this lubricated track and the grinding noise of cars rounding curves is practically eliminated, while also the general noise of the car traffic is reduced. Grease lubrication at curves is rendered unnecessary.

SMALL WATER POWER WANTED.

A subscriber would like full particulars, with price, of small water powers of about 2,000 horse-power. A firm of carbide manufacturers desires this information. Those interested are invited to correspond with the managing director of The Canadian Engineer.

The Canadian Northern Railway have just signed contracts with builders of rolling stock all over Canada for seven million dollars worth of railwav equipment to be delivered during 1913. This will include 130 locomotives, 76 passenger coaches, 300 box cars and variety of other cars. Equipment bonds will be issued for the purpose.

COSTS OF MACADAM ROADS OF DIFFERENT THICKNESSES.

Cost of building one mile of Waterbound Macadam Road of various widths and depths, Comparison of Day Labor and Contract Figures.

Day Labor prices based on the following data:
Cost of labor, 20c. per hour,
Cost of teams, 50c. per hour.
Cost of stone, $1.30 per ton, F. O. B.; $1.69 per cubic yard.
Weight of 1 cubic yard of Stone, 2,600 lbs.
Average wagon haul, 1 mile. For longer hauls add 25c. per cubic yard a mile.
Total cost in each case includes grading and shaping of road bottom.

MACADAM ROAD, 5 INCHES THICK

Width of Road.	Cubic Yards ot Material	Day Labor			Contract Prices Including Grading	
		Cost of Material	Cost of Labor and Teams Including Grading	Total Cost	Cost at Lowest Contract Price	Cost at Highest Contract Price
10 ft.	1,000	$1,690	$1,100	$2,790	$4,920	$5,140
11	1,100	1,860	1,210	3,070	5,280	5,520
12	1,200	2,030	1,320	3,350	5,640	5,900
13	1,300	2,200	1,430	3,630	6,000	6,280
14	1,400	2,370	1,540	3,910	6,360	6,660
15	1,500	2,540	1,650	4,190	6,720	7,040
16	1,600	2,710	1,760	4,470	7,080	7,420
18	1,800	3,050	1,980	5,030	7,800	8,180
20	2,000	3,390	2,200	5,590	8,520	8,940
22	2,200	3,730	2,420	6,150	9,240	9,700
24	2,400	4,070	2,640	6,710	9,960	10,460

Day Labor unit prices:
Per square yard, 47½c.
Per cubic yard, $2.79.

MACADAM ROAD, 6 INCHES THICK

Width of Road	Cubic Yards of Material	Day Labor			Contract Prices Including Grading	
		Cost of Material	Cost of Labor and Teams Including Grading	Total Cost	Cost at Lowest Contract Price	Cost at Highest Contract Price
10 ft.	1,200	$2,000	$1,200	$3,200	$5,640	$5,904
11	1,320	2,200	1,320	3,520	6,072	6,362
12	1,440	2,400	1,440	3,840	6,504	6,820
13	1,560	2,600	1,560	4,160	6,936	7,279
14	1,680	2,800	1,680	4,480	7,368	7,737
15	1,800	3,000	1,800	4,800	7,800	8,195
16	1,920	3,200	1,920	5,120	8,232	8,654
18	2,160	3,600	2,160	5,760	9,096	9,573
20	2,400	4,000	2,400	6,400	9,960	10,492
22	2,640	4,400	2,640	7,040	10,824	11,411
24	2,880	4,800	2,880	7,680	11,688	12,330

Day Labor unit prices:
Per square yard, 54½c.
Per cubic yard, $2.67.

MACADAM ROAD, 7 INCHES THICK

Width of Road	Cubic Yards of Material	Day Labor			Contract Prices Including Grading	
		Cost of Material	Cost of Labor and Teams Including Grading	Total Cost	Cost at Lowest Contract Price	Cost at Highest Contract Price
10 ft.	1,400	$2,333	$1,300	$3,633	$6,360	$6,668
11	1,540	2,567	1,430	3,997	6,864	7,202
12	1,680	2,800	1,560	4,360	7,368	7,737
13	1,820	3,033	1,690	4,723	7,872	8,272
14	1,960	3,267	1,820	5,087	8,376	8,807
15	2,100	3,500	1,950	5,450	8,880	9,342
16	2,240	3,733	2,080	5,813	9,384	9,877
18	2,520	4,200	2,340	6,540	10,392	10,947
20	2,800	4,667	2,600	7,267	11,400	12,017
22	3,080	5,133	2,860	7,993	12,408	13,087
24	3,360	5,600	3,120	8,720	13,416	14,155

Day Labor unit prices:
Per square yard, 62c.
Per cubic yard, $2.59.

MACADAM ROAD, 8 INCHES THICK

Width of Road	Cubic Yards of Material	Day Labor			Contract Prices Including Grading		
		Cost of Material	Cost of Labor and Teams Including Grading	Total Cost	Cost at Lowest Contract Price	Cost at Highest Contract Price	
10 ft.	1,600	$2,667	$1,500	$4,167	$7,080	$7,432	
11	1,760	2,933	1,650	4,583	7,656	8,043	
12	1,920	3,200	1,800	5,000	8,232	8,654	
13	2,080	3,467	1,950	5,417	8,808	9,265	Day Labor unit prices :
14	2,240	3,733	2,100	5,833	9,384	9,876	Per square yard, 71c.
15	2,400	4,000	2,250	6,250	9,960	10,487	Per cubic yard, $2.61.
16	2,560	4,267	2,400	6,667	10,536	11,098	
18	2,880	4,800	2,700	7,500	11,688	12,320	
20	3,200	5,333	3,000	8,333	12,840	13,542	
22	3,520	5,867	3,300	9,167	13,992	14,764	
24	3,840	6,400	3,600	10,000	15,144	15,982	

MACADAM ROAD, 9 INCHES THICK

Width of Road	Cubic yards of Material	Day Labor			Contract Prices Including Grading		
		Cost of Material	Cost of Labor and Teams including grading	Total Cost	Cost at Lowest Contract Price	Cost at Highest Contract Price	
10 ft.	1,800	$3,000	$1,700	$4,700	$7,800	$8,197	
11	1,980	3,300	1,870	5,170	8,448	8,884	
12	2,160	3,600	2,040	5,640	9,096	9,571	
13	2,340	3,900	2,210	6,110	9,744	10,259	
14	2,520	4,200	2,380	6,580	10,392	10,946	Day Labor unit prices :
15	2,700	4,500	2,550	7,050	11,040	11,634	Per square yard, 80c.
16	2,880	4,800	2,720	7,520	11,688	12,322	Per cubic yard, $2.61.
18	3,240	5,400	3,060	8,460	12,984	13,697	
20	3,600	6,000	3,400	9,400	14,280	15,072	
22	3,960	6,600	3,740	10,340	15,576	16,447	
24	4,320	7,200	4,080	11,280	16,872	17,822	

MACADAM ROAD, 10 INCHES THICK

Width of Road	Cubic yards of Material	Day Labor			Contract Prices Including Grading		
		Cost of Material	Cost of Labor and Teams including grading	Total Cost	Cost at Lowest Contract Price	Cost at Highest Contract Price	
10ft.	2,000	$3,380	$1,850	$5,230	$8,520	$8,960	
11	2,200	3,720	2,035	5,755	9,240	9,724	
12	2,400	4,060	2,220	6,280	9,960	10,488	
13	2,600	4,400	2,405	6,805	10,680	11,252	
14	2,800	4,740	2,590	7,330	11,400	12,016	Day Labor unit prices :
15	3,000	5,080	2,775	7,855	12,120	12,780	per square yard 95c.
16	3,200	5,420	2,960	8,380	12,840	13,544	per cubic yard $2.61
18	3,600	6,100	3,330	9,430	142,80	15,072	
20	4,000	6,780	3,700	10,480	15,720	16,600	
22	4,400	7,460	4,070	11,530	17,160	18,128	
24	4,800	8,140	4,440	12,580	18,600	19,656	

N.B.—These day labor prices do not allow anything for depreciation of plant, management or capital investment.

WATERPROOF CONCRETE.

Some experiments on impervious concrete were made at Husum, Germany, recently in connection with preparations for the construction of a new lighthouse. Various mixtures of cement and fine dune sand in ratios 1:1 up to 1:6 and mixtures of 1:3 with the addition of various waterproofing material such as soft soap, oil and patented mixtures were prepared and were molded into pot-shaped vessels about 15 inches high, with 2½-inch walls. When these pots had set, some of them were filled with water, others (empty) were set into water; and the density of the walls was judged by noting the time required to empty or fill, the water acting under a maximum head of about 10 inches. The experiments showed that a satisfactory degree of imperviousness was not reached, since in every test the vessels filled or emptied within an hour. The relative success of the richer mixtures then induced tests of rich rubbed surfacing. To this end the surfaces were first wet, then thickly coated with cement paste, and with a soft brush the cement paste was then rubbed into the surface of the concrete. Repeating this procedure several times until the pores were closed, a very satisfactory imperviousness was reached, the pressure tests (as above) continued for three days showing no water passing through the walls of the pots. On the basis of these tests it was decided to build the lighthouse substructure of a 1:3 mixture with surface made impervious by the grout-rubbing process as used in the experiments.

EARTH AND GRAVEL ROADS.*

By Robert C. Terrell.†

Earth roads must be well drained and properly crowned, in order to be serviceable at all times. The maintenance of a road thus constructed is comparatively easy and not very expensive if the work is done at the proper time, but good drainage is very costly, if not altogether impossible, unless the road is properly located. A road, in order to be properly drained, must have the proper longitudinal grade; a minimum grade of ½ of 1 per cent., with a maximum grade, generally, of 5 per cent. The minimum grade is necessary in order to give the side ditches the proper amount of fall to carry the water quickly away from the road. Side ditches should never be made deep and narrow. If extra drainage is necessary, roads should be undertaken by use of tile or by excavating a deep ditch and filling with large stones. Where roads are located along side hills a ditch should be dug on the upper side sufficient to take all the water coming down the hill. Where the grade exceeds 5 per cent., the ditch should be paved with stone and the water should be carried under the road from the upper side at short intervals and disposed of.

If the road has been properly located and properly drained, the point of most importance is the crown; the parabola form is the best, having a centre elevation equal to 1/24 of the width of the road. Frequent causes of mudholes are the unevenness in the texture of the soil and the combining of vegetable matter with the soil while working the roads; this vegetable matter holds water, thus damaging the surface. In no case should stone be piled into a mudhole, as it only forms a rough and unsatisfactory surface and permits the formation of mudholes at either end from the impact of loaded vehicles. The road, however, can be successfully repaired by the removing of the softer soils, or soils containing vegetable matters, and replacing with clay, or soil of the same consistency as the remaining portions of the road, and by removing the shade, so that the sun may have free access to that portion of the road.

Earth roads should have their principal working in the spring of the year when the soils will work most readily and will have time to become consolidated before the fall rains begin. A scraping-grader drawn by a traction engine will do excellent work in giving a road sufficient crown. The earth removed from side ditches should not be thrown into the centre of the road.

In the construction of the gravel road, beginning with the sub-grade, it is probably best to open the trench to receive the gravel, giving it the same crown or cross section as the finished roadbed should have, which should be a parabola, with the centre height equal to 1/40 of the width of the road. Gravels containing clay or sand, or even loam, not exceeding 20 per cent. of the entire quantity, make excellent road material and will bind or compact very readily. After the gravel has been properly placed on the sub-grade it should be thoroughly sprinkled and rolled. In western Kentucky gravel roads cost approximately $1,000 per mile. In eastern Kentucky the cost is slightly higher.

In my opinion the maintenance of earth and gravel roads will never be effectively accomplished until we receive government aid for all post roads and until every road becomes a post road. I do not mean, however, by "government aid" that the government shall bear the entire or major portion of the expense of constructing and maintaining roads, but that the government will merely assist in the construction and maintenance of roads to such an extent as will enable the government to direct the local authorities how the work must be done before the federal aid is available, and then that these roads be put under direct government inspection by making each and every rural mail carrier the inspector of his route, reporting deficiencies in the road as they occur to the local authorities and to make reports to the federal government once each month as to the condition of the road.

* Abstract of paper delivered to American Road Builders' Association, at Cincinnati, December 3 to 5, 1912.

† Commissioner, State Department of Public Roads, Kentucky.

CANADA IMPORTS MUCH CLAY.

Canada's clay imports are classified by the department of customs under three main subdivisions: clays, brick and tile, and earthenware and chinaware, and their total value is shown as $5,156,544, or 62 per cent. of the domestic production, in the annual report of Mr. J. McLeish, B.A., chief of the division of mineral resources and statistics. The imports of clays in 1911 were valued at $270,247, and included chiefly china clay and fire clay, with a small quantity of pipe clay, and others clays not classified. The value of china clay imports was $125,768, and of fire clay, $125,199.

The imports of these clays have varied considerably from year to year, and do not show the same general increase as do the imports of manufactured clays. The imports classified under brick and tile were valued in 1911 at $2,369,761, of which about 34 per cent. was firebrick, other important items being building brick, sewer pipe, and paving brick.

There was also an importation under this class of manufactures of clay not specifically designated, valued at $523,998. The imports of these "unclassified" brick and tile have increased steadily year by year, the value of such imports in 1905 having been only $20,804. The total imports of brick and tile in 1910 were valued at $1,755,773, showing an increase in 1911 of about 35 per cent.

The imports of earthenware and chinaware, of which the most important class is tableware, were valued in 1911 at $2,516,536, as against $2,283,116, an increase of about 10 per cent.

There is also a considerable annual importation of "chalk, china or cornwall stone, cliff stone and feldspar, fluorspar, magnesite ground or unground," much of which is no doubt used in connection with the manufacture of clay products.

The value of these imports during 1911 was $147,640; of which $90,119 was from the United States, $54,548 from Great Britain, and $2,973 from other countries. The value of the imports under this item during the calendar year 1910 was $121,959.

There is also an annual importation of "baths, bath tubs, basins, closets, lavatories, urinals, sinks, and laundry tubs of any material," the value of such imports during 1911 being $285,847, as compared with $262,667 during the year 1910.

Imported clay products are derived chiefly from Great Britain, and the United States, although considerable quantities of earthenware, china, and porcelain ware, white granite or ironstoneware, etc., are brought from Germany, France, Austria-Hungary, and Japan.

Of the brick and tile imported, 76.7 per cent. was from the United States and 23.2 per cent. from Great Britain; and only $578 worth from other countries.

Of the earthenware and chinaware, 62 per cent. was imported from Great Britain; 15 per cent. from the United States; 9 per cent. from Germany; 7 per cent. from France, and considerable values also from Japan, Austria-Hungary, and other countries. The crude clays were imported principally from Great Britain and the United States.

COAST TO COAST.

Victoria, B.C.—The water report for the council of this city will be completed within a few days.

Port Arthur, Ont.—The past year has been a season of activity in the municipal engineering department, and the expense account for general work totals $584,027.

Calgary, Alta.—Colon bacilli has been found in certain sections of the water supply on this city and the medical health authorities have issued warnings to the citizens concerning the same.

Hamilton, Ont.—Mr. C. H. Mitchell, of Toronto, and Prof. Hutt, of the Ontario Agricultural College, Guelph, addressed a large gathering in this city recently on the subject "The Beautification of the Mountain Park."

Montreal, P.Q.—The Harbor Commissioners of Montreal have awarded the John S. Metcalf Company, Limited, a contract for a 1,500,000-bushel addition to the Harbor Commissioners' Elevator No. 1 at Montreal. It will be of reinforced concrete and steel and will cost approximately $700,000. This will make the capacity of Elevator No. 1, 2,500,000 bushels, as compared with 2,600,000 bushels' capacity in the new Elevator No. 2 recently completed by the John S. Metcalf Company.

Eastern Central Canada.—Col. Greenwood, assistant chief engineer of construction on the Canadian Northern's eastern lines, states that rapid progress is now being made on the company's four large bridges now being constructed between Montreal city and Pembroke, at a total cost of about $1,250,000. They are being built over the rivers Laprairie or Back River, the Mille Iles, and the Ottawa at Shaw Falls, and at Portage du Fort. All the sub-structures of these bridges are of concrete, while the superstructure will be of steel, and which will be placed in position during the coming summer. No. 1, which crosses the Back River near St. Genevieve, has eight spans, and is about 1,400 feet in length, while No. 2 has thirteen spans in all, and strikes the Mille Ile after crossing the upper end of Ile Jesu, which at this point is about one and a half miles wide. The structure at Shaw Falls will be 1,800 feet in length, and that at Portage du Fort some 1,300 feet, so, taking the whole four, they make a series of very formidable structures and will all be on the C.N.R.'s main line from Montreal to the harbor of Prince Rupert.

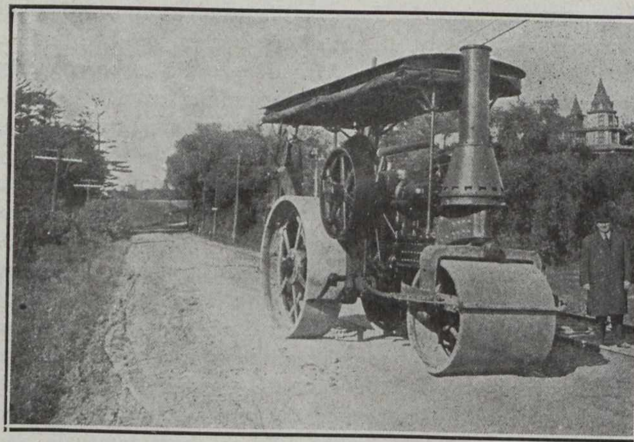
GASOLINE ROAD ROLLERS.*

As far as Ontario is concerned, Gasoline Road Rollers are an inovation in road building machinery.

When making their purchases in 1911, the Commission were recommended to purchase Steam Road Rollers. The Engineer for the Commission took the stand that the steam machines were better known and operators for steam machines could be more easily procured, and, further, that the life of the Gasoline Road Roller was not yet known.

During 1911, and the spring of 1912, all the available information on Gasoline Road Machinery was studied, and when the purchasing of machinery for 1912 was under advisement, Gasoline Machinery was carefully considered, with the result that it was decided to purchase one 12-ton 2-cylinder Gasoline Road Roller.

The advantages claimed by the sales agent for Gasoline Road Rollers are outlined in the catalogue. Amongst them may be found the absence of smoke, sparks, and the risks of boiler explosion. The expense of teams for hauling coal and water is done away with. There is a saving of an hour in the raising of steam and half an hour in closing down. There is some saving through the day, because the engineer has not to fire and take on water. Claim is made by some salesmen that the machinery is much quieter, and not so apt to scare horses on the highway and the grade, as a steam roller; but we might say that in our short experience we do not find much gain in this connection.



Double Cylinder Gasoline Roller Working on the Kingston Road.

We have now had two seasons in which to compare the cost of operation of the steam and gasoline machinery, and the following table will give the comparison of cost, as nearly as can be judged, both rollers working under similar conditions:

COST OF OPERATING STEAM ROLLER.

For Ten-hour Rolling.

Fuel—	
Kindling wood	$0.05
Coal, 380 lbs. at $6.85 per ton	1.30
Water—	
600 gallons—Hauling three hours at, per hour, 50c.	1.50
Oil, etc.	0.05
Engineer—	
11½ hours at 30 cents per hour	3.45
	$6.35
Cost of rolling, 63½c. per hour.	

For Ten Hours' Spiking and Scarifying.

Fuel—	
Kindling wood	$0.05
Coal, 480 lbs. at $6.85 per ton	1.64
Water—	
800 gallons, hauling	2.00
Oil.	0.05
Engineer—	
11½ hours at 30c.	3.45
	$7.19
Cost of spiking and scarifying, 71 9/10c. per hour.	

COST OF OPERATING A GASOLINE ROLLER.

For Ten Hours' Rolling.

Fuel—	
12 gallons of gasoline at 15c. per gallon	$1.80
Water—	
Cooling quarter hour	0.12½
Oil.	0.07
Engineer—	
10¼ hours at 30c.	3.07½
	$5.07
Cost of rolling, 50c. per hour.	

* Abstract from 1912 report of the Board of Highway Commissioners, York County, Ontario.

For Ten Hours' Spiking and Scarifying.

Fuel—	
20 gallons of gasoline at 15c. per gallon	$3.00
Water—	
For cooling	0.15
Oil	0.07
Engineer—	
10¼ hours at 30c.	3.07
	$6.29

Cost of spiking per hour, 62 9/10 cents per hour.

The saving which is shown on the work in favor of gasoline has been in its constant operations. We gain from one to two hours a day of actual operations with our gasoline roller.

When we first purchased these machines we were afraid they would be difficult to start in cold weather, but this has not been the case.

The gasoline road roller has not been in operation long enough in Canada for us to be sure of just what it will do, but the success that has accompanied the gasoline engine in other fields of operations would indicate that it could be successfully operated in connection with road roller work.

GRAND TRUNK PACIFIC CONSTRUCTION.

The work accomplished by the Grand Trunk Pacific Railway for the twelve months ended December 20th is contained in the chief engineer's annual report issued in Winnipeg. It shows that construction has been undertaken on 563 miles of main line, and on 688 miles of branch lines, making a total of 1,251 miles of line on which clearing, grading and track-laying have been done. Track has been laid on 128 miles of main line, and on 331 miles of branch lines, making a total of 459 miles of railway completed exclusive of second tracks and sidings.

On the section known as "main line Winnipeg west," grade is now completed to mile 1,124, Rau Shuswap crossing, and track should be laid to that point before the close of the year. The line is in operation from Winnipeg to Tete Jaune Cache, mile 1,095. From the Rau Shuswap crossing at mile 1,124, westerly to mile 1,403 (Endako river crossing), the right of way is being cleared and at those points where clearing has been completed, active grading operations are under way. For instance, the grade from Rau Shuswap crossing to the second crossing of the Fraser river at mile 1,190, should permit of track laying in the space of a month or two.

From Prince Rupert easterly the track is laid to mile 189, being held up at that point, owing to the erection of steel bridges. Eighty-nine miles of this track were laid during 1912, and the line is in operation to Hazelton. From mile 189 to the Endako river crossing (mile 341 Prince Rupert, or mile 1,403 Winnipeg), active grading operations are in progress.

Harte to Brandon—Grading is under way on this branch and although 10.8 miles are ready for track no steel has yet been laid. The total length of this branch is 25 miles. Regina to international boundary, only the last 19 miles of this line require to be graded. The track is laid for 106 miles, and was all put down this season.

Prince Albert Branch—This line extends from Young on the main line, and is in operation from that point to Wakaw, a distance of 67 miles. No track was laid in 1912. A large steel bridge has yet to be erected over the South Saskatchewan river, but with the exception of the entrance into Prince Albert the grade is practically completed.

Tofield to Calgary—This line is 202 miles long. A few steel bridges have yet to be erected but grading is almost completed. During 1912 steel was laid from mile 07 to mile 165.3, and the track will be continued to Calgary in the early spring of 1913. The line is in operation to mile 62.

Other branch lines reported upon are the Talmage-Weyburn line, 15 miles in length, of which 39 per cent. of the grade is completed; and the Regina-Moose Jaw connection, of 49 miles, which is now completed, and its terminals at Moose Jaw in course of construction. Grading is completed on Moose Jaw-Northwest branch, but no steel has been laid. All the track on the Oban-Battleford branch was laid during 1912, and the line, 48.5 miles in length, is now completed. The Cut Knife branch from Battleford westerly toward Wainwright is finished, so far as grading is concerned, and four miles of track are laid. Steel will be laid throughout its length in the early spring of 1913. A branch line is surveyed from Biggar to Calgary, and it is stated by the chief engineer that for the present time this line is only being constructed as far as the Saskatchewan-Alberta boundary, a distance of 104 miles from Biggar. Grading on this portion was completed in 1912, and steel is laid to mile 37. The Alberta coal branch, which extends 56 miles southerly from Bickerdike on the main line, is graded for the whole of its present length.

PERSONAL.

FRANK BARBER, consulting engineer, Toronto, has quite recovered from his recent illness, and is able to look after all his work.

O. H. HOOVER, B.A.Sc., is at present located at Moose Jaw, Sask. He has taken charge of the hydrographic work in the Moose Jaw district for the present winter.

W. K. TASKER, formerly superintendent of the Pere Marquette R.R., at Saginaw, Mich., has been made superintendent of the Canadian division with headquarters at St. Thomas, Ont.

F. A. CREIGHTON, who has been city engineer of Prince Albert, Sask., since July, 1907, tendered his resignation at the final meeting of the city council. It is probable that he will locate in private practice in Winnipeg.

PHILIP P. SHARPLES, chief chemist, Barrett Manufacturing Company, Boston, on December 30th delivered an illustrated lecture on the "Manufacture of Refined Coal Tar," before the graduate students in Highway Engineering at Columbia University.

N. H. MANNING, a graduate of the Faculty of Applied Science and Engineering, of the University of Toronto of the class of '09, is the Toronto district representative of the Canadian Inspection and Testing Laboratories, Limited, 25-27 Manning Arcade Annex.

J. W. EBER has been appointed to the position of general manager of the Toronto, Hamilton and Buffalo Railway Company. Mr. Eber was formerly general superintendent for the same company; that position is now abolished. His headquarters will be Hamilton, Ont.

JAMES B. GOODWIN, recently superintendent of construction and assistant general manager of the Mount Hood Railway and Power Company, Portland, Ore., has been appointed construction engineer for the city of Edmonton, Alberta. Edmonton proposes to do a large amount of new work in the coming year.

LIEUT.-COL. WILLIAM PATRICK ANDERSON, of the Dominion Department of Marine and Fisheries, who has just been honored by King George with a C.M.G., was born at Levis, Quebec, in 1851. He was one of the charter members and subsequently president of the Canadian Society of Civil Engineers. He was the founder of The Canada Militia Gazette, and has had a long and distinguished military service. For many years he was member and chairman of the Ottawa School Board.

OBITUARY.

MR. JOHN J. McDONALD, a former assistant engineer of Medicine Hat, Alberta, died recently in that municipality. He was 32 years of age and came to Western Canada about six years ago, and has held several important civic and government engineering positions. His home is in Glace Bay, N.S. Heart failure is given as the cause of death.

COMING MEETINGS.

AMERICAN WOOD PRESERVERS' ASSOCIATION.—Ninth Annual Convention will be held at Chicago. Jan. 21-23, 1913. Secy-Treasurer, F. J. Angier, Mount Royal Station, B. & O. R. R., Baltimore, Md.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.—Annual Meeting, January 14th, 1912, will be held at The Engineers Club, 32 West Fortieth Street, New York, N.Y. Secretary, Eugene W. Stern, 103 Park Avenue, New York.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Annual Meeting will be held on Jan. 28th, 29th, and 30th, 1913, at the Society's new headquarters, 176 Mansfield St., Montreal. Secretary, C. H. McLeod.

THE CLAY PRODUCTS EXPOSITION.—To be held in the Coliseum, Chicago, Feb. 26th to Mar. 8th.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving: Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright Secretary, Mr. Hugh B. Fergusson, 911 Rogers Building, Vancouver, B.C. Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre: Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. McMurchy; Secretary, Mr. McClung, Regina.

BRITISH COLUMBIA LAND SURVEYORS' ASSOCIATION.—President, W. S. Drewry, Nelson, B.C.; Secretary-Treasurer, S. A. Roberts, Victoria, B.C.

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.—President, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

CANADIAN CLAY PRODUCTS' MANUFACTURERS' ASSOCIATION.—President, W. McCredie; Secretary-Treasurer, D. O. McKinnon, Toronto

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler Canadian Building, Ottawa.

CANADIAN GAS ASSOCIATION.—President, Arthur Hewitt, General Manager Consumers' Gas Company, Toronto; John Kelilor, Secretary-Treasurer, Hamilton, Ont.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

CANADIAN RAILWAY CLUB.—President, A. A. Goodchild; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, J. E. Ritchie; Corresponding Secretary, C. C. Rous.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Willis Chipman; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

INSTITUTION OF MINING AND METALLURGY.—President, Edgar Taylor; Secretary, C. McDermid, London, England. Canadian members of Council:—Prof. F. D. Adams, J. B. Porter, H. E. T. Haultain and W. H. Miller and Messrs W. H. Trewartha-James and J. B. Tyrrell.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C. B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, Major. T. L. Kennedy; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

THE PEAT ASSOCIATION OF CANADA.—Secretary, Wm. J. W. Booth, New Drawer, 2263, Main P.O., Montreal.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Secretary, J. E. Ganier, No. 5. Beaver Hall Square, Montreal.

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman, Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.